



M4.45

M-LINE Marine Diesel Engines

Operation manual

Operation manual



M2.13

M2.18

M3.29

M4.35

M4.45

M4.56

M3.28 SOLAS

M4.15 SOLAS

M4.17 SOLAS

M4.55 SOLAS

Serial numbers

Engine serial number Vetus:

.....

Engine serial number Mitsubishi:

.....

Gearbox serial number:

.....

Please enter the serial numbers here.

These numbers should be quoted when inquiring about Customer Service, Repairs or Spare Parts (see page 6).

We reserve the right to make any changes without previous notice.

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Please read and observe the information given in this operation manual. This will enable you to avoid accidents, preserve the manufacturer's warranty and maintain the engine in peak operating condition.

Make sure that the manual will remain intact and damage is prevented. Keep the manual away from humidity and heat.

Do not alter the content of the manual.

The manual is an integral part of the engine. Hand over the manual to the new owner if boat or engine is being sold.

For the Guarantee Conditions, see the Vetus Diesel 'Service and Warranty Manual' (320199.06).

This engine has been built exclusively for the application specified in the scope of supply and is to be used only for the intended purpose. Any use exceeding that scope is considered to be contrary to the intended purpose. The manufacturer will not assume responsibility for any damage resulting therefrom. The risks involved are to be borne by the user.

Use in accordance with the intended purpose also implies compliance with the conditions laid down by the manufacturer for operation, maintenance and servicing. The engine should only be operated, maintained and serviced by persons which are familiar with the former and the hazards involved.

The relevant accident prevention guidelines and other generally accepted safety and industrial hygiene regulations must be observed.

Unauthorized engine modifications will invalidate any liability claims against the manufacturer for resultant damage.

Manipulations of the injection and regulating system may also influence the performance of the engine, and its emissions. Adherence to legislation on pollution cannot be guaranteed under such conditions.

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1 Safety measures

Warning indications

Warning indications

The following warning indications are used in this manual in the context of safety:



DANGER

Indicates that great potential danger exists that can lead to serious injury or death.



WARNING

Indicates that a potential danger that can lead to injury exists.



CAUTION

Indicates that the usage procedures, actions etc. concerned can result in serious damage to or destruction of the engine. Some CAUTION indications also advise that a potential danger exists that can lead to serious injury or death.



NOTE

Emphasises important procedures, circumstances etc.

Symbols



Indicates that the relevant procedure must be carried out.



Indicates that a particular action is forbidden.

Pass the safety precautions on to other people who will use the engine.

General rules and laws concerning safety and accident prevention must always be observed.

1 Safety measures



FIRE RISK!

- Do not smoke if refuelling.
- Avoid spilling fuel on hot surfaces. Spilled fuel must be cleaned up immediately.
- Do not use petrol or diesel to clean components but make use of good quality, non-flammable, non-poisonous solvents that are available from dealers.
- Always be alert to possible fuel or oil leakage!
If you discover a leak, take counter-measures immediately. If fuel or oil is spilled on a hot engine, fire can break out. This can cause physical injury or damage to the equipment.
- Do not fill the fuel tank while the engine is running!
Only refuel with the engine stopped.
- Never put flammable materials in the vicinity of the engine!
- Keep the engine and engine compartment clean!
Remove all inflammable materials such as fuel, oil and other litter before it builds up in the vicinity of the engine.

Preventing fire and explosion

- Connecting (emergency) extra starting battery
Proceed as follows when an extra starting battery is used to jump start the engine:
 - First connect the positive lead
 - Lastly connect the earth cable (negative pole) to the engine block
- If this cable is connected in error to the negative pole of the engine battery, a spark can occur. The result of this could be that explosive gas produced by the battery explodes.**
- Once the engine is started, first remove the earth cable.

1 Safety measures

Prevention of injury

- The moving parts of the engine are dangerous. Never touch moving parts of the engine while it is running, to prevent cuts and other injuries.
- Stop the engine before carrying out maintenance!
- Always stop the engine before topping up or replacing fuel, oil or coolant.
- Before carrying out inspection or maintenance, the ignition key must be removed and the main battery switch turned off.
- Satisfy yourself that everything is in order before the engine is started again! Make sure that no-one is working on or close to the engine before you start it. Remove all foreign objects from around the engine, such as litter, oil, tools and other components that are not part of the engine.
- Install all protective covers! To prevent injury, make sure that all protective covers and cover plates are replaced over moving parts.
- Remove any tool used to turn the engine over. If you leave this in position, serious injury or damage to the equipment can result.
- NEVER open the cap of the expansion tank when the engine is at working temperature.
- Only check the coolant level after the engine has been stopped and the filler cap on the heat exchanger is cool enough to be removed with bare hands.
- Never attempt to adjust the fan belt on a running engine.

1 Safety measures

Prevention of injury

- Be careful with battery acid!
If battery acid comes in contact with the eyes or skin, rinse the affected part immediately with copious amounts of water. If battery acid comes in contact with the eyes, rinse them out immediately with plenty of water and consult a doctor.
- Be careful with antifreeze!
If you accidentally swallow antifreeze, make yourself vomit and consult a doctor immediately. If antifreeze comes in contact with your eyes, wash them out immediately with plenty of water and consult a doctor.
- Make sure that you are wearing suitable clothing before starting work!
For your own safety you will most likely need special equipment – safety helmet, eye protection, safety boots, safety goggles, heavy gloves, ear protectors etc. Use them when necessary.
- Carry out maintenance procedures safely by only using suitable tools.
- Exhaust gases
Do not start the engine if the exhaust system is not connected.

1 Safety measures

When problems occur

When the engine stops suddenly:

If the engine stops suddenly, do not start it again immediately. Track down the cause and carry out the necessary repairs before you start the engine again. If you do not do this, serious engine problems can develop.

If the oil pressure is too low:

Stop the engine immediately and check the lubrication system. Running an engine with low oil pressure can cause bearing and other parts to seize.

If the engine overheats:

If the engine should overheat, do not switch it off immediately. If an overheated engine is stopped suddenly, this can cause the coolant temperature to rise rapidly and moving parts to seize. First let the engine run in neutral to allow the hot parts of the engine to cool down, stop the engine and allow it to cool, and then gradually top up the coolant. Remember: adding coolant to an overheated engine can cause damage to the cylinder head.

If the fan belt is broken:

Immediately stop the engine. If an engine is used with a broken fan belt, this can lead to the engine overheating, which in turn can cause coolant to spray out of the expansion tank.

If the engine behaves strangely:

Stop the engine or reduce the speed as far as possible.
Do not use the engine again until the cause of the defect has been solved.

2 Introduction

Dear customer,

Vetus diesel engines are designed both for pleasure craft and commercial craft. Consequently, a wide range of variants are offered to meet the requirements of specific cases.

Your engine is appropriately equipped for your vessel, which means that not necessarily all components described in this manual are mounted to your engine.

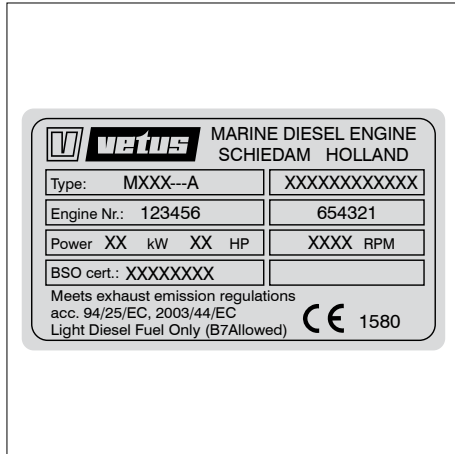
We have endeavoured to highlight any differences so that you will be able to locate the operating and maintenance instructions relevant to your engine quickly and easily.

Please read this manual before starting your engine and always observe the operating and maintenance instructions.

We are available to help with any additional inquiries.

Sincerely,
Vetus b.v.

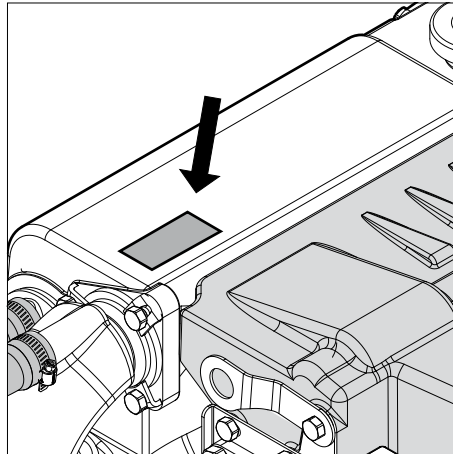
2 Introduction



1 Engine data tag

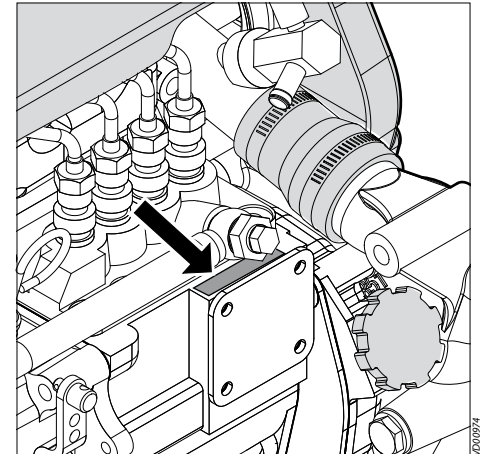
The Vetus engine serial number and performance data are printed on the engine data tag.

Model and engine serial number must be given when ordering spare parts.



2 Engine data tag location

The type plate is positioned as shown.

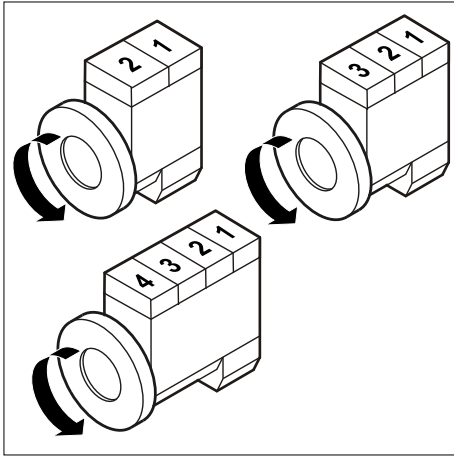


3 Engine serial number

The Mitsubishi engine serial number is stamped on the fuel injection pump.

**Data tag
Serial number**

2 Introduction



4 Cylinder numbering and direction of rotation

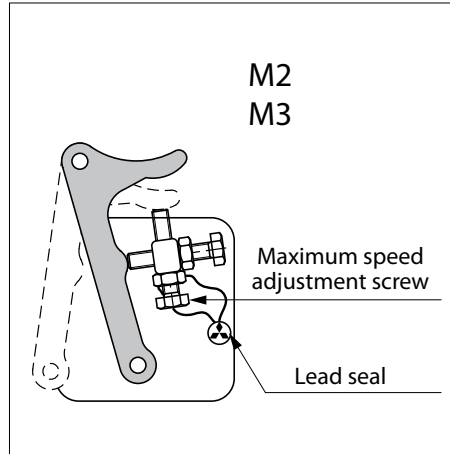
Cylinder numbering

Cylinders are numbered consecutively, beginning at the front end.

Direction of rotation

The direction of rotation is viewed towards the flywheel counter clockwise.

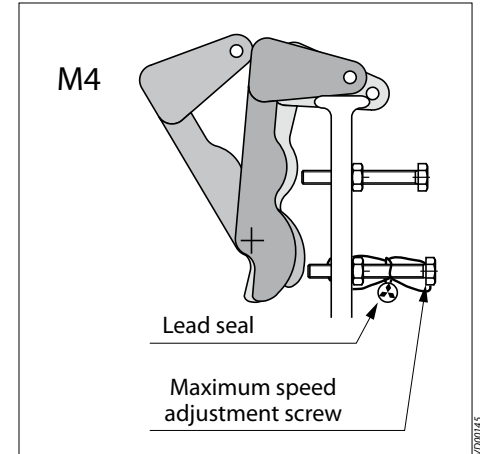
Cylinder numbering and direction of rotation Fuel pump seal



5 Fuel pump seal



Breaking the seals on the regulator to alter the settings of maximum rpm and maximum injector volume may only be carried out by authorised Vetus Service personnel.



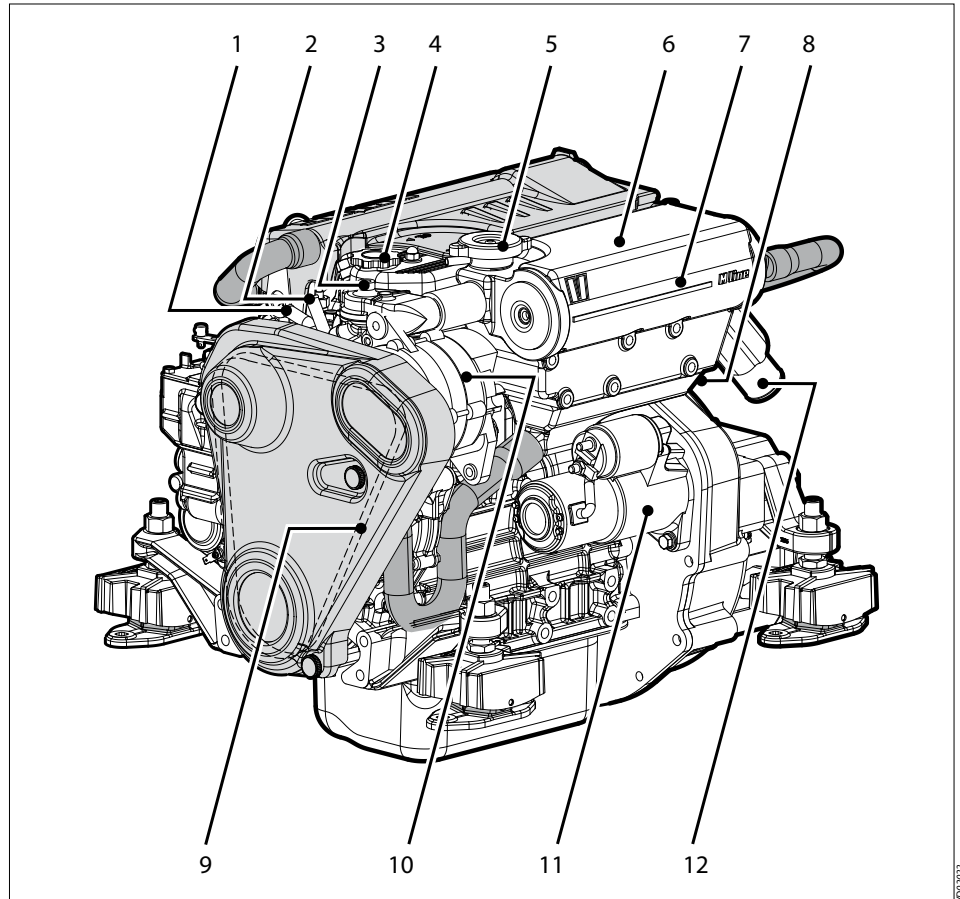
Breaking the seals and altering the settings can lead to:

- Accelerated wear of engine components.
- Increased fuel and oil consumption.
- Incorrectly adjusted injector volume and poor engine performance.
- Breaking emission regulations.

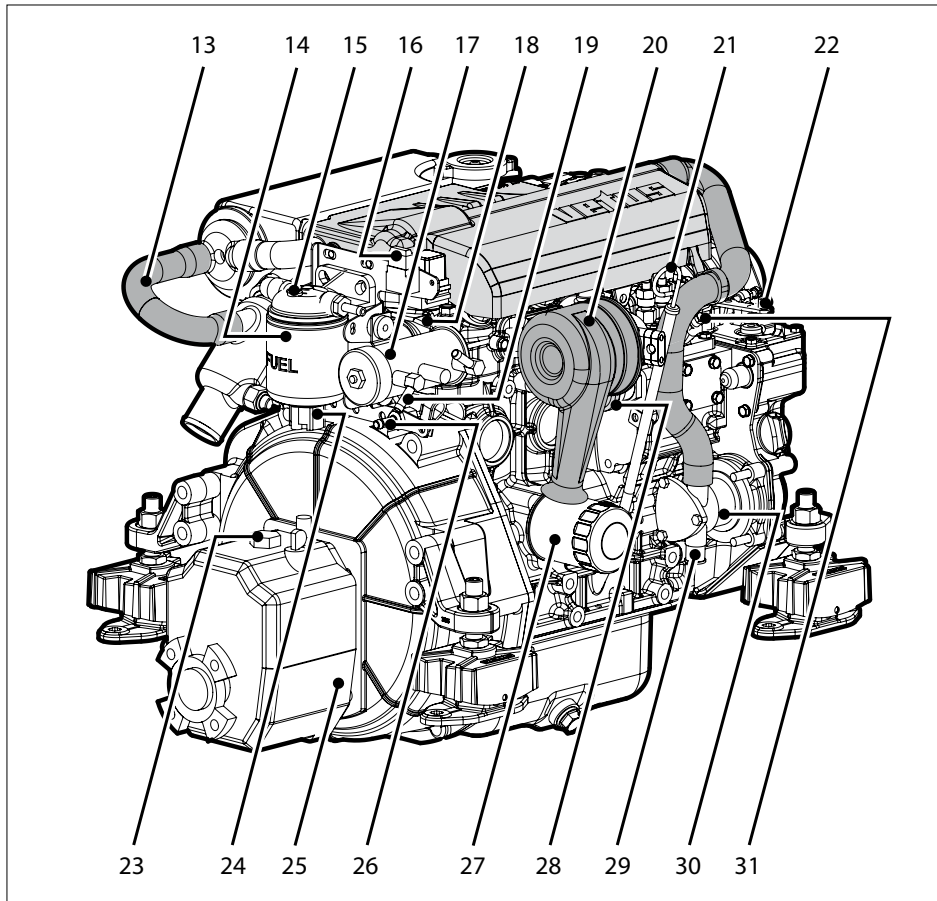
2 Introduction

Identification of engine parts M2, M3

- 1 Calorifier connection, engine 'IN'
- 2 Calorifier connection, engine 'OUT'
- 3 Cooling system air bleed nipple / Connection for extra expansion tank (Keel cooling model only)
- 4 Oil filler cap
- 5 Filler cap for cooling system
- 6 Expansion tank
- 7 Heat exchanger
- 8 Cooling system drain plug
- 9 V-belt
- 10 Alternator
- 11 Starter motor
- 12 Exhaust injection bend \varnothing 40 mm



2 Introduction



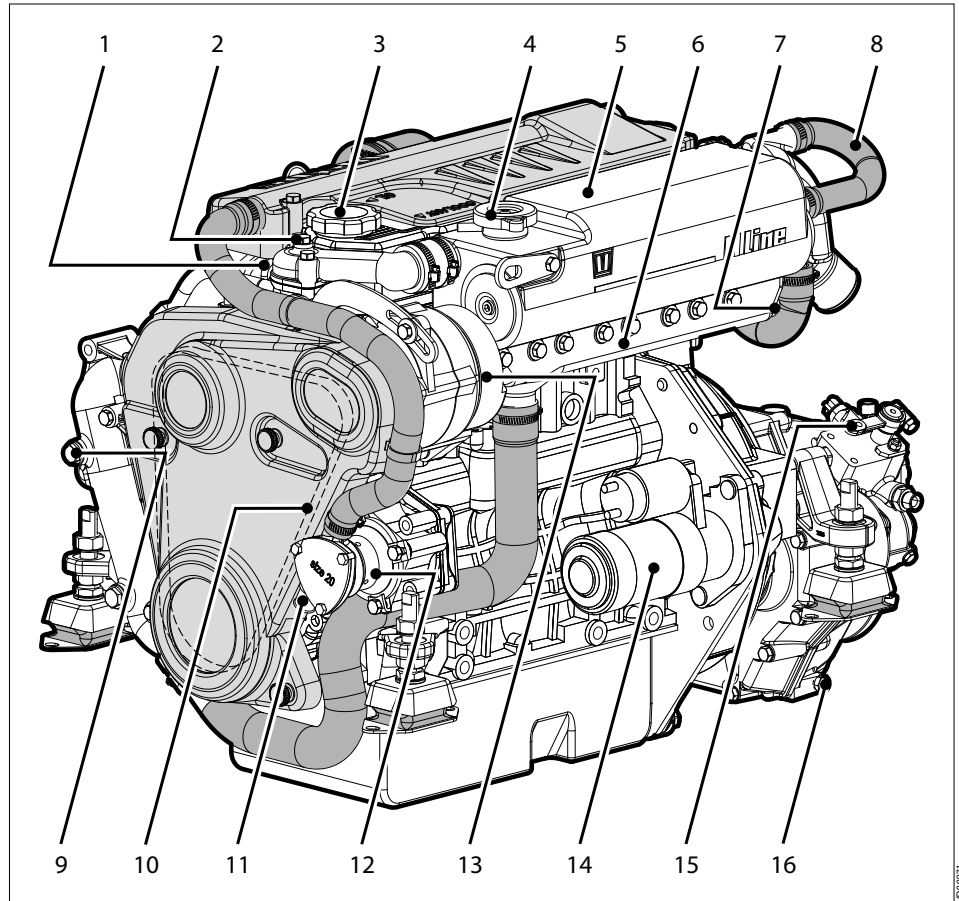
Identification of engine parts M2, M3

- 13 Airvent connection
- 14 Water separator/Fuel filter
- 15 Water separator/fuel filter air bleed nipple
- 16 Fuse
- 17 Fuel lift pump
- 18 Connection electrical system
- 19 Fuel supply pipe connection \varnothing 8 mm
- 20 Air inlet silencer / Air filter
- 21 Oil dipstick
- 22 Connection for throttle push-pull cable
- 23 Gearbox filler cap
- 24 Water separator/fuel filter drain plug
- 25 Gearbox
- 26 Fuel return pipe connection \varnothing 8 mm
- 27 Oil filter
- 28 Manual operation of electric stop
- 29 Raw water inlet \varnothing 20 mm
- 30 Raw water pump
- 31 Fuel pump air bleed nipple

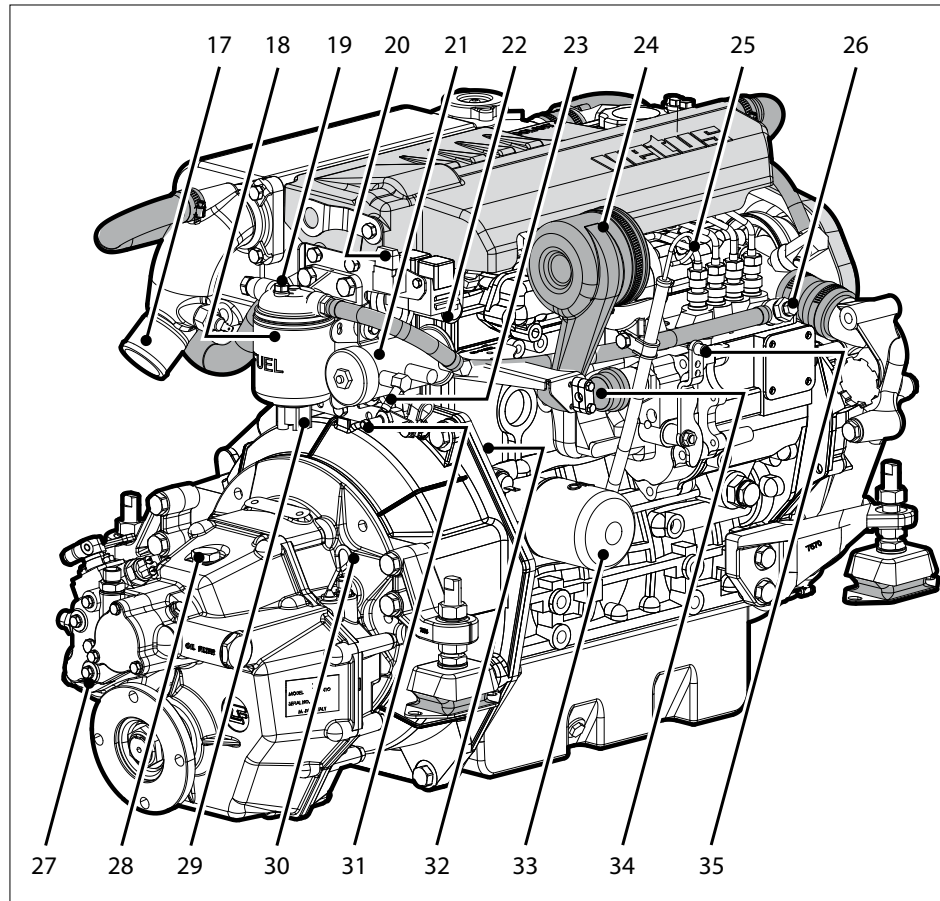
2 Introduction

Identification of engine parts M4

- 1 Calorifier connection, engine 'OUT'
- 2 Cooling system air bleed nipple / Connection for extra expansion tank (Keel cooling model only)
- 3 Oil filler cap
- 4 Filler cap for cooling system
- 5 Expansion tank
- 6 Heat exchanger
- 7 Cooling system drain plug
- 8 Airvent connection
- 9 Calorifier connection, engine 'IN'
- 10 V-belt
- 11 Raw water inlet \varnothing 20 mm
- 12 Raw water pump
- 13 Alternator
- 14 Starter motor
- 15 Connection for gearbox push-pull cable
- 16 Gearbox drain plug



2 Introduction



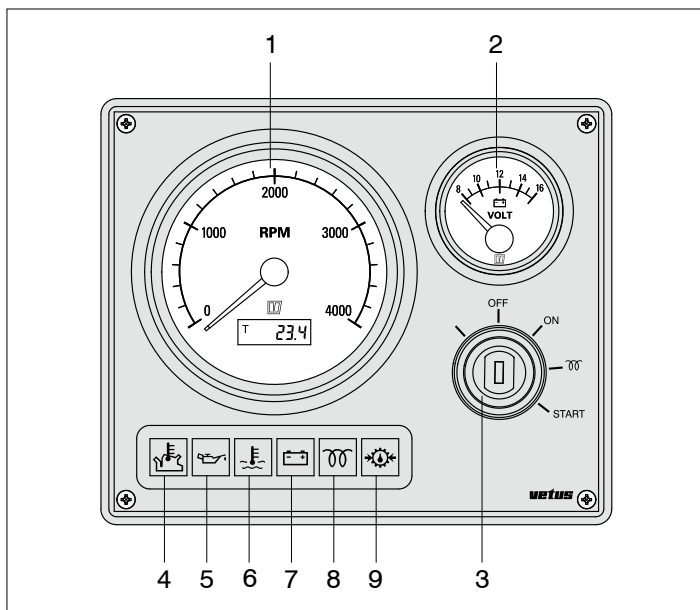
Identification of engine parts M4

- 17 Exhaust injection bend \varnothing 50 mm
- 18 Water separator/Fuel filter
- 19 Water separator/fuel filter air bleed nipple
- 20 Fuse
- 21 Fuel lift pump
- 22 Connection electrical system
- 23 Fuel supply pipe connection \varnothing 8 mm
- 24 Air inlet silencer / Air filter
- 25 Oil dipstick
- 26 Fuel pump air bleed nipple
- 27 Gearbox
- 28 Gearbox filler cap
- 29 Water separator/fuel filter drain plug
- 30 Gearbox oil dipstick
- 31 Fuel return pipe connection \varnothing 8 mm
- 32 Cooling system drain plug
- 33 Oil filter
- 34 Manual operation of electric stop
- 35 Connection for throttle push-pull cable

1000972

2 Introduction

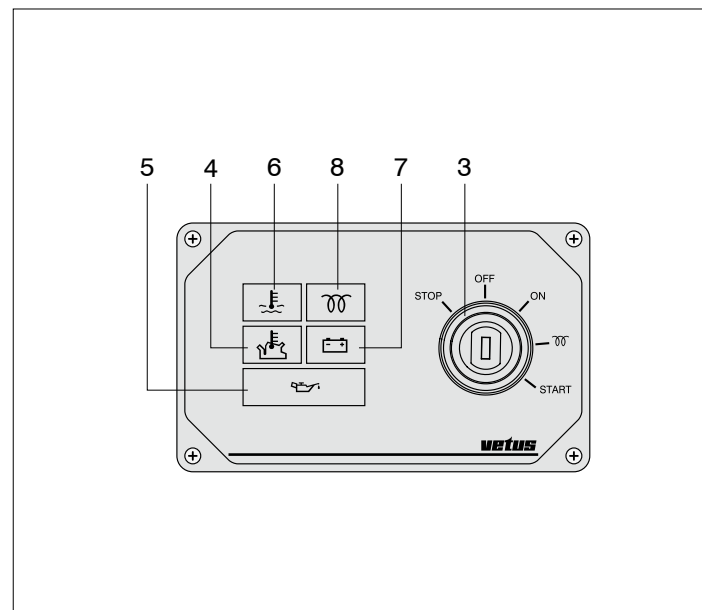
Control panels



Panel, model MP22

Panel, excl. voltmeter, model MP21

- 1 Tachometer/Operating hours counter
- 2 Voltmeter
- 3 Starter pre-heat switch/lock
- 4 Warning light high raw water temperature
- 5 Warning light low oil pressure
- 6 Warning light high coolant temperature
- 7 Warning light battery charging



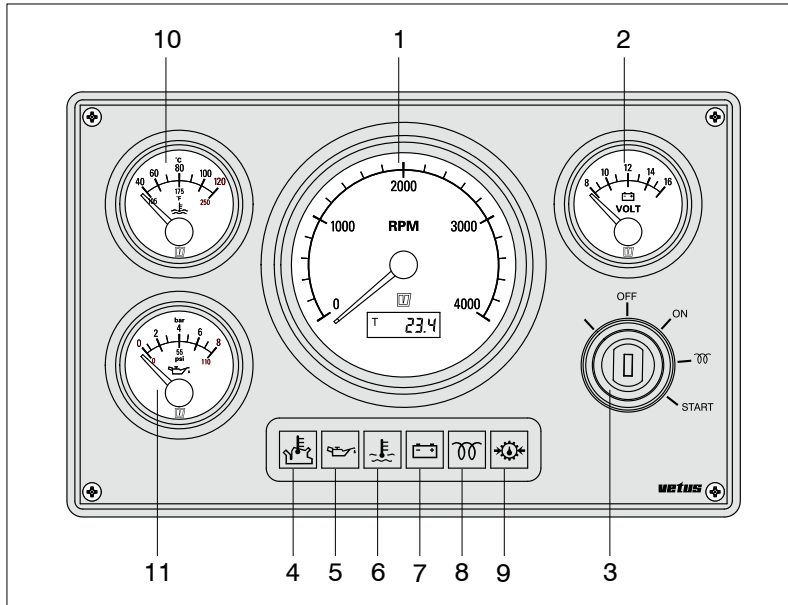
Panel, model MP10

- 8 Indicator light pre-heating
- 9 Warning light gearbox low oil pressure [1]

[1] This is an option, not fitted as standard.

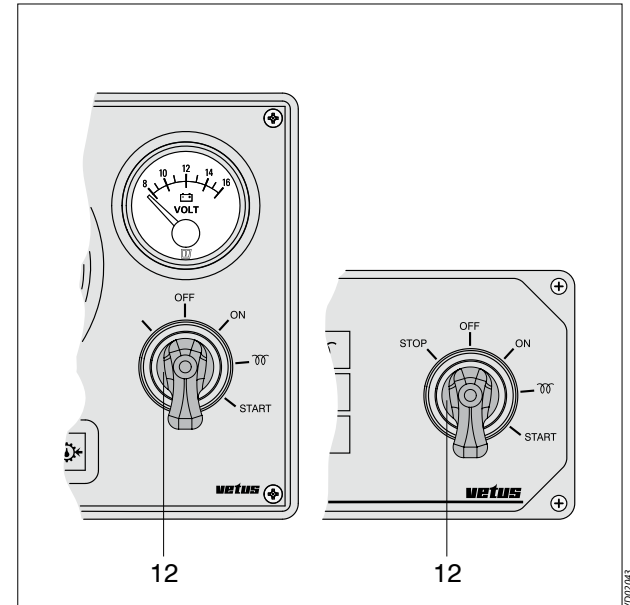
2 Introduction

Control panels, option



Panel, model MP34

- 1 Tachometer/Operating hours counter
- 2 Voltmeter
- 3 Starter pre-heat switch/lock
- 4 Warning light high raw water temperature
- 5 Warning light low oil pressure
- 6 Warning light high coolant temperature
- 7 Warning light battery charging



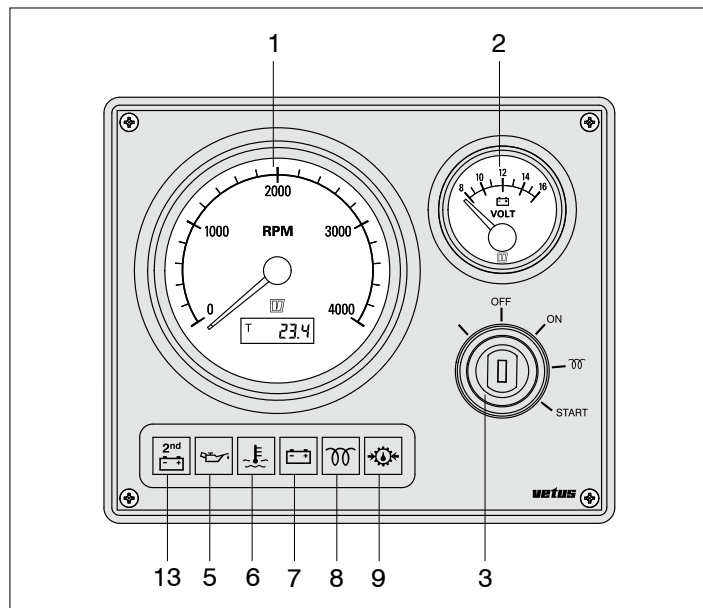
Panels, model MP10, MP22, MP34
for SOLAS engines only

- 8 Indicator light pre-heating
- 9 Warning light gearbox low oil pressure [1]
- 10 Temperature gauge, coolant
- 11 Oil pressure gauge
- 12 Starter pre-heat switch

[1] This is an option, not fitted as standard.

2 Introduction

Control panels, option

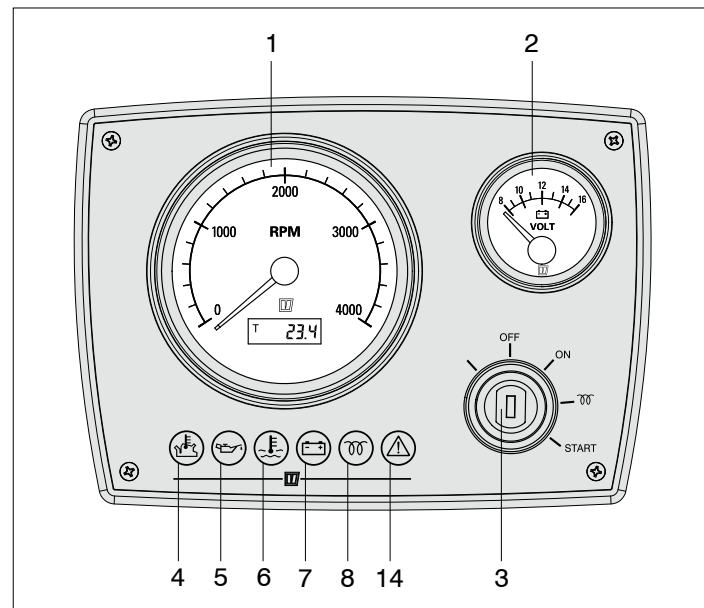


V000630

Panel, model MP22

for keel cooled engines with second alternator only

- 1 Tachometer/Operating hours counter
- 2 Voltmeter
- 3 Starter pre-heat switch/lock
- 4 Warning light high raw water temperature
- 5 Warning light low oil pressure
- 6 Warning light high coolant temperature
- 7 Warning light battery charging

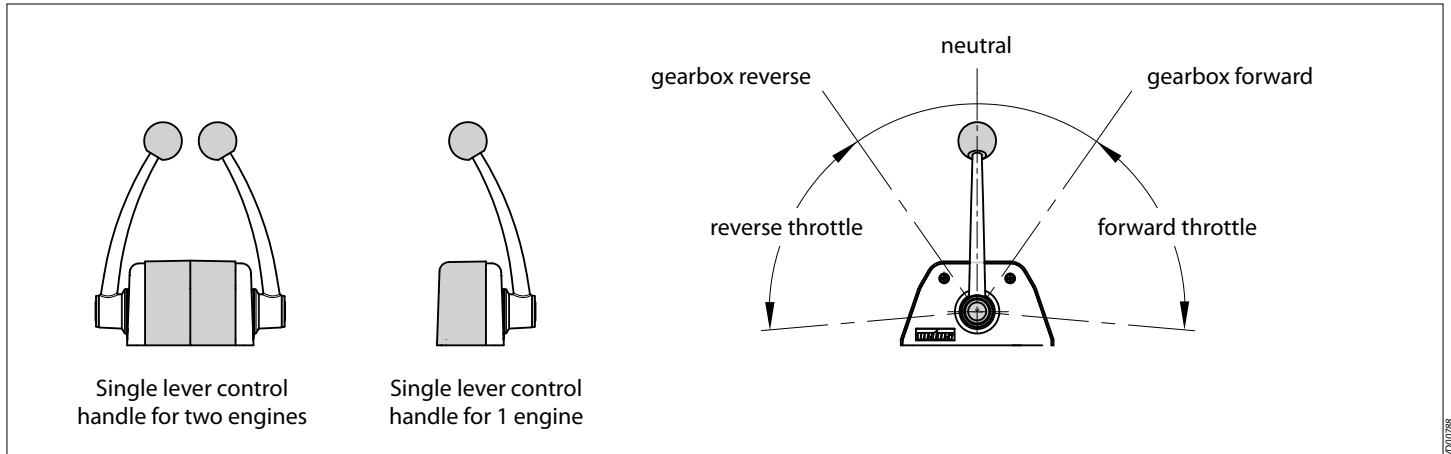


V000952

Panel, model MPA22

- 8 Indicator light pre-heating
- 9 Warning light gearbox low oil pressure [1]
- 13 Warning light second alternator
- 14 Warning light general

[1] This is an option, not fitted as standard.



6 Operating lever

Operating lever for 1 or 2 engines.

The control lever works as shown in the diagram.

Starting from neutral put the engine in ahead or astern by moving the lever 35° forwards or backwards.

The throttle lever operates at an angle of 60° forwards and 60° reverse.

3 First commissioning

Engine Oil 15W40

API: CF4, CG4, CH4, CI4

ACEA: A3/B3, A3/B4, E7

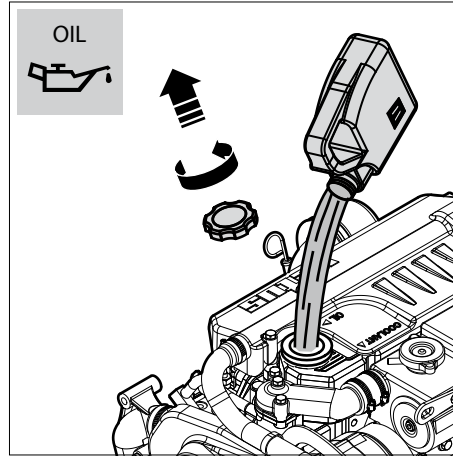
For example:

- Vetus Marine Diesel Engine Oil 15W40
- Shell Rimula R4 L 15W40

	litres	Imp. pt	US pt
M2 :	2.3	4.0	4.9
M3 :	3.4	6.0	7.2
M4 :	5.5	9.7	11.6

1 Commissioning the engine

Before starting the engine for the first time, the following procedures must be carried out:



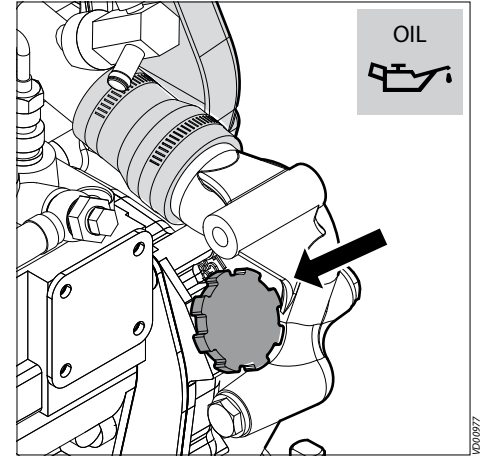
2 Filling with engine oil

As a rule engines are delivered empty of oil.

- Fill the engine with oil through the filler neck on top of the valve cover.

For quantity and oil specification see page [118](#) and [126](#).

- Check the oil level with the dipstick, see page [48](#).



A second oil filling cap is located at the distribution cover.

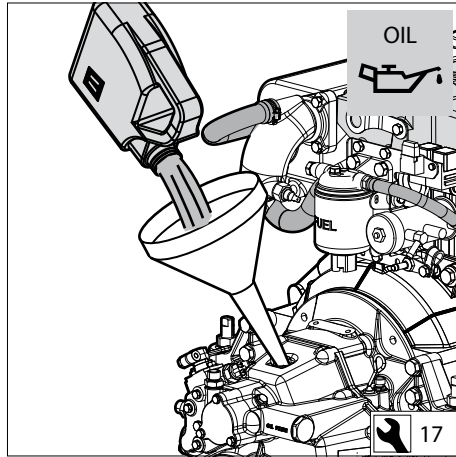
3 First commissioning

Vetus engines are normally equipped with Technodrive or ZF-Hurth gearboxes.

In case your engine is equipped with another brand of gearbox follow the instructions given in the supplied owners manual.

3 Filling gearbox with oil

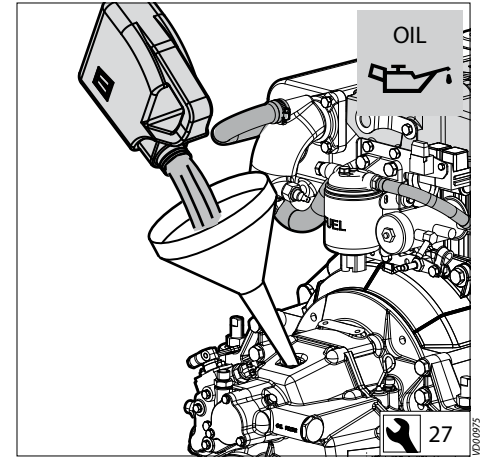
- Fill the gearbox with oil.



Technodrive:

For quantity and oil specification see page [128](#).

- Check the oil level with the dipstick, see page [64](#).

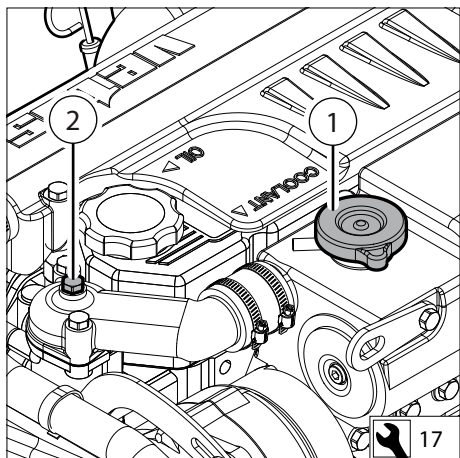


ZF Hurth:

For quantity and oil specification see page [128](#).

- Check the oil level with the dipstick, see page [64](#).

3 First commissioning

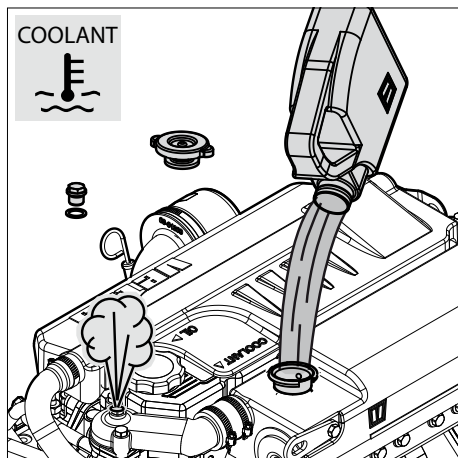


4 Filling the cooling system, INTERCOOLING,

- Remove the cap (1) of the filler neck on the top of the heat exchanger housing.
- Remove the bolt (2) from the upper side of the thermostat cover, so that air can escape from the cooling system.

NOTE

If a water heater is connected to the engine, see page [26](#) and [27](#).



- Fill the cooling system.

Use a mixture of 40% antifreeze (ethylene-glycol based) and 60% tap water or use a special coolant.

For specifications see page [129](#).

Coolant quantity:

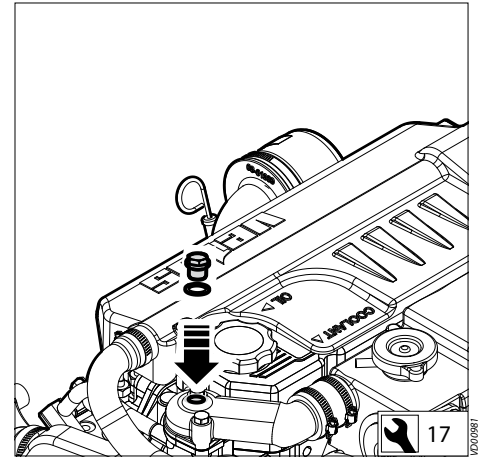
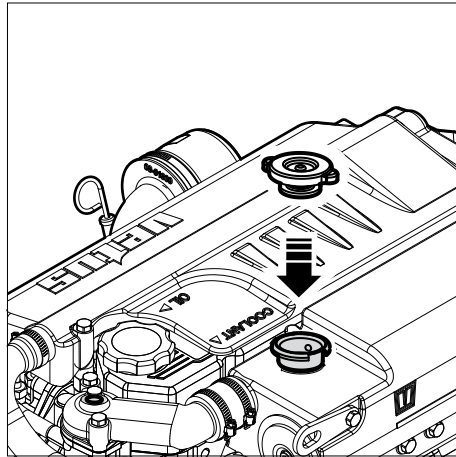
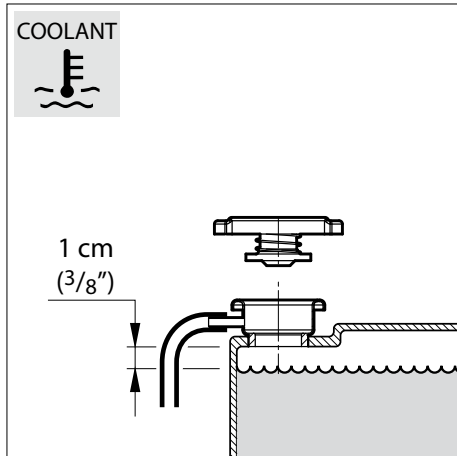
	litres	Imp. pt	US pt
M2	: 2.2	3.9	4.6
M3	: 3.0	5.3	6.3
M4	: 6.5	11.4	13.7



CAUTION

Never fill the cooling system with sea water or brackish water.

3 First commissioning



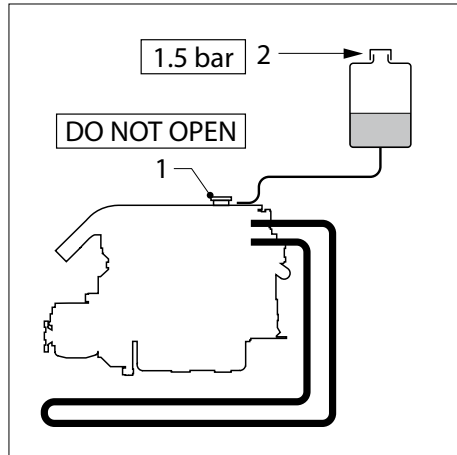
The level of the coolant must be approx. 1 cm (3/8") below the lower edge of the filler neck.

Bleeding will take place automatically during filling!

- Replace the filler cap.

- Reinstall the bolt in the thermostat cover..

3 First commissioning



5 Filling the cooling system, KEEL COOLING

- Remove the cap 'DO NOT OPEN' (1) of the filler neck on the top of the heat exchanger housing.
- Fill the cooling system.
- Reinstall the filler cap 'DO NOT OPEN'.

NOTE

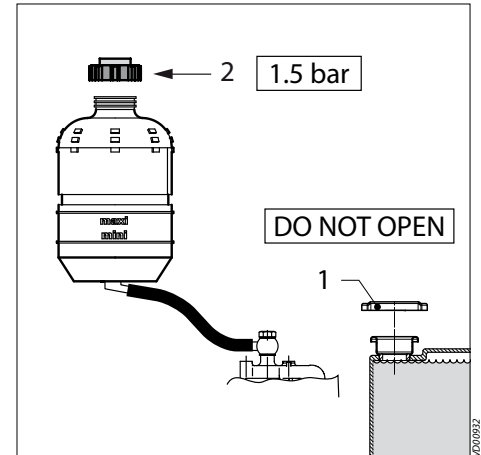
If a water heater is connected to the engine, see page [26](#) and [27](#).

Coolant quantity (engine only):

	litres	Imp. pt	US pt
M2 :	3.0	5.3	6.3
M3 :	4.0	7.0	8.4
M4 :	7.2	12.7	15.2



Never fill the cooling system with sea water or brackish water.

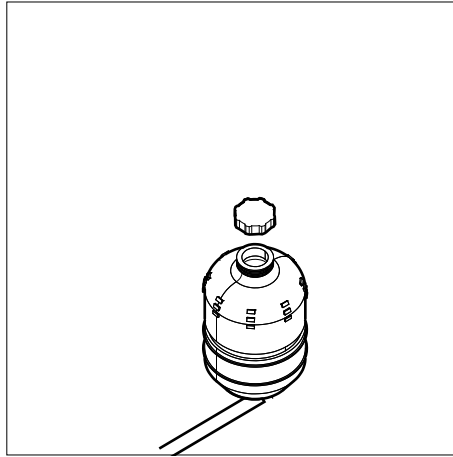
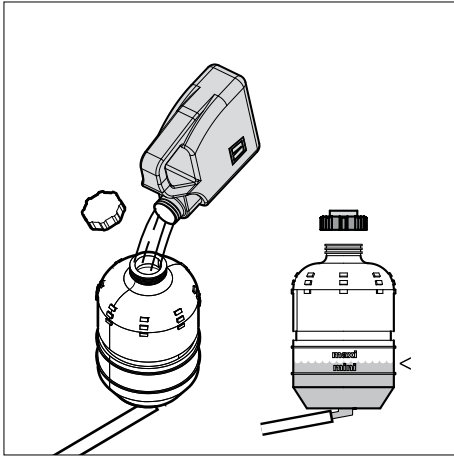


- Remove the pressure cap (2) of the extra expansion tank.

Use a mixture of 40% antifreeze (ethylene-glycol based) and 60% tap water or use a special coolant.

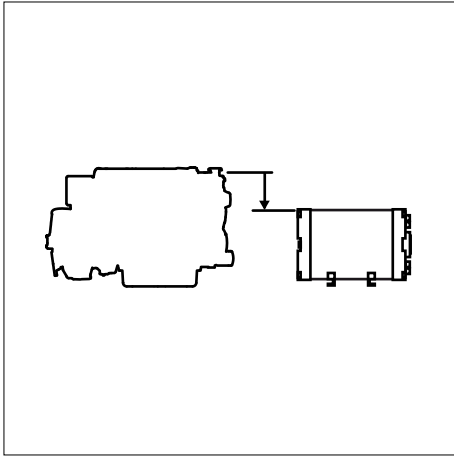
For specifications see page [129](#).

3 First commissioning



- Top up the extra expansion tank to the minimum level.
- Reinstall the pressure cap (2).

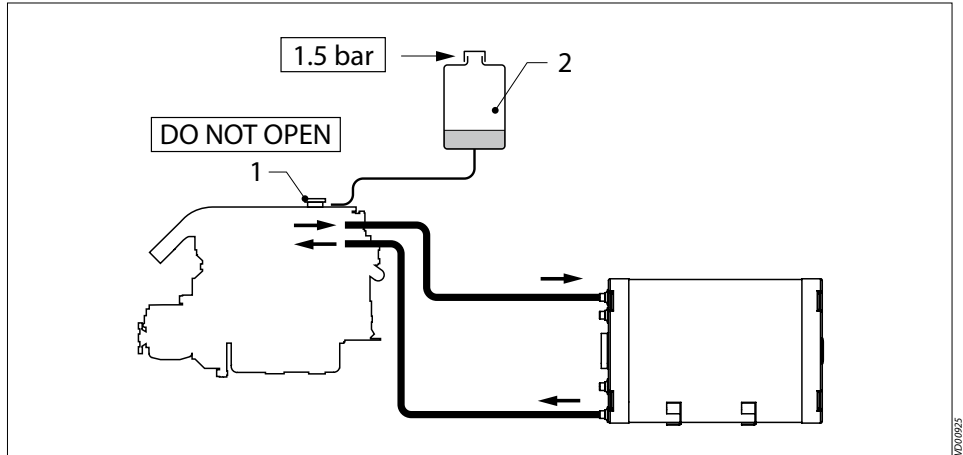
3 First commissioning



6 Filling coolant system, if a water heater is connected -1-

The **HIGHEST** point of the water heater is situated at a **LOWER** level than the expansion tank for the ship's engine.

The water heater will **be filled and bled automatically** during filling of the cooling system.



- Remove the 'DO NOT OPEN' cap (1) and fill the cooling system via the filler neck.
- Add coolant into the expansion tank (2) until minimal level has been reached.

Use a mixture of 40% antifreeze (ethylene-glycol based) and 60% tap water or use a special coolant.

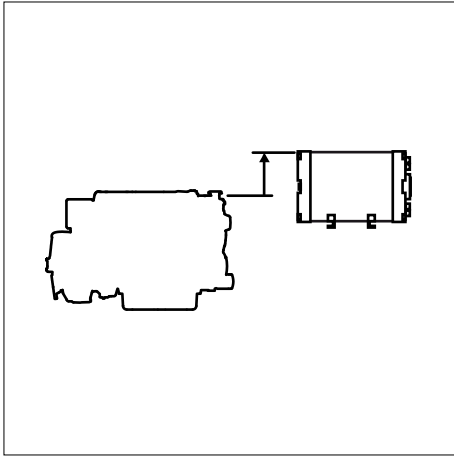
For specifications see page [129](#).



CAUTION

Never fill the cooling system with sea water or brackish water.

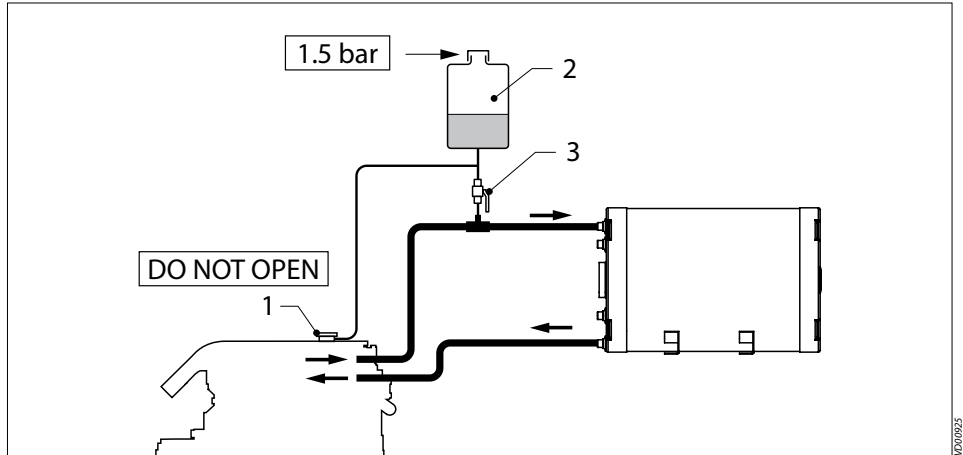
3 First commissioning



7 Filling coolant system, if a water heater is connected -2-

The **HIGHEST** point of the water heater is situated at a **HIGHER** level than the expansion tank for the ship's engine.

The water heater will **NOT be filled and bled automatically** during filling of the cooling system.



- Fill the cooling system via the expansion tank (2).
- Open valve (3) during filling and bleeding the system.

Use a mixture of 40% antifreeze (ethylene-glycol based) and 60% tap water or use a special coolant.

For specifications see page 129.



NOTE

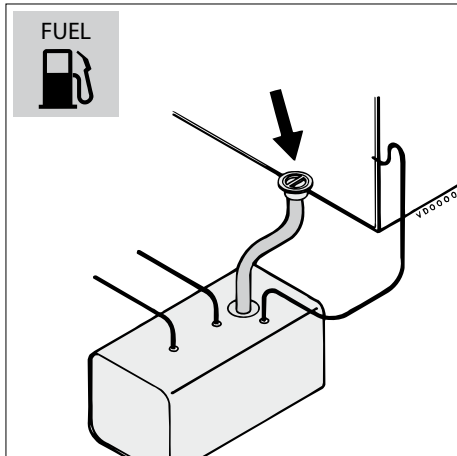
- Remember to close valve (3) after filling the system.



CAUTION

Never fill the cooling system with sea water or brackish water.

3 First commissioning



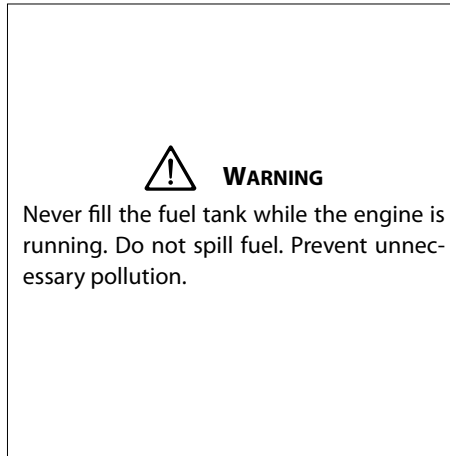
8 Fuel

- Ensure that the fuel tank is filled with diesel fuel.

Use only clean, water-free, commercial approved diesel fuel.

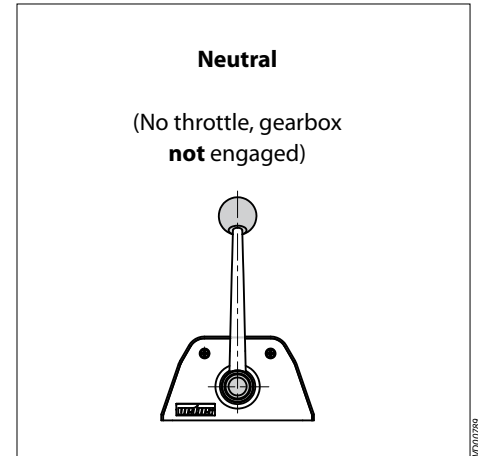
For fuel grade see page 124.

- Bleed the fuel system, see page 54.



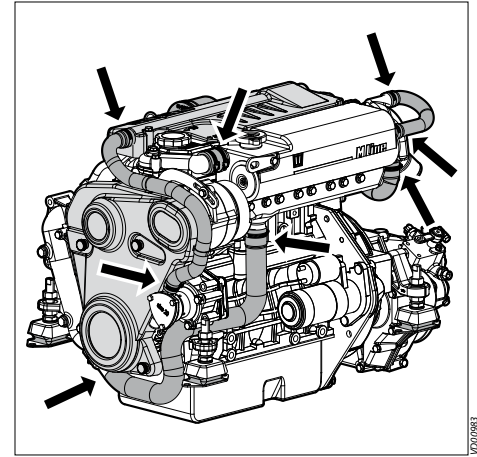
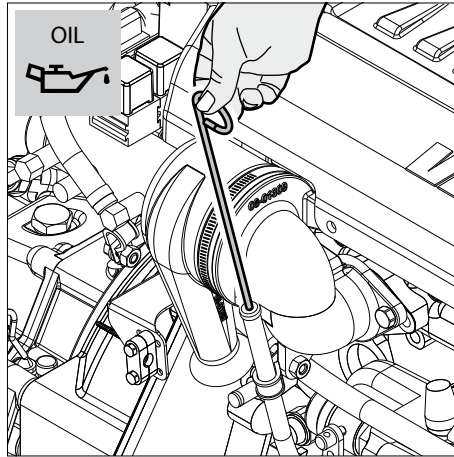
9 Other preparations

- Check that the battery is charged and check the battery cable connections.
- Set the main switch to position 'ON'.
- Open the sea cock.



- Check that the gearbox control lever is set to 'NEUTRAL'.

3 First commissioning



10 Test run

- Start the engine.

How to start the engine and what to check before, during and immediately after starting is described on page 34 and further.

- Allow the engine to test run for about 2 minutes at idling speed .
- Stop the engine
- Check the oil level. If necessary top up to the indicated level.
- Start the engine.
- Allow the engine to test run for about 10 minutes at idling speed.
- Stop the engine.

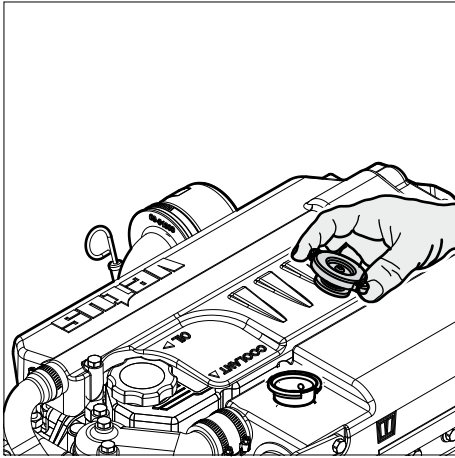
- Check that the engine and all connections (fuel, coolant and exhaust) for leaks.



CAUTION

Stop the engine immediately if it makes any strange noises, vibrates excessively or if black smoke comes out of the exhaust!

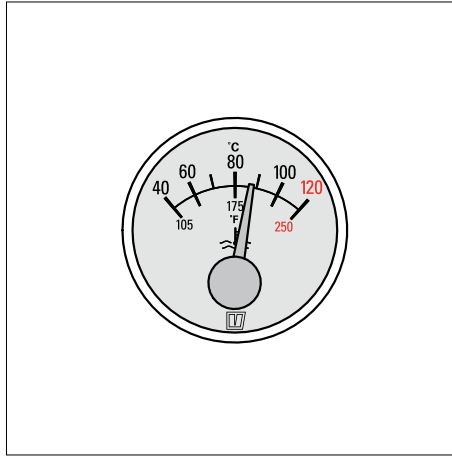
3 First commissioning



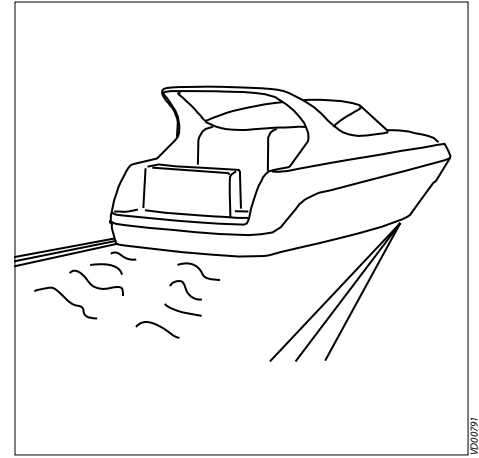
11 Bleeding

The cooling system must be bled as soon as the engine has reached normal working temperature.

- Open the cap on the filler neck.
- Vary the revolutions between idling and 2000 rev/min.
- Add coolant if necessary.



- Replace the cap on the filler neck.
- Check the coolant temperature.



12 Sea trial

- Check the operation of the remote control.
- Carry out a sea trial

4 Running-in

In order to ensure a long life for your engine, please observe the following for the first 50 operating hours:

- Allow the engine to reach operating temperature before applying a load.
- Avoid fast acceleration.
- Do not allow the engine to run faster than 3/4 of maximum RPM.

After the first 50 operation hours carry out the following maintenance:

- Drain water from fuel filter, see page 53.
- Engine oil change, see page 56.
- Replace oil filter, see page 58.
- Replace fuel filter, see page 65.
- Change gearbox oil, see page 68.
- Check V-belt, see page 74.
- Check flexible engine mounts, see page 69.
- Check engine for leaks, see page 69.
- Check tightness of all fasteners, bolts and nuts, see page 69.

General guidelines for use

Implementing the following recommendations will result in longer life and better performance and more economical operation of your engine.

- Carry out the maintenance described regularly, including the 'Daily procedures before starting'.
- Use anti-freeze in the engine coolant all year long, this helps prevent corrosion as well as protecting against frost damage. For specifications see page 129.
- Never run the engine without a thermostat.
- Use a good quality lubricating oil. For specifications see page 126.
- Use a good quality diesel fuel that is free of water and other pollutants.
- Always stop the engine immediately if one of the warning lamps for oil pressure, high coolant temperature, high raw water temperature ^[1] or battery charging lights up.
- Always follow the safety advice, see page 4.

[1] Only engines with intercooling.



NOTE

First commissioning

Follow the instructions given for 'First commissioning' on page 20 and further if the engine is being commissioned for the first time.

After repair work:

Check that all guards have been replaced and that all tools have been removed from the engine.
When starting with pre-heating, do not use any other substance (e.g. injection with 'Easy Start'). Doing so could result in an accident.

5 Use

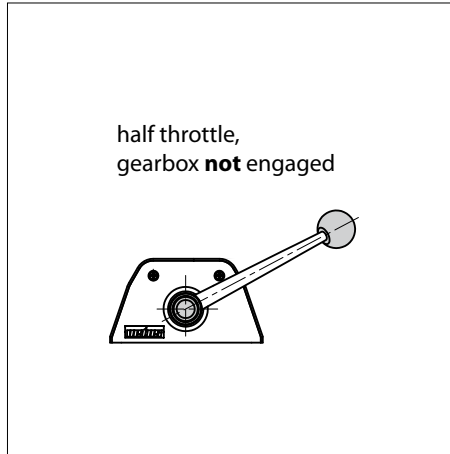
Before starting, always check the following points:

- Engine oil level.
- Coolant level.
- Sea cock open.
- Main switch 'ON'.
- Gearbox in 'NEUTRAL' position.



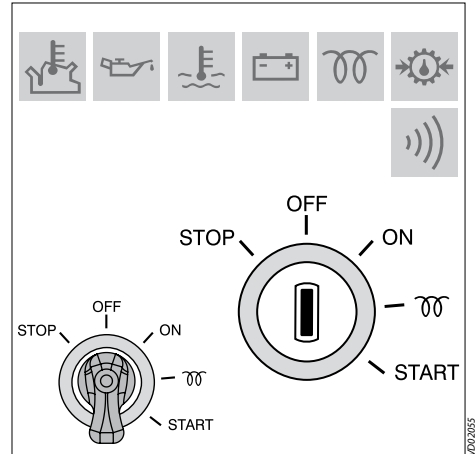
WARNING

Never start the engine with the fuel injection pump removed. Disconnect battery.



1 Control lever

Set the control lever to 'half throttle' **without** engaging the gearbox.

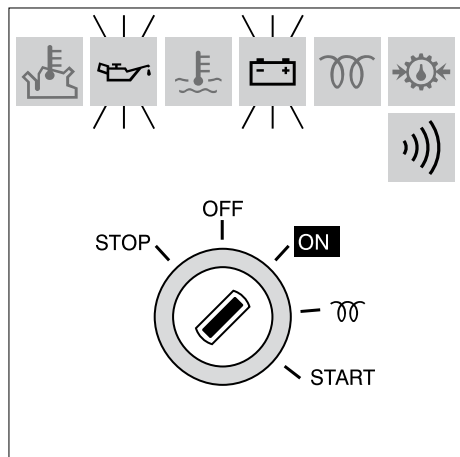


2 Control panel

The starter switch on the control panel is key operated or knob operated (for SOLAS engines only).

The knob has exactly the same functions as the starter key.

5 Use



3 Switching on

- Turn the start key on the instrument panel clock-wise; the warning lights for oil pressure and alternator will now light up and the alarm buzzer will sound.

Ambient Temperature	Pre-heating time
Above +5°C (41°F)	about 6 seconds
+5°C to -5°C (+41°F to +23°F)	about 12 seconds
Below -5°C (23°F)	about 18 seconds
Maximum pre-heating time	1 minute

4 Pre-heating

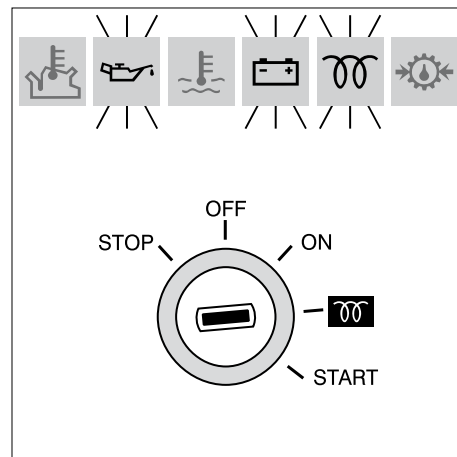
The ideal pre-heating time depends on ambient temperature; the lower the ambient temperature, the longer the pre-heating time required. See table.



CAUTION

To prevent the glow plugs from burning out, **never** exceed the stated maximum pre-heating time.

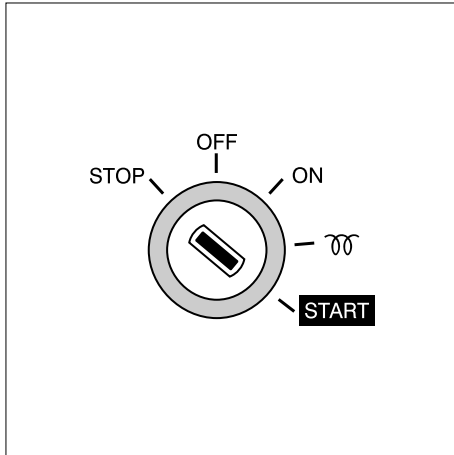
Starting



- Turn the key further clockwise to the 'START' position.

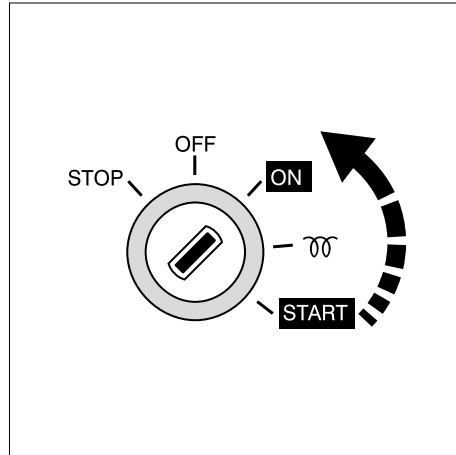
While pre-heating takes place the preheating indicator light will be on and the alarm buzzer off.

- Hold the key in this position for about 6 seconds.



5 Starting

Now turn the key further to the 'START' position.



Release the key as soon as the engine fires (the key will return to the 'ON' position) and throttle back.

Leave the key in this position while the engine is running.

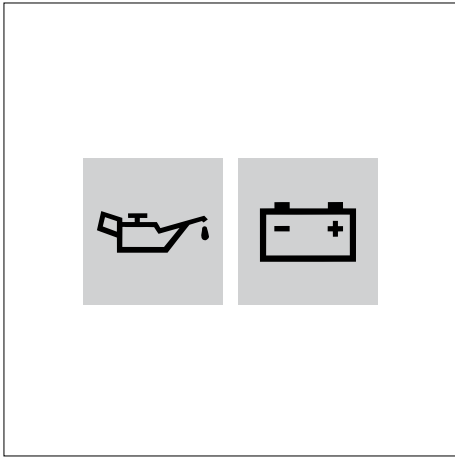


CAUTION

Release the key if the engine does not fire within 10 seconds.

Let the starter motor cool for 30 seconds before turning the key to the 'START' position again.

5 Use



Check that the indicator lights for oil pressure and alternator are off.

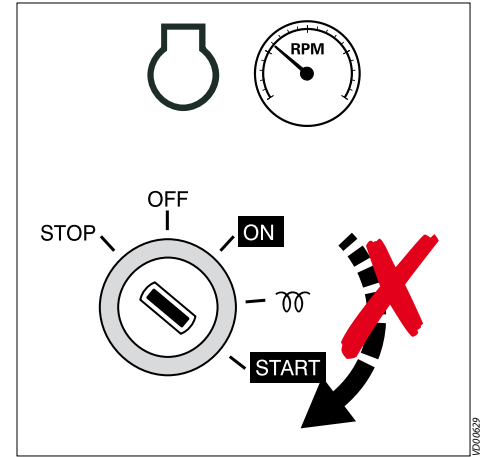
Cooling water should now flow out of the exhaust; if this is not the case, stop the engine immediately ^[1].

Let the engine run for 5 to 10 minutes in neutral. A good warm up is essential to ensure maximum lifetime and good performance.

Never turn the main switch off while the engine is running.

[1] Only engines with intercooling.

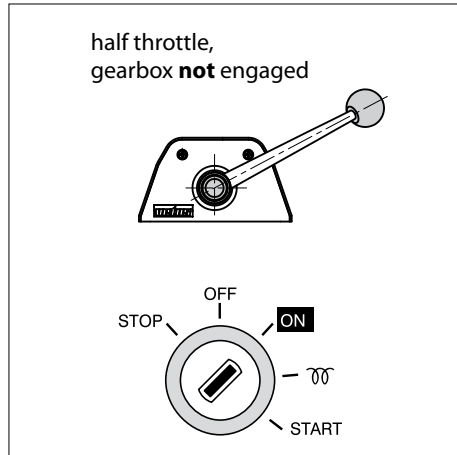
Starting



CAUTION

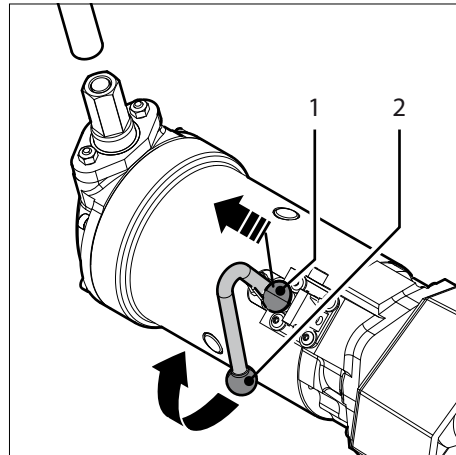
Never turn the key to the 'START' position while the engine is running. Doing so will damage the starter motor.

5 Use



6 Preparation

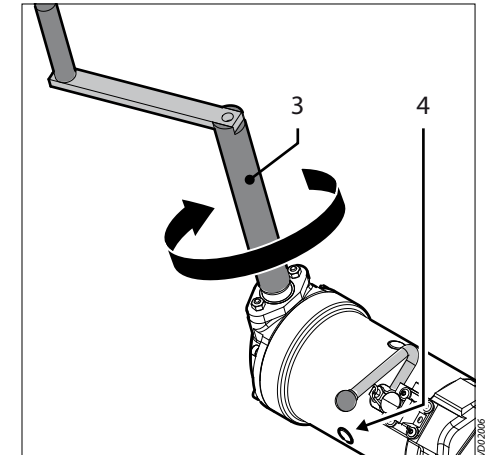
- Convince yourself that it is safe to start the engine.
- Set the control lever to 'half throttle' **with-out** engaging the gearbox.
- Turn the start key on the instrument panel clock-wise to the '**ON**' position.



7 Re-set trip mechanism

- Re-set the trip mechanism by lifting the plunger (1) allowing the trip lever (2) to move upwards.
- Place the handle (3) on the spring starter.

Starting using the spring starter (option)



8 Winding the springs

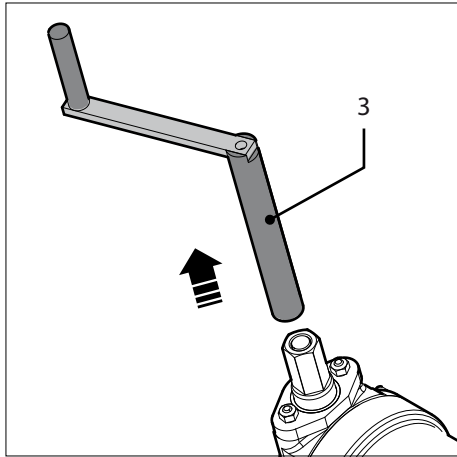
- Using the handle (3) **clockwise** to wind the springs.

For a **warm engine** wind until the **white springs** are visible through the inspection window (4).

For a **cold engine** wind further until the **red springs** are visible through the inspection window.

Overwinding will reduce the life of the starter.

5 Use



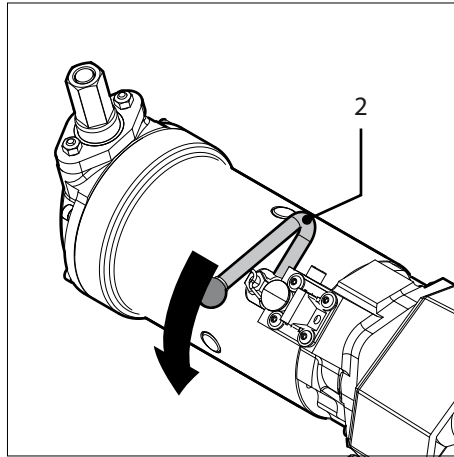
9 Starting

- Remove the handle (3) from the starter.



NOTE

The starter must NEVER be tripped with the winding handle in place.



- Now start the engine by moving the trip lever (2) through 90 degrees until it holds out. Throttle back as soon as the engine runs.

Leave the key in the 'ON' position while the engine is running.

Starting using the spring starter (option)



CAUTION

Never leave the spring starter part-wound.



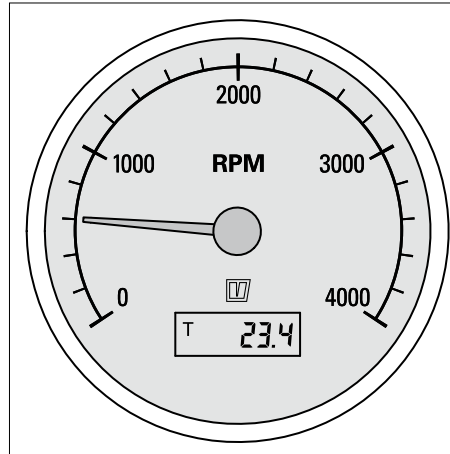
NOTE

It is possible to unwind the starter, should the need occur, by turning the handle anti-clockwise. Additional force will be required to overcome the initial friction.



NOTE

If the engine does not start first time, allow it to come to a complete rest before retrying.



10 Tachometer

The instrument panel is provided with the following instruments (Depending of the type of panel, see page 16).

Indicating the number of revolutions per minute of the engine.

Also the number of running hours is indicated.

Idling speed:

M2.13,
M2.18 : 850 rpm

M3.29
M3.28 SOLAS : 900 rpm

M4.35
M4.45 : 840 rpm
M4.15 SOLAS
M4.17 SOLAS

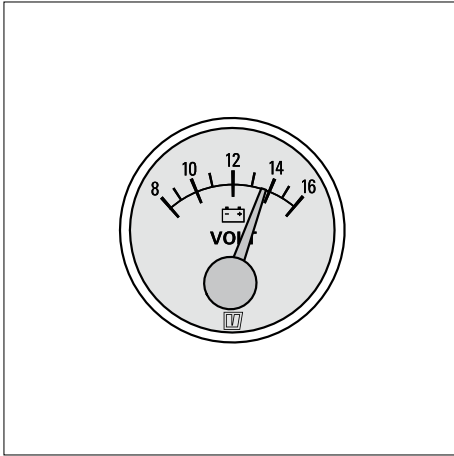
M4.56 : 900 rpm
M4.55 SOLAS



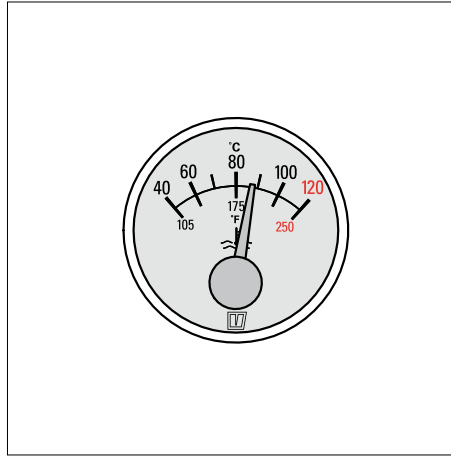
WARNING

Avoid idling for more than 10 minutes.

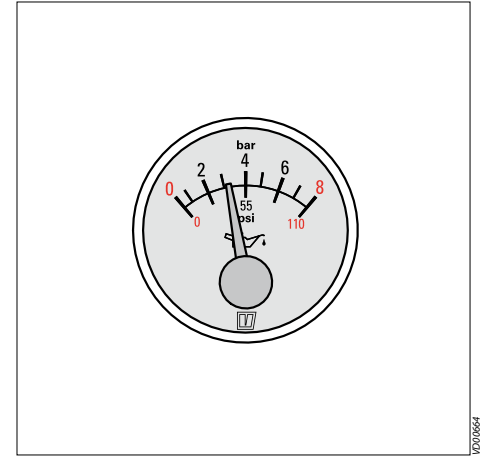
This can lead to carbon deposits in the combustion chambers and incomplete combustion of fuel.

**11 Voltmeter**

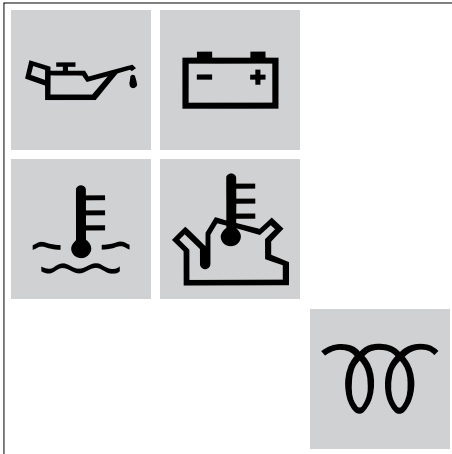
Indicating the battery voltage.
 When the engine is running, the battery voltage should be between 12 and 14 Volts.
 With the engine stopped and the start key in the first position, the voltmeter should indicate 12 Volts.

**12 Temperature gauge**

Indicating the temperature of the internal cooling system.
 For the operating temperature, see technical data page 119.
 In case the engine is overheated: turn off the engine and establish the cause, see fault finding table, page 106 .. 115.

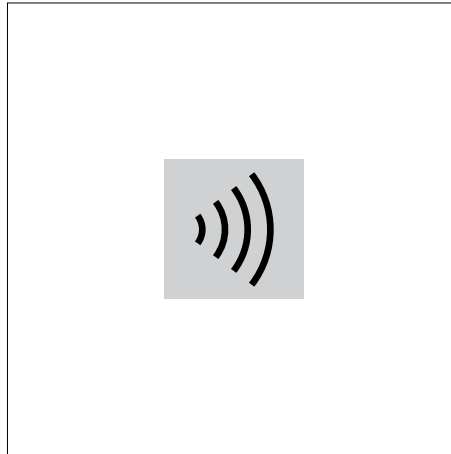
**13 Oil pressure gauge**

With the engine at operating temperature, the oil pressure is:
 When idling: at least 1 bar (7 psi).
 In case the oil pressure is too low: turn off the engine and establish the cause, see fault finding table, page 106 .. 115.



14 Warning lights

None of the five warning lights should light up while the engine is running.

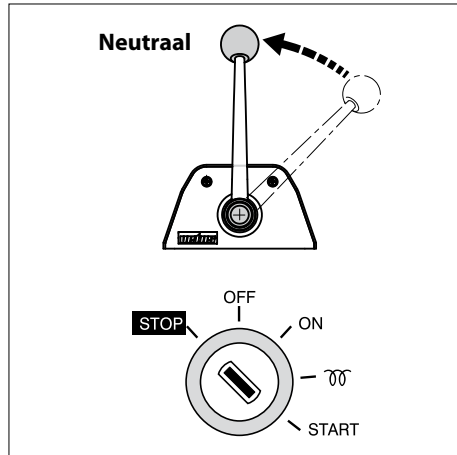


15 Alarm buzzer

Oil pressure, battery charging and temperature indicator lights are all connected to an alarm buzzer. If this alarm buzzer sounds while running, Stop the engine immediately!

5 Use

Stopping

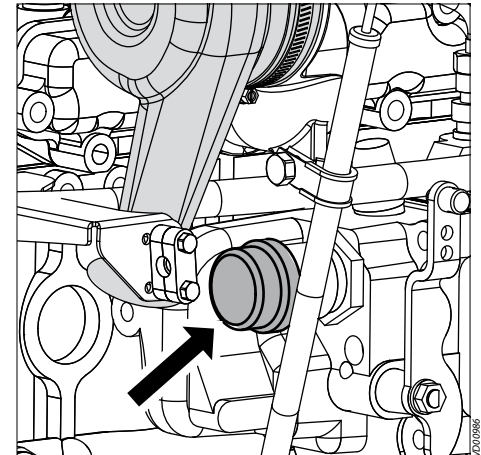
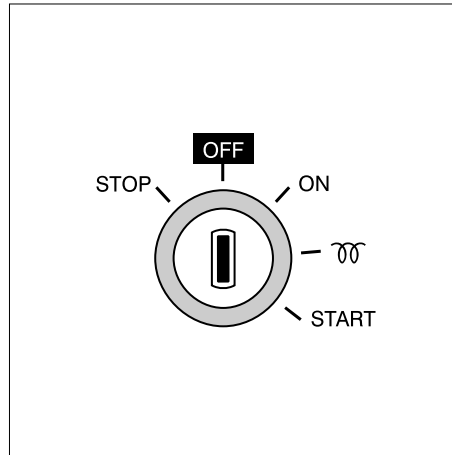


16 Stopping

- Reduce engine speed to idle and shift the gearbox to '**Neutral**'.
- Turn the key **entirely** to the left, through the '**OFF**' position.

NOTE

Never stop the engine immediately after it has been in operation for a long time. Allow the engine to idle for a few minutes before stopping.



17 Stopping on the engine itself

- When the engine has stopped, turn the key to the '**OFF**' position.

On the engine itself stopping is possible by pressing the black button on the fuel injection pump. If the fuel supply is not shut off by the electrically operated fuel solenoid stopping of the engine can be done this way.

NOTE

If the engine is not to be used for some time, it is recommended that the sea cock is closed and the battery main switch turned off.

Introduction

The following guidelines should be observed for daily and periodic maintenance. Perform each function at the indicated time interval.

The intervals stated are for normal operational conditions. Service the unit more frequently under severe conditions.

Failure to carry out maintenance can result in faults and permanent damage to the engine.

No claim can be made on the Guarantee if maintenance has been neglected.

Keep record of the following information in the logbook and/or the 'Service and Warranty Manual':

- Total engine hours (reading engine hour counter).
- Amounts of oil, fuel and coolant needed for topping up.
- The dates and intervals at which the oil and coolant are changed.
- Oil pressure and coolant temperature.
- Parts on which maintenance is conducted and type of maintenance (adjustment, repair or replacement), and the results of each procedure.
- Changes in operating conditions, such as 'Exhaust gas became black', etc.

6 Maintenance

Maintenance schedule

Every 10 hours or daily, before starting	page
Check engine oil level	48
Check engine oil level, at free-fall lifeboats (SOLAS)	49
Check coolant level	50
Check water strainer	52

After the first 50 hours	page
Drain water from fuel filter	53
Engine oil change	56
Replace oil filter	58
Check gearbox oil level	64
Replace fuel filter	65
Check flexible engine mounts	69
Check engine for leaks	69
Check tightness of all fasteners, bolts and nuts	69
Check V-belt	74

Every 100 hours, at least once every year	page
Drain water from fuel filter	53
Engine oil change	56
Replace oil filter	58
Battery, cables and cable connections	60
Check gearbox oil level	64

Every 500 hours, at least once every year	page
Replace fuel filter	65
Cleaning fuel lift pump	66
Change gearbox oil	68
Check flexible engine mounts	69
Check engine for leaks	69
Check tightness of all fasteners, bolts and nuts	69
Check valve clearance	70
Check V-belt	74
Check valve oil sump ventilation (SOLAS)	76



DANGER

Stop the engine before carrying out any maintenance work

6 Maintenance

Maintenance schedule

Every 500 hours	page
Check glow plugs	[1]
Check and adjust injector pressure	[1]

Every 1000 hours, at least once every 2 years	page.
Raw water pump inspection	77
Replace coolant	80
Replace air filter	84

Every 1000 hours	page
Check starter motor	85
Check alternator	85
Check turbocharger	[1]

When required	page
Bleeding fuel system	54
Check idle rpm	86
Cleaning heat exchanger [2]	88



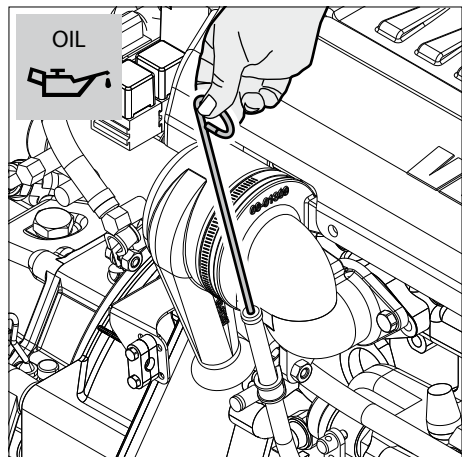
DANGER

Stop the engine before carrying out any maintenance work

[1] Consult the service manual, work to be carried out by a Vetus Mitsubishi dealer.

[1] Only engines with intercooling.

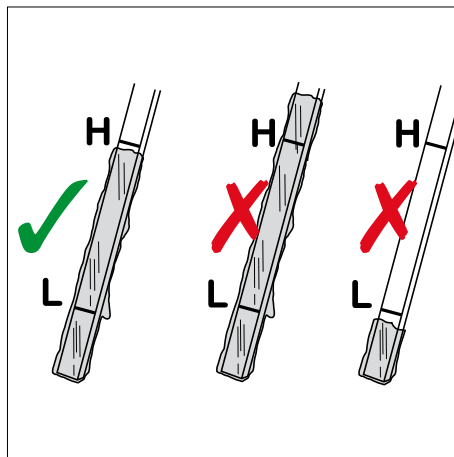
6 Maintenance



1 Check oil level

- Turn the engine off.

The dipstick is located on the starboard side of the engine.



2 Oil level

The oil level must be at or near the upper mark on the dipstick [1].

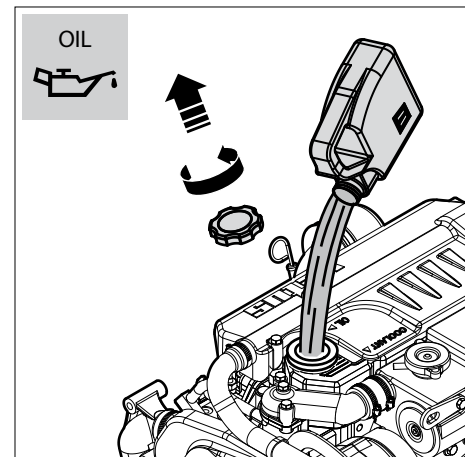
- If necessary top up with the same brand and type of oil.

[1] The difference between the two oil level marks is:

	litres	Imp. pt	US pt
M2	: 1.25	2.2	2.6
M3	: 1.3	2.3	2.7
M4	: 1.8	3.2	3.8

Checking engine oil level

Daily, before starting.



3 Topping up oil

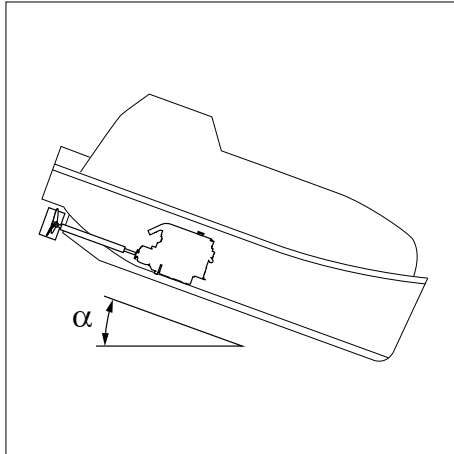
The oil filling cap is on top of the the valve cover,.

A second oil filling cap is located at the distribu- tion cover, see page 20.

6 Maintenance

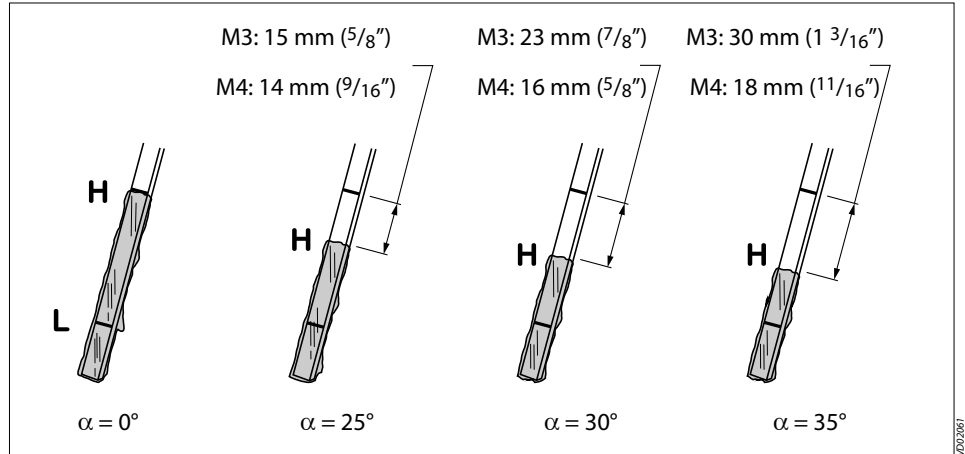
Checking engine oil level

For free-fall life boats.



4 Position of the boat

- Determine the angle on which the boat is positioned.



5 Oil level

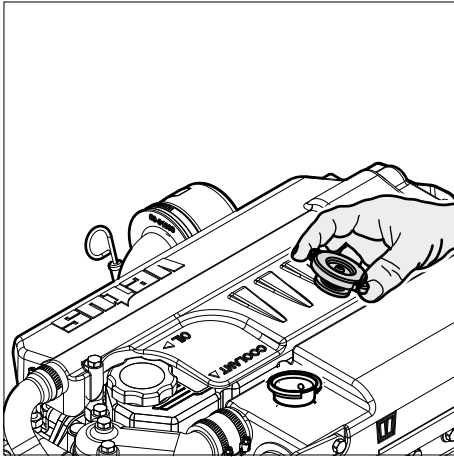
The oil level must be at or near the with 'H' indicated level on the dipstick [1].

- If necessary top up with the same brand and type of oil.

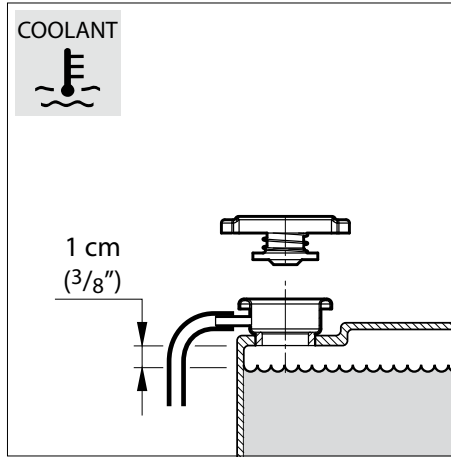
6 Maintenance

Checking coolant level

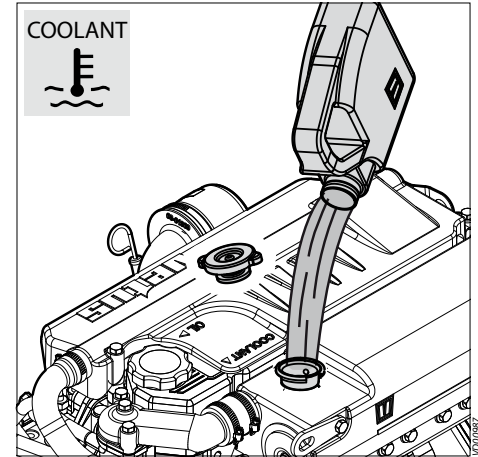
Daily, before starting.



6 Checking coolant level



7 Coolant level



8 Topping up coolant

- Check the coolant level in the header tank. This has to be checked when the engine is **cold**.
- Remove the cap of the filler neck on the heat exchanger.

The level of the coolant must be approx. 1 cm (3/8") below the lower edge of the filler neck.

- If necessary, top up. The internal cooling system can be filled with a mixture of anti-freeze (40 %) and tap water (60 %) or with a special coolant. For specification, see page **129**.



WARNING

Never open the cap on the header tank when the engine is at operating temperature.



NOTE

For a keel-cooled version, see page **24**.
If a water heater is connected, see page **26** and **27**



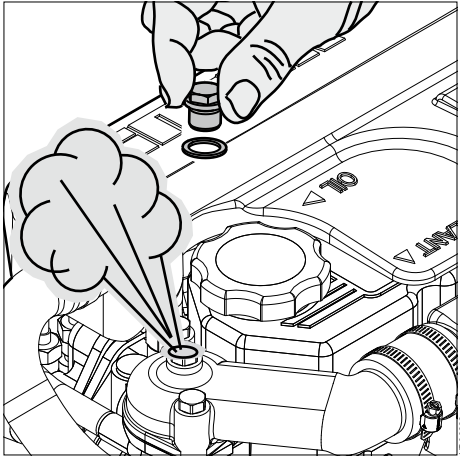
CAUTION

Never fill the cooling system with sea water or brackish water.

6 Maintenance

Checking coolant level

Daily, before starting.

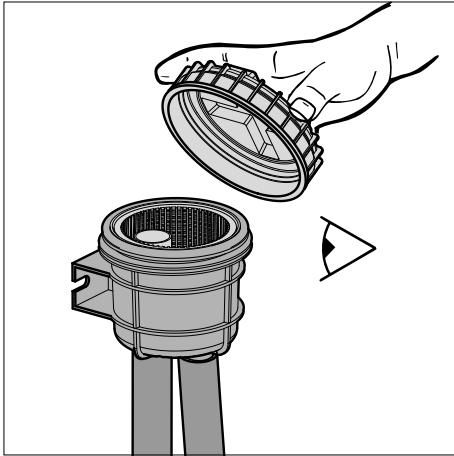


- When topping up coolant, remove the bolt from the upper side of the thermostat cover, so that air can escape from the cooling system.

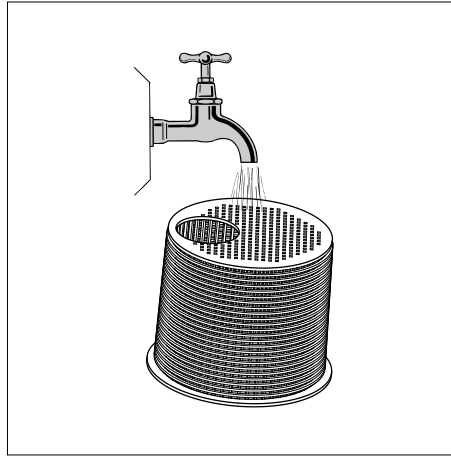
6 Maintenance

Checking and cleaning the raw water strainer

Daily, before starting.



9 Checking the raw water strainer



10 Cleaning the strainer

- Check daily whether there is any dirt in the raw water strainer.
- Close the seacock before removing the lid of the water strainer.
- Clean the raw water strainer as often as is necessary, depending on the pollution of the waterways, but at least once every 6 months. A clogged raw water strainer will result in excessive temperatures or overheating of the engine coolant.
- Check the sealing between the lid and housing after cleaning and re-assembling the strainer. An improperly sealed lid will result in air sucked in by the sea water pump which again will result in overheating of the engine.

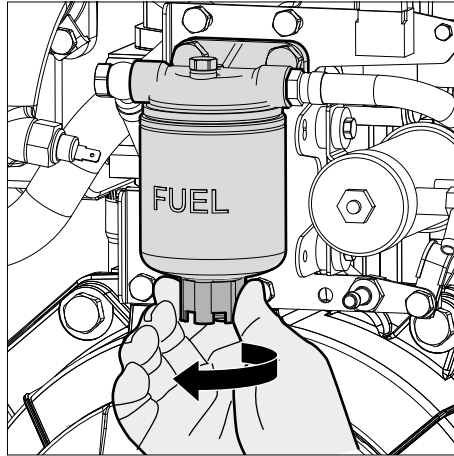
NOTE

Only engines with intercooling!

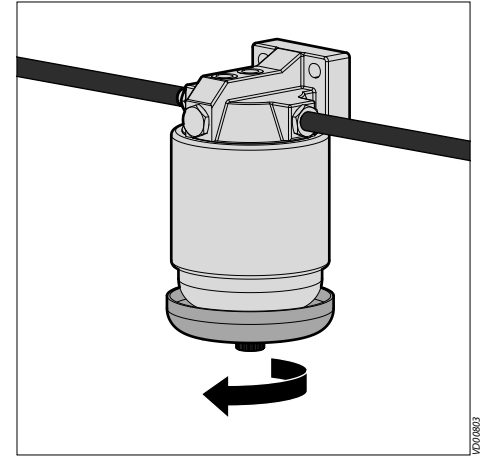
6 Maintenance

Draining of water from the water separator/fuel filter

Every 100 operating hours.



11 Empty fuel filter



12 Empty water separator



DANGER

Do not smoke when draining off water and sediment. Keep flame and sources of ignition out of the area. Remove spilled fuel and litter before you start the engine.

- Open the drain plug at the lower side of the filter.
- Drain the water and close the drain plug.

Empty the separately installed water separator/fuel filter:

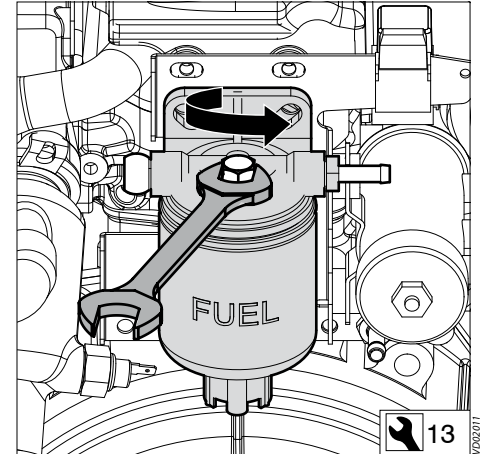
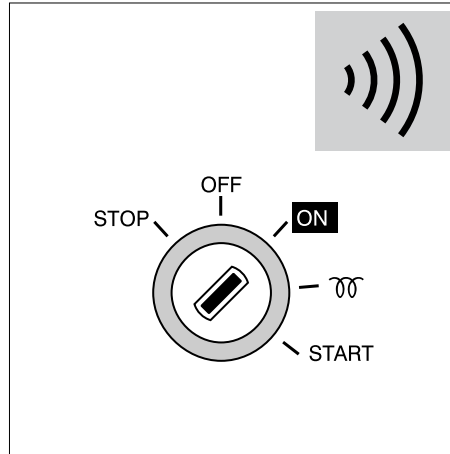
- Open the drain plug at the lower side of the filter.
- Drain the water and close the drain plug.

Note : The water separator is not within the scope of supply but installation is required!

6 Maintenance

Draining of water from the water separator/fuel filter

Every 100 operating hours.



13 Bleeding

After the water separator/fuel filter has been drained, the air has to be bled from the fuel system

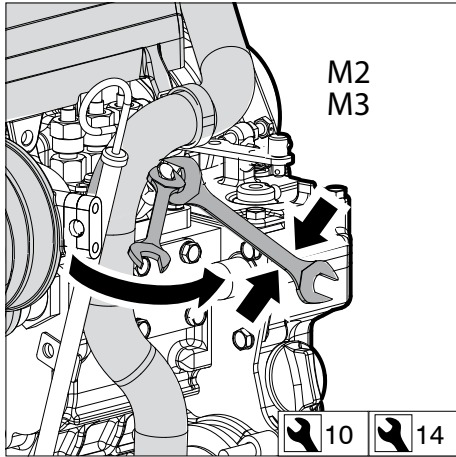
The fuel system is self-bleeding.

- Turn the key of the starter switch to position 'ON' and the fuel lift pump will feed the fuel system.

- Open the two bleeding nipples to speed up the bleeding process.

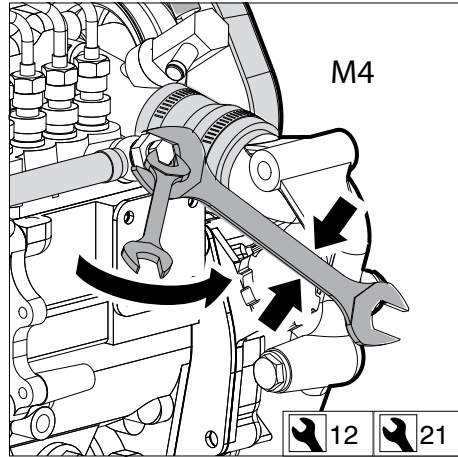
One (1) bleeding nipple is located at the filter.

6 Maintenance



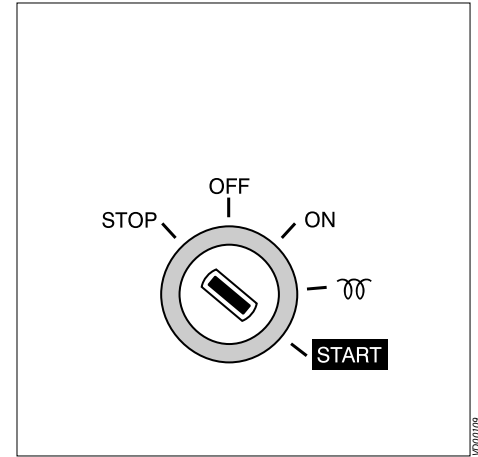
A second bleeding nipple is located at the fuel injection pump.

- Close the bleeding nipples when all air has escaped.



Draining of water from the water separator/fuel filter

Every 100 operating hours.



14 Start the engine

- Operate the starter switch until the engine fires; release the starter switch if the engine does not fire within 20 seconds.
- Wait until the starter motor has stopped before making a new attempt to start the engine.
- Repeat the above if the engine cuts out after a short time.

6 Maintenance

Engine oil change
Every 100 operating hours.

15 Engine oil change

Change the engine oil every 100 hours of operation (together with engine oil filter replacement).

If the engine runs less than 100 hours during the year the oil should be changed at least once a year.

Run the engine for a few minutes before changing the oil; warm oil can be pumped out more easily.

Change the oil with a switched off engine at operation temperature. (Lube oil temperature approx. 80°C (176°F).)



DANGER

Be aware of the risk of skin burning during draining the hot oil! Used oil must be collected in a container for proper disposal according to laws and regulations.



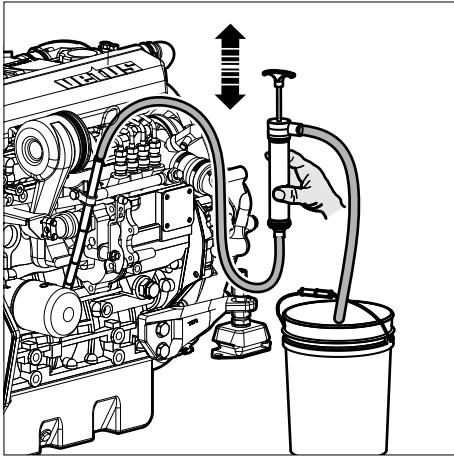
WARNING

Never use additives.

This could cause damage to the engine which is not covered by the guarantee.

6 Maintenance

Engine oil change
Every 100 operating hours.



16 Draining the oil

- Remove the dipstick; insert the suction hose of the supplied sump pump in the dipstick tube.
- Push down the pump handle quickly and pull it up slowly.
- Pump the sump empty.
- After draining remove the suction hose of the sump pump out of the dipstick tube.



WARNING

The engine oil must be disposed in accordance with the applicable environmental regulations.



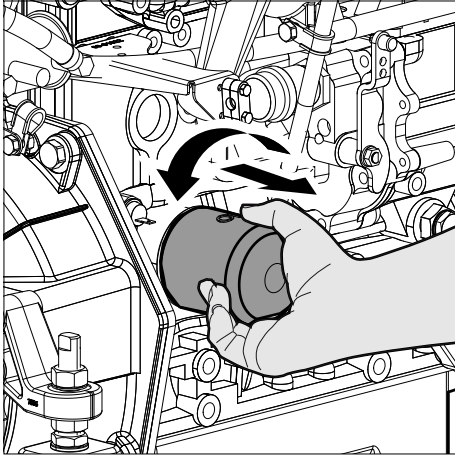
DANGER

Beware of burns from hot oil.

6 Maintenance

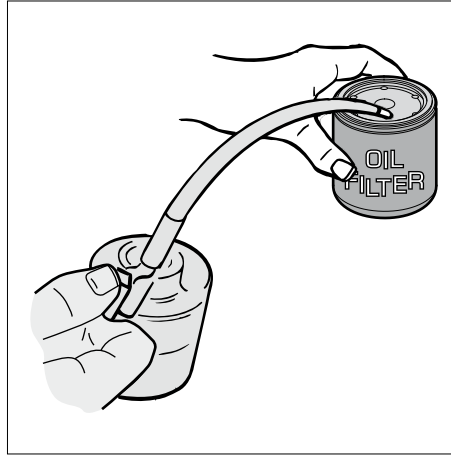
Engine oil change

Every 100 operating hours.



17 Removing the oil filter

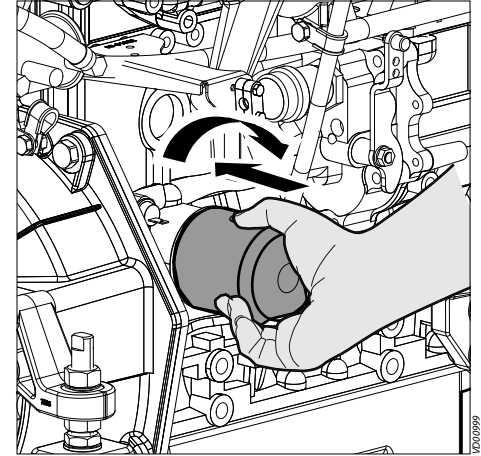
- Unscrew the oil filter, with a commercially available tool.
Catch any dripping oil.



18 Oiling the oil seal

- Clean the contact surface of the gasket.
- Lubricate the oil seal of the new filter element with clean engine oil.

For **oil filter art. code** see page **140**.



19 Oil filter installation

- Install the filter in accordance with the instructions printed on the filter element housing.

Tightening torque 11 - 13 Nm (8-10 ft.lbf)

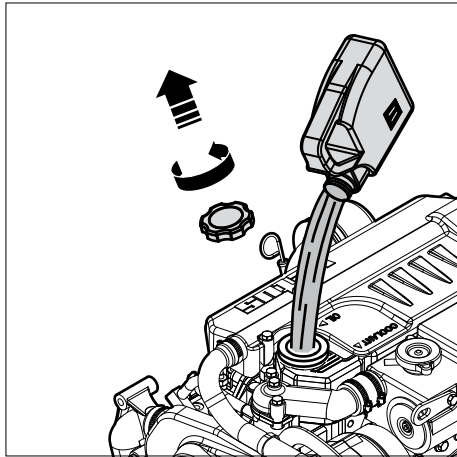


DANGER

Beware of burns from hot oil.

6 Maintenance

Engine oil change
Every 100 operating hours.



20 Refilling with oil

AMOUNT OF OIL (OIL FILTER INCL.):

	litres	Imp. pt	US pt
M2 :	2.5	4.4	5.3
M3 :	3.6	6.3	7.6
M4 :	5.7	10	12

- Refill the engine with new oil (for specification see page 126) through the filler opening in the valve cover.
- Operate the engine at idling speed for a short period of time. Check for oil leaks whilst the engine is running. Stop the engine. Allow 5 minutes for the oil to return to the sump. Check the oil level with the dipstick.

6 Maintenance

Warning notes and safety regulations for working with batteries



Wear eye protection.



Keep children away from acid and batteries.



Explosion hazard:

A highly-explosive oxyhydrogen gas mixture occurs when charging batteries, therefore:



Fires, sparks, naked flames and smoking are prohibited:

- Avoid causing sparks when dealing with cables and electrical equipment, and beware of electrostatic discharges.
- Avoid short-circuits.



Corrosive hazard:

Battery acid is highly corrosive, therefore:

- Wear protective gloves and eye protection.
- Do not tilt battery, acid can escape from the degassing openings or vents.



First aid:

- Rinse off acid splashed in the eyes immediately for several minutes with fresh water. Then consult a doctor immediately.
- Neutralize acid splash on skin or clothes immediately with acid neutralizer (soda) or soap suds and rinse with plenty of water.
- If acid is consumed, consult a doctor immediately.

Battery, cables and connections

Every 100 operating hours.



Warning note:

- Do not place batteries in direct daylight without protection.
- Discharged batteries can freeze up, therefore store in an area free from frost.



Disposal:

Hand in old batteries at a collection point.

Keep the batteries upright and do not tip during transport and storage to prevent acid leaking out.

Never dispose of old batteries as domestic waste.

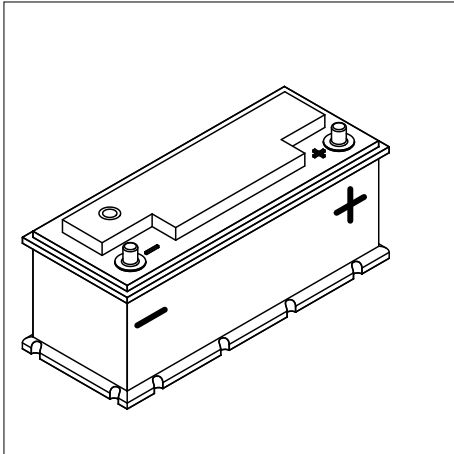


Careful! Metal parts of the battery will be always live so never lay objects or tools on the battery.

6 Maintenance

Battery, cables and connections

Every 100 operating hours.



21 Battery, battery connections

Keep battery clean and dry.

- Remove battery cables (negative first).
- Clean battery posts (+ and -) and clamps and grease with acid-free and acid-resistant grease.

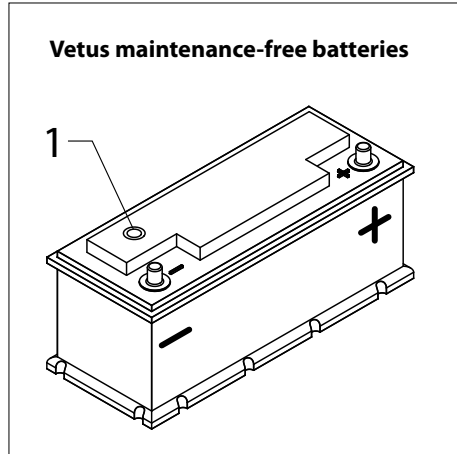
Ensure that clamps make good contact after reassembling.

- Hand tighten the bolts only.

6 Maintenance

Battery, cables and connections

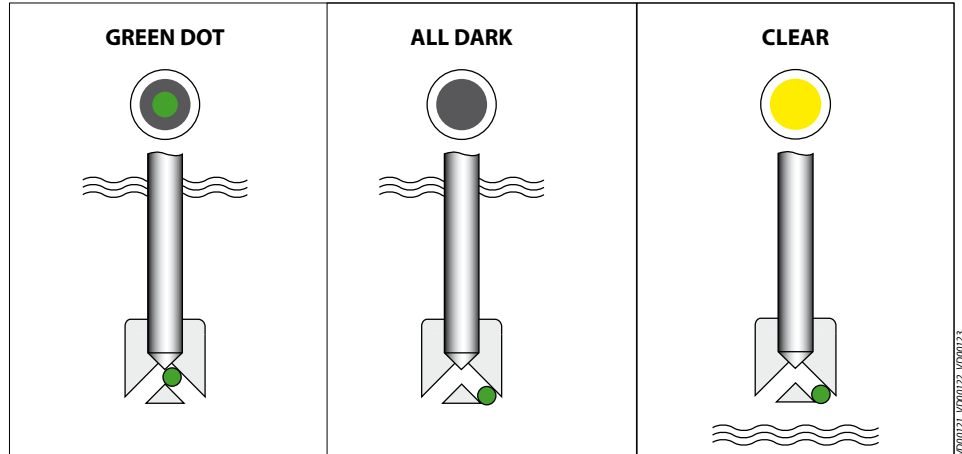
Every 100 operating hours.



22 Checking specific gravity

Every Vetus Maintenance-free battery has a hydrometer (1) built into the cover.

Visual inspection of the hydrometer will show one of three conditions:



23 Hydrometer operation

Green dot visible:

State of charge 65 % or more.

Dark:

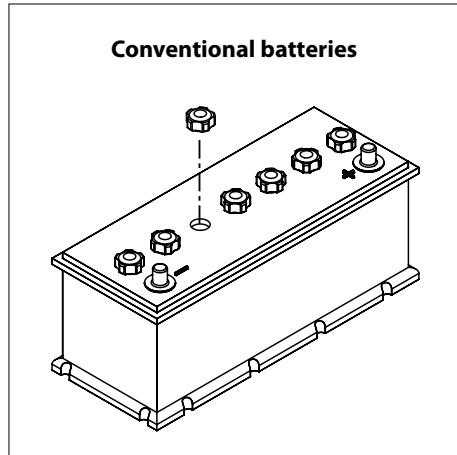
State of charge less than 65 %. Recharge immediately.

Clear or light yellow:

Electrolyte level low.

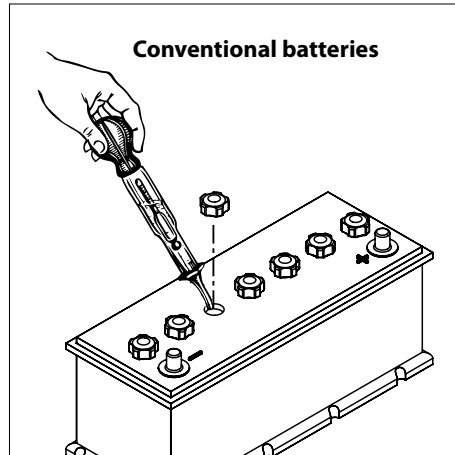
In case of low level, caused by overcharging the battery for a long period of time with a voltage too high, replace battery. Check alternator and/or voltage regulator.

6 Maintenance



24 Checking electrolyte level

For conventional batteries it is required to check the electrolyte level regularly. Remove vent caps (taking care no spark or open flame is nearby) and inspect the level. Fluid should be 10 to 15 mm ($\frac{3}{8}$ " to $\frac{5}{8}$ ") above top of all plates. If necessary top up with distilled water. Replace vent caps and charge the battery for 15 minutes at 15 - 25 Amps to mix electrolyte.



25 Checking specific gravity

Measure the electrolyte specific gravity of the individual cells with a commercial hydrometer. The hydrometer reading (see table) indicates the state of charge. Hydrometer reading of all cells should be at least 1.200 and show less than 0.050 between high and low. If not, recharge or replace battery.

Battery, cables and connections

Every 100 operating hours.

Specific gravity	State of charge	
1,8 kg/l	100%	
1.20 kg/l	50%	recharge
1.12 kg/l	10%	recharge immediately

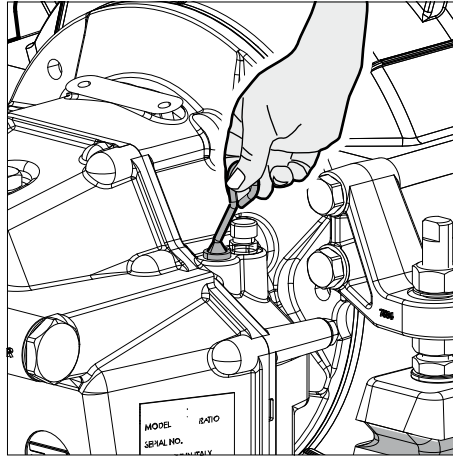
During checking the temperature of the electrolyte should preferably be 20°C (68°F).

Measuring the specific gravity shortly after water has been added results in an incorrect measurement. First charge the battery to mix the added water thoroughly.

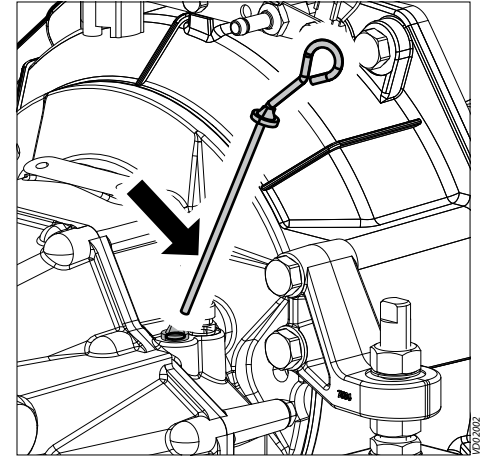
6 Maintenance

Gearbox oil level check

Every 100 operating hours.



26 Oil level check



Vetus engines are normally equipped with Technodrive or ZF-Hurth gearboxes. Consult the supplied Owners Manual for more details about care and maintenance. In case your engine is equipped with another brand of gearbox follow the instructions given in the supplied owners manual for changing oil and other care and maintenance.

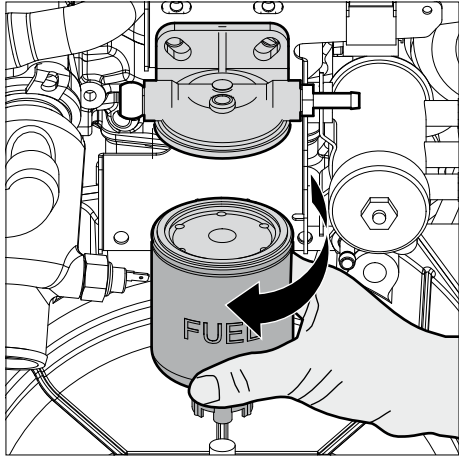
- Take the dipstick out of the gearbox housing by pulling or unscrewing.
- Check the oil level by lowering the dipstick (cleaned) into the hole.

The oil level must be between the two marks on the dipstick

- If necessary top up by pouring oil into the filler hole or the dipstick hole.

For oil type and specification see page **128**.

6 Maintenance



27 Fuel filter removal

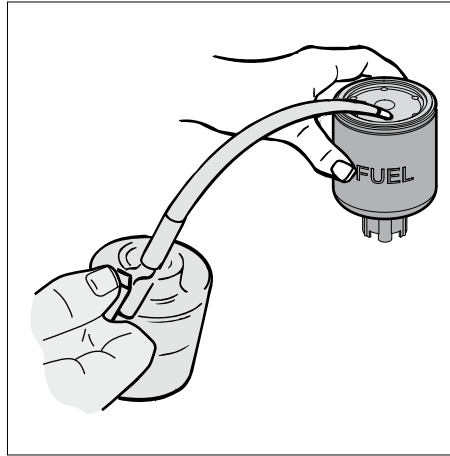
The fuel filter is to be replaced as a unit.

- Close the fuel stopcock.
- Remove the fuel filter, use a filter wrench. Catch any fuel.



DANGER

Keep naked flames away when working on the fuel system. Do not smoke!



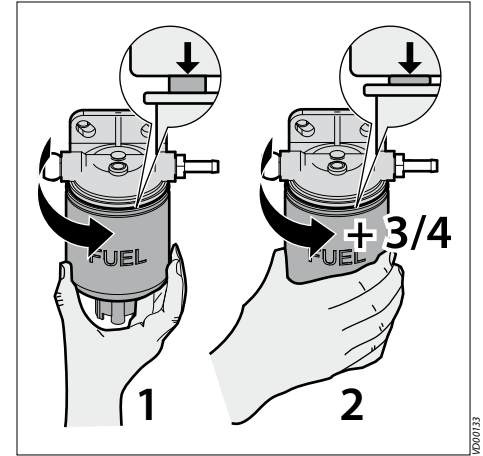
28 Fuel filter installation

- Clean any debris from the filter carrier rim.
- Lubricate the rubber gasket sparingly with clean engine oil.
- Fill the new filter with clean diesel fuel.

For **fuel filter art. code** see page **140**.

Fuel filter replacement

Every 500 operating hours.

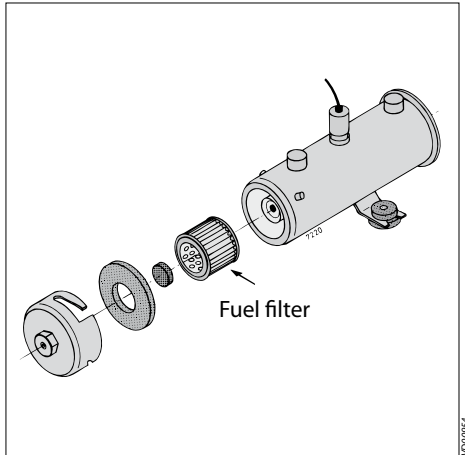


- Install the filter. When the rubber gasket touches the housing, apply another tightening of a half to three quarters of a turn by hand.
- Open fuel stopcock.
- Check for leaks.

6 Maintenance

Cleaning filter fuel lift pump

Every 500 operating hours.



29 Fuel lift pump

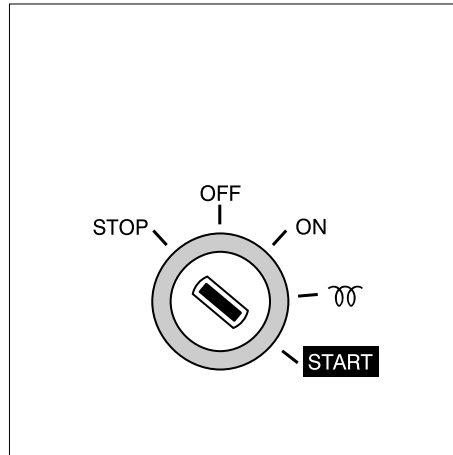
- Check, and if necessary clean, filter inside the fuel lift pump.
- Open the fuel stop cock.
- Check for leakage.

For **fuel filter art. code** see page **140**.

6 Maintenance

Bleeding, after fuel filter replacement

Every 500 operating hours.



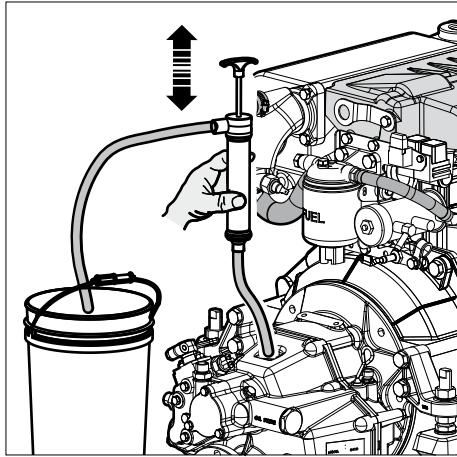
30 Bleeding

- After replacing the fuel filter the air has to be bled from the fuel system.
- For bleeding see page 45.

31 Start the engine

- Operate the starter switch until the engine fires; release the starter switch if the engine does not fire within 20 seconds. Wait until the starter motor has stopped before making a new attempt to start the engine.
- Repeat the above if the engine cuts out after a short time.
- Check for leaks once more.

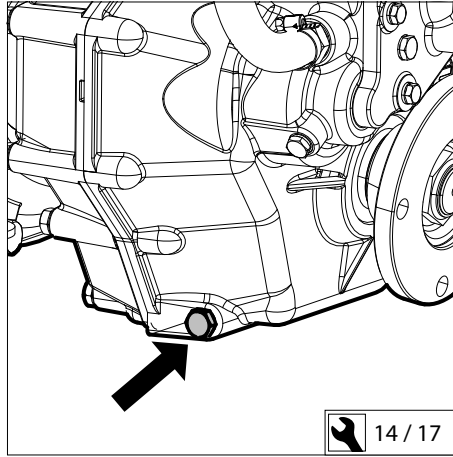
6 Maintenance



32 Draining the oil

Drain the oil with the aid of a separate sump pump.

- Remove the dipstick.
- Insert the suction hose of the sump pump in the dipstick hole. Push down the pump handle quickly and pull it up slowly.
- Remove the sump pump when all the old oil has been pumped out.

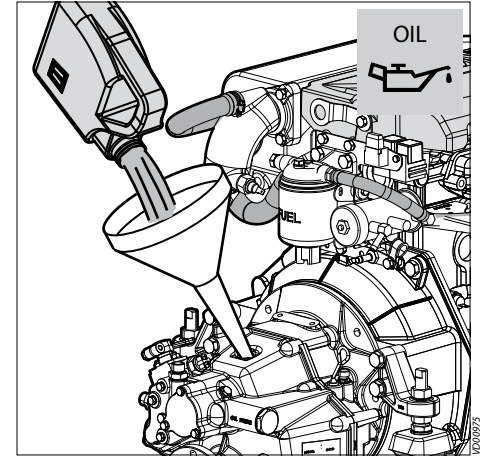


Or, if sufficient space below the gearbox is available, oil can be drained by removing the drain plug.

- Remove the filler cap to vent the gearbox and check if all oil has been drained
- Collect the oil in a dripping pan.

Changing the gearbox oil

Every 500 operating hours.



33 Filling with new oil

- Refill the gearbox to the correct level via the dipstick opening.

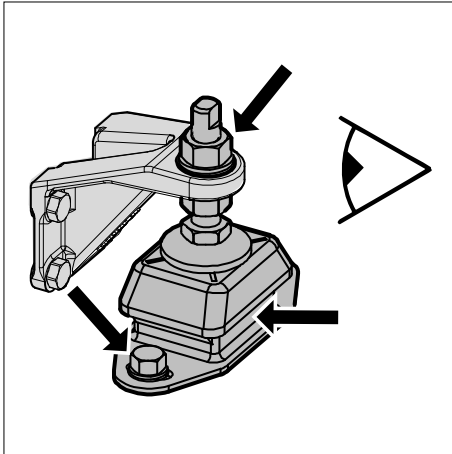
For oil specification see page [128](#).

In case your engine is equipped with another brand of gearbox follow the instructions given in the supplied owners manual for changing oil and other care and maintenance.

6 Maintenance

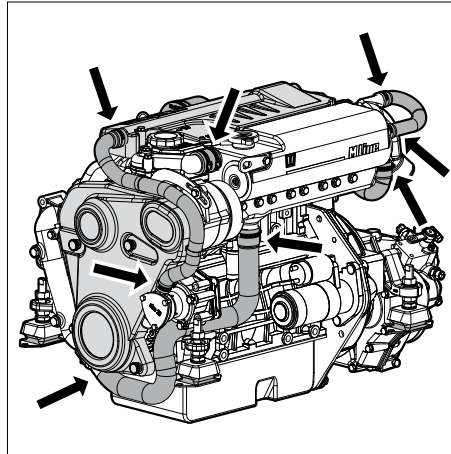
Flexible engine mounts, hose connections and fasteners

Every 500 operating hours.



34 Check flexible engine mounts

- Check the bolts which secure the damper element, the mounting bolts to engine bed and the nuts at the adjustment spindle for tightness.
- Inspect the rubber element of the engine support for cracks. Also check the deflection of the damper element, the deflection influences the alignment of engine and propshaft! Re-align engine in case of doubt.



35 Inspection hose connections

- Inspect all hose connections of the cooling-system. (Cracked hoses, loose hose clamps)

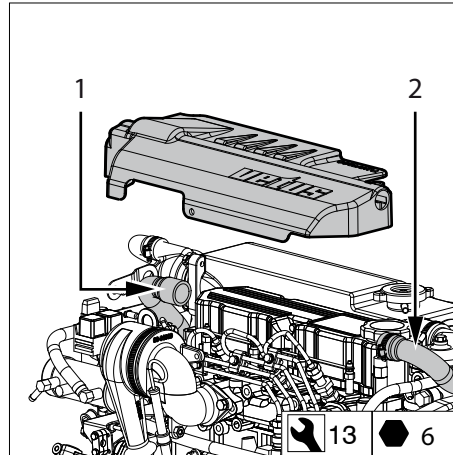
36 Check fasteners

- Check tightness of all fasteners, bolts and nuts.

6 Maintenance

Checking valve clearance

Every 500 operating hours.

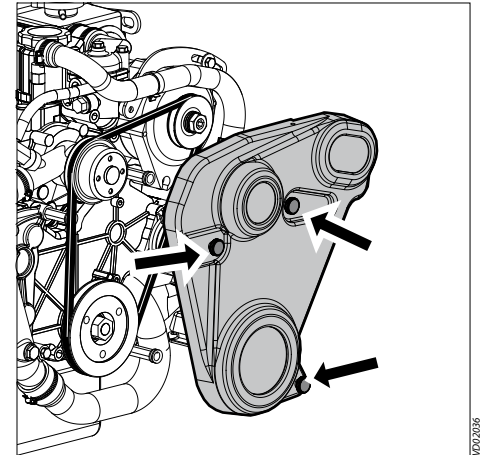


38 Remove upper cover

37 Checking / adjusting valve clearance

Checking the valve clearance must be done with a cold engine, that is an engine which did not run for at least 6 hours.

- Close the sea cock.
- Disconnect the hoses (1) and (2).
- Remove the 4 bolts and remove the upper cover.



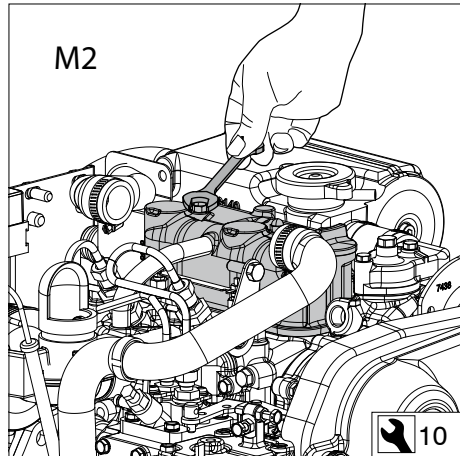
39 Remove the V-belt protection cover

- Loosen the the screws -the screws can be loosened without tools and they have anti-loss rings- and remove the V-belt protection.

NOTE

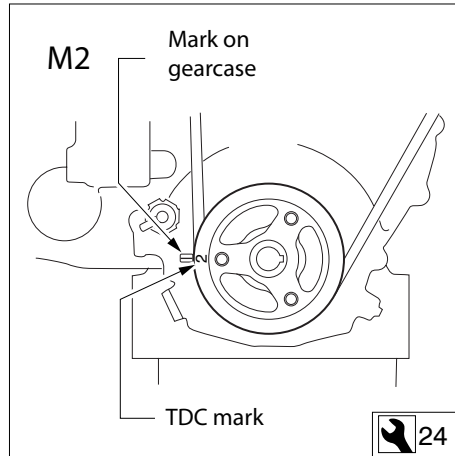
After checking / adjusting the valve clearance re-install the V-belt protection and the upper cover and re-connect the hoses.

6 Maintenance



40 Remove rocker cover

- Remove the 2 nuts of the rocker cover.
- Complete the following steps:



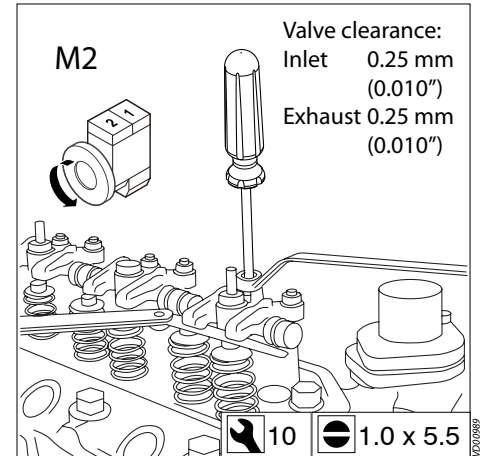
41 Locating TDC

- Locate the Top Dead Center (TDC), at the end of the compression stroke, for cylinder 1 by barring the engine slowly until the TDC marks of the engine block and the crank pulley match.

Note: There are two TDC's e.g. compression and suction. At the TDC at the end of the compression stroke the rocker arm does not move when the crank pulley is rotated a little.

Checking valve clearance

Every 500 operating hours.

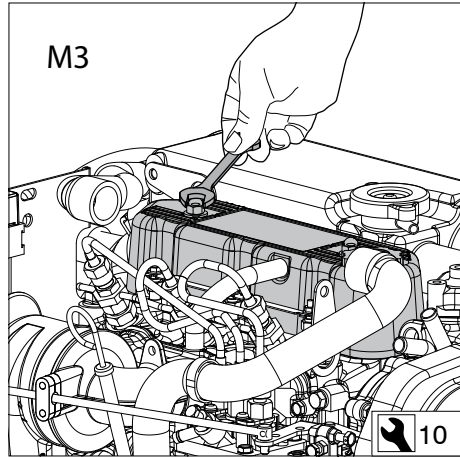


42 Adjusting valve clearance

Cylinders are numbered consecutively, beginning at the front end.

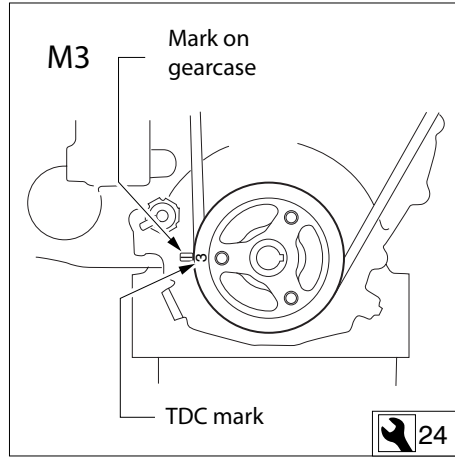
- Check valve clearance at cylinder 1 and adjust if necessary.
- Rotate the crankshaft 180° clockwise and check valve clearance at cylinder 2.

6 Maintenance



43 Remove rocker cover

- Remove the 2 nuts of the rocker cover.
- Complete the following steps:



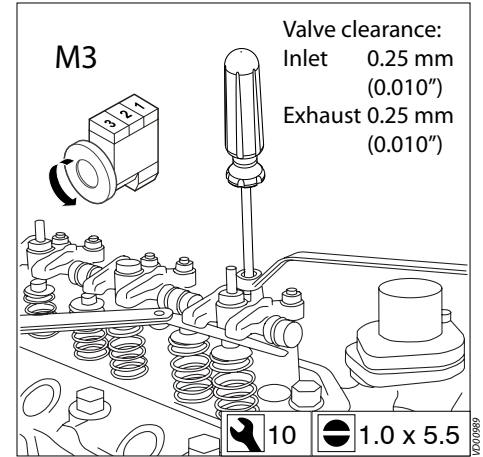
44 Locating TDC

- Locate the Top Dead Center (TDC), at the end of the compression stroke, for cylinder 1 by barring the engine slowly until the TDC marks of the engine block and the crank pulley match.

Note: There are two TDC's e.g. compression and suction. At the TDC at the end of the compression stroke the rocker arm does not move when the crank pulley is rotated a little.

Checking valve clearance

Every 500 operating hours.

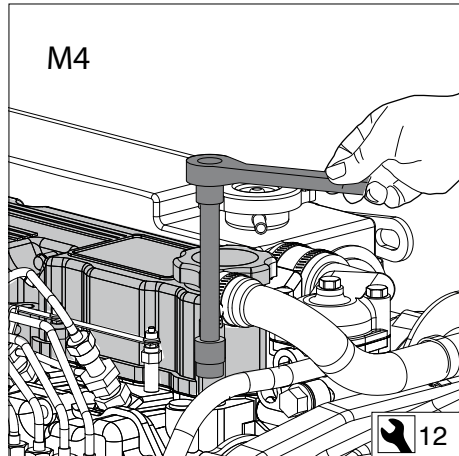


45 Adjusting valve clearance

Cylinders are numbered consecutively, beginning at the front end.

- Check valve clearance at cylinder 1 and adjust if necessary.
- Rotate the crankshaft 240° clockwise and check valve clearance at cylinder 3.
- Again rotate the crankshaft 240° and check valve clearance at cylinder 2.

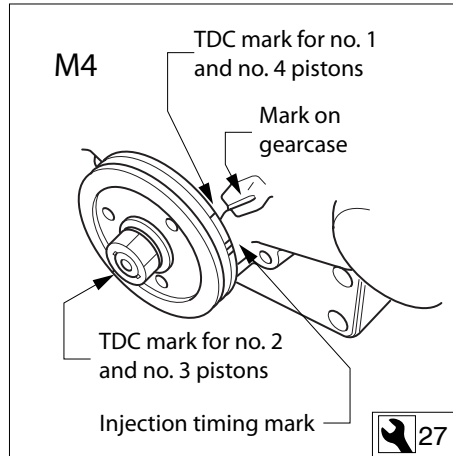
6 Maintenance



46 Remove rocker cover

- Remove the 2 nuts of the rocker cover.
- Complete the following steps:

Note 1: There are two TDC's e.g. compression and suction. At the TDC at the end of the compression stroke the rocker arm does not move when the crank pulley is rotated a little.



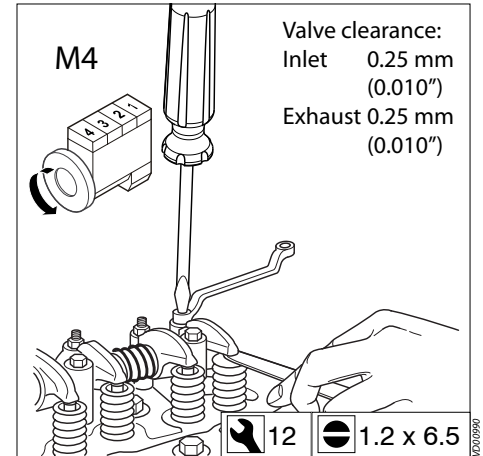
47 Locating TDC

- Locate the Top Dead Center (TDC), at the end of the compression stroke, for cylinder 1 by barring the engine slowly until the TDC marks of the engine block and the crank pulley match.

Note 2: Cylinders are numbered consecutively, beginning at the front end.

Checking valve clearance

Every 500 operating hours.

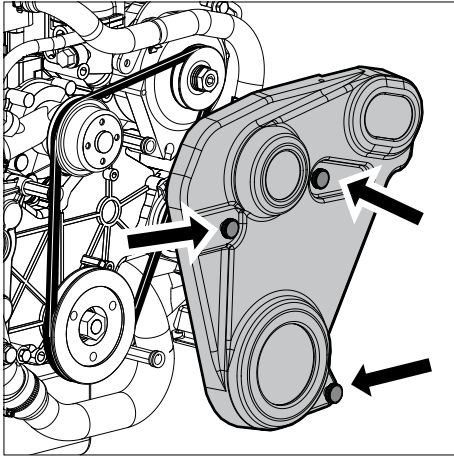


48 Adjusting valve clearance

- Check valve clearance at cylinder 1 and adjust if necessary.
- Rotate the crankshaft 180° clockwise and check valve clearance at cylinder 3.
- Again rotate the crankshaft 180° and check valve clearance at cylinder 4.
- Finally again rotate the crankshaft 180° and check valve clearance at cylinder 2.

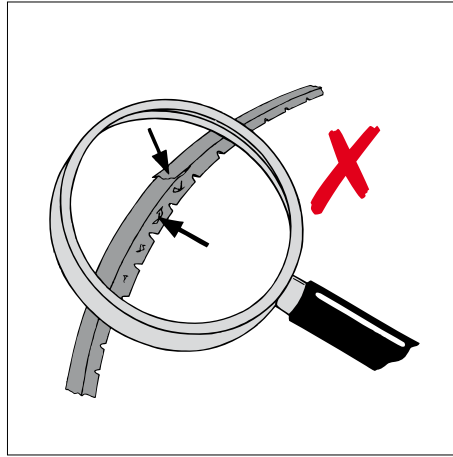
6 Maintenance

Checking the V-belt
Every 500 operating hours.



49 Remove the V-belt protection cover

- Loosen the the screws -the screws can be loosened without tools and they have anti-loss rings- and remove the V-belt protection.



50 Inspection V-belt

- Inspect the belt for wear and tear (fraying and cracking). Belts which are in poor condition should be replaced.

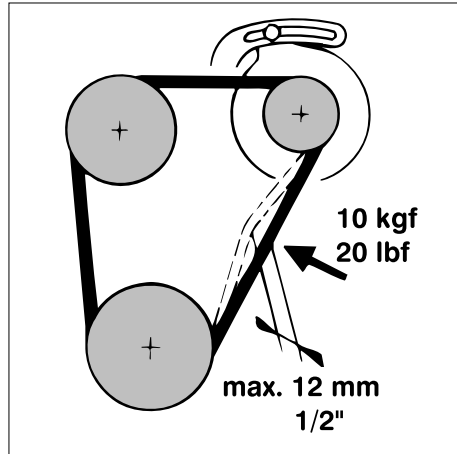
For **V-belt art. code** see page **140**.



DANGER

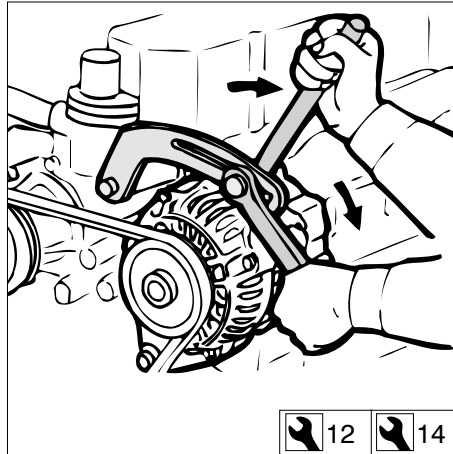
Check, tension and change belts only with the engine off. Refit belt guard, if provided.

6 Maintenance



51 Checking tension

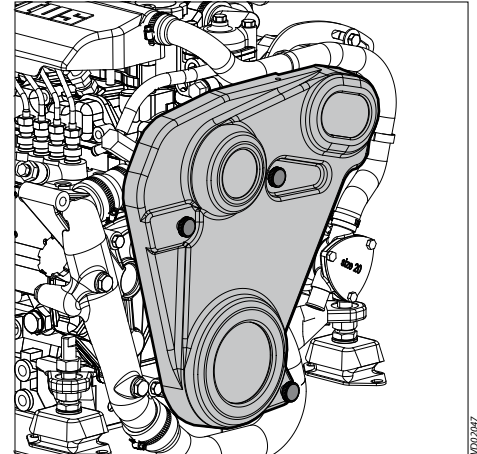
- Check tension of the V-belt by applying moderate finger and thumb pressure. If the deflection of the belt is more than 12 mm (1/2"), using about 10 kg (20 lbs) thumb pressure, it should be tensioned.



52 Tensioning V-belt

- Loosen the bolt of the adjustment bracket and both the alternator mounting bolts. Now push the alternator outwards until the belt tension is correct.
- Now first re-tighten the upper mounting bolt of the alternator.
- Then re-tighten the bolt of the adjustment bracket and the lower mounting bolt.

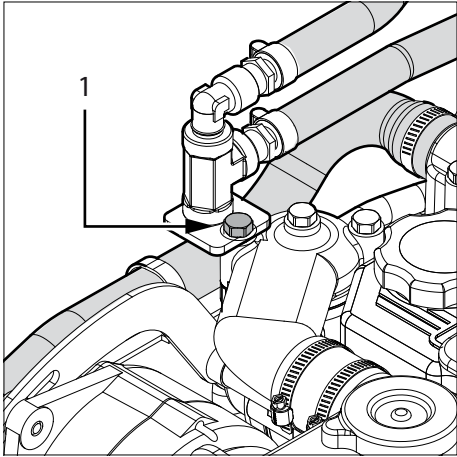
Checking the V-belt Every 500 operating hours.



53 Reinstall the protection cover

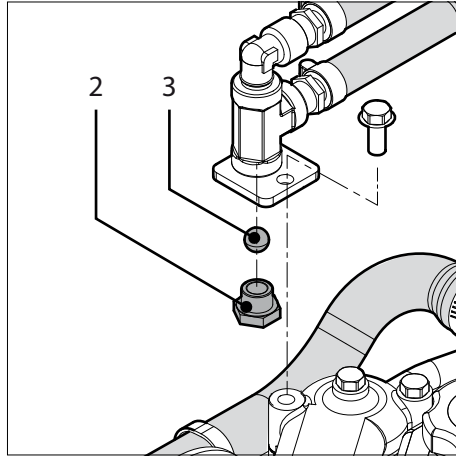
- Always reinstall the V-belt guard onto the engine.

6 Maintenance



54 Checking valve

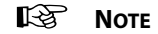
- Loosen bolt (1) and lift the valve from the engine.



- Remove the plug (2).
- Check if the ball (3) can move freely in the valve housing.
- Also inspect the ball for corrosion. A corroded ball needs to be replaced.

Checking valve oil sump ventilation

Once every year.



NOTE

Only at engines (SOLAS) for lifeboats!

- Re-assemble the valve in reverse order.

6 Maintenance



NOTE

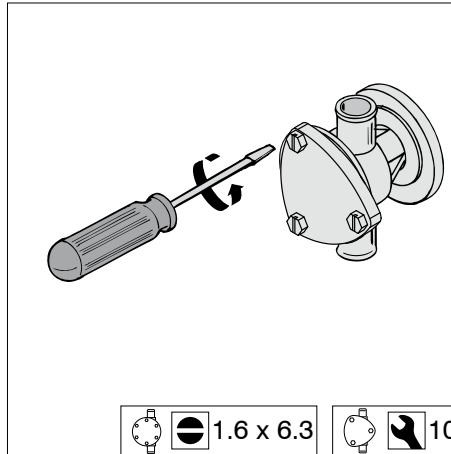
Only engines with intercooling!

55 Raw water pump inspection

The rubber impeller of the outboard water pump is not proof against running dry.

Note The impeller used on SOLAS engines is indeed proof against running dry.

If the water supply has been blocked, it may be necessary to replace the impeller. Always carry a spare impeller on board.



56 Pump cover removal

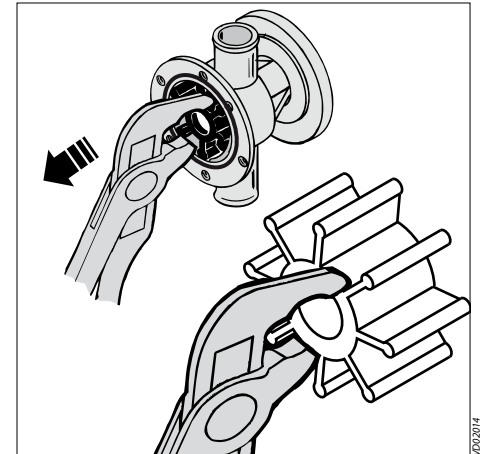
Inspection where appropriate changing is as follows:

- Close the sea cock.
- Remove the cover of the pump by unscrewing the screws out of the housing.

The position of the hose connections on the pump may be different as in the drawing

Raw water pump inspection

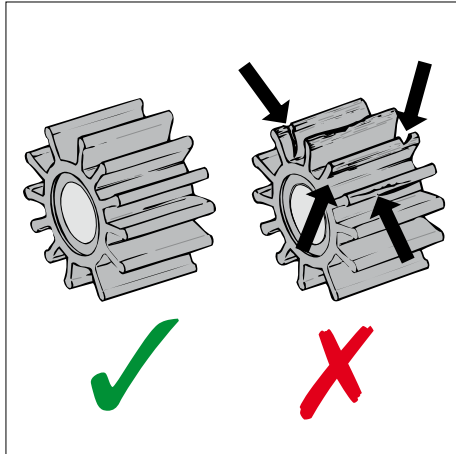
Every 1000 operating hours.



57 Impeller removal

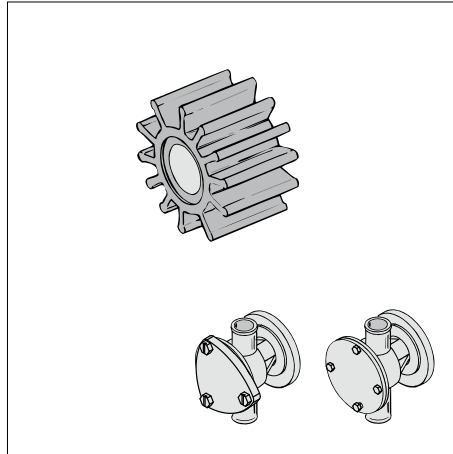
- Slide the impeller off of the shaft using a waterpump plier.
- Mark the impeller to ensure correct re-installation if it is to be re-used. The impeller must be installed in the same position as removed.

6 Maintenance



58 Impeller inspection

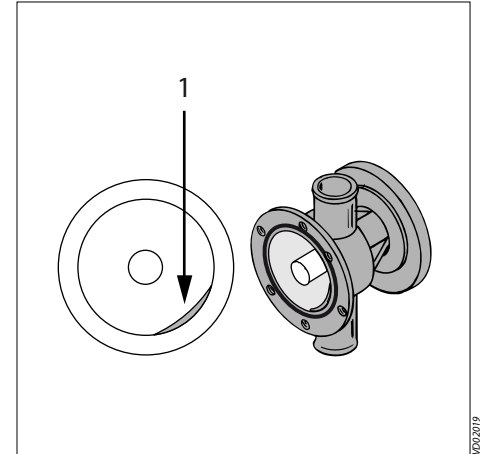
- Inspect the impeller for damage.
- Replace the impeller if necessary.



For **impeller art. code** see page 140.

Raw water pump inspection

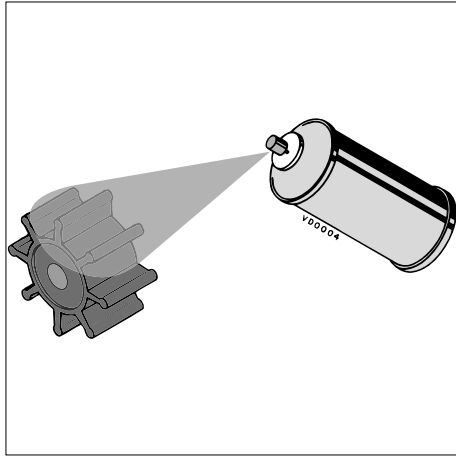
Every 1000 operating hours.



59 Pump housing inspection

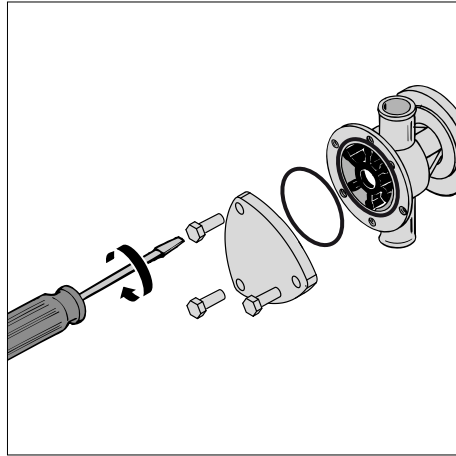
- Check the inside of the pump housing for damage. Pay special attention to wear of the cam (1).
- Replace the cam and/or the pump housing in case of excessive wear.

6 Maintenance



60 Re-install the impeller

- The impeller should be lubricated with glycerin or a non-petroleum based lubricant such as a silicone spray before fitting it into the impeller housing.
- Fit the impeller to the pump shaft. (if an existing impeller is re-used, install it in the same position as removed).



61 Reinstall the pump cover

- Reinstall the cover with a **new** O-ring.
- Check the water filter and open the sea cock.

For **O-ring art. code** see page **140**.

Raw water pump inspection

Every 1000 operating hours.

6 Maintenance

62 Coolant replacement

The coolant has to be replaced every 1000 operating hours or at least once every two years.

N.B. Replacing the coolant may also be necessary as part of the winter storage procedure; in case that the coolant present in the cooling system offers insufficient protection for the winter.



DANGER

Be aware of the risk of skin burning during draining the hot coolant! Used coolant must be collected in a container for proper disposal according to laws and regulations.



NOTE

Keel cooler

How the cooling system in engines with **keel cooling** should be drained depends on the installation of the keel cooler. Refer to the keel cooler manufacturer's instructions for this.

Check using a coolant hydrometer whether the coolant is providing sufficient protection against freezing if total draining off is not possible.

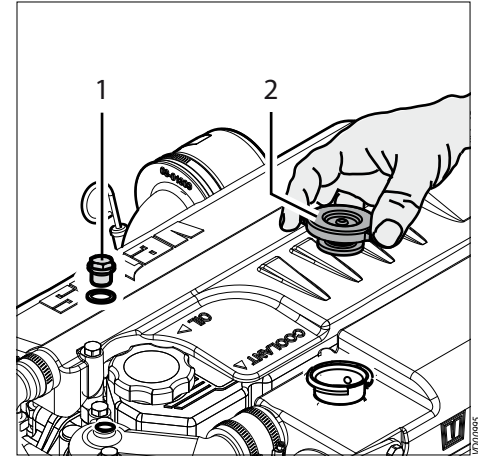


WARNING

Cooling system protective liquids must be disposed of in accordance with environmental regulations.



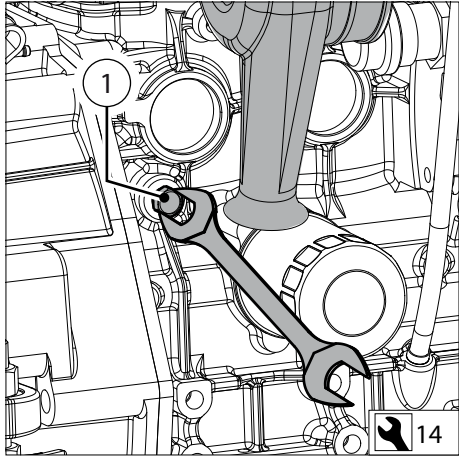
Coolant replacement Every 1000 operating hours.



63 Preparation

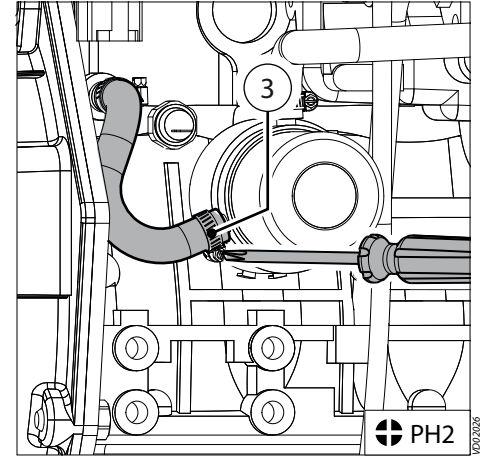
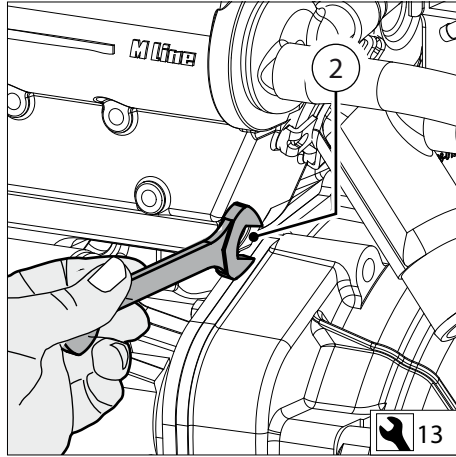
- Remove the plug (1) and the filler cap (2) to vent the cooling system.

6 Maintenance



64 Draining of coolant

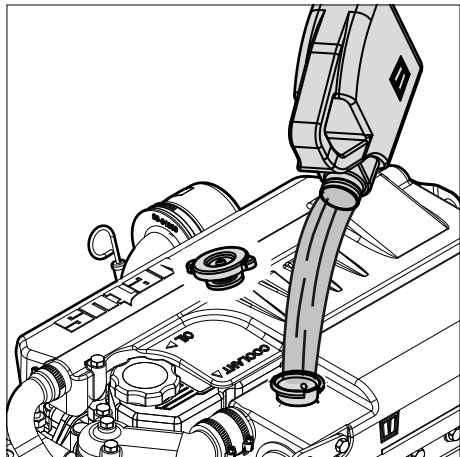
- Remove the drain plugs from the engine block (1) and heat exchanger housing (2).
- After draining replace the drain plugs.



Coolant replacement Every 1000 operating hours.

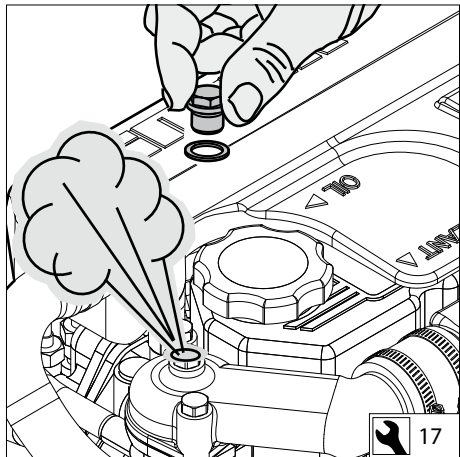
- For M4.56 and M4.55 SOLAS only
- Detach the hose to the oil cooler (3) and remove the drain plug from the heat exchanger housing (2).
- After draining re-install the hose and the drain plug.

6 Maintenance



65 Filling the cooling system

- Remove the cap of the filler neck on the top of the heat exchanger housing.
- Remove the bolt from the upper side of the thermostat cover, so that air can escape from the cooling system.
- Fill the cooling system.



Coolant replacement

Every 1000 operating hours.

Coolant quantity:

	litres	Imp. pt	US pt
M2 :	2.2	3.9	4.6
M3 :	3.0	5.3	6.3
M4 :	6.5	11.4	13.7



CAUTION

Never fill the cooling system with sea water or brackish water.

Use a mixture of 40% antifreeze (ethylene-glycol based) and 60% tap water or use a special coolant.

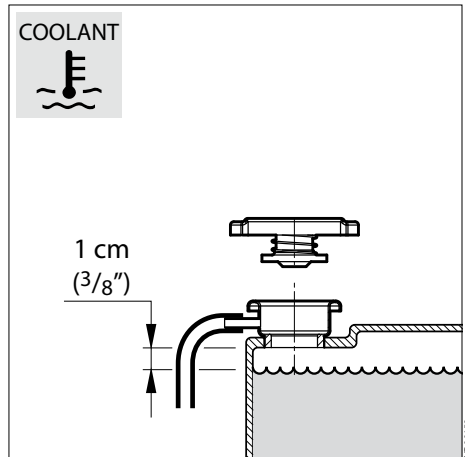
For specifications see page [129](#).



NOTE

For a keel-cooled version, see page [24](#).
If a water heater is connected, see page [26](#) and [27](#)

6 Maintenance



The level of the coolant must be approx. 1 cm (3/8") below the lower edge of the filler neck.

Bleeding will take place automatically during filling!

- After filling replace the filler cap and re-install the plug.

- After the engine has run for the first time and has reached operating temperature and has cooled down again to ambient temperature, check the coolant level in the heat exchanger housing.

- If necessary, add coolant.

Coolant replacement

Every 1000 operating hours.

WATER HEATER

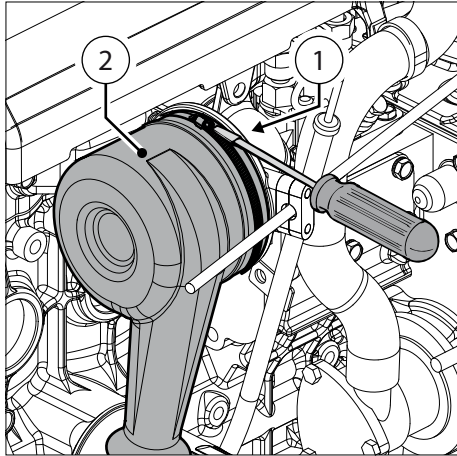
If a water heater is connected to the engine and this heater is positioned above the upper side of the engine than bleeding of the heater will not take place automatically! Fill the heater separately to bleed the cooling system completely.



CAUTION

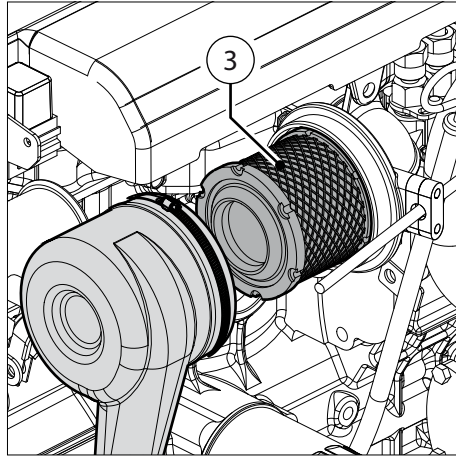
Never fill the cooling system with sea water or brackish water.

6 Maintenance



66 Air filter replacement

- Loosen the hose clamp (1).
- Remove the filter housing (2).



- Remove the old filter and fit a new filter (3).
- Replace the unit in reverse order and tighten the hose clamp again.

For **air filter art. code** see page **140**.

Air filter replacement

Every 1000 operating hours.

NOTE

Engines for lifeboats (**SOLAS**) are supplied **without an air filter**.

NEVER install an air filter into the filter housing at these engines.

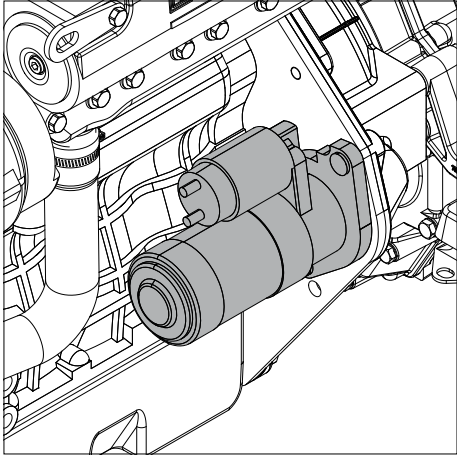
WARNING

Never clean the element with petrol or hot liquids.

Never apply any oil to the air filter.

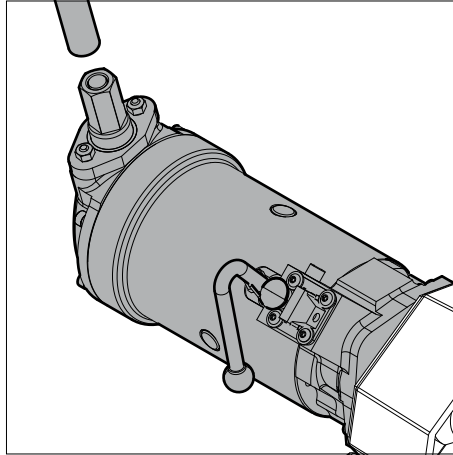
Never start the engine without the air filter in place.

6 Maintenance



67 Checking the starter motor

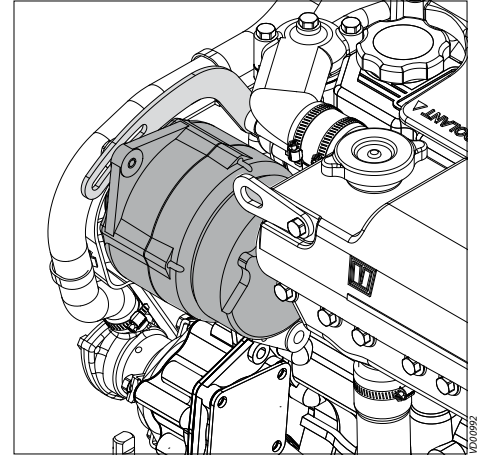
- Check for visible defects.
- Check whether the Bendix engages with the starter ring when the starter motor is activated. If the Bendix does not engage properly, contact your Vetus dealer.



- If a spring starter is installed then check functioning by starting the engine as described on pages 38 and 39.

Checking the starter motor and alternator

Every 1000 operating hours.



68 Checking the alternator

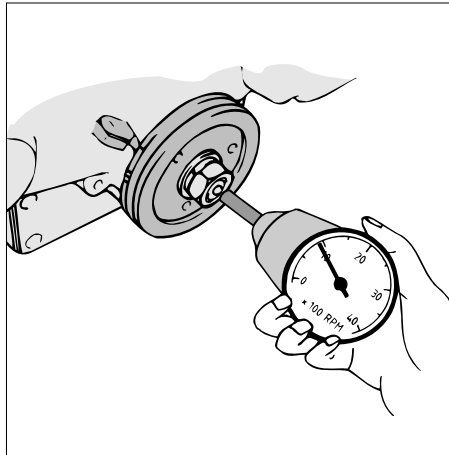
- Check for visible defects.
- Remove the alternator belt. Turn the pulley by hand to check whether the alternator can be turned easily. If this is not the case, contact your Vetus dealer.

6 Maintenance



WARNING

The maximum engine speed adjustment screw has been correctly set at the factory and sealed. DO NOT attempt to remove this seal.



69 Checking engine speed

At full load (with the boat cruising) the maximum engine speed should be approximately as specified in the table.

If the engine does not reach this speed, it is being overloaded!

If this is the case, check the ship's propeller for defects or irregularities, and also to see that it is the correct pitch and diameter.

- Allow the engine to warm up normally (until the coolant temperature reaches at least 60°C (140°F).
- Check the engine RPM using a rev. counter, or use the rev. counter fitted to the control panel.

Checking engine speed

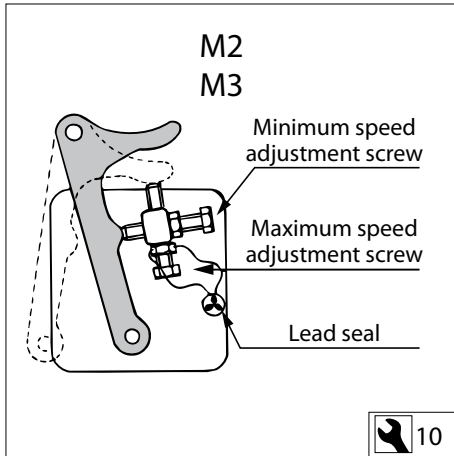
	Speed (rpm)	
	Max.	Idle
M2.13	3000	850
M2.18	3600	850
M3.29	3600	900
M3.28 SOLAS		
M4.35	3600	840
M415 SOLAS		
M4.45	3200	840
M4.17 SOLAS		
M4.56	3000	900
M4.55 SOLAS		

Idle speed must be as specified in the table.

- Now check the speed and adjust if required.

6 Maintenance

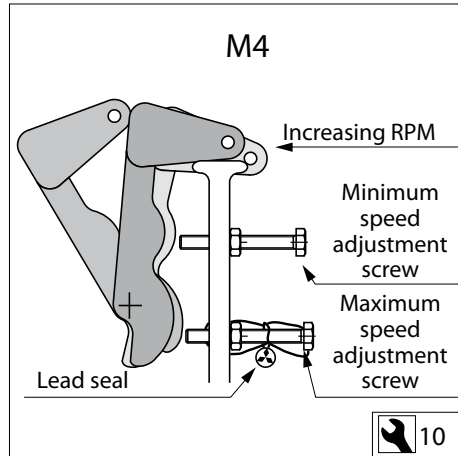
Checking engine speed



70 Adjusting engine idling speed

If the engine speed differs from that stated above, it must be adjusted.

The engine idling speed can be reset using the adjustment screw on the fuel pump.





NOTE

Cleaning of the heat exchanger is not a routine maintenance job.

Only clean the heat exchanger if this is (badly) fouled.

Under normal conditions of use cleaning the heat exchanger is not necessary!

The engine temperature will be higher than normal if the heat exchanger is fouled.

Possible causes of fouling are:

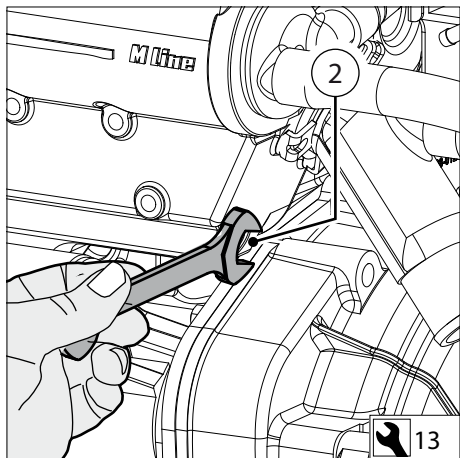
- Small rubber particles from a damaged sea water pump impeller.
- Growth of algae or seaweed.



NOTE

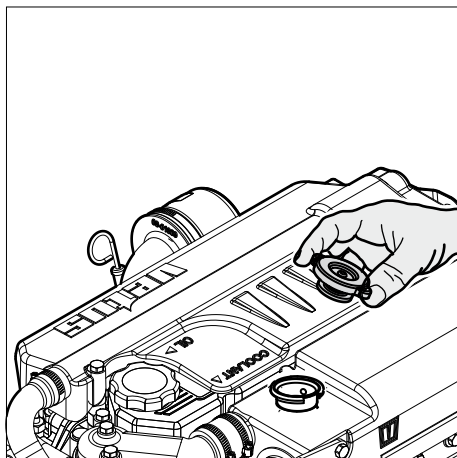
Only engines with intercooling!

6 Maintenance



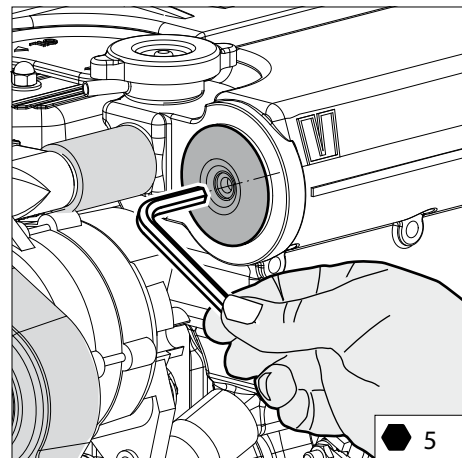
71 Remove the drain plug

- Close the seacock and detach the water inlet hose from the sea water pump.
- Drain the coolant: To do this, remove the drain plug from the heat exchanger housing.



- Remove the filler cap from the top of the heat exchanger housing to allow air into the system and check that all coolant has drained off.

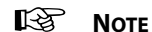
Cleaning the heat exchanger



72 Removal of bolts out of the end covers

- Take out both central bolts from the end covers and take the end covers with the O-rings out of the housing.

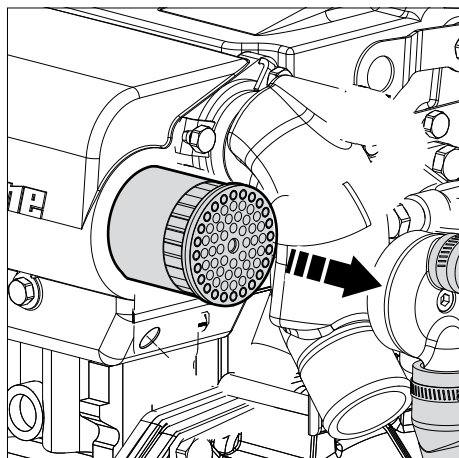
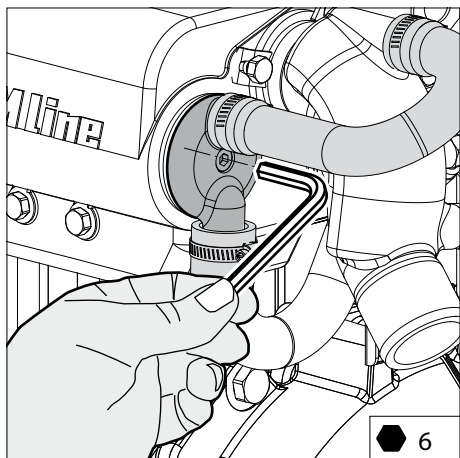
Turn the alternator outwards, by loosening the bolts and removing the V-belt, if more space is required for the Allen key.



NOTE

Only engines with intercooling!

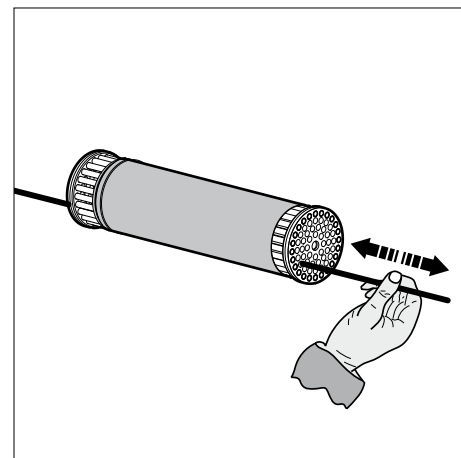
6 Maintenance



73 Remove heat exchanger

- Slide the heat exchanger out of the housing.
- At the M4.56 and M4.55 SOLAS the heat exchanger must be slide out of the housing to the front, instead of to the rear. Therefore loosen the bolts of the alternator, remove the V-belt and turn the alternator outwards.

Cleaning the heat exchanger



74 Cleaning the heat exchanger

- Clean the heat exchanger: Use a pipe cleaner to remove fouling in the pipes.
- Then rinse the heat exchanger pipes with clean water.
- Ensure that both heat exchanger end chambers are free from dirt.

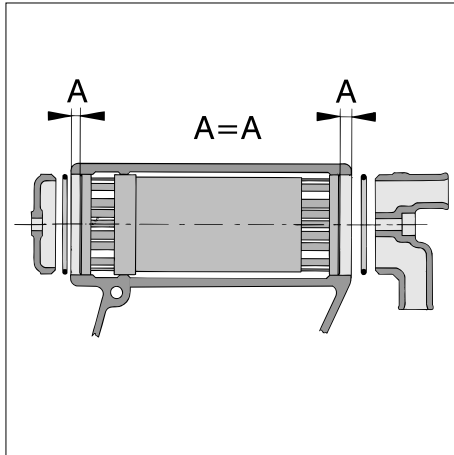


NOTE

Only engines with intercooling!

6 Maintenance

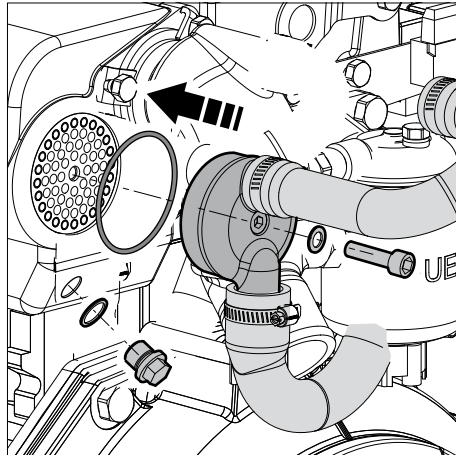
Cleaning the heat exchanger



75 Replacing heat exchanger

- Replace the heat exchanger in the original position in the heat exchanger housing.
- Use new O-rings (61 x 2.5 mm) which have been greased.

For **O-ring art. code** see page **140**.



76 Replacing the end covers

- Fit the end covers in the housing.
- Tighten up the bolts when both covers are in the **correct** position.
- Refit the drain plug.
- Reconnect all hoses previously removed.
- Refill the cooling system, see page **82**.



NOTE

Only engines with intercooling!

7 Lay-up / Winter storage procedure

In case of lay-up for a long period the storage procedures as described in this chapter should be carried out.

A long period means a period longer than 3 months, for example, during the winter period.

Make sure that the engine compartment is well ventilated during the winter period.

Good ventilation prevents damp in the engine compartment, thus preventing corrosion of the engine from occurring.

The engine should be inspected at the start of the storage period and any necessary repairs should be carried out.

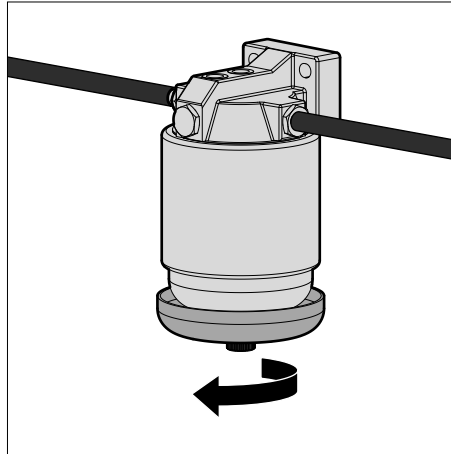
Consult a Vetus Dealer if help is required with this.

Inspections and maintenance work to be carried out are:

7 Lay-up / Winter storage procedure

Inspections and maintenance work to be carried out:		page
1	Clean the engine, remove any salt. Paint any rust spots and spray the whole engine with a protective medium, for example CRC protective 6-66.	94
2	Drain off the water from the fuel system and fill the fuel tank.	94
3	Make sure that the engine fuel system is filled with a fuel mixture with protective properties.	95
4	Flush out the raw water circuit with fresh water and if necessary fill with antifreeze. Clean the heat exchanger if necessary.	96
5	Make sure that the cooling system is filled with a suitable anti-freeze.	97
6	Change the oil filter and the engine oil.	98
7	Change the oil in the gearbox.	98
8	Disconnect the battery cables, charge the batteries if necessary and grease the battery terminals.	99

7 Lay-up / Winter storage procedure



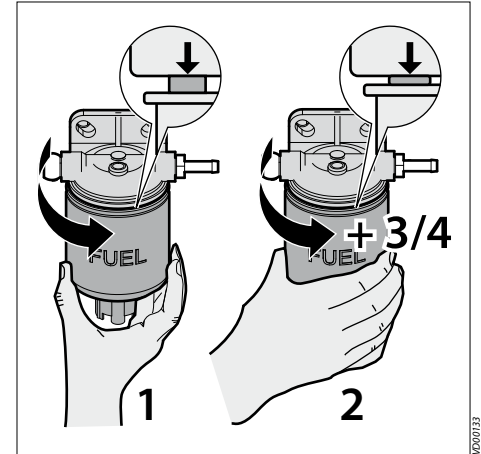
1 Corrosion protection

The various parts of the engine (except the engine block) have been treated with an anti-corrosion protective medium. In order to prevent corrosion, the engine should be rinsed off to remove any salt residues. If there is any corrosion, the paint should be touched up. Engine parts that become hot must be touched up with heat-resistant paint.

2 Fuel system

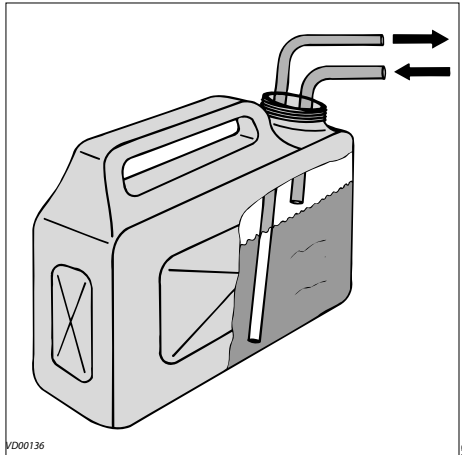
• Drain the water from the water separator/ fuel filter and the fuel tank.

Ensure that the tank is completely filled with fuel.



• Install a new fuel filter. (page 65).

7 Lay-up / Winter storage procedure



3 Protective fuel mixture

- Connect the fuel supply pipe to a can filled with protective diesel fuel, for example 'Calibration Fluid' (ISO 4113) or with a mixture of 1 part of engine oil [1] to 9 parts of clean fuel [2].
- Use this mixture to run the engine at **no load** for approx. 5 minutes.
- Stop the engine.



CAUTION

Never run the engine under load with this mixture of fuel and oil.



TIP!

Combine running the engine with the protective fuel mixture with flushing the raw water circuit with fresh water, see 'Winter storage procedure - Raw water cooling system'.

[1] Engine oil with protective properties.

E.g.:

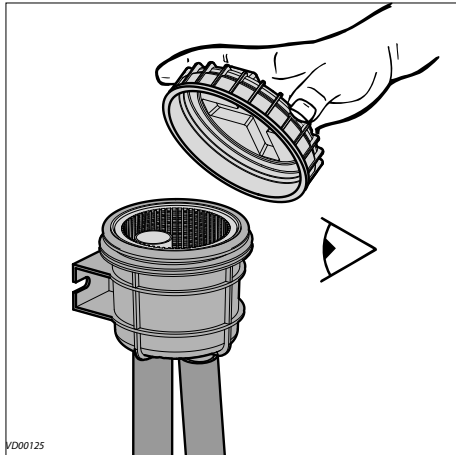
- Vetus Marine Diesel Engine Oil 15W40
- Shell Rimula R4 L 15W40

[2] Only use CEN EN 590 Diesel fuel.

Preferably water-free fuel.

Collect some fuel from the return pipe, while engine is running.

7 Lay-up / Winter storage procedure



4 Raw water cooling system

- Close the sea cock.
- Remove the lid of the water strainer.
- If necessary, clean the raw water strainer.

NOTE

Only engines with intercooling!

TIP!

Combine flushing the raw water circuit with fresh water with running the engine with the protective fuel mixture, see 'Winter storage procedure - Protective fuel mixture'

Heat exchanger

Only clean the heat exchanger if this is absolutely necessary, see page 88.

Raw water pump

Check the impeller of the raw water pump at least once every two years, see page 77.

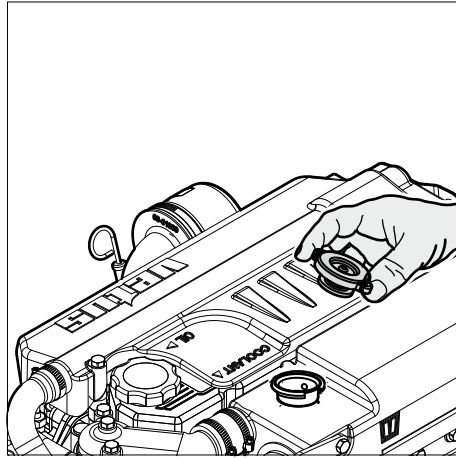
- Connect the raw water intake to a fresh water (tap water) supply or a tank containing fresh water. Open the tap and allow the engine to idle for at least 5 minutes to remove any salt and contamination from the raw water cooling system. Make sure that there is a sufficient supply of water to prevent the engine from overheating.
- Stop the engine and close the sea cock.
- The raw water system must be protected in areas where the temperature drops to below zero during the winter. Pour 1 litre (1/4 gallon) of anti-freeze (preferably a non-toxic biodegradable anti-freeze) into the water strainer and run the engine until the anti-freeze has disappeared into the cooling system.

7 Lay-up / Winter storage procedure

TIP!

Protect the sea cock as follows:
With the motor stopped.

- Place the sea cock in a position that it is just opening.
- Pour a small amount of non-toxic biodegradable anti-freeze into the raw water strainer.
- Close the sea cock as soon as it is filled with anti-freeze.



5 Fresh water cooling system

Anti-freeze can be toxic. Take care that no anti-freeze is spilled into the waterway

- Check the seal between the lid and housing after cleaning and re-assembling the strainer.

An improperly sealed lid will result in air sucked in by the raw water pump which again will result in overheating of the engine

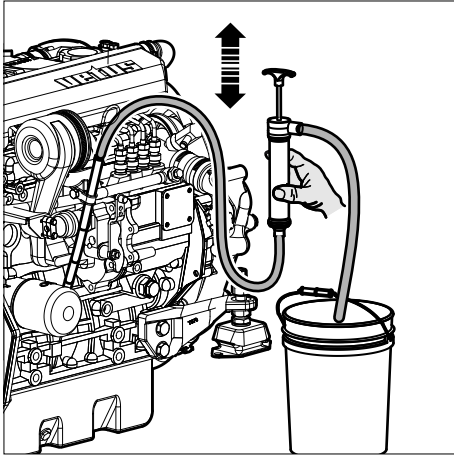
To avoid corrosion during winter storage the cooling system must be filled with an anti-freeze/water mixture (or a coolant).

For specifications see page [129](#).

N.B. Replacing the coolant is only necessary if the coolant present in the cooling system offers insufficient protection against temperatures below 0°C (32°F).

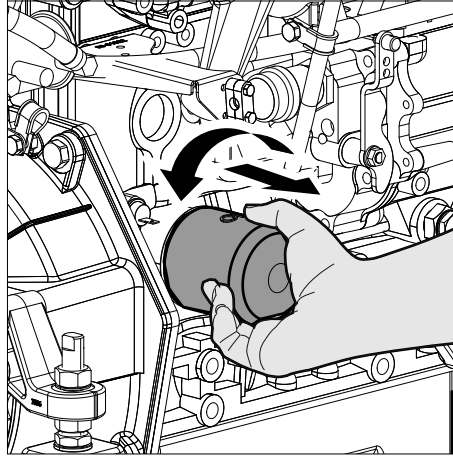
For coolant replacement see page [80](#).

7 Lay-up / Winter storage procedure



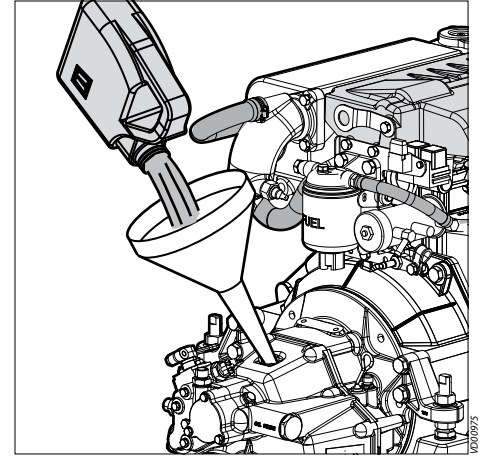
6 Lubrication system

With the engine still at operating temperature: (If not, run the engine until warm, then turn off.)



- Replace the oil filter and change the engine oil; use oil with protective properties. See page 56.

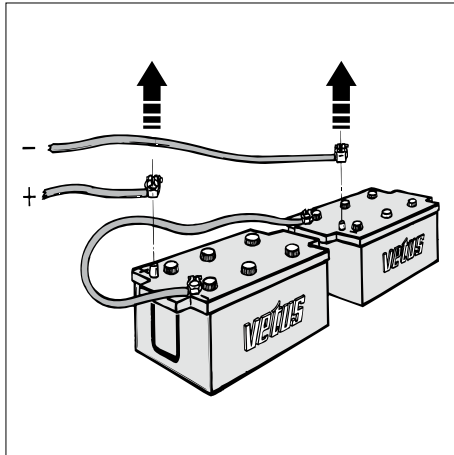
For quantity and oil specification see page 118 and 126.



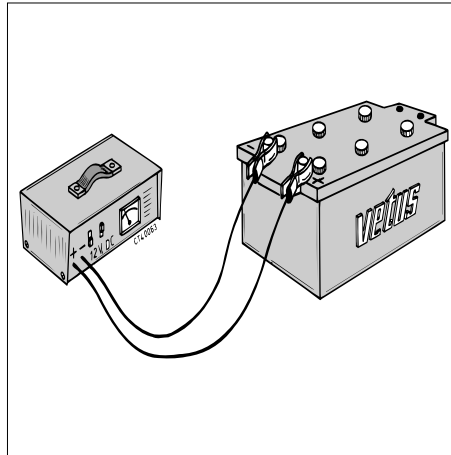
7 Changing the gearbox oil

- Stop the engine and change the oil of the gearbox. (page 68)

7 Lay-up / Winter storage procedure



8 Electrical system



- Disconnect the battery cables.
- Charge batteries during winter lay-up regularly if required!
- Follow the recommendations given on pages 60 to 63 or consult the recommendations given by the battery supplier for inspection and maintenance of the batteries.

8 Recommissioning after lay-up or winter storage

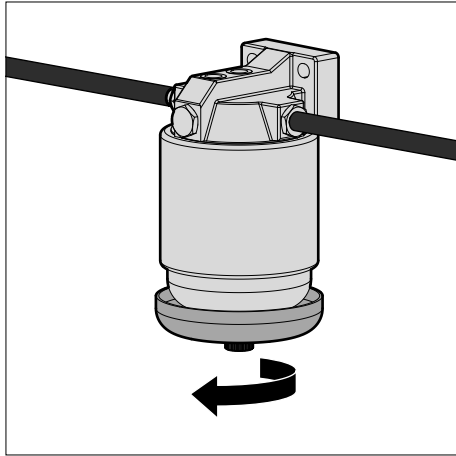
The engine must be inspected and any maintenance work carried out when re-commissioning for example at the beginning of the sailing season.

Consult a Vetus Dealer if help is required with this.

Inspections and maintenance work to be carried out are:

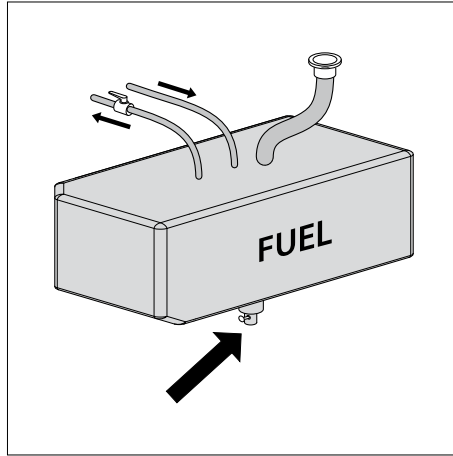
Inspections and maintenance work to be carried out are:		page
1	Drain the water from the fuel system.	101
2	Check the raw water system.	102
3	Check the coolant level in the internal cooling system.	103
4	Check the oil level.	103
5	Check the batteries and reconnect these.	104
6	Check the operation of the engine.	104
7	Check all hose connections for leaks.	105
8	Check the operation of the instruments and the engine controls.	105

8 Recommissioning after lay-up or winter storage

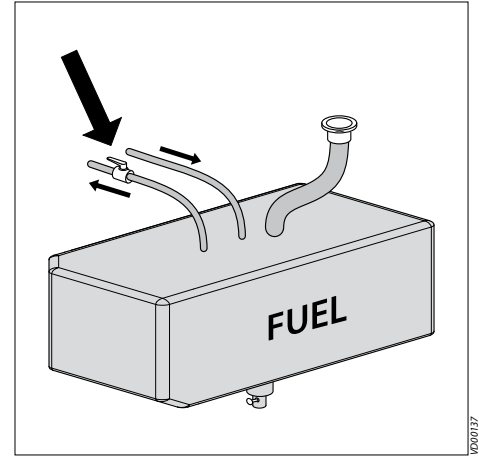


1 Fuel system

- Drain the water from the water separator/ fuel filter. (page 53)

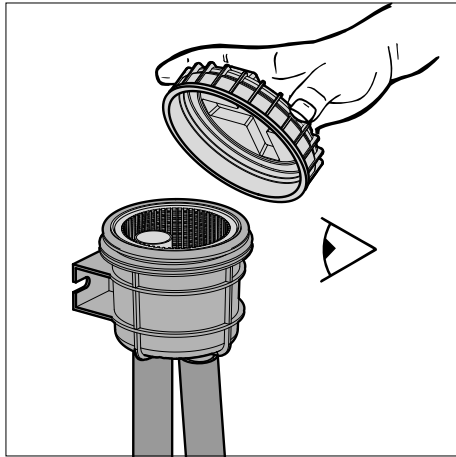


- Drain the water from the fuel tank.



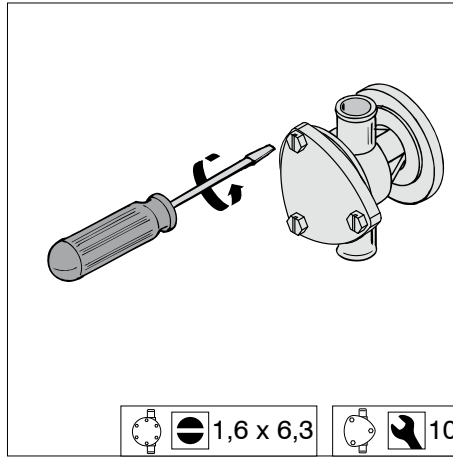
- Open the fuel valve.

8 Recommissioning after lay-up or winter storage

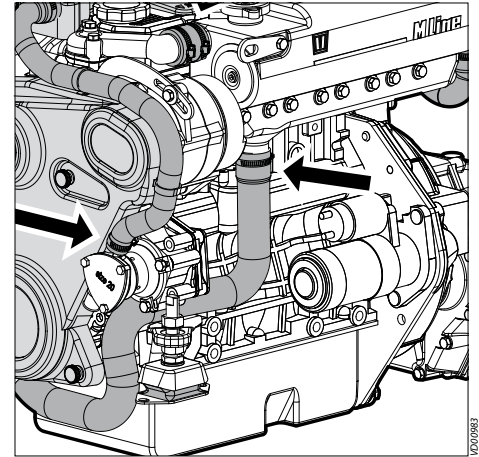


2 Raw water cooling system

- Check that the lid of the raw water strainer is reinstalled.



- Check whether the lid of the raw water pump and drain plugs are reinstalled. (pages 77, 81)



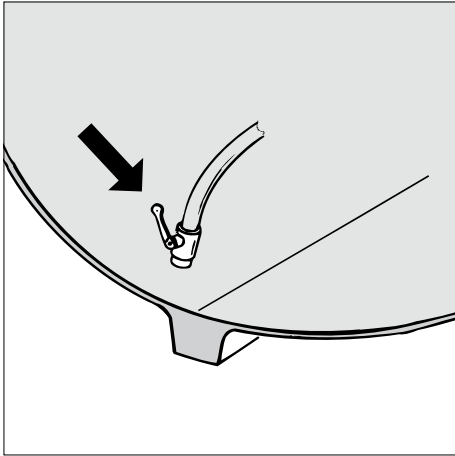
- Re-tighten possible loose hose clamps.



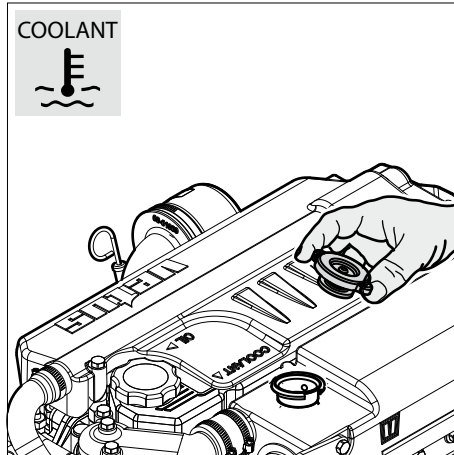
NOTE

Only engines with intercooling!

8 Recommissioning after lay-up or winter storage

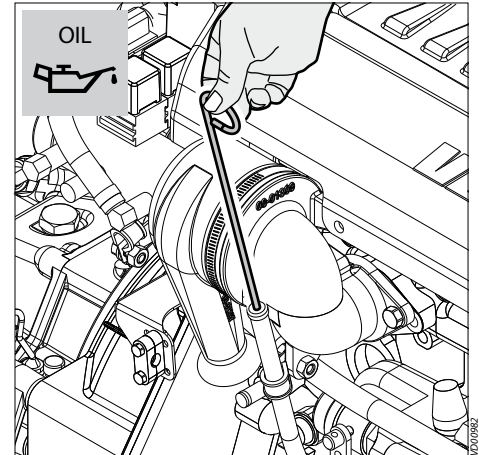


- Open the sea cock.



3 Fresh water cooling system

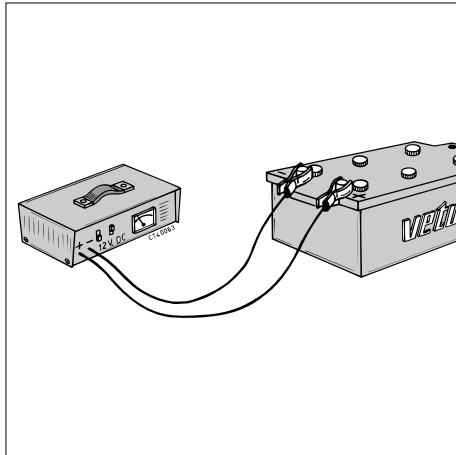
- Check the coolant level. (page 50)



4 Lubrication system

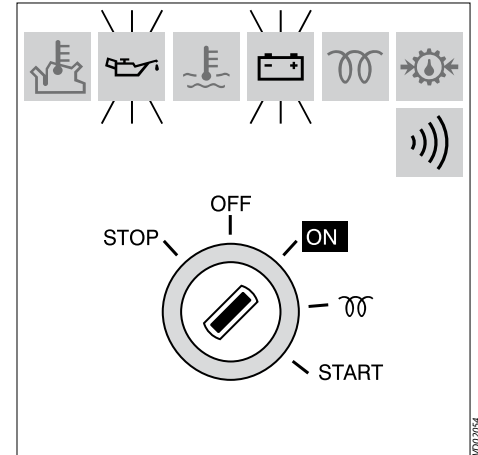
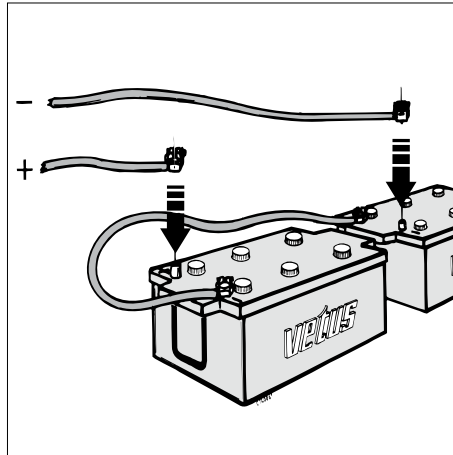
- Check the engine oil level. (page 48)

8 Recommissioning after lay-up or winter storage



5 Electrical system

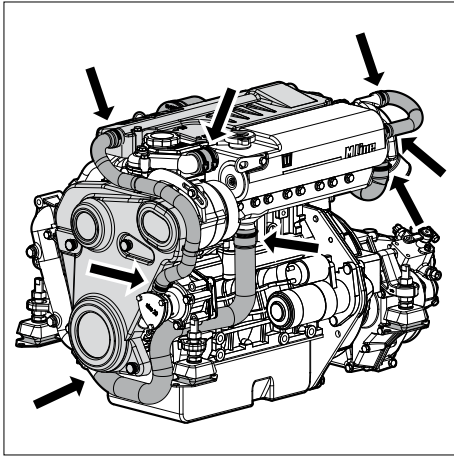
- Make sure that the batteries are fully charged. (page 60, 99)
- Connect the batteries.



6 Switching on

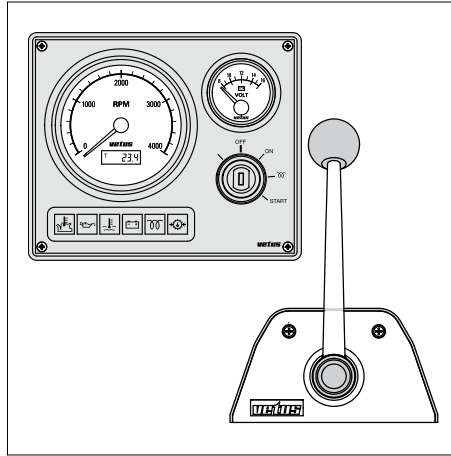
- Turn the start key on the instrument panel clock-wise; the warning lights for oil pressure and alternator will now light up and the alarm buzzer will sound.

8 Recommissioning after lay-up or winter storage



7 Check engine for leaks

- Start the engine.
- Check the fuel system, the cooling system and the exhaust for leakage.



8 Checking instruments and remote controls

- Check the operation of the instruments, the remote control and the gearbox.

Engine faults are in most cases caused by improper operation or insufficient maintenance.

Note Not all possible faults mentioned will be applicable to your engine.

In case of a fault, always check first that the operation and maintenance instructions have been followed.

In the following tables information is given about the possible causes of faults and suggested remedies. Please note that these tables can never be complete.

If you are unable to identify the cause of the fault or to rectify it yourself, then contact the nearest service representative.



DANGER

Before starting, make sure that nobody is in the immediate vicinity of the engine.

When carrying out repair, **never** start the engine with the fuel injection pump removed.

Disconnect battery!

	Fault	page
1	Engine will not crank	108
2	Engine cranks but will not start, no smoke from exhaust	108
3	Engine cranks but will not start, smoke from exhaust	109
4	Engine starts but runs unevenly (rough idling) or stalls	109
5	Engine does not reach maximum rpm under load	110
6	Engine overheats	111
7	Engine not firing on all cylinders	111
8	Engine has little or no oil pressure	112
9	Engine oil consumption excessive	112
10	Fuel consumption excessive	113
11	Black exhaust smoke (idling)	113
12	Blue exhaust smoke (idling)	113
13	Black exhaust smoke (at load)	114
14	White exhaust smoke (at full load)	114
15	Burnt oil trace in exhaust line .	115

9 Troubleshooting

Fault finding table

1 Engine will not crank

Possible fault	Remedy
Faulty or discharged battery (too low voltage).	Check / recharge battery and check engine alternator and/or battery charger.
Fuse blown.	Replace.
Loose or corroded connections in starting circuit.	Clean and tighten connections.
Wrong engine electric mass connection.	Repair.
Starter relay is not engaged due to a voltage too low; caused by a very long intermediate cable from engine to control panel.	Install an auxiliary starter relay
Faulty starter-switch or faulty starter-relay.	Check / replace.
Faulty starter-motor or pinion does not engage.	Check / replace starter-motor.
Seized components.	Repair.
Control lever not in neutral.	Put operating lever in neutral
Water in the cylinder.	Check / Repair.

2 Engine cranks but will not start, no smoke from exhaust

Possible fault	Remedy
(Nearly) Empty fuel tank.	Refill.
Fuel stop valve closed.	Open.
Fuel pre-filter clogged .	Clean /replace
Fuel filter clogged with water and/or contamination.	Check or replace.
Vent line of fuel supply tank clogged.	Check / clean.
Faulty injector/injection pump..	Check, replace if required.
Leaking fuel supply line or fuel injection line.	Check / replace.
Air in fuel system.	Check and bleed.
Electrical fuel low pressure pump is not working.	Check the electrical connection ,check the pump ,replace.
Dirt in the inlet or outlet valves of the electric fuel pump.	Install a strainer in the fuel line between tank and engine.
Electric fuel pump filter blocked.	Check / clean.
Exhaust restricted.	Check.

9 Troubleshooting

Fault finding table

3 Engine cranks but will not start, smoke from exhaust

Possible fault	Remedy
Faulty injector/injection pump.	Check, replace if required.
Air in fuel system.	Check and bleed.
Wrong fuel quality or contaminated fuel.	Check fuel. Drain and flush fuel tank. Replace with new fuel.
Incorrect injection timing.	Check / adjust.
Setting of stop valve incorrect.	Check / adjust.
Incorrect lube oil SAE class or quality for ambient temperature.	Replace.
Faulty glow plugs.	Check / replace.
Insufficient intake air.	Check.
Intake air filter clogged .	Clean/replace
Incorrect valve clearance.	Adjust.

4 Engine starts but runs unevenly (rough idling) or stalls

Possible fault	Remedy
(Nearly) Empty fuel tank.	Refill.
Fuel supply line restricted.	Check / clean.
Fuel filter clogged with water and/or contamination.	Check or replace.
Vent line of fuel supply tank clogged.	Check / clean.
Faulty injector/injection pump.	Check, replace if required.
Leaking fuel supply line or fuel injection line.	Check / replace.
Air in fuel system.	Check and bleed.
Wrong fuel quality or contaminated fuel.	Check fuel. Drain and flush fuel tank. Replace with new fuel.
Exhaust restricted.	Check.
Incorrect valve clearance.	Adjust.
Idle setting too low.	Check/ adjust.
Clogged filter of electric fuel lift pump.	Check / clean.

9 Troubleshooting

Fault finding table

5 Engine does not reach maximum rpm under load

Possible fault	Remedy
Fuel pre-filter clogged .	Clean /replace
Fuel filter clogged with water and/or contamination.	Check or replace.
Clogged injectors	Check, replace if required.
Faulty injector/injection pump.	Check, replace if required.
Leaking fuel supply line or fuel injection line.	Check / replace.
Air in fuel system.	Check and bleed.
Wrong fuel quality or contaminated fuel.	Check fuel. Drain and flush fuel tank. Replace with new fuel.
Incorrect injection timing.	Check / adjust.
Setting of stop valve incorrect.	Check / adjust.
Oil level too high.	Lower level.
Lubricating oil incorrect SAE spec or quality for ambient temperature.	Replace.
Insufficient intake air.	Check.
Leak in inlet manifold.	Check / replace.
Exhaust restricted.	Check / clean.
Incorrect valve clearance.	Adjust.
Transmission defect.	Check
Turbocharger damaged .	Replace

5 Engine does not reach maximum rpm under load

Possible fault	Remedy
Engine overloaded.	Check size of propeller.
Boat load inadequate .	-
Hull/propeller dirty .	Clean

9 Troubleshooting

Fault finding table

6 Engine overheats

Possible fault	Remedy
Faulty injector/injection pump.	Check, replace if required.
Sea cock closed.	Open.
Raw water strainer clogged.	Check / clean.
Faulty raw water pump impeller.	Check / replace.
Leak in raw water feed system.	Check / replace.
Coolant level too low.	Check / top up.
Faulty coolant pump.	Check / replace.
Faulty thermostat.	Check / replace.
Leak in coolant circuit .	Check.
Heat exchanger dirty or clogged as a result of rubber particles from a worn impeller.	Check / clean.
Oil level too low.	Increase level.
Oil level too high.	Lower level.
Faulty oil filter.	Replace.
Insufficient intake air.	Check / replace air intake filter.
Leak in inlet manifold.	Check / replace.
Faulty turbo compressor.	Check / replace.
Motor becomes apparently overheated as a result of faulty temperature switch, sensor or meter.	Check / replace.

7 Engine not firing on all cylinders

Possible fault	Remedy
Fuel supply line restricted.	Check / clean.
Fuel filter clogged with water and/or contamination.	Check or replace.
Faulty electric fuel pump.	Check / replace.
Faulty injector/injection pump.	Check, replace if required.
Leaking fuel supply line or fuel injection line.	Check / replace.
Air in fuel system.	Check and bleed.
Faulty glow plugs.	Check / replace.
Incorrect valve clearance.	Adjust.

9 Troubleshooting

Fault finding table

8 Engine has little or no oil pressure

Possible fault	Remedy
Oil level too low.	Increase level.
Incorrect lube oil SAE class or quality for ambient temperature.	Replace.
Blocked oil filter.	Replace.
Faulty oil pump.	Repair / replace.
Oil leaks .	Check.
Excessive inclination of engine.	Check / Adjust.
Oil pressure apparently too low due to faulty oil pressure switch, sensor or meter.	Check / replace.

9 Engine oil consumption excessive

Possible fault	Remedy
Oil level too high.	Lower level.
Incorrect lube oil SAE class or quality for ambient temperature.	Replace.
Leak in lubricating oil system.	Repair / replace.
Insufficient intake air.	Check.
Excessive wear of cylinder/piston.	Check compression; overhaul engine.
Turbocharger leaks oil.	Repair / replace.
Engine overloaded.	Check size of propeller. Clean the propeller.
Excessive inclination of engine.	Check / Adjust.

9 Troubleshooting

Fault finding table

10 Fuel consumption excessive

Possible fault	Remedy
Faulty injector/injector pump.	Check, replace if necessary.
Incorrect fuel quality or dirty fuel.	Check fuel. Drain and rinse fuel tank. Replace with new fuel.
Fuel leaks .	Check and repair.
Incorrect injection timing.	Check / adjust.
Insufficient air intake.	Check.
Excessive wear of cylinder / piston.	Check compression; refurbish engine.

11 Black exhaust smoke (idling)

Possible fault	Remedy
Injector fault	Check /replace.
Oil level too high.	Lower level.
Excessive inclination of engine.	Check / Adjust.

12 Blue exhaust smoke (idling)

Possible fault	Remedy
Oil level too high.	Lower level.
Leaking from turbo compressor oil seal.	Check / replace oil seal.

9 Troubleshooting

Fault finding table

13 Black exhaust smoke (at load)

Possible fault	Remedy
Faulty injector / injection pump.	Check / replace if required.
Incorrect injection timing.	Check / adjust.
Oil level incorrect.	Check .
Insufficient intake air, air filter dirty.	Check/clean the filter .
Leak in inlet manifold.	Check / replace.
Incorrect valve clearance.	Adjust.
Excessive wear of cylinder / piston.	Check compression; refurbish engine.
Faulty turbo compressor.	Check / replace.
Engine overloaded, max. rpm is not reached.	Check sizes of propeller.
Engine overloaded, dirty propeller-boat hull, excessive load on-board.	Check /clean.

14 White exhaust smoke (at full load)

Possible fault	Remedy
Faulty injector/injection pump.	Check, replace if required.
Air in fuel system.	Check and bleed.
Wrong fuel quality or contaminated fuel.	Check fuel. Drain and flush fuel tank. Replace with new fuel.
Water in fuel system.	Check water separator.
Incorrect injection timing.	Check / adjust.
Faulty glow plugs.	Check / replace.
Incorrect valve clearance.	Adjust.
Vapour in exhaust gases condenses as a result of very low ambient temperature.	-

15 Burnt oil trace in exhaust line .

Possible fault	Remedy
Oil level too high .	Lower level.
Excessive wear of cylinder / piston, piston rings.	Check compression; refurbish engine.
Faulty turbocharger .	Check, Repair / Replace .

10 Technical data

Engine specifications

Model	:	M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
General							
Make	:	Vetus Mitsubishi					
Number of cylinders	:	2	2	3	4	4	4
Based on	:	L2E-65DMA	L2E-65DM	L3E-6ADM	S4L2-66DM	S4L2-65DM	S4L2-T
Type	:	4-stroke diesel, in-line					
Injection	:	Indirect					
Aspiration	:	Natural				Turbo-charged	
Bore	:	76 mm	76 mm	76 mm	78 mm	78 mm	78 mm
Stroke	:	70 mm	70 mm	70 mm	78,5 mm	92 mm	92 mm
Total displacement	:	635 cm ³ (39 cu.in.)	635 cm ³ (39 cu.in.)	952 cm ³ (58 cu.in.)	1500 cm ³ (91 cu.in.)	1758 cm ³ (104 cu.in.)	1758 cm ³ (104 cu.in.)
Compression ratio	:	23:1	23:1	22:1	22:1	22:1	22:1
Idling speed	:	850 rpm	850 rpm	900 rpm	840 rpm	840 rpm	900 rpm
Max. no. of revolutions at no load	:	3000 rpm	3600 rpm	3600 rpm	3200 rpm	3200 rpm	3250 rpm
Direction of rotation	:	Counter clockwise, viewed towards the flywheel					
Valve Clearances (cold)	:	Inlet 0.25 mm (0.010") Exhaust 0.25 mm (0.010")					
Weight (with standard gearbox)	:	107 kgs (236 lbs)	107 kgs (236 lbs)	134 kgs (295 lbs)	199 kgs (439 lbs)	199 kgs (439 lbs)	206 kgs (454 lbs)

10 Technical data

Engine specifications

Model	:	M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
Engine installation							
Max. installation angle	:	15 degrees backwards					
Max. athwartships angle	:	25 degrees continuously, 30 degrees intermittent					
Maximum Output							
at the flywheel (ISO 8665)	:	8.8 kW (12 hp)	11.8 kW (16 hp)	20 kW (27.2 hp)	24.3 kW (33 hp)	30.9 kW (42 hp)	38.3 kW (52 hp)
at the prop shaft (ISO 8665)	:	8.7 kW (11.8 hp)	11.6 kW (15.8 hp)	19.3 kW (26.2 hp)	23.6 kW (32.1 hp)	30 kW (40.8 hp)	37.1 kW (50.4 hp)
at no. of revolutions of	:	3000 rpm	3600 rpm	3600 rpm	3000 rpm	3000 rpm	3000 rpm
Torque.	:	32.7 Nm (3.3 kgm) (24.1 ft.lb)	35.1 Nm (3.6 kgm) (25.9 ft.lb)	51.3 Nm (5.2 kgm) (37.8 ft.lb)	77.4 Nm (7.9 kgm) (57.1 ft.lb)	98 Nm (10 kgm) (72.3 ft.lb)	127 Nm (13 kgm) (93.7 ft.lb)
at no. of revolutions	:	1600 rpm	2000 rpm	3600 rpm	3000 rpm	3000 rpm	3000 rpm
Fuel consumption	:	268 g/kW.h (196 g/hp.h) (6.9 oz/hp.h)	268 g/kW.h (196 g/hp.h) (6.9 oz/hp.h)	270 g/kW.h (199 g/hp.h) (7.0 oz/hp.h)	252 g/kW.h (185 g/hp.h) (6.5 oz/hp.h)	252 g/kW.h (185 g/hp.h) (6.5 oz/hp.h))	244 g/kW.h (179 g/hp.h) (6.3 oz/hp.h)
at no. of revolutions	:	2500 rpm	2500 rpm	2600 rpm	1800 rpm	1800 rpm	1800 rpm

10 Technical data

Engine specifications

Model	:	M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
Fuel System (Self-bleeding)							
Injection pump	:	Bosch type NC	Bosch type NC	Bosch type NC	Bosch type M	Bosch type M	Bosch type M
Injectors	:	Plug injector					
Opening pressure	:	140 bar (kgf/cm ²) (2030 psi)					
Firing order	:	1 - 2	1 - 2	1 - 3 - 2	1 - 3 - 4 - 2	1 - 3 - 4 - 2	1 - 3 - 4 - 2
Injection timing	:	17° BTDC	17° BTDC	17° BTDC	21° BTDC	17° BTDC	14° BTDC
Fuel lift pump	:	Suction height max. max. 1,5 m (5 ft)					
Fuel supply connection	:	for hose 8 mm (5/16") I.D.					
Fuel return connection	:	for hose 8 mm (5/16") I.D.					
Oil lubrication system							
Oil capacity, max.							
without oil filter	:	2.3 litres (4.0 Imp. pt) (4.9 US pt)	2.3 litres (4.0 Imp. pt) (4.9 US pt)	3.4 litres (6.0 Imp. pt) (7.2 US pt)	5.5 litres (9.7 Imp. pt) (11.6 US pt)	5.5 litres (9.7 Imp. pt) (11.6 US pt)	5.5 litres (9.7 Imp. pt) (11.6 US pt)
with oil filter	:	2.5 litres (4.4 Imp. pt) (5.3 US pt)	2.5 litres (4.4 Imp. pt) (5.3 US pt)	3.6 litres (6.3 Imp. pt) (7.6 US pt)	5.7 litres (10 Imp. pt) (12 US pt)	5.7 litres (10 Imp. pt) (12 US pt)	5.7 litres (10 Imp. pt) (12 US pt)
Oil temperature in sump	:	max. 130°C (266°F)					

10 Technical data

Engine specifications

Model	:	M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
Cooling system							
Capacity,							
Intercooler version	:	2.2 litres (3.9 Imp. pt) (4.6 US pt)	2.2 litres (3.9 Imp. pt) (4.6 US pt)	3 litres (5.3 Imp. pt) (6.3 US pt)	6.5 litres (11.4 Imp. pt) (13.7 US pt)	6.5 litres (11.4 Imp. pt) (13.7 US pt)	6.5 litres (11.4 Imp. pt) (13.7 US pt)
Keel cooler version, engine only	:	3 litres (5.3 Imp. pt) (6.3 US pt)	3 litres (5.3 Imp. pt) (6.3 US pt)	4 litres (7.0 Imp. pt) (8.4 US pt)	7.2 litres (12.7 Imp. pt) (15.2 US pt)	7.2 litres (12.7 Imp. pt) (15.2 US pt)	7.2 litres (12.7 Imp. pt) (15.2 US pt)
Thermostat							
Opening at	:	71±1.5°C (160°F)	71±1.5°C (160°F)	71±1.5°C (160°F)	76±1.5°C (168°F)	76±1.5°C (168°F)	76±1.5°C (168°F)
Fully opened at	:	84°C (183°F)	84°C (183°F)	84°C (183°F)	90°C (194°F)	90°C (194°F)	90°C (194°F)
Coolant pump,							
Flow at max. engine rpm	:	50 l/min (11 Imp. Gal/min, 13.2 US Gal/min)					
Total head keelcooler at max. flow	:	2 m Water (6' 7")					
Inlet connection for hose keel-cooler	:	28 mm (1 1/8") I.D.	28 mm (1 1/8") I.D.	28 mm (1 1/8") I.D.	32 mm inw. (1 1/4") I.D.	32 mm inw. (1 1/4") I.D.	32 mm inw. (1 1/4") I.D.

10 Technical data

Engine specifications

Model	:	M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
Raw water pump,							
Flow at max. engine rpm	:	20 l/min (4.4 Imp. Gal/min) (5.3 US Gal/min)	20 l/min (4.4 Imp. Gal/min) (5.3 US Gal/min)	20 l/min (4.4 Imp. Gal/min) (5.3 US Gal/min)	30 l/min (6.6 Imp. Gal/min) (7.9 US Gal/min)	30 l/min (6.6 Imp. Gal/min) (7.9 US Gal/min)	78 l/min (17.2 Imp. Gal/min) (20.6 US Gal/min)
Total head at max. flow	:	2 m Water (6' 7")					
Inlet connection for hose	:	20 mm (3/4") I.D.					
Heater supply connection	:	10 mm (3/8")	10 mm (3/8")	10 mm (3/8")	16 mm (5/8")	16 mm (5/8")	16 mm (5/8")
Heater return connection	:	10 mm (3/8")	10 mm (3/8")	10 mm (3/8")	16 mm (5/8")	16 mm (5/8")	16 mm (5/8")

Electrical System

Voltage	:	12 Volt					
Alternator	:	14 Volt, 75 A	14 Volt, 75 A	14 Volt, 75 A	14 Volt, 110 A	14 Volt, 110 A	14 Volt, 110 A
2 nd Alternator							
Intercooled version, option		—	—	—	14 Volt, 75 A	14 Volt, 75 A	14 Volt, 95 A
Keelcooled version, standard		—	—	—	14 Volt, 110 A	14 Volt, 110 A	14 Volt, 110 A
Starter motor	:	14 Volt, 1.2 kW	14 Volt, 1.2 kW	14 Volt, 1.2 kW	14 Volt, 1.7 kW	14 Volt, 1.7 kW	14 Volt, 1.7 kW
Battery capacity, starter battery	:	min. 55 Ah, max. 108 Ah					
Protection	:	Blade fuse 'ATO' 20 A					

10 Technical data

Engine specifications Gearbox specifications

Model		M2.13	M2.18	M3.29 M3.28 SOLAS	M4.35 M4.15 SOLAS	M4.45 M4.17 SOLAS	M4.56 M4.55 SOLAS
Exhaust system							
Exhaust diameter	:	40 mm	40 mm	40 mm	50 mm	50 mm	60 mm
Exhaust back pressure	:	at specified output max. 150 mbar (2.2 psi)					
Gearbox							
		Gear ratio					
Technodrive:	model TMC40P	: 2.00 / 2.60 : 1	2.00 / 2.60 : 1	2.00 / 2.60 : 1	—	—	—
	model TMC60A	: 2.00 / 2.45 : 1	2.00 / 2.45 : 1	2.00 / 2.45 : 1	2.00 / 2.45 : 1	2.00 / 2.45 : 1	—
	model TMC60P	: —	—	—	2.00 / 2.45 / 2.83 : 1	2.00 / 2.45 / 2.83 : 1	2.00 / 2.45 : 1
	model TM345	: —	—	—	—	—	2.00 / 2.47 : 1
	model TM345A	: —	—	—	—	—	2.00 / 2.47 : 1
ZF Hurth:	model ZF12M	: 2.14 / 2.63 : 1	2.14 / 2.63 : 1	2.14 / 2.63 : 1	2.14 / 2.63 : 1	2.14 / 2.63 : 1	2.14 : 1
	model ZF15MIV	: 2.13 / 2.99 : 1	2.13 / 2.99 : 1	2.13 / 2.99 : 1	2.13 / 2.99 : 1	2.13 / 2.99 : 1	2.13 / 2.99 : 1

10 Technical data

Torque wrench settings M2.13 M2.18 M3.29 M3.28 SOLAS

Screw connection	Torque					
	Diameter	Wrench size	Nm	(kgm)	(ft.lbf)	
Cylinder head bolt	M10	14	78 ±5	(8 ±0.5)	(58 ±3.5)	
Cilinder head bolt	M8	12	25 ±5	(2.5 ±0.5)	(18 ±3.5)	
Connecting rod nut	M8	14	33 ±1.5	(3.35 ±0.15)	(24 ±1)	
Fly wheel bolt	M10	17	88 ±5	(9 ±0.5)	(65 ±3.5)	
Crank shaft pulley nut	M16	24	108 ±10	(11 ±1.0)	(80 ±7)	
Main bearing cap bolt	M10	17	52 ±2.5	(5.25 ±0.25)	(38 ±2)	
Rocker stay bolt	M8	12	18 ±3.5	(1.85 ±0.35)	(13 ±2.5)	
Valve cover nut	M6	10	6 ±1	(0.6 ±0.1)	(4.5 ±0.8)	
Nozzle holder	M20	21	54 ±5	(5.5 ±0.5)	(40 ±3.5)	
Fuel leak oil pipe nut	M12	17	25 ±5	(2.5 ±0.5)	(18 ±3.5)	
Nozzle retaining nut	M16	21	37 ±2.5	(3.75 ±0.25)	(27 ±2)	
Fuel injection pipe nut	M12	17	29 ±5	(3.0 ±0.5)	(21 ±3.5)	
Delivery valve holder	M16	17	36 ±2	(3.7 ±0.2)	(26 ±1.5)	
Injection pump hollow screw	M10	14	12 ±2.5	(1.25 ±0.25)	(9 ±2)	
Injection pump air vent screw	M6	10	6 ±1	(0.6 ±0.1)	(4.5 ±0.8)	
Solenoid lock nut	M30	36	44 ±5	(4.5 ±0.5)	(32 ±3.5)	
Temperature switch	M16	19	22.5 ±4	(2.3 ±0.4)	(16.5 ±3)	
Oil filter	M20	—	12 ±1	(1.2 ±0.1)	(9 ±0.8)	
Oil pressure switch	PT1/8	26	10 ±2	(1 ±0.2)	(7 ±1.5)	
Pressure relief valve	M18	22	44 ±5	(4.5 ±0.5)	(32 ±3.5)	
Oil drain plug	M18	19	54 ±5	(5.5 ±0.5)	(40 ±3.5)	
Glow plug	M10	12	17.5 ±2.5	(1.75 ±0.25)	(13 ±2)	

10 Technical data

Torque wrench settings

M4.35 M4.45 M4.56 M4.15 SOLAS M4.17 SOLAS M4.55 SOLAS

Screw connection	Thread			Torque		
	Diameter	Pitch	Wrench Size	Nm	(kgm)	(ft.lbf)
Cylinder head bolt	M10	1.25	14	88 ±5	(9 ±0.5)	(65 ±3.5)
Connecting rod nut	M9	1.0	14	34.8 ±2.5	(3.55 ±0.25)	(26 ±2)
Fly-wheel bolt	M12	1.25	19	132 ±5	(13.5 ±0.5)	(98 ±3.5)
Crank shaft pulley nut	M18	1.5	27	172 ±25	(17.5 ±2.5)	(127 ±19)
Main bearing cap bolt	M10	1.25	17	51.5 ±2.5	(5.25 ±0.25)	(38 ±2)
Rocker stay bolt	M8	1.25	12	14.7 ±5	(1.5 ±0.5)	(10 ±3.5)
Valve cover bolt	M8	1.25	12	11.3 ±1.5	(1.15 ±0.15)	(8 ±1)
Nozzle holder	M20	1.5	21	54 ±5	(5.5 ±0.5)	(40 ±3.5)
Fuel leak oil pipe nut	M12	1.5	18	27 ±2.5	(2.75 ±0.25)	(20 ±2)
Nozzle retaining nut	M16	0.75	19	37 ±2.5	(3.75 ±0.25)	(27 ±2)
Fuel injection pipe nut	M12	1.5	—	29 ±5	(3 ±0.5)	(22 ±3.5)
Delivery valve holder	—		19	44 ±5	(4.5 ±0.5)	(32 ±3.5)
Solenoid lock nut	M30	1.5	36	44 ±5	(4.5 ±0.5)	(32 ±3.5)
Temperature switch	M16	1.5	17	22.6 ±4	(2.3 ±0.4)	(16 ±3)
Oil filter	M20	1.5	—	12 ±1	(1.2 ±0.1)	(9 ±0.8)
Oil pressure switch	PT1/8		26	10 ±2	(1 ±0.2)	(7 ±1.5)
Pressure relief valve	M22	1.5	22	49 ±5	(5 ±0.5)	(36 ±3.5)
Oil drain plug	M14	1.5	22	39 ±5	(4 ±0.5)	(29 ±3.5)
Glow plug	M10	1.25	12	17.2 ±2.5	(1.75 ±0.25)	(13 ±2)
Fly-wheel housing bolt	M12	1.25	17	64 ±10	(6.5 ±1)	(47 ±7)

11 Operating media

Fuel Quality Grade

Use only diesel fuel or diesel blends with up to 7% FAME (B7), with less than 0.5% sulphur content of which the quality is fully controlled and conform the standards below.

The following fuel specifications / standards are approved:

- CEN EN 590:2009
- ASTM D975-09

Don't use fuel with more than 1% sulfur!

The cetane number must be at least 49.

The exhaust emission levels determined during certification by the supervising authority are always based on the reference fuel described by law. These fuels match the diesel fuels which are in accordance with CEN EN 590 and ASTM D 975. Emission levels cannot be guaranteed with other fuels.

Winter-grade fuel

Waxing may occur at low temperatures, clogging the fuel system and reducing engine efficiency.

If the ambient temperature is less than 0°C (+32°F), winter-grade fuel -suitable down to -15°C (+5°F) - should be used. This fuel is usually available from filling stations well in advance of the cold months. Diesel fuel containing additives (Super Diesel) is often on sale as well, for use down to -20°C (-4°F).

11 Operating media

Biodiesel



CAUTION

Use only the prescribed diesel fuel or diesel blends. **Do not use 100% biodiesel (B100)!**

Although the use of biodiesel is allowed in diesel blends with up to 7% FAME (Fatty Acid Methyl Esters) (B7) fast degradation of the biodiesel should be taken in account.

Problems caused by using FAME of poor quality or degraded fuel are not covered by warranty.

11 Operating media

Lubricating oil

Engine oil

Lubricating oils are specified by performance and quality classes. It is usual for the specifications to be indicated according to the API (American Petroleum Institute) and ACEA (European Automobile Manufacturers Association).

Acceptable API oils: CF4, CG4, CH4, CI4

Acceptable ACEA oils: A3/B3, A3/B4, E7

Only use oil of a recognised brand to lubricate the engine. The choice of a correct oil guarantees that the engine starts easily, because an oil film remains on the cylinder walls and bearing surfaces. The friction is low and so the starting rpm necessary for a dependable start can be achieved with a lower starting torque. An incorrect choice of oil can lead to a thickened oil layer on the cylinder walls and bearing surfaces. This can in turn lead to higher frictional resistance and more effort, which forms a hindrance to reaching the starting rpm required for a dependable start, and this results in a reduced lifespan.

Recommended lubricating oil viscosity

There are two important considerations when it comes to ambient temperature in order to achieve satisfactory engine performance.

- the possibility to turn the engine over quickly enough to make an easy start possible and
- adequate lubrication of internal wear surfaces during starting and warming up.

By making the right choice of lubricating oil these requirements can be met.

Because the viscosity (runniness) of lubricating oil varies with temperature, the ambient temperature in which the engine is started determines the choice of viscosity class (SAE class).

To avoid having to change the oil for different seasons we recommend SAE 15W-40 all-season motor oil.

For example:

Vetus Marine Diesel Engine Oil 15 W40

Shell Rimula R4 15W40

For oil capacity see p. 118.

11 Operating media

Lubricating oil



CAUTION

Do not mix oil of different brands together. Oils of different brands are mostly not compatible with each other. If they are mixed, the mixtures can cause components such as piston rings, cylinders etc. to seize up and cause wear to moving parts. The best thing is to keep to one brand and one type of lubricating oil for each subsequent service.

Limits concerning motor oil

If an analysis of the used lubricating oil is conducted to determine its condition, consult the overview below. Change the oil if one or more of the conditions is not met.



NOTE

- How often the oil has to be changed depends on the characteristics of the fuel. Only use the recommended fuels.
- The limit for the total base number is half of that of new oil in the case of an analysis method based on perchloric acid.

Limits concerning motor oil

Characteristic	Unit	Test method	Limit
Viscosity	cSt @ 100°C	JIS: K 2283	+30% / -15% max. for new oil
Total base number _I (HCl)	mgKOH/g	JIS: K 2501	2.0 min.
Total acid number	mgKOH/g		+3.0 max. for new oil
Water content	% volume	JIS: K 2275	0.2 max.
Flash point	°C	JIS: K 2265	180 min.
Pentane insolubles	% weight	ASTM: D 893	0.5 max.
Coagulated pentane insolubles	% weight		3.0 max.

11 Operating media

Gearbox Lubricating Oil

Only use a recognised brand of oil for lubricating the gearbox.

Technodrive:

- model TMC40P : 0.2 litres (0.35 Imp. pt, 0.42 US pt), ATF ^[1]
- model TMC60A : 0.6 litres (1.05 Imp. pt, 1.25 US pt), ATF ^[1]
- model TMC60P : 0.65 litres (1.15 Imp. pt, 1.37 US pt), ATF ^[1]
- model TM345 : 1.6 litres, (2.82 Imp. pt, 3.38 US pt), Engine oil SAE 20W40-CD
- model TM345A : 1.6 litres (2.82 Imp. pt, 3.38 US pt), Engine oil SAE 20W40-CD

ZF Hurth:

- model ZF12M : 0,56 litres (0.98 Imp. pt, 1.18 US pt), ATF ^[1]
- model ZF15MIV : 1,0 litres (1.76 Imp. pt, 2.11 US pt), ATF ^[1]

^[1] ATF : AutomaticTransmission Fluid;
Transmission oil type A, Suffix A.

For example: Vetus Transmission Oil
Shell Donax T6
Gulf Synth

Other brands of gearboxes:

See supplied owners manual for oil type and quantities.

11 Operating media

Coolant

Coolant fluid

The preparation and monitoring of coolant in inter-cooled engines is especially important because corrosion, cavitation and freezing can lead to engine damage. Use as coolant a mixture of a cooling system protective liquid (anti-freeze, ethylene glycol based) and tap water.

In tropical climates, where anti-freeze availability may be limited, use a corrosion inhibitor to protect the engine cooling system.

The concentration of the cooling system protective liquid in the coolant should not fall below/exceed the following limits:

Cooling system protective liquid (Anti-freeze)	Water	Protection against freezing to
max. 45 vol%	55%	-35°C (-31°F)
40 vol%	60%	-28°C (-18°F)
min. 35 vol%	65%	-22°C (-8°F)

The protective liquid concentration must be maintained under all circumstances. Therefore if coolant must be added always use the same mixture of anti-freeze and tap water.

Water quality for coolant preparation

Use preferably tap water.

If an other available fresh water is used; the values given below must not be exceeded.

Water quality		min.	max.
pH-value at 20°C (68°F)		6.5	8.5
Chloride ion content	[mg/dm ³]	–	100
Sulfate ion content	[mg/dm ³]	–	100
Total hardness	[degrees]	3	12



CAUTION

Never use sea-water or brackish water.



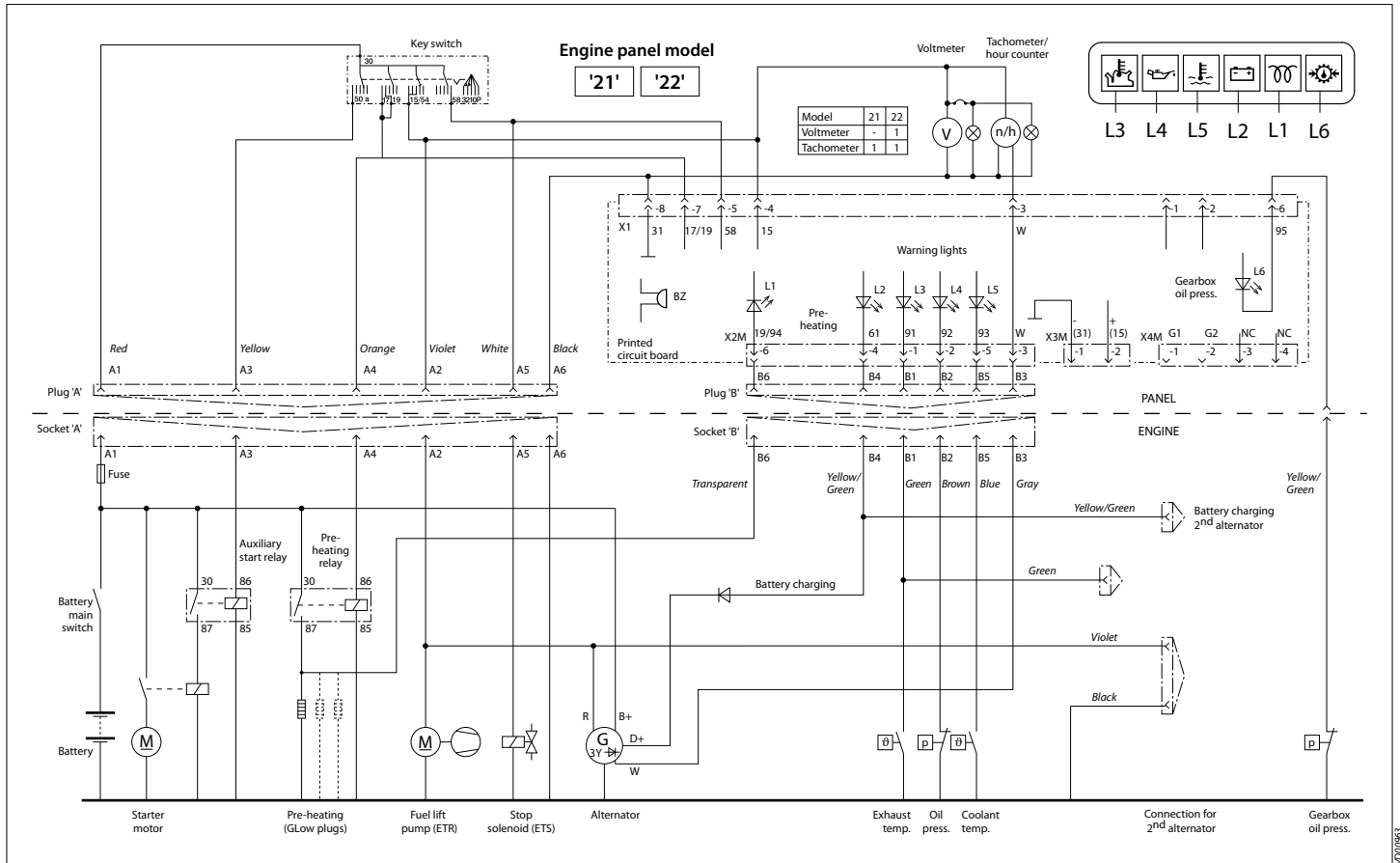
WARNING

Cooling system protective liquids must be disposed of in accordance with environmental regulations.



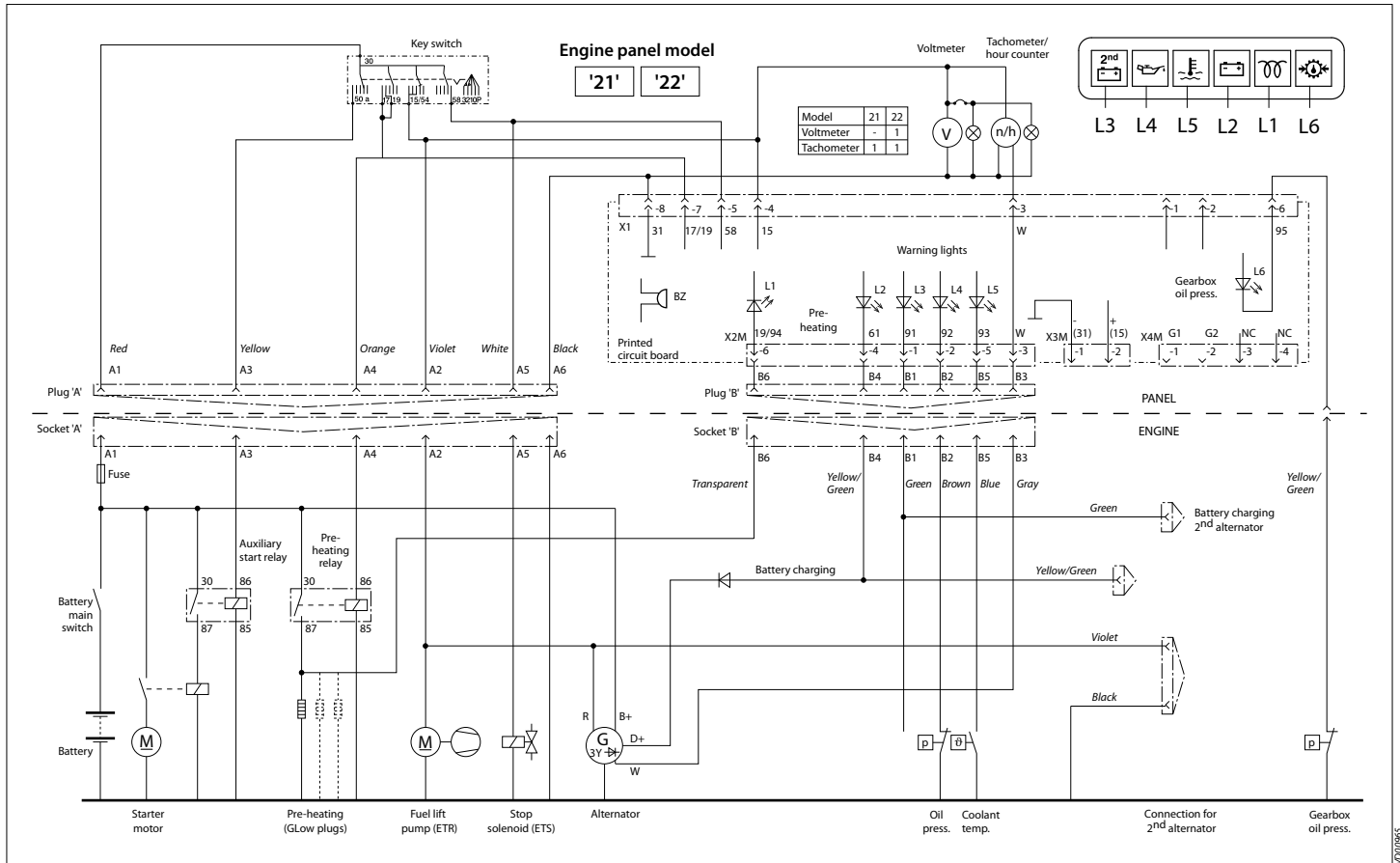
12 Wiring diagrams

Engine with panel model '21','22' M4, intercooled version



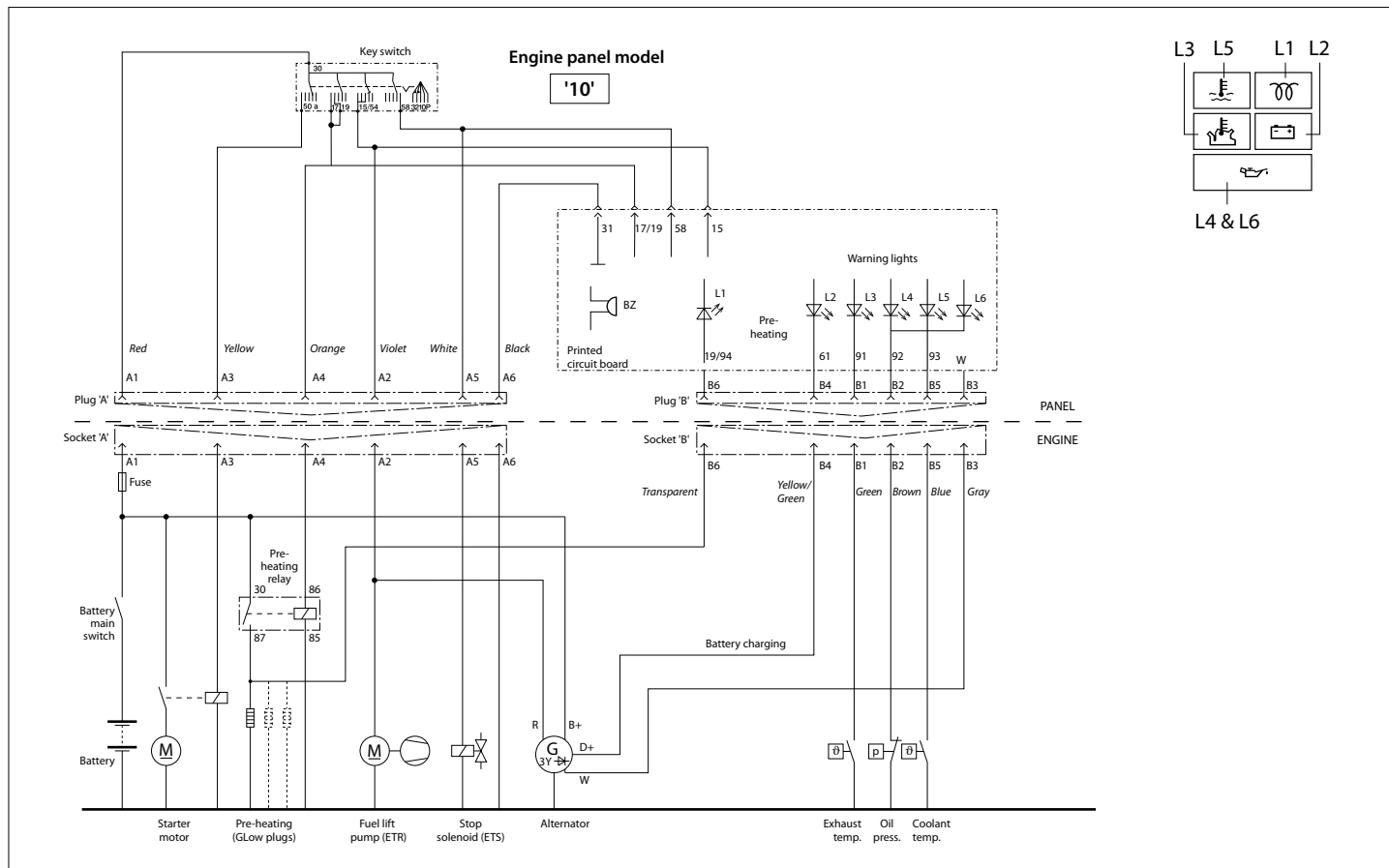
12 Wiring diagrams

Engine with panel model '21','22' M4, keelcooled version



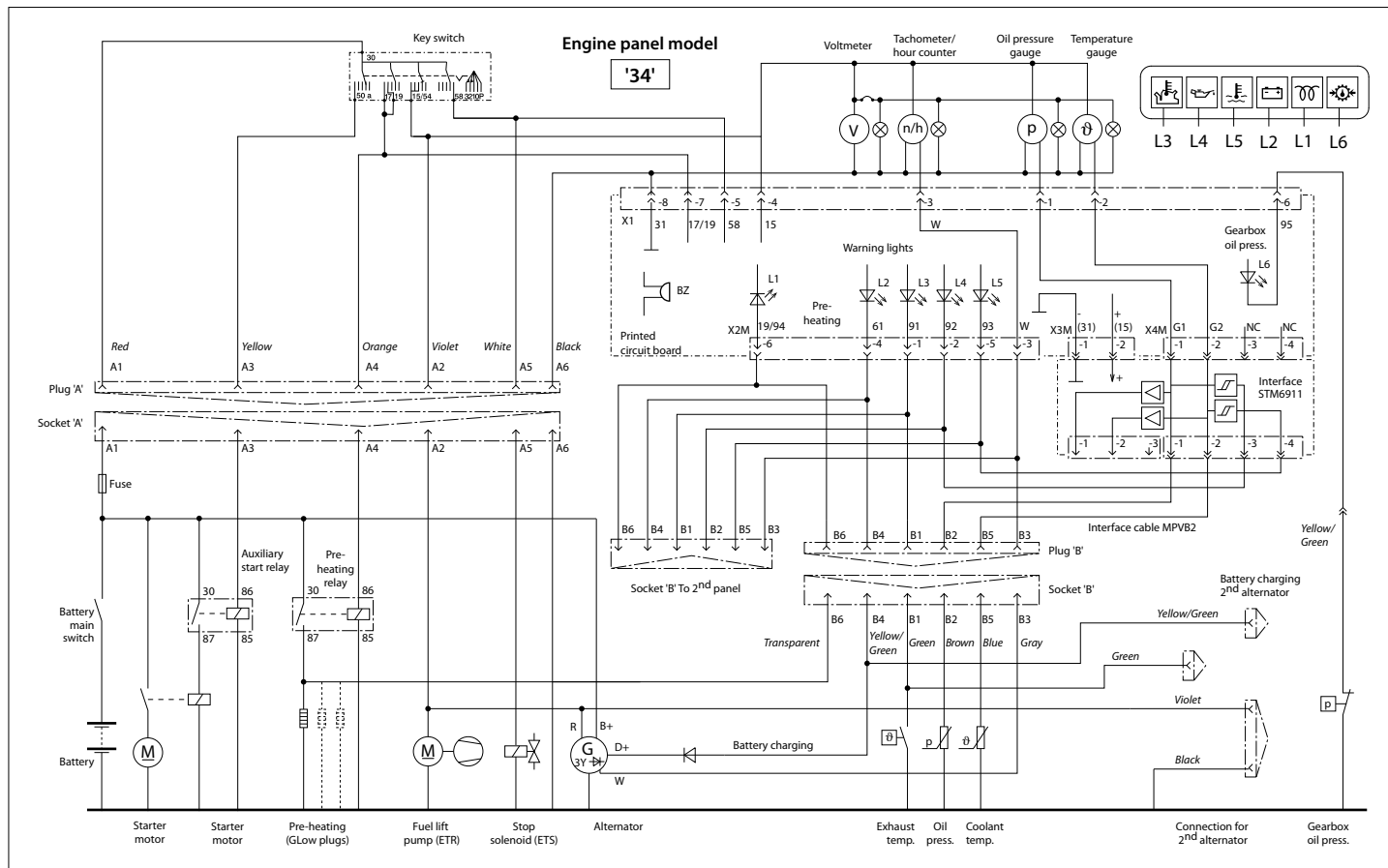
12 Wiring diagrams

Option, panel model '10'

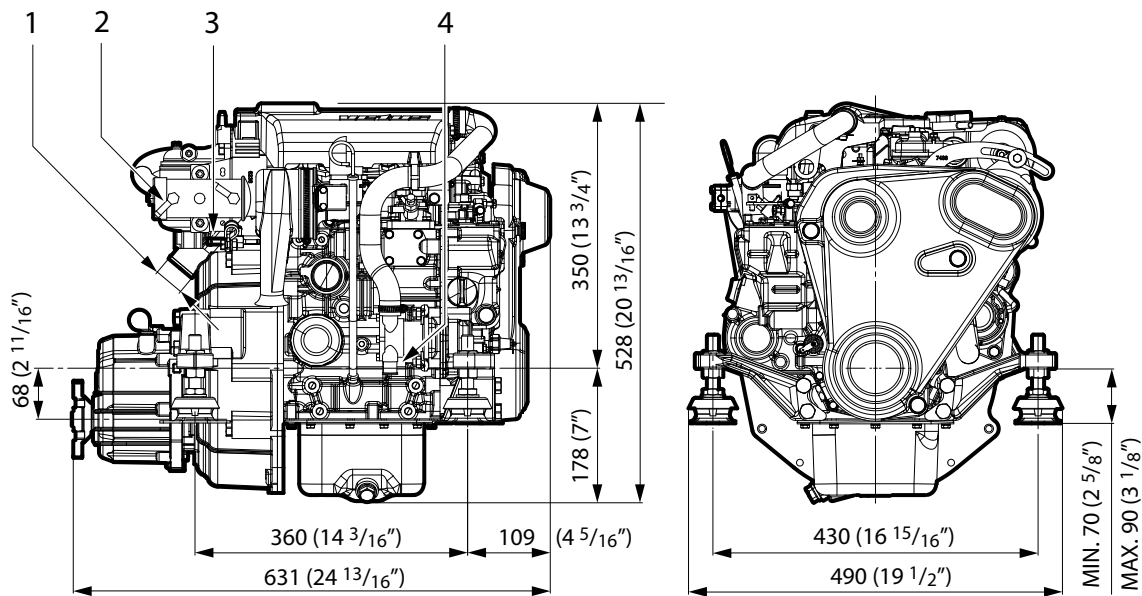


12 Wiring diagrams

Option, panel model '34'



13 Overall dimensions

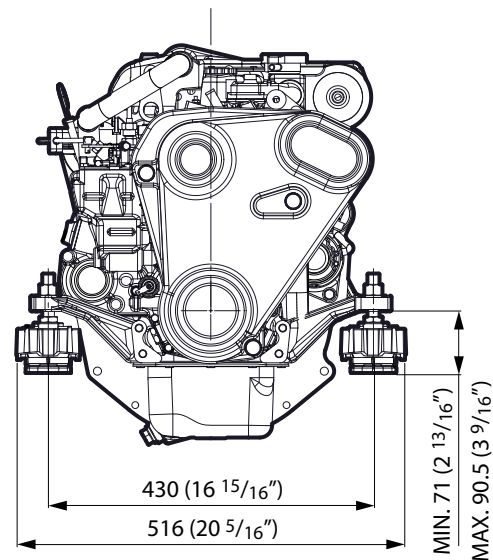
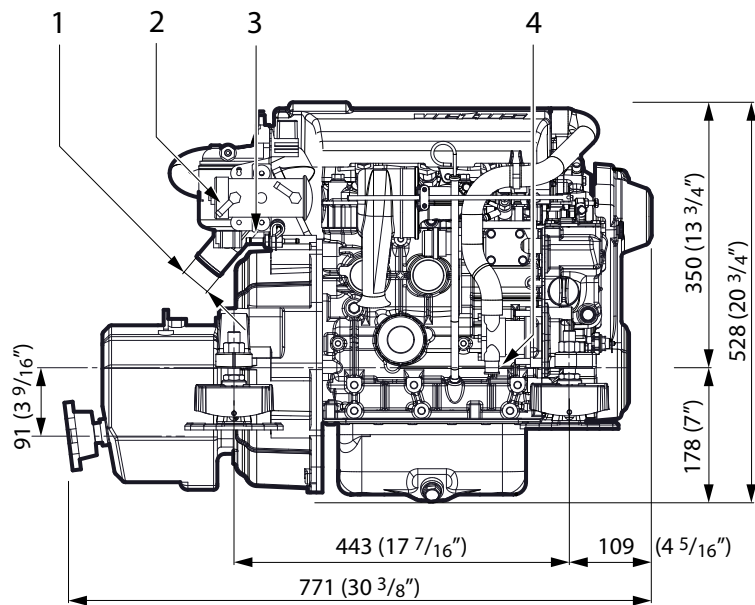


- 1 Exhaust \varnothing 40 mm
- 2 Fuel supply \varnothing 8 mm
- 3 Fuel return \varnothing 8 mm
- 4 Sea water intake \varnothing 20 mm

Vetus[®] M2.13 / M2.18

1 : 10

13 Overall dimensions



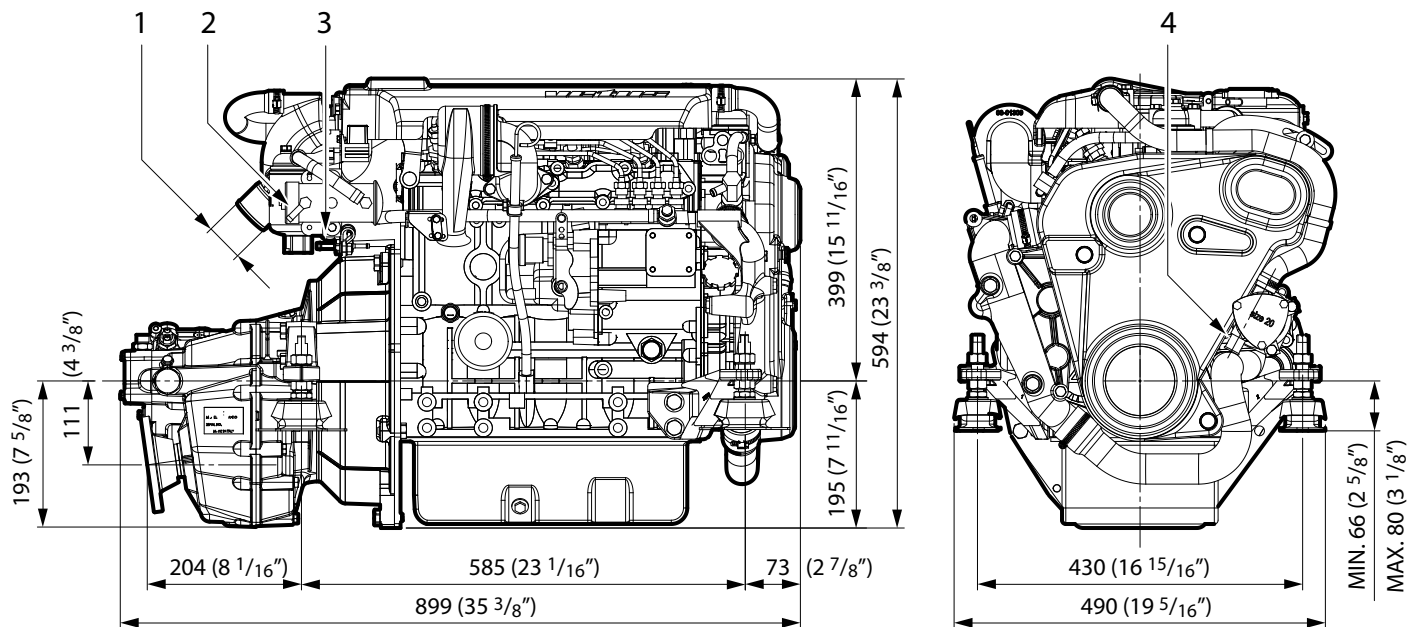
- 1 Exhaust \varnothing 40 mm
- 2 Fuel supply \varnothing 8 mm
- 3 Fuel return \varnothing 8 mm
- 4 Sea water intake \varnothing 20 mm

Vetus[®]

M3.29
M3.28 SOLAS

1 : 10

13 Overall dimensions



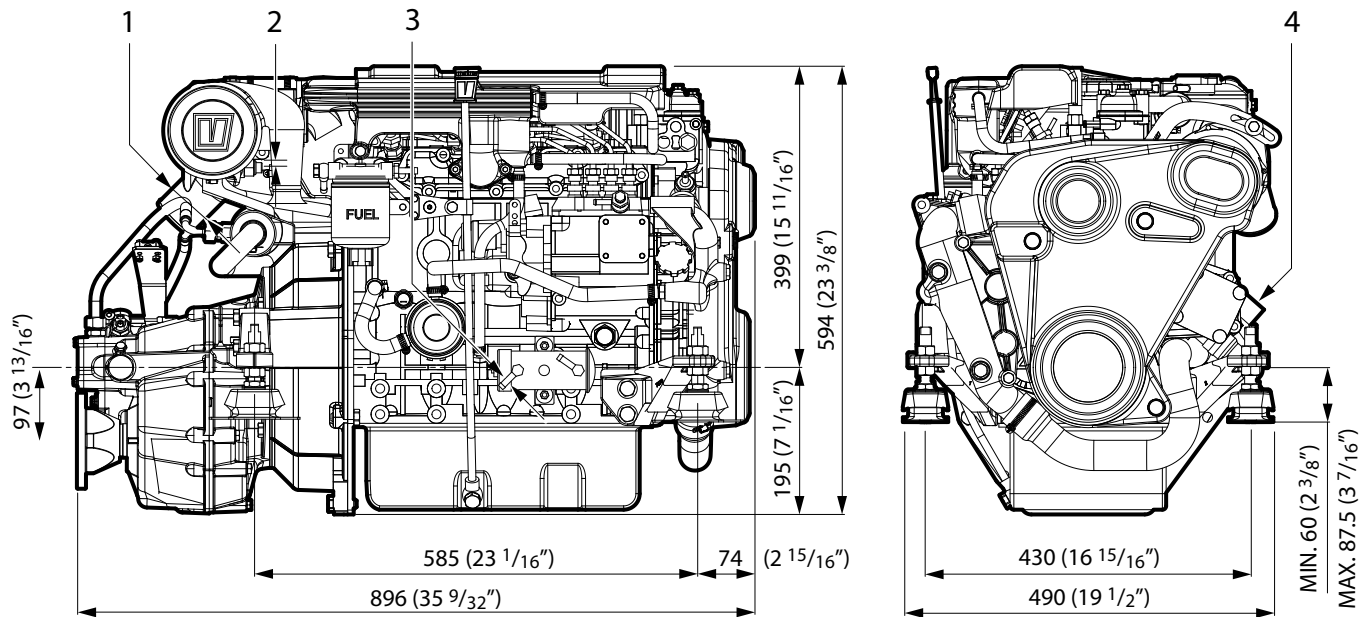
Vetus[®]

M4.35 / M4.45
M4.15 SOLAS / M4.17 SOLAS

- 1 Exhaust ø 50 mm
- 2 Fuel supply ø 8 mm
- 3 Fuel return ø 8 mm
- 4 Sea water intake ø 20 mm

1 : 10

13 Overall dimensions



Vetus[®]

M4.56
M4.55 SOLAS

- 1 Exhaust ø 60 mm
- 2 Fuel return ø 8 mm
- 3 Fuel supply ø 8 mm
- 4 Sea water intake ø 20 mm

1 : 10

14 Parts for maintenance

Engine model	Oil filter	Fuel filter	Filter fuel lift pump	V-Belt	Raw water pump			Air filter	O-ring heat exchanger cover
					Impeller + O-ring	Impeller	O-ring		
M2.13	STM0051	STM3690	STM4050	STM7439	STM8076	STM6161	STM7696	08-01308	2 x STM6113
M2.18	STM0051	STM3690	STM4050	STM7439	STM8076	STM6161	STM7696	08-01308	2 x STM6113
M3.29	STM0051	STM3690	STM4050	STM7439	STM8076	STM6161	STM7696	08-01308	2 x STM6113
M4.35	STM0051	STM3690	STM4050	STM7643		STM8061	STM7696	08-01308	2 x STM6113
M4.45	STM0051	STM3690	STM4050	STM7643		STM8061	STM7696	08-01308	2 x STM6113
M4.56	STM0051	STM3690	STM4050	STM7643	STM8074	08-01019	08-01022	STM7467	2 x STM6113
M3.28 SOLAS	STM0051	STM3690	STM4050	STM7439		08-01352	STM7696	08-01308	2 x STM6113
M4.15 SOLAS	STM0051	STM3690	STM4050	STM7643		08-01352	STM7696	08-01308	2 x STM6113
M4.17 SOLAS	STM0051	STM3690	STM4050	STM7643		08-01352	STM7696	08-01308	2 x STM6113
M4.55 SOLAS	STM0051	STM3690	STM4050	STM7643		08-01353	08-01022	STM7467	2 x STM6113

Check / replace every ... hour:

	100	500	500	500	1000	1000	1000	1000	-
See page:	58	65	66	74	78	78	78	84	91

V-belt 2 nd alternator:	M4.35 / M4.45	75 A (Intercooled engine) :	STM9857
	M4.56	95 A (Intercooled engine) :	STM9857
	M4.35 / M4.45 / M4.56	110 A (Keelcooled engine) :	STM9858

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Art. code	Description	
345101.01	Bedieningshandleiding M-LINE M2, M3, M4	(Nederlands)
345102.01	Operation manual M-LINE M2, M3, M4	(English)
345103.01	Bedienungsanleitung M-LINE M2, M3, M4	(Deutsch)
345104.01	Manuel d'utilisation M-LINE M2, M3, M4	(Français)
345105.01	Manual de operacion M-LINE M2, M3, M4	(Español)
345106.01	Istruzioni per l'uso M-LINE M2, M3, M4	(Italiano)
345107.01	Brugsanvisning M-LINE M2, M3, M4	(Dansk)
345108.01	Användarmanual M-LINE M2, M3, M4	(Svenska)
345109.01	Bruksanvisning M-LINE M2, M3, M4	(Norsk)
345110.01	Käyttöopas M-LINE M2, M3, M4	(Suomeksi)
320331.01	(STM0032) Installatiehandleiding / Installation manual	(Nederlands / English)
320199.06	(STM0016) Service- en Garantieboek / Service and Warranty Manual / Service- und Garantieheft / Livret Garantie et Service / Manual de servicio y garantía / Libretto di assistenza e garanzia Service- og garantibog / Service- och garantihäfte Service- og garantibok / Huolto- ja takuukirja	(Nederlands / English / Deutsch / Français / Español / Italiano / Dansk / Svenska / Norsk / Suomeksi)
341131.06	Onderdelenboek / Parts manual M2	(Nederlands / English)
341731.06	Onderdelenboek / Parts manual M3	(Nederlands / English)
341331.06	Onderdelenboek / Parts manual M4	(Nederlands / English)
342102.02	Service manual M2, M3	(English)
342402.02	Servive manual M4	(English)

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