OPERATION MANUAL

LAND USE GENERATOR ENGINE

AY40L-ET

(50/60 Hz switchable)

YANMAR

Thank you for purchasing
YANMAR Land Use Diesel Engine

This Operation Manual describes the operation, maintenance and inspection of the AY40L SERIES YANMAR land use diesel engine.

INTRODUCTION

- Read this Operation Manual carefully before operating the engine to ensure that the engine is used correctly and that it stays in the best possible condition.
- Keep this Operation Manual in a convenient place for easy access.
- Constant efforts are made to improve the quality and performance of YANMAR products, so some details included in this Operation Manual may differ slightly from your engine.

Please review and comply with the applicable laws and regulations of the international export control regimes at the territory or country where the product and manual are intended to be imported and used.

OPERATION MANUAL	MODEL	AY40L-ET (50/60 Hz switchable)
	CODE	0AAYL-EN0080

CONTENTS

FOR YOUR SAFETY

This manual describes the safety labels used on this product. They contain important symbols and warnings that are necessary to operate this product safely.

Safety Labels

The safety labels show the following meanings.

This safety symbol is used with most safety precautions. It says: Attention! Warning! Your safety is involved!
Carefully read and obey the safety instructions after the safety alert symbol.

⚠ DANGER — **DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING — **WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION — **CAUTION indicates a hazardous situation which, if not avoided, could result in injury.**

NOTICE — NOTICE indicates a situation which can cause damage to the engine, personal property and/or the environment or cause the equipment to operate incorrectly.

Safety Precautions

⚠ DANGER

Beware of fire

- Make sure that the type of fuel oil is correct before adding. The wrong fuel oils (e.g. gasoline) can cause fire.
- When supplying fuel oil, remove all flammables around.
- If you spill fuel, wipe it clean.
- Do not put oil or other flammable materials near the engine.

Fires from electric short-circuits

- Always turn off the battery switch or detach the earth cable (–) before you inspect the electrical system.
  If you make an incorrect connection, you can cause a short circuit and a fire.

Burns from steam

- Never remove the filler cap from the radiator while the engine is still hot. Steam and hot air will spurt out and seriously burn you. After engine stop, wait until the water temperature drops. Wrap a cloth around the filler cap and slowly loosen the cap.
- After inspection, tighten the filler cap firmly.
- If the cap is not secure, steam or hot air can spurt out during operation and seriously burn you.

⚠ WARNING

Exhaust gas poisoning

- Never cover or block the windows, air vents, fans or other ventilation devices in the engine room. Always maintain good ventilation in the engine room during operation. Breathing exhaust gas is dangerous to your health.

Moving parts

- Keep your hands, other body parts and clothing away from moving parts (e.g. the front drive shaft or V-belt). You will get caught and injured.
- Stop the engine before inspection, unless operation is absolutely necessary.
- Never operate the engine without the covers on the moving parts.

Side cover opening

- Do not open the side cover when the engine is hot. Fresh air that flows into the engine can cause an explosion.

⚠ WARNING

Alcohol and drugs

- **Never operate the engine while you are under the influence of alcohol or drugs. Never operate the engine when you feel ill or unwell.**

⚠ CAUTION

Burns

- **During operation and after engine stop, all of the engine is very hot. Be careful that you do not get burned.**
- **Keep your hands, other body parts and clothing away from the exhaust manifold, exhaust pipes, turbocharger, air cooler and engine body.**

NOTICE

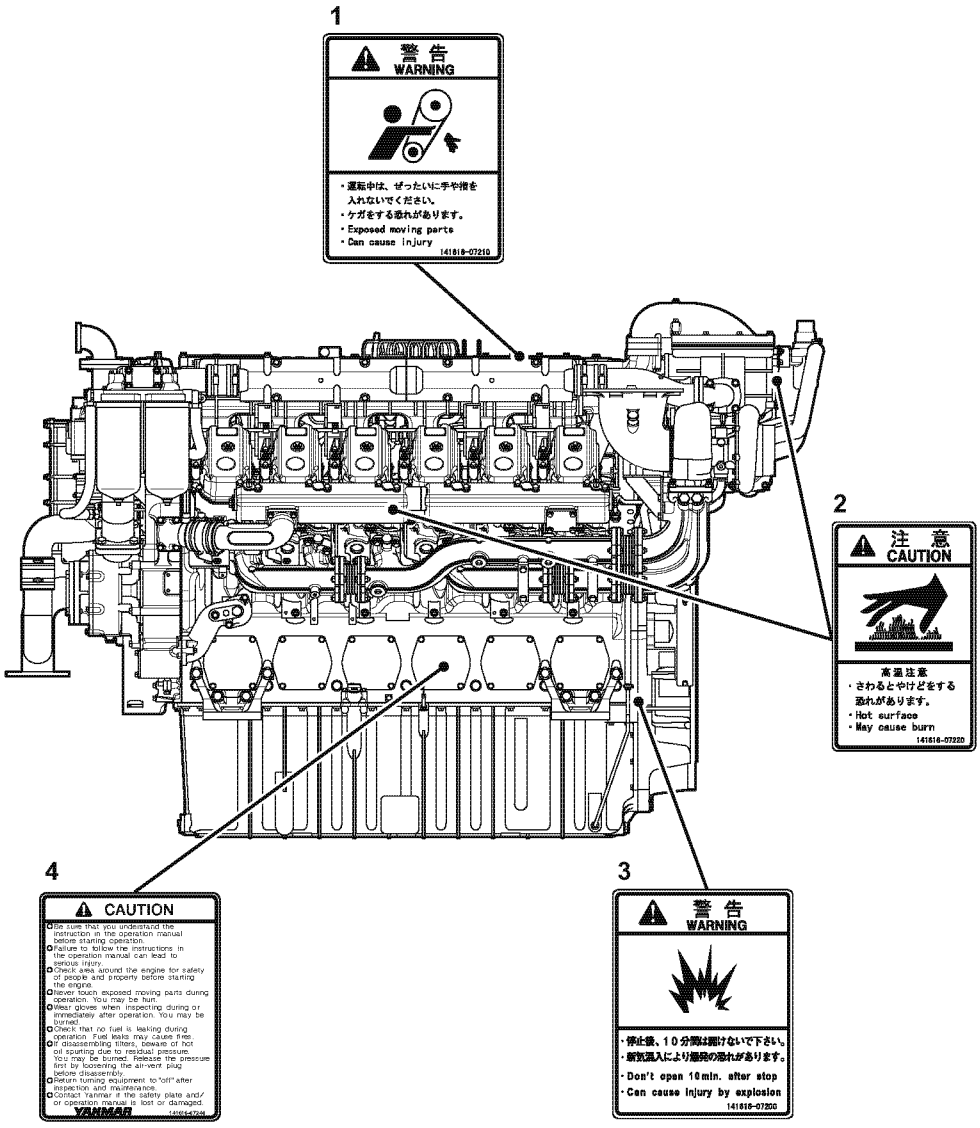
No modification

To keep the engine in good condition, the engine has been sealed to control the engine speed limit and the fuel injection quantity. If a seal is removed, the sliding and moving parts of the engine will suffer from increased wear. Engine performance will deteriorate and service life may shorten significantly. Removing a seal may also lead to increased lubricating oil and fuel consumption, seizure and breakage in all portions of the engine. Therefore, do not remove any seals. If the seal is removed, no warranty will be given even during the warranty period.

Location of Safety Labels

- To ensure your safety, the locations of the safety decals are indicated.
- Protect the safety decals from dirt and damage. If they are damaged or lost, replace them with new ones.

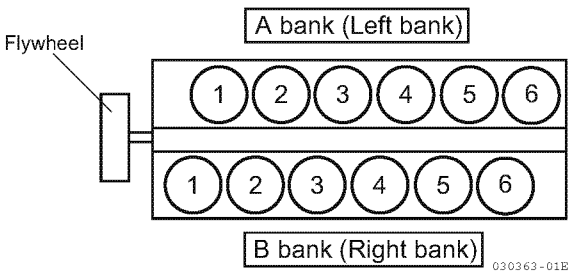
■ A bank (L bank) side



No.	Part No.
1	141616-07210
2	141616-07220
3	141616-07200
4	141616-07240

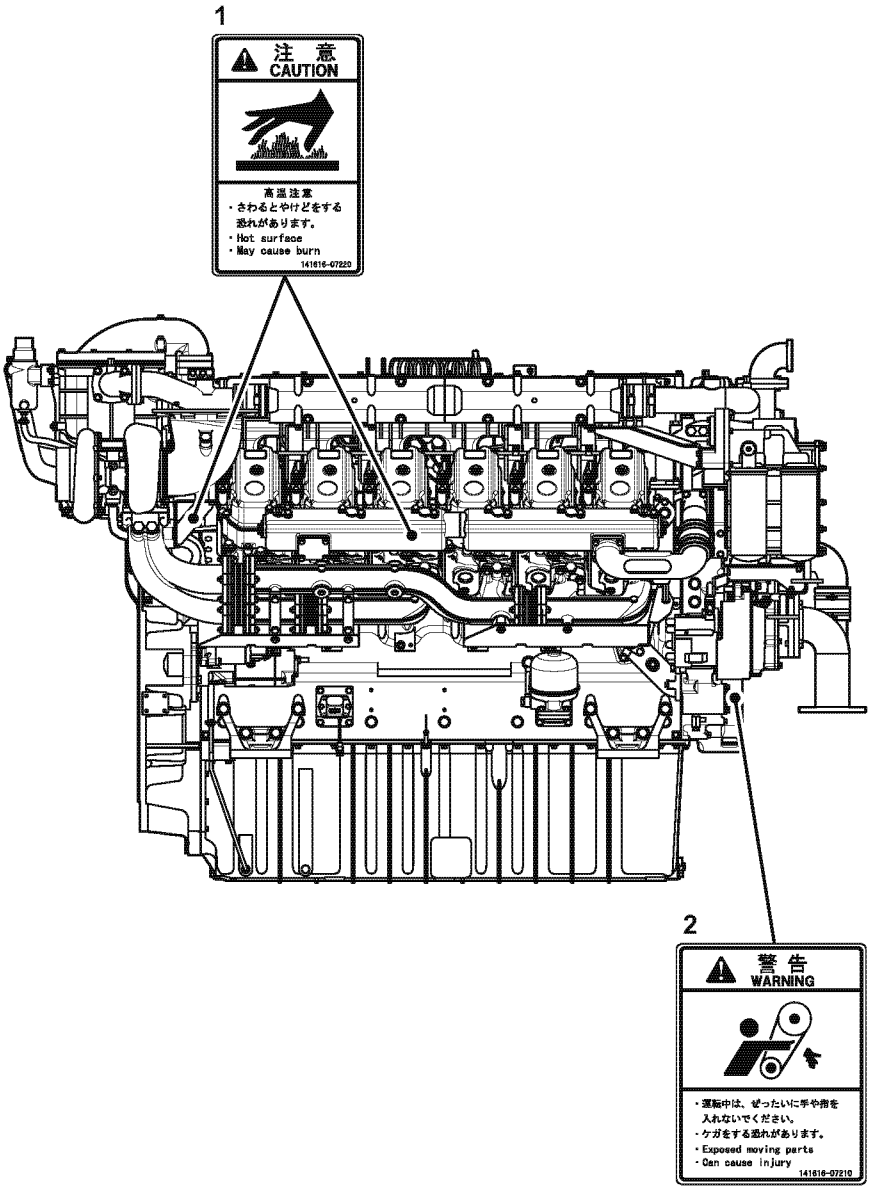
110744-00EN01

● Cylinder numbers



030363-01E

■ B bank (R bank) side



No.	Part No.
1	141616-07220
2	141616-07210

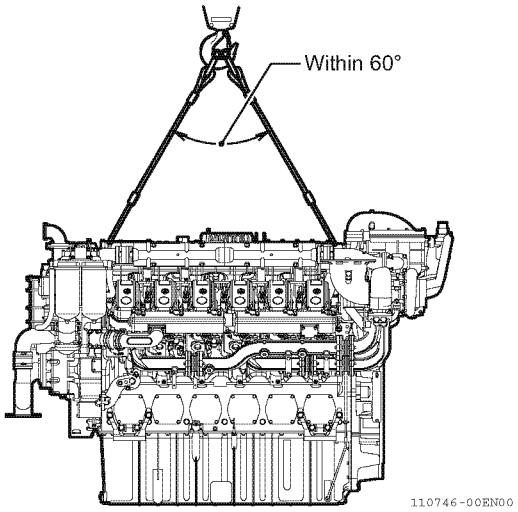
110745-00X00

Precautions for Lifting the Engine

Falling of the engine during its lifting is very dangerous if so happened.
When you lift, obey the following precautions to prevent an accident:

⚠ WARNING

- **Make sure that the engine is lifted by qualified person.**
- **The specified license and certification are required for the lifting work depending on the lifting appliance and load.**
  Check the engine lifting metal fittings and the mounting bolts for failure and damage before starting work. If you find a fault, stop immediately.
- **Before lifting, always check the engine mass described in the approval drawings. The engine mass greatly varies with the specifications.**
- **If you find any equipment that is not described in the approval drawings installed, remove the equipment before lifting.**
- **Select the lifting tools including wire rope and shackle in accordance with the weight of heavy parts.**
- **Adjust the length of the wire rope so that the engine does not lean to one side.**
- **Inspect the lifting tools for failure and damage before starting work.**
- **Protect the parts of the engine or driven equipment that touch the wire rope with protective material.**
- **The tension of the wire rope changes depending on the lifting angle.**
- **Make sure that the angle is within 60°.**
- **During lifting and moving the engine, do not go under or near the engine.**



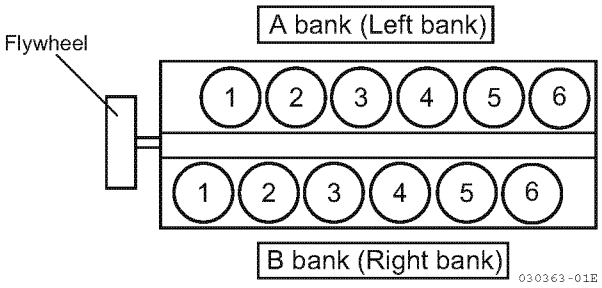
Refer to the approval drawings for mass.

PRODUCT OVERVIEW

Engine Specifications

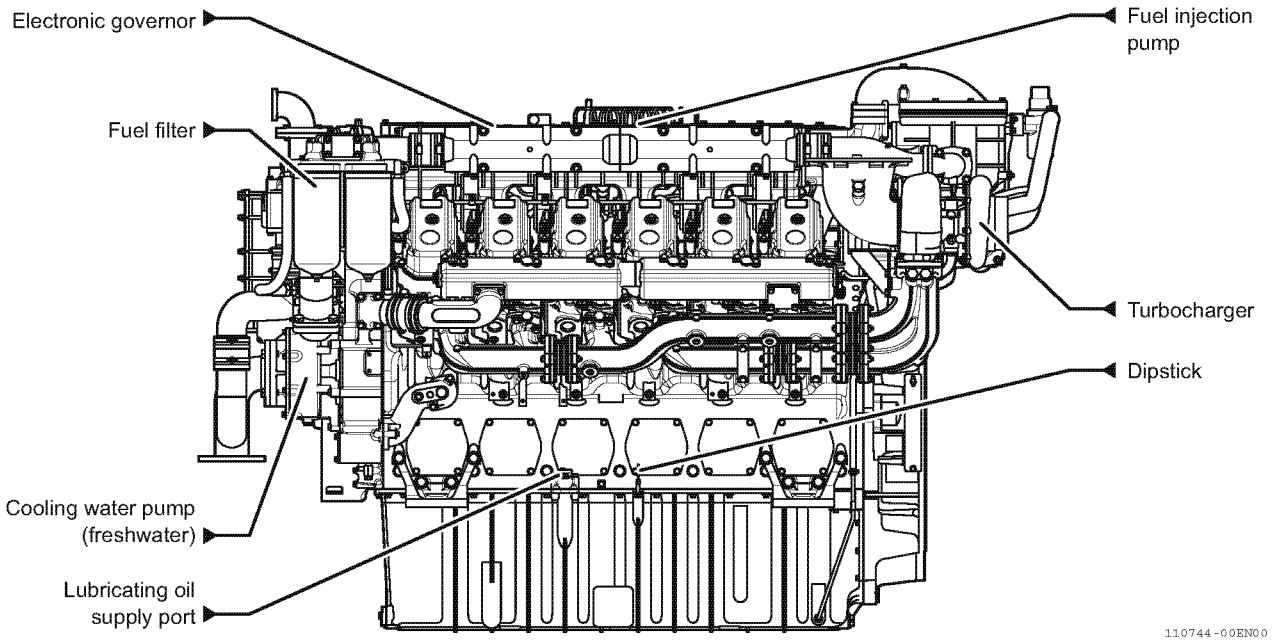
			Unit	Specifications	
Type			–	Vertical, water-cooled, 4-cycle diesel engine	
Combustion chamber			–	Direct injection type	
Turbocharging			–	Exhaust gas turbocharger with air cooler	
Number of cylinders - Inner diameter × Stroke			mm	12 - ø155 × 180	
Total cylinder displacement			L	40.757	
At continuous rating	Output		kW	1106	1127
	Crankshaft speed		min^{-1}	1500	1800
Maximum capacity of applying generator	Output		kVA	1250	
			kW	1000	
Top clearance / Valve clearance			mm	1.56 ± 0.108 / 0.30 ± 0.05 (SUC), 0.50 ± 0.05 (EXH)	
Fuel injection pump			–	Bosch set type (YANMAR) (YPE-1617)	
Fuel injection timing (FID) Operation side (A bank) / Non-operation side (B bank)			Degrees (b.T.D.C)	17.5 / 18.0 (±0.5)	
Ignition order			–	90° 30° 90° 30° 90° 30° 90° 30° 90° 30° 90° 30° B1 - A6 - B4 - A3 - B2 - A5 - B6 - A1 - B3 - A4 - B5 - A2 - B1	
Crankshaft direction of rotation			–	Counter clockwise seen from the flywheel side	
Governor			–	Electric governor	
Engine cooling	Method		–	Radiator cooling (installed separately)	
	Cooling water capacity		L	139	
Engine lubricating	Method		–	Forced lubrication by gear pump	
	Lubricating oil capacity	Oil pan	L	190	
	Lubricating oil cooler	Type	–	Multi-disc type	
Turbocharger	Type		–	TD13M1 (MHI)	
	Cooling system		–	Air cooling	
	Lubricating system		–	Forced lubrication by engine lubricating oil	
Air cooler	Type		–	Corrugate fin type	
	Cooling system		–	Freshwater cooling	

● Cylinder numbers

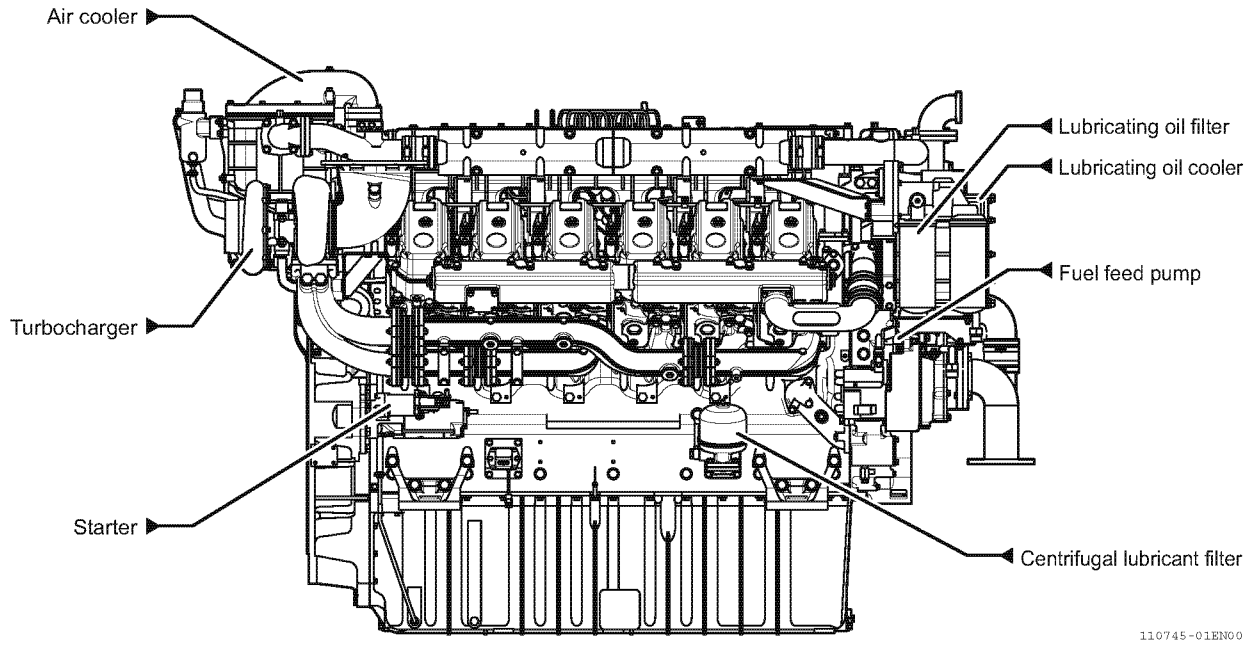


Location of Components

■ A bank (L bank) side



■ B bank (R bank) side



Control System

Starting device

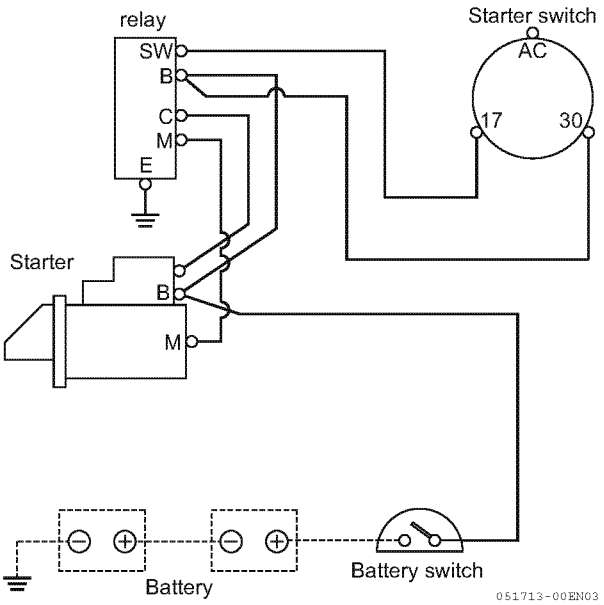
The electric starting can be operated locally or remotely (automatically).

■ Electric starting system

When you push the remote start button or when the automatic start command is given from the control panel, the engine obeys the “Time schedule for remote (automatic) start/stops” and starts.

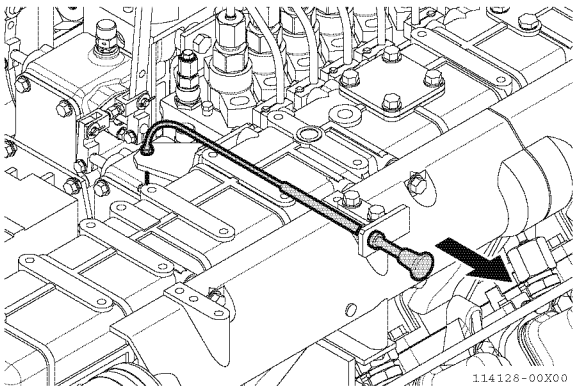
■ Local starting system

Start the engine with the starter switch on the engine side.



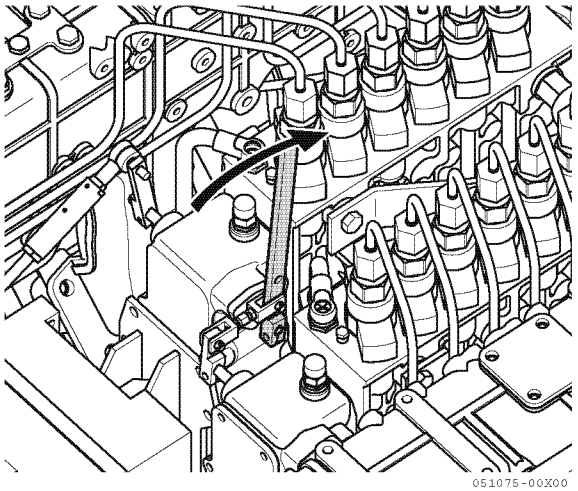
Speed control device

The speed control of the engine applies an electronic governor. Therefore, there is no engine governor lever. Operate from the control panel. The rated speed of the engine (50 Hz or 60 Hz) is set at the control panel.



Stop device

Pull the stop knob (stopper cable at upper part of the charge air manifold) or set the governor stop lever to “stop” position to stop the engine.
Warning alarms and stop switches are equipped for safe operation. If a value exceeds a normal value, the warnings turn on and the engine stops.



FUEL OIL, LUBRICATING OIL, AND COOLING WATER

Fuel Oil

■ Choosing the diesel fuel

Use clean marine gas oil (diesel fuel) as fuel oil.

- The diesel fuel must comply with the following guideline. The specification of the fuel oil must comply with the regulation of each country and international standards.

Diesel fuel specification	ASTM D975	No. 1-D or No. 2-D
	EN590	
	BS-2869	Class A1 or A2
	ISO 8217	DMX
Standard value of characteristic	Sulfur content	0.5% or lower in volume
	Diesel index	Cetane No. of ≥ 45
	Viscosity at 50°C	3 - 8 mm^2/s

NOTICE

- In order to exert maximum engine performance and keep durability, use only the recommended fuel oil.
- Do not use fuel oil that is contaminated with water or dirt. The fuel injection system has many precision parts. Such fuel oil can cause machine trouble.
  Therefore when supplying fuel oil, make sure no water or contamination mixes in.
  Refer to P25 [Periodic Inspection Chart] for details on discharging oil or servicing the fuel filter.

Lubricating Oil

■ Choosing the lubricating oil

Use lubricating oil with the following conditions.

- Grade: A.P.I. CF (or CH-4)
- SAE Viscosity grade: 15W-40
- T.B.N. [mgKOH/g]: 9 - 15

NOTICE

- Do not blend different brand lubricating oil. It can drop lubricity and shorten the service life of the engine.
- YANMAR does not recommend the use of additives to lubricating oil.
- When supplying lubricating oil, make sure no water or contamination mixes in. Clean the fuel filler port before supplying oil.
- Always follow P25 [Periodic Inspection Chart] for replacing lubricating oil and servicing the fuel filter.

Cooling Water

Be sure to use clean, soft water (e.g. tap water) for cooling water.
Recommended cooling water is as follows.

Recommended water quality

PH	6.5 to 8.0 (25°C)
Total hardness ($CaCO_3$)	≤ 100 ppm
Chloride ion (Cℓ) concentration	≤ 100 ppm
M alkalinity	30 to 100 ppm
Ammonium ion (NH4)	≤ 0.05 ppm
Sulfate ion (S04)	≤ 100 ppm
Evaporation residue	≤ 400 ppm

Add Long Life Coolant (LLC) to the fresh cooling water. In any case, the ratio should be between 30% and 55%.
Otherwise, scale or rust can build up in the water line, leading to low cooling efficiency.
YANMAR Royal Freeze has an anti-corrosive effect and can be used year round.
Select a commercial Long Life Coolant with a quality that is equivalent to YANMAR Genuine Long Life Coolant or better.
Do not use LLC with ingredients that cause corrosion on aluminum.

OPERATION

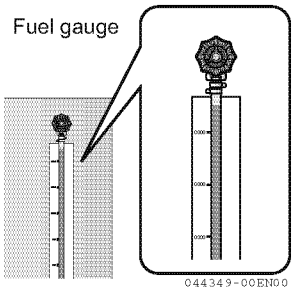
Operation Preparation

When you operate the engine for the first time after installation, or a scheduled inspection and maintenance, or a long rest, check the following list before preparing for operation.
Regarding details, consult your YANMAR dealer or distributor.

- Make sure that there are no unwanted parts or tools inside or near the engine.
- Make sure that all parts are correctly tightened.
- Check the clearance of the intake and exhaust valve heads if you disassembled the valve mechanism.
- Measure the deflection of the crankshaft.
- Check the starter.
  Electric starter: Make sure that the battery has enough voltage.

Refilling the fuel oil

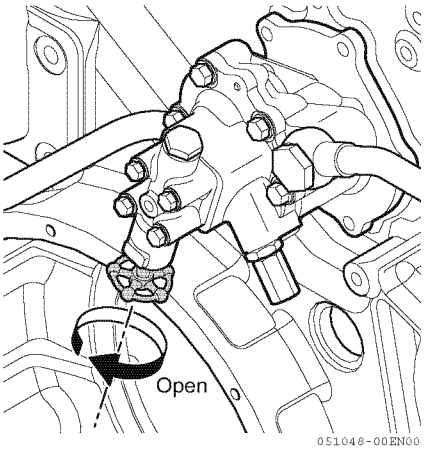
- Fill the tank with clean fuel that is free of water and dirt.
- Fill fuel oil to maximum of fuel tank.
- Bleed air from the fuel system when supplying fuel for the first time, or when replacing parts of the fuel system, such as the fuel filter.



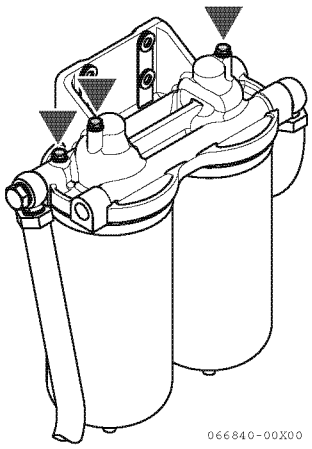
Bleeding air from the fuel oil system

Bleed air from the fuel system and obey the following procedure when you fill fuel oil to the fuel tank for the first time, perform maintenance (such as replacing the fuel filter) of the fuel system, or when the fuel oil has run out. When the engine is operating normally, do not bleed air.

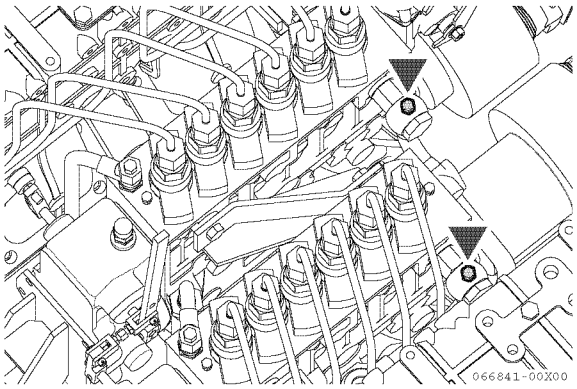
1. Check the provided fuel tank to see the remaining amount of oil, and make sure that its level is at its maximum.
2. Open the fuel cock (or valve) of the fuel tank.
3. Open the by-pass valve of the fuel feed pump.



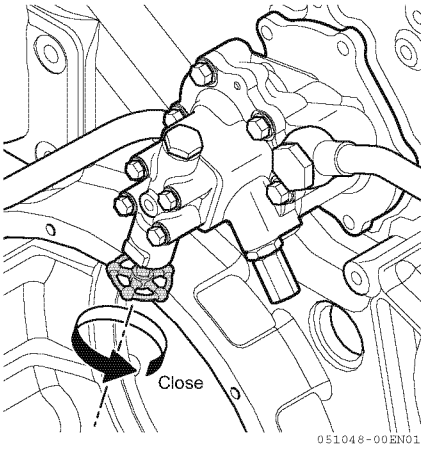
4. Loosen the air bleeding bolts (3 parts) on the upper part of the fuel filter, and when fuel starts pouring without air bubbles from the air bleeding bolt hole, close the cap.



5. Loosen the air bleeding bolts of the fuel inlet pipe joint of the fuel injection pump (Bank A and B), and when fuel without air bubbles starts pouring from the air bleeding bolt hole, tighten the bolts.



6. After completely bleeding the air, close the by-pass valve of the fuel feed pump. It should always be closed during normal operation.

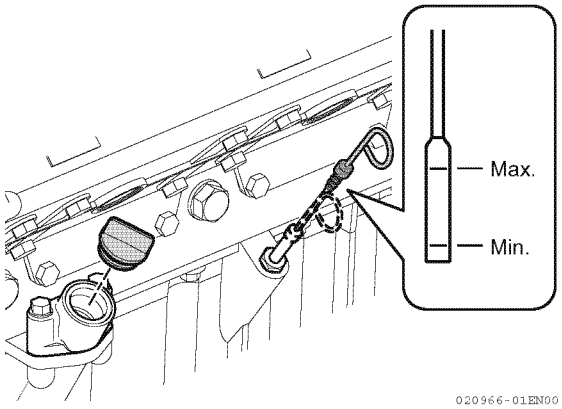


7. In order to operate the engine after bleeding air, first you must idle run and make sure that there is no air included or that there is no fuel leak. Then, check that the engine speed rises smoothly to rated speed.

Filling the engine lubricating oil

Obey this procedure when you refill the engine lubricating oil.

1. Remove the cover on the yellow filler port attached to the oil pan.
2. Fill lubricating oil to the upper gauge line on the dipstick.
   1- Remove the dipstick.
   2- Wipe off the oil on the gauge with a clean cloth.
   3- Fully insert and remove the dipstick again.
   4- Fill lubricating oil to the upper gauge line on the dipstick.



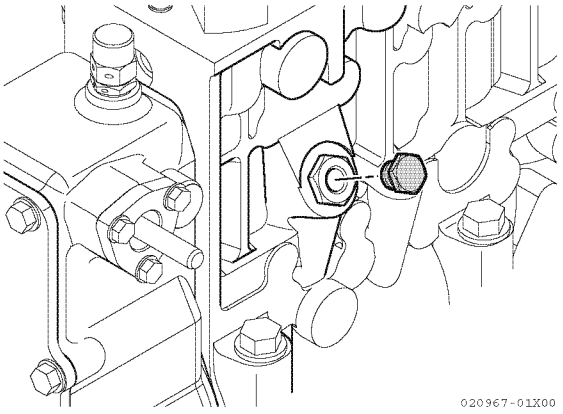
Engine lubricating oil capacity

Oil pan	**190 L**

NOTICE

Do not fill oil over the top line of the dipstick. Lubricating oil may spout out of the breather while the engine is running.

3. Install the cover of the filler port.
4. Remove the oil filler plug attached to the fuel injection pump (yellow).
5. Fill lubricating oil.
   - Supplying to the fuel injection pump should be done when operating the engine for the first time or at maintenance work.



Fuel injection pump oil capacity

A-bank and B-bank Fuel injection pump	**1.5 L each**

6. After supplying, plug the filler port.

Filling the cooling water

Follow the instructions below for supplying cooling water.

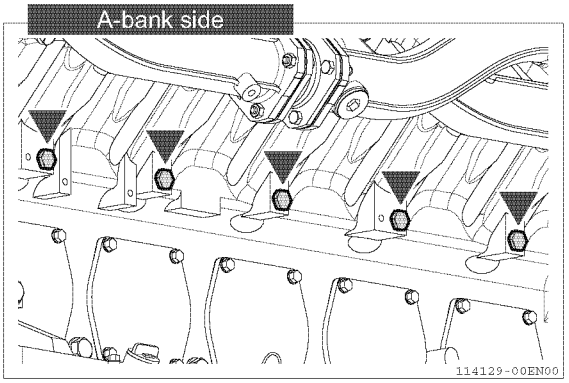
Only use clean, soft water (e.g. tap water) for cooling water. Do not use hard water (e.g. well water).

1. Make sure that all drain valves and plugs are closed.
   - Cylinder block (5 parts in both A-bank and B-bank)
   - Gear housing on non-flywheel side (2 parts)
   - Air cooler cooling water inlet bend (1 part)

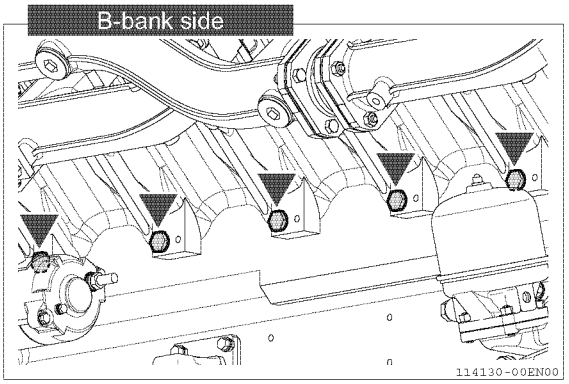
2. Supply clean cooling water from the filler port.

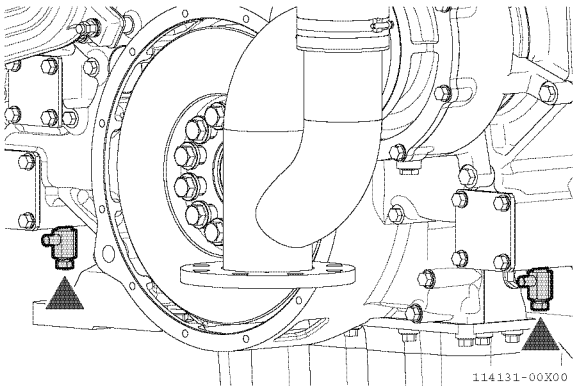
Amount of engine cooling water	139 L

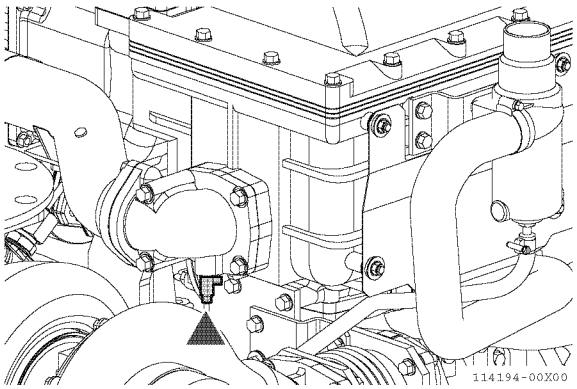
A-bank side



B-bank side

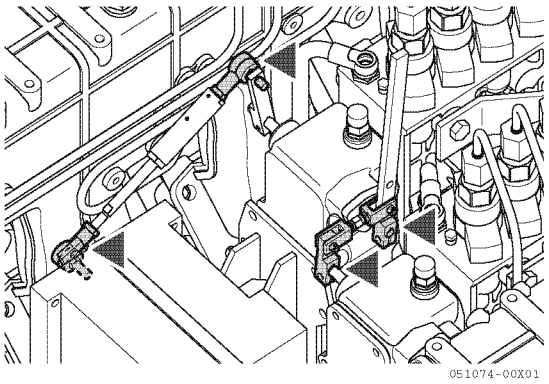




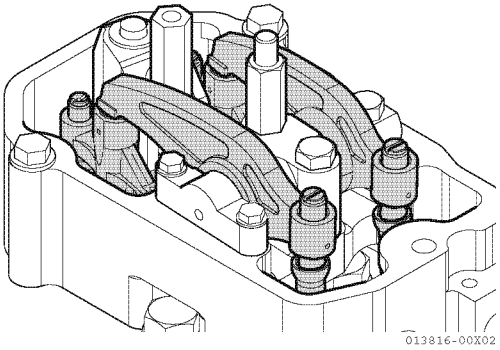


Lubricating engine components

1. Apply grease to the rod end coupling of the governor link.

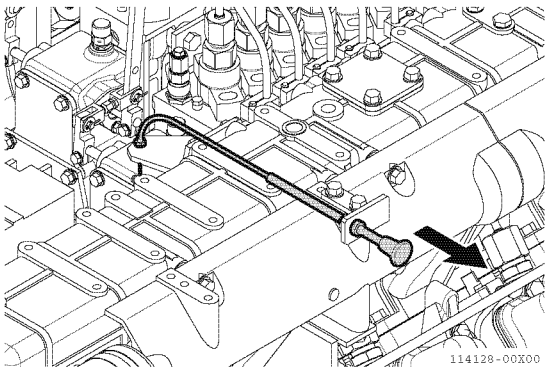


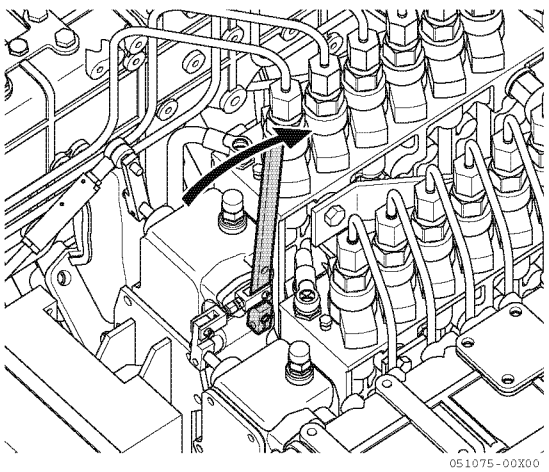
2. Apply oil to the rocker arm.



Check for fuel stopping

Pull the stop knob (stopper cable at upper part of the charge air manifold) or set the stop handle of the governor to the “STOP” position, for turning the flywheel to make sure there are no fuel injection noise.





Inspection before Engine Start

Do these checks before engine start.

Visual inspection of the engine

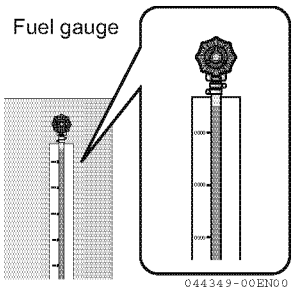
Check the following and make sure that there are no defects.

- Check for oil leaks from the engine.
- Check for fuel oil leaks from the fuel system.
- Check for water leaks from the cooling water system.
- Check for gas leaks from the exhaust pipe.
- Check for loose or missing bolts.
- Check for loose or missing wire ends.
- Check for damage/contact/displacement of wiring cables.

Checking and refilling the fuel oil

Check the fuel level inside the tank. If necessary, refill with a recommended fuel.

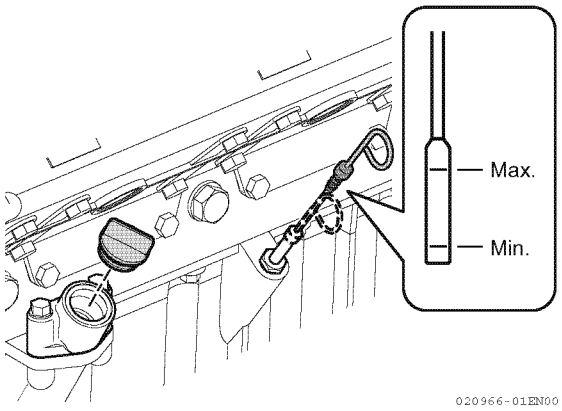
- Refill fuel oil sufficiently to avoid running out of fuel oil during operation.
- Fill the tank with clean fuel that is free of water or dirt.
- Drain the fuel tank at refilling.



Checking and refilling the engine lubricating oil

Check and refill the engine lubricating oil before starting the engine, while the engine is cold.

- Check the level of the engine lubricating oil with a dipstick. Make sure that the oil level is between the top and bottom lines on the dipstick.
- If necessary, fill with lubricating oil to the top line on the dipstick.
- Make sure that lubricating oil level is in the oil level gauge of the lubricating oil level gauge tank. The lubricating oil level gauge tank is equipped with a level switch.



Checking the starting system

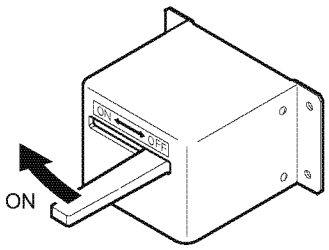
Be sure to check that the starting system is normal.

- Make sure that the battery for starting has enough voltage.

Battery switch

Turn the battery switch to ON.

- Keep the switch ON while the engine is running. Turn the switch OFF when stopping the engine.



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Starting and Operation

Starting for the first time

When running the engine for the first time or after a maintenance work, or after storing for over three months, please carry on the following operation.

In order to make sure that the engine runs smoothly, and that the sliding parts are surely lubricated, follow the procedure below.

1. Operate the starter switch of the instrument panel for a short time (within 5 seconds), and make sure that the rotation of the starter is smooth and there is no unusual sound from the engine.
2. Carry out four crankings (15 seconds each). After 15 seconds of cranking, wait for at least 30 seconds to carry out the next 15 seconds. Carry out cranking by operating on the engine side, in a state where fuel oil is shut out by pulling the stop knob or setting the stop lever of the governor to the “STOP” position.
3. After that, run the engine for about 5 minutes at low idle (600 min^{-1}).
4. Make sure that the switches such as the circuit breaker of the power generator or the load switches are turned OFF. Accelerate the engine to rated speed.
5. Make sure that the lubricating oil pressure meter in the instrument panel is showing 0.45 to 0.55 MPa. When cold-starting, it is 0.55 MPa or more.

NOTICE

When restarting after failing to start the engine, in order to prevent damage to the starter, wait for about 15 seconds after the engine has stopped, and then start again.

■ Rechecking the amount of lubricant and cooling water

After stopping the engine, leave it for a while (about 10 minutes), and then recheck the amount of coolant and lubricating oil to refill the decreased amount. When operating a new engine for the first time, cooling water and lubricating oil spreads throughout each part, which makes the fluid decrease from the initial amount.

Long-term Storage

When storing the engine for a long time or restarting after a long time, necessary treatment and inspection are as follows. When the engine was stored for over a year, inspection and maintenance service are required.

■ Treatment for long-term storage

- Before you put the engine in storage, do all the periodic inspections and maintenance that are soon due.
- In cold areas, be sure to drain water from all cooling water passage to prevent freezing.
- Loosen the V-belt.
- Remove the battery cable from the negative terminal side of the battery.
  Charge at least once a month to prevent voltage decrease due to self-discharging of the battery.
- Carefully remove dust and oily dirt from the outside of the engine. Apply rust inhibitor or clean oil.
- To prevent moisture from entering, cover the exhaust pipe, intake port, and electrical equipment with a protective cover.
- To prevent condensation in the fuel tank, either drain or fill up the fuel oil.
- Close the fuel cock (valve).

● Draining water from the cooling water passage

- If long life coolant is mixed in freshwater, there is no need to take out the freshwater.
- If long life coolant is not mixed in freshwater, open the drain cock of the freshwater system, and drain all the water inside. Storing the engine without draining may freeze the engine and damage the parts of the cooling water passage.

■ Restarting the engine after long-term storage

- Do the same start preparations as for the initial start of a new engine.
- Inspect the V-belt, and replace if necessary. Adjust the V-belt tension.
- Attach the battery cable to the battery from the positive terminal side.
- If it freshwater is already drained, clean the freshwater passage by rinsing water through the passage with the drain cock open. Then, close the water drain cock and fill water. Add long life coolant to freshwater.
- If the storing lasts for more than three months, carry out four cranking (15 seconds each) to lubricate the sliding parts. After a 15 seconds of cranking, wait for at least 30 seconds to carry out the next 15 seconds. After that, run the engine for about 5 minutes at low idle (600 min^{-1}).
- After warming up, check the amount of lubricating oil and freshwater. Supply the decreased amount.

Engine Warming-up

Do an engine warm-up with no-load after starting the engine.

1. Do a no-load operation for 5 to 10 minutes at rated speed.
2. Check the followings during warm-up running.
   - Cooling water pressure: 0.15 to 0.25 MPa
   - Lubricating oil pressure: 0.45 to 0.55 MPa
   - Check for water, oil, and gas leaks from each part in the engine
   - Check for unusual noise and heat from each part in the engine

Load Operation

● Operating condition

	Load rate	Limited time	Remarks
Average load	70% or less	–	Every 24 hours of operation (comply to ISO 8528)
Continuous operation	90% or more	3 hours or less	• Every 24 hours of operation • After using under 0 to 30% load, operate with at least 50% load for at least half an hour.
	30 to 90%	Non-limited	
	15 to 30%	5 hours or less	
	0 to 15%	0.5 hours or less	

• Yearly usage: Non-limited

● Output correction

	Correction value	Condition
Ambient temperature	Rated output 3.0% less / 5°C	40°C or higher
Altitude	Rated output 1.0% less / 100 m	1000 m or higher

⚠ WARNING

In load operation, carefully check the situation and safety on the load side beforehand.

If there is nothing abnormal during warming-up, turn ON the power generator circuit breaker and start the load operation, then check the next procedure. For more details on the test operation after the load operation, please refer to the specification and manual for the power generator control panel.
If an engine error has occurred while operating, do not continue using it. Immediately stop the engine, and contact the nearest YANMAR dealer or authorized service provider.

● Lubricating oil pressure

If the lubricating oil pressure is the following value, it is normal.
Although pressure may exceed the following value immediately after starting, it is not unusual.

0.45 to 0.55 MPa

● Cooling water pressure

It is normal if the cooling water pressure is the following value.

0.15 to 0.25 MPa

● Lubricating oil temperature

It is normal if the temperature at the inlet of lubricating oil cooler is the following value.

110°C or lower

● Exhaust temperature (Turbocharger outlet)

While operating, it is normal if the exhaust temperature is the following value.

540°C or lower

● Color of exhaust smoke

The exhaust smoke is colorless in normal condition. Black smoke is a sign of engine overload.

● Water, oil and gas leaks and operation condition

Always check for water, oil and gas leaks, loose bolts and unusual noise.

Engine Stop

■ Stopping the normal operation

In cases beside emergency, stop the engine with the following steps.

1. Turn OFF the power generator circuit breaker, and cut all of the loads to a no-load state.
2. Slow down the rotation to the minimum and implement no-load operation for 5 to 10 minutes.
3. Stop the engine with a stopper lever if the governor, or a stop switch of the control panel.
4. Make sure that the engine completely stops.
5. Turn OFF the battery switch.

NOTICE

- If the engine suddenly stops after the load operation, the engine temperature sharply rises and the rise may cause the operating parts to stick.
- For more details on the stand-by state after the load operation, please refer to the specification and manual for the power generator control panel.

■ Emergency stop (Engine protective device)

⚠ WARNING

After the emergency stop, do not leave open the crank case side cover for at least 10 minutes. When new air flows in, the oil mist may ignite, and possibly explode.

PERIODIC INSPECTION

Periodic Inspection Chart

Referring to the following tables, plan a suitable periodic inspection schedule for the engine, and enforce them as planned.

Note • This chart also includes equipment other than the engine itself.

• The replacement timings are reference. They are not to guarantee the life of the parts.

• Replace any parts when damage is obvious to come, even if is not scheduled.

• There may be times for inspection and replacement besides this chart.

○: Inspect, adjust, check, or record ●: Replacement (as a unit or partially)

System part		What to check	Period							Remarks
			Daily	A Every 500 hours	B Every 1000 hours	C Every 2000 hours	D Every 4000 hours	E Every 8000 hours	F Every 16000 hours	
Fuel oil system	Equipment	Cleaning of 1st fuel filter	○ After first 50 hours		○					Cleaning
	Engine	Inspection and replacement of fuel pipe	○	○				●		Replacement: Flexible tube (At engine inlet and middle of piping)
		Replacement of fuel filter element			●					
		Replacement of fuel injection valve needle				●				Replacement: Needle assembly
		Fuel injection pipe						○	●	Inspection: Scratches on nipple part
		Inspection and maintenance of fuel injection pump				○				Inspection: Sliding and function of rack
								●		Disassembly, inspection, and replacement: Plunger, barrel, deflector, and delivery valve
		Fuel pressure control valve						●		Pressure adjusting valve assembly and gaskets
		Fuel feed pump						●		Disassembly, inspection, and replacement: Oil seal and bearing
		Injection timing						○		Inspection, and adjustment if necessary
Lubricating oil system	Engine	Replacement of lubricating oil	● After first 50 hours	●						
		Replacement of lubricating oil filter element	● After first 50 hours	●						
		Cleaning of centrifugal lubricating oil filter		○						
		Checking the lubricating oil pressure	○							
		Lubricating oil cooler: Visual check: Water or oil leak		○						
		Lubricating oil cooler: Cleaning (Cooling water passage and oil passage)						○		
		Lubricating oil cooler: Pressure test						○		Water: 0.39 MPa Oil: 1.53 MPa
		Lubricating oil pump (Disassembly and inspection)							○	

○: Inspect, adjust, check, or record ●: Replacement (as a unit or partially)

System part		What to check	Period							Remarks
			Daily	A Every 500 hours	B Every 1000 hours	C Every 2000 hours	D Every 4000 hours	E Every 8000 hours	F Every 16000 hours	
Cooling water system		Inspecting the cooling water temperature	○							
		Inspection of leakage in every part	○							
	Cooling water pump	Replacement of mechanical seal	○					●		Inspection: Leakage
		Replacement of ball bearing						●		
		Inspecting and replacing the impeller						○		
		Inspection and replacement of shaft						○		
		Replacement of cooling water (LLC)						●		LLC concentration 30%
		Retightening of cooling water rubber hose	○ After first 50 hours	○						After the hose is replaced, retighten after 50 hours
		Replacement of cooling water rubber hose						●		or Every 2 years whichever comes earlier
		Replacement of thermostat						●		
		Cleaning of cooling water system						○		
Turbocharger		Inspection of air and gas leakage from each connection part	○							
		Cleaning of blower				○				
		Inspection of all tightening parts		○						
		Inspection of play and rotation of turbine shaft					○			
		Disassembly, inspection, and replacement of main parts						●		Replacement: Floating bearing, thrust bearing, and seal ring
Air cooler		Visual check: Water or oil leak	○							
		Cleaning (Cooling water passage, and air passage)						○		
		Pressure test						○		Water: 0.39 MPa
Inspection of looseness and wear/abrasion of electronic governor link						○				When related parts are replaced, always adjust the position of the fuel exhaust rack of the fuel injection pump (-2 scale).
Inspection and cleaning of gap in magnetic pickup							○			Clearance with ring gear: Screw in the pickup tip until it touches the tip of the ring gear. Then turn it back by 3/8 turn.
Cylinder head and Valve mechanism	Intake valve and exhaust valve	Adjustment of valve clearance	○ After first 50 hours			○				
		Replacement of stem seal						●		Use special tool
		Refacing or replacement of intake/exhaust valves and valve seat						○ (Lapping)	●	
		Inspecting and replacing the valve guide						○	●	Replace if necessary at inspection
		Inspection of valve bridge wear/abrasion						○		
		Inspecting and replacing the valve spring						○	●	Replace if necessary at inspection
		Replacement of rotator						●		
		Replacement of cotter						●		
	Head	Cleaning of cooling water passage						○		
		Inspection of combustion surface						○		Inspection: Disassemble, clean, and check by penetration test
	Camshaft	Inspecting and replacing the tappet						○	●	
		Inspecting the cam						○		
		Inspection of gear backlash							○	Inspection: Check specified value

○: Inspect, adjust, check, or record ●: Replacement (as a unit or partially)

System part		What to check	Period: Daily	A: Every 500 hours	B: Every 1000 hours	C: Every 2000 hours	D: Every 4000 hours	E: Every 8000 hours	F: Every 16000 hours	Remarks
Main moving parts	Piston	Presence of dirt and damage						○		After taking out the piston, clean and check by penetration check. Replace if necessary.
		Measurement of outer diameter of piston						○		Check usage limit: Replace if necessary
		Measurement of piston ring groove width						○		
		Measurement of piston pin bore						○		
		Measurement of outer diameter of piston pin						○		
		Replacement of piston ring						●		
	Connecting rod	Inspection and replacement of piston pin bearing						○	●	Inspection: Check usage limit
		Inspection and replacement of crank pin bearing						○	●	
		Inspecting and replacing the connecting rod bolt						○	●	Inspection: Penetration check
	Cylinder liner	Contacting condition and scratches on sliding face						○		
		Measurement of inner diameter						○		Check usage limit
		Drawing out and cleaning							○	
	Crankshaft	Measurement of deflection							○	
		Inspection of crank pin							○	Check for scratches and measure outer diameter
		Inspection of journal							○	Check for scratches and measure outer diameter
		Replacement of main bearing							●	
		Replacement of crankshaft oil seal						●		Front and rear
	Inspecting the ring gear							○		
Inspecting and replacing the viscous damper							○	●		
Intake/Exhaust system	Inspection of leakage in every part		○							
	Exhaust manifold	Disassembly, cleaning, and inspection						○		Check for damage
		Inspection and replacement of exhaust bellows				○		●		Inspection of bellows: Look for cracks Replace if necessary at inspection
	Inspection and replacement of flexible tube and bellows						○			
Start/stop device	Starter	Inspection of loose terminal	○							
		Inspection of contact points and brushes						○		Replace if necessary
		Break down maintenance							○	or Every 4 years whichever comes earlier
	Stop solenoid	Loosening of mounting bolt		○						
		Inspection of operation check and wear of link lever		○						
	Alternator	Adjustment of belt tension	○ After first 50 hours	○						
		Replacement of belt						●		
Protective switches		L.O. filter bypass valve switch				○				
Inspection and replacement of shock absorber								○	●	Replace every 4 years, or when necessary
Operation	Inspection of loose bolts and nuts		○							
	Inspection of unusual sound, heat, vibration, or leakage		○							
	Operation record (Load, temperature, pressure, etc.)		○							
			○							
	Maintenance record (Replacement parts, etc.)									At each maintenance

Periodic Inspection

Fuel system

■ Checking and refilling fuel oil

Check the fuel level inside the tank. If necessary, refill with a recommended fuel.

Interval	Daily

■ Drain the fuel tank

Open the drain cock of fuel tank and drain water or dirt.

Interval	When supplying fuel

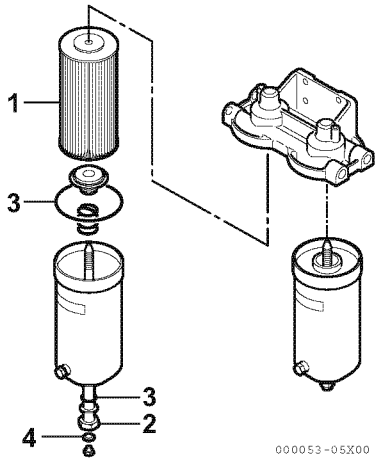
■ Replacing the fuel filter element

Replace the fuel filter periodically because dirt accumulates.

Every 1000 hours for diesel fuel (light oil).

Interval	B

1. Close the fuel cock (valve).
2. Remove the drain plug. Drain fuel oil into a waste oil container.
3. Loosen the center bolt (2) of the fuel filter.
4. Remove the lower case and the internal element (1).
5. Clean the inside of the filter case.
6. Attach a new element (1), O-ring (3), and a seal washer (4) and fix it with the center bolt (2).
   When assembling the element, attach the retainer, spring, etc, to the original positions.
7. Release air from the fuel system.



Lubricating oil system

■ Checking and refilling lubricating oil

Before operating, pull out the dipstick, wipe off oil from the dipstick, and insert it again to check the oil level. Make sure that the oil level is between the top and bottom lines on the dipstick. If necessary, add lubricating oil.
Make sure that there is lubricating oil inside the lubricating oil level gauge tank.

Interval	Daily

NOTICE

Do not overfill lubricating oil. Lubricating oil can spout out and cause engine malfunction.

■ Changing the lubricating oil

⚠ CAUTION

Lubricating oil is very hot. Be careful not to burn yourself.

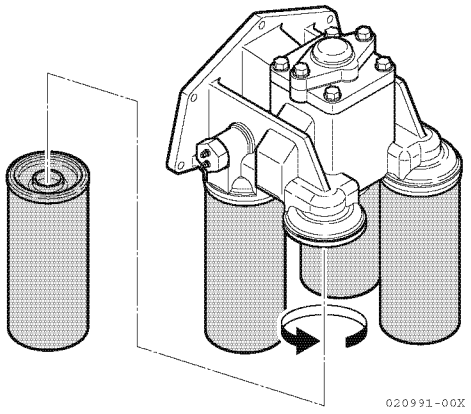
The lubricating oil drains easier if you replace the oil while the engine is still warm.

Interval	1st time	After 50 hours
	A	

1. Push in the rubber hose of the oil discharge pump into the fuel filler port, and drain oil. Or, open the drain valve and drain oil. Make sure to close the drain valve after draining.
2. Fill new lubricating oil into the oil supply port.

■ Replacing the lubricating oil filter element (cartridge type)

Interval	1st time	After 50 hours
	A	



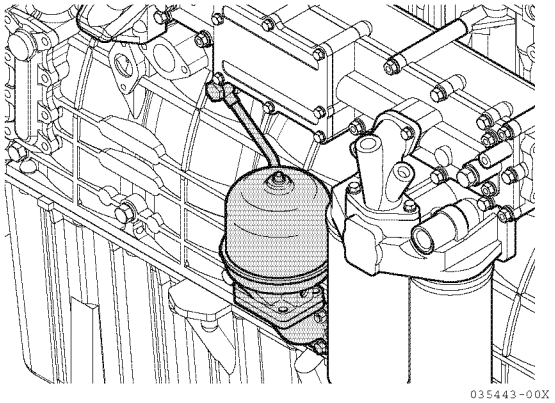
1. Remove the element with a filter wrench. (Counterclockwise)
2. Do the following tasks before you install the new element.
   1- Carefully clean the mounting surface.
   2- Apply lubricating oil to the surface of the rubber packing.
3. Tighten the filter element fully by hand.
4. Then, use a filter wrench to further tighten the filter for about 3/4 turns. (right turn)
5. Check for oil leaks during engine operation.

■ Cleaning of centrifugal lubricant filter (bypass filter) (if equipped)

⚠ CAUTION

Stop the engine before cleaning the bypass filter. Do not disassemble while the engine is running. The burn might be done because it is hot immediately after engine stop.

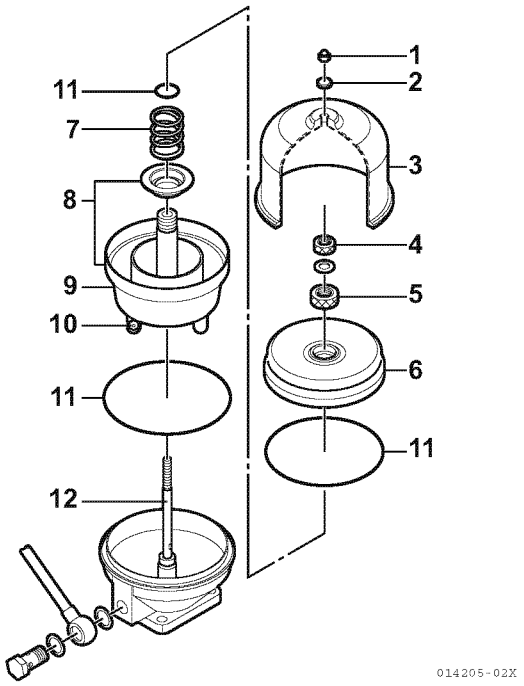
Interval	A



● Disassembly and cleaning

1. Loosen the cap nut (1). Remove the cover (3).
2. Loosen the nut (4). Remove the rotor body (9).
3. Loosen the stopper nut (5). Remove the rotor cover (6).
4. Remove spring (7) and insulator assembly (8).

5. Remove the sludge inside the rotor (9) with a spatula.
   Completely remove the sludge. Otherwise, residual sludge may cause an unbalance in rotation, resulting in damage to the bearing of the spindle shaft.
6. Clean the nozzle (10) with a brass wire brush.
7. Check each part and O-ring (11). If any damage or excessive wear is found, replace the part.



● Assembly

1. Install the insulator assembly (8) and spring (7) into the rotor (9).
2. Cover the rotor body with the rotor cover (6).
3. Make sure that the rotor (9) and rotor cover (6) fit well.
   When the fitting is not aligned, the rotor speed becomes unbalanced and may damage the equipment.
4. Tighten the rotor cover (6) to the rotor (9) with a lock nut (5).

Tightening torque of lock nut	Tighten by hand

5. Insert the rotor (9) to the spindle shaft (12), and tighten with knurled nut (4). (Do not use tools such as pipe wrenches.)

Tightening torque of knurled nut	Tighten by hand

6. Install the cover (3). Attach the thrust collar (2) and tighten with the cap nut (1).

Tightening torque of cap nut	16 ± 2 N•m (1.6 ± 0.2 kgf•m) Or, after the cap nut is attached, use a spanner for M12 and tighten for 1 to 1 -1/4 turns.

   Be careful not to tighten the nut and cap nut too much. If the cap nut is too tight, the next time when loosening, the spindle shaft may rotate together and lose tightening force, which leads to the spindle shaft falling out.
7. After assembling, activate the lubricating oil bypass filter and make sure that oil is not leaking from the engaging parts and that the vibration is normal.

Cooling water system

■ Replacing freshwater

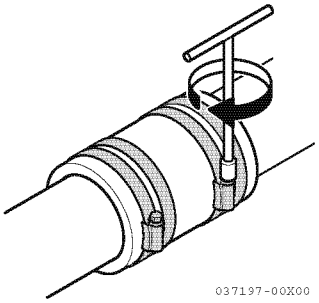
Cooling water gradually accumulates scale and rust in the water system which impedes cooling. Therefore, periodically change the cooling water. Always use clean water (tap water) for cooling water, and be sure to add the correct amount of Long Life Coolant.

Replacement interval	E

Other

■ Re-tighten the hose clips

Check all rubber hose joint for water or oil leaks and re-tighten the hose clips.



Interval	First time and after replacing the rubber hose	After 50 hours
	A	

■ Replacing the rubber hose

Check for cracks and scratches on the rubber part. Periodically replace them even if there is nothing wrong with the appearance.

Interval	E, or every 2 years

Inspection and maintenance of each engine part and shock absorber

As technical skill and knowledge are required for checking the following items, you are requested to consult the nearest YANMAR dealer or authorized service provider.

■ Checking and maintaining fuel injection timing

This process improves the timing of the fuel injection for maintaining engine performance.

■ Checking the injection pressure and spray condition of the fuel injection valve

Check and adjust so that the fuel injection state is always optimum.

■ Replacing the fuel injection valve

This process improves the fuel injection condition to exert the best engine performance.

■ Adjusting the valve clearance of the intake and exhaust valves

Certain valve clearance is required for correct movement of the valves. Periodic inspection and maintenance for the clearance is necessary.

■ Lapping intake and exhaust valves

This process improves the airtightness of the intake and exhaust valves for maintaining engine performance.

■ Maintenance for shock absorber

Inspect cracks on rubber parts, peeling of adhesive parts, and check for any oils, acids, other organic solvents, etc. Then, measure the height of the shock absorber. If there is a crack or peeling, or the height of the rubber exceeds the usage limit, replace the shock absorber.
Even if there is nothing wrong in its appearance, replace every 4 years.
Measure the crankshaft deflection after replacing the shock absorber.

TROUBLESHOOTING AND COUNTERMEASURES

For correct troubleshooting, you need to thoroughly understand each system of the engine and the function of each part. In addition, in the event of a failure, it is important to carefully observe and systematically analyze the defective part to find the cause. Possible failures are classified as follows.

Failure when Starting

■ Flywheel does not run

Cause	Countermeasure	Remarks
Electric starter failure • Voltage of the starter battery is low	 • Charge the battery	
Viscosity of lubricating oil is too high	Warm up the engine, or change to a low-viscosity oil	
Seizure of moving part • Seizure of piston and cylinder liner • Seizure of main bearing and/or camshaft bearing	 • Inspect, and repair or replace • Inspect, and repair or replace	

■ Flywheel turned, but ignition did not occur

Cause	Countermeasure	Remarks
Fuel does not reach the injection pump • Not enough fuel in tank • Fuel pipe is blocked (improper opening and closing of each valve) • Fuel filter is clogged • Fuel feed pump failure • Air is entering from joints	 • Supply fuel to the fuel tank • Inspect the opening and closing status of each valve • Clean the filter • Inspect and repair • Inspect, repair, and bleed air	
Failure of fuel injection pump • Sticking of plunger and plunger guide • Wear or seizure of plunger • Improper assembling (deviation of match marks)	 • Inspect, and repair or replace • Replace • Disassemble and inspect	
Failure of fuel injection valve • Sticking or seizure of needle • Nozzle spring is broken • Fuel injection pressure is low • Excessive oil leakage from nozzle • Breakage or improper clamping of high-pressure fuel pipe	 • Inspect, and repair or replace • Replace • Regulate the pressure • Inspect or clean the mating surfaces of the nozzle and body, or replace the nozzle • Replace, or correct the tightening	
Malfunction of electronic governor (Loose governor link and worn spline)	Inspect, and repair or replace	
Air is leaking from intake/exhaust valve • No clearance in valve head of the intake/exhaust valve • Sticking of intake/exhaust valve • The intake/exhaust valve has damage	 • Adjust the valve head clearance • Lap or replace • Lap or replace	
Cetane number of fuel is too low	Use a high-quality fuel oil (cetane number 45 or higher)	

Failure while Operating

■ Rotation speed spontaneously decreases

Cause	Countermeasure	Remarks
Fuel filter is clogged	Clean the filter	
Seizure of a moving part (piston, main bearing, or turbo-charger)	Inspect, and repair or replace	
Air mixed in fuel pipe system	Inspect, repair, and bleed air	
There is water in the fuel oil	Drain the fuel filter and tank	
Failure of fuel injection pump	Inspect, and repair or replace	
Failure of fuel injection valve	Examine and adjust the part, or replace it	
Overload	Reduce load	

■ Output from each cylinder does not average (The maximum fuel pressure and exhaust temperature of all cylinders are unbalanced)

Cause	Countermeasure	Remarks
Air mixed in fuel pipe system	Inspect, repair, and bleed air	
Water mixed in fuel oil	Drain the fuel filter and tank	
The fuel injection volume of the cylinders is irregular		
• Fuel injection pump plunger is stuck or worn	• Inspect, and repair or replace	
• Failure of fuel injection valve	• Inspect, and repair or replace	
• Looseness or breakage of fuel injection pipe	• Inspect or replace	
• The intake/exhaust valves are stuck or the seat of the intake/exhaust valves are damaged	• Inspect, and repair or replace	
• Fuel cam or the intake/exhaust cam is damaged	• Inspect, and repair or replace	

■ Color of exhaust gas is bad

Cause	Countermeasure	Remarks
The injection timing is incorrect	Inspect and adjust	Refer to the Records of Shop Trial
Malfunction of the fuel injection valve (e.g. the fuel injection pressure decreases or the nozzle is stuck)	Inspect, and adjust the pressure or replace	
Malfunction of the fuel injection pump	Inspect, and repair or replace	
The clearance of the intake/exhaust valve head is incorrect or the seat part is damaged	Adjust the clearance, or repair or replace the valve seat	
Sticking of intake/exhaust valve	Disassemble, and correct	
Damaged intake/exhaust cam	Replace the camshaft	
Failure of turbocharger		
• The blower side or turbine side is dirty	• Disassemble and clean the part	
Air cooler is stained (Boost air temperature is too high)	Disassembly and Cleaning	
The fuel oil is not good	Use a fuel oil with higher quality	
Overload	Reduce the load	

■ Cannot operate in full load

Cause	Countermeasure	Remarks
Insufficient fuel feed pressure • Discharging pressure of the fuel feed pump is low • Lack of head of fuel tank	 • Adjust the feed pump • Inspect the oil amount and outlet valve of the fuel tank	
Fuel filter is clogged	Clean the filter	
Fuel pump plunger is worn	Replace the worn plunger and barrel	
Air cooler is dirty	Clean the air cooler	

■ Pressure of lubricating oil is below specified pressure

Cause	Countermeasure	Remarks
Lubricating oil pipe or cylinder block oil hole plug is loose	Examine and repair the lubricating oil pipe and all oil hole plugs	
Clogging of lubricating oil filter	Disassembly and Cleaning	
Clearance of the crankshaft bearing is big	Measure the clearance, and then replace the bearing	
Oil pressure control valve is stuck or the adjusting bolt is loose	Inspect, and repair or adjust	
Lubricating oil relief valve is stuck	Inspect the part, and repair	
Temperature of lubricating oil is too high • Insufficient cooling water • Oil cooler is dirty • Excessive blow-by (gas leakage) in crankcase	 • Inspect the cooling water pump • Inspect, and then disassemble and clean • Inspect the piston rings and cylinder liner	
Air in lubricating oil pump (Lack of lubricating oil)	Fill with lubricating oil	

■ Unusual sounds during engine operation

Cause	Countermeasure	Remarks
Bearings of crankshaft or camshaft have too much clearance	Inspect, and replace the bearing	
Loose bolt • Connecting rod bolt • Flywheel tightening bolt	 • Replace the connecting rod and the bolts, and then re-tighten or replace the bolts • Inspect, and then re-tighten or replace the bolts	
Clearance of the intake/exhaust valve head is incorrect or a bolt is loose	Examine, and then adjust the clearance	
Incorrectly adjusted fuel injection timing	Inspect, and then adjust	
Excessive fuel injection volume • Malfunction of the fuel injection pump • Failure of fuel injection valve	 • Examine and repair the part, or replace it • Inspect, repair, and then adjust	
Increasing gear backlash, or gear bearing wear	Examine and adjust the governor, or replace it	

■ Temperature of cooling water is too high

Cause	Countermeasure	Remarks
Excessively low circulating amount of cooling water	Inspect and repair the cooling water pump	
Cooling water thermostat is stuck or malfunctioning	Examine or replace the thermostat	
Failure of radiator • Radiator core is dirty or broken • Lack of wind from cooling fan • Lack of water	 • Clean the radiator core • Adjust the fan belt tension • Supply up to specified amount	
Lack of cooling water	Inspect the tank level and cooling water system	
Cooling water pipe is clogged	Inspect, and clean the inside of pump	
Air is taken in	Inspect the connecting parts of piping	

■ Temperature of lubricating oil is too high

Cause	Countermeasure	Remarks
Oil cooler is dirty	Inspect, and clean	
Insufficient cooling water	Inspect the cooling water pump and system	
Excessive gas leak to crankcase	Inspect the piston rings and cylinder liner	
Overload	Reduce the load	

■ Hunting occurs

Cause	Countermeasure	Remarks
Adjustment failure of electronic governor controller	Set again	
Operation failure around the adjustment device ring	Inspect and adjust	
Operation failure of fuel injection valve	Inspect and adjust (Replace if necessary)	
Malfunction of the fuel injection pump	Inspect and adjust (Replace if necessary)	
Air is in the fuel injection pipe	Prime the pipe and bleed air	
Malfunction of the governor or governor gear	Inspect, and repair or replace the parts	
Not enough fuel in tank	Fill with fuel oil	
Air is in the fuel oil system	Release air from the filter and fuel pipe	
Fuel filter is clogged	Disassemble and clean	
Moving parts have seizure (e.g. piston, main bearing, crank pin bearing, timing gear, etc.)	Inspect, repair or replace parts	

Hunting may be generated right after a cold start or right after the load interception until the engine settles.
The following conditions are normal.

- Hunting after cold-start: Engine settles within 20 seconds.
- Hunting after load interception: Engine settles within 8 seconds.

The definition here for the engine settling is the time settled within the range of ±1% of the steady state speed.

■ Exhaust temperature of all cylinders are too high

Cause	Countermeasure	Remarks
Boost air temperature is too high		
• Cooling water temperature of air cooler is too high	• Inspect the cooling water system, and lower the cooling water temperature to the predetermined range	
• Cooling water level of air cooler is too low	• Inspect and repair the cooling water pump	
• Air cooler is stained (cooling water side and air side)	• Overhaul and wash	
• Engine room temperature is too high	• Inspect and service the engine room vent	
Boost air pressure is too low		
• Air cooler (air side) is clogged	• Overhaul and wash	
• Turbocharger is stained or damaged	• Wash the blower side, or overhaul and wash the turbocharger	
• Back pressure at exhaust port is rising	• Inspect and clean the exhaust manifold and exhaust pipe	
• Negative pressure in engine room	• Inspect and service the engine room vent	
Property of fuel oil is not suitable	Depending on the analysis result, change the fuel oil	
Overload	Reduce the load	

YANMAR CO., LTD.

■ **Large Power Products Management Division**
Quality Assurance Division
5-3-1, Tsukaguchi-honmachi, Amagasaki
Hyogo, 661-0001, Japan
Phone: +81-6-6428-3137 Fax: +81-6-6421-5549

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