



SDEC POWER

**H**  
SERIES  
POWER  
GENERATION ENGINES



## G-DRIVE POWERPACK

Power Generation Specification

### OPERATION AND MAINTENANCE MANUAL

#### Power Output Range

62kW – 198kW

STAGE II EMISSION COMPLIANT  
FOR USE IN THE FOLLOWING TERRITORIES. ASIA, MIDDLE EAST AND AFRICA.

## H SERIES DIESEL ENGINE

MODELS	MAX ENGINE OUTPUT		RATED GENERATOR OUTPUT	
	Prime kW	Standby kW	Prime kVA	Standby kVA
4HT4.3-G22 (1500 rpm)	62	68	60	66
4HT4.3-G22 (1800 rpm)	67	74	68	74
4HT4.3-G23 (1500 rpm)	78	86	80	88
4HT4.3-G23 (1800 rpm)	86	95	85	94
4HTAA4.3-G21 (1500 rpm)	95	105	100	110
4HTAA4.3-G21 (1800 rpm)	105	116	110	121
4HTAA4.3-G22 (1500 rpm)	120	132	125	138
4HTAA4.3-G22 (1800 rpm)	120	132	125	138
4HTAA4.3-G23 (1500 rpm)	120	132	138	150
4HTAA4.3-G23 (1800 rpm)	120	132	138	150
6HTAA6.5-G22 (1500 rpm)	140	155	150	165
6HTAA6.5-G22 (1800 rpm)	150	165	160	176
6HTAA6.5-G23 (1500 rpm)	168	185	188	206
6HTAA6.5-G23 (1800 rpm)	180	198	200	220

Generator outputs calculated using nett engine power at 0.8 power factor, at an altitude below 1000 m.a.s.l. and 40-degree Celsius ambient temperature.  
Refer to the outputs and ratings tables for exact site conditions.

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## 1. INTRODUCTION

### 1.1 To User and Operator

Thank you for purchasing a product of Shanghai Diesel Engine Co., Ltd!

The H series diesel engine, available in two displacements of 4L and 7L, is a medium-power four-valve diesel engine with four or six cylinders that is newly developed by SDEC. Featuring strong power and low fuel consumption and with the emissions conforming to relevant national regulations, The H series diesel engine is a perfect power for middle- and high-end vehicles, construction machinery, generation sets and marine applications.

This manual mainly covers technical specifications, operation and maintenance instruction, with an aim to familiarize you with the engine, as well as the proper operation and maintenance thereof. Before using the engine, read carefully the relevant contents and requirements in this manual. Due to the continuous improvement of performance and structure of the engine, the technical specifications and illustrations of the engine in this manual may be slightly different from those of the engine you have, please note that we will provide the supplement and perfection in the later editions without notice. In case of any question during your engine operation and maintenance, please never hesitate to contact SDEC's after-sale service center [spare@sdecie.com](mailto:spare@sdecie.com) for technical advice or guidance.

SDEC has adopted the latest technology and high-quality parts for the engine. The genuine SDEC service parts are recommended to be used for repair and maintenance. Please contact SDEC's after-sale service center [spare@sdecie.com](mailto:spare@sdecie.com) for service parts.

Since this manual ensures proper engine operation and maintenance, it should be given to the new owner when the engine is traded or sold.

### 1.2 Scope

This manual is for the operation and maintenance of engineering mechanical/marine engine/power station engine series diesel engine.

### 1.3 Notices for Engine Quality Feedback

To better our service, please provide following information when you give feedback about quality issues, whereby we can understand and analyze the quality issues and the root causes thereof, and make the improvement in time:

- 1) When and where fault occurred.
- 2) Engine serial number, model, order number, delivery date and the detailed address of consignee.
- 3) Service conditions, cumulative operation time (in hours or kilometres), operating conditions (power, speed) and the grade of fuel and engine oil that were used.
- 4) The characteristics of the driven equipment (model, power consumption and structural feature, etc.)
- 5) The description of faults.
- 6) Parts or components claimed for compensation or repair should be mailed or sent in person to SDEC headquarters with the damage process record or description for facilitating analysis. If there are several problems or a very serious problem, please leave the site as it was and inform us promptly, and then SDEC will send staff for a joint analysis.

Quality issues should be dealt with based on the relevant provisions in the quality warranty manual.

### 1.4 Safety Instructions

Read and understand all safety notes and warnings before use and maintenance of the engine.

Following safety notes and warnings should be obeyed to avoid any personal injuries.

- Be sure to work in a safe place and be prepared for potential danger at any time.
- When working on the engine, always remain alert.
- Never work on the engine when physically or mentally fatigued.
- Do not smoke when working on the engine.
- Smoking is not allowed during fuel refilling, otherwise, fuel steam can cause fire easily.
- Smoking is not allowed when checking battery electrolyte level because electrolyte releases flammable gases.
- Do not wear a loose garment or any jewellery when working around the engine or its driven equipment. If necessary, wear safety goggles, work clothes, safety helmet or other protective items.
- Gen-sets must be kept 1 meter away from building or other equipment during operation to avoid fire.
- The engine exhaust fumes contain carbon monoxide and other harmful stuff which can be DEADLY. If the engine runs indoors, exhaust gas must be piped safely away from any building or enclosure that houses the engine.

- Do not remove guards and protective devices with which the engine is equipped for its exhaust system parts and exposed rotating parts when required. To prevent personal injury, marine engine exhaust parts like the exhaust tailpipe, muffler should be provided by OEM with protective devices; the engine exposed rotating parts like the belt pulley, net winding machine are better equipped with guards or protective devices.
- Do not put flammable stuff like fuel, lubricating oil, coolant, or danger stuff like explosive around the engine. They may cause fire or explosion.
- Wipe up any fuel, oil or coolant spills. They may cause fire when being lighted. Put rags with fuel, oil or coolant into a fire-protection container, and do not leave it on the engine.
- Remove dust, mud or other odds and ends on the engine. They can be a cause of fire or engine overheating.
- Before starting the engine, make sure there are no persons around, nor tools or other things on the engine. Do not start the engine when a tag of Do Not Start is on the starting switch.
- When fuel, oil, or exhaust gas leak is found, take measures to eliminate the leakage source immediately. Splashed fuel or oil on high temperature parts or exhaust gas contacting flammable stuff can cause fire, personal injure or engine damage.
- Do not check fuel, oil and coolant leaks with hand. High pressure and high temperature fuel, oil or coolant can cause personal injure. Be very careful when checking fuel leak, because high pressure fuel can inject into skin and cause personal injure or even death. Use a thick plate to check for fuel leak and avoid contacting injected fuel when finding fuel leak.
- Use an explosion-proof light to check fuel, oil, coolant or electrolyte if light is needed to prevent fire explosion.
- Do not smoke, and do not use fire when handling or working near fuel system components, for fuel steam may be lighted and cause damage to components or personal injure.
- Do not make any maintenance to fuel system parts when the engine is in operation.
- Fuel flows from the injection pump to the injectors through the high-pressure fuel pipes under very high pressure. Do not loosen the high-pressure fuel pipes when the engine is in operation. This will result in serious scald.
- If the engine will not be used for a long time or for repair, always disconnect the battery cables or the air line of an air starter motor if used to prevent accidental startup. Meanwhile, place a tag of Do Not Operate in the operation room or on the starting switch. Disconnect the cable from the post indicated by a NEGATIVE, NEG, or (-) first, then remove the POSITIVE, POS, or (+) cable. When reconnecting the cables, connect the POSITIVE cable first, the NEGATIVE cable last.
- Do not use a metal tool to contact the two battery posts, and do not make the two posts short circuit, or explosion may happen.
- The connection of the battery cable posts must be secured. Explosion may happen due to poor connection. Damaged wires or cables will cause fire. Check and replace them before reconnecting the wires and cables.
- Do not use fire, nor make welding near the battery(s) because battery can produce flammable hydrogen and oxygen.
- Do not use the battery(s) when its electrolyte is lower than the minimum level. Improper use of electrolyte can cause blind or scald.
- If the engine runs indoors, always keep a fire extinguisher near the engine. Keep the extinguisher properly charged and be familiar with its use. Keep an emergency medical box in a specified place where is accessible. Make sure there are measures available for dealing with fire or accidents. Do not use any carbon fire extinguishers of tetrachloride type. These fire extinguishers emit toxic fumes, and the liquid can damage wiring insulation.
- Keep skin or eyes free from coolant or electrolyte when refilling and changing. In case of skin contact, please flush they contacted part with soap and clean water; in case of eye(s) contact, flush your eye(s) for 15 minutes with clean water and seek for medical treatment immediately.
- Cool down the engine first when refilling coolant to avoid being hurt by coolant steam. Open the pressure cap or filler cap only when the coolant temperature is lower than 50°C, and then slowly loosen the cap to release the pressure of coolant. The coolant is very hot when the engine has just stopped, and coolant steam or hot coolant can inject and cause scald if the cap is opened. The cap must be tightened after checking, refilling or changing coolant.
- Do not touch by hand the intake and exhaust system components like the exhaust manifold, exhaust tailpipe, turbocharger, intercooler air inlet pipe and expand tank when the engine is in operation because they are very hot. The coolant is very hot when the engine is in operation, and steam or hot coolant will inject and cause scald if the cap is opened.
- Stop the engine when the fan drive belt breaks, or the engine will overheat, and coolant steam in the expansion tank will inject and can cause scald.
- Do not handle discharged oil or replaced oil filter with bare hand, for high temperature oil or lubricating system part are very hot and can cause scald.
- Release the pressure in the air, lubricating, cooling or fuel system prior to dismantling or loosening any of its pipelines, permanent joints, connectors or relevant parts of the system. Otherwise, high pressure fuel, lubricating

oil and coolant can cause personal injury.

- Do not get near to the exposed rotating parts when the engine is in operation and keep away things that may be easily caught by the rotating parts from around the engine, or serious personal injury can happen.
- Make sure to shut down the engine before any adjustment is performed to it and its driven equipment. Anything that is caught in rotating parts can cause a serious accident.
- Use a barring tool to rotate the engine. Do not rotate the engine with the fan, otherwise severe personal injury or damage to fan blades can be caused.
- Take away the barring tool after being used, or it can damage the engine and cause personal injury when the engine is in operation.
- Used lubricating oil may contain carcinogenic substance which can result in reproductive toxicity, therefore, inhalation of or longtime exposure to oil steam should be avoided. Waste oil should be disposed in proper, safe and reliable manner.
- To prevent choke or cold injury, removal of air-conditioning refrigerant (Freon) pipeline should be conducted in well-ventilated environment with protective clothing on. For environment protection, the refrigerating system should be emptied or filled using dedicated equipment to prevent diffusion of Freon into atmosphere. Refrigerant should be recovered and recycled.
- For environment protection, used oil, fuel, coolant, oil filter or fuel filter must be properly disposed according to relevant environment protection regulations when changing oil, oil filter, fuel filter or coolant. And discarded battery(s) must be also properly disposed.

### 1.5 Engine Operation Instructions

Read and understand all notes and warnings before use and maintenance of the engine. Following notes and warnings must be followed to prevent the engine from fault or damage

- Read this manual carefully and be in strict accordance with operation instructions and maintenance procedures specified in this manual.
- Conduct daily and 4-level maintenances as specified in this manual and keep the records of scheduled maintenances.
- Use the proper fuel, lubricating oil and coolant specified in this manual.
- The coolant specified in the manual should be adopted for the engine in any climate.
- When refilling lubricating oil, it is not allowed to use the mixture of oil of different specifications.
- Check if fuel, oil and coolant are enough before starting the engine.
- Be sure to remember that the engine must be started with no load.
- 60 hours' running-in must be conducted for a new or overhauled engine.
- Do not run the engine without air filter (marine application is exceptional), otherwise, early engine wear can happen.
- If the engine runs indoors, always keep the engine room in good ventilation. Insufficient air sucked by engine will cause high coolant temperature, low power output and poor performance. Ventilation equipment is provided for the engine room if necessary.
- Observe the engine operation and all the instrument readings. In case of abnormal condition or critical situation, an emergency stop should be performed, and faults must be removed to prevent the seizure of moving parts caused by low oil pressure or engine overheating due to lack of coolant.
- Do not run the engine at high load and high speed when the coolant temperature is blow 60°C.
- Do not run the engine at overloaded condition.
- Stop the engine when it is overheating. Do not add coolant right after the engine has stopped, which leads to damage to cylinder head parts.
- Stop the engine when its warming device goes alarm. Find and remove the root cause before starting the engine again. Let the engine having problems continue to run will lead to greater ones.
- Stop the engine when its oil pressure goes down in abnormal due to some reason. Find and remove the root cause. Let the engine continue to run at low pressure oil will lead to engine bearings burning.
- Before starting the engine after being repaired, make sure to be ready to cut air supply. In case of any abnormal, cut air supply to stop the engine immediately.
- Welding on the engine or equipment is not recommended. When welding on the engine or equipment is necessary, cut equipment power supply before welding, disconnect electronic components from their harnesses. It is not allowed to connect and disconnect harnesses when power is on. Do not plug a harness in and out without necessary. If necessary, plug it in and out when power is off to avoid its malfunction.
- The belt tension and the other drive devices can only be inspected when the engine is in stop.
- Do not pry the drive belt in the pulleys with a crowbar, or this can cause damage to the reinforced fibres inside the belts.

- Remove and install the belts only by hand.
- If the belt has been contaminated by oil, fuel, or other harmful liquid, make sure to replace it. Do not try to clean it. Find out and remove the source of pollution.
- When storing and carrying the drive belt, make sure its bent diameter is not less than 25 mm. Do not hang it on a hook.
- The surfaces of the drive belt pulleys must be smooth to prolong the belt service life. Therefore, before installing the belt, make sure the pulley surfaces are free from roughness or burr, and the pulleys can rotate smoothly.
- The battery(s) must be replaced when its lifetime is due.
- Malfunction thermostat should be replaced in time, but the use of thermostat cannot be omitted.
- Do not cut the seal on the fuel injection pump. The seal prevents the fuel control part from being moved. The engine warranty will not be given if the seal is cut. If the seal is cut, the wear of moving and rotating parts of the fuel injection pump will increase and be damaged, fuel and oil consumptions will increase dramatically, fuel will be injected improperly, governor performance will go degenerated, and the engine will over-speed.
- Do not use raw water to cool the engine directly.
- Do not clean the fuel injection pump with electronic governor by watering it directly.
- Do not let rain enter the engine from the exhaust and intake ports. Do not clean the engine when it is in operation. Detergent or water may be introduced into the inside of the engine. When the engine is started, detergent or water inside the engine combustion chamber can cause damage to the parts inside by its hydraulic pressure, which leads to a serious accident.
- Do not change the application and scope of the engine without permission, or it can cause damage to the engine, and/or equipment, and personal injury.
- The changed engine will not get any warranty even though it is in the warranty period.
- If the engine is scrapped, it should be disposed according to the relevant national and local laws and regulations.

### 1.6 Warning Signs on the Engine

There are warning signs as below on the engine. They must be strictly observed to avoid personal injure or engine damage.



警告



注意防止手衣服等卷入运转时，切勿触及或靠近风扇、皮带等旋转零件。切勿拆下旋转部件罩盖运行。

Warning: Prevent hands and clothes from being dragged in Do not touch or get close to running parts such as fan, belt, etc and do not remove covers of running parts when the engine is in operation.



敬告  
警告  
WARNING



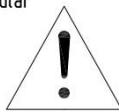
注意防止高温烫伤

柴油机运转时，请勿触及排气管、增压器、中冷器进气管、膨胀水箱等高温部件。

**Be Careful With Scalding**

When the engine is operating, do not touch the heated components such as the exhaust pipe, the turbocharger, the inlet pipe of after-cooler, the expansion tank, etc.

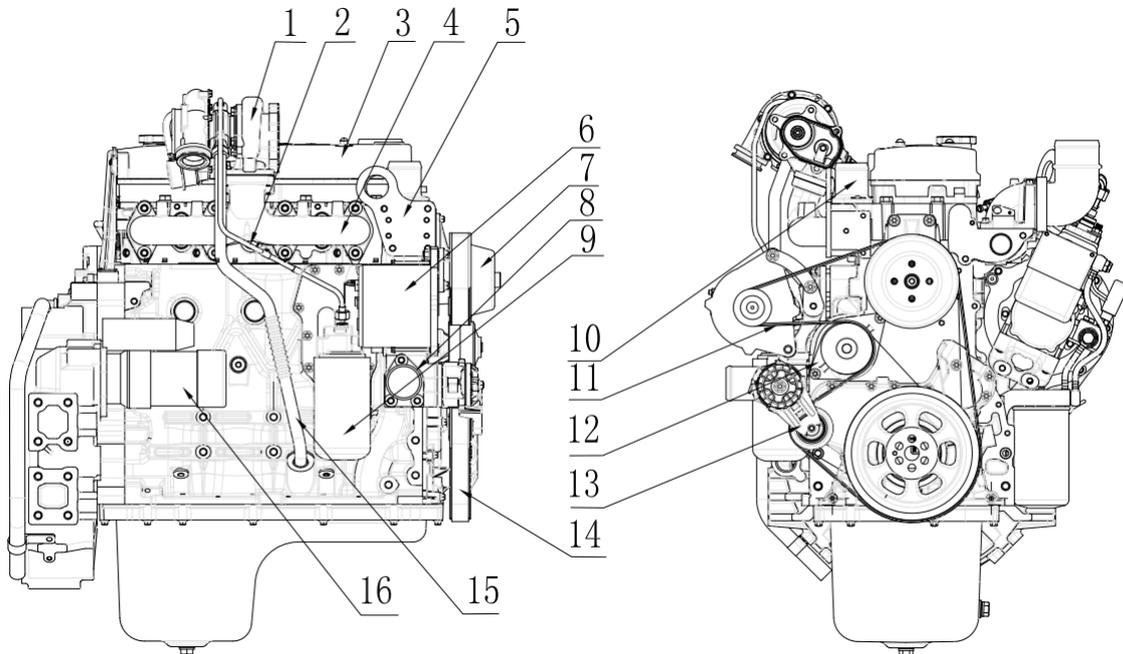
- △ 使用机器前，操作人员必须阅读柴油机使用保养说明书，并严格按照规定操作！
- △ 必须用上柴专用机油；定期更换机滤、柴滤；每天检查空滤器！
- △ 柴油机怠速运行不得大于10min!当冷却液温度低于 60°C 时，严禁柴油机高速高负荷运行。
- Operator must read Operation and Maintenance Manual carefully before starting the engine and run the engine strictly per the instruction in the manual!
- Special lubricating oil designated by Shanghai Diesel Engine Co.Ltd must be used; Regular replacements of oil filter and fuel filter and daily check of air filter are required!
- Do not run the engine at idle speed for over 10 minutes! Do not run the engine towards high load when the coolant temperature is below 60°C.



## 2. ABOUT THE ENGINE

### 2.1 Engine Outline Diagrams

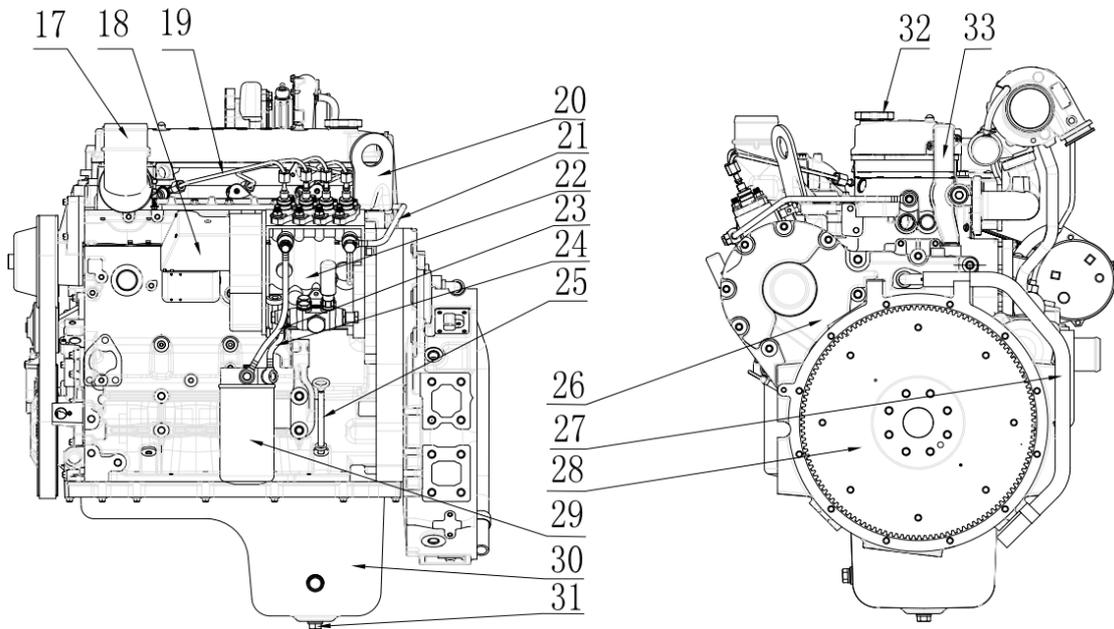
#### 2.1.1 4HTAA Diesel Engine (4L)



Exhaust Side View

Front End View

1	Turbocharger
2	Turbocharge Oil Inlet Pipe
3	Valve Cover
4	Exhaust Manifold
5	Front Engine Lifting Plate
6	Alternator
7	Fan Pulley
8	Engine Coolant Inlet Pipe
9	Oil Filter
10	Engine Coolant Outlet Pipe
11	Fan Belt
12	Water Pump
13	Belt Tensioner
14	Crankshaft Pulley
15	Turbocharger Oil Return Pipe
16	Starting Motor

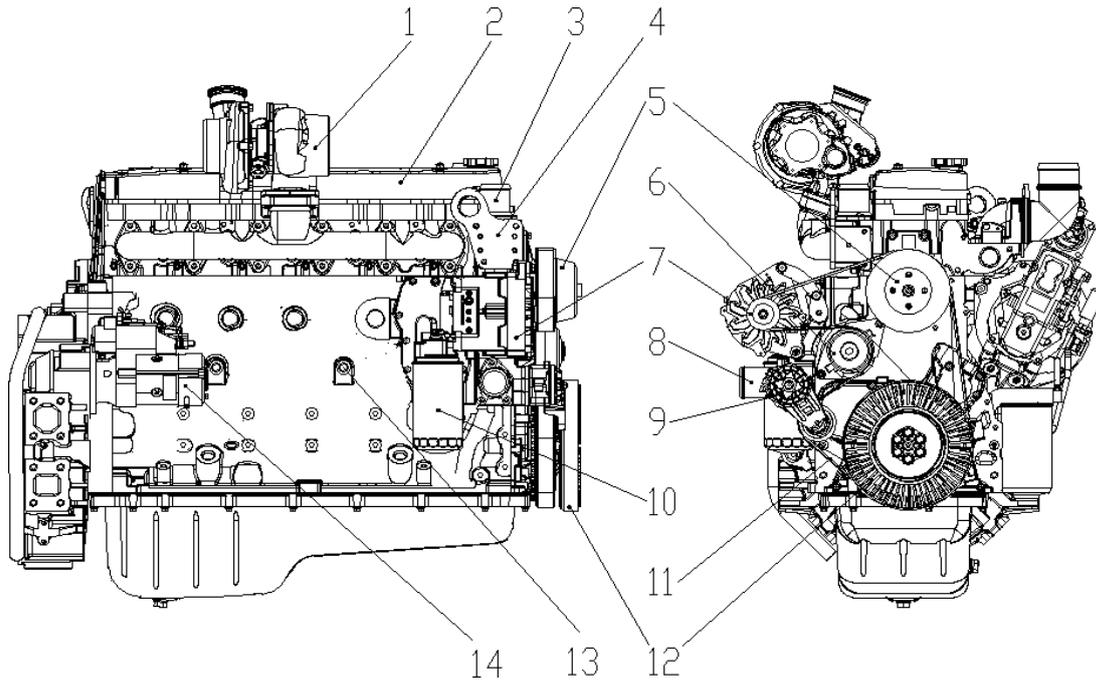


Intake Side View

Rear End View

17	Air Inlet Elbow
18	Governor (Mechanical or Electronic)
19	High-pressure Fuel Pipe
20	Engine Rear Lifting Plate
21	Fuel Return Pipe
22	Fuel Injection Pump
23	Fuel Injection Pump Fuel Inlet Pipe
24	Fuel Filter Inlet Pipe
25	Oil Dipstick
26	Flywheel Housing
27	Outlet Pipe of Crankcase Ventilation
28	Flywheel
29	Fuel Filter
30	Oil Pan
31	Oil Drain Plug
32	Oil Filter
33	Engine Ventilation Pipe

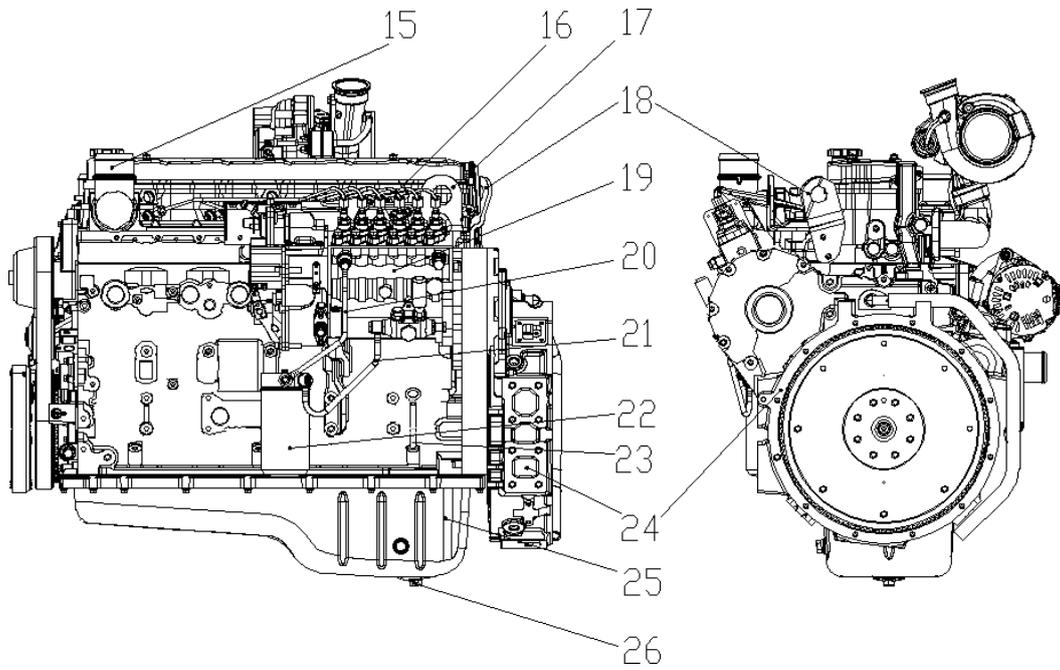
## 2.1.2 6HTAA Diesel Engine (7L)



Exhaust Side View

Front End View

1	Turbocharger
2	Valve Cover
3	Engine Coolant Outlet Pipe
4	Front Engine Lifting Plate
5	Fan Bearing Housing
6	Water Pump
7	Alternator
8	Engine Coolant Inlet Pipe
9	Tensioner
10	Oil Filter
11	Fan Belt
12	Vibration Damper
13	Water Drain Plug
14	Starting Motor

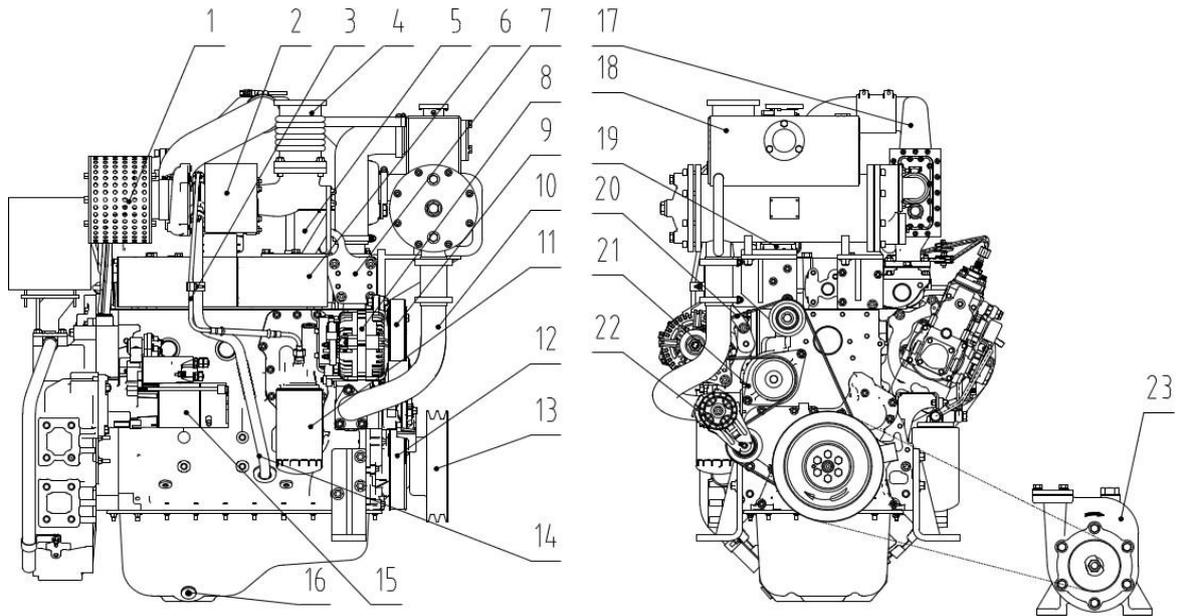


Intake Side View

Rear End View

15	Intake Pipe
16	High-pressure Fuel Pipe
17	Right Engine Lifting Plate
18	Rear Engine Lifting Plate (Optional)
19	Fuel Injection Pump (mechanical or Electronic Governor)
20	Fuel Injection Pump Fuel Inlet Pipe
21	Fuel Filter Inlet Pipe
22	Fuel Filter
23	Oil Dipstick
24	Flywheel Housing
25	Oil Pan
26	Oil Drain Plug

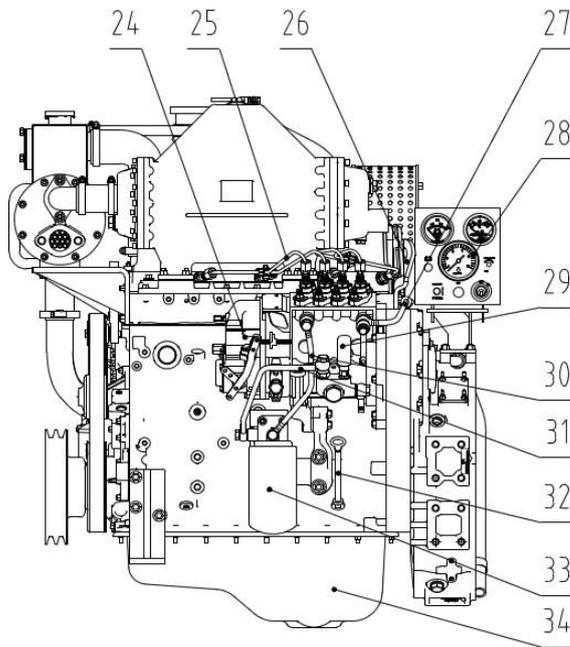
### 2.1.3 4HTAA Diesel Engine for Marine Auxiliaries (4L)



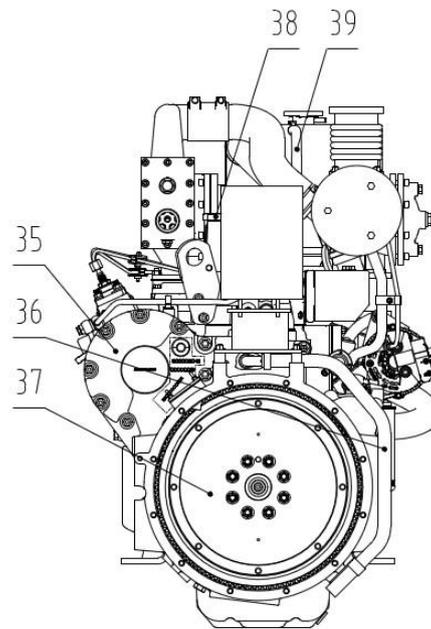
Exhaust Side View

Front End View

1	Air Filter
2	Turbocharger
3	Turbocharger Oil Inlet Pipe
4	Expansible Pipe
5	Valve Cover
6	Exhaust Manifold
7	Engine Front Lifting Plate
8	Alternator
9	Drive Pulley
10	Engine Coolant Inlet Pipe
11	Oil Filter
12	Crankshaft Pulley
13	Drive Pulley
14	Turbocharger Oil Return Pipe
15	Starting Motor
16	Oil Drain Plug
17	Intercooler
18	Heat Exchanger
19	Engine Coolant Outlet Pipe
20	Drive Belt
21	Water Pump
22	Belt Tensioner
23	Raw Water Pump



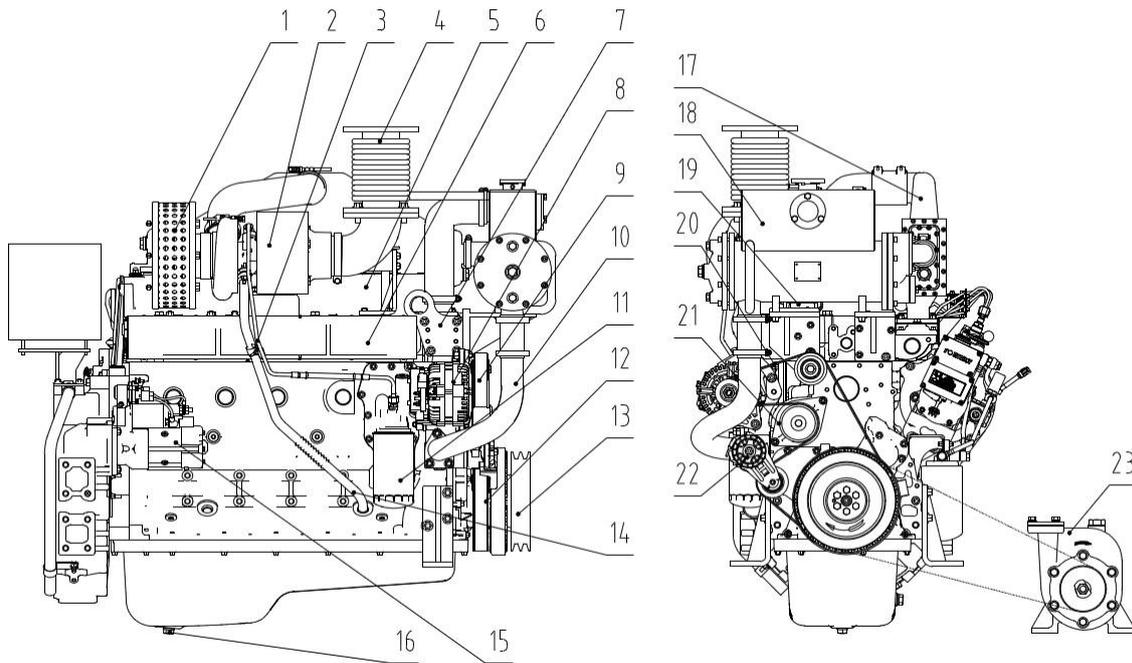
Intake Side View



Rear End View

24	Governor (Mechanical or Electronic)
25	High-pressure Fuel Pipe
26	Engine Rear Lifting Plate
27	Fuel Return Pipe
28	Instrument Pan Box
29	Fuel Injection Pump
30	Fuel Pump Fuel Inlet Pipe
31	Fuel Filter Inlet Pipe
32	Oil Dipstick
33	Fuel Filter
34	Oil Pan
35	Flywheel Housing
36	Oil Separator Gas Outlet Pipe
37	Flywheel
38	Oil Filter Cap
39	Oil Separator Gas Inlet Pipe

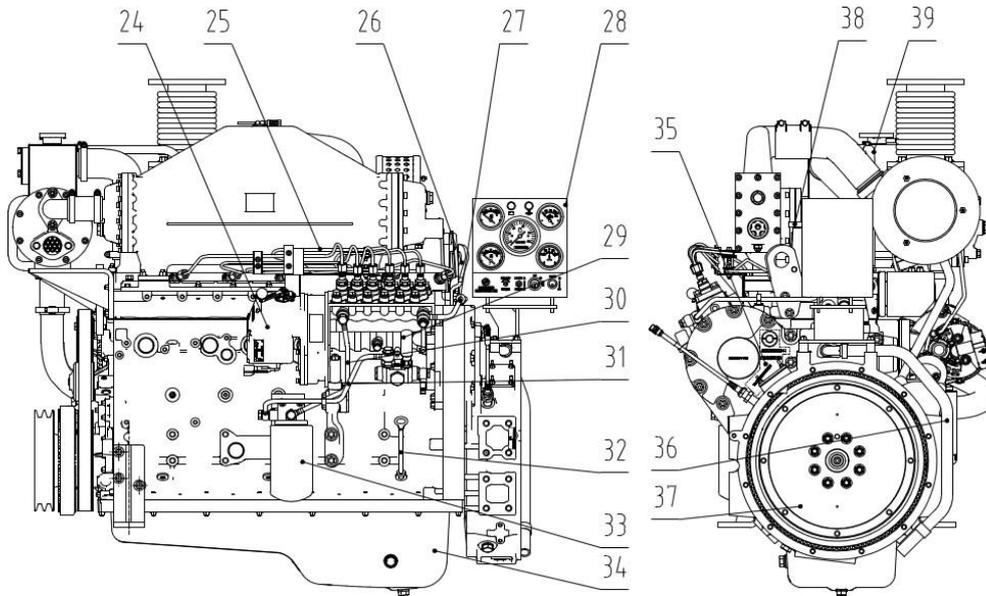
## 2.1.4 6HTAA Diesel Engine for Marine Auxiliaries (7L)



Exhaust Side View

Front End View

1	Air Filter
2	Turbocharger
3	Turbocharger Oil Inlet Pipe
4	Expansible Pipe
5	Valve Cover
6	Exhaust Manifold
7	Engine Front Lifting Plate
8	Alternator
9	Drive Pulley
10	Engine Coolant Inlet Pipe
11	Oil Filter
12	Crankshaft Pulley
13	Drive Pulley
14	Turbocharger Oil Return Pipe
15	Starting Motor
16	Oil Drain Plug
17	Intercooler
18	Heat Exchanger
19	Engine Coolant Outlet Pipe
20	Drive Belt
21	Water Pump
22	Belt Tensioner
23	Raw Water Pump



Intake Side View

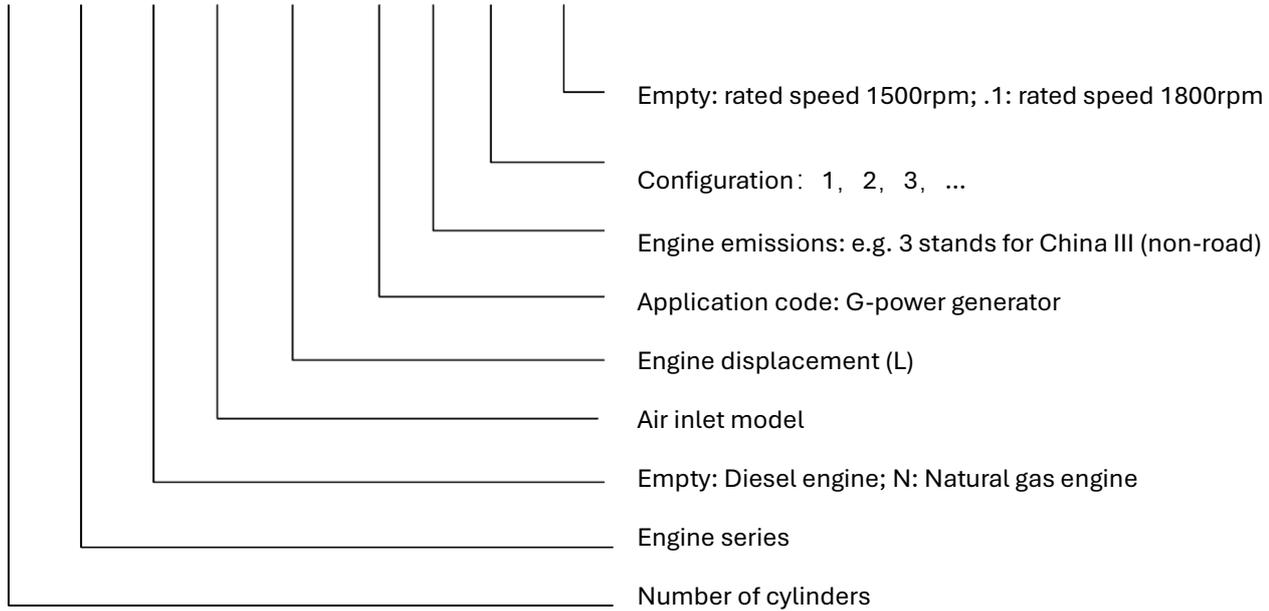
Rear End View

24	Governor (Mechanical or Electronic)
25	High-pressure Fuel Pipe
26	Engine Rear Lifting Plate
27	Fuel Return Pipe
28	Instrument Pan Box
29	Fuel Injection Pump
30	Fuel Pump Fuel Inlet Pipe
31	Fuel Filter Inlet Pipe
32	Oil Dipstick
33	Fuel Filter
34	Oil Pan
35	Flywheel Housing
36	Oil Separator Gas Outlet Pipe
37	Flywheel
38	Oil Filter Cap
39	Oil Separator Gas Inlet Pipe

## 2.2 Engine Model Identification

The engine model represents the meanings as follows:

□ □ □ □ □ - G □ □ .1



## 2.3 Engine Nameplate

The diesel engine nameplate indicates the main technical data and information: engine model, order number, serial number, date of manufacture, rated power and rated speed, which are the major basis for you to purchase service parts and for SDEC to conduct after-sale technical service. We hope you put the information and data into the daily record of work of your engine or equipment for later repair and reflection of quality problems. This is helpful for the correct settlement of your problems. The nameplate is located at the top of the cylinder head cover. Protect it from being damaged.

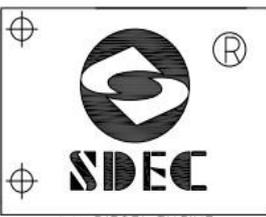
### For General Application

 <p>柴油機 DIESEL ENGINE</p>	型号 MODEL	机号 SER.NO.	出厂日期 DATE		
	许可证号 LICENCE NO.	标定功率/转速 RATED POWER/SPEED		kW/r/min	
	型式核准号 TYPE-APPROVAL NO.	排放阶段 EMISSION LIM.	净质量 NET WT.	kg	
	执行标准 EXECUTED STANDARD	订货号 ORD.NO.			
	中国上海柴油机股份有限公司 SHANGHAI DIESEL ENGINE CO. LTD. CHINA				

### For Generator Sets

 <p>柴油機 DIESEL ENGINE</p>	型号 MODEL	订货号 ORD.NO.	出厂日期 DATE		
	许可证号 LICENCE NO.	额定功率/转速 RATED POWER/SPEED		kW/r/min	
	最大功率/转速 MAX POWER/SPEED	kW/r/min	排放阶段 EMISSION LIM.	净质量 NET WT.	kg
	执行标准 EXECUTED STANDARD	机号 SER.NO.			
	中国上海柴油机股份有限公司 SHANGHAI DIESEL ENGINE CO. LTD. CHINA				

## For Marine Auxiliaries

 柴油机 DIESEL ENGINE	型号 MODEL	订货号 ORD. NO.	机号 SER. NO.			
	许可证号 LICENSE NO.	执行标准 EXECUTED STANDARD	排放阶段 EMISSION LIM.	出厂日期 DATE		
	额定功率/转速 RATED POWER/SPEED	KW/r/min	无限航区额定功率 OCEANGONG RATED OUTPUT	KW	净质量 NET WT.	Kg
	最大功率/转速 MAX POWER/SPEED	KW/r/min	无限航区最大功率 OCEANGONG MAX. OUTPUT	KW	海拔高度 MAX ALT.	m
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**Note: Do not change the nameplate without our permission!**

## 2.4 Specifications and Parameters

## 2.4.1 Specifications

## 2.4.1.1 For General Application

Engine	4HTAA	6HTAA
Total piston displacement/L	4.3	6.5
Type	In-line, four-stroke, water-cooled	
Bore/mm	105	
Stroke/mm	124	124
Number of Cylinders	4	6
Number of valves of each cylinder	4	
Firing order (Viewed from the free end)	1-3-4-2	1-5-3-6-2-4
Aspiration	Turbocharged and intercooled	
Fuel system	Mechanical fuel injection pump with mechanical or electronic governor	
Crankshaft rotation (facing flywheel)	Counterclockwise	
Starting mode	Electric	
Dry weight/kg	423	560
Dimensions(basic model)	Length/mm	807
	Width/mm	722
	Height/mm	968
		1048
		722
		995

- The dry weight does not include the weight of starting motor, alternator, air compressor, power steering pump, clutch, coolant and oil but includes the weight of flywheel and flywheel housing according to DIN 70020.
- Outline dimensions listed above refer only to the basic engine model and those of other models are different.

## 2.4.1.2 For Generator Sets

Engine model		4HT4.3-G22	4HT4.3-G23	4HTAA4.3-G21	4HTAA4.3-G22 4HTAA4.3-G23	6HTAA-6.5-G22	6HTAA-6.5-G23
Type		In-line, four- cylinder, water cooled, four-stroke, direct injection				In-line, six- cylinder, water cooled, four-stroke, direct injection	
Aspiration type		Turbocharged		Turbocharged and intercooled			
Bore/mm		105					
Stroke/mm		124					
Displacement/L		4.3			6.5		
Crankshaft rotation (viewed from flywheel end)		Counterclockwise					
Firing order (from frond end)		1-3-4-2			1-5-3-6-2-4		
Rated	Power/kW	62	78	105	120	154	168
	Speed/(r/min)	1,500					
Overloaded	Power/kW	68	86	116	132	170	185
	Speed/(r/min)	1,500					
Stable speed governing rate%		5%					
Starting mode		Electric, 24V					
Net weight/kg		430		460		600	
Dimensions	Length/m m	1,012		1,053		1,343	
	Width/mm	723		717		741	
	Height/m m	1,079		1,158		1,178	

## Note:

- The listed engine performance data are obtained at the standard test conditions: ambient temperature is 25°C, relative humidity 30% and barometric pressure 100 kPa.
- When the engine operates on over 2,000 meters above the seal level, its power output will decrease and its performance become bad. So, it is required to reduce the engine power output when it runs at altitude higher than 2,000 meter. It is not recommended to run the engine over 4,000 meters above the sea level.
- The performance data of an engine model shall be referred to the ones on its nameplate.

### 2.4.1.3 For Marine Auxiliaries

Model		4HT4.3-G22	4HT4.3-G23	4HTAA4.3-G21	4HTAA4.3-G22 4HTAA4.3-G23	6HTAA-6.5-G22	6HTAA-6.5-G23
Type		In-line, four-cylinder, water-cooled, four-stroke, direct injection				In-line, six-cylinder, water-cooled, four-stroke, direct injection	
Aspiration type		Turbocharged		Turbocharged and intercooled			
Bore/mm		105					
Stroke/mm		124					
Displacement/L		4.3				6.5	
Crankshaft rotation (facing flywheel)		Counterclockwise					
Firing order (Viewed from the free end)		1-3-4-2				1-5-3-6-2-4	
Rated	Power/kW	62	78	105	120	154	168
	Speed/(r/min)	1,500					
Overloaded	Power/kW	68	86	116	132	170	185
	Speed/(r/min)	1,500					
Rated power @ unrestricted navigation area /kW		60	75	102	116	149	163
Max. power @ unrestricted navigation area /kW		66	83	112	128	164	179
Stable speed governing rate%		5%					
Starting mode		Electric, 24V					
Net weight/kg		475		540		675	
Dimensions	Length/mm	971		971		1,267	
	Width/mm	729		767		787	
	Height/mm	1,028		1,055		1,179	

**Note:**

- The listed engine performance data are obtained at the standard test conditions: ambient temperature is 25°C, relative humidity 30% and barometric pressure 100 kPa.
- When the engine operates on over 2,000 meters above the seal level, its power output will decrease and its performance become bad. So, it is required to reduce the engine power output when it runs at altitude higher than 2,000 meter. It is not recommended to run the engine over 4,000 meters above the sea level.
- The performance data of an engine model shall be referred to the one on its nameplate.

## 2.4.2 Parameters

Diesel engine	4HTAA	6HTAA
<b>Lubricating System</b>		
Oil pressure/kPa	70	
Idle speed (minimum allowable) Rated speed (minimum allowable)	207	
Oil pan capacity/L (Oil dipstick “high-low”)	11.4-9.4	18-15
Total system capacity/L	13.4	20.5
<b>Cooling system</b>		
Coolant capacity/L	6.8 13.3 (marine application)	9.6 16.1 (marine application)
<b>Intake-exhaust system</b>		
Max. allowable intake resistance/kPa (@ rated condition, with dry-type air filter)	4 (with new element)	
Max. allowable exhaust resistance/kPa (Turbine outlet pressure @ rated condition)	10	
<b>Electrical system</b>		
Min. recommended battery capacity/Ah	120	150
24V system	24V	
Battery current of at -18°C for cold starting /CCA	600	750
<b>Starting motor</b>		
Voltage/V	24V	
Power/kW	4.5	6
<b>Alternator</b>		
Voltage/V	28	
Current/A	55, 70 ,35 (optional)	
Rated power/kW	1.5, 2.0, 1.0 (optional)	

- Coolant capacity only refers to the coolant volume in the engine cooling system.
- The value does not include the resistance of exhaust butterfly valve.
- The capacity of a battery should be properly increased for a starting with higher requirement.

### 3. ENGINE OPERATION

Proper use of your engine can not only keep it in normal working order and good performance but also can extend its service life and reduce its use cost. Adopt proper fuel, oil and coolant, as well as the correct operation steps stipulated in this section.

#### 3.1 Fuel

The specifications of the fuel used for the engine should be in accordance with the standards GB 19147. Proper fuel designation should be chosen for the engine according to ambient temperature. In cold winter, fuel with low-freezing-point should be adopted, while contrary in summer. You may choose the right fuel according to the standards GB 19147 or refer to the table below: e.g. for ambient temperature of above -27°C, fuel with the designation of -35# should be used.

##### Relationship between diesel fuel grades and applicable minimum temperatures.

Designation of fuel	0#	-10#	-20#	-35#
Cetane value	≥49	≥49	≥46	≥45
Solid point/°C	≤0	≤-10	-20	-35
Minimum applicable temperature (engine working temperature)/°C	Above 4°C	Above -5°C	Above -14°C	Above -29°C

**Caution: Fuel must be kept at the highest level of cleanness and not polluted by dust, impurities or water.**

#### 3.2 Lubricating Oil

SDEC-designated special lubricating oil of grade CF-4 and above is strongly recommended for this engine to ensure its normal operation and long service life and improve its emissions. If the above engine oil is not available, oil of CF-4 grade or above meeting the requirements of American Petroleum Institute (API) can serve as an alternative. Choose the oil viscosity under the expected highest working temperature by using the data in the maximum ambient temperature in the table below.

##### Operating temperature range for engine oil (GB 11122-2006)

Viscosity grades of SDEC-designated engine oil of CF-4	Ambient temperature	
	Minimum	Maximum
0W-40	-50°C	40°C
5W-20	-40°C	30°C
5W-40	-40°C	40°C
10W-30	-30°C	30°C
10W-40	-30°C	40°C
10W-60	-30°C	60°C
15W-40	-20°C	40°C
20W-50	-10°C	50°C

**Caution: Engine oil must be kept clean and free from dust, impurities or water.**

**Caution: Do not use the mixture of oil of different specifications.**

### 3.3 Coolant

To ensure the normal operation and long service life of the engine, use coolant with functions of anti-freeze, anti-rust and anti-corrosion at any weather condition.

### 3.4 Engine Power Output

Engine power output for driving the equipment is taken from flywheel. When using coupling to connect the equipment, the centerline of the equipment should be aligned with the centerline of the crankshaft. If using an elastic coupling, the misalignment shall not be greater than  $\phi 0.30\text{mm}$ . If using a rigid coupling, the misalignment shall not be greater than  $\phi 0.10\text{mm}$ .

**Caution: The engine should not be started with load. So, there should be kind of clutch device between the engine and driven equipment.**

A certain power can be taken from the front crankshaft of the engine. But the output power for transverse driving with a belt directly on the front crankshaft pulley should not exceed 11 kW. The amount of power from front engine end is subject to the limitation of bending moment that changes with power delivery location and pulley shape. It is therefore required to get approval from SDCE for a transverse power delivery arrangement at the front end.

It is forbidden to directly install a pulley on the flywheel to drive equipment transversely by belt because such operation can easily damage the crankshaft and main bearings. If it is required to have a transverse driving, use an engine or an additional device that is suitable for transverse driving. Do not let the crankshaft and main bearings sustain transverse forces directly.

### 3.5 Engine Start

Before using the engine, choose proper lubricating oil, fuel and coolant according to local ambient conditions. Besides, the following work should be done before starting:

- Make a surround inspection of the engine and its starting system and solve problems in time if any.
- Check oil pressure and temperature gauges, coolant temperature gauge, warning lights and other instruments for normality.
- Check the service indicator of the air filter for appearance of red piston.

**Caution: Do not to start the engine without an air filter to avoid early engine wear. Marine engine is exceptional.**

- Check the service indicator of the primary fuel filter for appearance in red.
- Check the oil level for being within the specified range. Add proper amount of clean oil into the turbocharger oil inlet port when the engine is first put into use or after being overhauled.
- Check the coolant level for being within the specified range.
- Check the electrolyte level for being within the specified range.
- When the engine is first put into use, or overhauled, or out of service for some days, or its fuel filter has just been replaced, there can be air in the fuel system. It is required to prime the fuel system with the priming pump. Refer to Section 4.3 for specific priming operation.
- Check the electric starting wires for normality.
- All the safety devices must be installed in place.
- Check the accelerator pedal or lever for free movement.

#### 3.5.1 Normal Starting Procedure

- Disengage the engine from the drive system or put transmission into the “neutral” position if equipped.
- Put the mechanical operating devices into the “running” position.
- Insert electric key and turn the switch from the OFF position to the ON position to electrify intake air heating device and other electrical devices. The pre-heating indicator light flashes on when intake air pre-heating proceeds and it doesn't flash when no pre-heating happens.
- If pre-heating happens, wait until the pre-heating indicator light goes out and then turn the switch from the ON position to the START position to start the engine. For vehicle application, it is required to step on the accelerator pedal when starting.

**Caution: Starting time should be no more than 15 seconds and there should be a two-minute interval before the next starting to prevent the damage to starting motor.**

Each start usually lasts 2 -3 seconds.

- The switch goes back to the ON position from the START position automatically after starting up.

**Caution: The oil pressure gauge should show reading within 15 seconds after the engine has successfully been started; otherwise, stop the engine immediately to prevent damage to the engine and find the causes and remove the fault according to Section 5 Troubleshooting Guidelines.**

- Started up from a hot state, the engine should run at idle for 1-3 minutes before being accelerated and loaded gradually.
- Started up from a cold state, the engine should run at idle for 3-5 minutes. Increase the engine speed slowly to have every bearing adequately lubricated and oil pressure stable. Gradually accelerate and load the engine after oil pressure is stable.
- Check the instruments for operational conditions in engine idle running.

**Caution: Do not accelerate and load the engine immediately after it is started up.**

**Caution: Do not idle the engine for a long period of time or it can cause problems to the engine. When an engine idles, the temperature in the combustion chamber is low and combustion is not complete. It can cause carbon deposit in cylinder that results in blocking of orifice of fuel injector, as well as the seizures of piston rings and valve, thus leading to engine performance deterioration.**

**Caution: If the engine is start by a jumper cable, parallel connection of the cable should be adopted by connecting the positive pole to the positive terminal and the negative pole to the negative terminal. If the engine is start by an external power supply, the circuit breaker should be set to the OFF position. Take out the key to prevent accidental activation before connection of jumper cable.**

### 3.5.2 Cold Starting

The engine can start successfully without any pre-warming aid if the temperature is above  $-15^{\circ}\text{C}$ . It is, however, recommended to use an intake air heating device (electric heating device) to get a fast and smooth start as well as to keep speed stable and improving the smoke after starting up.

Electric heating devices consist of electric heaters, electronic controllers, temperature sensors and indicator light. Its work is governed by the electronic controller.

The electronic controller governs intake air heating according to ambient temperature. The heating is divided into two stages: heating intake air before engine starts (pre-heating) and heating intake air after engine starts (after-heating). Generally, it is not allowed to start engine during the first stage of heating (pre-heating). Once the engine is started, the pre-heating will automatically stop. Start the engine after the pre-heating is over.

- Insert the electric key and turn the switch from the OFF position to the ON position to electrify the electronic controller. Pre-heating intake air starts, and the indicator light flashes on. Intake air heating ends and the indicator light flickers. The engine is ready to start.
- Turn the switch from the ON position to the START position to start the engine after the indicator light goes out. The switch turns back to the ON position automatically after the engine has started up.
- After-heating begins and its duration is governed by the electronic controller. The indicator light does not flash in the process.
- Refer to Normal Starting Procedure for other engine starting instructions.

**Note:** If startup does not happen or the engine has not been started up within 30 seconds after the indicator light starts flickering, the electronic controller will automatically disconnect the circuits of glow plug, solenoid and indicator light, entering delay protection. If another startup is initiated, turn the electric key back to the OFF position, and wait for 5 seconds before repeating the above process.

### 3.5.3 Starting after a long-time stop or replacement of lubricating oil

If the engine hasn't been used for more than 30 days or its engine oil has just been replaced, it is necessary to check the oil level for being within the range of the level marks in the dipstick before starting and prime the fuel system. Refer to Section 4.3 Priming Fuel System for specific operation.

## 3.6 Engine Operation

Cautions for operation of the engine:

- Pay frequent attention to oil pressure and coolant temperature. In case of any abnormality, stop the engine immediately for inspection.
- When engine overheating starts to happen that is indicated by the coolant temperature alarming, reduce engine speed or reduce load or take both actions until the coolant temperature falls into the normal range; otherwise, find the cause and remove the fault as per Section 5 Troubleshooting Guidelines.
- When driving down a steep slope, the transmission gear and brake should be used simultaneously to control the vehicle speed and engine speed; when driving up a steep slope, a proper gear must be chosen to prevent the vehicle from rushing on the slope.

**Caution: Over-speed running will cause serious damage to the engine**

- Proper lubricating oil, fuel and coolant must be used for the engine when it runs in an extremely cold area. There are significant signs before the faults of an engine occur, such as changes in performance, sound, or engine appearance. Listening and observing will help to detect in advance or predict some problems of the engine that will occur later, with which the proper measures can be taken in time to eliminate such problems as can lead to a serious engine failure.

Typical engine fault signs:

- Engine misfires
- Engine vibrates abnormally
- Engine sounds abnormal
- Engine coolant temperature and oil pressure change abruptly
- Engine produces black smoke
- Engine power output is insufficient
- Engine oil consumption is too much
- Fuel consumption is too much
- There is leakage of oil, fuel or/and coolant

### 3.7 Engine Shutdown

#### 3.7.1 Normal Shutdown

If the engine has just worked at a high speed and heavy load for a long time, reduce its load and speed gradually and run it at idle for 3-5 minutes before stopping it to let the engine cool down evenly and let turbocharger speed fall considerably to protect the engine and turbocharger. Turn the switch from the ON position to the OFF position and take out the electric key after the engine has been stopped.

If the engine is not used for a period (6 months at most), keep it properly. Refer to Section 6 for engine storage.

#### 3.7.2 Emergency Shutdown

Under an emergency or special condition, make an emergency stop to avoid serious engine failure. Manually pulling the emergency stop handle can achieve an emergency shutdown.

### 3.8 Running-In of a New or Overhauled Engine

When the engine is first put into use or after being overhauled, run the engine for 60 hours (about 2,000 km) in running-in condition and change its oil thereafter before running it in full load condition to improve its moving parts working condition and its reliability and service life.

The way of running-in varies from one engine application and loading manner to another. In principle, engine speed and load in running-in process will be increased gradually with the running-in going on. Load should be 50%-80% of its full load, and speed should not exceed 80% of its rated speed.

Do not run an engine at idle or with low load for a long time either in running-in period or normal working period thereafter. Continuous running at idle should not be longer than 10 minutes to avoid early wear due to carbon deposit or engine performance being affected.

## 4. ENGINE MAINTENANCE

### 4.1 Maintenance Schedule

The following table gives maintenance period and tasks. Make regular maintenance based on this table. If the engine frequently operates at an ambient temperature below  $-18^{\circ}\text{C}$  or above  $38^{\circ}\text{C}$ , or in dusty environment or under a stop-and-go condition, the maintenance period should be shortened properly.

Maintenance tasks	First maintenance 1500~2000km	Daily	Every 10,000 km or 250 h or 3 months	Every 20,000 km or 500 h or 6 months	Every 40,000km or 1,000 h or 12 months	Every 80,000 km or 2,000 h or 2 years
Checking engine periphery	●	●	●	●	●	●
Checking fuel tank	●	●	●	●	●	●
Checking air filter service indicator	●	●	●	●	●	●
Checking primary fuel filter service indicator	●	●	●	●	●	●
Checking oil level	●	●	●	●	●	●
Checking coolant level	●	●	●	●	●	●
Checking electrolyte level	●	●	●	●	●	●
Checking drive belt	●	●	●	●	●	●
Checking cooling fan	●	●	●	●	●	●
Check leakage	●	●	●	●	●	●
Check accessories tighten condition	●	●	●	●	●	●
Excluding water and sediment in oil-water separator	●	●	●	●	●	●
Checking intake system		●	●	●	●	●
Changing lubricating oil and oil filter	●		●	●	●	●
Changing fuel filter (including primary filter)				●	●	●
Priming fuel system				●	●	●
Checking/adjusting valve clearance	●			●	●	●
Checking intercooler and its lines			●	●	●	●
Check antifreeze density				●	●	●
Checking belt tensioner	●				●	●
Checking fan bearing	●					●
Checking turbocharger	●					●
Checking vibration damper						●
Checking air compressor						●
Changing coolant and cleaning cooling system						●

- The Belt must be replaced when it has crack or defect(s) that affects its use.



## 4.3 Tasks and Methods of Engine Maintenance

### 4.3.1 Checking Engine Periphery

#### Check the periphery of the engine each time before starting:

- Check if the engine is in clean state and free from useless things on it.
- Check the joints and connections of the fuel system, cooling system and lubricating system for leakage.
- Check if the fan and its safety guard are fastened in place.
- Check the fastening condition of the accessories.
- Check the electrical circuits and the wire for intact.
- Check the drive belt for intact.

### 4.3.2 Checking Fuel Tank

Check the fuel level in the fuel tank daily.

### 4.3.3 Checking Air Filter Service Indicator

Check the maintenance indicator of the air filter every day. If the viewing window shows red piston, it represents that the intake resistance of the air filter exceeds the specified value, and the filter element requires to be replaced. Refer to Section 4.3.24 for the requirement and procedure of the replacement. Press the button on the top of the service indicator for reposition after the replacement

**Caution: Do not operate the engine without an air filter, and failure to do so would easily cause early engine wear. Marine application exceptional.**



### 4.3.4 Checking Primary Fuel Filter Service Indicator

The primary fuel filter has a service indicator. It turns red when the filter has accumulated a certain number of foreign particulates that will cause it difficulty for the fuel transfer pump to pump fuel. Check the service indicator daily and replace the filter when the indicator appears red. The filter must be replaced even if the indicator does not appear red after being used for 500 hours. The filter is a spin-on type one like the fuel filter. Refer to “Replacing fuel filter” for the replacement procedure.



### 4.3.6 Checking Coolant Level

**Warning: Avoid skin or eye contact with coolant to prevent personal injury.**

#### For non- vehicle application:

- Slowly loosen the pressure cap on the radiator to release pressure before starting the engine or until coolant temperature goes below 50°C after stopping the engine.
- Remove the pressure cap and check coolant level from the filler or inspection port. The coolant level should remain between the marks in the radiator or expansion tank or meet the requirement of equipment manufacturer.
- Add if necessary. Coolant should be added near the upper mark or meet the requirement of equipment manufacturer.

**Warning: At operating temperature, engine coolant is hot and under pressure, and the steam can cause personal injury. Do not remove the pressure cap on the radiator until the engine stops and coolant temperature drops below 50°C. Slowly loosen the cap to release the cooling system before checking coolant level or making supplement.**

**Caution: Coolant should be added slowly to avoid air lock.**

### 4.3.7 Checking Electrolyte Level

Some batteries are free from maintenance. Pay attention to its lifetime and change it when the lifetime is due. Refer to the instruction on the battery for the lifetime. Some batteries need maintenance (adding special liquid or distilled water).

- Check the electrolyte level before starting the engine. Remove the filler cap and check the electrolyte level. It should be at the bottom of the filler port. If necessary, make supplement as per requirement.

### 4.3.8 Checking Drive Belt

Perform visual check on the drive belt every day for any intersecting cracks. Transverse cracks along the width direction of the belt are acceptable, while longitudinal cracks (along the length direction) that intersect with transverse cracks are not allowed. If and wear or abrasion occurs on the belt, replace it.

### 4.3.9 Checking Cooling Fan

Perform visual check on the cooling fan for flaw or any other defect. The fan should be installed reliably. Tighten the fastening bolts (55-65 N·m) or replace the damaged fan if necessary.

**Warning: Damaged fan blades can cause serious personal injury. Do not pull or pry the fan and never rotate the engine crankshaft with the fan.**

### 4.3.10 Checking Intake System

Check the intake hoses for any crack, as well as perforation, and clamps for looseness. Replace the hose(s) if any fault is found and tighten clamp screw(s) if looseness is found to ensure leak-proof of the intake system.

### 4.3.11 Changing Lubricating Oil and Oil Filter

**Warning: Be careful when changing lubricating oil and oil filter because skin contact with the hot engine oil or hot engine surface can cause scald.**

- Don't stop the engine until the temperature of coolant reaches 60°C, then remove the oil drain plug, scrap the gasket and drain the engine oil.

**Caution: Do not drain engine oil when the engine is in a cold state at which foreign particles has deposited and attached to the bottom of an oil pan and will not drain with oil. When engine oil is warm, foreign particles suspend it and can easily drain with engine oil.**

- Clean the installation surface of the oil drain plug on the oil pan. Fit the drain plug with a new gasket and tighten it by 56-64 N·m.
- Clean the outside surface of the oil filter. Remove the oil filter with tool and scrap it.
- Clean the sealing surface of the filter head, and there should be no old O-ring left.
- Before installing a new oil filter, fill it with clean oil from 8 peripheral holes. The oil level should be 3-15mm below the threaded hole. Apply a light film of clean engine oil to the O-ring on the new filter to form a lubricating film.

**Caution: Do not add oil from the central hole of the filter.**

- Turn the filter by hand until the O-ring touches the sealing surface of the filter head and further tighten it to 40-45 N·m or 3/4 to one of a turn with tool.
- Open the filler cap and fill the engine with clean engine oil until the oil level is near the mark FULL in the oil dipstick.

Engine lubricating system capacity	
13.4 L (4HTAA)	20.5 L (6HTAA)

- Start the engine and keep it running at idle and then check the oil filter and drain plug for oil leaks.
- Shut off the engine, wait for about 5 minutes to provide enough time for the oil to flow into the oil pan, and check the oil level. If required, add engine oil until it is near the mark FULL (high level) in the oil dipstick.
- Install the filler cap and tighten it until you feel suitable.

### 4.3.12 Changing Fuel Filter

- Clean the outside surface of the fuel filter. Remove the filter with tool and scrap it.
- Clean the filter head and its sealing surface. Ther should be no O-ring left.
- Before installing a new fuel filter, fill it with clean fuel from 8 peripheral holes. The fuel level should be 3-15 mm below the threaded hole. Apply a light film of Vaseline or clean lubricating oil to the O-ring on the new fuel filter to form a lubricant film.

**Caution: Do not add fuel from the central hole of the filter.**

- Screw the filter by hand until the O-ring touches the sealing surface of the filter head and further tighten it to 40-45 N·m or 3/4 to one turn with tool.

### 4.3.13 Changing Primary Fuel Filter

- The primary fuel filter is also spin-on type. Refer to "Changing fuel filter" for the procedure. First remove the water container from the filter and then remove the filter.

### 4.3.14 Priming Fuel System

If the engine is first put into use, or after being overhauled, or has been out of use for a long time, or fuel filter (including the primary fuel filter) is changed, there can be air in the fuel system. It is required to prime the fuel system as per following steps:

- Loosen the bleed bolt on the fuel return pipe or on the first stage fuel filter.
- Prime the priming pump until there is no bubble visible in the fuel that outflows from the bolt.
- Tighten the bolt.

**Caution: Priming the fuel system is required if air filter enters the fuel pipeline due to untimely fuel supplement or there is air in the fuel system due to other reasons.**

### 4.3.15 Draining Water in Primary Fuel Filter

The primary fuel filter has a function of water and fuel separation. When water level in the water container of the filter reaches a certain level, the water-level sensor will send a signal to the water-level indicator, reminding the driver or operator to drain the water timely. Loosen the water drain valve about three and half turn to drain the water and sediment until clean fuel outflows. Then tighten the valve until you feel suitable. Don't over-tighten it

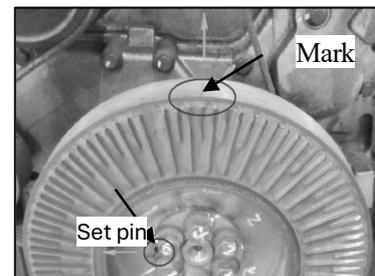
### 4.3.16 Checking and Adjusting Valve Clearance

When doing the first maintenance for a new or overhauled engine, conduct valve-clearance checking to timely regulate and correct the initial changes of the valve clearances. Later valve clearance checking and regulation should be based on the maintenance plan if the engine operates normally.

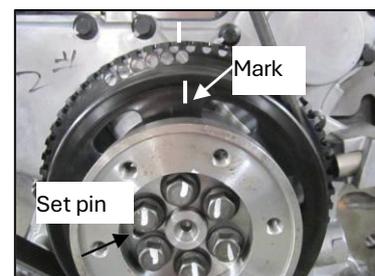
Valve clearance checking should be conducted after the engine has stopped and the coolant temperature fallen below 60°C.

- Remove the valve cover and scrap the cover seal.
- Rotate the engine anticlockwise with barring tool and make the piston of No. 1 cylinder (4HTAA) or No. 6 cylinder (6HTAA) position at the top dead centre.

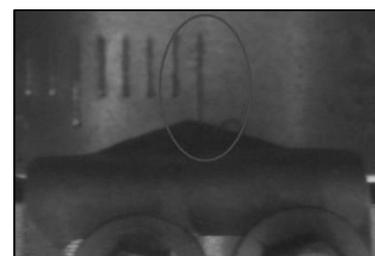
**Note:** When the set pin is on the left side or the mark in the vibration damper is in alignment with the mark in the gear housing cover, the piston of No 1 cylinder (4HTAA) or No. 6 cylinder (6HTAA) is at the top dead center.



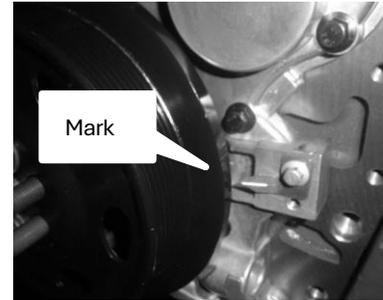
**Note:** When the set pin is on the left side or the mark in the pulley is in alignment with the mark in the gear housing cover, the piston of No 1 cylinder or (4HTAA) or No. 6 cylinder (6HTAA) is at the top dead center.



**Note:** Method 1: When the point indicator on the flywheel housing points at the mark 0 in the flywheel, the piston of No 1 cylinder (4HTAA) or No. 6 cylinder (6HTAA) is at the top dead center.



**Note:** Method 2: the front gear housing pointer aligns crankshaft front side belt wheel zero engraved, the piston of No 1-cylinder or No. 6 cylinder (6HTAA) is at the top dead center.



- Looking for TDC on compression stroke: if the rocker arm of the No. 1 cylinder can be swayed, the piston of No. 1 cylinder (4HTAA) is at the top dead centre on compression stroke or the piston of No. 6 cylinder (6HTAA) is at the top dead centre on compression stroke.
- When the piston of No. 1 cylinder is at the top dead centre on compression stroke, check the following valve clearances with feeler gauge. for the 4HTAA engine (4- cylinder): check the intake valve clearances of No. 1 and No. 2 cylinders as well as the exhaust valve clearances of No. 1 and No. 3 cylinders; for the 6HTAA engine (6- cylinder): check the intake valve clearances of No. 1, No. 2 and No. 4 cylinders as well as the exhaust valve clearances of No. 1, No. 3 and No. 5 cylinders. When the piston of No. 4 cylinder (4HTAA) is at the top dead centre on compression stroke, check with feeler gauge the intake valve clearances of No. 3 and 4 cylinders, as well as the exhaust valve clearances of No. 2 and 4 cylinders.



When the piston of No. 6 cylinder (6HTAA) is at the top dead centre on compression stroke, check with feeler gauge the intake valve clearances of No. 3, No. 5 and No. 6 cylinders as well as the exhaust valve clearances of No. 2, No. 4 and No. 6 cylinders.

**Note:** The clearance is correct when some resistance is felt when the feeler gauge is slipped between a valve bridge and a rocker arm.

- If a valve clearance fails to meet the requirement, loosen the adjusting screw locknut on the corresponding rocker arm, adjust the clearance to the specified value and tighten the locknut to 39-47 N·m. Check the valve clearance again and it should not change.

Valve clearance

Intake:  $0.25 \pm 0.08$  mm; exhaust:  $0.50 \pm 0.08$  mm.

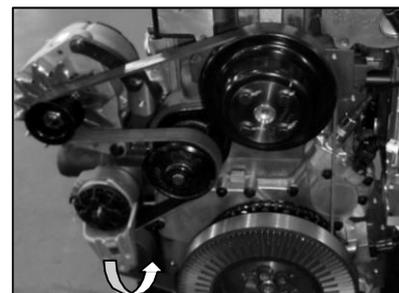
- Mark a sign on the damper or fan adaptor plate and rotate the crankshaft for a circle (360°). Follow the same steps to adjust the other intake and exhaust valve clearances.
- Install the valve cover with a new cover seal. Tighten the cover bolts to 22-26 N·m

#### 4.3.17 Checking Intercooler and its Lines

- Perform visual check on the air inlet and outlet chambers of the intercooler for crack, perforation or other damage, and of the air inlet and outlet pipes of the intercooler for sealing-off and other damages. Replace the intercooler if necessary.
- Perform visual check on the hoses of air inlet and outlet pipes and water inlet and outlet pipes (water-to-air cooler) for crack and check the clamps for looseness. Replace the hose(s) if any fault is found and tighten clamp screws if looseness is found.

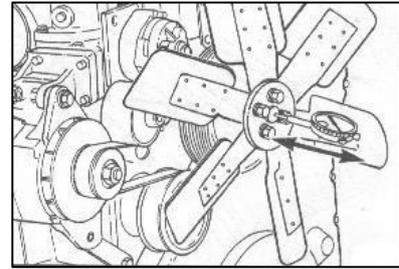
#### 4.3.18 Checking Belt Tensioner

- Rotate the belt tensioner anticlockwise and remove the drive belt. Turn the tensioner pulley to check it for seizure or radial/axial movement, by which to determine if there is scratch or wear on the bearing surface of the tensioner pulley. Swing the tensioner arm to check if the spring performs well.
- Install the drive belt and make a visual inspection after the installation to make sure that the belt centre line is in alignment with the centre lines of the pulleys.



### 4.3.19 Checking Fan Bearing

- Rotate the belt tensioner anticlockwise and remove the drive belt. Turn the fan to check the fan bearing for normality. When rotating the fan, there should be no vibration or excessive axial movement. Replace the fan hub if necessary.



### 4.3.20 Checking Turbocharger

- Perform visual check on turbine and compressor blades of the turbocharger for damage, crack, or contact with their housings when a light finger pressure applied on them. And check the turbocharger shaft for not being free spinning. In case any of the above problems occur, the turbocharger should be replaced.

### 4.3.21 Checking Vibration Damper

#### Viscous Damper:

- Check the vibration damper for damping fluid (silicon fluid) leak and surface dents. Also examine the thickness of damper to confirm if the damper has become deformed. In case any of the above problems occur, the damper should be replaced.

#### Rubber Damper:

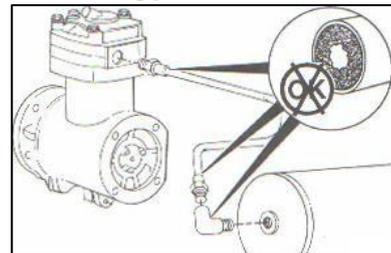
- Check the vibration damper for rubber ring aging problem or movement between of inner and outer rings. In case any of the above problems occur, the damper should be replaced.

### 4.3.22 Checking Air Compressor

**Warning: Air pressure should be released from the air system before removing parts from the air compressor to avoid personal injury.**

#### Air Outlet Pipe:

- Check the air outlet pipe and joints for carbon deposit. Clean or replace relevant parts based on the deposit.



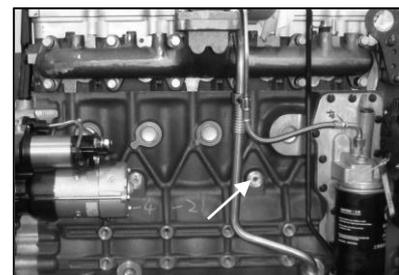
### 4.3.23 Changing Coolant and Cleaning Cooling System

- To ensure the engine coolant to be good in cooling and anticorrosion, changing of coolant and cleaning of cooling system is required every 80,000 km, 2,000 hours or 2 years, whichever comes.

**Warning: At operating temperature, engine coolants are hot and under pressure, and coolant steam can cause personal injury. Do not remove the pressure cap from the radiator until the engine stops and coolant temperatures go below 50°C. Slowly unscrew the pressure cap to release the cooling system pressure.**

**Warning: The anti-rust additive in the coolant contains alkali, so avoid skin and eye contact to prevent personal injury.**

- Stop the engine and wait until the temperature of coolant falls to below 50°C. Slowly unscrew the pressure cap to release pressure and remove the cap. Loosen the drain cock on the radiator to completely drain the coolant in the radiator.
- Remove the water drain plug on the engine, scrap the O- ring and completely drain the coolant in the cooling system. Loosen the water drain cock on the air compressor and completely drain the coolant in it.



**Clean the cooling system according to the following steps:**

- Install and screw up all the drain cocks and plug and add the sodium carbonate solution (or the mixture of sodium carbonate and water that is available in market) into the cooling system from the coolant filler.

**Caution: Each 23 L of water should be mixed with 0.5 kg sodium carbonate. Do not use caustic cleaner or it will do harm to the aluminium parts.**

**Purge the air in the coolant system while adding the cleaning fluid. Pour the cleaning fluid slowly to avoid air lock. The cleaning fluid should be added up to the bottom of the filler in the radiator and wait for about 3-5 minutes for a full purge of air.**

- Start the engine and keep it running for 5 minutes after the cleaning fluid temperature has gone up to above 80°C, then stop the engine and completely drain the cleaning fluid in the cooling system.

**Caution: During the whole cleaning process the pressure cap should not be on and the engine runs without the cap on.**

- Add clean water into the cooling system.

**Caution: Pour clean water slowly to avoid air lock. Clean water should be added up to the bottom of the filler in the radiator and wait for about 3-5 minutes for a full purge of air.**

- Start the engine and keep it running for 5 minutes after the water temperature has gone up to above 80°C, then stop the engine and completely drain the clean water in the cooling system.

**Caution: If the discharged water is still dirty, clean the cooling system again according to the above steps until discharged water becomes clean.**

- After cleaning, tighten all water drain cocks on the radiator and air compressor and use a new O-ring and tighten the plug on the engine to 45 N·m.
- Add coolant. Fill the cooling system with the specified coolant, and the total engine cooling system volume is as follows:

Engine cooling capacity			
4HTAA		6HTAA	
6.8 L	13.3 L (marine application)	9.6 L	16.1 L (marine application)

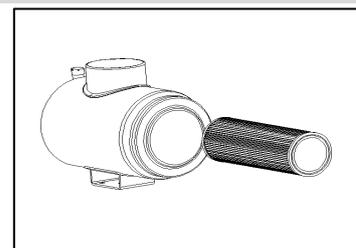
**Caution: Engine coolant capacity listed above refers to the coolant volume in the engine cooling system. The actual amount refers to the vehicle or equipment data.**

**Caution: add coolant slowly to avoid air lock. Coolant should be added up to the bottom of the filler in the radiator or meet the requirement of vehicle or equipment manufacturer. Wait for about 3-5 minutes for a full purge of air.**

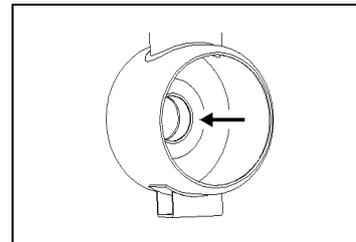
- Install the pressure cap on the radiator, start and run the engine until coolant temperature goes up to 80°C, then stop the engine and check the cooling system for leakage.
- Stop the engine and wait until the coolant temperature falls to below 50°C. Then open the pressure cap and recheck the coolant level. Supplement properly, if necessary.

#### 4.3.24 Replacing Air filter Element (Paper Element)

- Blow off dirt on the filter with compressed air.
- Remove the filter cover, remove and scrap the element.



- Cover the compressor inlet from inside the air filter body with clean stuff to prevent dirt from entering the intake system.
- Clean the inside of the filter body with compressed air.



- Check the new filter element for any defects and remove the covering stuff from the compressor inlet. Install the new element and make sure a sound seal at both ends. Install the air filter cover.

**Caution: Be sure that both end faces of the air filter are reliably sealed without leakage after the air filter element has been changed.**

#### 4.3.25 Cleaning Air filter Element (Non-paper Element)

Remove the air filter cover and the element. Dip the element in warm neutral cleaning liquid to remove oily dirt on it. Do not use brush for cleaning. Dry the element after cleaning. Flushing afterward with clean water is necessary when non-neutral cleaning liquid is used. Check the element for any damage after cleaning. Install the element and make sure a sound seal at both ends. Install the cover.

**Caution: Be sure that both end faces of the air filter are reliably sealed without leakage after the air filter element has been changed**

#### 4.3.26 Servicing Primary Air Filter

- Remove the upper part of the air filter (primary air filter)
- Blow off the dust in the tubes and the housing with compressed air.
- Reinstall the filter.

### 5. TROUBLESHOOTING GUIDELINES

Some simple typical diesel engine fault modes, possible causes and troubleshooting steps are listed in the tables below. If any one of modes occurs in engine operation, it is required to eliminate it by taking appropriate measures. Otherwise, it would lead to severe engine failure. For simple engine faults, you can locate and eliminate them on your own. For complex faults, contact SDEC's after-sale service center (spare@sdecie.com) for technical guidance.

No	Fault mode	No	Fault mode
1	Alternator refuses to charge or fails to charge enough	16	Diesel knock
2	Starting motor fault	17	Excessive noise
3	Engine is difficult to start or will not start	18	Black smoke
4	Engine starts, but will not keep running	19	White smoke
5	Liable misfire or unsteady speed	20	Blue smoke
6	Liable misfire at low speed	21	Fuel consumption too much
7	Engine cannot reach rated speed under load	22	Coolant temperature above normal gradual overheats
8	Engine power output low	23	Coolant temperature above normal—sudden overheat
9	Rough running and misfiring	24	Coolant temperature below normal
10	Unexpected engine halt or misfire in deceleration	25	Coolant contamination
11	Poor acceleration	26	Oil consumption too much
12	Engine will not stop	27	Oil pressure too high
13	Unsteady idle speed and engine hunting	28	Oil pressure too low
14	Rough running at idle speed	29	Oil contamination
15	Excessive vibration		

### Fault Mode 1: Alternator Refuses to Charge or Fails to Charge Enough

Possible Cause	Correction
The instrument or indicator light failure	Check and replace the instrument or indicator light
The battery connector(s) is loose or eroded	Clean and tighten the battery connector(s)
The drive belt slip or failure of the belt tensioner	Check and replace the belt and check the spring performance of the tensioner
Poor terminal contact of the alternator	Tighten all terminal connects of the alternator

### Fault Mode 2: Starting System Fault

Possible Cause	Correction
The terminals and connectors of the starting circuit and/or the battery are loose, open or eroded	Clean and tighten all the terminals and the connectors
Insufficient battery output	Adopt a battery with sufficient output or add some more batteries in parallel
Starting motor fault	Check the starting motor

### Fault Mode 3: Engine is Difficult to Start or will not Start

Possible Cause	Correction
Improper starting method	Refer to the operating instruction manual of the vehicle or the equipment for proper starting method
The time for engine starts up is 2-3 seconds	It is normal and needs no adjustment
The drive system is engaged	Disengage the drive system
Too low starting speed (minimum starting speed is 100 rpm)	Check battery for voltage and check starting motor for looseness or eroded connection
Insufficient fuel in the tank	Add fuel
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes and relevant parts if necessary and then prime the system
The connectors of low-pressure fuel pipeline are loose	Check the low-pressure fuel pipeline and tighten all the connectors
The fuel filter or fuel suction pipe is blocked	Replace the fuel filter or fuel suction pipe
Fuel rises solidification because of cold weather	Choose proper fuel specified in this manual based on the ambient condition
There is no fuel in the fuel injection pump	Check the fuel transfer pump
The resistance of the intake system exceeds the specified value	Check the intake system and replace the air filter element if necessary
The resistance of the exhaust system fails to meet the requirements	Check the exhaust system
The crankshaft rotation is restricted	Barring the crankshaft and check for restriction.
Injection pump timing is not correct	Check and adjust injection pump timing. Refer to 5.2 for the procedure
Intake/exhaust valve clearance error (s)	Check and adjust valve clearance

#### Fault Mode 4: Engine Starts but will not Keep Running

Possible Cause	Correction
The engine is engaged with the drive system	Disengage the engine with the drive system
Fuel rises solidification because of cold weather	Choose proper fuel specified in this manual based on the ambient condition
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes and relevant parts if necessary and then prime the system
The fuel filter or fuel suction pipe is blocked	Replace the fuel filter or fuel suction pipe
The resistance of intake system exceeds the specified value	Check the intake system and replace the air filter element if necessary
The resistance of exhaust system fails to meet the requirements	Check the exhaust system
Fuel fails to meet required specification, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue

#### Fault Mode 5: Liable Misfire or Unsteady Speed

Possible Cause	Correction
Fuel level in the fuel tank too low	Add fuel
Air in fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes if necessary and then prime the system
Fuel pressure too low	Check the fuel tank for fuel level, check the pipe between the tank and the fuel transfer pump for leakage, serious deformation, bent or plug and for air
Leakage at high-pressure fuel pipe connectors	Tighten the connectors and make replacement if required
Injection pump timing is not correct	Check and adjust injection timing. Refer to 5.2 for the procedure
Intake/exhaust valve clearance error (s)	Check and adjust valve clearance

#### Fault Mode 6: Liable Misfire at Low Speed

Possible Cause	Correction
Fuel level is low in the tank	Add fuel
Air in the low-pressure fuel pipeline	Check the low-pressure fuel pipeline for air source. Tighten or replace joints or pipes if necessary and then prime the system

### Fault Mode 7: Engine cannot Reach Rated Speed with Load

Possible Cause	Correction
The load is too heavy	Reduce the load or shift to lower gear
The driving system has been changed and cannot match the engine	Check the transmission gears for mismatch of the engine
Fault of the tachometer or speed sensor	Check the tachometer and speed sensor, and make replacement when necessary
The resistance of fuel inlet is great	Check the fuel filter and fuel suction pipe and replace the fuel filter if necessary
Fault of the turbocharger	Check the boost pressure
Leakage in the intake system	Check the connection of intake manifold, intake pipe, intercooler, its pipeline for looseness or leakage
The resistance of intake system exceeds the specified value	Check the intake system resistance and replace the air filter element if necessary
Fuel fails to meet required specification, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue

### Fault Mode 8: Rough Running and Misfiring

Possible Cause	Correction
Only happens at idle speed	Refer to the fault mode "Rough running at idle" for correction
Low running temperature	Refer to the fault mode "Coolant temperature below normal"
Intake/exhaust valve clearance error	Check and adjust valve clearance

### Fault Mode 9: Unexpected Engine Halt or Misfire in Deceleration

Possible Cause	Correction
Causes related to the protective system of the vehicle or equipment	Contact the manufacturer of the vehicle or equipment
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes if necessary and then prime the system
The fuel has been contaminated	Replace it with clean and qualified fuel

## Fault Mode 10: Engine Power Output Low

Possible Cause	Correction
Inquire about the driver or operator	Obtain all the information related to the problem
Overloaded operation	Reduce the load to allowed range
The engine runs on the plateau beyond the specification	Run the engine on the specified plateau. Engine power decreases with increase of altitude
The driving system has been changed and cannot match the engine	Check the transmission gears for mismatch of the engine
Oil level is too high	Check and lower oil level to the specified range
The accelerator pedal or accelerator lever doesn't arrive at the full position	Check accelerator pedal or accelerator lever for restriction
Accessories load is too big	Check the cooling fan for abnormal operation and vehicle braking for friction
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes if necessary and then prime the system
Fuel inlet temperature is high	Add fuel into the fuel tank
The fuel supply is blocked	Check the fuel inlet resistance and replace the fuel filter (first stage) and fuel filter (second state) if necessary
Leakage of the exhaust manifold or turbocharger	Check the exhaust manifold and boost pressure to find and eliminate the source of leakage
The resistance of exhaust system fails to meet the requirements	Check the exhaust system resistance
The resistance of intake system exceeds the specified value	Check the intake system resistance and replace the air filter element if necessary
Leakage in the intake system	Check the connection of intake manifold, intake pipe, intercooler, its pipeline for looseness or leakage
Fault of the turbocharger	Check the boost pressure
Fuel is not proper, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue
Incorrect injection pump timing	Check and adjust injection timing. Refer to 5.2 for the procedure
Intake/exhaust valve clearance error (s)	Check and adjust valve clearance

### Fault Mode 11: Poor Acceleration

Possible Cause	Correction
Inquire about the driver or operator	Obtain all the information relevant to the problem
The driving system has been changed and cannot match the engine	Check the transmission gears for mismatch of the engine
Overload of accessories	Check the cooling fan, air conditioner and vehicle braking system for too much resistance and reduce the load of the accessories
The accelerator pedal or accelerator lever movement is restricted	Check the pedal or f accelerator lever or restriction
Leakage of the intake system	Check the intake manifold, intake pipe, intercooler and its pipelines for leakage
The intake system or exhaust system is blocked	Check the resistances of intake and exhaust systems.
Injection pump timing is not correct	Check and adjust injection pump timing. Refer to 5.2 for the procedure
Intake/exhaust valve clearance error (s)	Check and adjust valve clearance

### Fault Mode 12: Engine will not Stop

Possible Cause	Correction
Electric key switch fault	Refer to the manual of vehicle or equipment manufacturer for instruction
The engine inhales fuel mist	Check the intake manifold and separate the source of fuel mist
External power supply	Check and make sure there are no external power supply being connected to the power supply circuit of the vehicle or equipment
Oil leak in the turbocharger due to poor seal	Check the compressor outlet and intake pipe for oil trace

### Fault Mode 13: Unsteady Idle Speed and Engine Hunting

Possible Cause	Correction
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes if necessary and then prime the system

### Fault Mode 14: Rough Running at Idle Speed

Possible Cause	Correction
Engine temperature is too low	Warm up the engine
The load at idle speed is too heavy (more than 50 horsepower)	Reduce the load at idle speed
Leakage of the intercooler or its pipeline	Check intercooler and its pipeline for leaks
Leakage of the intake manifold or pipeline	Check the intake manifold or pipeline for leaks
Engine support problem	Check the engine support and cushion
Alternator fault	Disconnect the alternator to check the problem
Valve clearance error (s)	Check and adjust valve clearance
Engine support problem	Check the supporter and cushion pad of the engine

### Fault Mode 15: Excessive Vibration

Possible Cause	Correction
The engine runs unsteadily	Refer to fault mode "Rough running or misfire"
Pulley or vibrator bolts or nuts loose	Check and tighten loose bolts or nuts
Fan blade not in balance	Loosen or remove fan belts and operate engine for a short time at the r/min that the vibration was present. If vibration is not present anymore, make a replacement of the fan assembly
Damage of fan or accessories	Check, and replace relevant parts if required
The vibration damper is broken	Check/replace the damper
Offset of the central lines of the engine and propeller shaft (marine application)	Make the central lines in alignment
Engine support problem	Check the supporter and cushion pad of the engine for problem. Make replacement if necessary

### Fault Mode 16: Diesel Knock

Possible Cause	Correction
Air in the fuel system	Check for air in the system. Tighten or replace the fuel joints, fuel pipes if necessary and then prime the system
Poor quality fuel	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue
Injection pump timing is not correct	Check and adjust injection timing. Refer to 5.2 for the procedure

### Fault Mode 17: Excessive Noise

Possible Cause	Correction
Noise from drive belt due to poor tension or heavy load	Check the belt drive system and ensure all pulleys running
Leakage of intake system and exhaust system	Check the intake and exhaust systems for leakage. Tighten the loose components and replace the related parts if necessary
Noise from the turbocharger	Check the blades of compressor or turbine for their contact with their housings
Incorrect injection pump timing	Check and adjust injection timing. Refer to 5.2 for the procedure
Too big valve clearance	Check and adjust valve clearance

### Fault Mode 18: Blue Smoke

Possible Cause	Correction
A big gap between piston and liner channeling oil into the combustion chamber due to the engine running long time at low load (below 40% of full load)	Increase engine load and make proper engine load match
Too much oil in the oil pan	Adjust oil level to be within the specified range
Oil leak in the turbocharger due to poor seal	Check the compressor outlet and intake pipe for oil trace

### Fault Mode 19: Black Smoke

Possible Cause	Correction
The engine is overloaded	Set to lower gear or reduce equipment load
Intake system resistance exceeds the specified value	Check the intake system for resistance and replace the air filter element if necessary
Incorrect injection pump timing	Check and adjust injection timing. Refer to 5.2 for the procedure
Intake/exhaust valve clearance error	Check and adjust the valve clearance
Fuel is not proper, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue

### Fault Mode 20: White Smoke

Possible Cause	Correction
The engine is in cold state	Warm the diesel engine
Water in fuel	Check the first stage fuel filter for fuel and water separate function. Replace it if required
Injection pump timing is not correct	Check and adjust injection timing. Refer to 5.2 for the procedure
Fuel is not correct, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue

### Fault Mode 21: Fuel Consumption too Much

Possible Cause	Correction
Something related to driving technique	Check driver's operation for gear shift, deceleration and idle speed
Display error of the odometer	Adjust or replace the odometer
The drive system cannot match the engine	Check the transmission gears and make sure that the components of the engine and drive system are correct
Leakage of fuel	Check the fuel system pipeline for leakage and tighten connectors if loosened
The resistance of intake or exhaust is too great	Check the intake and exhaust systems, especially the air filter and exhaust muffler.
Oil level is too high	Check and adjust the oil level
Injection pump timing is not correct	Check and adjust injection timing. Refer to 5.2 for the procedure
Poor seal of intake valve or exhaust valve	Check and adjust valve clearance
Fuel is not correct, or its quality is poor	Use the fuel specified in this manual and fill a temporary tank with right high-quality one, with which to run the engine and verify the fuel issue

### Fault Mode 22: Coolant Temperature Above Normal- Gradual Overheat

Possible Cause	Correction
Overload operation	Reduce the load
Coolant level is too low	Check the coolant level and engine external for leakage, eliminating the leakage and adding the coolant to be within the specified range
Oil level is too high or too low	Check oil level and adjust it to be within the specified range
The radiator core is broken or blocked	Check the radiator core and repair or replace it if necessary
The coolant pipe collapsed and there is leakage	Check the pipe and replace it if necessary
The drive belt is loose	Check the drive belt and replace it if necessary
Fault of the pressure cap of radiator and pressure calibration is too low	Check the function of the pressure cap
Fault of the thermometer or temperature sensor	Check the thermometer and sensor, and make replacement when necessary
Air in the cooling system	Check the connector at water pump inlet for leakage

### Fault Mode 23: Coolant Temperature Above Normal- Sudden Overheat

Possible Cause	Correction
Coolant level is too low	Check coolant level and engine external for leakage, eliminating the leakage and adding the coolant to be within the specified range
Coolant system hose(s) is collapsed and there is leakage	Check the hose(s) and replace it if necessary
The drive belt is broken	Check the drive belt and replace it if necessary
Fault of the coolant thermometer	Check the coolant thermometer and replace it if necessary

### Fault Mode 24: Coolant Temperature Below Normal

Possible Cause	Correction
The radiator shutter is blocked at the maximum opening	Check the radiator shutter and replace it if necessary
Too much cold air flows though the radiator	Visually check the fan and fan clutch (if equipped) for operation
Running in low ambient temperature	Take measures to increase intake air temperature
Fault of the coolant thermometer	Check the coolant thermometer and replace it if necessary

### Fault Mode 25: Coolant Contamination

Possible Cause	Correction
Improper coolant	Choose the coolant specified in this manual
Coolant change interval too long	Change coolant at the specified time

### Fault Mode 26: Oil Consumption too Much

Possible Cause	Correction
The engine runs at idle speed for too long time	Shorten the time of the engine running at idle
The oil level is too high	Check the oil level and make adjustment if necessary
External oil leakage of the engine	Check the external pipeline, sealing gasket and crankshaft seals for leakage and replace the damaged components
The oil in the turbocharger leaks into the intake system or exhaust system	Check the compressor inlet, air intake pipe and turbine outlet for oil trace
Big blow-by push oil in crankcase to the crankcase ventilation device	Check the crankcase ventilation device for oil trace on its periphery
Air compressor pumps oil	Check the air compressor outlet for oil trace
Oil is not correct	Check the oil for its specification. Use correct oil and change the oil and oil filter

### Fault Mode 27: Oil Pressure too High

Possible Cause	Correction
The operating temperature of the engine is too low, and the oil viscosity is high	Refer to the fault mode "Coolant temperature below normal"
Fault of the oil pressure meter or pressure sensor	Check the pressure meter and sensor, and make replacement when necessary
The lubricating oil fails to meet the requirements	Use the lubricating oil specified in this manual and replace the oil filter

### Fault Mode 28: Oil Pressure too Low

Possible Cause	Correction
Oil level is too low	Check oil level and adjust it to the specified range
Leakage of the oil pipeline	Check the oil pipeline and eliminate the leakage
Oil temperature is higher than the specified value	Refer to the fault mode "Coolant temperature above normal"
Fault of the oil pressure meter or pressure sensor	Check the pressure meter and sensor, and make replacement when necessary
Water in engine oil	Check the oil filler cover or the oil dipstick for their missing. Replace the oil if required
The oil filter is blocked	Replace the oil and oil filter
The engine oil fails to meet the requirements, and the oil viscosity is too low	Check the oil specification and replace the oil and oil filter if necessary
Hydraulic oil in the engine oil	Check for hydraulic oil leak, replace the oil and oil filter if required

### Fault Mode 29: Oil Contamination

Possible Cause	Correction
Cold running of the engine leads to fuel in engine oil	Check if the engine runs at idle for too long time. Shorten idle running time

## 5.2 Checking and Adjusting of Static Fuel Injection Pump Timing

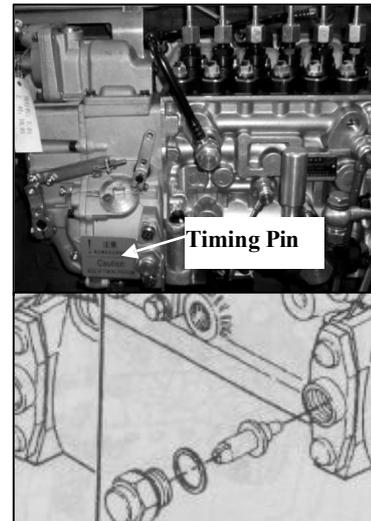
Pump timing check and adjustment shall be done by or under the instruction of professional serviceman. To eliminate gear backlashes, it is required to rotate the engine counterclockwise viewed from the flywheel end, which is defined as the working rotation, during checking and adjusting of the injection pump timing. The No.1 piston at TDC of the compression stroke is the starting point of the timing check and adjustment procedures.

### 5.2.1 Locating TDC of the Compression Stroke for the Piston of Cylinder 1 (for a Pump without Timing Pin)

- Remove the observing window cover of the flywheel housing.
- Rotate the engine counterclockwise to make the timing pointer on the flywheel housing point at the mark 0 in the flywheel.
- Remove the oil filler cap.
- When the oil filler is located at No. 1 cylinder, sway the rocker arm(s) of No. 1 cylinder from the oil filler. If the rocker arm can be swayed, the piston of No. 1 cylinder is at the top dead centre of the compression stroke. If not, rotate the engine 360 degrees counterclockwise to let the piston of No. 1 cylinder be at the top dead centre of the compression stroke. When the oil filler is located at No. 4 cylinder (4HTAA) or at No. 6 cylinder (6HTAA), sway the rocker arm of No. 4 cylinder or No. 6 cylinder from the oil filler. If the rocker arm can be swayed, the piston of No. 4 cylinder or No. 6 cylinder is at the top dead centre of the compression stroke. Rotate the engine 360 degrees counterclockwise to let the piston of No. 1 cylinder be at the top dead centre of the compression stroke.
- Install and tighten the oil filler cap.

### 5.2.2 Locating TDC of the Compression Stroke for the Piston of Cylinder 1 (for a Pump with Timing Pin)

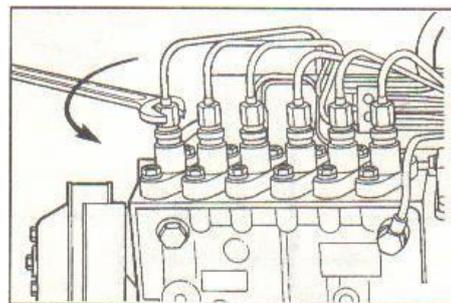
- Remove the cover of the observing window.
- Rotate the engine counterclockwise to make the timing pointer point at the mark 0 in the flywheel.
- Remove the timing pin plug from the governor housing of the fuel injection pump, take the timing pin out and insert the
- other end of the pin into the timing gear or timing slot in the pump camshaft (rotating the engine back and forth slowly and slightly when inserting the pin). If the pin cannot be inserted, rotate the engine 360 degrees counterclockwise and insert the pin again. When the pin can be inserted, the theoretical static pump timing is achieved, and the piston of No. 1 cylinder is at TDC of the compression stroke.
- Take the pin out. Reinstall it with the other end in its original place and install the plug and washer. Tighten the plug to 15 N·m.



**Caution: The pin must be taken out before checking and adjusting the injection timing to avoid it being damaged.**

### 5.2.3 Checking Procedure

- Rotate the engine clockwise 40 degrees to make the timing pointer on the flywheel housing point at the number mark of 40 in flywheel (40 degrees before DTC).
- Loosen the nut of the high-pressure fuel pipe of No. 1 cylinder at the fuel pump end and move the pipe aside.
- Put the hand lever of the governor in high idle speed position and use the priming pump to pump fuel to the fuel system.
- Rotate the engine counterclockwise slowly until the fuel at the fuel delivery valve joint just starts to move and check the number mark at which the timing pointer points. The pointed number represents the actual injection pump timing. It is required to make the adjustment if the actual timing is out of the specified range.

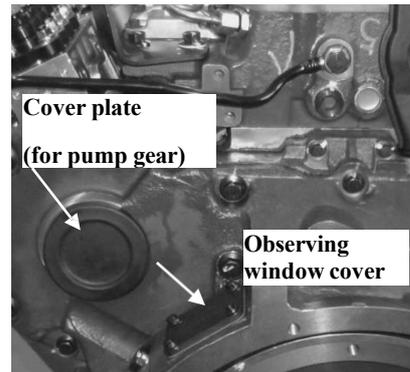


### 5.2.3 Adjusting Procedure

- Remove the cover on the flywheel housing for removal and installation of the injection pump gear and scrap the O- ring.
- Remove the injection pump gear nut.

**Caution: Be careful not to let the nut and spring washers fall into the gear housing.**

- Pull the injection pump gear from the pump camshaft with a special tool (pulling tool).



- Rotate the engine counterclockwise or clockwise according to the checking result until the timing pointer points at the required fuel injection pump timing.
- Install the injection pump gear and making it engage with the camshaft gear.
- Install the gear nut and washer. Tighten the nut to **190-210 N·m (M20)**, **172-188 N·m (M18)**.
- Recheck the static injection pump timing. If it is not correct, adjust it over until the correct one is attained.
- Install the high-pressure fuel pipe and tighten the nut to 32-38 N·m.
- Install the cover with a new O-ring.
- Install the observing cover.
- Put the hand lever of the governor back to the normal position.

## 6. Engine Storage

### 6.1 Short Time Storage

- If the engine is to be out of service for a period (1 to 3 months), measures of cleaning and necessary oil seal should be taken for rust protection.

#### 6.1.1 Before Storage

- Clean the engine surface and check for any dirt or oil stain or water stain and rust. Dry the engine with compressed air. Apply anti-rust oil to the unpainted machining surfaces of the engine with a brush and keep the parts of rubber, plastic and fibre free from the anti-rust oil.

**Caution: The surfaces of the front pulleys must be kept from rust.**

**The anti-rust oil requirement for outside engine is as follows:**

Item		Requirement
Appearance		Brown in even
Moisture		None
Drop point		≥55
Freezing resistance		Qualified
Oil stability (ml)		≤2
Salt test	Steel sheet	≥14
	Cast iron sheet	≥7
Humid heat test	Steel sheet	≥30
	Cast iron sheet	≥14
Lamination test (7 days)	Steel sheet	Qualified
Corrosion test (14 days)	Steel sheet	Qualified
	Cast iron sheet	Qualified

- Disconnect the battery, clean terminals and apply a light film of grease. Charge the battery.
- Let the drive belt in loose.
- Seal all ports of air, fuel, oil and coolant, as well as the air filter with damp-proof material or plastic one.
- Cover the engine with plastic cover or similar stuff and place the engine in a dry area with good ventilation.

### 6.1.2 During the Storage

- Charge the battery every month. Check the battery electrolyte level before charging. Crank the crankshaft three to four turns every month with barring tool.

### 6.1.3 After Storage

- When putting the engine into use, remove the fuel pump and send it to the authorized service provider for adjustment. Remove the engine cover and all port seals and connect necessary lines. Install the fuel pump and prime the fuel system. Connect battery and install the belt. Check lubricating oil and coolant levels and add proper amount of clean lubricating oil into the turbocharger from its oil inlet. Crank the engine three to five circles with barring tool. Then follow the starting procedure in Section 3.4 to start the engine.

## 6.2 Long Time Storage

### 6.2.1 Before Storage

If the engine is to be out of service for a long time (more than 3 months), proper storage of the engine is required.

- On last engine operation, drain the lubricating oil in the engine and oil filter after the engine has stopped and cooled down to warm state. It is not necessary to drain coolant because it is anti-rust. Add qualified anti-rust oil (dewatered CF 15W-40 oil) into the engine, start the engine to idle for 1-1.5 minutes and stop it, then drain the anti-rust oil.
- Refer to Article 1, 2, 3, 4 and 5 in Section 6.1.1 Short Time Storage for cleaning, preventing rust and other requirements. And put a tag which reads "The engine does not contain oil and do not use it."

### 6.2.2 During the Storage

Refer to Section 6.1.2 for storage.

### 6.2.3 After Storage

When putting the engine into use, remove the fuel pump and send it to the authorized service provider for adjustment. Remove the engine cover and all port covers and connect necessary lines. Install the fuel pump and prime the fuel system. Connect battery and install the belt. Fill the engine and oil filter with clean lubricating oil and add proper amount of clean lubricating oil into turbocharger from its oil inlet. Check oil and coolant levels and crank the engine three to five circles with a barring tool. Then follow the starting procedures in Section 3.4 to start the engine. If the engine is stored for over 2 years, its coolant should be changed, and its cooling system should be cleaned.

