YANMAR

M9961-03E101

YANMAR®

SERVICE MANUAL

MARINE DIESEL ENGINE

3YM30/3YM20/2YM15

YANMAR CO.,LTD.

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History of Revision					
Manual Name		Service Manual for Marine Diesel Engine			
Engine Model:		3YM30/3YM20/2YM15			
Number of revision	Date of revision	Reason for correction	Outline of correction	Correction item No (page)	Corrected by
New edition		March 2004			
R1	April 25, 2005	Add : Eug. Model 2YM15	1. Specifications table added. 2. Engine outline added. 3. Piping diagram added. 4. Other data added.		Quality Control Dept. Marine Factory
		Corrected data. (3YM30, 3YM20)	1. Front cover added to engine outline. 2. Notice on seawater pump rotating direction was changed. 3. Incorrect word corrected.	P.6-P.9 P.32	

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FOREWORD

This service manual has been complied for engineers engaged in sales, service, inspection and maintenance. Accordingly, descriptions of the construction and functions of the engine are emphasized in this manual, while items, which should already be common knowledge, are omitted.

One characteristic of a marine diesel engine is that its performance in a vessel is governed by the applicability of the vessel's hull construction and its steering system.

Engine installation, fitting out and propeller selection have a substantial effect on the performance of the engine and the vessel. Moreover, when the engine runs unevenly or when trouble occurs, it is essential to check a wide range of operating conditions - such as installation to the full and suitability of the ship's piping and propeller - and not just the engine itself. To get maximum performance from this engine, you should completely understand its functions, construction and capabilities, as well as proper use and servicing.

Use this manual as a handy reference in daily inspection and maintenance, and as a text for engineering guidance.

Model 3YM30 has been used for the illustrations in this service manual, but they apply to other models in the 3YM series engines.

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

California Proposition 65 Warning

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.
Wash hands, after handling.

CONTENTS

FOR SAFETY

1. SAFETY LABELS

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

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

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

⚠ DANGER **DANGER**-indicates an imminent hazardous situation which, if not avoided, WILL result in death or serious injury.

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

⚠ CAUTION **CAUTION**-indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

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

2. Safety Precautions

(1) SERVICE AREA

⚠ WARNING

• Sufficient Ventilation

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

⚠ CAUTION

• Safe / Adequate Work Area

The service area should be clean, spacious, level and free from holes in the floor, to prevent "slip" or "trip and fall" type accidents.

⚠ CAUTION

• Clean, orderly arranged place

No dust, mud, oil or parts should be left on the floor surface.
[Failure to Observe]
An unexpected accident may be caused.

⚠ CAUTION

• Bright, Safely Illuminated Area

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

⚠ CAUTION

• Safety Equipment

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

(2) WORK - WEAR (GARMENTS)

⚠ CAUTION

• Safe Work Clothing

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

(3) TOOLS

⚠ WARNING

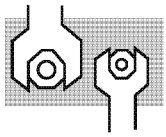
• Appropriate Lifting / Holding

When lifting an engine, use only a lifting device (crane, jack, etc.) with sufficient lifting capacity. Do not overload the device. Use only a chain, cable, or lifting strap as an attaching device. Do not use rope, serious injury may result.

To hold or support an engine, secure the engine to a support stand, test bed or test cart designed to carry the weight of the engine. Do not overload this device, serious injury may result.

Never run an engine without being properly secured to an engine support stand, test bed or test cart, serious injury may result.

⚠ WARNING



• Appropriate Tools

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

(4) GENUINE PARTS and MATERIALS

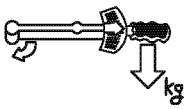
⚠ CAUTION

• Genuine Parts

Always use genuine YANMAR parts or YANMAR recommended parts and goods. Damage to the engine, shortened engine life and or personal injury may result.

(5) FASTENER TORQUE

⚠ WARNING

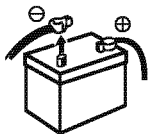


• Torquing Fasteners

Always follow the torque values and procedures as designated in the service manual. Incorrect values, procedures and or tools may cause damage to the engine and or personal injury.

(6) Electrical

⚠ WARNING



• Short Circuits

Always disconnect the (-) Negative battery cable before working on the electrical system. An accidental "short circuit" may cause damage, fire and or personal injury. Remember to connect the (-) Negative battery cable (back onto the battery) LAST

⚠ WARNING

• Charging Batteries

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

⚠ WARNING

• Battery Electrolyte

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

(7) WASTE MANAGEMENT

⚠ CAUTION

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

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

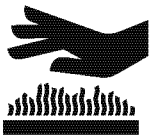
(8) FURTHER PRECAUTIONS

⚠ WARNING

• Fueling / Refueling

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

⚠ WARNING



• Hot Surfaces.

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

⚠ WARNING

• Rotating Parts

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

⚠ WARNING

• Preventing burns from scalding

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

⚠ CAUTION

• Safety Label Check

Pay attention to the product safety label.
A safety label (caution plate) is affixed on the product for calling special attention to safety.
If it is missing or illegible, always affix a new one.

3. Precautions for Service Work

(1) Precautions for Safety

Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

(2) Preparation for Service Work

Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.

- Preceding service date
- Period/operation hours after preceding service
- Problems and actions in preceding service
- Replacement parts expected to be required for service
- Recording form/check sheet required for service

(3) Preparation before Disassembly

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

(4) Precautions in Disassembly

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

(5) Precautions for Inspection and Measurement

Inspect and measure parts to be used again as required to determine whether they are reusable or not.

(6) Precautions for Reassembly

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

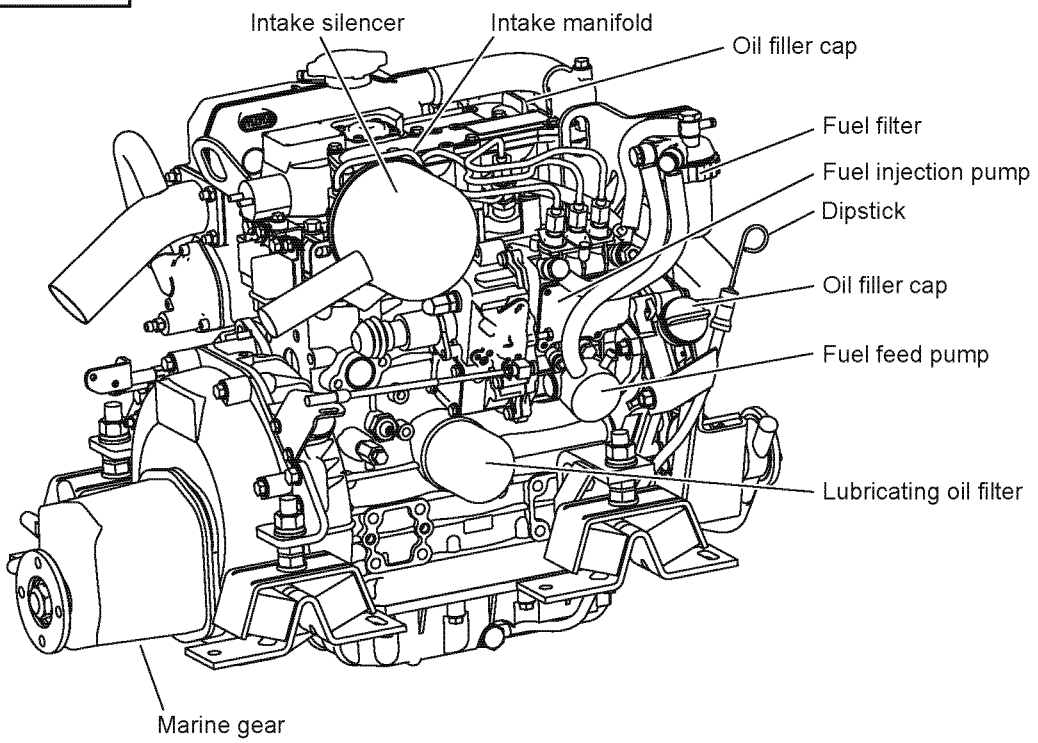
(7) Precautions for Adjustment and Check

Use measuring instruments for adjustment to the specified service standards.

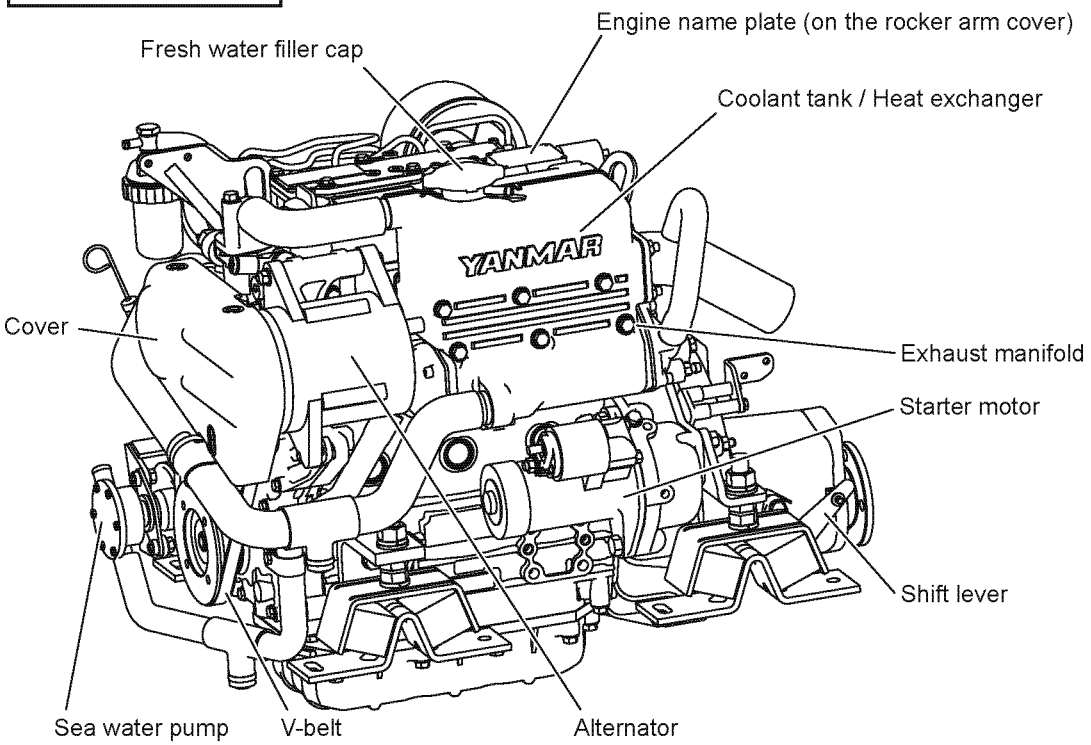
1. General

1.1 Exterior views

Operating Side



Non-Operating Side



<Note> This illustration shows the 3YM30 with Yanmar marine gear (Model:KM2P-1).

1.2 Specifications

Official engine model name		unit	3YM30		3YM20	
Company internal model name		-	3YM30	3YM30C	3YM20	3YM20C
Marine gear model		-	KM2P-1	SD20	KM2P-1	SD20
Use		-	Pleasure use			
Type		-	Vertical water cooled 4 cycle diesel engine			
Combustion system		-	Indirect injection			
Air charging		-	Naturally aspirated			
Number of cylinders		-	3			
Bore x stroke		mm(inch)	76 x 82 (2.99 x 3.23)		70 x 74 (2.76 x 2.91)	
Displacement		L	1.115		0.854	
Continuous power	Output at crankshaft / Engine speed	kW(HP)/ min^{-1}	20.1(27.3) / 3489 (at Fuel temp. 25°C) *		14.7(20.0) / 3489 (at Fuel temp. 25°C) *	
Fuel stop power	Output at crankshaft / Engine speed	kW(HP)/ min^{-1}	22.1(30) / 3600 (at Fuel temp. 25°C) * 21.3(29.0) / 3600 (at Fuel temp. 40°C) **		16.2(22) / 3600 (at Fuel temp. 25°C) * 15.3(20.8) / 3600 (at Fuel temp. 40°C) **	
	Output at propeller shaft / Engine speed	kW(HP)/ min^{-1}	21.4(29.1) / 3600 (at Fuel temp. 25°C) * 20.7(28.1) / 3600 (at Fuel temp. 40°C) **		15.7(21.3) / 3600 (at Fuel temp. 25°C) * 14.9(20.2) / 3600 (at Fuel temp. 40°C) **	
Installation		-	Flexible mounting			
Fuel injection timing		deg b.T.D.C.	FID 16±1 (FIC-Air : 18±1)		FID 22±1 (FIC-Air : 24±1)	
Fuel injection opening pressure		MPa (kgf/cm^2)	$11.8^{+0.98}/_{-0}$ ($120^{+10}/_{-0}$)		$12.3^{+0.98}/_{-0}$ ($125^{+10}/_{-0}$)	
Main power take off		-	At Flywheel side			
Direction of rotation	Crankshaft	-	Counter-clockwise viewed from stern			
	Propeller shaft (Ahead)	-	Clockwise viewed from stern			
Cooling system		-	Fresh water cooling with heat exchanger			
Lubrication system		-	Complete enclosed forced lubrication			
Cooling water capacity (fresh water)		L(quart)	Engine:4.9 (5.2), Coolant recovery tank : 0.8 (0.8)		Engine:4.1 (4.3), Coolant recovery tank : 0.8 (0.8)	
Lubricating oil capacity (engine)	Rake angle	deg.	at rake angle 8 deg.	at rake angle 0 deg.	at rake angle 8 deg.	at rake angle 0 deg.
	Total (Note 4)	L(quart)	$2.8\ {}^{0}/_{-0.2}$ ($3.0\ {}^{0}/_{-0.2}$)	$2.5\ {}^{0}/_{-0.2}$ ($2.6\ {}^{0}/_{-0.2}$)	$2.7\ {}^{0}/_{-0.2}$ ($2.9\ {}^{0}/_{-0.2}$)	$2.4\ {}^{0}/_{-0.2}$ ($2.5\ {}^{0}/_{-0.2}$)
	Effective (Note 5)		1.4 (1.5)	1.5 (1.6)	1.4 (1.5)	1.5 (1.6)
Starting system	Type	-	Electric			
	Starting motor	V-kW	DC 12V-1.4 kW			
	AC generator	V-A	12V-60A (12V-80A optional)			
Engine Dimension	Overall length	mm(inch)	715 (28.1)	715 (28.1)	698 (27.5)	698 (27.5)
	Overall width		463 (18.2)	463 (18.2)	463 (18.2)	463 (18.2)
	Overall height		545 (21.5)	545 (21.5)	528 (20.8)	528 (20.8)
Engine dry mass (include marine gear)		kg	133	157 (with SD20)	120	144 (with SD20)

Official engine model name		unit	2YM15	
Company internal model name		-	2YM15	2YM15C
Marine gear model		-	KM2P-1	SD20
Use		-	Pleasure use	
Type		-	Vertical water cooled 4 cycle diesel engine	
Combustion system		-	Indirect injection	
Air charging		-	Naturally aspirated	
Number of cylinders		-	2	
Bore x stroke		mm(inch)	70 x 74 (2.76 x 2.91)	
Displacement		L	0.570	
Continuous power	Output at crankshaft / Engine speed	kW(HP)/ min^{-1}	9.4(12.8) / 3489 (at Fuel temp. 25°C) *	
Fuel stop power	Output at crankshaft / Engine speed	kW(HP)/ min^{-1}	10.3(14.0) / 3600 (at Fuel temp. 25°C) * 10.0(13.6) / 3600 (at Fuel temp. 40°C) **	
	Output at propeller shaft / Engine speed	kW(HP)/ min^{-1}	10.0(13.6) / 3600 (at Fuel temp. 25°C) * 9.7(13.2) / 3600 (at Fuel temp. 40°C) **	
Installation		-	Flexible mounting	
Fuel injection timing		deg b.T.D.C.	FID 21±1 (FIC-Air : 23±1)	
Fuel injection opening pressure		MPa (kgf/cm^2)	$12.3^{+0.98}/_{-0}$ ($125^{+10}/_{-0}$)	
Main power take off		-	At Flywheel side	
Direction of rotation	Crankshaft	-	Counter-clockwise viewed from stern	
	Propeller shaft (Ahead)	-	Clockwise viewed from stern	
Cooling system		-	Fresh water cooling with heat exchanger	
Lubrication system		-	Complete enclosed forced lubrication	
Cooling water capacity (fresh water)		L(quart)	Engine:3.0 (3.2), Coolant recovery tank : 0.8 (0.8)	
Lubricating oil capacity (engine)	Rake angle	deg.	at rake angle 8 deg.	at rake angle 0 deg.
	Total (Note 4)	L(quart)	$2.0\ ^{0}/_{-0.2}$ ($2.1\ ^{0}/_{-0.2}$)	$1.8\ ^{0}/_{-0.2}$ ($1.9\ ^{0}/_{-0.2}$)
	Effective (Note 5)		0.95 (1.0)	1.5 (1.6)
Starting system	Type	-	Electric	
	Starting motor	V-kW	DC 12V-1.4 kW	
	AC generator	V-A	12V-60A (12V-80A optional)	
Engine Dimension	Overall length	mm(inch)	613 (24.1)	613 (24.1)
	Overall width		463 (18.2)	463 (18.2)
	Overall height		528 (20.8)	528 (20.8)
Engine dry mass (include marine gear)		kg	115	134 (with SD20)

(Note)
1. Rating condition : ISO 3046-1, 8665
2. 1HP (metric horse power) ≒ 0.7355 kW
3. Fuel condition : Density at 15°C = 0.842
   * Fuel temperature 25°C at the inlet of the fuel injection pump. (ISO 3046-1)
   ** Fuel temperature 40°C at the inlet of the fuel injection pump. (ISO 8665)
4. The "Total" oil quantity includes: oil in oil pan and oil in channels, coolers and filter.
5. The effective amount of oil shows the difference in maximum scale of the dipstick and minimum scale.

1.3 Fuel oil, lubricating oil and cooling water

1.3.1 Fuel oil

IMPORTANT:
Only use the recommended fuel to obtain the best engine performance and prevent damage of parts, also prevent air pollution.

(1) Selection of fuel oil

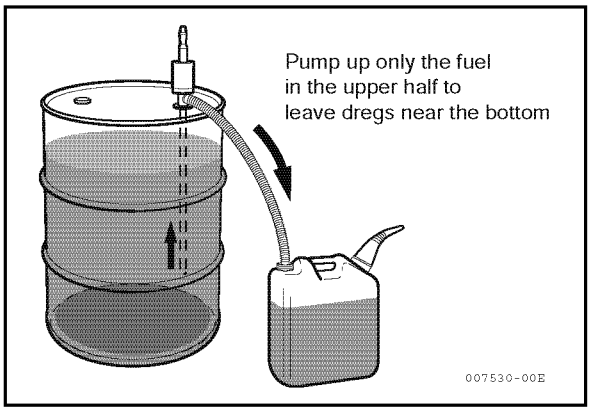
Use the following diesel fuels for best engine performance:
BS 2869 A1 or A2

Fuels equivalent to Japanese Industrial Standard, JIS. No. K2204-2

Fuel cetane number should be 45 or greater

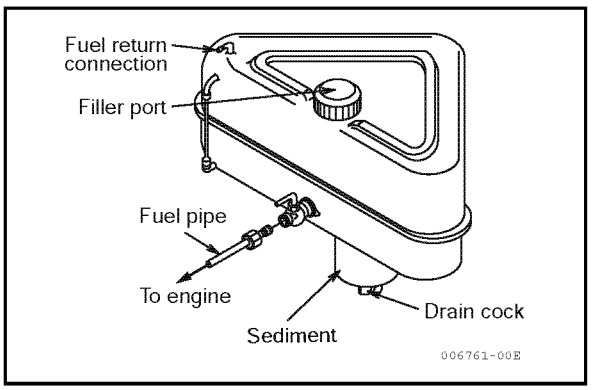
(2) Fuel handling

- Water and dust in the fuel oil can cause operation failure. Use containers which are clean inside to store fuel oil. Store the containers away from rain water and dust.
- Before supplying fuel, let the fuel container rest for several hours so that water and dust in the fuel are deposited on the bottom. Pump up only the clean fuel.



(3) Fuel tank

Fuel tank inside should be always clean enough and dry it inside for the first use.
Drain the water according to the maintenance schedule with a drain cock.



1.3.2 Lubricating oil

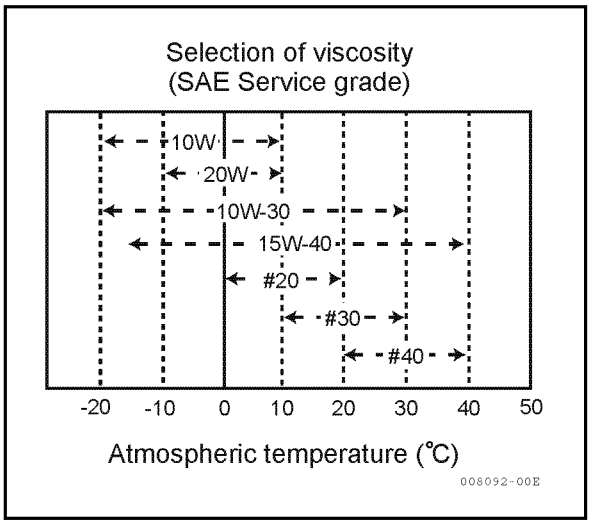
IMPORTANT:
Use of other than the specified engine oil may cause inner parts seizure or early wear, leading to shorten the engine service life.

(1) Selection of engine lube oil

Use the following engine oil

- API classification ..... CD or better
  (Standards of America Petroleum Institute)
- SAE viscosity ..... 10W-30 or 15W-40
  (Standard of Society of Automotive Engineering)

Engine oil with 10W-30 or 15W-40 can be used throughout the year.
(Refer to the right figure.)



(2) Selection of marine gear lube oil

Use the following engine oil

- API classification ..... CD or better
  (Standards of America Petroleum Institute)
- SAE viscosity ..... #20 or #30
  (Standard of Society of Automotive Engineering)

(3) Selection of lube oil for sail drive unit

API service grade GL4, 5
SAE viscosity ..... #90 or 80W-90
or QuickSilver High Performance Gear Lube
QuickSilver® is registered trademark of Brunswick Corporation.

(4) Handling of engine oil

- Carefully store and handle the oil so as to prevent dust or dirt entrance. When supplying the oil, pay attention and clean around the filler port.
- Do not mix different types of oil as it may adversely affect the lubricating performance.

⚠ CAUTION

When touching engine oil by hand, the skin of the hand may become rough. Be careful not to touch oil with your hands without protective gloves. If touch, wash your hands with soap and water thoroughly.

1.3.3 Cooling water

Use clean soft water and be sure to add the Long Life Coolant Antifreeze (LLC) in order to prevent rust built up and freezing. If there is any doubt over the water quality, distilled water or pre-mixed coolant should be used.
The coolants / antifreezes, which are good performance for example, are shown below.

- TEXACO LONG LIFE COOLANT ANTIFREEZE, both standard and pre-mixed.
  Product codes 7997 and 7998
- HAVOLINE EXTENDED LIFE ANTIFREEZE / COOLANT
  Product code 7994

IMPORTANT:

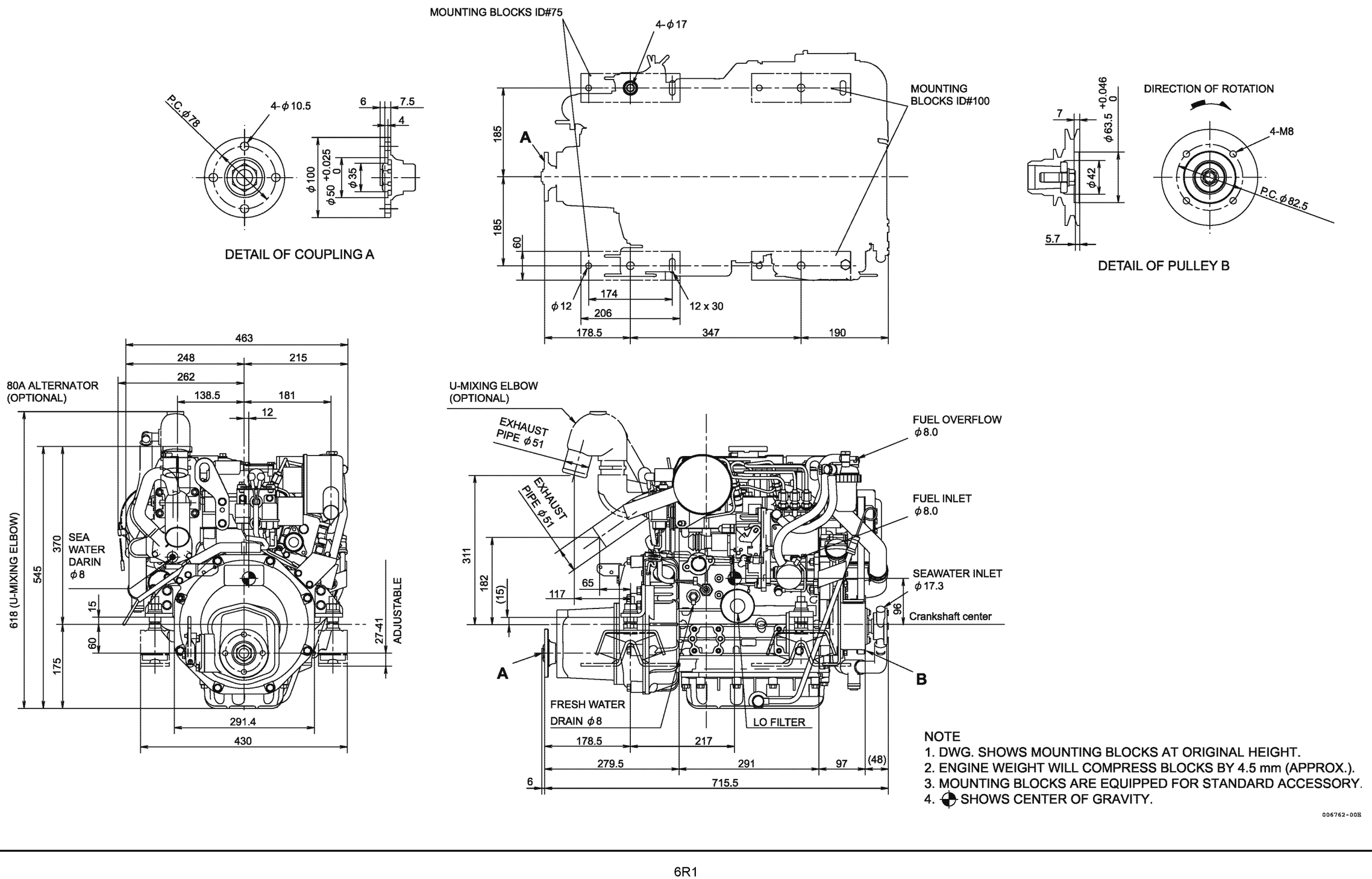
- Be sure to add Long Life Coolant Antifreeze (LLC) to soft water. In cold season, the LLC is especially important. Without LLC, cooling performance will decrease due to scale and rust in the cooling water line. Without LLC, cooling water will freeze and expand to break the cooling line.
- Be sure to use the mixing ratios specified by the LLC manufacturer for your temperature range.
- Do not mix different types (brand) of LLC, chemical reactions may make the LLC useless and engine trouble could result.
- Replace the cooling water every once a year.

⚠ CAUTION

When handling Long Life Coolant Antifreeze, wear protective rubber gloves not to touch it. If LLC gets eyes or skin, wash with clean water at once.

1.4 Engine outline

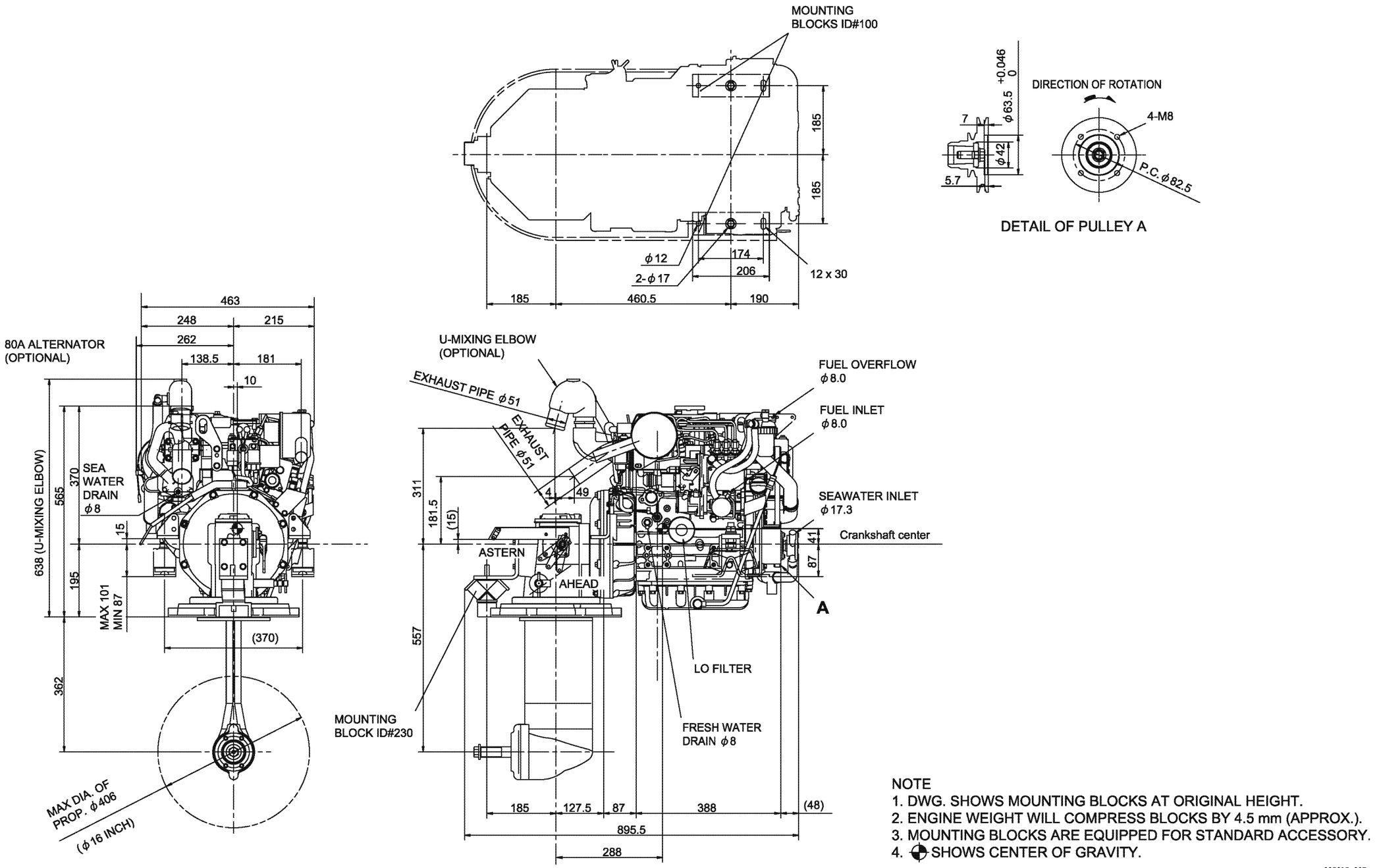
(1) 3YM30 (with KM2P-1 marine gear)



NOTE
1. DWG. SHOWS MOUNTING BLOCKS AT ORIGINAL HEIGHT.
2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

006762-00E

(2) 3YM30C (with SD20 sail drive)



NOTE
1. DWG. SHOWS MOUNTING BLOCKS AT ORIGINAL HEIGHT.
2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

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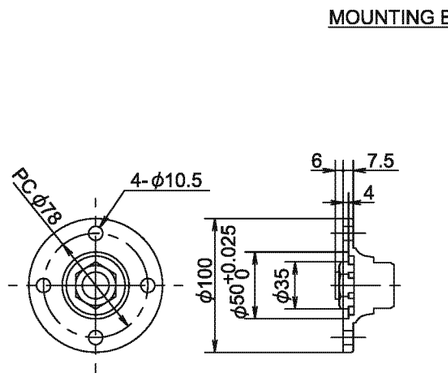
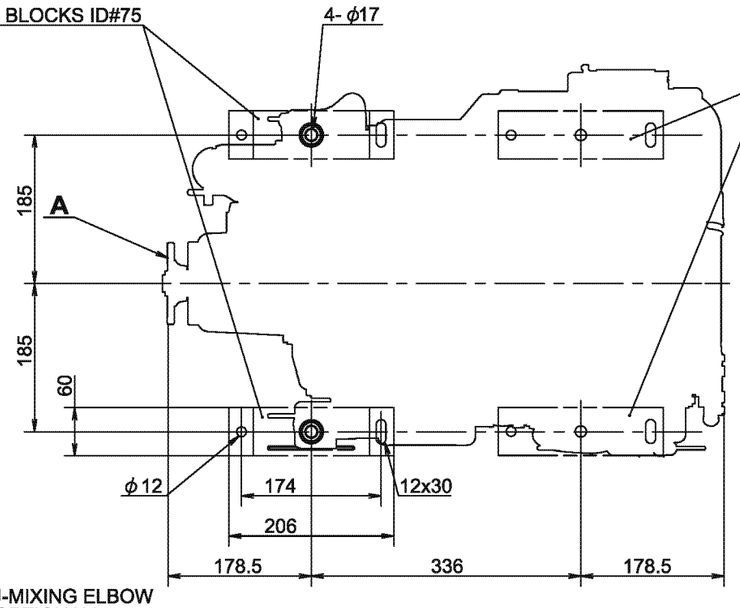
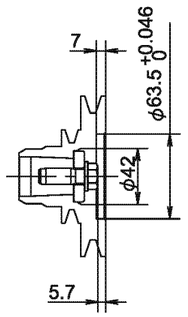
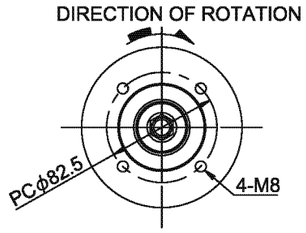
(3) 3YM20 (with KM2P-1 marine gear)



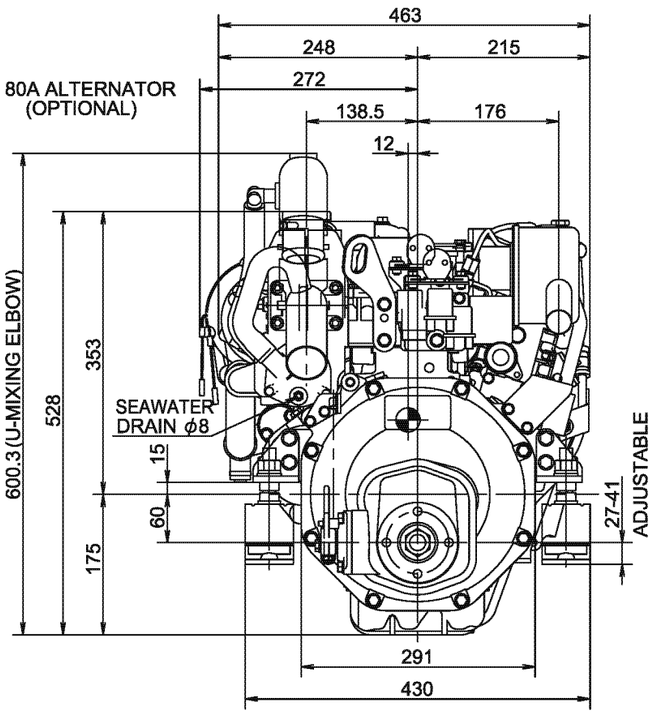
DETAIL OF COUPLING **A**

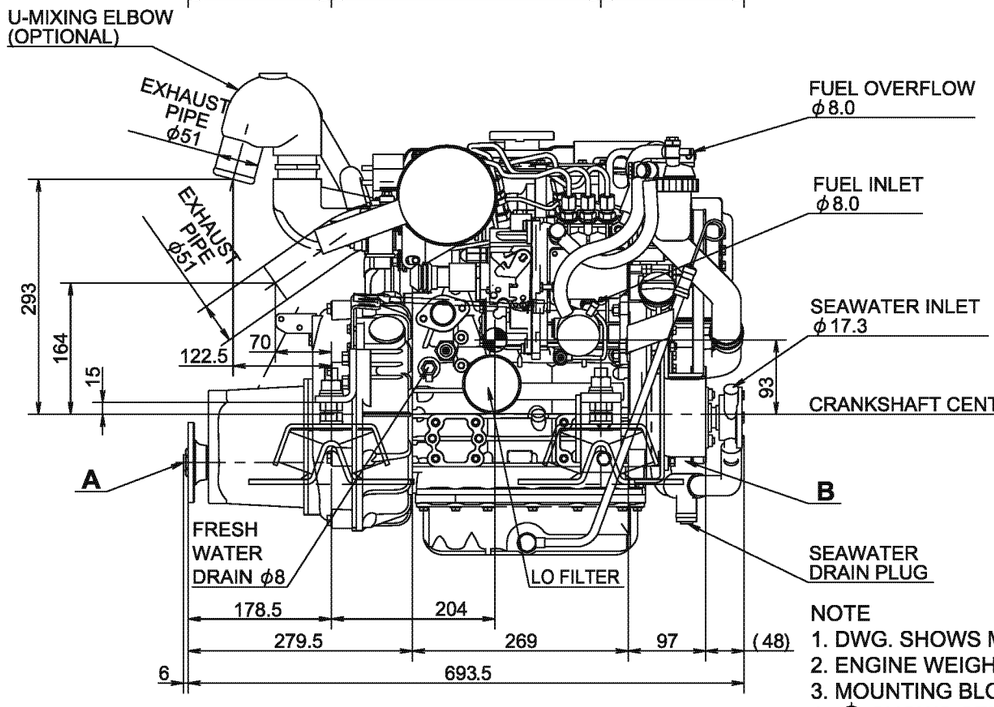






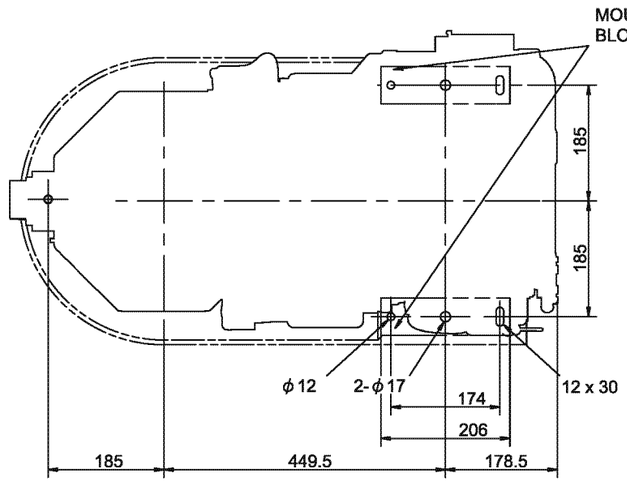
DETAIL OF PULLEY **B**

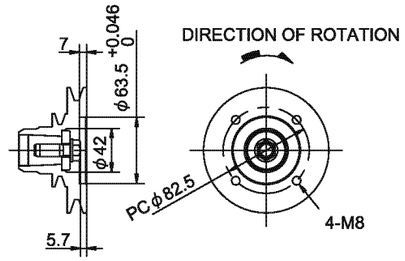




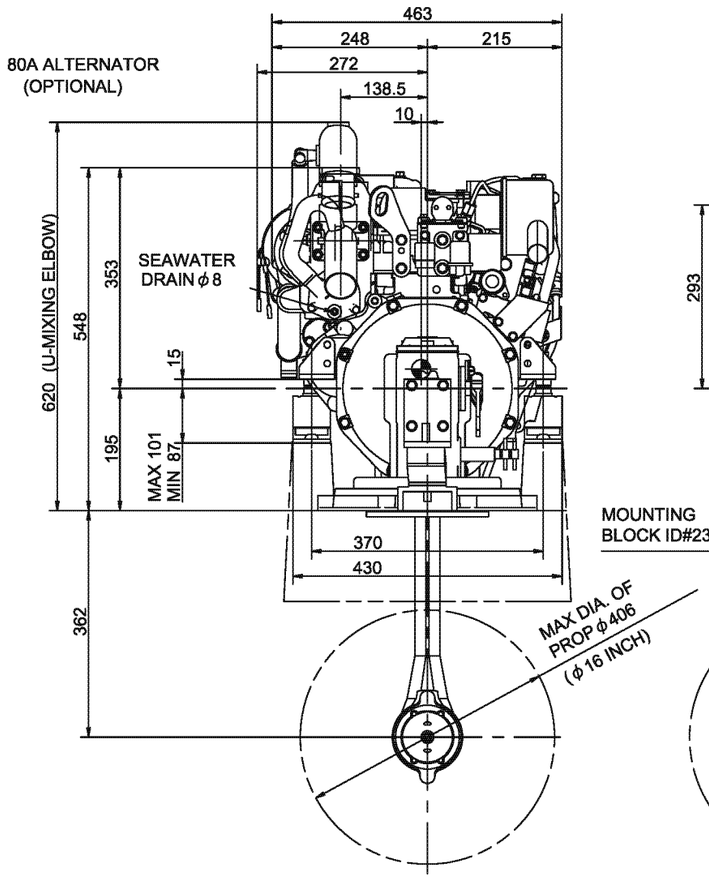
NOTE
1. DWG. SHOWS MOUNTING BLOCKS AT ORIGINAL HEIGHT.
2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

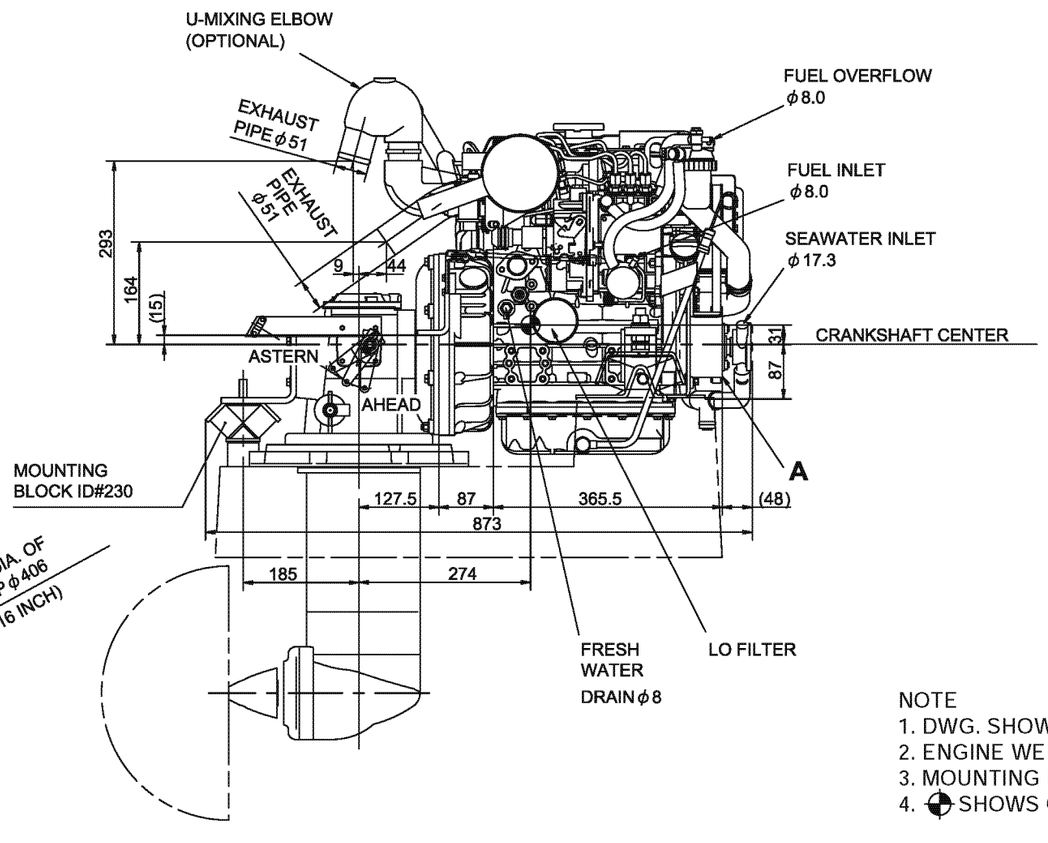
(4) 3YM20C (with SD20 sail drive)





DETAIL OF PULLEY A





NOTE
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2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

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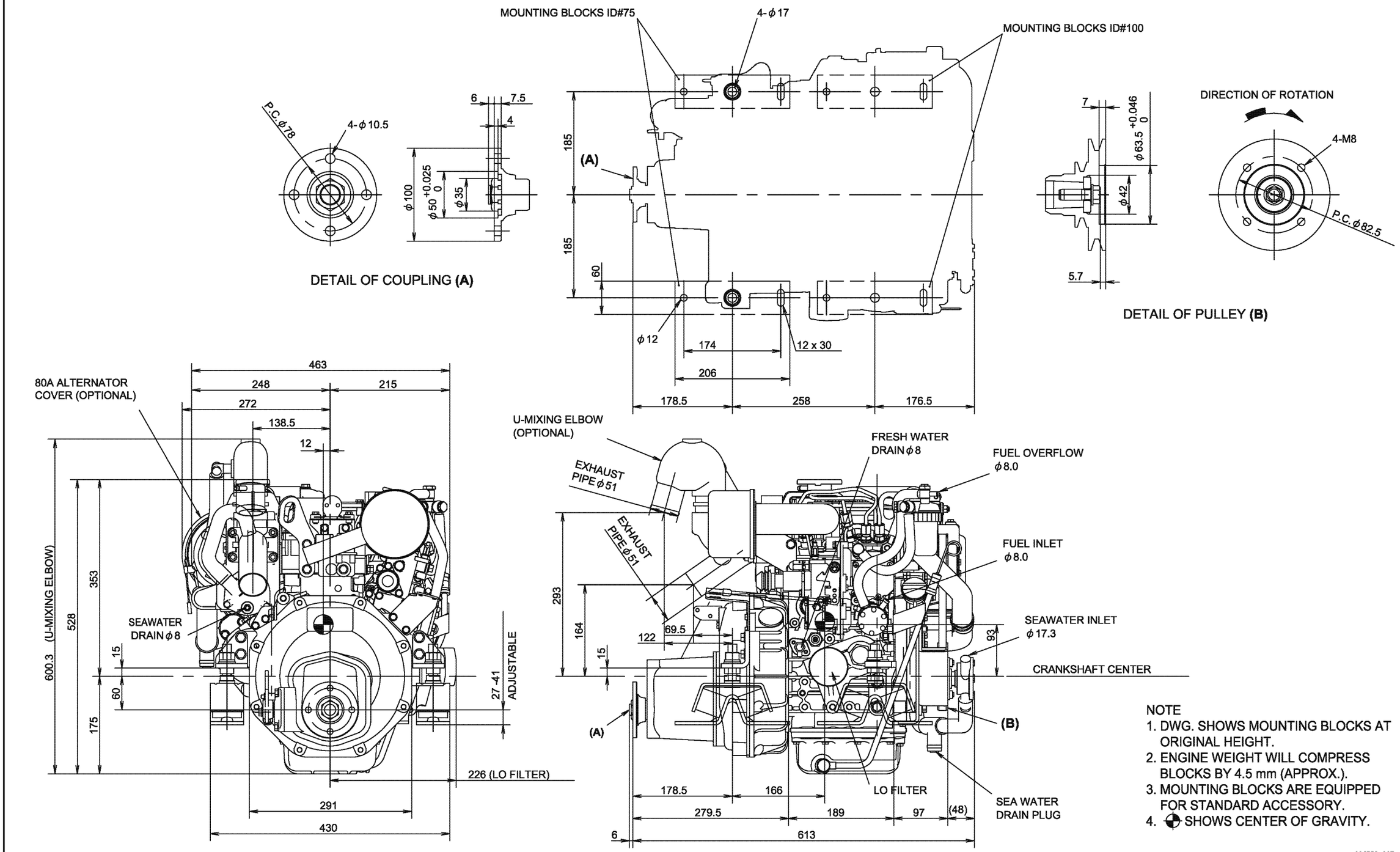
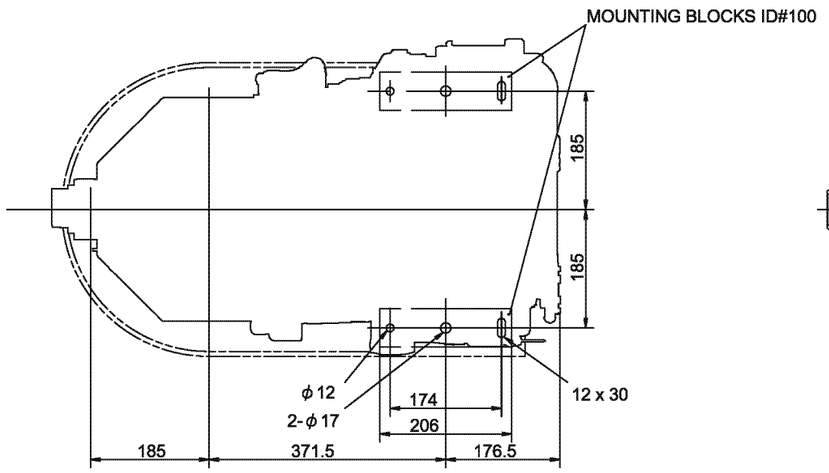
(5) 2YM15 (with KM2P-1 marine gear)

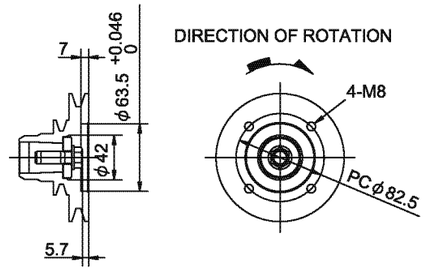


NOTE
1. DWG. SHOWS MOUNTING BLOCKS AT ORIGINAL HEIGHT.
2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

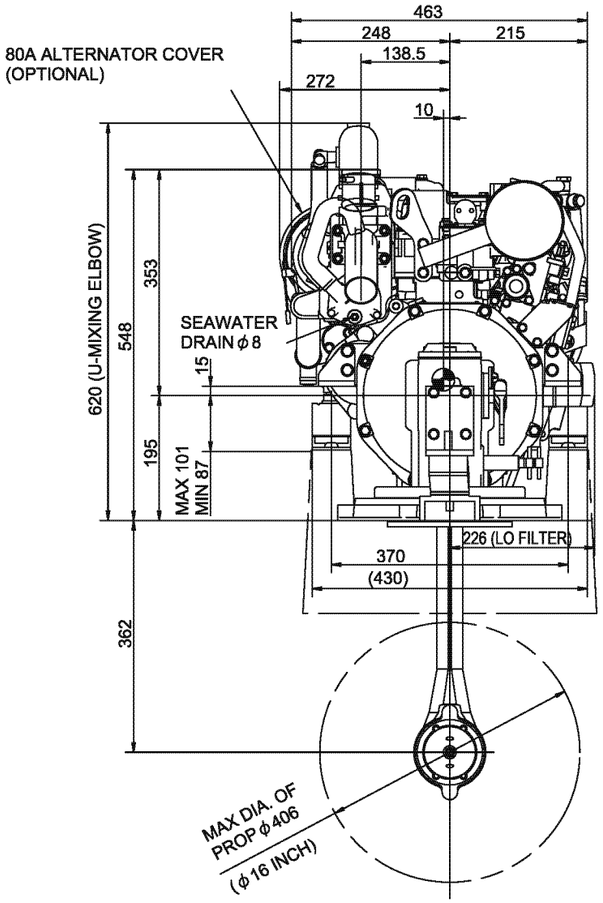
006253-00E

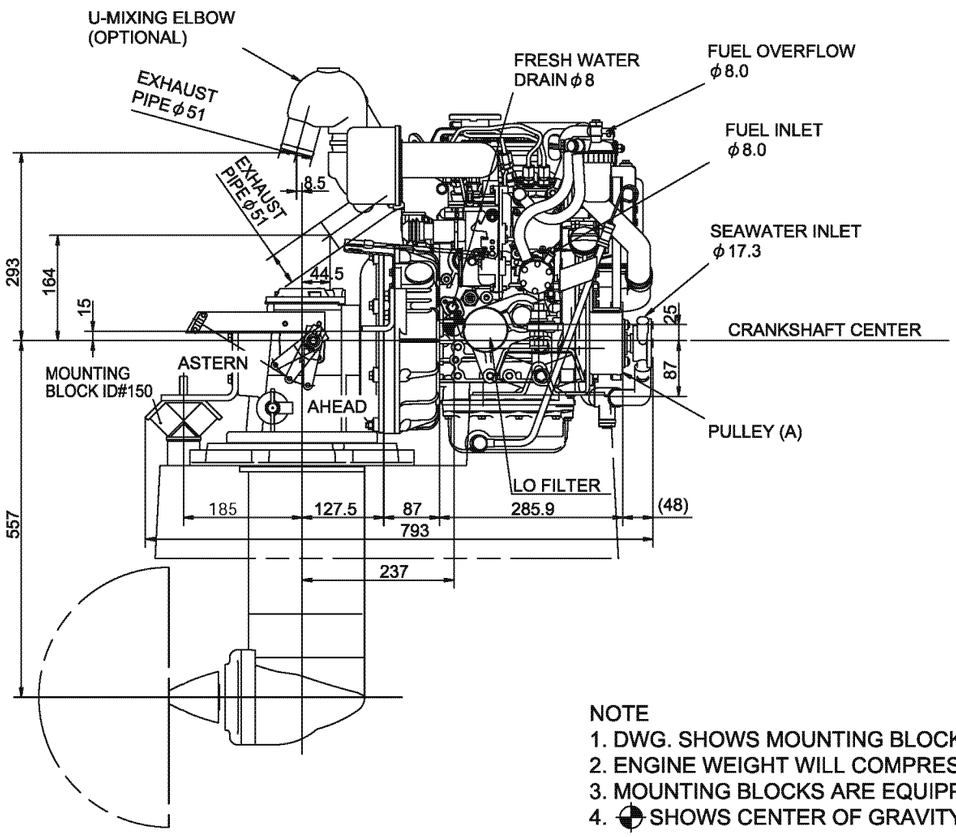
(6) 2YM15C (with SD20 sail drive)





DETAIL OF PULLEY **(A)**





NOTE
1. DWG. SHOWS MOUNTING BLOCKS AT ORIGINAL HEIGHT.
2. ENGINE WEIGHT WILL COMPRESS BLOCKS BY 4.5 mm (APPROX.).
3. MOUNTING BLOCKS ARE EQUIPPED FOR STANDARD ACCESSORY.
4. ⊕ SHOWS CENTER OF GRAVITY.

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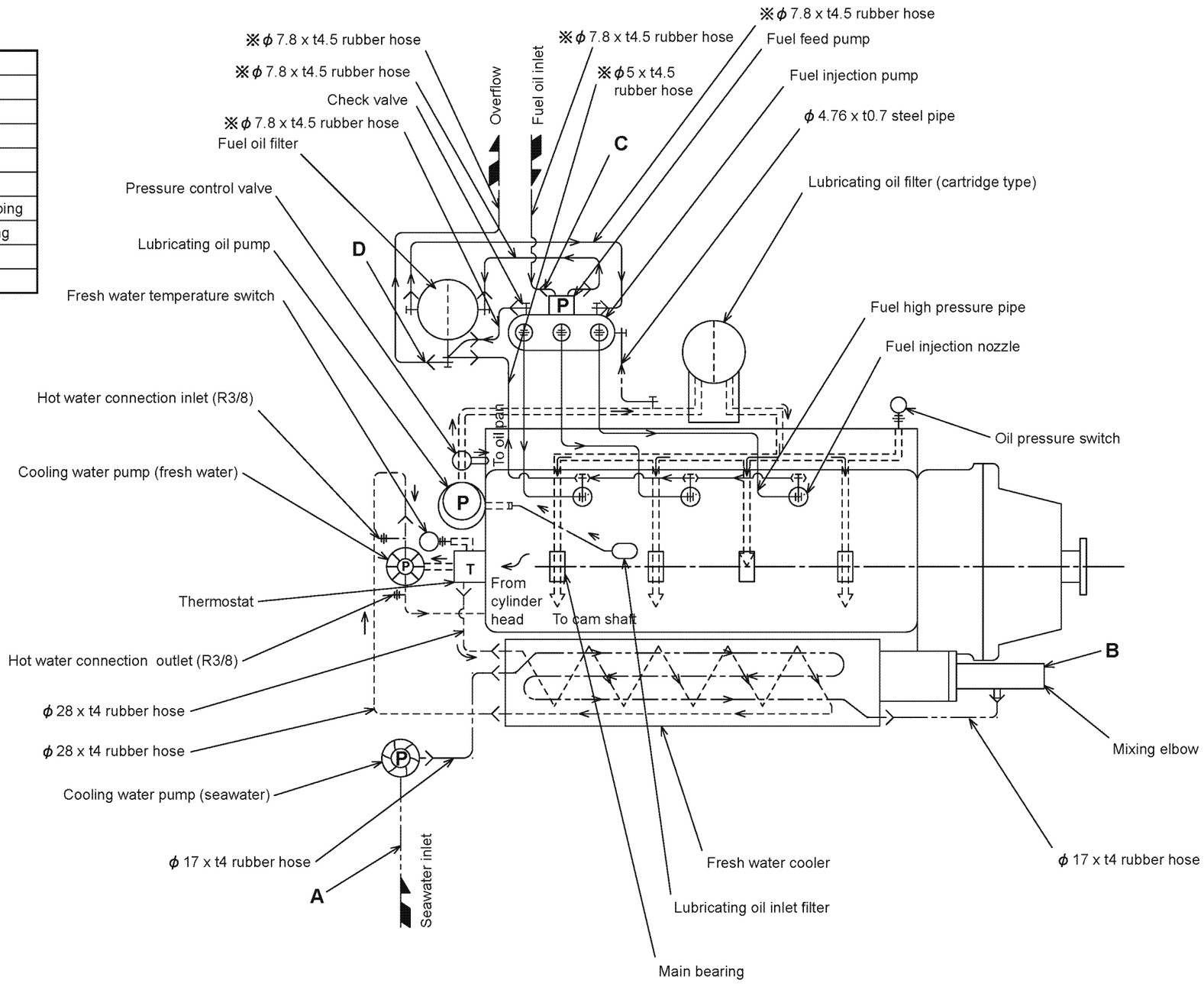
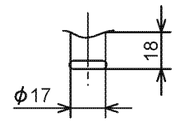
1.5 Piping diagrams

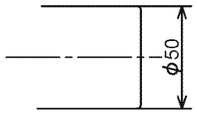
(1) 3YM30/3YM20 (with KM2P-1 marine gear)

Marks of piping	
—||—	Screw joint (Union)
—|—	Flange joint
—T—	Eye joint
—<	Insertion joint
----------	Drill hole
----------	Cooling fresh water piping
—·—·—	Cooling seawater piping
—·—·—	Lubricating oil piping
———	Fuel oil piping

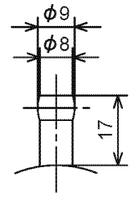




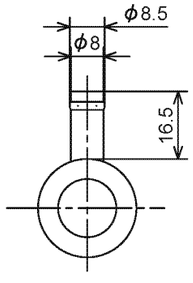
Detail of part **A**



Detail of part **B**



Detail of part **C**

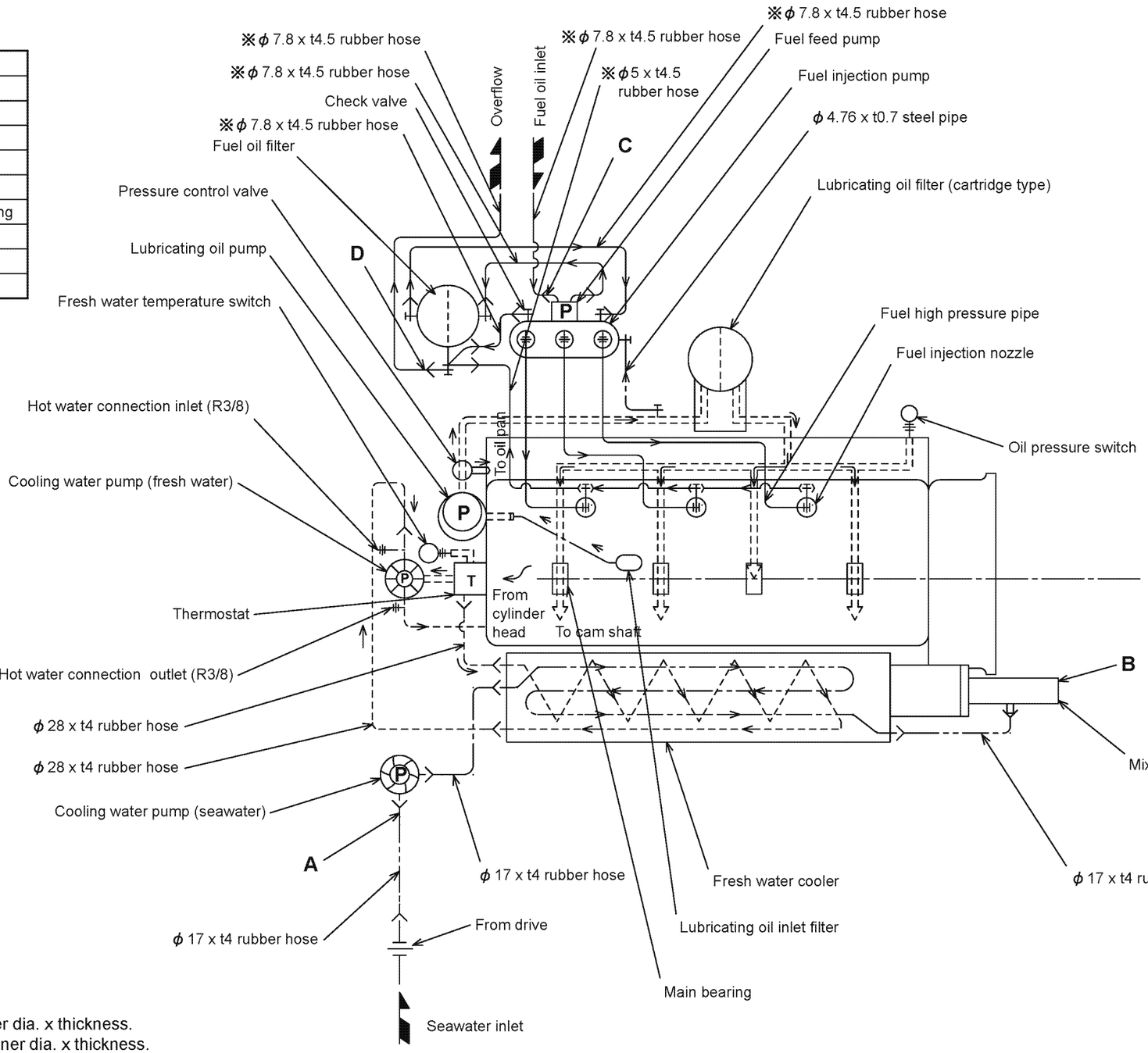


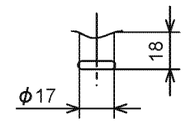
Detail of part **D**

Notes
1. Dimension of steel pipe : outer dia. x thickness.
   Dimension of rubber pipe : inner dia. x thickness.
2. Fuel rubber pipes (marked ※) satisfy EN/ISO7840.

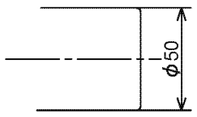
(2) 3YM30C/3YM20C (with sale drive SD20)

Marks of piping	
	Screw joint (Union)
	Flange joint
	Eye joint
	Insertion joint
	Drill hole
	Cooling fresh water piping
	Cooling seawater piping
	Lubricating oil piping
	Fuel oil piping

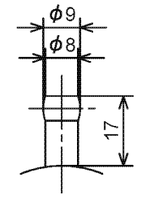




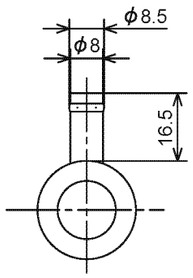
Detail of part **A**



Detail of part **B**



Detail of part **C**

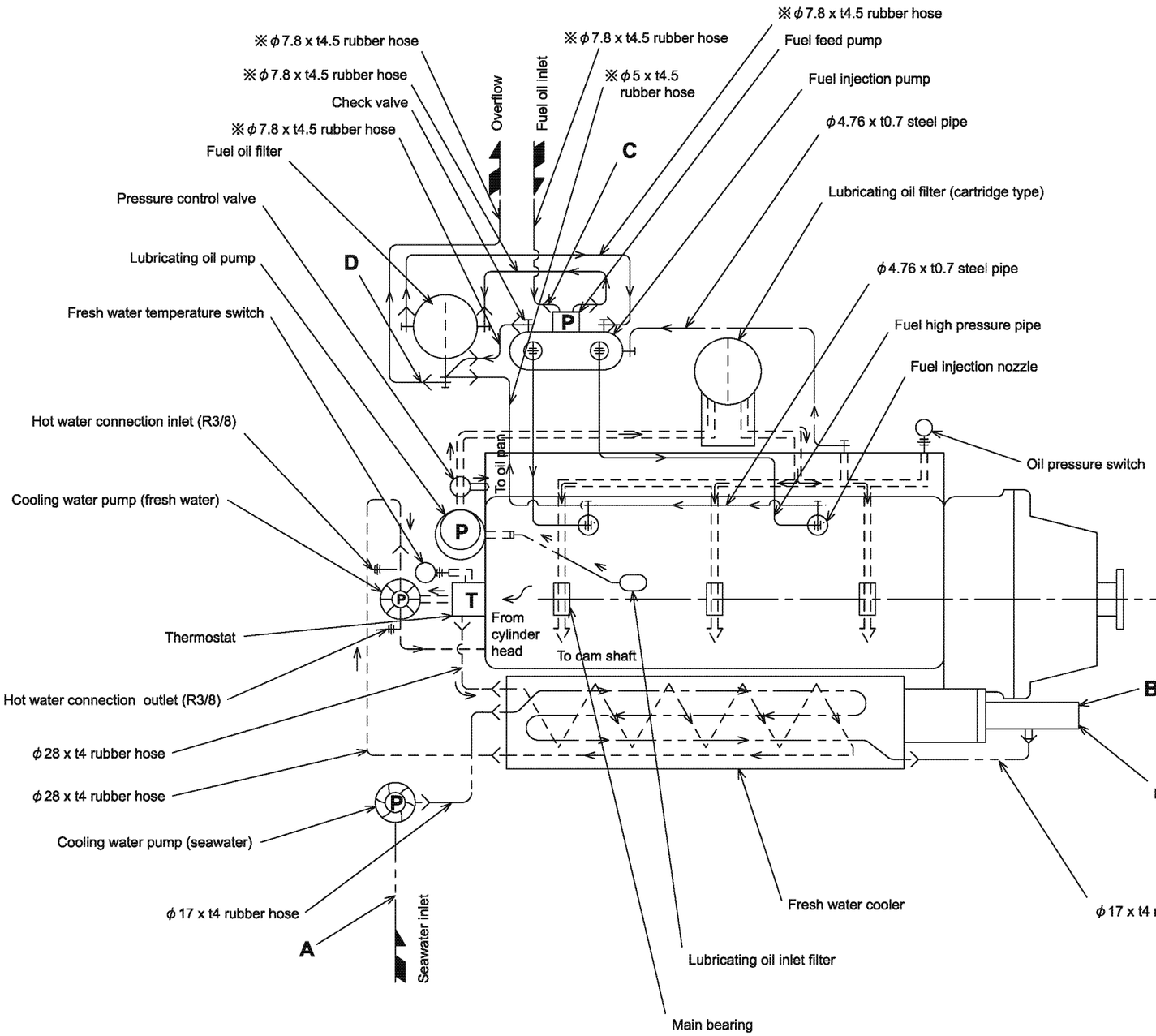


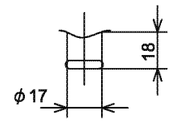
Detail of part **D**

Notes
1. Dimension of steel pipe : outer dia. x thickness.
   Dimension of rubber pipe : inner dia. x thickness.
2. Fuel rubber pipes (marked ※) satisfy EN/ISO7840.

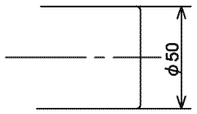
(3) 2YM15 (with KM2P-1 marine gear)

Marks of piping	
	Screw joint (Union)
	Flange joint
	Eye joint
	Insertion joint
	Drill hole
	Cooling fresh water piping
	Cooling seawater piping
	Lubricating oil piping
	Fuel oil piping

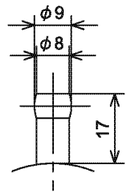




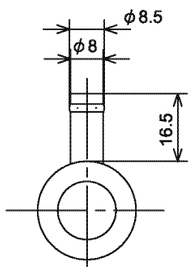
Detail of part **A**



Detail of part **B**



Detail of part **C**



Detail of part **D**

Notes
1. Dimension of steel pipe : outer dia. x thickness.
   Dimension of rubber pipe : inner dia. x thickness.
2. Fuel rubber pipes (marked ※) satisfy EN/ISO7840.

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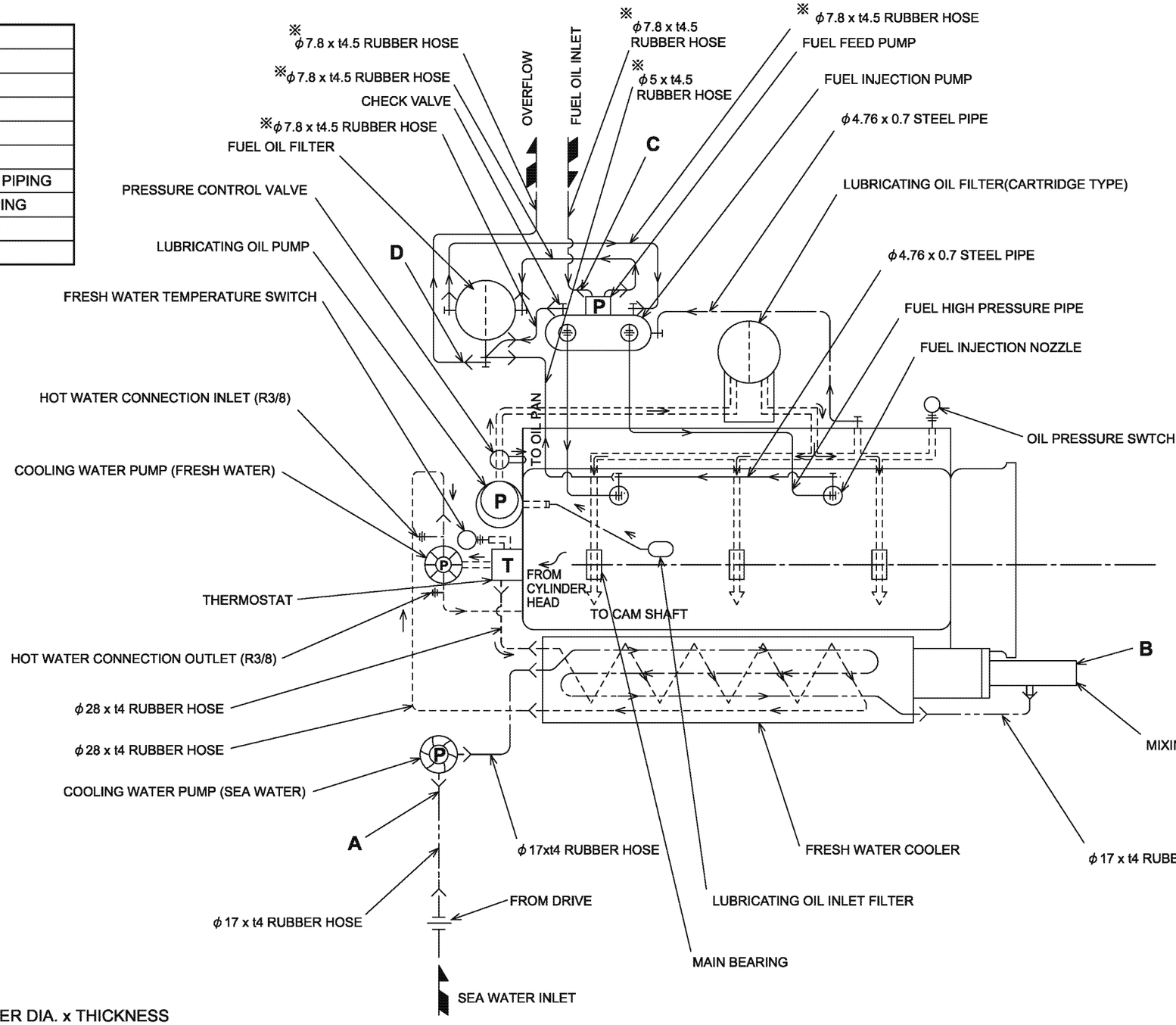
(4) 2YM15C (with sale drive SD20)

MARKS OF PIPING	
—||—	SCREW JOINT (UNION)
—|—	FLANGE JOINT
—T—	EYE JOINT
—<	INSERTION JOINT
=======	DRILL HOLE
- - - - - - -	COOLING FRESH WATER PIPING
— - - —	COOLING SEAWATER PIPING
— - — -	LUBRICATING OIL PIPING
———	FUEL OIL PIPING



NOTES
1.DIMENSION OF STEELPIPE:OUTER DIA. x THICKNESS
DIMENSION OF RUBBER PIPE:INNER DIA. x THICKNESS
2.FUEL RUBBER PIPES(MARKED※) SATISFY EN/ISO7840.

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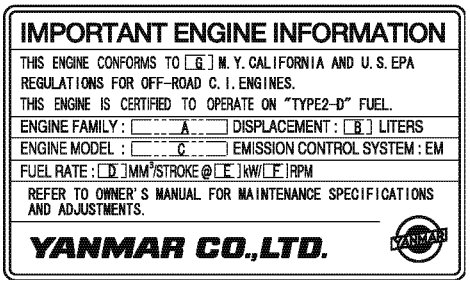
1.6 Exhaust gas emission regulation

3YM30/3YM20/2YM15 series engines are applicable with Off-road Compression Ignition engines regulations of the EPA and ARB (,California Air Resources Board) in USA and BSO regulations in Europe.

1.6.1 Engine identification (EPA/ARB)

With the regulations on exhaust gas emission worldwide, it has become necessary to identify engines in a manner to determine which regulations they comply with, hence

(1) Emission control label (EPA and ARB)

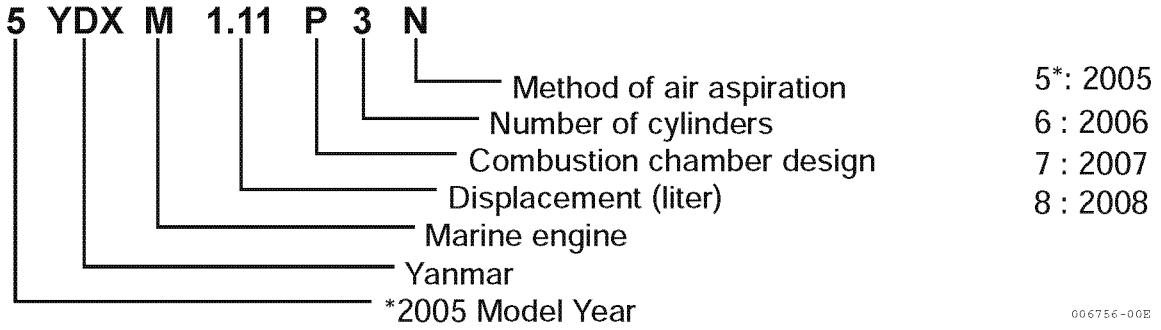


(EPA and ARB label)

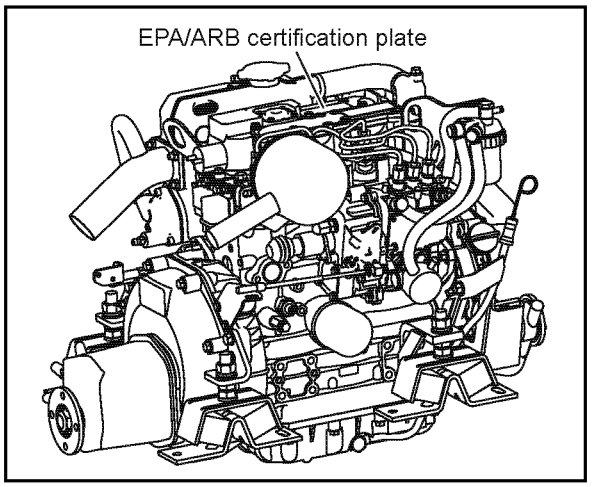
(Note) Emission Control is accomplished through Engine Modification (EM-Design)

- The tamper resistance device is installed with EPA/ARB certified 3YM30/3YM20/2YM15 series engines to prevent illegal change of fuel injection volume and high idling speed.
  (Fuel injection volume : cap type, High idling speed : cap type)
- Engine family name as assigned by EPA/ARB identifying engine family group
  5YDXM1.11P3N and this identifies

YYDXM1.11P3N and this identifies



(2) Label location:



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1.6.2 Exhaust gas emission standard (EPA/ARB)

Engine Power	Tier	Model Year	NOx	HC	NMHC + NOx	CO	PM
8 <= kW < 19 (11 <= hp < 25)	Tier 1	2000	-	-	9.5 (7.1)	6.6 (4.9)	0.80 (0.60)
	Tier 2	2005	-	-	7.5 (5.6)	6.6 (4.9)	0.80 (0.60)
19<= kW < 37 (25 <= hp < 50)	Tier 1	1999	-	-	9.5 (7.1)	5.5 (4.1)	0.80 (0.60)
	Tier 2	2004	-	-	7.5 (5.6)	5.5 (4.1)	0.60 (0.45)

Note
1. The transit smoke (ACC/LUG/PEAK) is not applicable.
2. The EPA recommended fuel is used.
3. The ARB emission standard is the same as the EPA's.
4. As for Model year, the year, which a regulation is applicable to, is shown.

1.6.3 Guarantee conditions for emission standard (EPA/ARB)

In addition to making sure that these conditions are met, check for any deterioration that may occur before the required periodic maintenance times.

(1) Requirement on engine installation condition

(a) Air intake negative pressure

kPa (mmAq)

Permissible
≦3.9 (400)

(b) Exhaust gas back pressure

kPa (mmAq)

Permissible
≦14.7 (1500)

(2) Fuel oil and lubricating oil

(a) Fuel: The diesel fuel oil [BS 2869 A1 or A2 (Cetane No.45 min.)]

(b) Lube oil : API grade, class CD

(3) Do not remove the caps restricting injection quantity and engine speed.

(4) Perform maintenance without fail.

Note: Inspections to be carried out by the user and by the maker are divided and set down in the "List of Periodic Inspection" on the operation manual and should be checked carefully.

EPA allows to apply the maintenance schedule for the emission related parts as follows.

	Maintenance period	
Parts / Power Rating	Fuel nozzle cleaning	Adjustment, cleaning, repairs for fuel nozzle, fuel pump, and electronic control unit etc.
kW < 19	Every 1500 hours	Every 3000 hours
19 ≦ kW < 37	Every 1500 hours	Every 3000 hours

(5) Quality guarantee period for exhaust emission related parts

For exhaust emission related parts, follow the inspections outlined in the "List of Periodic Inspections", on the operation manual, and use the table below to carry out inspections based on operation hours or time in years. Whichever comes first is the guarantee period.

Parts / Power Rating	For fuel nozzle, fuel pump
kW < 19	1500 hours or 2 years
19 ≦ kW < 37	3000 hours or 5 years

The specific emissions-related parts are

(a) Fuel injection nozzle

(b) Fuel injection pump

2. Inspection and adjustment

2.1 Periodic maintenance schedule

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

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

System	Item		Before starting	*2 Initial 50hrs. or one month	*2 Every 50hrs. or one month	*2 Every 100 hrs. or six months	*2 Every 150 hrs. or one year	*2 Every 250 hrs. or one year	*2 Every 1000 hrs. or 4 years
Whole	Visual inspection of engine outside		○						
Fuel system	Check the fuel level, and refill		○						
	Drain the fuel tank			○				○	
	Drain the fuel filter				○				
	Replace the fuel filter							◎	
	Check the injection timing								●
	Check the injection spray condition								●*1
Lubricating system	Check the lube oil level	Crankcase	○						
		Marine gear	○						
	Replace the lube oil	Crankcase		◎			◎		
		Marine gear		◎			◎		
		Sail drive		◎		◎			
	Replace the engine lube oil filter.			◎				◎	
Cooling system	Seawater outlet		○ During operation						
	Check cooling water level		○						
	Check the impeller of the cooling water pump (seawater pump)							○	◎
	Replace the fresh water coolant		Every year When long life coolant of a specified type is used, replacement period of two years can be obtained.						
	Clean & check the water passages								●

*1 For EPA requirements see also 1.5 in chapter 1.

*2 Whichever comes first

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

System	Item	Before starting	*2 Initial 50hrs. or one month	*2 Every 50hrs. or one month	*2 Every 100 hrs. or six months	*2 Every 150 hrs. or one year	*2 Every 250 hrs. or one year	*2 Every 1000 hrs. or 4 years
Air intake and exhaust system	Clean the element of the air intake silencer						○	
	Clean the exhaust/water mixing elbow						○	
	Check the exhaust gas condition	○ During operation						
	Diaphragm assembly inspection							●
Electrical system	Check the alarm lamps & devices	○						
	Check the electrolyte level in the battery			○				
	Adjust the tension of the alternator driving belt		○				○	◎
	Check the wiring connectors						○	
Cylinder head, etc.	Check for leakage of water and oil	○ After starting						
	Retighten all major nuts and bolts							●
	Adjust intake/exhaust valve clearance		○					●
Remote control system, etc.	Check/adjust the remote control operation	○	○					●
	Adjust the propeller shaft alignment		○					●

*2 Whichever comes first

2.2 Periodic inspection and maintenance procedure

2.2.1 Check before starting

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

No.	Inspection Item
(1)	Visual inspection of engine outside
(2)	Check the fuel level, and refill
(3)	Check the lube oil level (Crankcase/Marine gear)
(4)	Seawater outlet
(5)	Check cooling water level
(6)	Check the alarm lamps & devices
(7)	Check the leakage of water, lube oil and fuel
(8)	Check/adjust the remote control operation

(1) Visual inspection of engine outside

If any problem is found, do not use before the engine repairs have been completed.

- Oil leak from the lubrication system
- Fuel leak from the fuel system
- Cooling water leak from the cooling water system
- Damaged parts
- Loosened or lost bolts
- Fuel, coolant tank rubber hoses, V belt cracked, loosened clamp

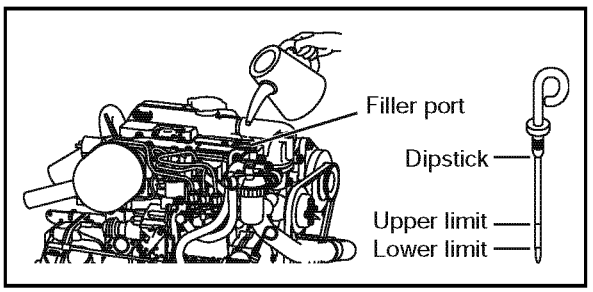
(2) Check the fuel level, and refill

Check the remaining fuel oil level in the fuel tank and refill the recommended fuel if necessary.

(3) Check the lube oil level (Crankcase/Marine gear)

1) Checking engine lube oil level

a) Check the lube oil level of a engine with a dipstick. Insert the dipstick fully and check the oil level. The oil shall not be contaminated heavily and have appropriate viscosity. No cooling water or diesel fuel shall be mixed



Standard

The level shall be between the upper and lower limit lines on the dipstick.

Unit : liter (quart)

Model	Rake angle	Engine oil capacity (Full)
3YM30 with KM2P-1	8 degree	2.8 $^{0}/_{-0.2}$ (3.0)
3YM20 with KM2P-1		2.7 $^{0}/_{-0.2}$ (2.9)
2YM15 with KM2P-1		2.0 $^{0}/_{-0.2}$ (2.1)
3YM30C with SD20	0 degree	2.5 $^{0}/_{-0.2}$ (2.6)
3YM20C with SD20		2.4 $^{0}/_{-0.2}$ (2.5)
2YM15C with SD20		1.8 $^{0}/_{-0.2}$ (1.9)

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

[NOTICE]

The engine oil should not be overfilled to exceed the upper limit line. If engine oil is overfilled, the engine may intake the engine oil in the combustion chamber during the operation, and white smoke, oil hummer or urgent rotation may occur, because the blowby gas is reduced in the suction air flow.

2) Checking marine gear lube oil level

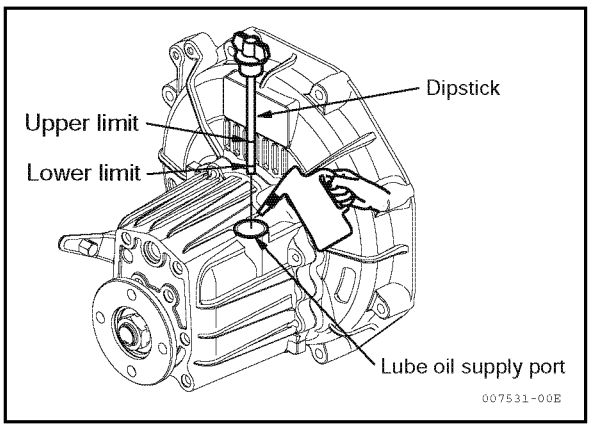
a) Check the lube oil level of the marine gear with a dipstick.

Unit: liter (pint)

Marine gear oil capacity	
KM2P-1	Full : 0.30 (0.64)

b) When the level is low, remove a oil filler cap at the top of the housing, and fill it with marine gear-clutch- lube oil to the upper limit on the dipstick.

c) Tighten the oil filler cap securely by hand.



(4) Seawater outlet

Check whether seawater comes out just after the engine has started.
If seawater doesn't come out, shut down the engine immediately.
Check the leakage of seawater in the seawater pass and the damage of the seawater pump impeller.

(5) Check cooling water level

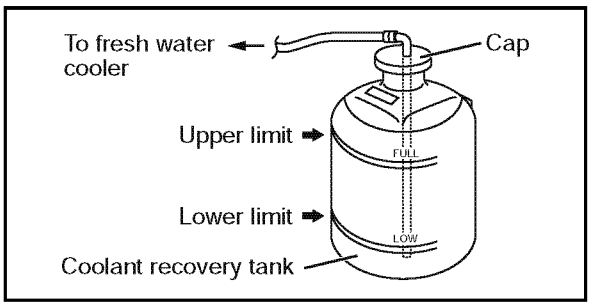
Daily inspection of cooling water should be done only by coolant recovery tank.

⚠ WARNING

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

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

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



2) Replenishing engine with water
If the cooling water leveling the coolant recovery tank is lower than the LOW mark, open the filler cap and check the cooling water level in the coolant tank. Replenish the engine with the cooling water, if the level is low.

- Check the cooling water level when the engine is cool.
  Checking when the engine is hot is dangerous. And the water volume is expanded due to the temperature.
- Daily cooling water level check and replenishing shall be done only at the coolant recovery tank. Usually do not open the filler cap to check or replenish.

Standard

Cooling water volume Unit : liter (quart)

Model	Engine	Coolant recovery tank
3YM30	4.9 (5.2)	0.8 (0.8)
3YM20	4.1 (4.3)	0.8 (0.8)
2YM15	3.0 (3.2)	0.8 (0.8)

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

(6) Check the alarm lamps & devices

Before and after starting the engine, check to see that the alarm functions normally. Failure of alarm cannot warn the lack of the engine oil or the cooling water. Make it a rule to check the alarm operation before and after starting engine every day.
When the sensor detects a problem during operation, the lamp comes on and the buzzer goes off.
Alarm lamps are located on the panel, buzzer is located on the back of panel.
Under normal conditions, the monitors are off. When there is a problem, the monitors light up.

	Battery low charge alarm	When the alternator output is too low, the lamp will come on. When charge begins, the lamp will turn off. (The alarm buzzer will not sound, when the lamp comes on.)
	Coolant high temperature alarm	When the temperature reaches the maximum (95°C [203F] or higher), the lamp will light. Continuing operation at temperatures exceeding the maximum limit will result in damage and seizure. Check the load and the fresh water cooling system for any abnormalities.
	Lubricating oil low pressure alarm	When the lube oil pressure falls below normal, the oil pressure sensor will register this and the lamp will come on and alarm will sound. Continuing operation with insufficient oil pressure will result in damage and seizure. Check the oil level.
	Water in sail drive seal alarm	When seawater is detected between the seals of sail drive, the lamp will come on and the alarm will sound.

Normal action of alarm devices
Alarm devices act as shown below. Check that the alarm lamps and buzzer are working normally, when the key is turned on.

Key switch		OFF → ON	START → ON
Engine		Before start	Running
Alarm buzzer		Goes on	Stop
Alarm lamps	Battery low charge alarm	Light	Off
	Coolant high temperature alarm	Off	Off
	Lube oil low pressure alarm	Light	Off
	Water in sail drive seal alarm	Off	Off

(7) Check the leakage of water, lube oil and fuel.

Before and after starting the engine, check the leakage of cooling water and seawater from cooling water system. Also check the leakage of lube oil and fuel.

(8) Check/adjust the remote control operation

Make sure that the accelerator of a boat can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever.

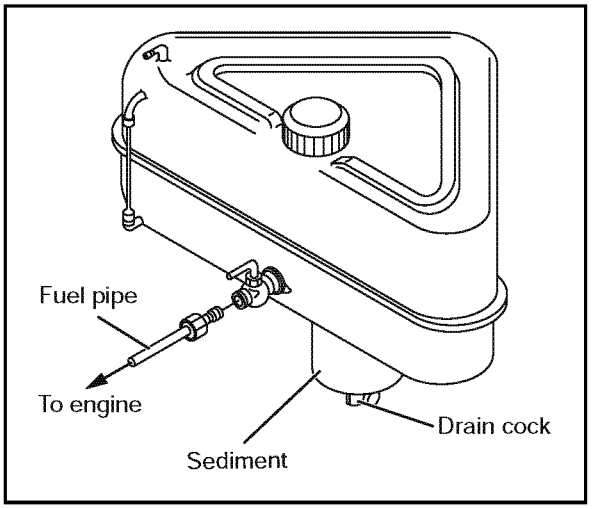
2.2.2 inspection after initial 50 hours or one month operation

Be sure to check the following points after initial 50 hours or one month operation, whichever comes first.

No.	Inspection Item
(1)	Drain the fuel tank
(2)	Replace the engine lube oil and the lube oil filter
(3)	Replace the marine gear & sail drive lube oil
(4)	Adjust the tension of the alternator driving belt
(5)	Adjust the intake/exhaust valve clearance
(6)	Check/adjust the remote control operation
(7)	Adjust the propeller shaft alignment

(1) Drain the fuel tank

1) Put a pan under the drain cock to catch the fuel.
2) Open the drain cock and drain off any water or dirt collected.
3) When the water and dirt are drained off and the fuel comes out, close the drain cock.



(2) Replace the engine lube oil and the lube oil filter.

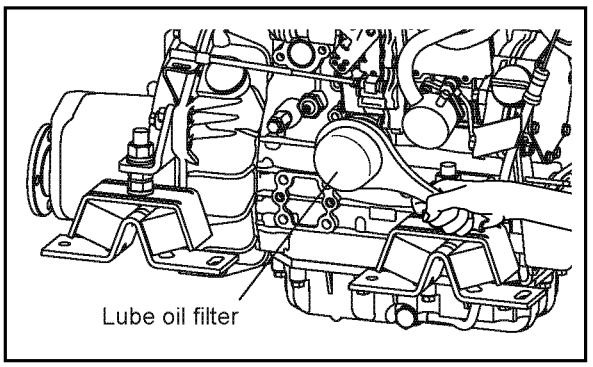
During the operation of an engine, the oil is quickly contaminated due to the initial wear of internal parts. The lube oil must therefore be replaced early. It is easiest and most effective to drain the engine lube oil after operation while the engine is still warm.
Replace the lube oil filter at the same time.

⚠ CAUTION Beware of oil splashes if extracting the Lube oil while it is hot

1) Remove the lube oil dipstick and also the oil filler cap at the top of the rocker arm cover. Attach the oil drain pump to the dipstick guide and drain off the lube oil.

[Notice]
For easier draining, remove the oil filler cap (yellow) at the top of the rocker arm cover.
When lube oil is absorbed without removing a oil filler cap, negative pressure grows big in the crankcase and it may cause the rubber of the diaphragm cracked.

2) Turn the lube oil filter counter-clockwise using a filter wrench to remove it.



3) Moisten the new oil filter gasket with the lube oil and install a new lube oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.
Tightening torque: 20-24N•m (177-212 lb-in)

Applicable oil filter Part No.
119305-35150

4) Fill with new lube oil.
5) Perform a trial run of the engine and check the oil leakage.
6) Approximately 10 minutes after stopping the engine, check the oil level by using the oil dipstick. Add oil if the level is too low.

Standard

The level shall be between the upper and lower limit lines on the dipstick.

Unit : liter (quart)

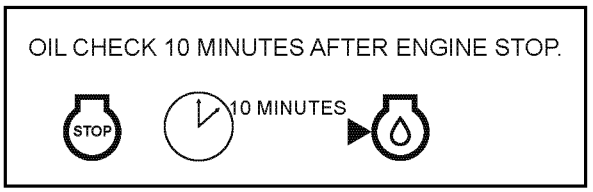
Model	Rake angle	Engine oil capacity (Full)
3YM30 with KM2P-1	8 degree	2.8 $^{0}/_{-0.2}$ (3.0)
3YM20 with KM2P-1		2.7 $^{0}/_{-0.2}$ (2.9)
2YM15 with KM2P-1		2.0 $^{0}/_{-0.2}$ (2.1)
3YM30C with SD20	0 degree	2.5 $^{0}/_{-0.2}$ (2.6)
3YM20C with SD20		2.4 $^{0}/_{-0.2}$ (2.5)
2YM15C with SD20		1.8 $^{0}/_{-0.2}$ (1.9)

[Notice]

When checking the lube oil level right after the engine running, the oil level in the dipstick guide decreases drastically, and the accurate oil measurement can't be performed because the pressure in the cylinder block decreases with the function of the diaphragm in the rocker arm cover. Therefore, measure the lube oil level about 10 minutes later after stopping the engine or after removing the oil filler cap.

Note:

The yellow label shown right is attached on the dipstick.



(3) Replace the marine gear lube oil.

During initial operation, the oil is quickly contaminated due to the initial wear of internal parts. The lube oil must therefore be replaced early.

1) Remove the cap from the filler port and attach the oil drain pump. Drain off the oil.
2) Fill with new lube oil.

Standard

Unit : liter (pint)

Marine gear oil capacity	
KM2P-1	Full: 0.30 (0.64)

3) Perform a trial run of the engine and check the oil leakage.

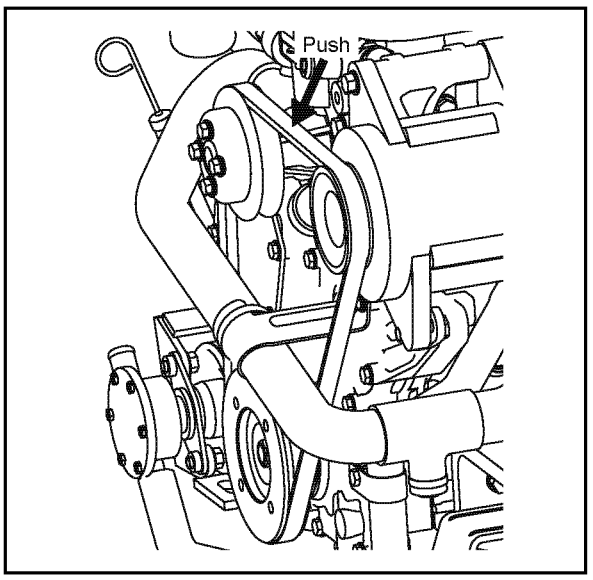
Refer to the sail drive operation manual for the procedure of replacing the sail drive lube oil.

Unit : liter (pint)

Sail drive oil capacity	
SD20	Full: 2.2 (4.7)

(4) Adjust the tension of the alternator drive belt

When there is not enough tension in the V-belt, it will slip and the cooling water pump will fail to supply cooling water. Engine over-heating and the seizure will occur.
When there is too much tension in the V-belt, the belt will become damaged more quickly and the bearing of the cooling water pump may be damaged.
Check and adjust the V-belt tension (deflection) in the following manner.



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

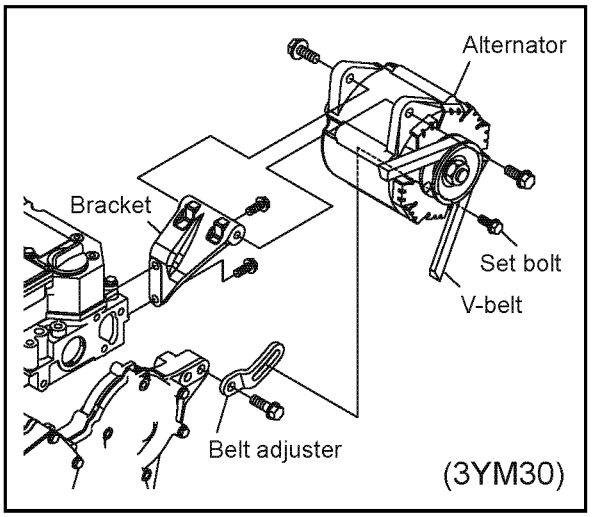
1) Remove the belt cover. Check the tension of the V-belt by pressing down on the middle of the belt with your finger [approx. 98N(10kgf)].

The specified deflection should be as follows.

For used V-belt	8-10 mm (0.315-0.393 inches)
For new V-belt	6-8 mm (0.236-0.315 inches)

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

2) If necessary, adjust the V-belt tension (deflection). To adjust the V-belt tension, loosen the set bolt for the belt adjuster and move the alternator to tighten the V-belt.
3) Visually check the V-belt for cracks, oiliness or wear. If any, replace the V-belt with new one.



[Notice]
When the V-belt will be replaced with new one, loosen the set bolt, move the alternator and also loosen the V-pulley set bolts for the cooling water pump. Remove the V-belt.

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

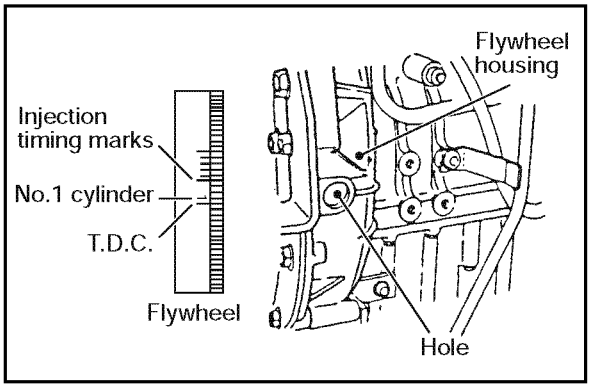
(5) Adjusting the intake/exhaust valve clearance

Make measurement and adjustment while the engine is cold.

1) Valve clearance measurement

a) Remove the rocker arm cover above cylinder head.

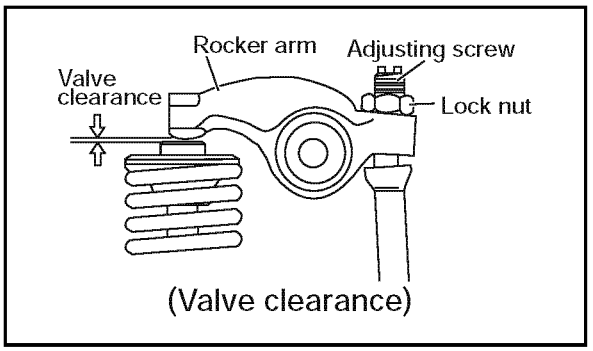
b) Set the No.1 cylinder in the compression TDC
Turn the crankshaft to bring the piston of the No.1 cylinder to its compression top dead center while watching the rocker arm motion, the timing mark of the flywheel housing and the top mark of the flywheel.
(Position where both the intake and exhaust valves are closed.)



(Notes)

- The crankshaft shall be turned clockwise as seen from the gear case side.
- The No.1 cylinder position is on the opposite side of the gear case.
- Since there is a clearance between the rocker arm and valve at the compression top dead center, the position of TDC can be checked by hand. Also see that the top mark on the flywheel aligns with the mark on the flywheel housing. If there is no valve clearance, disassemble and inspect around the valve seat, since the valve seat may be worn abnormally.

c) Valve clearance measurement
Insert a thickness gage between the rocker arm and valve cap, and record the measured valve clearance.
(Use it as the data for estimating the wear state.)



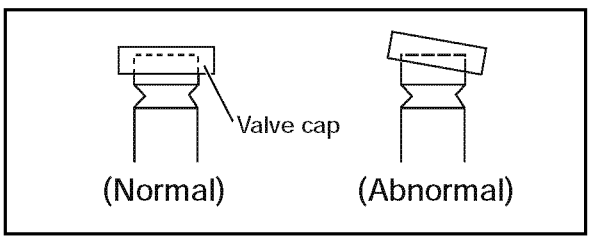
d) Adjusting other cylinders
Turn the crankshaft 240° and make adjustment for the No.3 cylinder. Then adjust the No.2 cylinder in this order.
The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 240° each time.

The adjustment method of reducing the flywheel turning numbers (for reference):
Set No.1 cylinder to the compression T.D.C. and adjust the clearance of the ● mark of the below table. Next, turn the flywheel once (the suction/ exhaust valve of No.1 cylinder is in the position of the overlap T.D.C. at this time), and adjust the clearance of the ○ mark.
Ignition order of 3 cylinder engines: 1 → 3 → 2

Cylinder No.	1		2		3		
Valve	Suction	Exhaust	Suction	Exhaust	Suction	Exhaust	
No.1 compression T.D.C	●	●	●			●	The first time
No.1 overlap T.D.C				○	○		The second time

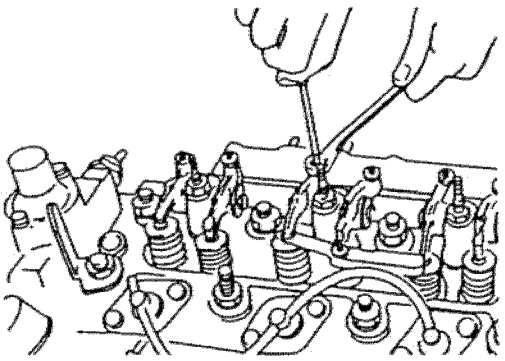
2) Valve clearance inspection and adjustment

a) Loosen adjusting bolts
Loosen the lock nut and adjust the screw. And check the valve for any inclination of valve cap, entrance of dirt or wear.



b) Measure valve clearance
Insert a 0.2 mm thickness gage between the rocker arm and valve cap, and adjust the valve clearance. Tighten the adjusting bolt.

Standard valve clearance (mm)
0.15-0.25



(Valve clearance adjustment)

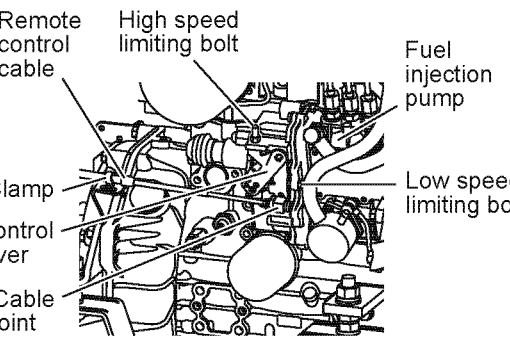
c) Apply oil to the contact surface between adjusting screw and push rod.

d) Adjusting other cylinders
Turn the crankshaft 240° then and make adjustment for the No.3 cylinder. Then adjust the No.2 cylinder in this order.
The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 240° each time.

(6) Check and adjust the remote control operation

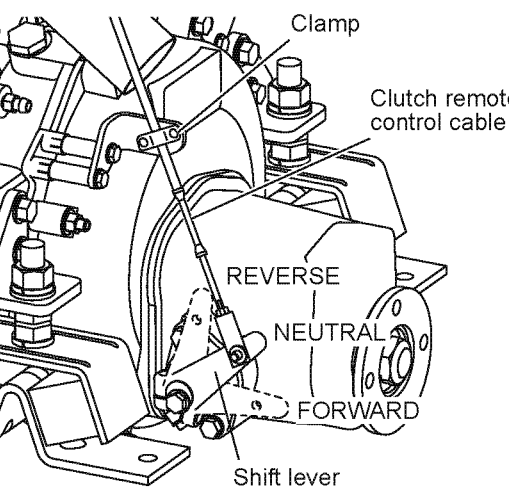
The various control levers on the engine side are connected to the remote control lever by the remote control cable. The cable will become stretched and the attachments loose after long hours of use causing deviation. It is dangerous to control operation under these conditions, and the remote control cable must be checked and adjusted periodically.

1) Adjusting the throttle remote control cable
Check to see that the control lever on the engine side moves to the high speed stop position and low speed stop position when the remote control lever is moved to H (high speed) and L (low speed) respectively.
When there is deviation, loosen the clamp for the remote control cable on the engine side and adjust.
Adjust the high speed stop position first and then adjust the low speed idling by the adjustment bolt on the remote control lever.



⚠ CAUTION Never adjust the high speed limiting bolt. This will void warranty.

2) Adjusting the clutch remote control cable
Check that the shift lever moves to the correct position, when the remote control handle is put in NEUTRAL, FORWARD and REVERSE position.
Use the NEUTRAL position as the standard for adjustment. When there is deviation, loosen the clamp for the remote control cable and adjust the shift lever position



(7) Adjust the propeller shaft alignment

The flexible engine mounts is compressed a little in the initial engine operation and it may cause the centering misalignment between the engine & the propeller shaft.

1) Check unusual noise and vibration of the engine / boat hull, while increasing the engine speed gradually and lowering it.
2) If there is unusual noise and/or vibration, adjust the propeller shaft alignment. (Refer to 6.4.5 "Centering the Engine" in the installation manual for pleasure boat use.)

2.2.3 Inspection every 50 hours or monthly

Be sure to check the following points every 50 hours or monthly, whichever comes first.

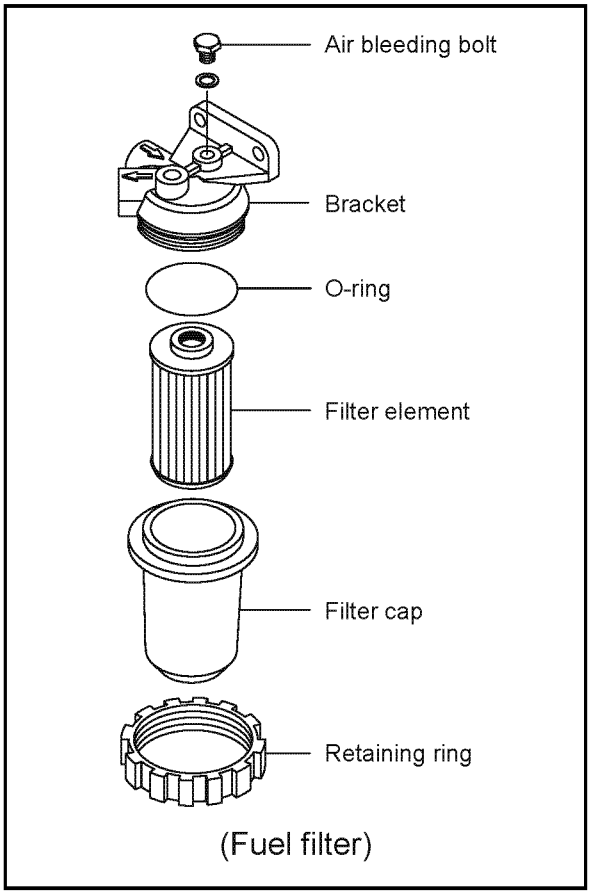
No.	Inspection Item
(1)	Drain the fuel filter
(2)	Check the electrolyte level in the battery

(1) Drain the fuel filter.

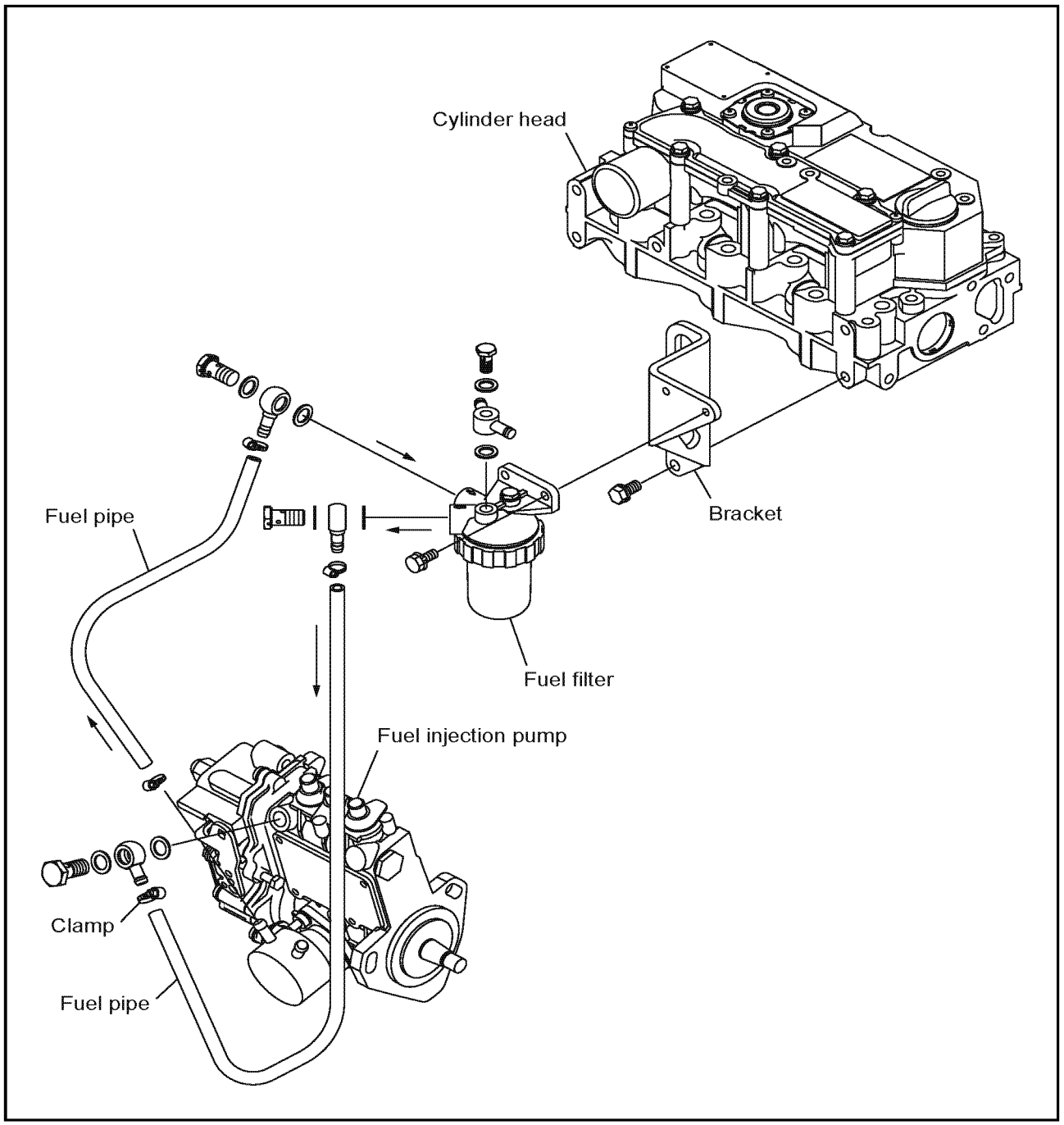
1) Close the fuel cock of a fuel tank.
2) Loosen the retaining ring and remove the filter cap. Drain off any water and dirt collected inside.
3) After reassembly, be sure to vent air from the fuel system.
   If air is in the fuel system, fuel cannot reach the fuel injection pump. Vent the air in the system according to the following procedures.

Fuel system air bleeding procedures

1) Check the fuel level in the fuel tank. Replenish if Insufficient
2) Loosen the air bleeding bolt at the top of the fuel filter by turning it 2 or 3 times.
3) Feed fuel with the fuel feed pump by moving the lever on the left side of the feed pump up and down.
4) Allow the fuel containing air bubbles to flow out from the air bleeding bolt hole. When the fuel no longer contains bubbles, tighten the air bleeding bolt. This completes the air bleeding of the fuel system.
5) After the engine start-up, the automatic air-bleeding device works to purge the air in the fuel system. No manual air-venting is required for normal engine operation.



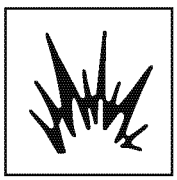
(Fuel filter)


Cylinder head
Bracket
Fuel pipe
Fuel filter
Fuel injection pump
Clamp
Fuel pipe

(2) Check the electrolyte level in the battery

Fire due to electric short-circuit

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



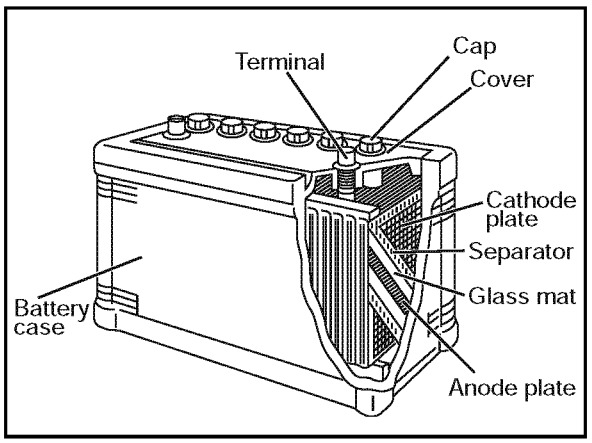
Proper ventilation of the battery area

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

Do not come in contact with battery electrolyte

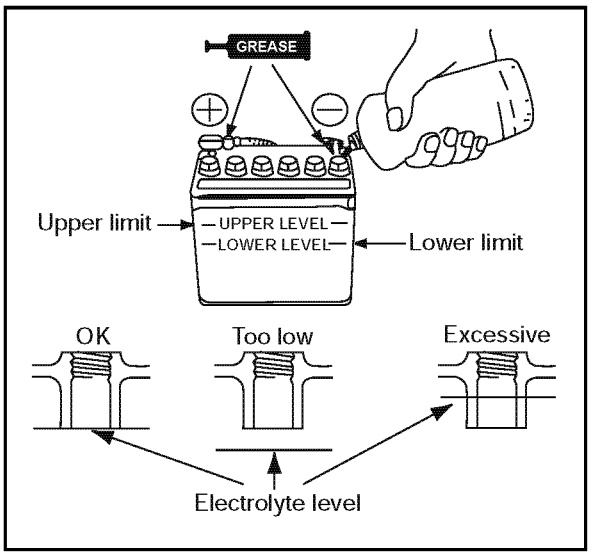
Pay sufficient attention to avoid your eyes or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

Battery structure



(1) Electrolyte level

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



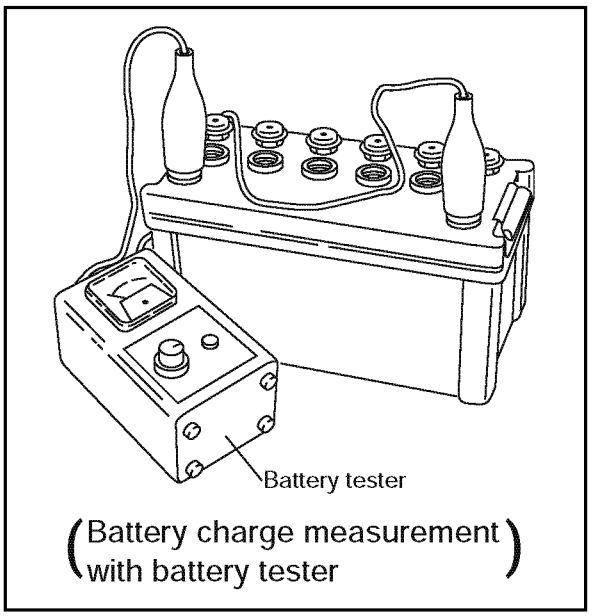
(2) Battery charge

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

(a) Measurement with a battery tester

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

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



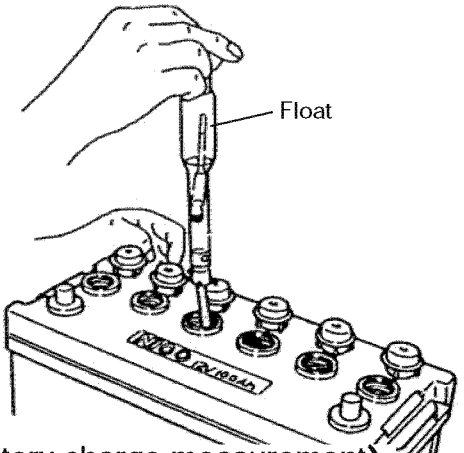
(Battery charge measurement with battery tester)

(b) Measurement with hydrometer

When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 20°C as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 1°C, correct the value according to the equation below.

$$S_{20} = St + 0.007 (t - 20)$$

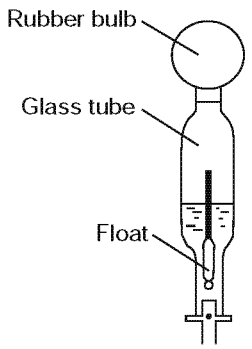
- S_{20}: Converted specific gravity at 20°C
- St: Specific gravity at measurement
- t: Electrolyte temperature at measurement



(Battery charge measurement with a hydrometer)

Specific gravity and remaining battery charge

Specific gravity (20°C)	Discharged quantity of electricity (%)	Remaining charge (%)
1.28	0	100
1.26	10	90
1.24	20	80
1.23	25	75



(Hydrometer structure)

(3) Terminals

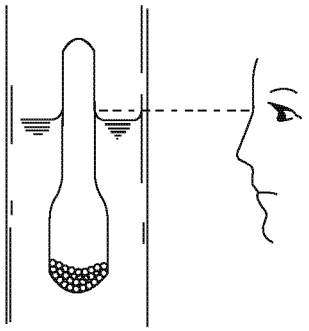
Clean if corroded or soiled.

(4) Mounting bracket

Repair or replace it if corroded.
Retighten if loosened.

(5) Battery appearance

Replace the battery if cracked or deformed.
Clean with fresh water if contaminated.



(How to read hydrometer)

2.2.4 Inspection every 100 hours six months

Be sure to check the following points every 100 hours or six months operation, whichever comes first.

No.	Inspection Item
(1)	Replace the lube oil in a sail drive.

(1) Replace the lube oil in a sail drive.

Refer to the sail drive operation manual for the procedure of replacing the oil.

2.2.5 Inspection every 150 hours or one year

Be sure to check the following points every 150 hours or one year operation, whichever comes first.

No.	Inspection Item
(1)	Replace the engine lube oil.
(2)	Replace the marine gear lube oil.

(1) Replace the engine lube oil

During the operation of an engine, the oil deteriorates by the high temperature of the engine and is contaminated due to the wear of internal parts. The lube oil must therefore be replaced periodically. It is easiest and most effective to drain the engine lube oil after operation while the engine is still warm.

⚠ CAUTION Beware of oil splashes if extracting the Lube oil while it is hot

1) Remove the lube oil dipstick and also the oil filler cap at the top of the rocker arm cover. Attach the oil drain pump to the dipstick guide and drain off the lube oil.

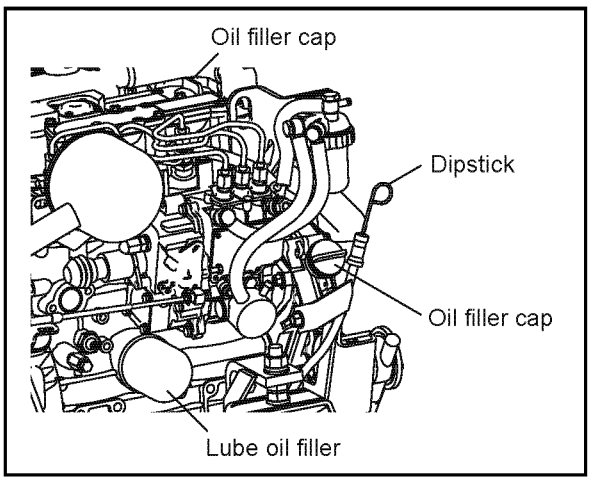
[Notice]

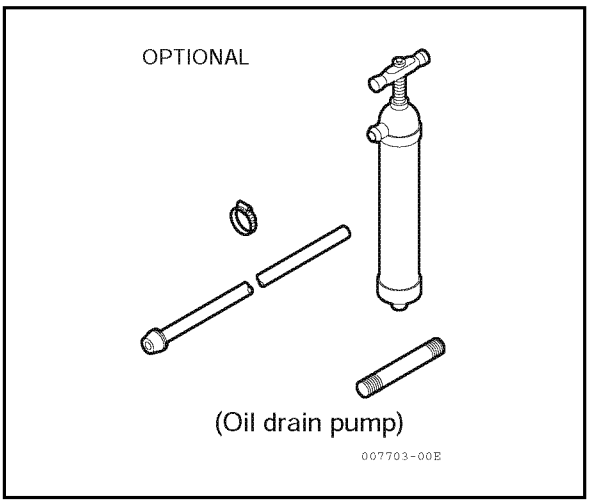
For easier draining, remove the oil filler cap (yellow) at the top of the rocker arm cover.
When lube oil is absorbed without removing a oil filler cap, negative pressure grows big in the crankcase and it may cause the rubber of the diaphragm cracked.

2) Fill with new lube oil.
3) Perform a trial run of the engine and check the oil leakage.
4) Approximately 10 minutes after stopping the engine, check the oil level by using the oil dipstick. Add oil if the level is too low.

Standard

The level shall be between the upper and lower limit lines on the dipstick.





Unit : liter (quart)

Model	Rake angle	Engine oil capacity (Full)
3YM30 with KM2P-1	8 degree	2.8 $^{0}/_{-0.2}$ (3.0)
3YM20 with KM2P-1		2.7 $^{0}/_{-0.2}$ (2.9)
2YM15 with KM2P-1		2.0 $^{0}/_{-0.2}$ (2.1)
3YM30C with SD20	0 degree	2.5 $^{0}/_{-0.2}$ (2.6)
3YM20C with SD20		2.4 $^{0}/_{-0.2}$ (2.5)
2YM15C with SD20		1.8 $^{0}/_{-0.2}$ (1.9)

[Notice]

When checking the oil level right after the engine running, the oil level in the dipstick guide decreases drastically, and the accurate oil measurement can't be performed because the pressure in the cylinder block decreases with the function of the diaphragm in the rocker arm cover. Therefore, measure the lube oil level after removing the oil filler cap or about 10 minutes later after stopping the engine.

(2) Replace the marine gear lube oil.

Refer to 2.2.2(3) for the procedure.

2.2.6 Inspection every 250 hours or one year

Be sure to check the following points every 250 hours or one year operation, whichever comes first.

No.	Inspection Item
(1)	Drain the fuel tank
(2)	Replace the fuel filter
(3)	Replace the marine gear lube oil
(4)	Replace the engine lube oil filter
(5)	Check the impeller of the cooling water pump (seawater pump)
(6)	Replace the fresh water coolant
(7)	Clean the element of the air intake silencer
(8)	Clean the exhaust/water mixing elbow
(9)	Adjust the tension of the alternator driving belt
(10)	Check the wiring connectors

(1) Drain the fuel tank

Refer to 2.2.2(1) for the procedure.

(2) Replace the fuel filter

Replace the fuel filter with new one at the specified interval, before it is clogged with dust to adversely affect the fuel flow. Also, replace the fuel filter after the engine has fully been cooled.

1) Close the fuel cock of the fuel tank.
2) Remove the fuel filter using a filter wrench (customer procured). When removing the fuel filter, hold the bottom of the fuel filter with a piece of rag to prevent the fuel oil from dropping.
3) Clean the filter mounting surface and slightly apply fuel oil to the gasket of the new fuel filter.
4) Install the new fuel filter manually turning until it comes into contact with the mounting surface, and tighten it further to one turn using a filter wrench.

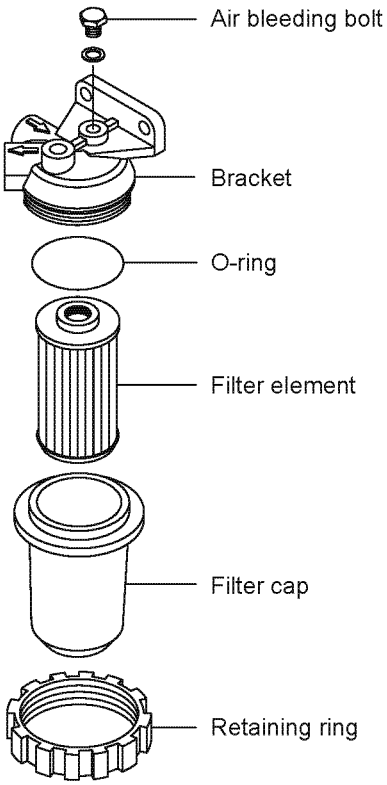
   Tightening torque: 20-24N•m

Applicable fuel filter element Part No.	O-ring Part No.
104500-55710	24341-000440

5) Bleed the fuel system. Refer to 2.2.3.(1).

IMPORTANT:

Be sure to use genuine Yanmar part (super fine mesh filter). Otherwise, it results in engine damage, uneven engine performance and shorten engine life.



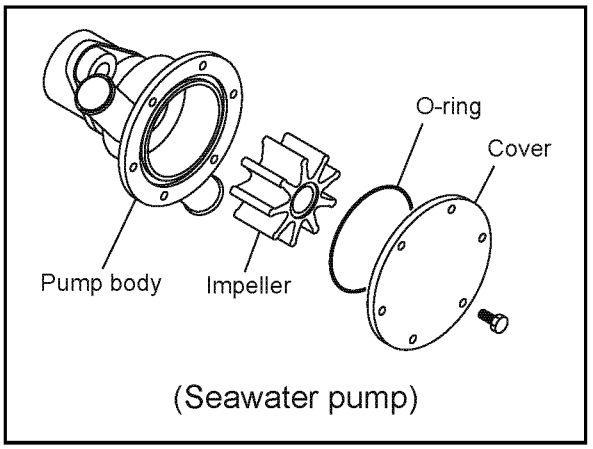
(Fuel filter)

(3) Replace the marine gear lube oil.
Refer to 2.2.2(3) for the procedure.

(4) Replace the engine lube oil filter.
Refer to 2.2.2(2) for the procedure.

(5) Check the impeller of the cooling water pump (seawater pump).

1) Remove the seawater pump cover and take out the O-ring, impeller and wear plate.
2) Inspect the rubber impeller, checking for splitting around the outside, damage or cracks, and replace if necessary.
Depending on the use, the inside parts of a seawater pump may deteriorate and the discharge performance may drop. At the specified interval or when the discharge volume of seawater is reduced, inspect the seawater pump in accordance with the following procedures.



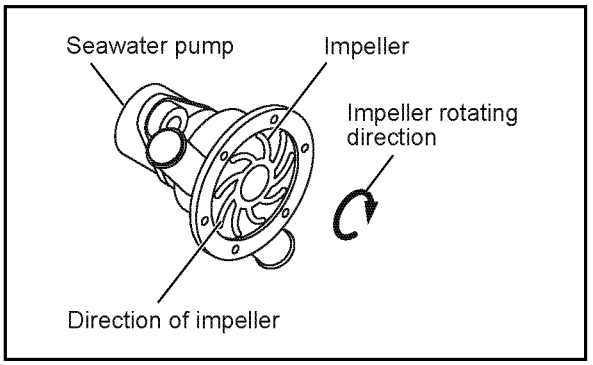
(Seawater pump)

a) Loosen the seawater pump cover set bolts and remove the cover.
b) Illuminate the inside of the seawater pump with a flashlight and inspect.
c) If no damage is found, reassemble the cover.
d) If any of the following problems are found, take out the O-ring and impeller. If necessary, replace with new one and reassemble the cover.
• Impeller blades are cracked or nicked. Edges or surfaces of the blades are marred or scratched.

Note: The impeller must be replaced periodically (every 1000 hrs or four years whichever comes first).

e) If a large amount of water leaks continuously from the water drain pipe beneath the seawater pump during engine operation, check the oil seal inside the seawater pump.

[Notice]
The seawater pump turns in the counterclockwise direction viewed from driving side. If the impeller has been removed for any reason and must be reassembled, be very careful not to make a mistake in impeller direction and turn it in the wrong direction. Additionally, if the engine is being turned manually, be careful to turn it in the correct direction. Incorrect turning will twist the impeller blades and damage it.



(6) Replace the fresh water coolant.

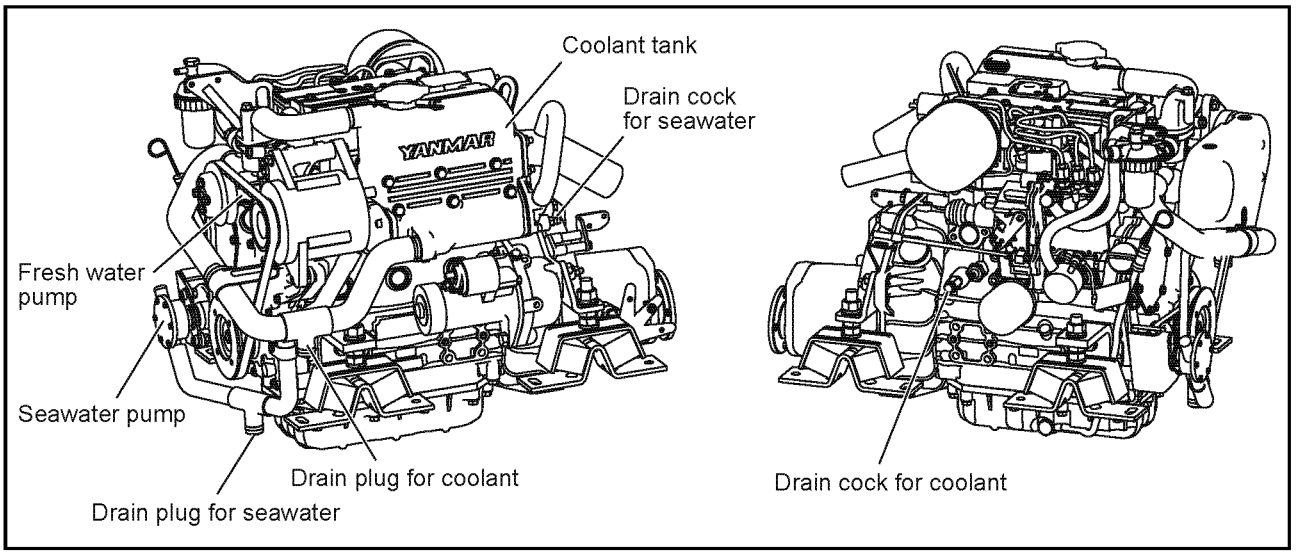
Be sure to replace the fresh water every year. When the long life coolant is used of the specified type, the replacement period of two years can be obtained.
Use clean soft water and be sure to add the Long Life Coolant Antifreeze (LLC) to the cooling water in order to prevent rust built up and freezing.
Cooling performance drops when cooling water is contaminated with rust and scale.
Even if antifreeze or antirust is added, the cooling water must be replaced periodically because the properties of the agent will degenerate.

1) Open the two cocks for fresh water and extract the fresh water.

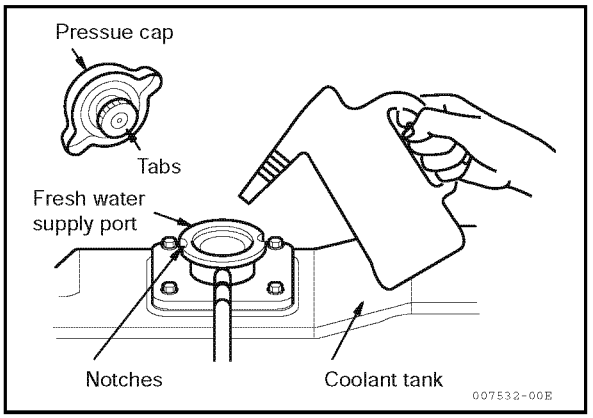
Note:
One drain cock is behind the belt cover. Remove the belt cover and open the cock.

2) Close the two cocks for fresh water.

Fresh water line	Seawater line
2	2



3) Remove the filler cap of the fresh water cooler by turning the cap counterclockwise 1/3 of a turn.



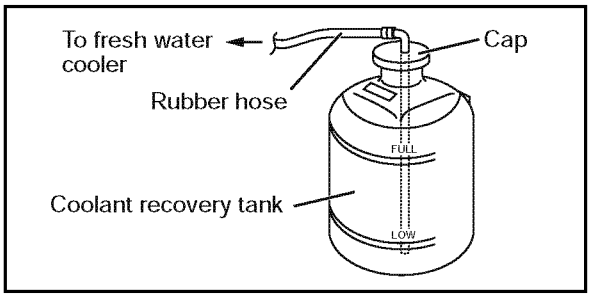
4) Pour cooling water slowly into the coolant tank so that air bubbles do not develop. Pour until the water overflows from the filler port.

⚠ WARNING If the filler cap is loose, hot steam and water will spout out which may cause burns.

5) After supplying cooling water, fit the filler cap and tighten it firmly. To reassemble the cap, align the tabs on the bottom of the cap with the notches on the filler port and turn clockwise 1/3 of a turn.
6) Remove the coolant recovery tank cap and fill with coolant mix to the lower limit. Replace the cap to the coolant recovery tank.

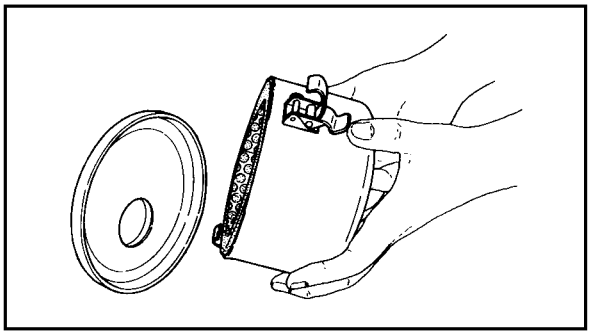
   Coolant recovery tank capacity: 0.8 L (1.7 pints)

7) Check the rubber hose connecting the coolant recovery tank to the fresh water cooler. Be sure the hose is securely connected and there is no looseness or damage.
   When the hose is not watertight, an excessive amount of cooling water will be used.

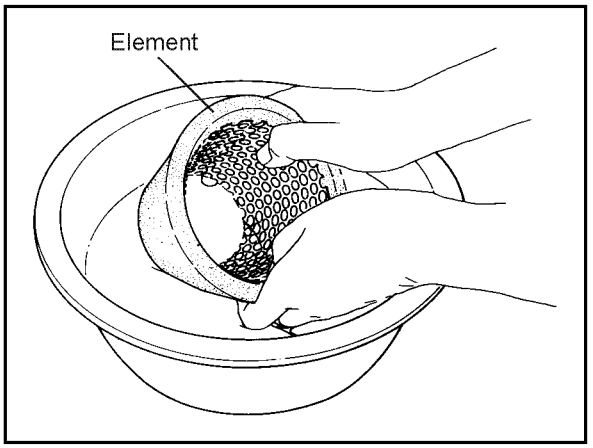


(7) Clean the element of the air intake silencer

1) Inspection of the intake silencer
   Occasionally, disassemble the intake silencer, remove the polyurethane element and inspect it. Because the element filters the air, if it is used over a long period of time it will become clogged and this decreases the amount of intake air, and may also be a cause of decreased output.

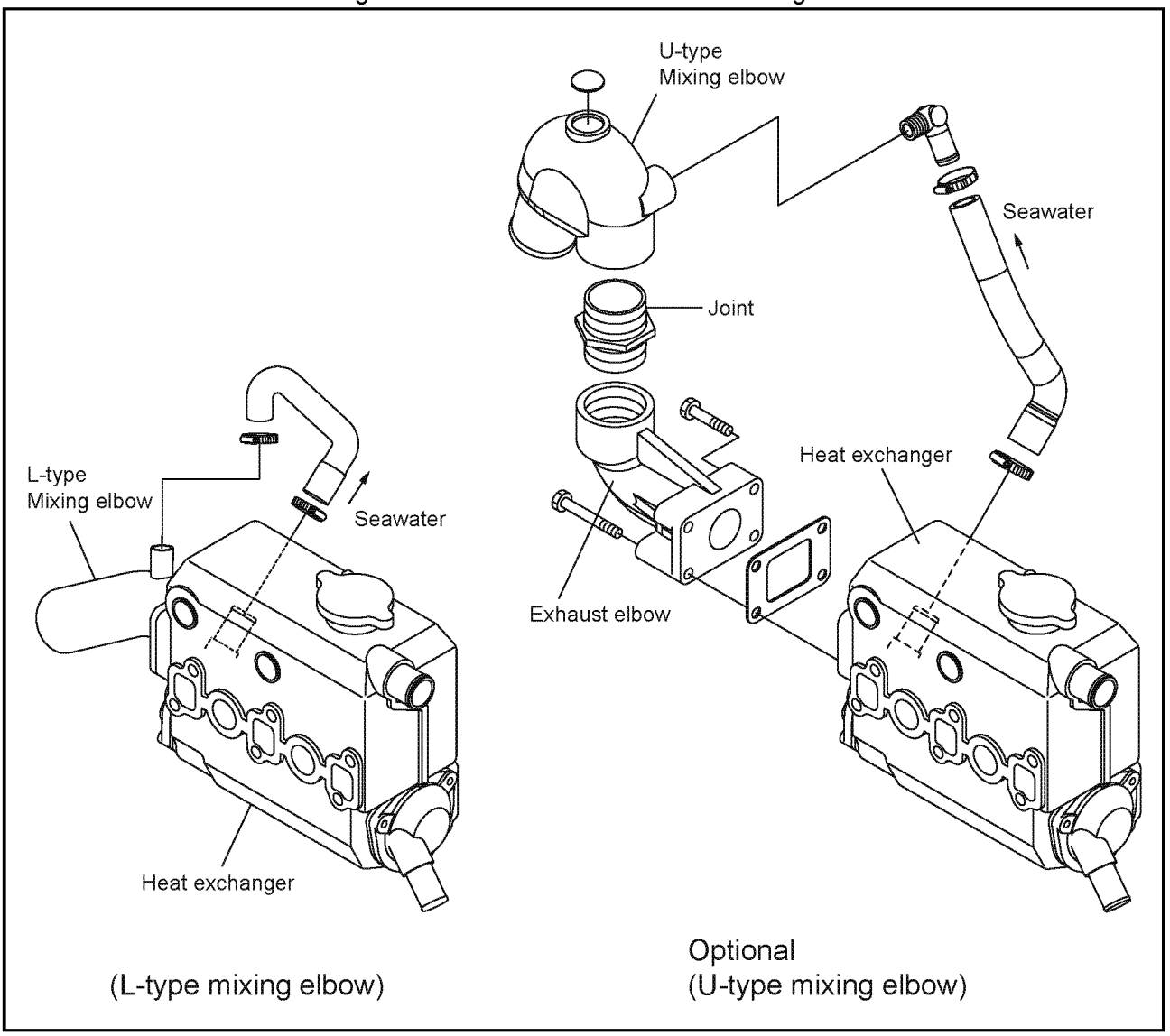


2) Washing the intake silencer element
   Wash the air intake silencer element with a neutral detergent.



(8) Clean the exhaust/water mixing elbow.

There are two types of mixing elbows, the L-type and the U-type. The mixing elbow is attached to the exhaust manifold. The exhaust gas is mixed with seawater in the mixing elbow.



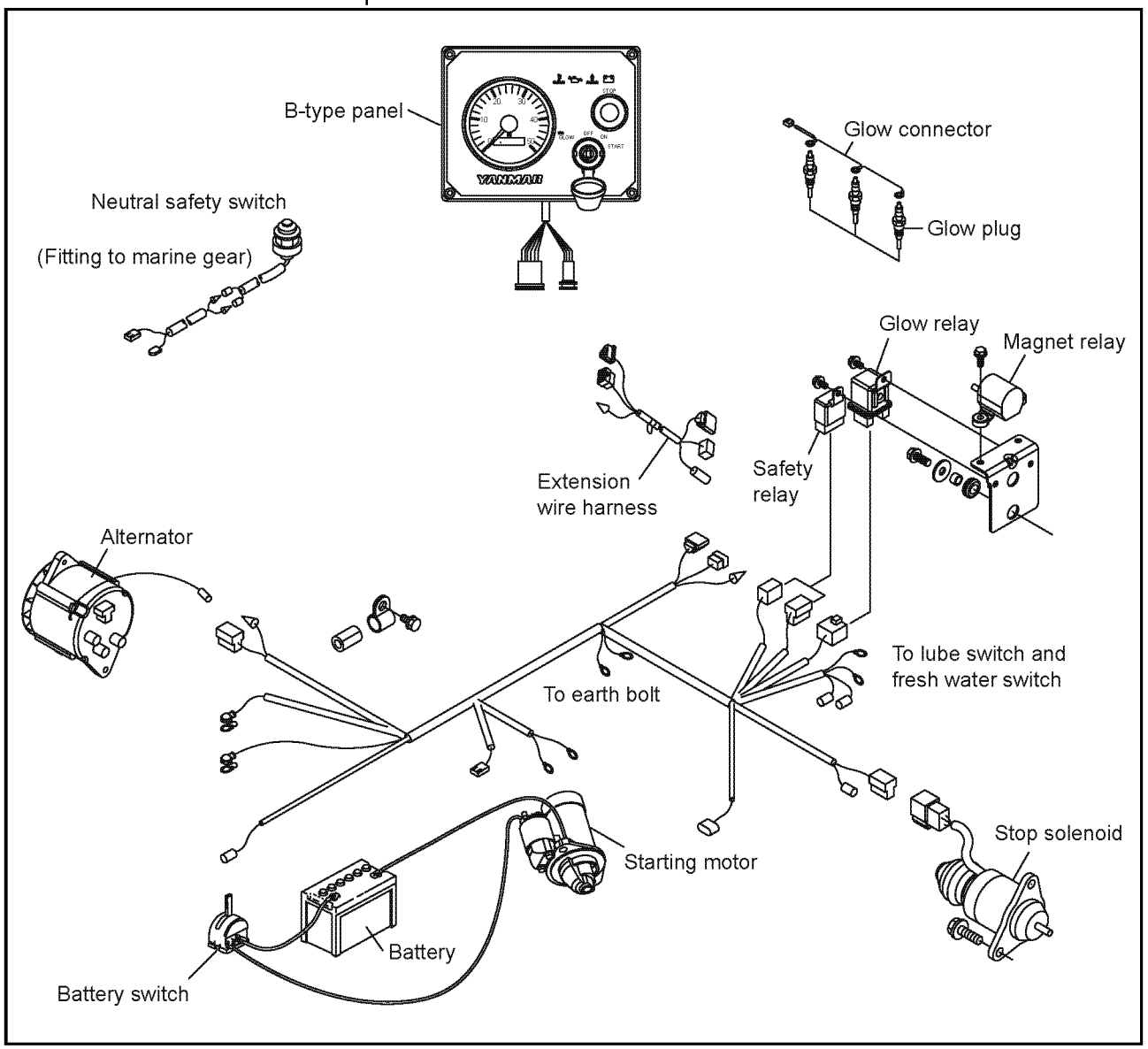
1) Clean dirt and scale out of the air pass and seawater pass of the mixing elbow.
2) Repair the crack or damage of the mixing elbow by welding, or replace if necessary.
3) Inspect the gasket and replace if necessary.

(9) Adjust the tension of the alternator driving belt.

Refer to 2.2.2(4).

(10) Check the wiring connectors.

Check whether each connection part doesn't have loosened.



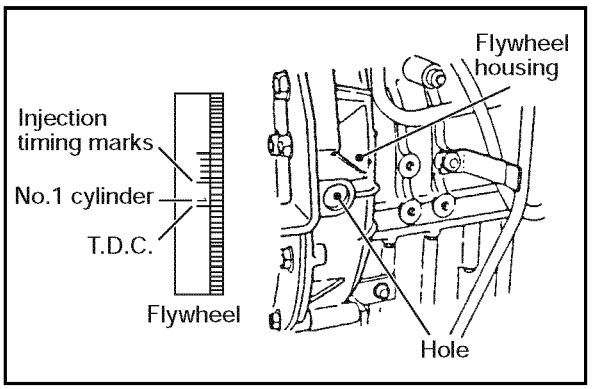
2.2.7 Inspection every 1,000 hours or four years

Be sure to check the following points every 1,000 hours or four years operation, whichever comes first.

No.	Inspection Item
(1)	Check the injection timing
(2)	Check the injection spray condition of a fuel nozzle
(3)	Check the impeller of the cooling water pump (seawater pump)
(4)	Clean & check the water passages
(5)	Diaphragm assembly inspection
(6)	Adjust the tension of the alternator driving belt
(7)	Retighten all major nuts and bolts
(8)	Adjust intake/exhaust valve clearance
(9)	Check/adjust the remote control operation
(10)	Adjust the propeller shaft alignment

(1) Check the injection timing

The fuel injection timing is adjusted so that engine performance may become the best condition. As for the inspection and adjustment of the fuel pump, it is based on the service manual of the ML pump. The fuel injection timing is adjusted by the following procedure.



1) Complete air bleeding from the fuel line and set the engine ready for starting.
2) See that the timing marks on fuel pump mounting flange and gear case are aligned.
3) Set the speed control lever at the operating position.
4) Disconnect the injection pipe on the fuel pump side for the No.1 cylinder. (Do not remove the delivery holder.)
5) Check the fuel discharge from the delivery holder while turning the crankshaft clockwise as seen from the radiator, and stop turning it at the same time when the fuel comes out. Wipe out the fuel of the delivery holder exit. Next, turn the crankshaft in the opposite direction (counterclockwise), and return it to about 20 degrees before top dead center.
6) Check again the fuel discharge from the delivery holder while turning the crankshaft clockwise, and stop turning it at the same time when the fuel comes out.
7) Read the timing scale on the flywheel from the hole on the flywheel housing. It is standard fuel injection timing if the timing mark position meets the fuel injection timing of the below table.

Model	Injection timing FID (FIC-Air) degree bTDC
3YM30	16 ± 1 (18 ± 1)
3YM20	22 ± 1 (24 ± 1)
2YM15	21 ± 1 (23 ± 1)

8) Repeat the step 5) to 7) a few times.

(Note)
Injection timing check for one cylinder is generally sufficient. If it is to be checked for all cylinders, check each cylinder in the ignition order of 1-3-2-1 (for 3 cyl. Eng.) or 1-2-1(for 2 cyl. Eng.).
The cylinder to be checked is not limited to the No.1 cylinder and any cylinder may be checked.

9) If the injection timing is out of the standard value, loosen the fuel pump mounting nut and incline the fuel injection pump toward or away from the engine for adjustment. Incline toward the engine to delay the timing, and away from the engine to advance it.

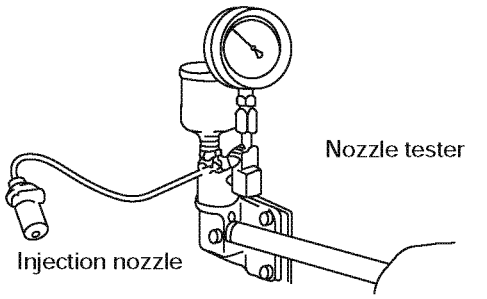
(2) Check the injection spray condition of a fuel nozzle

⚠ WARNING Wear protective glasses when testing injection from the fuel injection nozzle. Never approach the injection nozzle portion with a hand. The oil jetting out from the nozzle is at a high pressure to cause loss of sight or injury if coming into careless contact with it.

1) Injection pressure measurement

Standard fuel injection pressure

MPa (kgf/cm^2)
12.3-13.28 (125-135)



(Injection pressure measurement with nozzle tester)

[Notice]

As for the opening pressure of the brand-new fuel nozzle, about 0.5 MPa (5 kgf/cm) declines by the engine operation for about 5 hours because of the initial wear-out of a spring etc. Therefore, adjust 0.5 MPa (5 kgf/cm) higher than the standard value of the above table when adjusting a new fuel nozzle of a spare part.

Remove carbon deposit at the nozzle hole thoroughly before measurement.

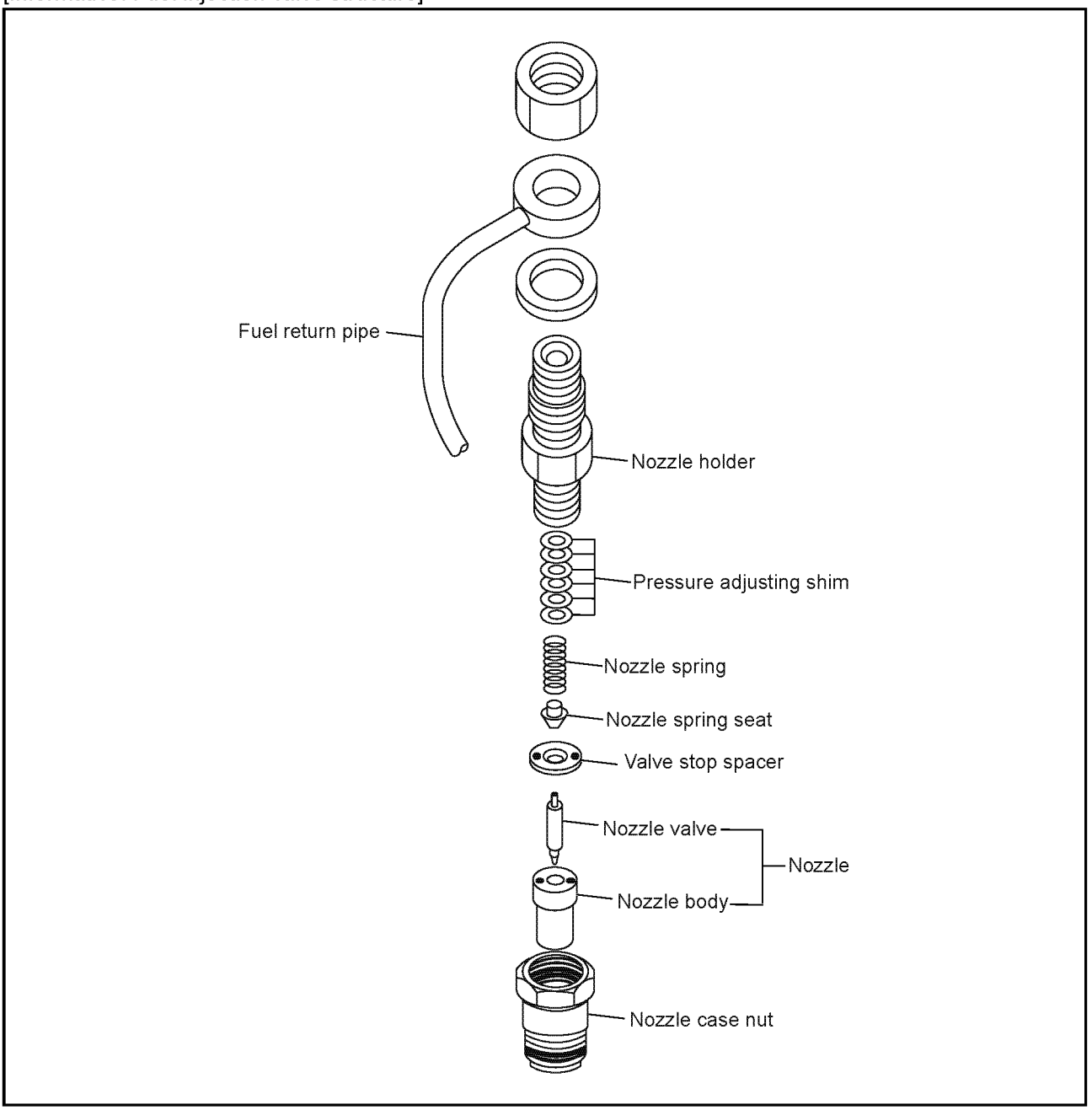
a) Connect the fuel injection valve to the high pressure pipe of the nozzle tester.

b) Operate the nozzle tester lever slowly and read the pressure at the moment when the fuel injection from the nozzle starts.

c) If the measured injection pressure is lower than the standard level, replace the pressure adjusting shim with a thicker one.

Thickness of pressure adjusting shims mm	Injection pressure adjustment
0.1, 0.2, 0.3, 0.4, 0.5, 0.52, 0.54, 0.56, 0.58, 0.8	The injection pressure is increased by approx. 1.1 MPa (11 kgf / cm^2), when the adjusting shim thickness is increased by 0.l mm.

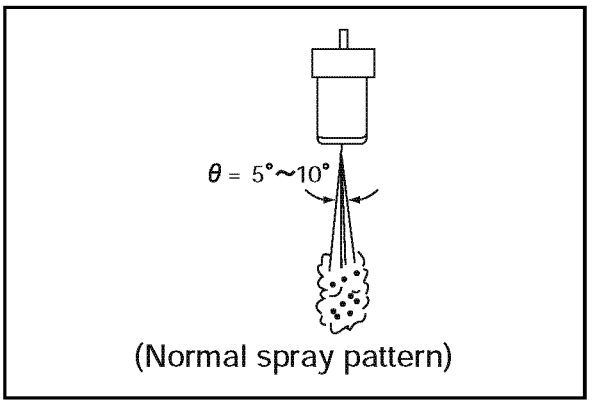
[Informative: Fuel injection valve structure]



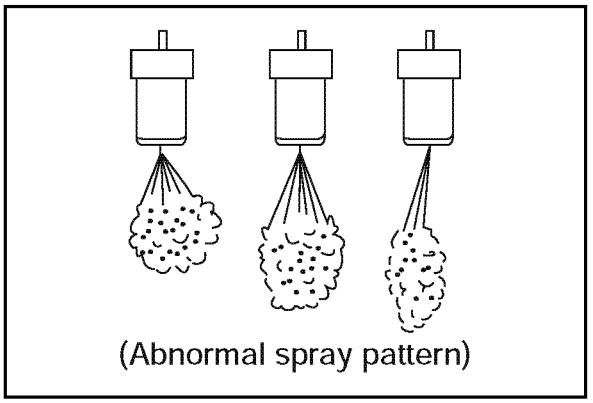
2) Spray pattern inspection
After adjustment to the specified valve opening pressure, use a nozzle tester and check the spray pattern and seat oil-tightness.

a) Seat oil tightness check
- After injecting a few times, increase the pressure gradually. Hold the pressure for about 5 seconds at a little before the valve opening pressure of 1.96 MPa (20 kgf/cm^2), and check to see that oil does not drip from the tip end of the nozzle.
- If extreme oil leak from the overflow joint exists during injection by the nozzle tester, check after retightening. If much oil is leaking, replace the nozzle assembly.

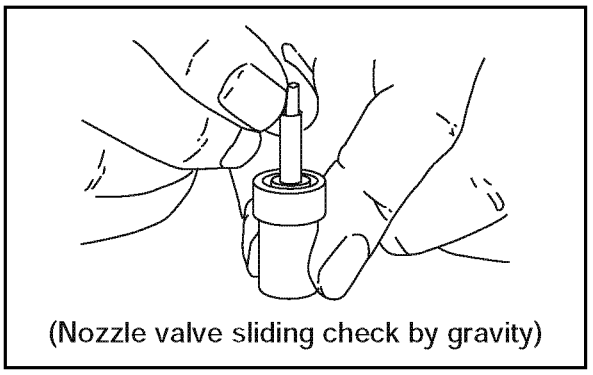
b) Spray and injection states
- Operate the nozzle tester lever at a rate of once or twice a second and check no abnormal injection.
- If normal injection as shown below cannot be obtained, replace the fuel injection valve.
- No extreme difference in angle(Θ)
- Finely atomized spray
- Excellent spray departure



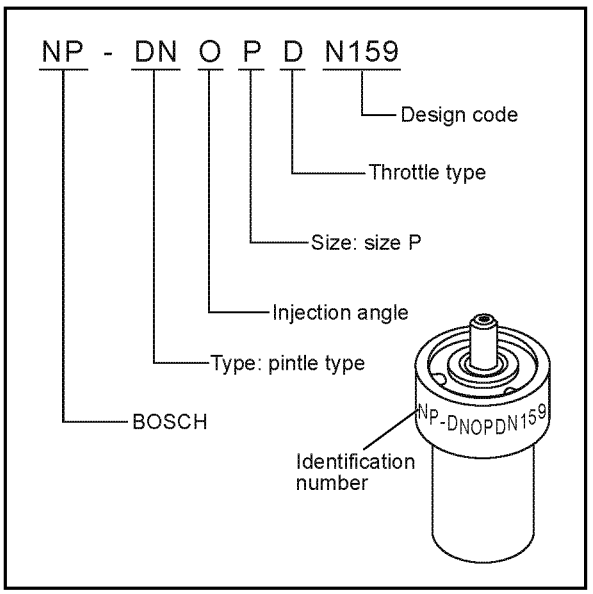
(Normal spray pattern)


(Abnormal spray pattern)

3) Nozzle valve sliding test
Wash the nozzle valve in clean fuel oil. Place the nozzle body vertically and insert the nozzle into the body to about 1/3 of its length. The valve is normal if it smoothly falls by its own weight into the body. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.


(Nozzle valve sliding check by gravity)

4) Nozzle punch mark



(3) Check the impeller of the cooling water pump (seawater pump)

The impeller must be replaced with new one periodically (every 1000 hrs or four years whichever comes first).
Refer to 2.2.5 (5) for the procedure.

(4) Clean & check the water passages

When it is used for a long time, cleaning of the cooling water passages is periodically necessary, because trash, scales, rust, and so on collect in the cooling water passages and the cooling performance declines.

(a) Cleaning and inspection of cooling water rubber hoses.

1) Remove the cooling water rubber hoses for the fresh water line and the seawater line.
2) Check the dust and trash inside the hoses. If necessary, clean it.
3) Check the crack and the deterioration of the rubber hoses. If necessary, replace with new ones.
4) Replace the used hose clips with new ones, if necessary.

(b) Heat exchanger inspection

1) Cooler core inspection
   a) Inspect the inside of the tubes for rust or scale buildup from seawater, and clean with a wire brush if necessary.

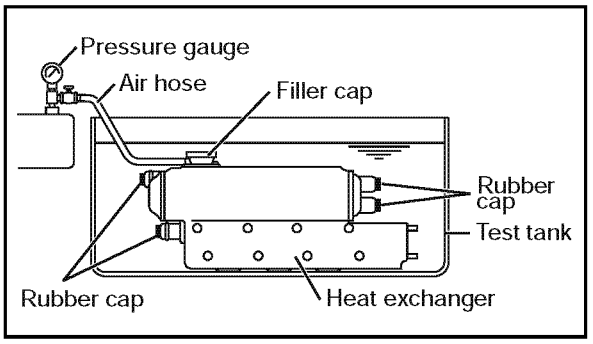
NOTE: Disassemble and wash when the cooling water temperature reaches 85°C.

   b) Check the joints at both ends of the tubes for looseness or damage, and repair if loose, Replace if damaged or corroded
   c) Check tubes and replace if leaking.
   d) Clean any scale or rust off the outside of the tubes.
2) Heat exchanger body inspection
   a) Check heat exchanger body and side cover for dirt and corrosion. Replace, if excessively corroded, or cracked.
   b) Inspect seawater and fresh water inlets and outlets, retighten any joints as necessary and clean the insides of the pipes.
   c) Check the exhaust gas intake flange and line, and replace if corroded or cracked.

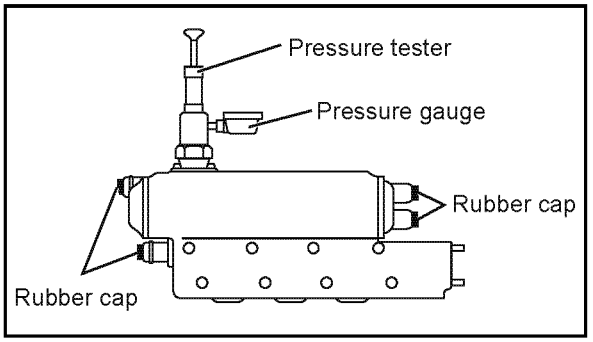
3) Heat exchanger body water leakage test

a) Compressed air/water tank test
Fit rubber covers on the fresh water and seawater inlets and outlets. Place the heat exchanger in a water tank, feed in compressed air from the overflow pipe and check for any (water) leakage, (air bubbles).

Test pressure	0.20 MPa (2 kgf/cm^2)



b) Use of the tester
Fit the fresh and seawater inlets and outlets with rubber covers and fill the fresh water tank with fresh water. Fit a pressure cap tester in place of the pressure cap, operate the pump for one minute and set the pressure at 0.15 Mpa (1.5 kgf/cm^2, 21.33 lb/in.^{2}). If there are any leaks the pressure will not rise. If there are no leaks the pressure will not fall.



4) Pressure cap inspection

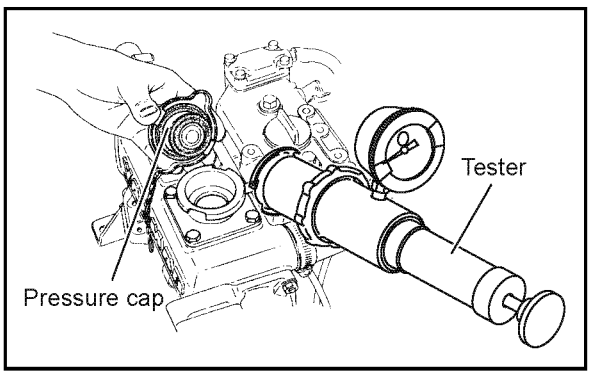
⚠ WARNING

Do not open the pressure cap while the engine is running or right after stopping because high temperature steam will be blown out. Remove the cap only after the water cools down.

a) Remove scale and rust and check the seat and seat valve, etc. for scratches or wear. Check the spring for corrosion or settling. Replace if necessary.

[NOTE]
Clean the pressure cap with fresh water as it will not close completely if it is dirty.

b) Fit the adopter on the tester to the pressure cap. Pump until the pressure gauge is within the specified pressure range 0.074-0.103 MPa (0.75-1.05 kgf/cm^2) and note the gauge reading. The cap is normal if the pressure holds for six seconds. If the pressure does not rise, or drop immediately, inspect the cap and repair or replace as necessary.



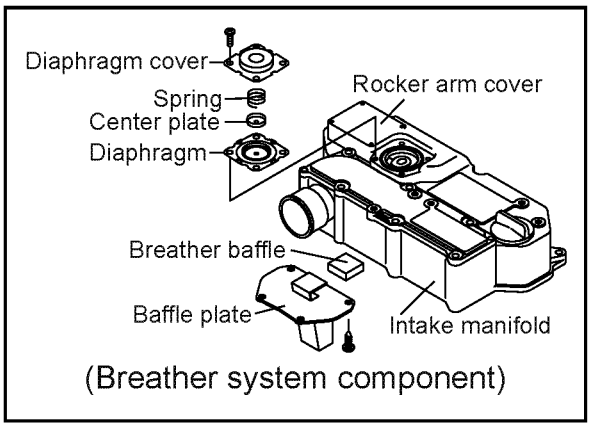
(5) Diaphragm assembly inspection

Inspect the diaphragm assy on the rocker arm cover.

1) Loosen screws, and remove a diaphragm assembly, and check whether oil and so on doesn't enter between the diaphragm and the cover. If oil and so on enters into the diaphragm assy, the diaphragm doesn't work well.
2) Check the damages of the diaphragm rubber and the spring. If necessary, replace with new ones.

[Notice]

1) When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles such as combustion defect and so on occur.



(Breather system component)

2) At lube oil replacement or lube oil supply, the amount of lube oil isn't to be beyond the standard upper limit. If the lube oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine, the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur.

(6) Adjust the tension of the alternator driving belt

Replace the alternator driving belt with new one every 1000 hours or four years, whichever comes first, even if there is no crack in the surface.
Refer to 2.2.2(4) for the procedure.

(7) Retighten all major nuts and bolts.

Retighten the major nuts and bolts bellow by the standard tightening torques. (See the table in 4.5.)

1) Cylinder head bolts
2) Crankshaft pulley bolts
3) Fuel injection nozzle set bolts
4) Fuel pump gear set bolts
5) Fuel injection line sleeve nut

Retighten the following major bolts as requested.

1) Rod bolts
2) Flywheel set bolts
3) Metal cap bolts

(8) Adjust intake/exhaust valve clearance.

Refer to 2.2.2(5) for the procedure.

(9) Check/adjust the remote control operation.

Refer to 2.2.2(6) for the procedure.

(10) Adjust the propeller shaft alignment.

1) The rubber tension of the flexible engine mounts is lost after many hours' use. This leads to a drop in vibration absorption performance, and also causes centering misalignment of the propeller shaft. (Refer to 5. "Flexible Engine Mount" in the installation manual for pleasure boat use.)

[Notice]

Be sure to replace the Yanmar flexible engine mounts every 1000 hours or 4 years, whichever comes first.

2) After replacing the flexible engine mounts, check unusual noise and vibration of the engine and the boat hull with increasing the engine speed gradually and lowering it.
3) If there is unusual noise and/or vibration, adjust the propeller shaft alignment. (Refer to 6.4.5 "Centering the Engine" in the installation manual for pleasure boat use.)