DAEWOO

65.99892-8051

Operation Manual

GENERATOR DIESEL ENGINE

DE12T

POLUS
P126TI

DE12T, P126TI, P126TI-1 Engine correct in the operation manual

- Page 1 (Contents 1.4 Engine specifications)
  - Fuel injection timing(B.T.D.C static) P126TI, P126TI-1 **12° → 16°**
- Page 13 (Contents 3.5.1 Recommended of lubricating oil)
  - Engine Oil Intervals **800hr → 200hr**
- Page 15 (Contents 3.6 Air cleaner)
  - Change of air cleaner element : every **600hr → 400hr**
- Page 19 (Contents 3.8.2 Fuel Filter)
  - Fuel Filter Cartridge Intervals **1200hr → 400hr**
- Page 37 (Contents 5.5.1 Fuel Filter)
  - Fuel Filter Cartridge Intervals **1200hr → 400hr**
- Page 44 (Contents 6.2.1 Method of adjusting injection timing)
  - Fuel injection timing(B.T.D.C static) P126TI **12° → 16°**
- Page 49 (Contents 1. General Engine Inspection Cycle)
  - Lubrication System : Change the lubrication oil **800hr → 200hr**

    Replace the oil filter cartridge **800hr → 200hr**
  - Intake & Exhaust system : Change the air cleaner element **600hr → 400hr**
  - Fuel System : Replace the fuel filter element **1200hr → 400hr**

FOREWORD

This manual has been prepared to help you use and maintain the DE12T/ P126TI generator diesel engines in a safe and correct manner.

These economical and high-performance diesel engines (OMEGA combustion system) have been designed and manufactured for generator application. They meet all the requirements such as low noise, fuel economy, high engine speed, and durability.

Nonetheless, to obtain the best performance and long life of an engine, it is essential to operate it appropriately and to carry out periodic checks as instructed in this manual. We strongly urge you to thoroughly read this manual from cover to cover and to acquaint yourself fully with all the information contained in this manual.

Please contact your authorized DAEWOO dealer for the answers to any questions you may have about your DE12T/ P126TI generator engine's features, operation, or manuals.

In order to operate the engine in the optimal conditions and to maintain its best performances, the contents in this instruction are to be thoroughly understood and observed.
In addition refer to the INSTALLATION manual about DAEWOO generator engine installation instructions.
All warranty claims to be addressed to;

Engine Export Team,
DAEWOO Heavy Industries LTD.
DAEWOO Center 541
Namdaemun-ro 5-ga, Chung-gu
Seoul, Korea
TEL : (82-2-726-3205~8), FAX: (82-2-726-3168)

Or to your local DEALER or DISTRIBUTOR.

DAEWOO Heavy Industries LTD.
July. 1999

CONTENTS

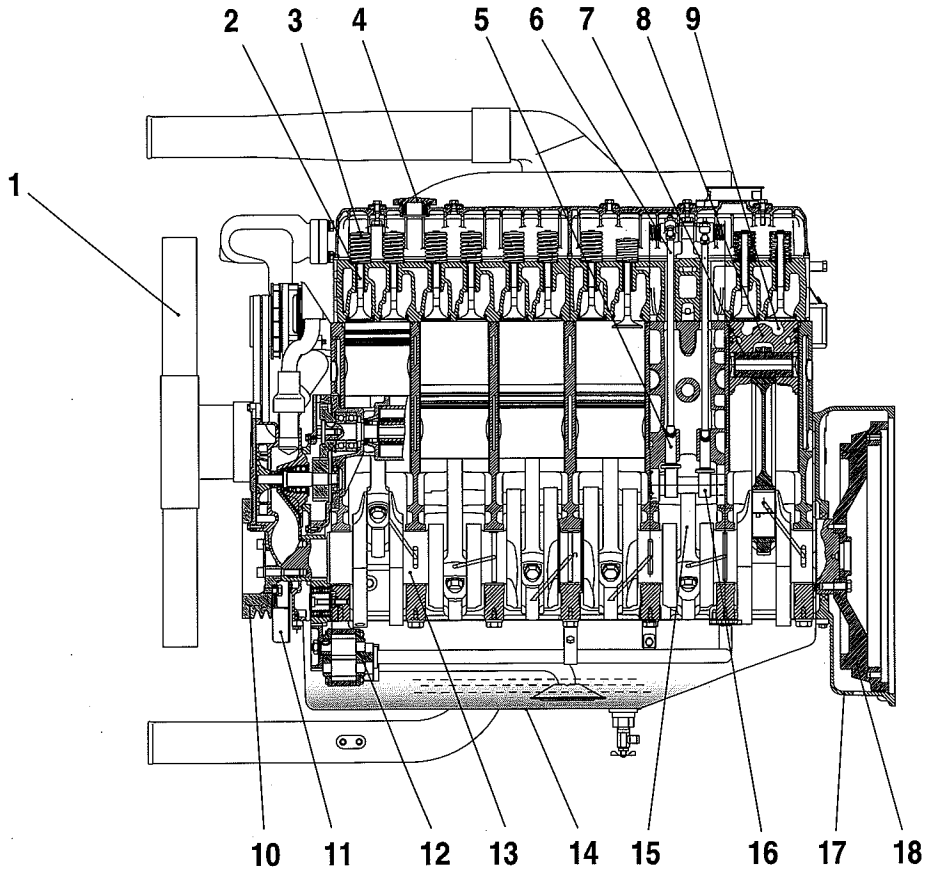
1. General information

1.1. Engine specification

Items \ Engine Model		DE12T	P126TI	P126TI-I
Engine type		Water-cooled, 4 cycle in-line type Turbo charged	Water-cooled, 4 cycle in-line type Turbo charged & intercooled	
Combustion chamber type		Direct injection type		
Cylinder liner type		Replaceable dry liner		
Timing gear system		Gear driven type		
No. of piston ring		Compression ring 2, oil ring 1		
No. of cylinder-bore x stroke (mm)		4 - 123 x 155		
Total piston displacement (cc)		11,051		
Compression ratio		17.1 : 1		
Engine dimension (length x width x height) (mm)		1,365.5 x 870 x 1,046	1,383 x 870 x 1,207	
Engine weight (kg)		910		
Rotating direction (from flywheel)		Counter clockwise		
Fuel injection order		1 - 5 - 3 - 6 - 2 - 4		
Fuel injection timing (B.T.D.C static)		12°		
Injection pump type		Zexel in-line "P" type		
Governor type		Mechanical governor type(RSV)	Electric governor type(GAC)	
Injection nozzle type		Multi-hole type (5 hole)	Multi-hole type (5 hole)	
Fuel injection pressure (kg/cm^2)		220	1st : 160, 2nd : 220	
Compression pressure (kg/cm^2)		28 (at 200 rpm)		
Power (ISO 3046)	Condition	50Hz (1,500rpm)	60Hz (1,800rpm)	50Hz (1,500rpm)	60Hz (1,800rpm)	60Hz (1,800rpm)
	Continuous	-	-	280PS (206kW)	336PS (247kW)	-
	Prime	205PS (151kW)	245PS (180kW)	328PS (241kW)	378PS (278kW)	356PS (262kW)
	Stand by	226PS (166kW)	270PS (199kW)	370PS (272kW)	405PS (298kW)	392PS (288kW)
Intake and exhaust valve clearance (at cold) (mm)		0.3		
Intake valve	Open at	18° (B.T.D.C)		
	Close at	34° (A.B.D.C)		
Exhaust valve	Open at	46° (B.B.D.C)		
	Close at	14° (A.T.D.C)		
Lubrication method		Full forced pressure feed type		
Oil pump type		Gear type driven by crankshaft		
Oil filter type		Full-flow, Cartridge type		
Lubricating oil capacity (max./min.) (lit)		23/20		
Oil cooler type		Water cooled		
Water pump		Gear driven impeller type		
Cooling Method		Pressurized circulation		
Cooling water capacity (engine only) (lit)		19		
Thermostat type		Wax pallet type (83 ~ 95 °C)		
Alternator voltage - capacity (V - A)		24 - 45		
Starting Motor voltage - output (V - kW)		24 - 6.0		

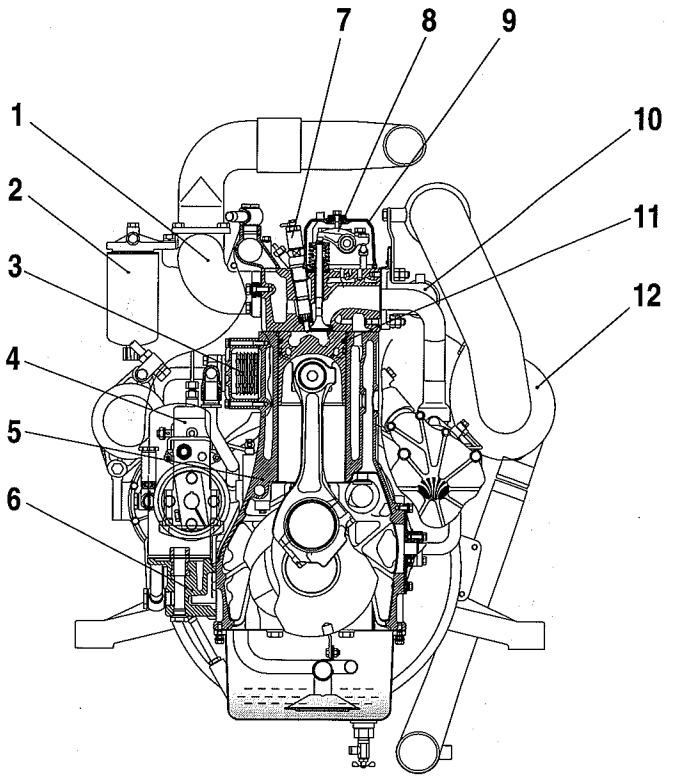
1.2. Engine assembly

1.2.1. Engine sectional view (Longitudinal)



1. Cooling fan
2. Exhaust valve
3. Valve spring
4. Oil filter
5. Tappet
6. Push rod
7. Piston pin
8. Piston
9. Combustion chamber
10. Crankshaft pulley
11. Vibration damper
12. Oil pump
13. Crankshaft
14. Oil pan
15. Connecting rod
16. Camshaft
17. Flywheel housing
18. Flywheel

1.2.2. Engine sectional view (Cross)

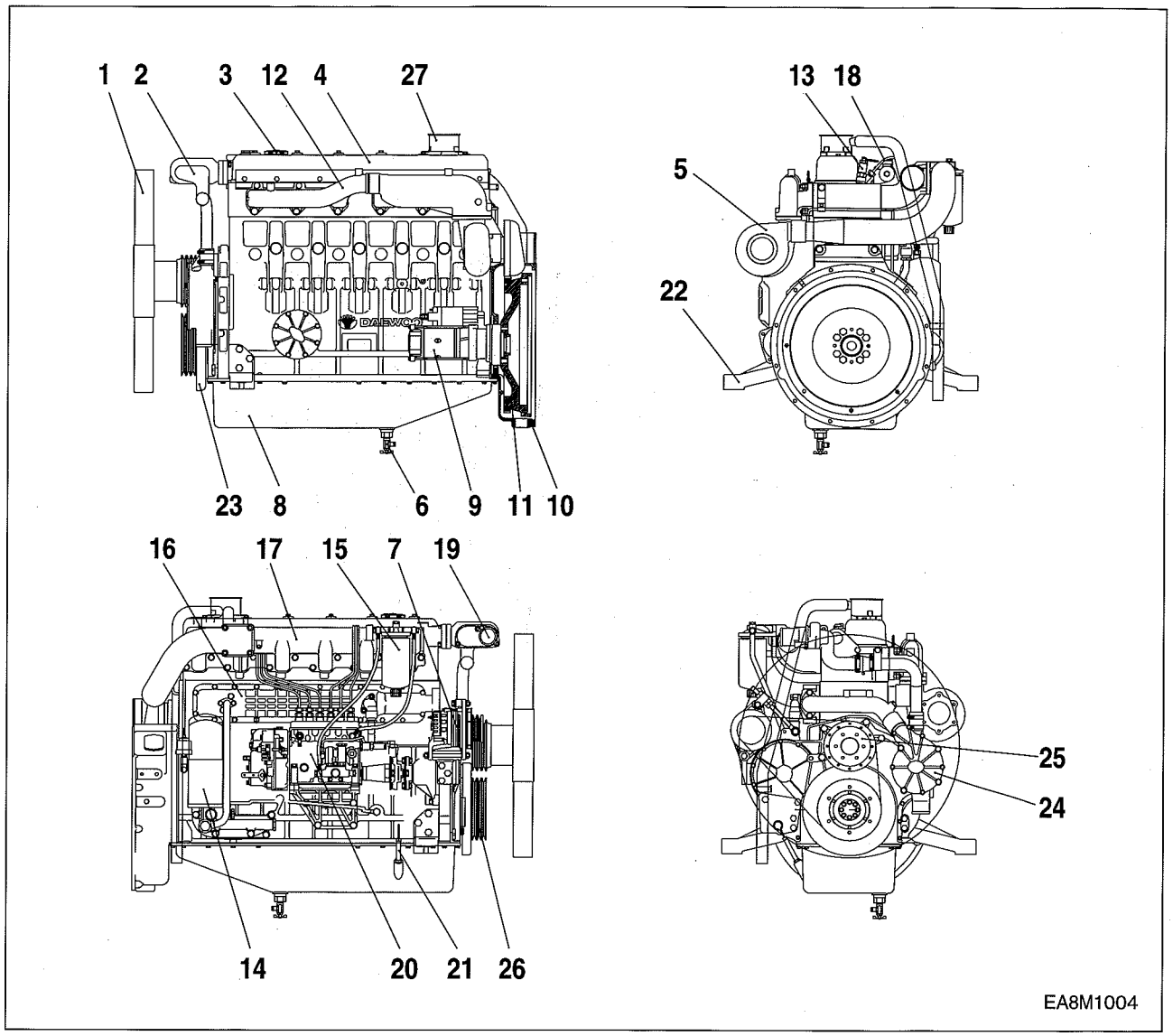


EA8M1003

1. Intake manifold
2. Fuel filter
3. Oil cooler
4. Injection pump
5. Cylinder block
6. Oil filter
7. Injection nozzle assembly
8. Rocker arm
9. Cylinder head cover
10. Exhaust manifold
11. Piston ring
12. Turbocharger

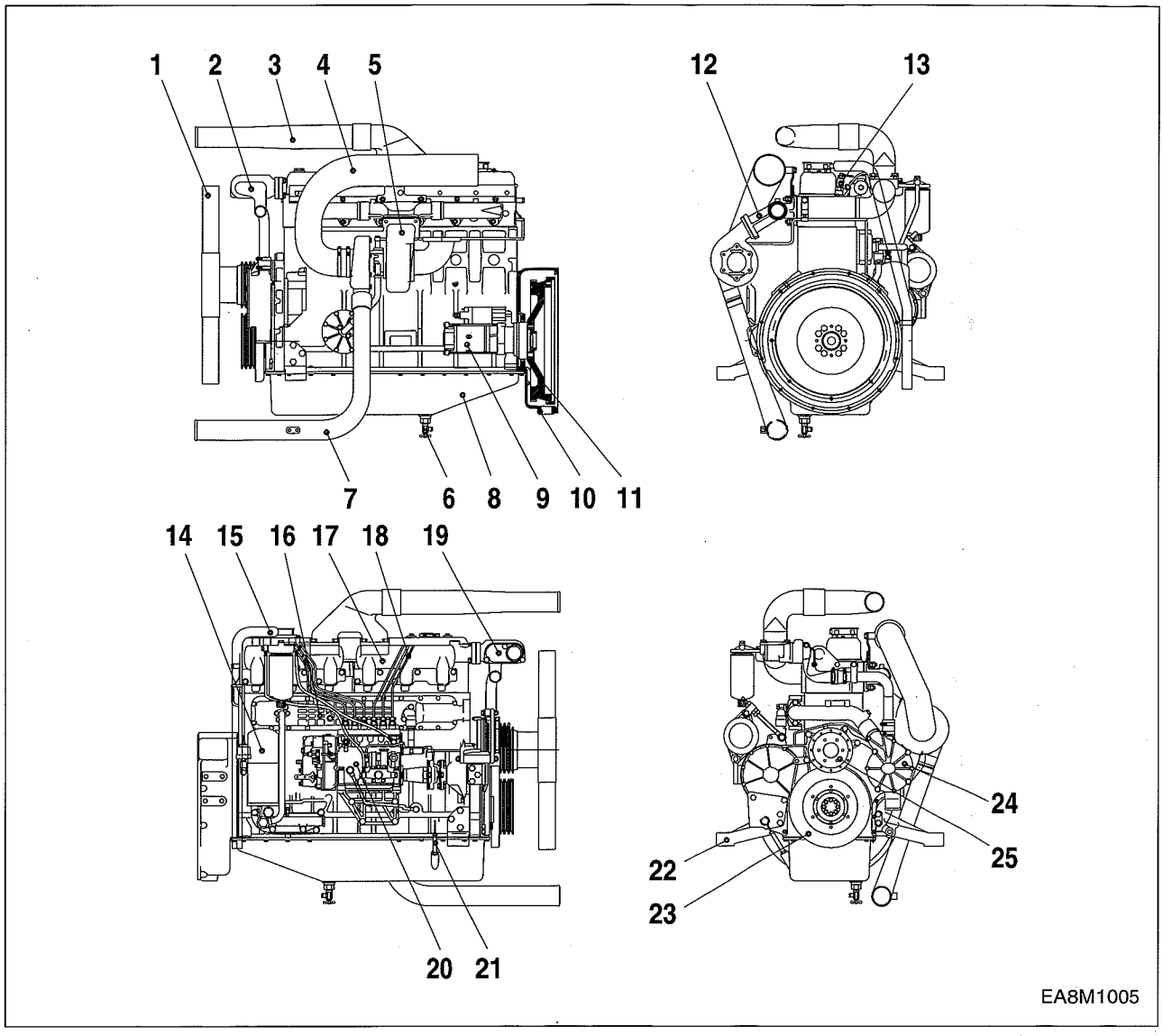
1.2.3. Engine assembly views

1) DE12T



1. Cooling fan
2. Cooling water pipe
3. Oil filler cap
4. Cylinder head cover
5. Turbocharger
6. Oil drain valve
7. Alternator
8. Oil pan
9. Starter
10. Flywheel housing
11. Flywheel
12. Exhaust manifold
13. Injection nozzle assembly
14. Oil filter
15. Fuel filter
16. Oil cooler
17. Intake manifold
18. Injection pipe
19. Thermostat
20. Injection pump
21. Oil level gauge
22. Mounting bracket
23. Vibration damper
24. Water pump
25. Fan drive
26. Crankshaft pulley
27. Breather

2) P126TI



1. Cooling fan
2. Cooling water pipe
3. Air pipe
   (Intercooler → Intake manifold)
4. Air pipe
   (Air cleaner → Turbocharger)
5. Turbocharger
6. Oil drain valve
7. Air pipe
   (Intercooler → Intake manifold)
8. Oil pan
9. Starter
10. Flywheel housing
11. Flywheel
12. Exhaust manifold
13. Injection nozzle assembly
14. Oil filter
15. Breather hose
16. Oil cooler
17. Intake manifold
18. Injection pipe
19. Thermostat
20. Injection pump
21. Oil level gauge
22. Mounting bracket
23. Vibration damper
24. Water pump
25. Fan drive

2. Safety regulations

2.1. General notes

Day-to-day use of power engines and the service products necessary for running them presents no problems if the persons occupied with their operation, maintenance and care are given suitable training and think as they work.

This summary is a compilation of the most important regulations. These are broken down into main sections which contain the information necessary for preventing injury to persons, damage to property and pollution. In addition to these regulations those dictated by the type of engine and its site are to be observed also.

Important :

If, despite all precautions, an accident occurs, in particular through contact with caustic acids, fuel penetrating the skin, scalding from oil, antifreeze being splashed in the eyes etc., consult a doctor immediately.

2.2. Regulations designed to prevent accidents

2.2.1. During commissioning, starting and operation

Before putting the engine into operation for the first time, read the operating instructions carefully and familiarize yourself with the "critical" points, If you are unsure, ask your DAEWOO representative.

- For reasons of safety we recommend you attach a notice to the door of the engine room prohibiting the access of unauthorized persons and that you draw the attention of the operating personal to the fact that they are responsible for the safety of persons who enter the engine room.
- The engine must be started and operated only by authorized personnel. Ensure that the engine cannot be started by unauthorized persons.
- When the engine is running, do not get too close to the rotating parts. Wear close-fitting clothing.
- Do not touch the engine with bare hands when it is warm from operation risk of burns.
- Exhaust gases are toxic. Comply with the installation instructions for the installation of DAEWOO generator diesel engines which are to be operated in enclosed spaces. Ensure that there is adequate ventilation and air extraction.
- Keep vicinity of engine, ladders and stairways free of oil and grease.
  Accidents caused by slipping can have serious consequences.

2.2.2. During maintenance and care

- Always carry out maintenance work when the engine is switched off. If the engine has to be maintained while it is running, e.g. changing the elements of change-over filters, remember that there is a risk of scalding. Do not get too close to rotating parts.
- Change the oil when the engine is warm from operation.

Caution :
There is a risk of burns and scalding. Do not touch oil drain valve or oil filters with bare hands.

- Take into account the amount of oil in the sump. Use a vessel of sufficient size to ensure that the oil will not overflow.
- Open the coolant circuit only when the engine has cooled down. If opening while the engine is still warm is unavoidable, comply with the instructions In the chapter entitled "Cooling".
- Neither tighten up nor open pipes and hoses (lube oil circuit, coolant circuit and any additional hydraulic oil circuit) during the operation. The fluid which flow out can cause injury.
- Fuel is inflammable. Do not smoke or use naked lights in its vicinity. The tank must be filled only when the engine is switched off.
- Keep service products (anti-freeze) only in containers which can not be confused with drinks containers.
- Comply with the manufacturer's instructions when handling batteries.

Caution :
Accumulator acid is toxic and caustic. Battery gases are explosive.

2.2.3. When carrying out checking, setting and repair work

- Checking, setting and repair work must be carried out by authorized personnel only.
- Use only tools which are in satisfactory condition. Slip caused by the worn open-end wrench could lead to Injury.
- When the engine is hanging on a crane, no-one must be allowed to stand or pass under it. Keep lifting gear in good condition.
- When checking injectors, do not put your hands under the jet of fuel.
  Do not inhale at atomized fuel.
- When working on the electrical system disconnect the battery earth cable first. Connect it up again last in prevent short circuits.

2.3. Regulations designed to prevent damage to engine and premature wear

1) Never demand more of the engine than it was designed to yield for its intended purpose. Detailed information on this can be found in the sales literature. The injection pump must not be adjusted without prior written permission of DAEWOO.

2) If faults occur, find the cause immediately and have it eliminate in order to prevent more serious of damage.
3) Use only genuine DAEWOO spare parts. DAEWOO will accept no responsibility for damage resulting from the installation of other parts which are supposedly "just as good".
4) In addition to the above, note the following points.
   - Never let the engine run when dry, i.e. without lube oil or coolant. Use only DAEWOO-approved service products (engine oil, anti-freeze and anticorrosion agent).
   - Pay attention to cleanliness, The Diesel fuel must be free of water. See "Maintenance and care".
   - Have the engine maintained at the specified intervals.
   - Do not switch off the engine immediately when it is warm, but let it run without load for about 5 minutes so that temperature equalization can take place.
   - Never put cold coolant into an overheated engine. See "Maintenance and care".
   - Do not add so much engine oil that the oil level rises above the max. marking on the dipstick. Do not exceed the maximum permissible tilt of the engine. Serious damage to the engine may result if these instructions are not adhered to.
   - Always ensure that the testing and monitoring equipment (for battery charge, oil pressure, and coolant temperature) function satisfactorily.
   - Comply with instructions for operation of the alternator. See "Commissioning and operation".
   - Do not let the water pump run dry. If there is a risk of frost, drain the water when the engine switched off.

2.4. Regulations designed to prevent pollution

2.4.1. Engine oil, filter element, fuel filter

- Take old oil only to an oil collection point. Take strict precautions to ensure that oil does not get into the drains or into the ground.
- The drinking water supply may be contaminated.
- Oil and fuel filter elements are classed as dangerous waste and must be treated as such.

2.4.2. Coolant

- Treat undiluted anti-corrosion agent and / or antifreeze as dangerous waste.
- When disposing of spent coolant comply with the regulations of the relevant local authorities.

2.5. Notes on safety in handling used engine oil

Prolonged or repeated contact between the skin and any kind of engine oil decreases the skin. Drying, irritation or inflammation of the skin may therefore occur. Used engine oil also contains dangerous substances which have caused skin cancer in animal experiments. If the basic rules of hygiene and health and safety at work are observed, health risks are not to the expected as a result of handling used engine oil.

Health precautions

- Avoid prolonged or repeated skin contact with used engine oil.
- Protect your skin by means of suitable agents (creams etc.) or wear protective gloves.
- Clean skin which has been in contact with engine oil.
  - Wash thoroughly with soap and water, A nailbrush is an effective aid.
  - Certain products make it easier to clean your hands.
  - Do not use petrol, Diesel fuel, gas oil, thinners or solvents as washing agents.
- After washing apply a fatty skin cream to the skin.
- Change oil-soaked clothing and shoes.
- Do not put oily rags into your pockets.

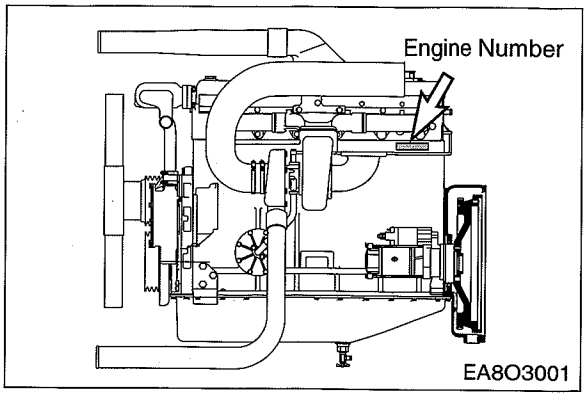
Ensure that used engine oil is disposed of properly.
- Engine oil can endanger the water supply -

For this reason do not let engine oil get into the ground, waterways, the drains or the sewers. Violations are punishable. Collect and dispose of used engine oil carefully.
For information on collection points please contact the seller, the supplier or the local authorities.

3. Technical information

3.1. Engine model and serial number

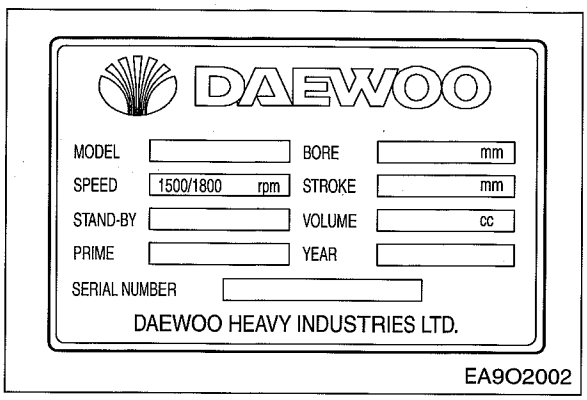
The engine model and serial number is located on the engine as illustrated. These numbers are required when requesting warranty and ordering parts. They are also referred to as engine model and serial number because of their location.



- **Engine serial No. (example 1 : DE12T)**

EBHGA900001

Serial No.
Production Year(19x9)
Engine Model Suffix

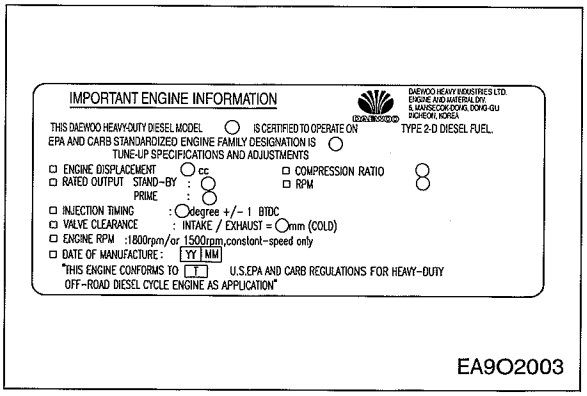


< Name Plate : General >

- **Engine serial No. (example 2 : P126TI)**

EDIGA900001

Serial No.
Production Year(1999)
Engine Model Suffix



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3.2. Engine type

The Engines DE12T/ P126TI are in-line vertical water-cooled 6-cylinder four-stroke diesel engines with direct injection. DE12T is turbo-charged engine, and P126TI model is turbo-charged and inter-cooled engine.

3.2.1. Cylinder block

The cylinder block is a single piece of alloy cast iron. To increase its stiffness, it is extended to a level below the crankshaft center line. The engine has replaceable dry cylinder liners and individual cylinder heads with struck-in valve seat rings and replaceable valve guides,

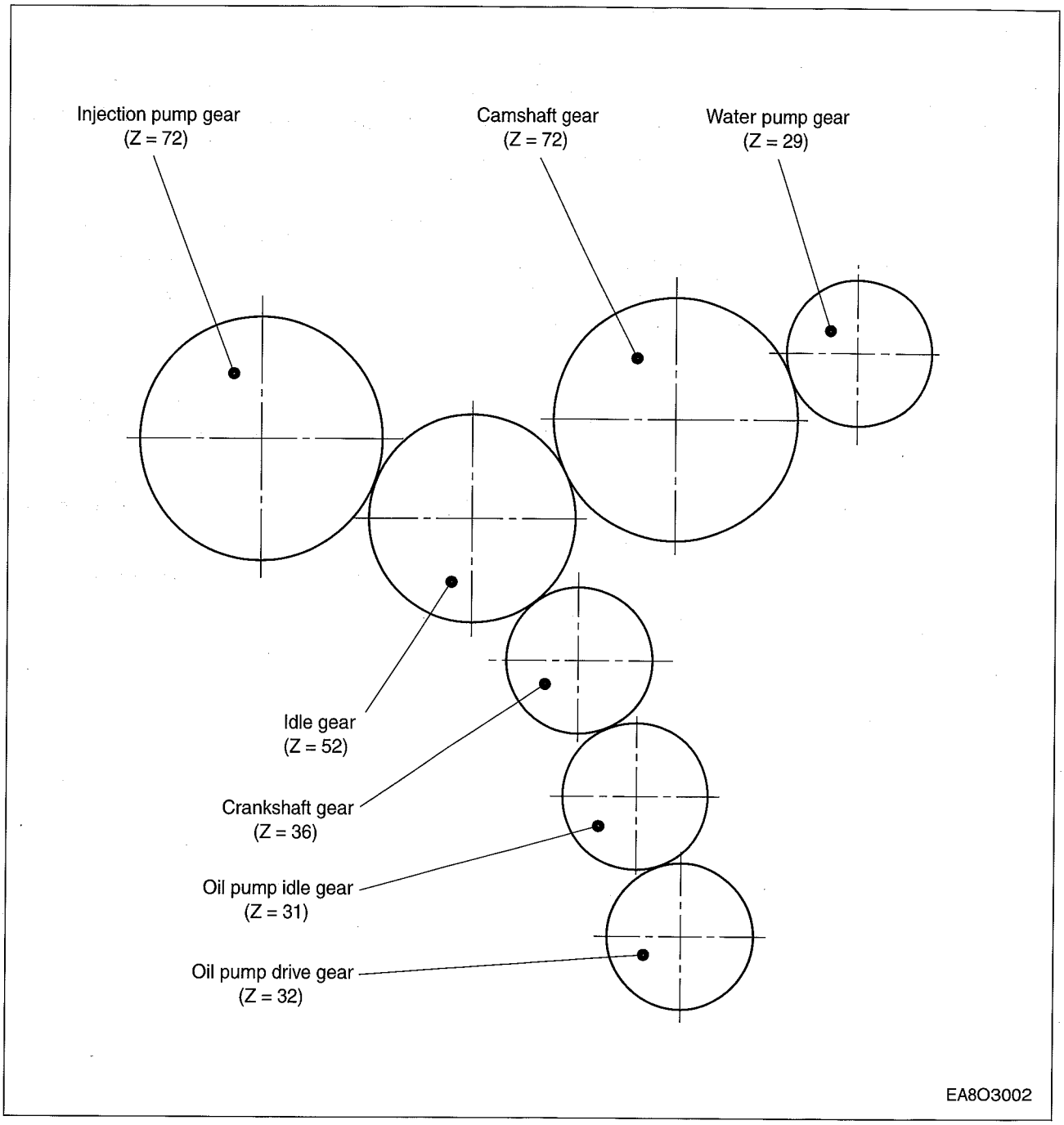
3.2.2. Piston con-rod / crankshaft

The forged crankshaft is a ingrate type (Counterweight is integrated with crank shaft body). Radial oil seal on crankshaft and flywheel are provided to seal the flywheel housing inside penetrations.

The con-rods (connecting rods) are die-forged, diagonally split and can be removed through the top of the cylinders together with the pistons. Crankshaft and connecting rods run in steel-backed lead bronze ready-to fit type bearings.

3.3. Engine timing

Camshaft, oil pump and injection pump are driven by a gear train arranged at the front end.

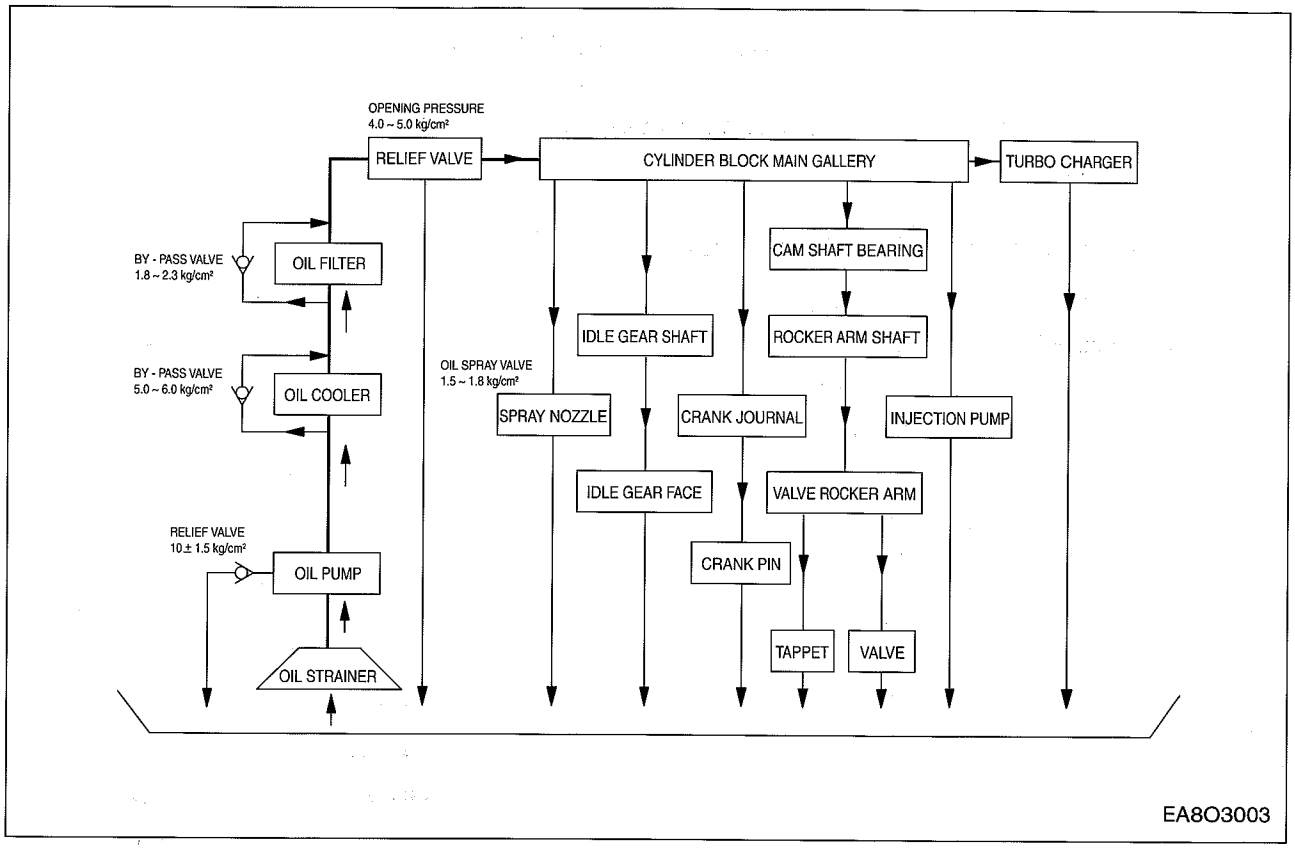


3.4. Valves

The overhead valves are actuated via chilled cast iron tappets, push rods and rocker arms from the camshaft.

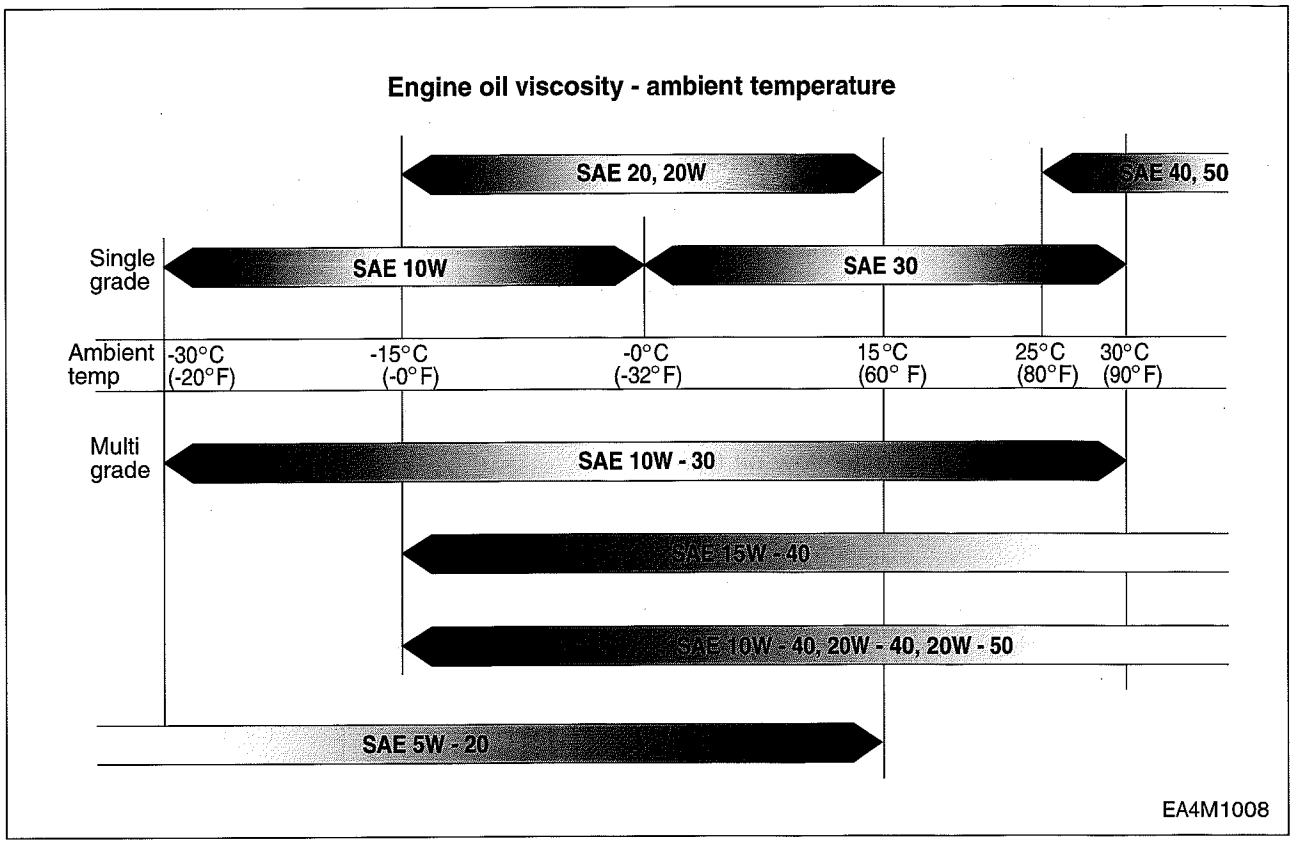
3.5. Lubrication system

The engine is equipped with force-feed lubrication.
The pressure is produced by a gear pump whose drive gear is in direct mesh with the crankshaft gear at the front end of cylinder block.
The oil pump draws the oil from the oil sump and delivers it through the oil cooler and oil filter to the main distributor gallery and from there to the main bearings, big-end bearings and camshaft bearings as well as to the small-end bearings and the rocker arms.
The injection pump and the turbocharger are also connected to the engine lubricating system.
The cylinder walls and timing gears are splash-lubricated.
Each cylinder has an oil jet provided for cooling the underside of the pistons.
The lube oil is cleaned in a full-flow oil filter.



3.5.1. Recommend of lubricating oil

Initial factory fill is high quality break-in oil for API Service CD. During the break-in period (50 hours), frequently check the oil level. Somewhat higher oil consumption is normal until piston rings are seated. The oil level should be maintained in the safe range between the Min. and Max. marks on the dipstick. The safe range between the marks represents approximately 3 liters. To obtain the best engine performance and engine life, grade of engine oil is recommended. Engine oils are specified by API Service, letter designations and SAE viscosity numbers. If the specified motor oil is not available, use a reputable brand of engine oil labeled for API Service CD and SAE viscosity 30 or 15w40. Refer to oil identification symbol on the container.
Engine oil should be changed at the specified intervals. (800hr)

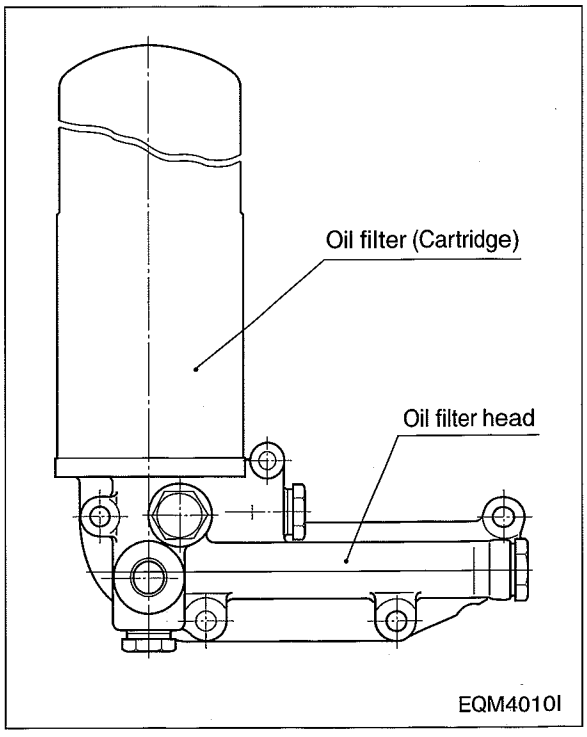


3.5.2. Oil cooler

An oil cooler is provided between the oil filter and the cylinder block. This cooler is a flat tube type with turbulence inserts and operated by the coolant.

3.5.3. Oil filter

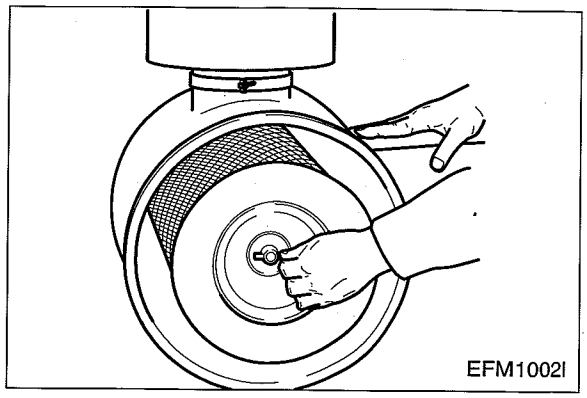
Check for oil pressure and oil leaks, and repair or replace the oil filter if necessary. Change the oil filter cartridge simultaneously at every replacement of engine oil.



3.6. Air cleaner

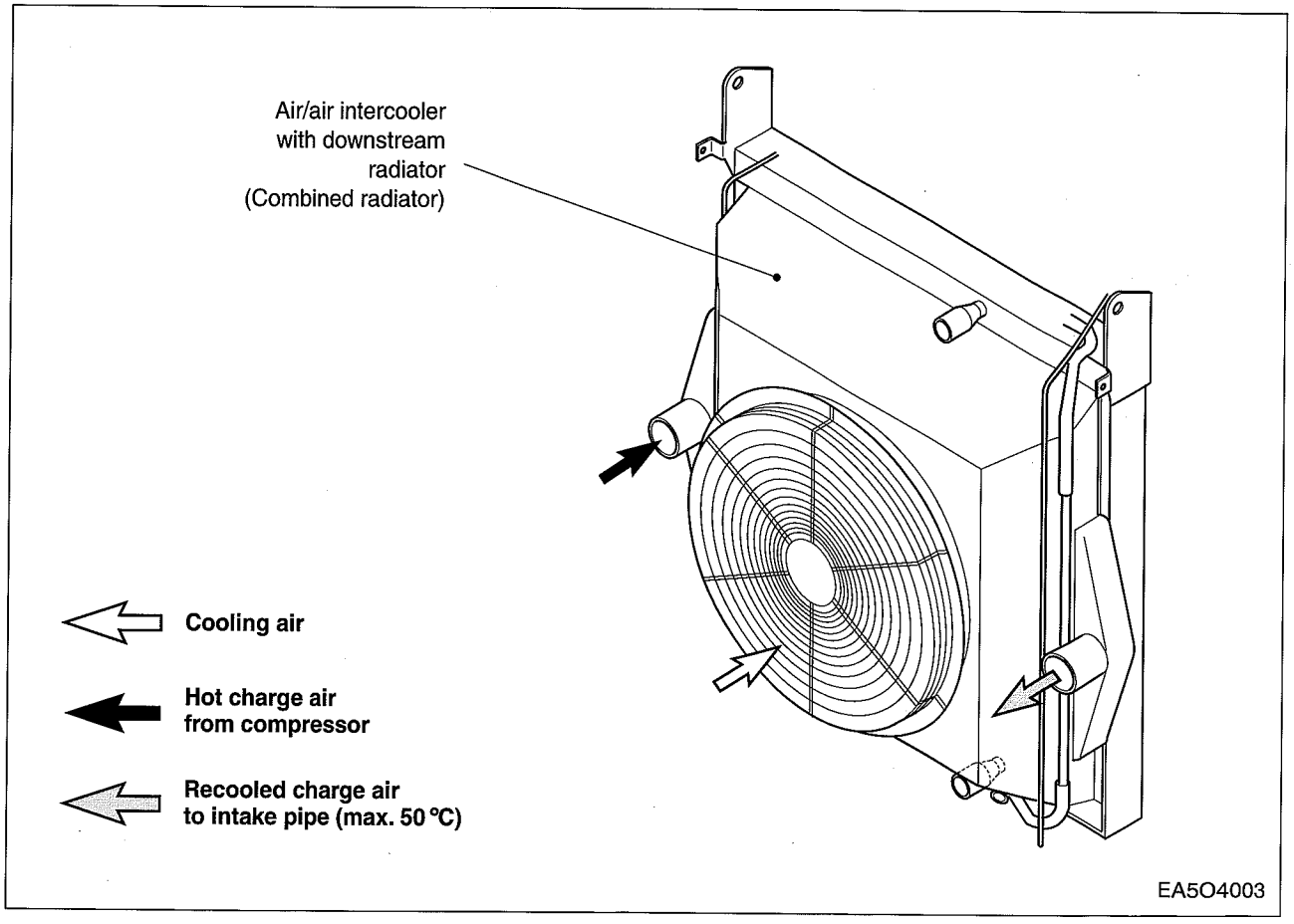
In case that elements are deformed, damaged or if the air cleaner has a crack, replace it.
By the definite interval, the elements must be cleaned and replaced.

- Cleaning of air cleaner element: Every 200 hours.
- Changing of air cleaner element: Every 600 hours.



3.7. Intercooler

The intercooler is air to air type and has a large cooling fan capacity. The intercooler life and performance depends on the intake air condition greatly. Fouled air pollutes and clogs the air fins of intercooler. As a result of this, the engine output is decreased and engine malfunction is occurred. So you always check whether the intake air systems like air filter element are worn or polluted.



- Cleaning of intercooler fins: Every 600 hours.

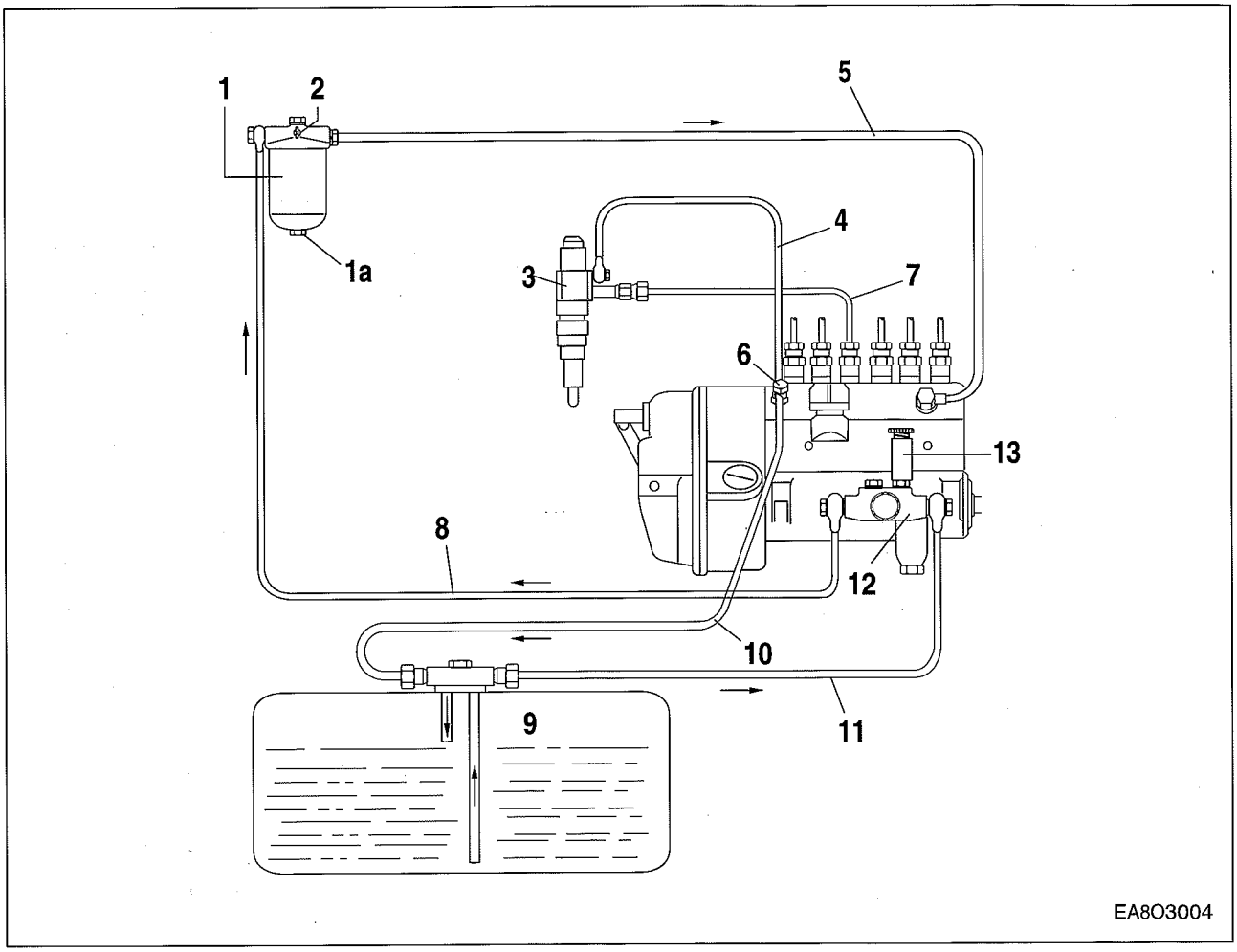
3.8. Fuel system

The fuel is delivered by the fuel feed pump via the fuel filter to the injection pump and from there to the injection nozzles.

The fuel is sprayed into the cylinders through nozzles fitted in screw-fit injection nozzle holders in the cylinder heads.

Excessively delivered fuel and leak fuel from the nozzle flow through the return pipe back to the tank.

A strainer is arranged ahead of the fuel feed pump.



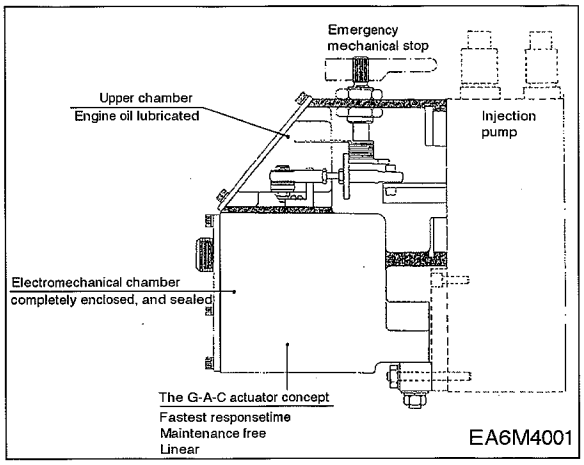
1. Fuel filter
1a. Full water drain plug
2. Air bleeding screw (for fuel filter)
3. Injection nozzle
4. Overflow tube
5. Fuel pipe (filter→ injection pump)
6. Overflow valve
7. Delivery pipe
8. Fuel pipe (manual pump→filter)
9. Fuel tank
10. Fuel return pipe
11. Suction pipe
12. Feed pump
13. Injection pump

3.8.1. Injection pump

The in-line injection pump is driven via gears from the crankshaft. It is connected to the force feed lubricating system of the engine and consequently maintenance-free. The governor flange-mounted on the pump casing is a variable range governor designed to keep the speed set by the speed control unit constant under conditions of varying load.

Governor system for fuel injection pump consists of "Integral Actuator" and " Speed Control Unit".

1) Integral Actuator



2) Speed control unit for governor system

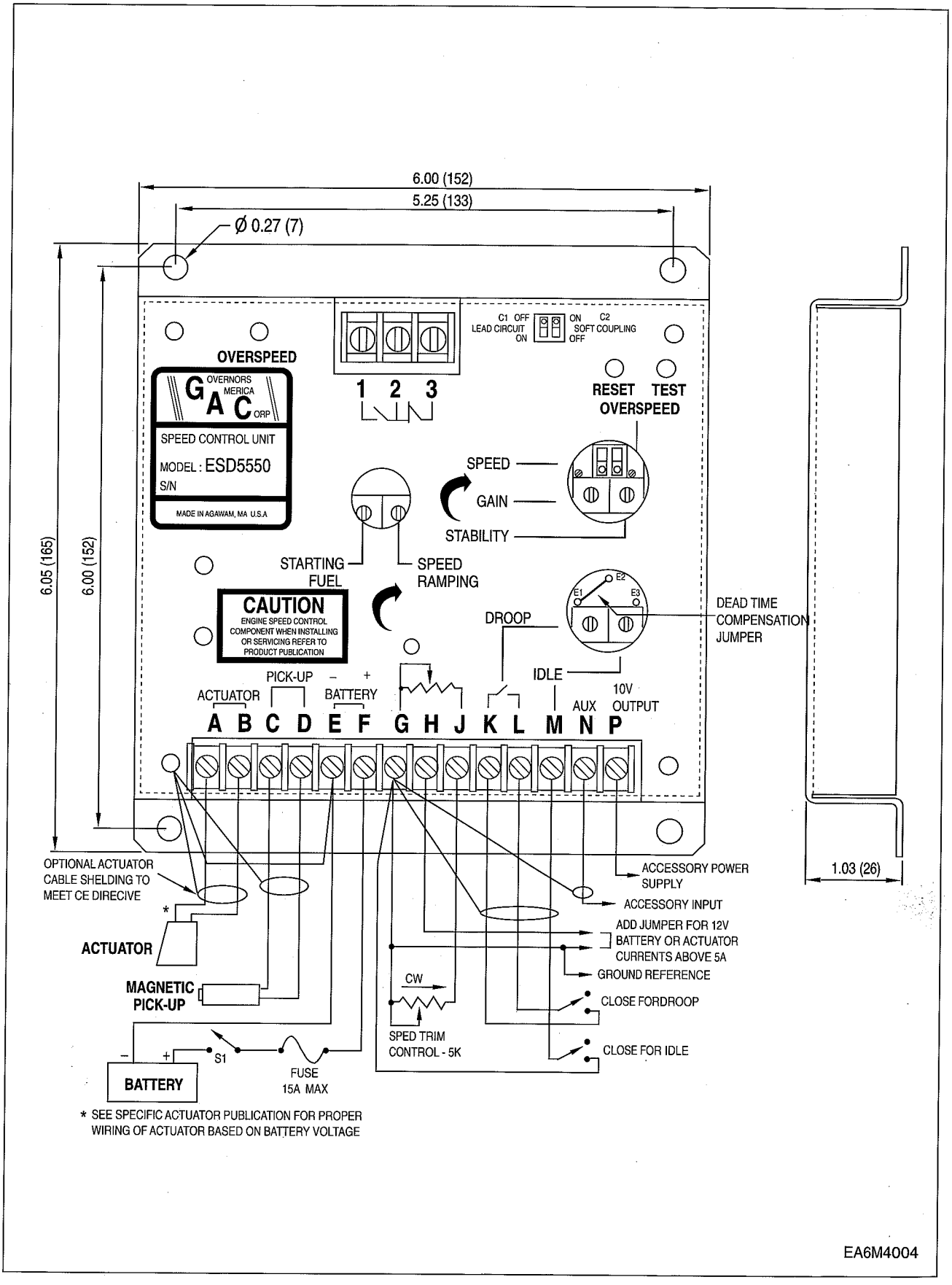
The ESD5550 Series speed control unit is an all electronic device designed to control engine speed with fast and precise response to transient load changes. This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, will control a wide variety of engines in an isochronous or droop mode. It is designed for high reliability and built ruggedly to withstand the engine environment.

Simplicity of installation and adjustment was foremost in the design. Non-interacting performance controls allow near optimum response to be easily obtained.

The primary features of the ESD5550 Series speed control unit are the engine STARTING FUEL and SPEED RAMPING adjustments. The use of these features will minimize engine exhaust smoke experienced prior to attaining engine operating speed.

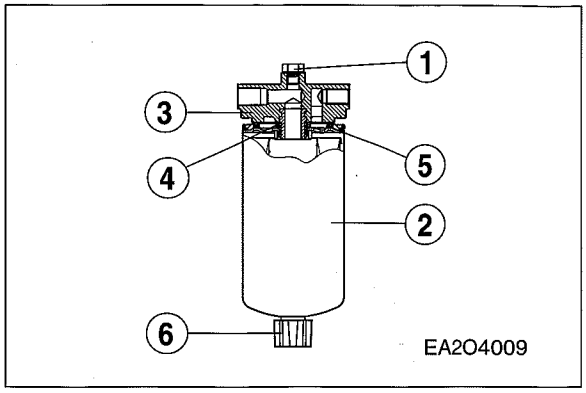
Other features include adjustable droop and idle operation, inputs for accessories used in multi-engine or special applications, protection against reverse battery voltage, transient voltages, accidental short circuit of the actuator and fail safe design in the event of loss of speed sensor signal or battery supply.

Engine model	P126TI
GAC governor model	ACE 175A
Speed control unit model	ESD5550


6.00 (152)
5.25 (133)
Ø 0.27 (7)
6.05 (165)
6.00 (152)
OVERSPEED
GAC GOVERNORS AMERICA CORP
SPEED CONTROL UNIT
MODEL : ESD5550
S/N
MADE IN AGAWAM, MA U.S.A
1 2 3
C1 OFF LEAD CIRCUIT ON
ON C2 SOFT COUPLING OFF
RESET TEST OVERSPEED
SPEED
GAIN
STABILITY
STARTING FUEL
SPEED RAMPING
CAUTION
ENGINE SPEED CONTROL COMPONENT WHEN INSTALLING OR SERVICING REFER TO PRODUCT PUBLICATION
DROOP
E1 E2 E3
DEAD TIME COMPENSATION JUMPER
IDLE
PICK-UP
ACTUATOR
BATTERY
10V OUTPUT
AUX
A B C D E F G H J K L M N P
1.03 (26)
OPTIONAL ACTUATOR CABLE SHELDING TO MEET CE DIRECIVE
ACCESSORY POWER SUPPLY
ACCESSORY INPUT
ADD JUMPER FOR 12V BATTERY OR ACTUATOR CURRENTS ABOVE 5A
GROUND REFERENCE
CLOSE FORDROOP
CLOSE FOR IDLE
ACTUATOR
MAGNETIC PICK-UP
CW
SPED TRIM CONTROL - 5K
BATTERY
S1
FUSE 15A MAX
* SEE SPECIFIC ACTUATOR PUBLICATION FOR PROPER WIRING OF ACTUATOR BASED ON BATTERY VOLTAGE
EA6M4004

3.8.2. Fuel filter

This fuel filter has two functions not only oil filtering but also water separating.
Before entering the suction chamber of the injection pump, the fuel is cleaned in a strainer of fuel feed pump and a fuel filter.
Drain water in cartridge with loosening the cock under filter manually (6) from time to time.
The fuel filter should be replaced at every 1,200 hours.



3.8.3. Fuel requirements

DAEWOO marine diesel engines was designed to use Number 2-D diesel fuel or equivalent that meets specification DIN 51601-DK. For maximum fuel economy, Number 2-D fuel whenever possible. When temperatures are below -7˚C(20˚F), use Number 1-D fuel. If Number 1-D fuel is not available, the mixture of one kerosene to two gallons of Number 2-D fuel can be used. Once kerosene has been added, the engine should be run for several minutes to mix the fuel.

3.8.4. How to select fuel oil

Fuel quality is an important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. DAEWOO engines are designed to operate on most diesel fuels marketed today. In general, fuels meeting the properties of ASTM Designation D975 (grades 1-D and 2-D) have provided satisfactory performance.
The ASTM 975 specification, however, does not in itself adequately define the fuel characteristics needed for assurance of fuel quality.
The properties listed in the fuel oil selection chart below have provided optimum engine performance. Grade 2-D fuel is normally available for generator service. Grade 1-D fuel should not be used in pleasure craft engines, except in an emergency.

Fuel oil selection chart

General Fuel Classification	ASTM Test	No. 1 ASTM 1-D	No. 2 ASTM 2-D	DIN 51601
Gravity,˚API #)	D 287	40 ~ 44	33 ~ 37	0.815 ~ 0.855
Flash Point Min. ˚F (˚C)	D 93	100 (38)	125 (52)	131 (55)
Viscosity, Kinematic CST 100 ˚F (40 ˚C)	D 445	1.3 ~ 2.4	1.9 ~ 4.1	1.8 ~ 10
Cloud Point ˚F #)	D 2500	See Note 1)	See Note 1)	See Note 1)
Sulfur Content wt%, Max.	D 129	0.5	0.5	0.15
Carbon Residue on 10%, wt%, Max.	D 524	0.15	0.35	0.1
Accelerated Stability Total Insolubles mg/100 ml, Max. #)	D 2274	1.5	1.5	
Ash, wt%, Max.	D 482	0.01	0.01	
Cetane Number, Min. +)	D 613	45	45	> 45
Distillation Temperature, ˚F(˚C)	D 86			
IMP, Typican #)		350(177)	375(191)	
10% Typical #)		385(196)	430(221)	
50% Typical #)		45(218)	510(256)	680(360)
90% +)		500 (260) Max.	625(329) Max.	
End Point #)		550(288) Max.	675(357) Max.	
Water & Sediment %, Max.	D 1796	0.05	0.05	0.05

#) Not specified In ASTM D 975

+) Differs from ASTM D 975

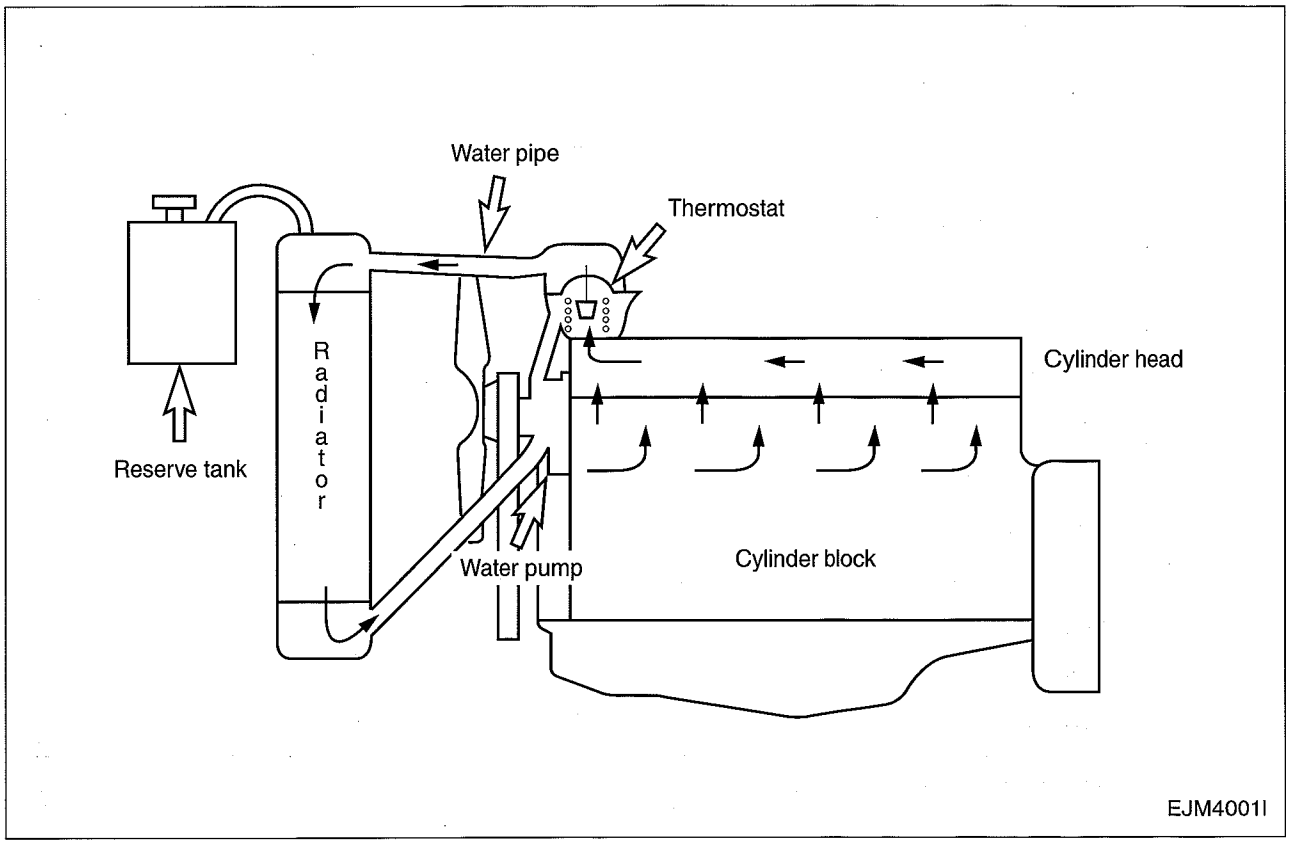
Note : *1.The cloud point should be 6˚C(10˚F) below the lowest expected fuel temperature to prevent clogging of fuel fitters by crystals.*

3.9. Cooling system

The engine has a liquid-cooling system. The fresh water pump is a maintenance-free by gear from the crankshaft.

Depending on the agreed extent of delivery and the design of the engine, the coolant circuit can be equipped with temperature monitors which, in the event of loss of coolant, shut the engine down.

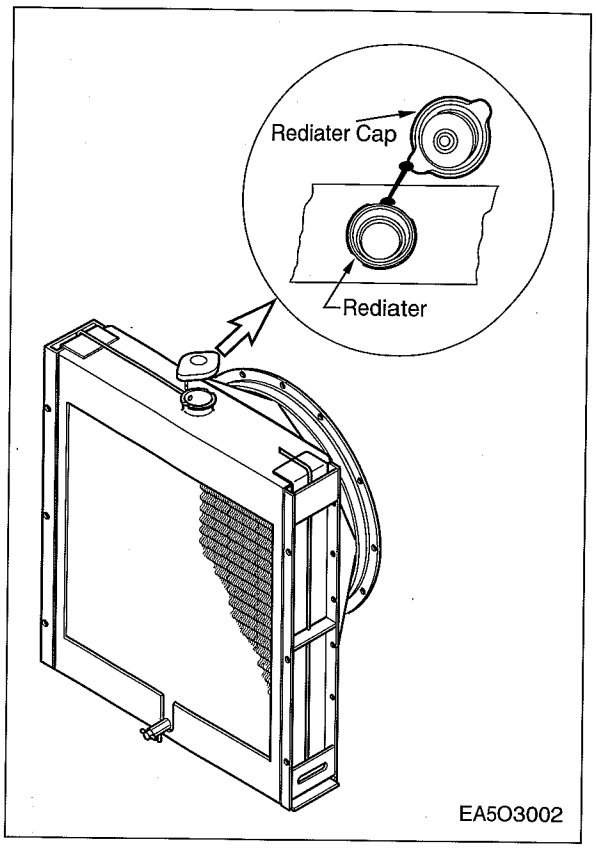
- Check the coolant level of the expansion tank by removing the expansion tank filler cap, and add coolant if necessary.
- When injecting antifreeze solution, first drain out the old coolant from the cylinder block and radiator, and then clean them with cleaning solution.
- Be sure to mix soft water with antifreeze solution.



3.9.1. Coolant pressure cap

Check the pressure valve opening pressure using a expansion tank cap tester. Replace the filler cap assembly if the measured valve does not reach the specified limit. (pressure valve opening pressure : 0.9 kg/cm²)

Note : *Because it is dangerous to open the pressure cap quickly when coolant is hot, after lowering the inside pressure of the tank by slow-opening at first open it fully.*



3.9.2. Anti-freeze

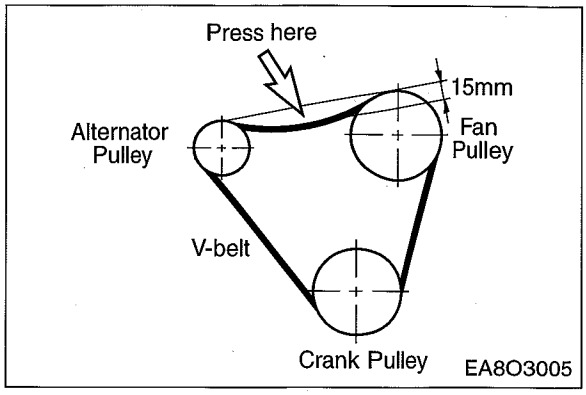
The anti-freeze, 50% of the whole coolant,
is always to be used to prevent the cooling system from the corrosion. And in winter the amount of anti-freeze shown in the following table should be used in accordance with the ambient temperature.
As the individual freezing points corresponding to the proportions of antifreeze in the table are subject to change slightly according to the kind of antifreeze, you must follow the specifications provided by the antifreeze manufacturer.

Ambient Temperature (˚C)	Cooling water (%)	Anti-freeze (%)
Over -10	85	15
-10	80	20
-15	73	27
-20	67	33
-25	60	40
-30	56	44
-40	50	50

As the ratio of antifreeze in the mixture decrease each time new coolant is added to make up for the loss coolant resulting from engine operation, Check the mix ratio with every replenishment of coolant, and top up as necessary.

3.10. V-belt tension check and adjust

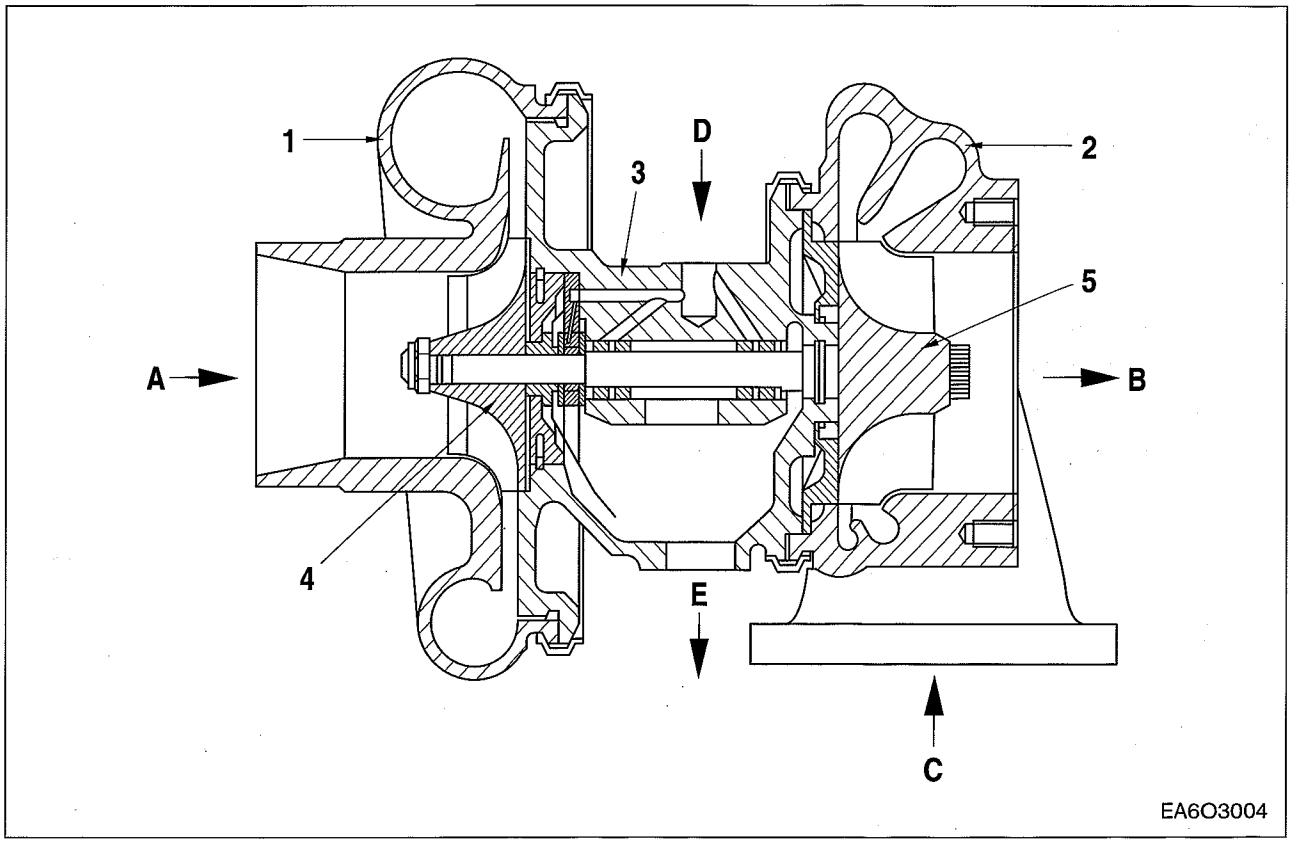
By the finger-pressure the belt is pressed by 10mm ~ 15mm between the fan pulley and the alternator pulley in normal condition. For the adjustment of the tension, loosen the adjusting bolts which support the alternator, adjust the tension and tighten the bolts again.



3.11. Turbocharger

The exhaust gases of the engine are passed through the turbine rotor of the turbocharger. Air compressor impeller mounted on the same shaft draws in fresh air and delivers it at a higher pressure to the cylinders.

The turbocharger is naturally air-cooled. Lubrication of the main bearing is by oil under pressure from the engine lubricating system.



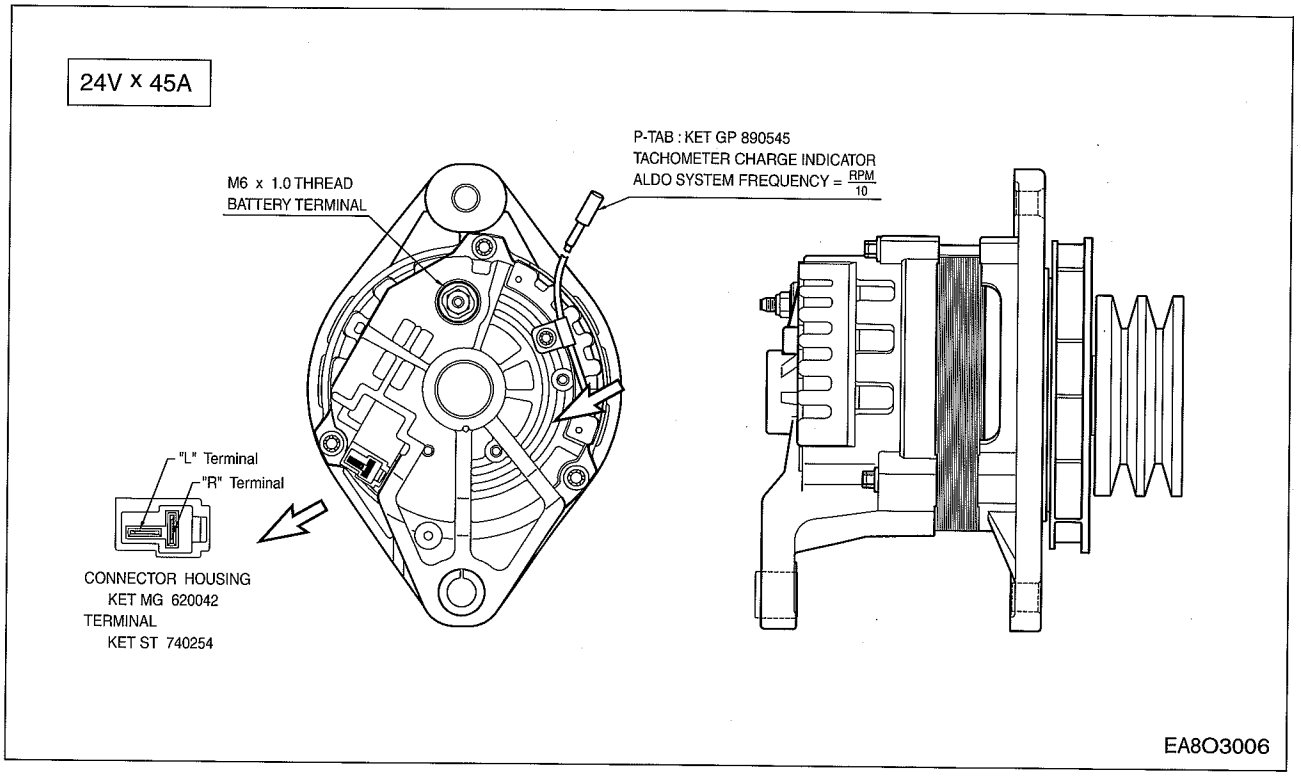
1. Compressor casing
2. Turbine casing
3. Compressor wheel
4. Impeller
5. Turbine

A. Air inlet
B. Gas outlet
C. Gas inlet
D. Oil supply
E. Oil return

3.12. Electrical equipment

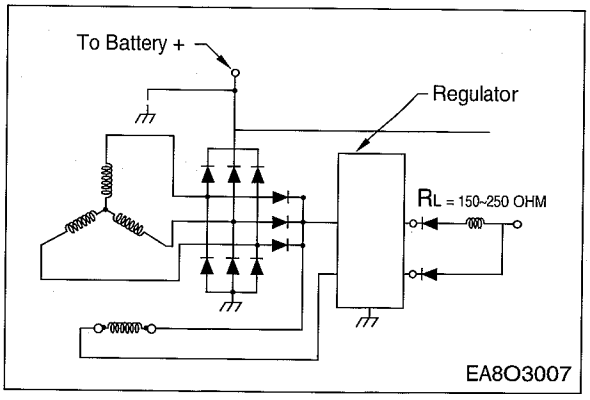
3.12.1. Alternator

The alternator is fitted with integral silicon rectifiers. A transistorized regulator mounted on the alternator body interior limits the alternator voltage. The alternator should not be operated except with the regulator and battery connected in circuit to avoid damage to the rectifier and regulator.



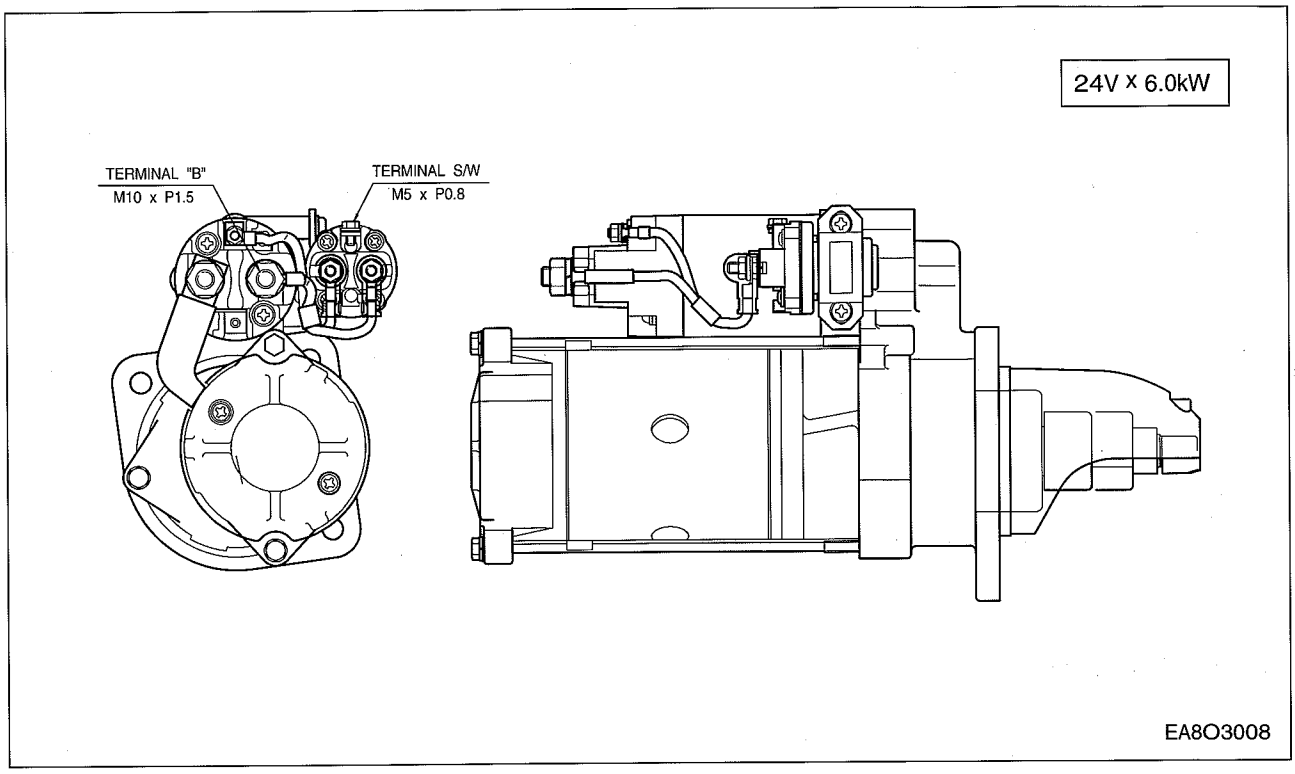
The alternator is maintenance-free, nevertheless, it must be protected against dust and, above all, against moisture and water.

Operate the alternator according to the instructions given in the chapter.



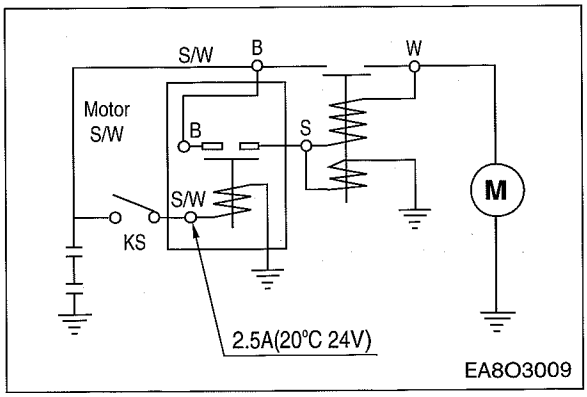
3.12.2. Starter motor

The sliding-gear starter motor is flanged to the rear of the flywheel housing on the left-hand side. As parts of every engine overhaul, the starter pinion and ring gear should be cleaned with a brush dipped in fuel and then a coat of grease should be applied again.



Always protect starter motor against moisture.

Warning : *Always disconnect the battery earth cable before starting work on the electrical system. Connect up the earth cable last, as there is otherwise a risk of short-circuits.*



4. Commissioning and operation

4.1. Preparation

At the time of initial commissioning of a new or overhauled engine make sure to have observed the "Technical Information for the installation DAEWOO generator engines".

- Oil filler neck on cylinder head cover

  Before daily starting of the engine, check the fuel, coolant and oil level, replenish if necessary.

  The notches in the dipstick indicate the highest and lowest permissible oil levels

  The oil required in the sump is specified in the "Engine Specification".

Note : *The oil required to fill the oil fillers and pipes depends upon the engine and use and must be determined individually at the time of initial commissioning. (Make the Max and Min. marks of the determined quantity on the oil level gauge.)*

- Cleanliness

  Ensure outmost cleanliness when handling fuels, lubricants and coolants.

4.2. Breaking-in

4.2.1. Operation of a new engine (Break-In)

Because the sliding surfaces of a new engine are not lapped enough, the oil film can be destroyed easily by overload or overspeed and the engine life-time may be shortened. Therefore the following things must be obeyed by all means.

Up to the first 2,000km (150 hours)

- Engine should be run at fast idling until the temperature of the engine becomes normal operating condition.
- Overload or continuous high speed operation should be avoided.
- High speed operation with no load should be prevented.
- Abrupt start and stop of the engine should be avoided.
- Engine speed must be under 70% of its maximum speed.
- Maintenance and inspection must be accomplished thoroughly.

4.2.2. Check points for break-in

During the break-in (the initial running of the engine) period, be particularly observant as follows:

a) Check engine oil level frequently. Maintain oil level in the safe range, between the "min." and "max." marks on dipstick.

Note : *If you have a problem getting a good oil level reading on dipstick, rotate dipstick 180° and re-insert for check.*

b) Watch the oil pressure warning lamp. If the lamp blinks, it may be the oil pick-up screen is not covered with oil. Check oil dipstick. Add oil to the oil pan, if required. Do not overfill. If level is correct and the status still exists, see your DEALER for possible switch or oil pump and line malfunction.

Note : *Oil pressure will rise as RPM increases, and fall as RPM decreases. In addition, cold oil will generally show higher oil pressure for any specific RPM than hot oil. Both of these conditions reflect normal engine operation.*

c) Watch the engine water temperature gauge and be sure there is proper water circulation. The water temperature gauge needle will fluctuate if water level in expansion tank is too low.

At the end of the break-in period, remove break-in oil and replace the oil filter. Fill oil pan with recommended engine oil. Refer to following table.

<Engine Oil capacity>

	Oil pan (only)
DE12T	23 liter
P126TI	23 liter

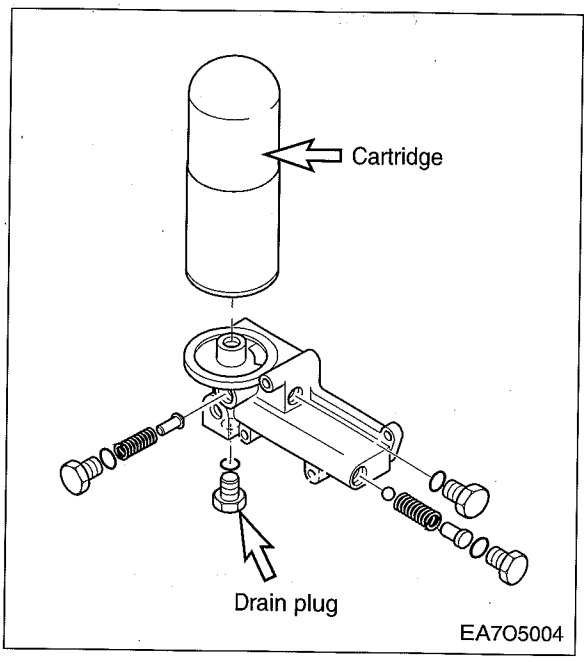
4.2.3. Operating after break-in

When starting a cold engine, always allow the engine to warm up gradually. Never run the engine at full throttle until the engine is thoroughly warmed up. Be sure to check the oil level frequently during the first 50 hours of operation, since the oil consumption will be high until the piston rings are properly seated.

5.2.4. Replacement of oil filter cartridge

At the same times of oil exchanges, replace the oil filter cartridge.

- Drain engine oil by loosening the drain plug on the filter head.



Caution : *Don't forget tightening the drain plug after having drained engine oil.*

- Loosen the oil filter by turning it counter-clockwise with a filter wrench.
- With a rag wipe clean the fitting face of the filter body and the oil filter body so that new oil filter cartridge can be seated properly.
- Lightly oil the O-ring and turn the oil filter until sealing face is fitted against the O-ring. Turn 1-1/4 turns further with the filter wrench.

Note : *It is strongly advisable to use DAEWOO genuine oil filter cartridge for replacement.*

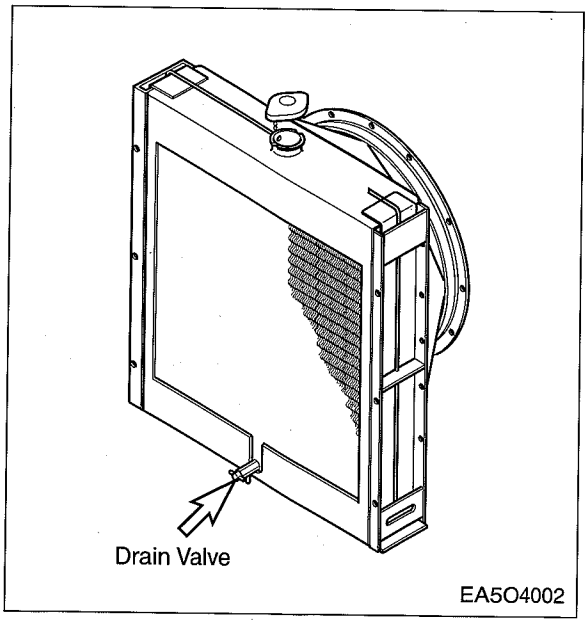
5.3. Cooling system

The coolant must be changed at intervals of 1,200 hours operation or six months whichever comes first. If the coolant is being fouled greatly, it will lead an engine overheat or coolant blow off from the expansion tank.

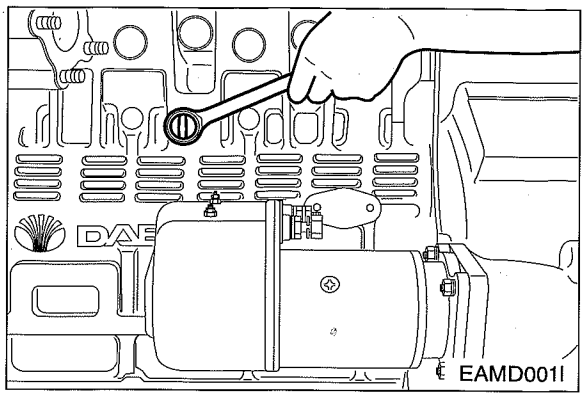
5.3.1. Coolant draining

a) Remove the pressure cap.

b) Open the drain valve at the radiator lower part to drain the coolant as the right figure.



c) Loosen the coolant drain plug.
Loosen the coolant drain plug of the cylinder block.



Caution : *When removing the pressure filler cap while the engine is still hot, cover the cap with a rag, then turn it slowly to release the internal steam pressure This will prevent a person from scalding with hot steam spouted out from the filler port.*

5.3.2. Cleaning of the cooling inside system circuit (by authorized specialist personnel)

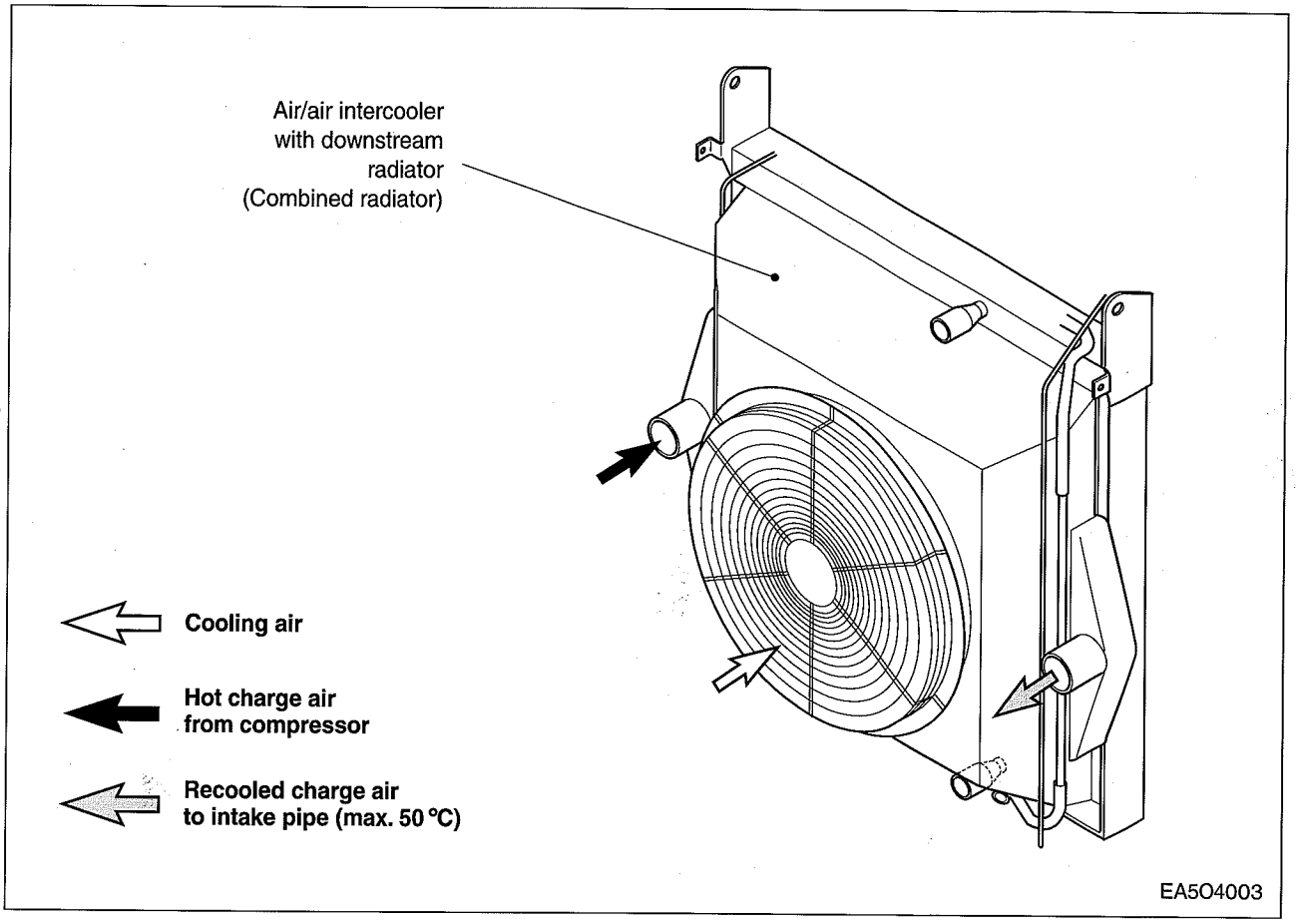
When the cooling system circuit are fouled with water scales or sludge particles, the cooling efficiency will be lowered.
Investigations have shown that in many cases the poor condition of the coolant and /or the cooling system accounts for damage to the water pump mechanical seal, The poor condition of the cooling system is normally due to use of unsuitable or no anti-freezing agents and corrosion inhibitor or defect, not early enough replaced covers for filler neck and working valves.
If twice in a short time the water pump of an engine develops leases or the coolant is heavily contaminated (dull, brown, mechanically contaminated, grey or black sings of a leakage on the water pump casing) clean the cooling system prior to removing that water pump as follows.

a) Drain coolant.
b) Remove thermostats, so that the whole cooling system is immediately flown through when cleaned.
c) Fill the cooling system with a mixture of potable water and 1.5% by volume of cleaner. (Henkel P3T5175)
d) Warm up engine under load. After a temperature of 60˚C is reached, run engine for a further 15 minutes.
e) Drain cleaning fluid.
f) Repeat steps c) and d).
g) Flush cooling system.
h) Replace drain plug by drain plug with a bore of 8mm diameter.
i) Fill cooling system with hot water.
j) Run engine at idle for 30 minutes. At the same time continuously replenish the water leaking from the bore in drain plug by adding fresh water.

Periodically clean the circuit interior with a cleaner.
- Cooling system cleaning interval: Every 1,200 hours.

5.3.3. Intercooler

The intercooler is air to air type and has a large cooling fan capacity. The intercooler life and performance depends on the intake air condition greatly. Fouled air pollutes and clogs the air fins of intercooler. As a result of this, the engine output is decreased and engine malfunction is occurred. So you always check whether the intake air systems like air filter element are worn or polluted.



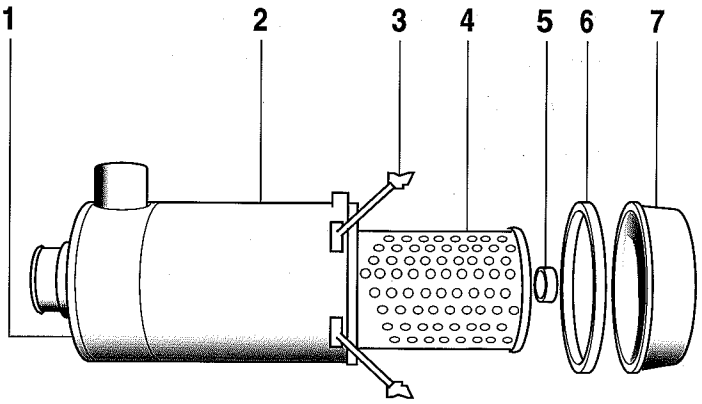
- **Cleaning**

In order to maintain the heat transfer efficiency of the intercooler, it is necessary to clean it at regular intervals.

Cleaning of intercooler fins : Every 600 hours.

5.4. Air intake system

1. Connection port, fouling indicator
2. Cleaner housing
3. Clamp
4. Element
5. Hexagon nut
6. Cover
7. Dust bowl



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5.4.1. Maintenance (only when engine is switched off)

Empty the dust bowl (7) regularly. The bowl should never be filled more than halfway with dust.

On slipping off the two clamps (3), the dust bowl can be removed. Take off the cover (6) of the dust bowl and empty.

Be careful to assemble cover and bowl correctly.

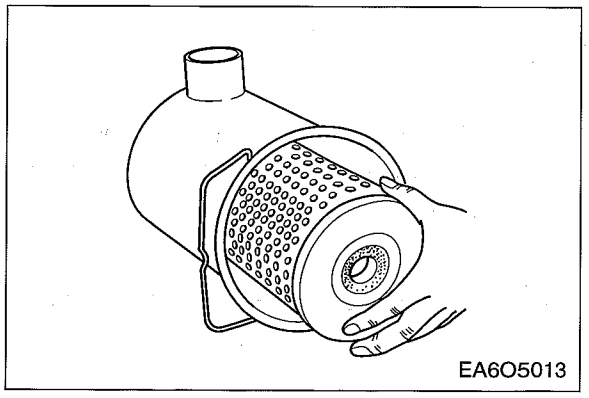
There is a recess in the cover rim and a lug on the collector which should register. Where the filter is installed horizontally, watch for "top" mark on cleaner bowl.

5.4.2. Changing filter element

Caution : *Do not allow dirt to get into the clean air end.*

On removing the hexagon nut, take out the dirty cartridge and renew or clean.

Wipe the cleaner housing with a damp cloth, in particular the sealing surface for the element.



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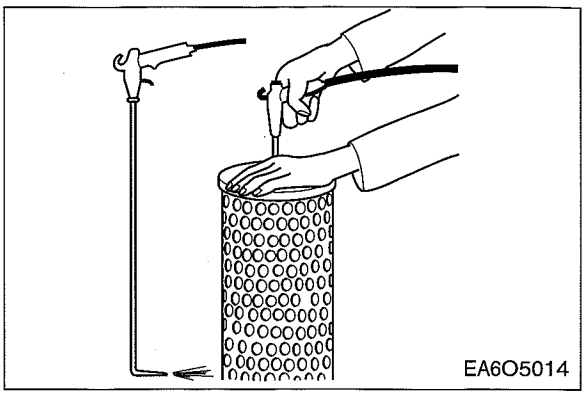
Notice : *Unless the maximum number of cleanings (up to 5 x) have been done, the filter cartridge should be renewed every two years or 4,000 hours operation.*

5.4.3. Cleaning filter elements

- **By compressed air (Wear goggles)**

For the purpose, the air gun should be fitted with a nozzle extension which is bent 90° at the discharge end and which is long enough to reach down inside to the bottom of the element.

Moving the air gun up and down, blow out the element from the inside (maximum 500kPa - 5 bar) until no more dust comes out of the filter pleats.

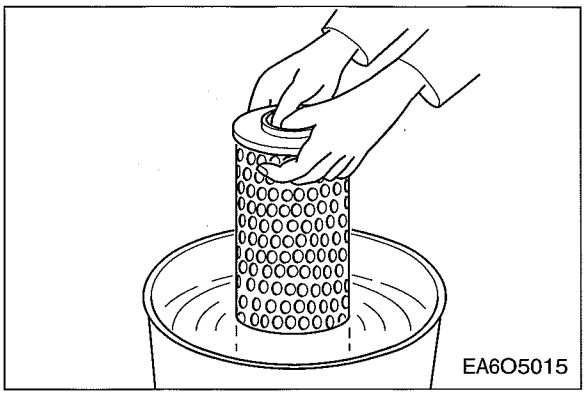


- **By washing**

Before washing, the element should be precleaned by means of compressed air, as described above.

Then allow the element to soak in lukewarm washing solvent for 10 minutes, and then move it to and for in the solvent for about 5 minutes.

Rinse thoroughly in clean water, shake out and allow drying at room temperature. The cartridge must be dry before it is reinstalled.



Never use steam sprayers, petrol (gasoline), alkalis or hot liquids etc. to clean the filter elements.

- **Knocking out dirt by hand**

In emergencies, when no compressed air or cleaning agent is available, it is possible to clean the filter cartridge provisionally by hitting the end disk of the cartridge with the ball of one's thumb.

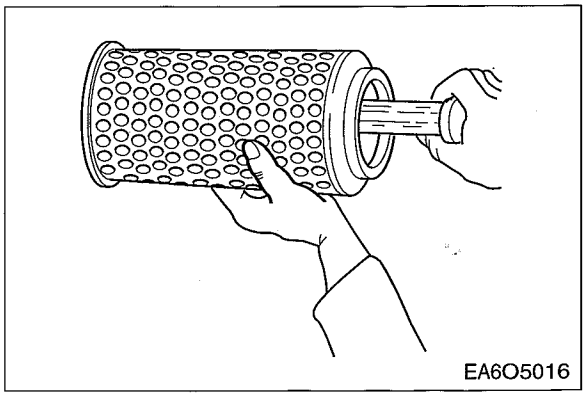
Under no circumstances should the element be hit with a hard object or knocked against a hard surface to loosen dirt deposits.

- **Checking the filter cartridge**

Before reinstalling the cartridge, it must be checked for damage e.g. to the paper pleats and rubber gaskets, or for bulges and dents etc. in the metal jacket.

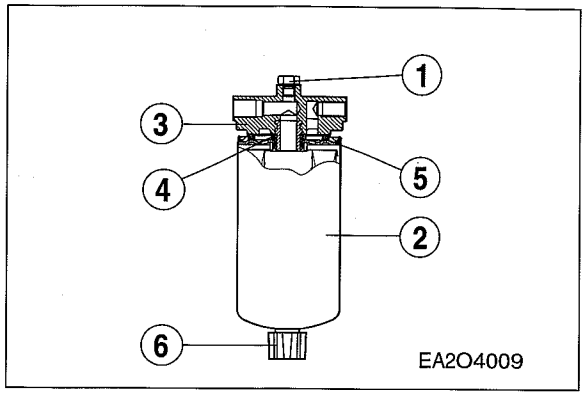
Cracks and holes in the paper pleating can be established by inspecting the cartridge with a flashlight.

Damaged cartridges should not be reused under any circumstances. In cases of doubt, discard the cartridge and install a new one.



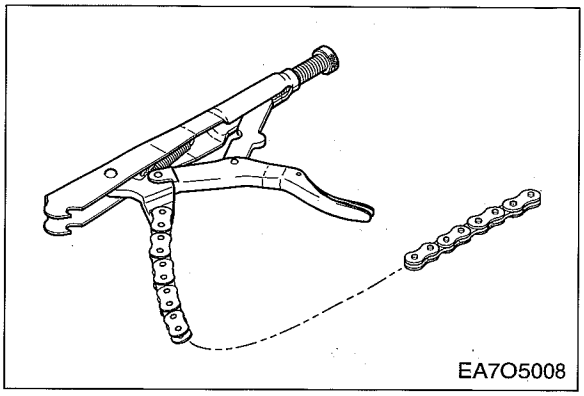
5.5. Fuel system

5.5.1. Fuel filter



- After every 1,200 hour of operation, drain the water and sediment from the fuel-water separator.
- Shut off the engine. Use your hand to open the drain valve ⑥.
- Turn the valve counter clockwise approximately 2 ~ 3 turns until draining occurs. Drain the filter sump of water until close fuel is visible.
- Turn the valve clockwise to close the drain valve. Do not over tighten the valve, overtightening can damage the threads.

5.5.2. Replacement of fuel filter



- Clean the area around the fuel filter head ③.
- Remove the fuel filter ② by turning it counter-clockwise with filter wrench. (Discard the used filter.)
- Remove the fuel filter thread adapter seal ring ④.
- Use a clean lint free cloth to clean the gasket surface of the fuel filter head ③.
- Install the new thread adapter seal ring ④ supplied with the new filter.
- Use clean oil to lubricate the filter seal ⑤, and fill the new filter with clean fuel.
- Install the filter on the filter head ③.
- Tighten the filter until the gasket contacts the filter head surface.
- Tighten the filter on additional one-half to three-fourths of a turn with the filter wrench, on as specified by the filter manufacturer.

Notice : *Mechanical over tightening of the filter can distort the thread or damage the filter element seal.*

5.5.3. Fuel system checks

Fill the tank with the recommended fuel. Keeping tanks full reduces water condensation and helps keep fuel cool, which is important to engine performance.
Make sure fuel supply valves (if used) are open.
To insure prompt starting and even running, the fuel system must be primed with the fuel feed pump manually before starting the engine the first time, or after a fuel filter change.
Refill at the end of each day's operation to prevent condensation from contaminating the fuel. Condensation formed in a partially filled tank promotes the growth of microbial organisms that can clog fuel filters and restrict fuel flow.

If the engine is equipped with a fuel water separator, drain off any water that has accumulated. Water in fuel can seriously affect engine performance and may cause engine damage. **DAEWOO recommends installation of a fuel water separator on generator units.**

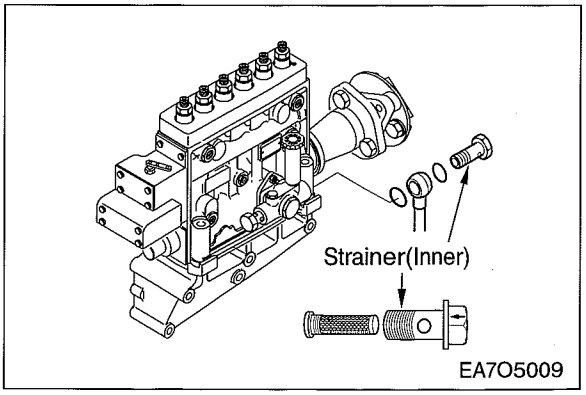
5.5.4. Fuel Contamination and water trap

In the generator environment, the most likely fuel contaminants are water and microbial growth (black "slime"). Generally, this type of contamination is the result of poor fuel handling practices.
Black "slime" requires water in the fuel to form and grow, so the best prevention is to keep water content to a minimum in storage tanks.
If diesel fuel which contains moisture is used the injection system and the cylinder liners / pistons will be damaged. This can be prevented to same extent by filling the tank as soon as the engine is switched off while the fuel tank is still warm (formation of condensation is prevented). Drain moisture from storage tanks regularly. Installation of a water trap upstream of the fuel filter is also advisable.

Notice : *A galvanized steel tank should never be used for fuel storage, because the fuel oil reacts chemically with the zinc coating to form powdery flakes which can quickly clog the fuel filters and damage the fuel pump and injection nozzles.*

5.5.5. Priming pump strainer cleaning

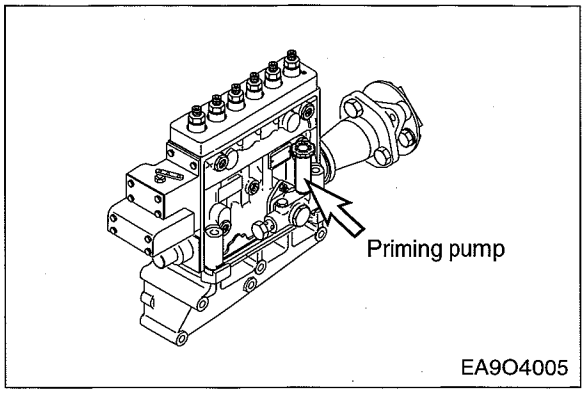
Clean the priming pump strainer every 200 operation hours.
The strainer is incorporated in the priming pump inlet side joint bolt.
Clean the strainer with the compressed air and rinse it in the fuel oil.



5.5.6. Bleeding the fuel system

After the cleaning of the fuel filter or after the engine stop by the lack of fuel, the bleeding of the fuel system must be executed by all means.

Bleed the system by manually operating the priming pump with fuel filter outlet joint bolt and injection pump bleeder screw loosened.



- Press the feed pump cap repetitively until the fuel without bubbles comes out from the bleeding valves.
- After the whole air is pulled out, close the valve of the filter.
- Confirm the resistance of fuel delivery by the repetition pressing of the feed pump cap, Pressure and turn the feed pump cap simultaneously to close it.

5.5.7. Injection pump

- Check the fuel injection pump housing for cracks or breaks, and replace if damaged.
- Check and see if the lead seal for idling control and speed control levers have not been removed.
- No alterations must be made to the injection pump. If the lead seal is damaged the warranty on the engine will become null and void.
- We strongly recommended that any faults developing in the injection pump should be taken care of by authorized specialist personnel.

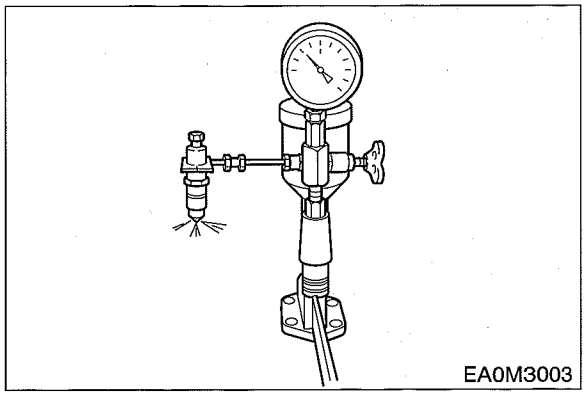
5.6. Injection Nozzle Maintenance (by authorized specialist personnel)

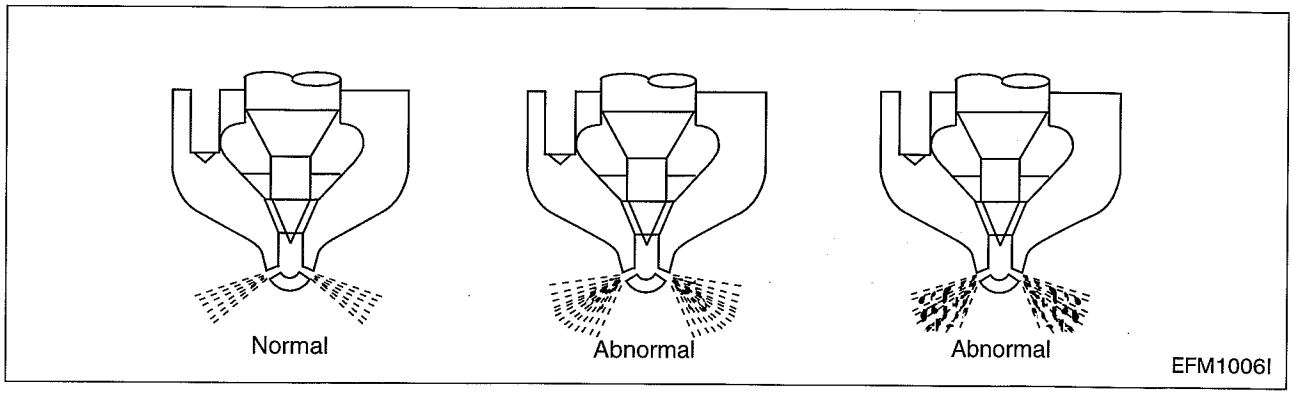
The injectors are designed to spray the fuel delivered by the injection pump directly into the spherical combustion chamber in the piston crown.

The injector consists of the nozzle and the nozzle holder.

A copper seal fitted to the injector ensures gas-tight seating and good heat dissipation.

The opening pressure of the nozzle is adjusted by means of shims at the compression spring.





- Install a nozzle to a nozzle tester.
- Check injection pressure, and adjust the nozzle using the adjusting shim if the pressure does not meet the specified limit.
- Check nozzle spray patterns and replace if damaged.

	DE12T	P126TI
Injection Nozzle pressure	220kg/cm^2	1st : 160kg/cm^2 2nd : 220kg/cm^2

Caution : *The injection lines are designed for high operating pressures and should thus be handled with particular care.*

- When mounting the pipes to the engine take care of good fitness.
- Do not bend pipes to permanent deformation (not for replacing the nozzles either).
- Do not mount any heavily bent pipes.
- Avoid bending the pipes at the ends by more than 2 to 3 degrees.

In case of faults in the injection system which might have resulted in excessive operating pressures, not only the failed part but also the injection line has to be replaced.

5.7. Turbocharger

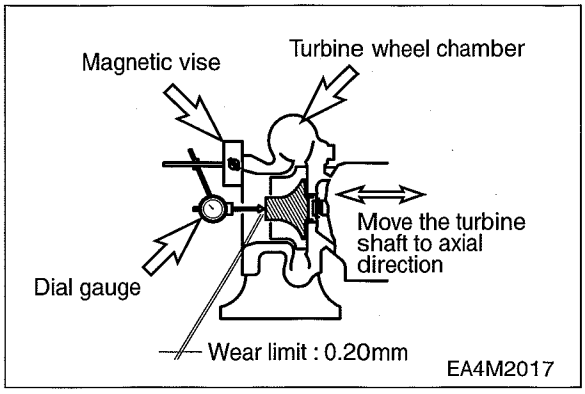
5.7.1. Maintenance (by authorized specialist personnel)

The turbochargers do not call for any specific maintenance.
The only points to be observed are the oil pipes which should be checked at every oil change for leakage and restrictions.
The air cleaners should be carefully serviced.
Furthermore, a regular check should be kept on charge air exhaust gas pipes. Any leakages should be attended to at once because they are liable to cause overheating of the engine.
When operating in highly dust or oil-laden atmospheres, cleaning of the air impeller may be necessary from time to time. To this end, remove compressor casing **(Caution : Do not skew it!)** and clean in a non-acid solvent, if necessary using a plastic scraper.
If the air compressor should be badly fouled, it is recommended that the wheel be allowed to

soak in a vessel with solvent and to clean it then with a stiff brush. In doing so, take care to see that only the compressor wheel is immersed and that the turbocharger is supported on the bearing casing and not on the wheel.

5.7.2. Special hints

It is recommended that the radial and axial clearances of the rotor be checked after every 3,000 hours operation.
This precaution will enable any wear of the Measuring of axial clearance bearings to be detected in good time before serious damage is caused to the rotor and bearings.

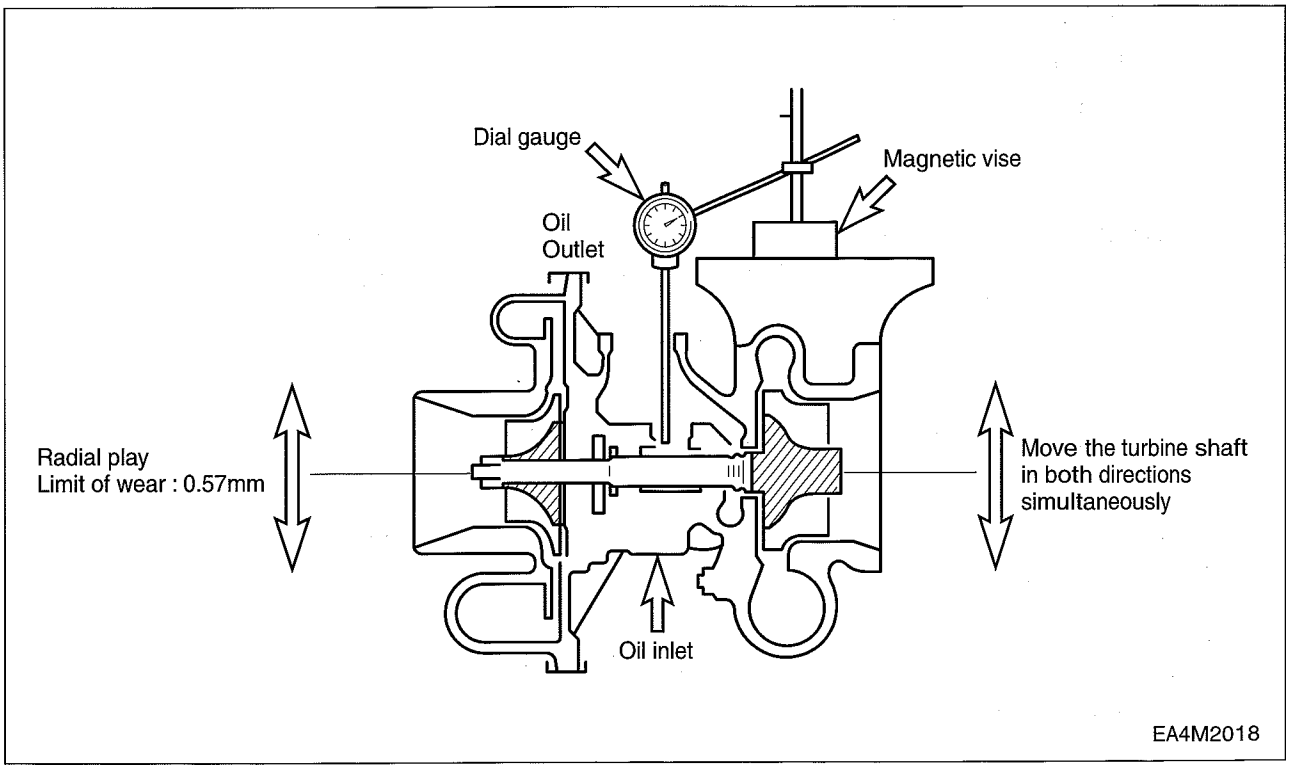


- Measuring rotor axial clearance

Axial clearance	0.2 mm

- Measuring radial clearance

Radial clearance	0.65 mm



6. Checking and setting

6.1. Adjustment of valve clearance

6.1.1. General information

The valve clearances are to be adjusted at the times of the following situations.

- After initial 50 hour's operation.
- When the engine is overhauled and the cylinder heads are disassembled.
- When severe noise comes from valve train.
- When the engine is not normally operated, even though there is no trouble in the fuel system.

The valve clearance of the cold engine are as follows.

- Intake valves : 0.3mm
- Exhaust valves : 0.3mm

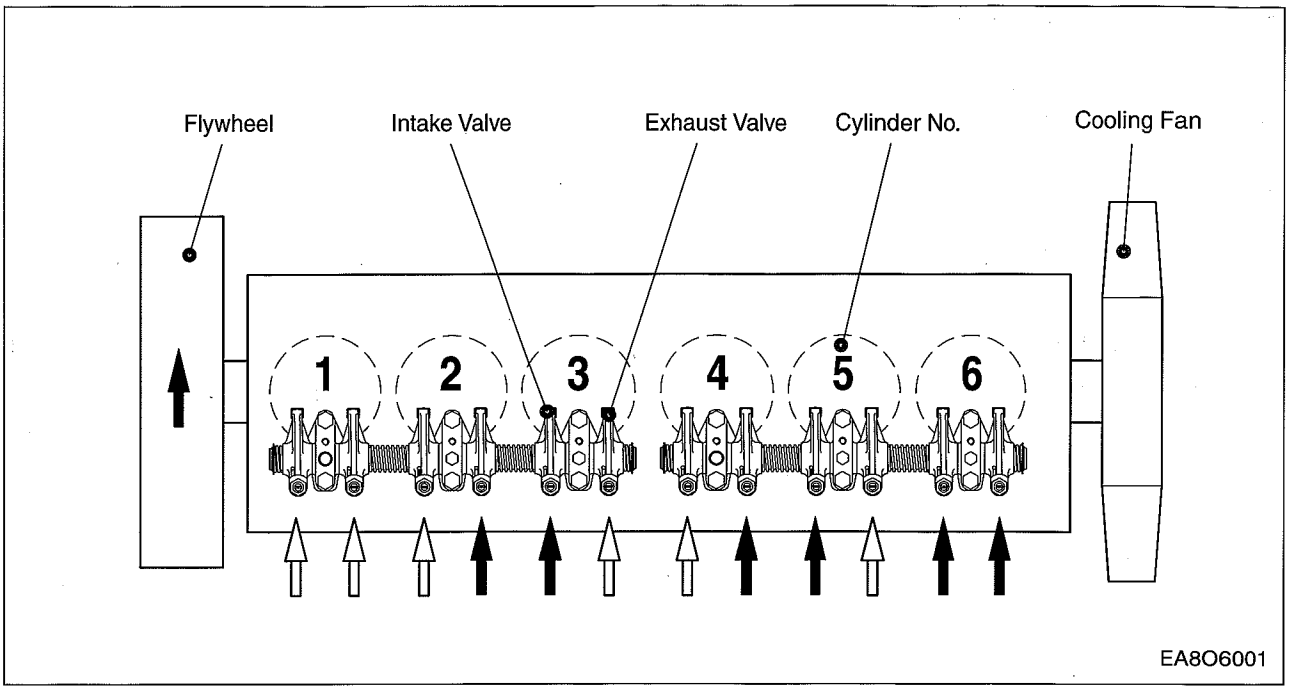
6.1.2. Adjusting order of the valve clearance

1) After letting the #1 cylinder's piston come at the compression top dead center by turning the crankshaft, adjust the valve clearances.
2) Loosen the lock nuts of rocker arm adjusting screws and push the feeler gauge of specified value between a rocker arm and a valve stem and adjust the clearance with adjusting screw respectively and then tighten with the lock nut.
3) As for the valve clearance, adjust it when in cold, as follow.

Model	Intake Valve	Exhaust Valve
DE12T P126TI	0.3 mm	0.3 mm

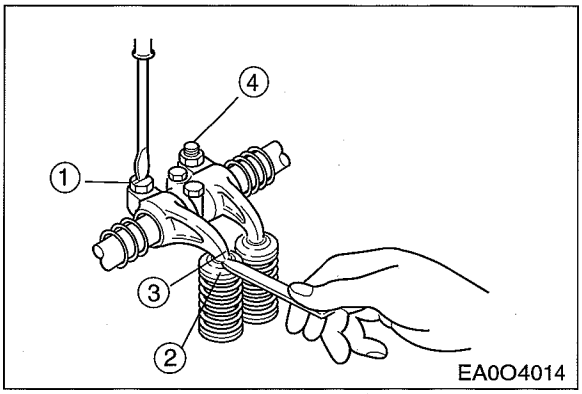
- By cranking the engine, let #6 cylinder's valves overlap.
- In time, adjust the valve clearance corresponding to " ⇨ "of lower lists.
- Adjust the valve clearance corresponding to " ➡ " of lower lists.
- After reinsuring the valve clearances, retighten if necessary.

4) No. 1 Cylinder is located at the side where flywheel was installed.



6.1.3 Method of adjusting the valve clearance

1) Loosen the lock-nuts ① using a ring spanner.
2) Insert a thickness gauge of 0.3mm between valve stem ② and rocker arm ③.
3) Turn the adjusting bolts ④ using a screw driver until the gauge can be pulled out with some restriction.
4) After the adjustment fix the adjusting bolt not to rotate and tighten the lock-nut at the same time.
5) Measure the clearance one more time and if necessary adjust again.

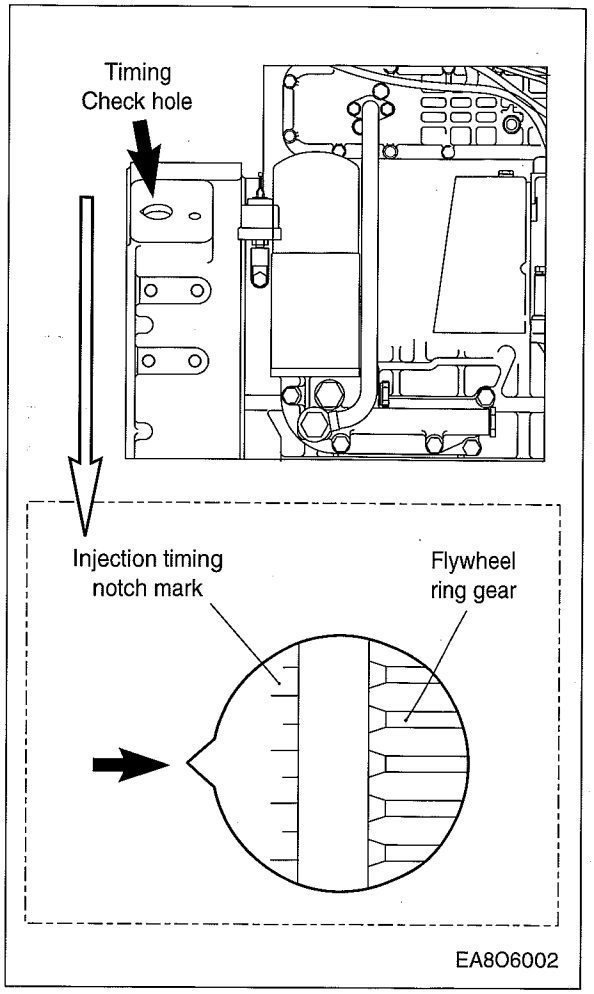


6.2. Adjustment of injection timing

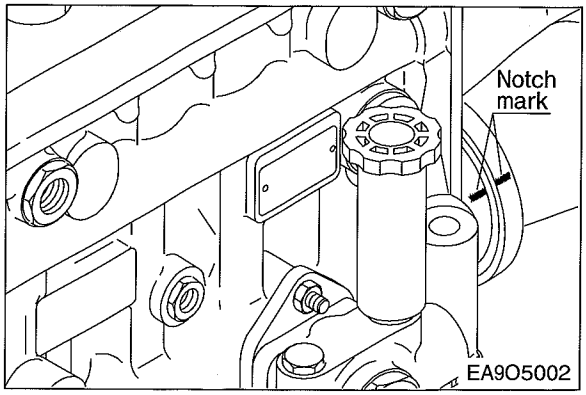
6.2.1. Method of adjusting injection timing

- Turn the flywheel until No. 1 piston is placed in the "OT" position of notch marks on the flywheel, and then turn again the flywheel clockwise until showing the notch mark of the right figure corresponding to the injection timing is aligned with the pointer (↓) on the flywheel housing.

	DE12T	P126TI
Fuel injection timing (B.T.D.C static)	12°	12°

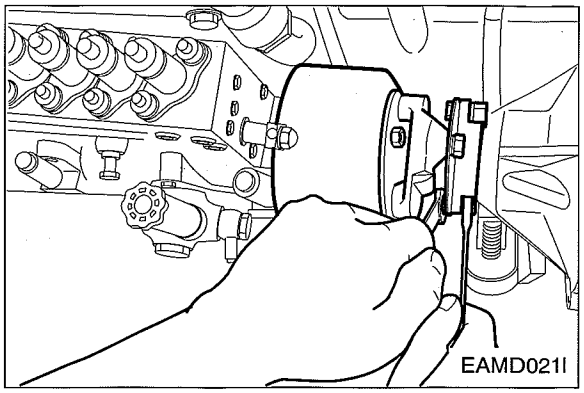


- Turn the timer until the notch mark of the indicator plate attached to the fuel injection pump is aligned with the notch mark of the timer.



- Tighten the coupling fixing bolts and nuts to specified torque.

Torque	6.0 kg•m



- Tighten the drive shaft connecting flange fixing bolts to specified torque.

Torque	7.5 ~ 8.5 kg•m

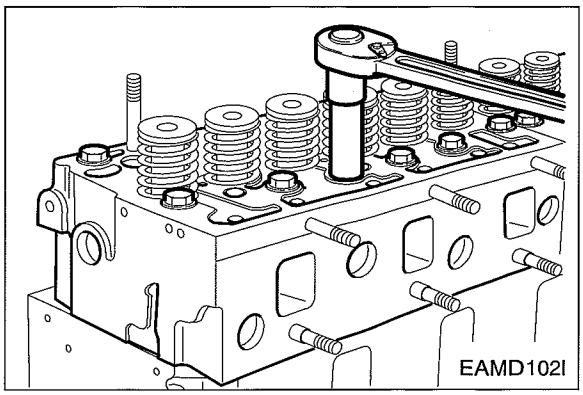
- Install the oil delivery pipe and return pipe.

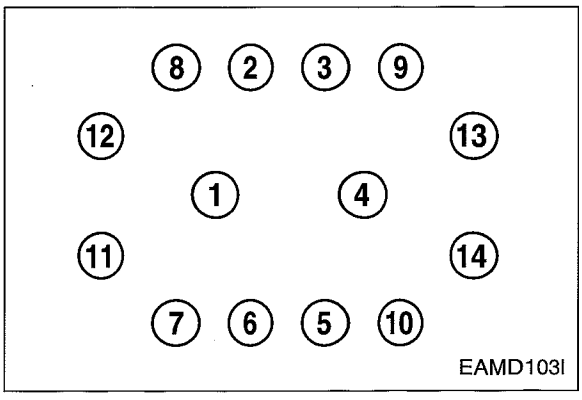
6.3. Tightening the cylinder head bolts

- The cylinder head bolts are to be tightened in the sequence shown in the illustrations, First tighten the bolts slightly, then slightly more again and finally tighten with a torque wrench.

<Cylinder Head Bolts>

	Type 1	Type 2
Specification	TY 12.9T M14x1.5x153	TY 10.9T M14x1.5x150
Torque	24.5 kg.m	6 kg.m +180°+150°

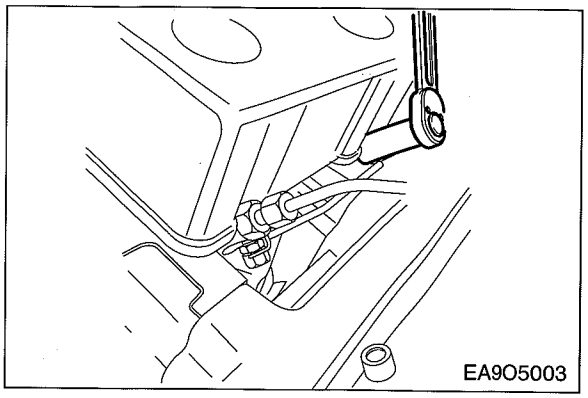




- The tightening by excessive torque may cause the damages of the cylinder head gaskets, the flanges of cylinder liners and the cylinder head bolts, therefore obey the regular torque.

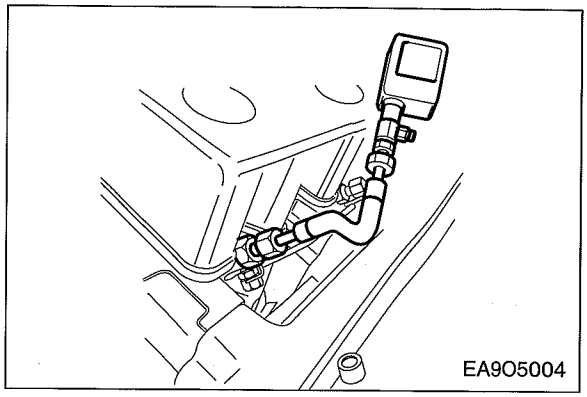
6.4. Cylinder compression pressure

1) Stop the engine after warming it up, then remove the nozzle assemblies.



2) Install a special tool (gauge adapter) in nozzle holder hole and connect the compression pressure gauge to the adapter.

3) Cut off fuel circulation, rotate the starter, then measure compression pressure of each cylinder.



Standard	24~28 kg/cm²
Limit	24 kg/cm² or less
Allowance among cylinders	±10% or less

- Testing conditions : at water temperature of 20 °C and speed of 200 rpm (10 turns)

6.5. V-belts

The tension of the V-belts should be checked after every 2,000 hours of operation.

(1) Change the V-belts if necessary

If in the case of a multiple belt drive, wear or differing tensions are found, always replace the complete set of belts.

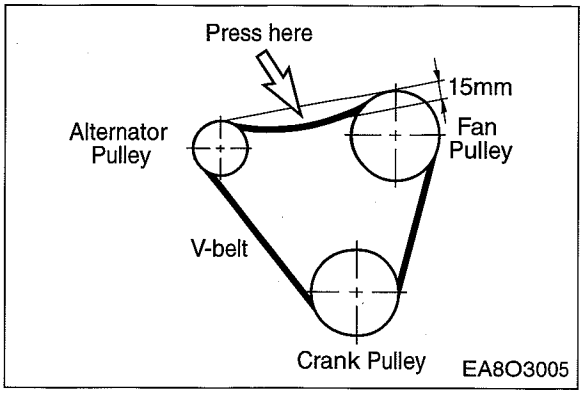
(2) Checking condition

Check V-belts for cracks, oil, overheating and wear.

(3) Testing by hand

The tension is correct if the V-belts can be pressed in by about the thickness of the V-belt. (no more midway between the belt pulleys)

A more precise check of the V-belt tension is possible only by using a V-belt tension tester.

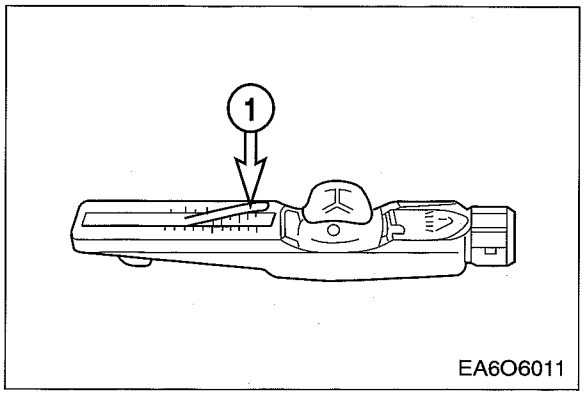


(4) Measuring tension

① Lower indicator arm (1) into the scale.

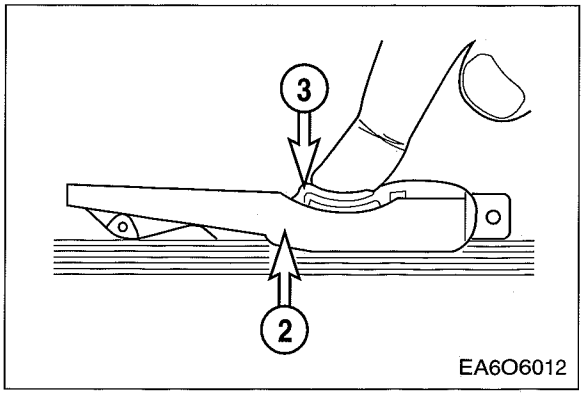
- Apply tester to belt at a point midway between two pulleys so that edge of contact surface (2) is flush with the V-belt.
- Slowly depress pad (3) until the spring can be heard to disengage. This will cause the indicator to move upwards.

If pressure is maintained after the spring has disengaged a false reading will be obtained!



② Reading of tension

- Read of the tensioning force of the belt at the point where the top surface of the indicator arm (1) intersects with the scale.
- Before taking readings make ensure that the indicator arm remains in its position.



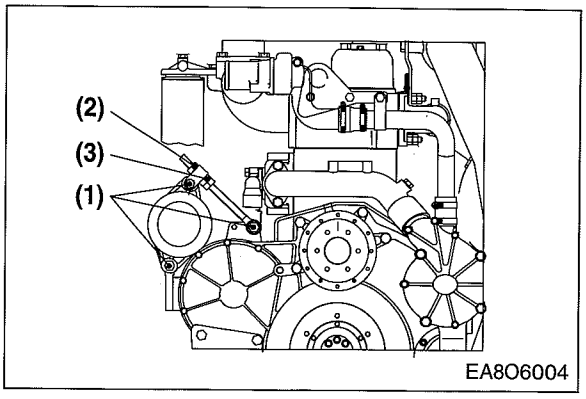
Type	Drive belt width	Tensioning forces on the tester		
		new installation		When servicing after long running time
		Installation	After 10 min. running time	
M	9.5 mm	50 kg	45 kg	40 kg
A *	**11.8 mm**	**55 kg**	**50 kg**	**45 kg**
B	15.5 mm	75 kg	70 kg	60 kg
C	20.2 mm	75 kg	70 kg	60 kg

*** : Adopted in DE12T and P126TI**

(5) Tensioning and changing V-belt

- Remove fixing bolts. (1)
- Remove lock nut. (2)
- Adjust nut (3) until V-belts have correct tensions.
- Retighten lock nut and fixing bolts.

To change the V-belts loosen mounting bolts (1) and lock nut (2) and push tension pulley inwards by turning adjusting nut (3).



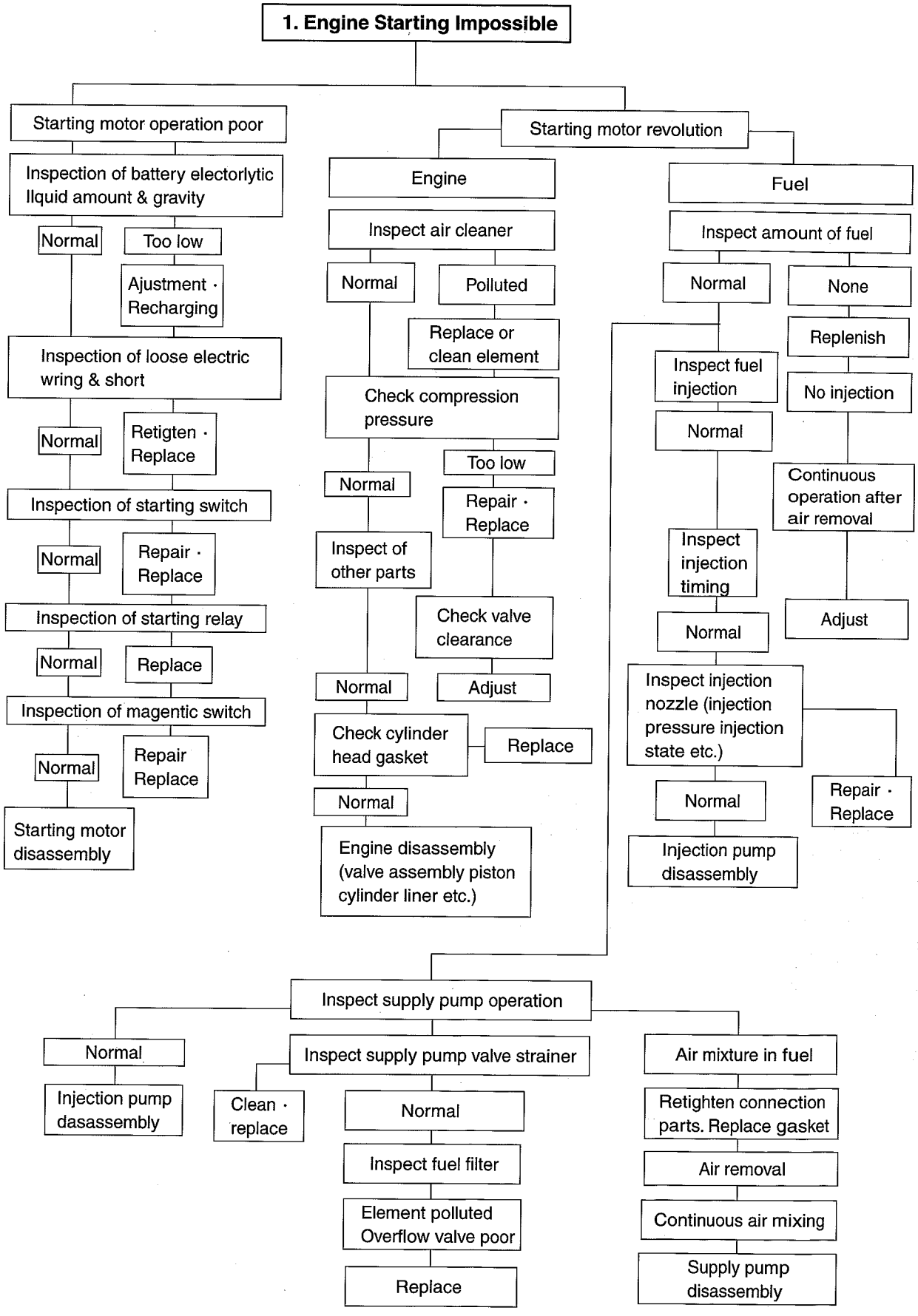
● Appendix

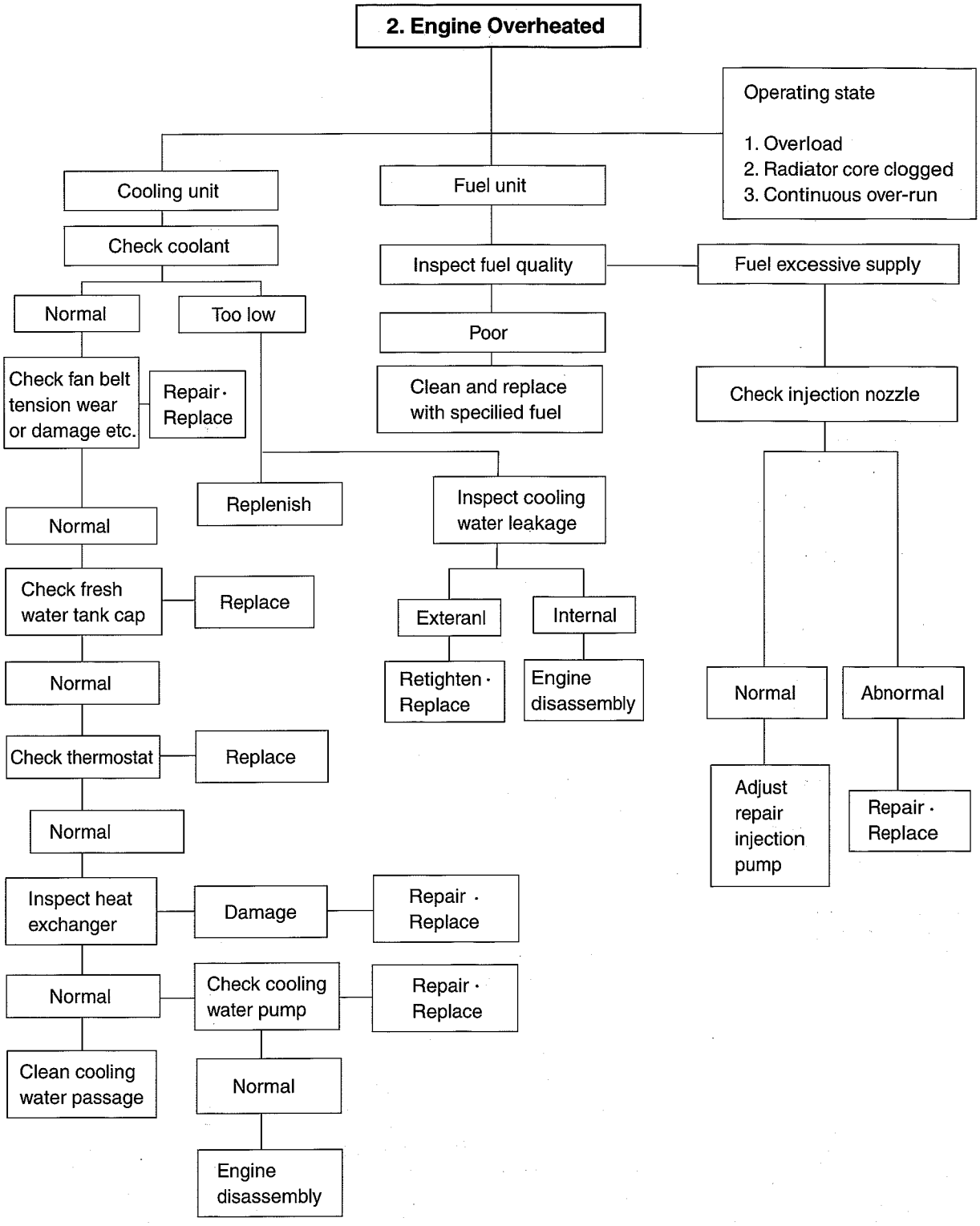
1. General engine inspection cycle

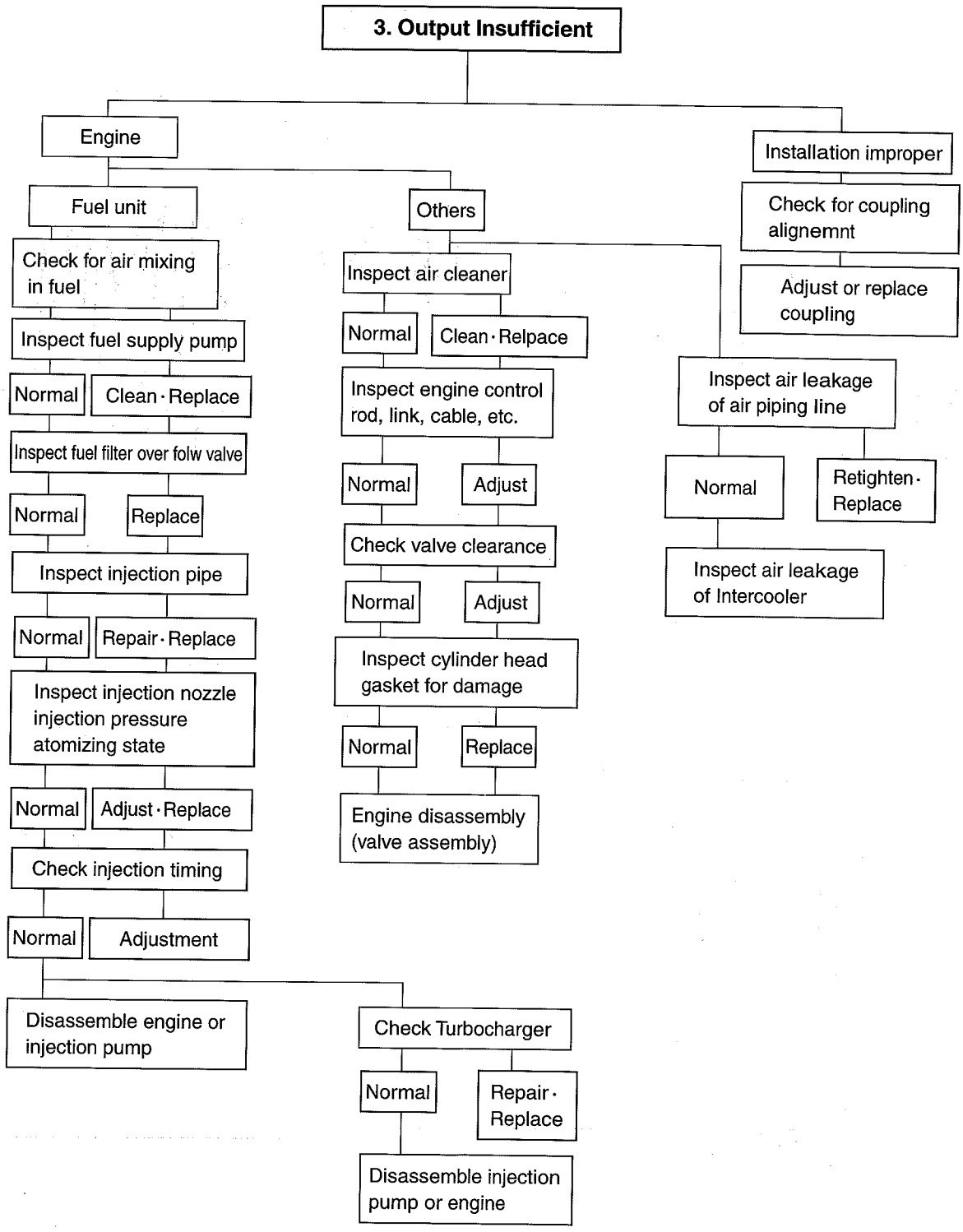
○ : Check & adjust ● : Replace

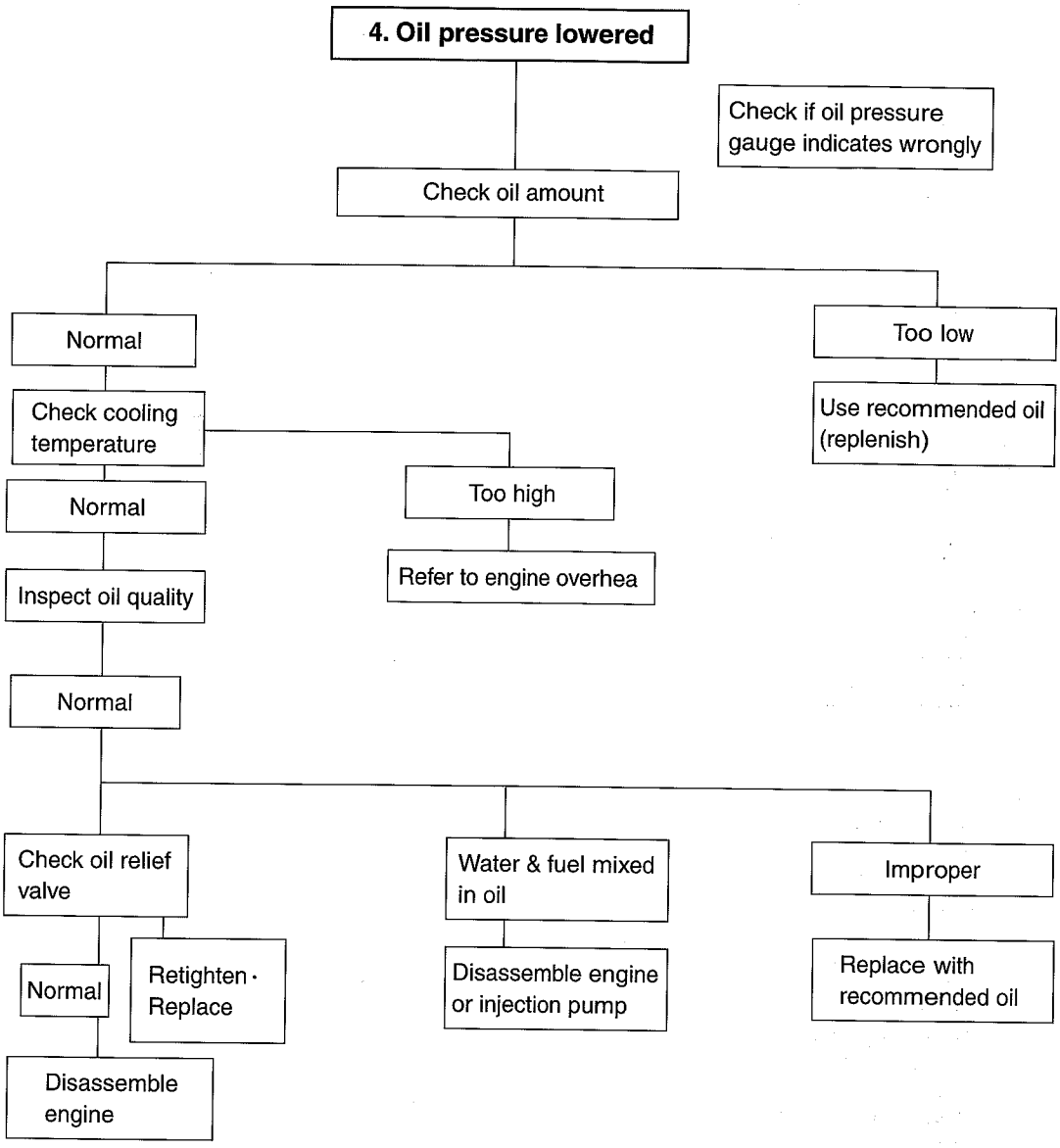
Inspection		Daily	Every 50hrs	Every 200hrs	Every 600hrs	Every 800hrs	Every 1200hrs	Remark
Cooling System	Check for leakage(hoses, clamp)	○						
	Check the water level	○						
	Change the coolant water						●	
	Adjust the V-belt tension	○						Every 2,000hrs
	Clean the radiator						○	
Lubrication System	Check for leakage	○						
	Check the oil level gauge	○						
	Change the lubricating oil		● 1st			○		
	Replace the oil filter cartridge		● 1st			○		
Intake & Exhaust System	Check the leakage for intercooler (hoses, clamp)	○						
	Clean and change the air cleaner element			○ clean	●			
	Clean the inter-cooler air fins				○			
	Clean the turbo-charger							Every 2,000hrs
Fuel System	Check the leakage fuel line	○						
	Clean the fuel strainer of fuel feed pump						○	
	Remove sediment from fuel tank						○	
	Drain the water in separator			○				
	Replace the fuel filter element						●	
	Check fuel Injection timing			○				When necessary
	Check the injection nozzles			○				When necessary
Engine Adjust	Check the state of exhaust gas	○						
	Check the battery charging	○						
	Check the compression pressure						○	When necessary
	Adjust Intake/Exhaust valve clearance		○ 1st					When necessary

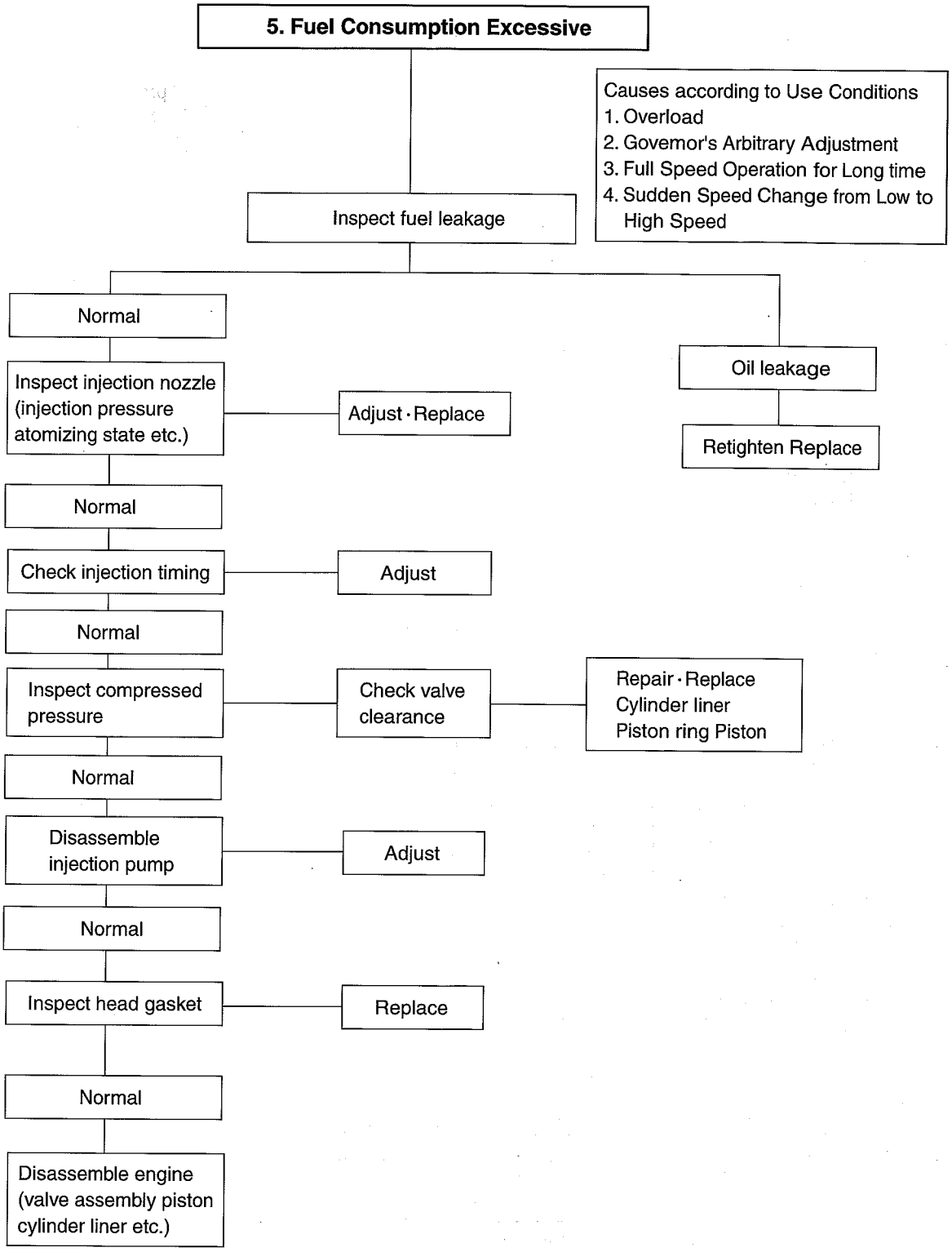
2. Diagnosis and remedy

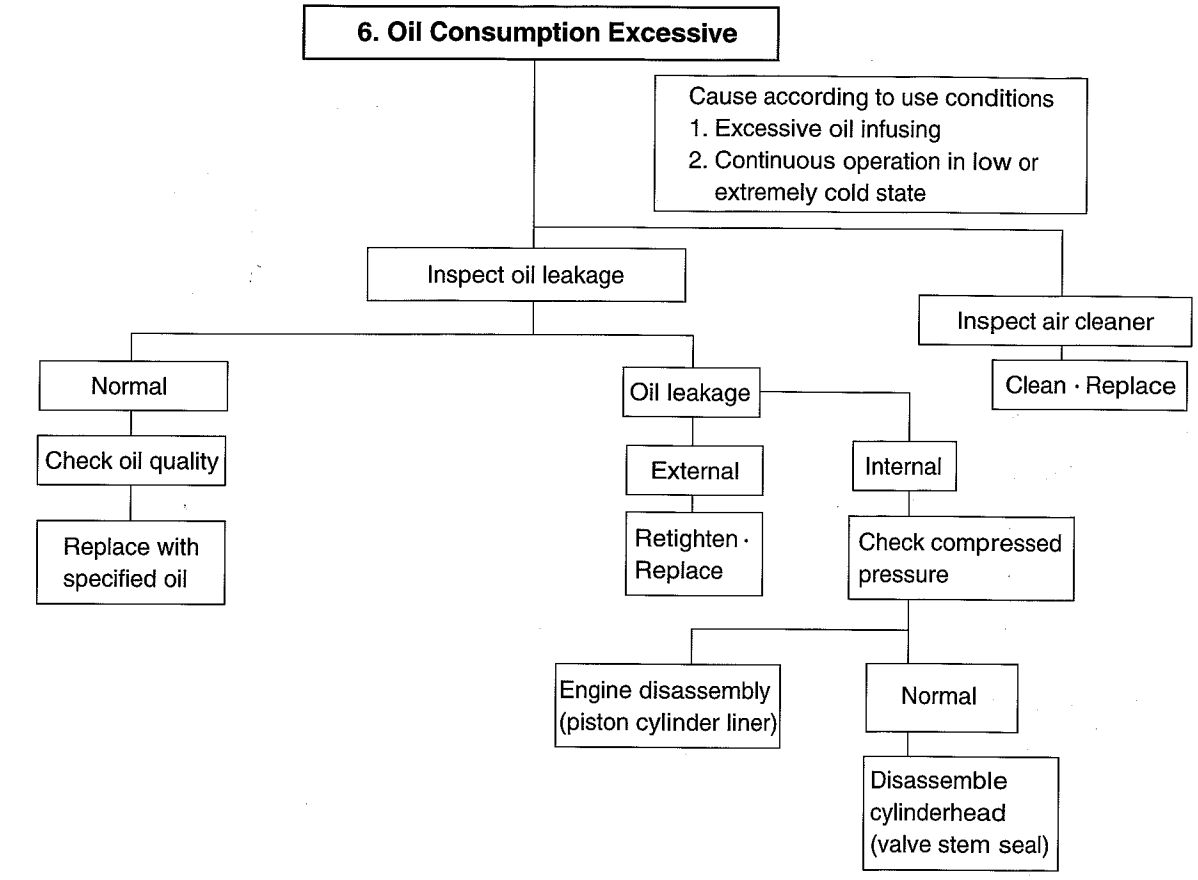


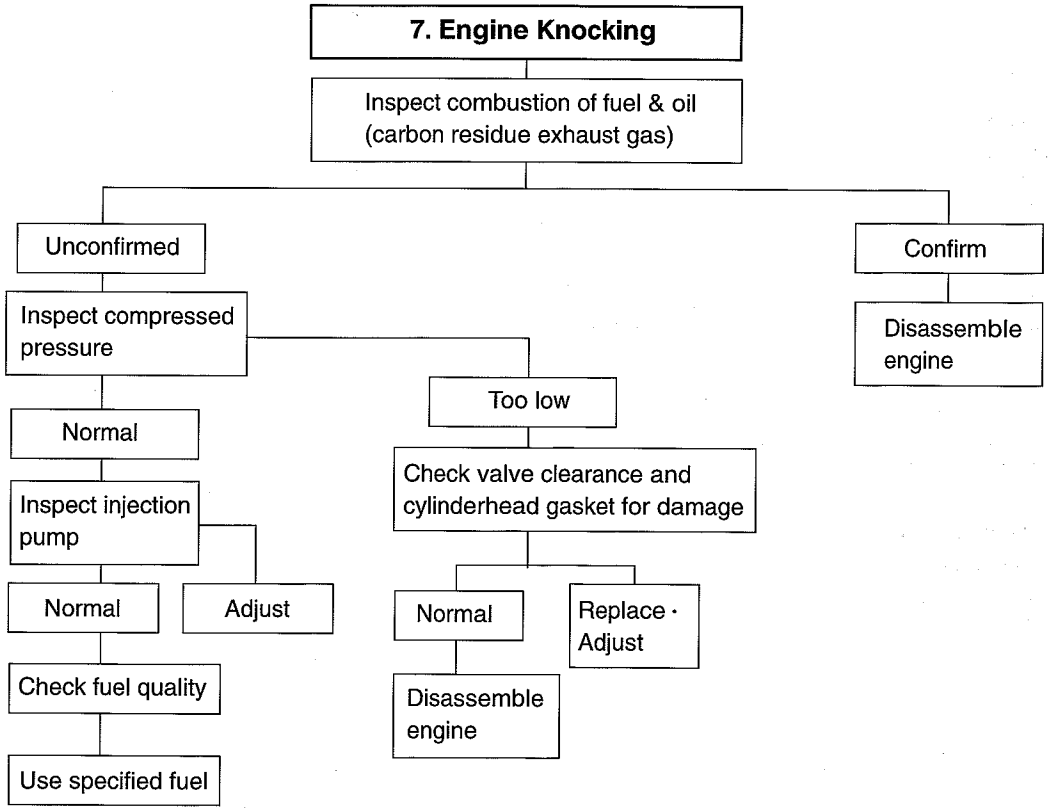

2. Engine Overheated
Operating state
1. Overload
2. Radiator core clogged
3. Continuous over-run
Cooling unit
Fuel unit
Check coolant
Inspect fuel quality
Fuel excessive supply
Normal
Too low
Poor
Check fan belt tension wear or damage etc.
Repair · Replace
Clean and replace with specified fuel
Check injection nozzle
Replenish
Inspect cooling water leakage
Normal
Check fresh water tank cap
Replace
Exteranl
Internal
Normal
Abnormal
Retighten · Replace
Engine disassembly
Normal
Check thermostat
Replace
Adjust repair injection pump
Repair · Replace
Normal
Inspect heat exchanger
Damage
Repair · Replace
Normal
Check cooling water pump
Repair · Replace
Clean cooling water passage
Normal
Engine disassembly

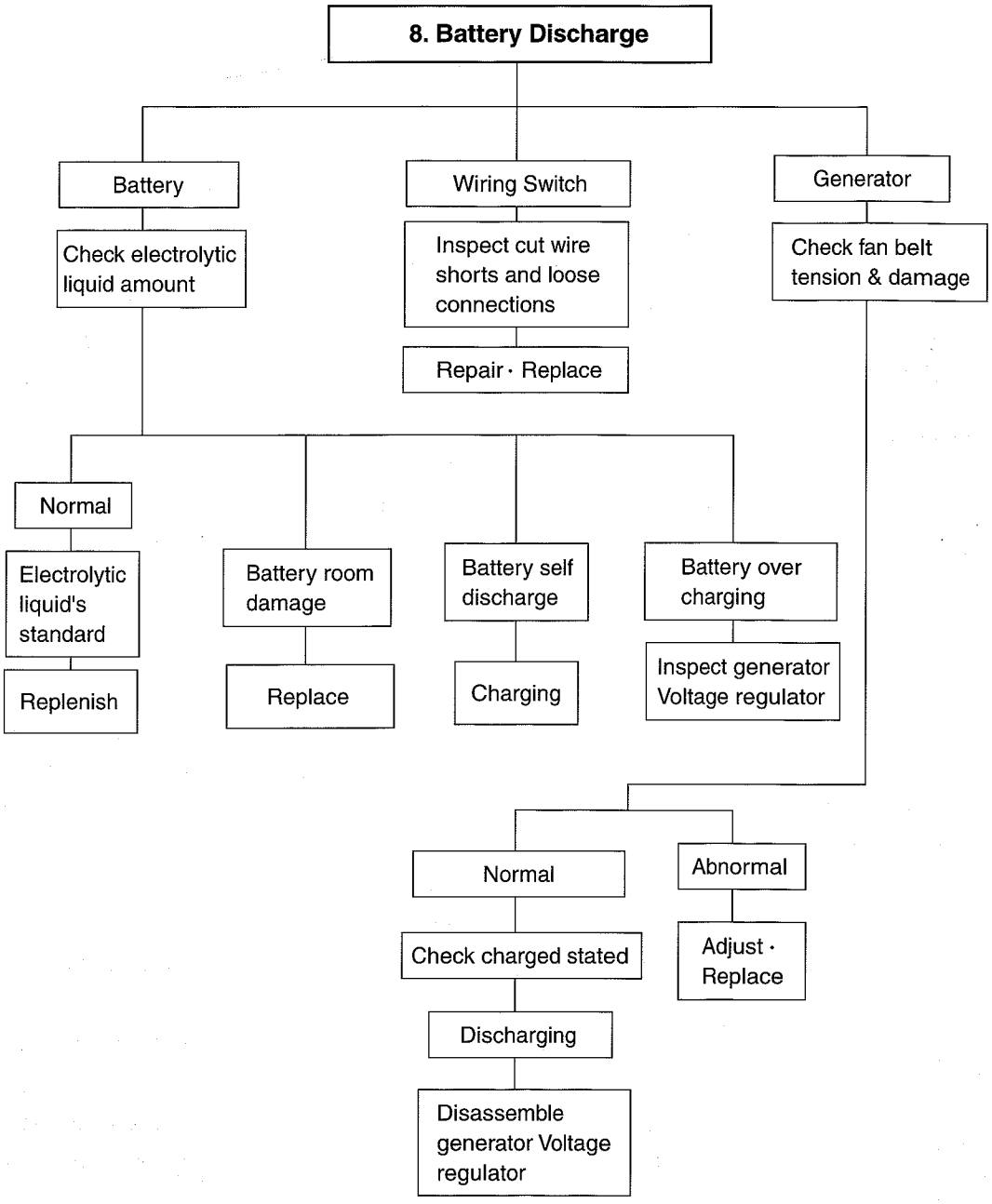

3. Output Insufficient
Engine
Fuel unit
Check for air mixing in fuel
Inspect fuel supply pump
Normal
Clean · Replace
Inspect fuel filter over folw valve
Normal
Replace
Inspect injection pipe
Normal
Repair · Replace
Inspect injection nozzle injection pressure atomizing state
Normal
Adjust · Replace
Check injection timing
Normal
Adjustment
Disassemble engine or injection pump
Others
Inspect air cleaner
Normal
Clean · Relpace
Inspect engine control rod, link, cable, etc.
Normal
Adjust
Check valve clearance
Normal
Adjust
Inspect cylinder head gasket for damage
Normal
Replace
Engine disassembly (valve assembly)
Check Turbocharger
Normal
Repair · Replace
Disassemble injection pump or engine
Installation improper
Check for coupling alignemnt
Adjust or replace coupling
Inspect air leakage of air piping line
Normal
Retighten · Replace
Inspect air leakage of Intercooler


4. Oil pressure lowered
Check if oil pressure gauge indicates wrongly
Check oil amount
Normal
Too low
Check cooling temperature
Use recommended oil (replenish)
Normal
Too high
Refer to engine overhea
Inspect oil quality
Normal
Check oil relief valve
Water & fuel mixed in oil
Improper
Normal
Retighten · Replace
Disassemble engine or injection pump
Replace with recommended oil
Disassemble engine


5. Fuel Consumption Excessive
Causes according to Use Conditions
1. Overload
2. Govemor's Arbitrary Adjustment
3. Full Speed Operation for Long time
4. Sudden Speed Change from Low to High Speed
Inspect fuel leakage
Normal
Oil leakage
Inspect injection nozzle (injection pressure atomizing state etc.)
Adjust · Replace
Retighten Replace
Normal
Check injection timing
Adjust
Normal
Inspect compressed pressure
Check valve clearance
Repair · Replace Cylinder liner Piston ring Piston
Normal
Disassemble injection pump
Adjust
Normal
Inspect head gasket
Replace
Normal
Disassemble engine (valve assembly piston cylinder liner etc.)


6. Oil Consumption Excessive
Cause according to use conditions
1. Excessive oil infusing
2. Continuous operation in low or extremely cold state
Inspect oil leakage
Inspect air cleaner
Clean · Replace
Normal
Check oil quality
Replace with specified oil
Oil leakage
External
Retighten · Replace
Internal
Check compressed pressure
Engine disassembly (piston cylinder liner)
Normal
Disassemble cylinderhead (valve stem seal)


7. Engine Knocking
Inspect combustion of fuel & oil (carbon residue exhaust gas)
Unconfirmed
Confirm
Disassemble engine
Inspect compressed pressure
Too low
Normal
Check valve clearance and cylinderhead gasket for damage
Inspect injection pump
Normal
Adjust
Normal
Replace · Adjust
Check fuel quality
Disassemble engine
Use specified fuel


8. Battery Discharge
Battery
Check electrolytic liquid amount
Wiring Switch
Inspect cut wire shorts and loose connections
Repair · Replace
Generator
Check fan belt tension & damage
Normal
Electrolytic liquid's standard
Replenish
Battery room damage
Replace
Battery self discharge
Charging
Battery over charging
Inspect generator Voltage regulator
Normal
Check charged stated
Discharging
Disassemble generator Voltage regulator
Abnormal
Adjust · Replace

Condition	Causes	Remedies
1) Starting difficult (1) Compression pressure	• Valve's poor shut, stem distortion • Valve spring damage • Cylinder head gasket's leak • Wear of piston, piston ring or liner	Repair or replace Replace valve spring Replace gasket Adjust
2) Idle operation abnormal	• Injection timing incorrect • Air mixing at injection pump	Adjust Remove air
3) Engine output insufficient (1) Continuous output insufficient	• Valve clearance incorrect • Valve tightness poor • Cylinder head gasket's leak • Wear, stick, damage of piston ring • Injection timing incorrect • Fuel injection amount insufficient • Nozzle injection pressure improper or stuck • Supply pump's function lowered • Fuel pipe system clogged • Air suction amount insufficient • Supercharger poor	Adjust Repair Replace gasket Replace piston ring Adjust Adjust injection pump Adjust or replace Repair or replace Repair Clean or replace air cleaner Repair or replace
(2) Output insufficient when in acceleration	• Compression pressure insufficient • Injection timing incorrect • Fuel injection amount insufficient • Injection pump timer's function insufficient • Nozzle infection pressure, infection angle improper • Supply pump's function lowered • Air intake amount insufficient cleaner	Disassemble engine Adjust Adjust injection pump Repair or replace Repair, replace Repair or replace Clean or replace air
4) Overheating	• Engine oil insufficient or poor • Cooling water insufficient • Fan belt loosened, worn, damaged • Cooling water pump's function lowered • Water temp. regulator's operation poor • Valve clearance incorrect • Exhaust system's resistance increased	Replenish or replace Replenish or replace Adjust or replace Repair or replace Replace Adjust Clean or replace

Condition	Cause	Remedies
5) Engine noisy	For noises arise compositely such asrota ting parts, lapping parts etc., there is nec essity to search the cause of noises accu rately.	
(1) Crankshaft	• As the wear of bearing or crankshaft progress, the oil clearances increase. • Lopsided wear of crankshaft • Oil supply insufficient due to oil passage clogging • Stuck bearing	Replace bearing & grind crankshaft Grind or replace Clean oil passage Replace bearing & Grind
(2) Con rod and Con rod bearing	• Lopsided wear of con rod bearing • Lopsided wear of crank pin • Connecting rod distortion • Stuck bearing • Oil supply insufficiency as clogging at oil passage progresses	Replace bearing Grind crankshaft Repair or replace Replace & grind crankshaft Clean oil passage
(3) Piston, piston pin & piston ring	• Piston clearance increase as the wear of piston and piston ring progresses • Wear of piston or piston pin • Piston stuck • Piston insertion poor • Piston ring damaged	Replace piston & piston ring Replace Replace piston Replace piston Replace piston
(4) Others	• Wear of crankshaft, thrust bearing bearing • Camshaft end play increased • Idle gear end play increased • Timing gear backlash excessive • Valve clearance excessive • Abnormal wear of tappet, cam • Supercharger inner part damaged	Replace thrust Replace thrust plate Replace thrust washer Repair or replace Adjust valve clearance Replace tappet, cam Repair or replace
6) Fuel Consumption Exttive	• Injection timing incorrect • Fuel injection amount excessive	Adjust Adjust injection pump

Condition	Cause	Remedies
7) Oil Consumption Excessive		
(1) Oil level elevated	• Clearance between cylinder iner & piston	Replace
	• Wear of piston ring, ring groove	Replace piston, piston ring
	• Piston ring's damage, stick, wear	Replace piston ring
	• Piston ring opening's disposition improper	Correct position
	• Piston skirt part damaged or abnormal wear	Replace piston
	• Oil ring's oil return hole clogged	Replace piston ring
	• Oil ring's contact poor	Replace piston ring
(2) Oil level lowered	• Looseness of valve stem & guide	Replace in set
	• Wear of valve stem seal	Replace seal
	• Cylinder head gasket's leak	Replace gasket
(3) Oil leak	• Looseness of connection parts	Replace gasket, repair
	• Various parts' packing poor	Replace packing
	• Oil seal poor	Replace oil seal

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