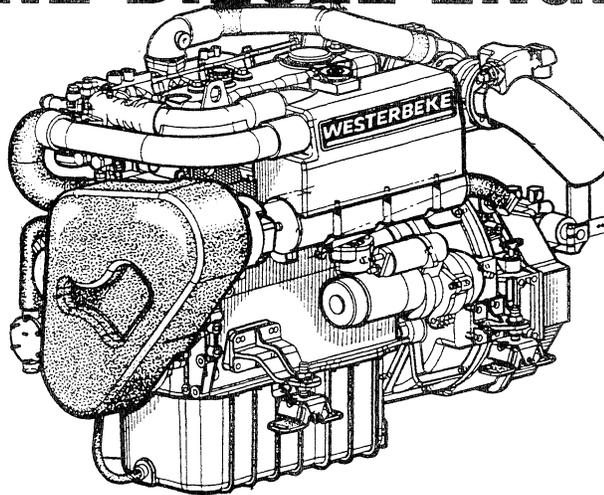




OPERATORS MANUAL

80N4/110T4-120N6/170T6

MARINE DIESEL ENGINES



PUBLICATION NO. 045139
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JULY 2000

WESTERBEKE

WESTERBEKE CORPORATION
MYLES STANDISH INDUSTRIAL PARK
150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319

 *Member National Marine Manufacturers Association*

⚠ WARNING

Exhaust gasses contain Carbon Monoxide, an odorless and colorless gas. Carbon Monoxide is poisonous and can cause unconsciousness and death. Symptoms of Carbon Monoxide exposure can include:

- **Dizziness**
- **Nausea**
- **Headache**
- **Weakness and Sleepiness**
- **Throbbing in Temples**
- **Muscular Twitching**
- **Vomiting**
- **Inability to Think Coherently**

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not restart until it has been inspected and repaired.



A WARNING DECAL is provided by WESTERBEKE and should be fixed to a bulkhead near your engine or generator. WESTERBEKE also recommends installing CARBON MONOXIDE DETECTORS in the living/sleeping quarters of your vessel. They are inexpensive and easily obtainable at your local marine store.

**CALIFORNIA
PROPOSITION 65 WARNING**

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

SAFETY INSTRUCTIONS

INTRODUCTION

Read this safety manual carefully. Most accidents are caused by failure to follow fundamental rules and precautions. Know when dangerous conditions exist and take the necessary precautions to protect yourself, your personnel, and your machinery.

The following safety instructions are in compliance with the American Boat and Yacht Council (ABYC) standards.

PREVENT ELECTRIC SHOCK

⚠ WARNING: *Do not touch AC electrical connections while engine is running, or when connected to shore power. Lethal voltage is present at these connections!*

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.
- Do not connect utility shore power to vessel's AC circuits, except through a ship-to-shore double throw transfer switch. Damage to vessel's AC generator may result if this procedure is not followed.
- Electrical shock results from handling a charged capacitor. Discharge capacitor by shorting terminals together.

PREVENT BURNS — HOT ENGINE

⚠ WARNING: *Do not touch hot engine parts or exhaust system components. A running engine gets very hot!*

- Always check the engine coolant level at the coolant recovery tank.

⚠ WARNING: *Steam can cause injury or death!*

- In case of an engine overheat, allow the engine to cool before touching the engine or checking the coolant.

PREVENT BURNS — FIRE

⚠ WARNING: *Fire can cause injury or death!*

- Prevent flash fires. Do not smoke or permit flames or sparks to occur near the carburetor, fuel line, filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. Use a suitable container to catch all fuel when removing the fuel line, carburetor, or fuel filters.
- Do not operate with a Coast Guard Approved flame arrester removed. Backfire can cause severe injury or death.
- Do not operate with the air cleaner/silencer removed. Backfire can cause severe injury or death.
- Do not smoke or permit flames or sparks to occur near the fuel system. Keep the compartment and the engine/generator clean and free of debris to minimize the chances of fire. Wipe up all spilled fuel and engine oil.
- Be aware — diesel fuel will burn.

PREVENT BURNS — EXPLOSION

⚠ WARNING: *Explosions from fuel vapors can cause injury or death!*

- Follow re-fueling safety instructions. Keep the vessel's hatches closed when fueling. Open and ventilate cabin after fueling. Check below for fumes/vapor before running the blower. Run the blower for four minutes before starting your engine.
- All fuel vapors are highly explosive. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children.
- Do not fill the fuel tank(s) while the engine is running.
- Shut off the fuel service valve at the engine when servicing the fuel system. Take care in catching any fuel that might spill. DO NOT allow any smoking, open flames, or other sources of fire near the fuel system or engine when servicing. Ensure proper ventilation exists when servicing the fuel system.
- Do not alter or modify the fuel system.
- Be sure all fuel supplies have a positive shutoff valve.
- Be certain fuel line fittings are adequately tightened and free of leaks.
- Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

SAFETY INSTRUCTIONS

ACCIDENTAL STARTING

⚠ WARNING: Accidental starting can cause injury or death!

- Disconnect the battery cables before servicing the engine/generator. Remove the negative lead first and reconnect it last.
- Make certain all personnel are clear of the engine before starting.
- Make certain all covers, guards, and hatches are re-installed before starting the engine.

BATTERY EXPLOSION

⚠ WARNING: Battery explosion can cause injury or death!

- Do not smoke or allow an open flame near the battery being serviced. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or by lit tobacco products. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.
- Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while the battery is being charged.
- Avoid contacting the terminals with tools, etc., to prevent burns or sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling the battery.
- Always turn the battery charger off before disconnecting the battery connections. Remove the negative lead first and reconnect it last when servicing the battery.

BATTERY ACID

⚠ WARNING: Sulphuric acid in batteries can cause severe injury or death!

- When servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Batteries contain sulfuric acid which is destructive. If it comes in contact with your skin, wash it off at once with water. Acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

TOXIC EXHAUST GASES

⚠ WARNING: Carbon monoxide (CO) is a deadly gas!

- Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check the exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists. Pay close attention to the manifold, water injection elbow, and exhaust pipe nipple.
- Be sure the unit and its surroundings are well ventilated.
- In addition to routine inspection of the exhaust system, install a carbon monoxide detector. Consult your boat builder or dealer for installation of approved detectors.
- For additional information refer to ABYC T-22 (educational information on Carbon Monoxide).

⚠ WARNING: Carbon monoxide (CO) is an invisible odorless gas. Inhalation produces flu-like symptoms, nausea or death!

- Do not use copper tubing in diesel exhaust systems. Diesel fumes can rapidly destroy copper tubing in exhaust systems. Exhaust sulfur causes rapid deterioration of copper tubing resulting in exhaust/water leakage.
- Do not install exhaust outlet where exhaust can be drawn through portholes, vents, or air conditioners. If the engine exhaust discharge outlet is near the waterline, water could enter the exhaust discharge outlet and close or restrict the flow of exhaust. Avoid overloading the craft.
- Although diesel engine exhaust gases are not as toxic as exhaust fumes from gasoline engines, carbon monoxide gas is present in diesel exhaust fumes. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are:
 - Vomiting
 - Dizziness
 - Throbbing in temples
 - Muscular twitching
 - Intense headache
 - Weakness and sleepiness

AVOID MOVING PARTS

⚠ WARNING: Rotating parts can cause injury or death!

- Do not service the engine/generator while it is running. If a situation arises in which it is absolutely necessary to make

SAFETY INSTRUCTIONS

- Do not wear loose clothing or jewelry when servicing equipment; avoid wearing loose jackets, shirts, sleeves, rings, necklaces or bracelets that could be caught in moving parts.
- Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective places at all times.
- Do not check fluid levels or the drive belts' tension while the engine/generator is operating.
- Stay clear of the drive shaft and the transmission coupling when the engine is running; hair and clothing can easily be caught in these rotating parts.

HAZARDOUS NOISE

 **WARNING:** *High noise levels can cause hearing loss!*

- Never operate a generator without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.
- Do not run engines or generators for long periods with their enclosures open.

 **WARNING:** *Do not work on machinery when you are mentally or physically incapacitated by fatigue!*

OPERATORS MANUAL

Many of the preceding safety tips and warnings are repeated in your Operators Manual along with other cautions and notes to highlight critical information. Read your manual carefully, maintain your equipment, and follow all safety procedures.

GASOLINE ENGINE AND GENERATOR INSTALLATIONS

Preparations to install a gasoline engine or generator should begin with a thorough examination of the American Boat and Yacht Council's (ABYC) standards. These standards are from a combination of sources including the USCG and the NFPA.

Sections of the ABYC standards of particular interest are:

H-2 Ventilation
H-24 Gasoline fuel systems
P-1 Exhaust systems
P-4 Inboard engines
E-9 DC Electrical systems

All installations must comply with the Federal Code of Regulations (FCR).

ABYC, NFPA AND USCG PUBLICATIONS FOR INSTALLING GASOLINE AND DIESEL ENGINES AND GENERATORS

Read the following ABYC, NFPA and USCG publications for safety codes and standards. Follow their recommendations when installing your WESTERBEKE engine/generator.

ABYC (American Boat and Yacht Council)
"Safety Standards for Small Craft"

Order From:
ABYC
3069 Solomon's Island Rd.
Edgewater, MD 21037

NFPA (National Fire Protection Association)
"Fire Protection Standard for Motor Craft"

Order From:
NFPA
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101

USCG (United States Coast Guard)
"USCG 33CFR183"

Order From:
U.S. Government Printing Office
Washington, D.C. 20404

INSTALLATION

When installing WESTERBEKE engines and generators it is important that strict attention be paid to the following information:

CODES AND REGULATIONS

Federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

SIPHON-BREAK

For installations where the exhaust manifold/water injected exhaust elbow is close to or will be below the vessel's waterline, provisions must be made to install a siphon-break in the raw water supply hose to the exhaust elbow. This hose must be looped a minimum of 20" above the vessel's waterline. ***Failure to use a siphon-break when the exhaust manifold injection port is at or below the load waterline will result in raw water damage to the engine and possible flooding of the boat.***

If you have any doubt about the position of the water-injected exhaust elbow relative to the vessel's waterline under the vessel's various operating conditions, ***install a siphon-break.***

NOTE: *A siphon-break requires periodic inspection and cleaning to ensure proper operation. Failure to properly maintain a siphon-break can result in catastrophic engine damage. Consult the siphon-break manufacturer for proper maintenance.*

EXHAUST SYSTEM

The exhaust hose must be certified for marine use. The system must be designed to prevent water from entering the exhaust under any sea conditions and at any angle of the vessels hull.

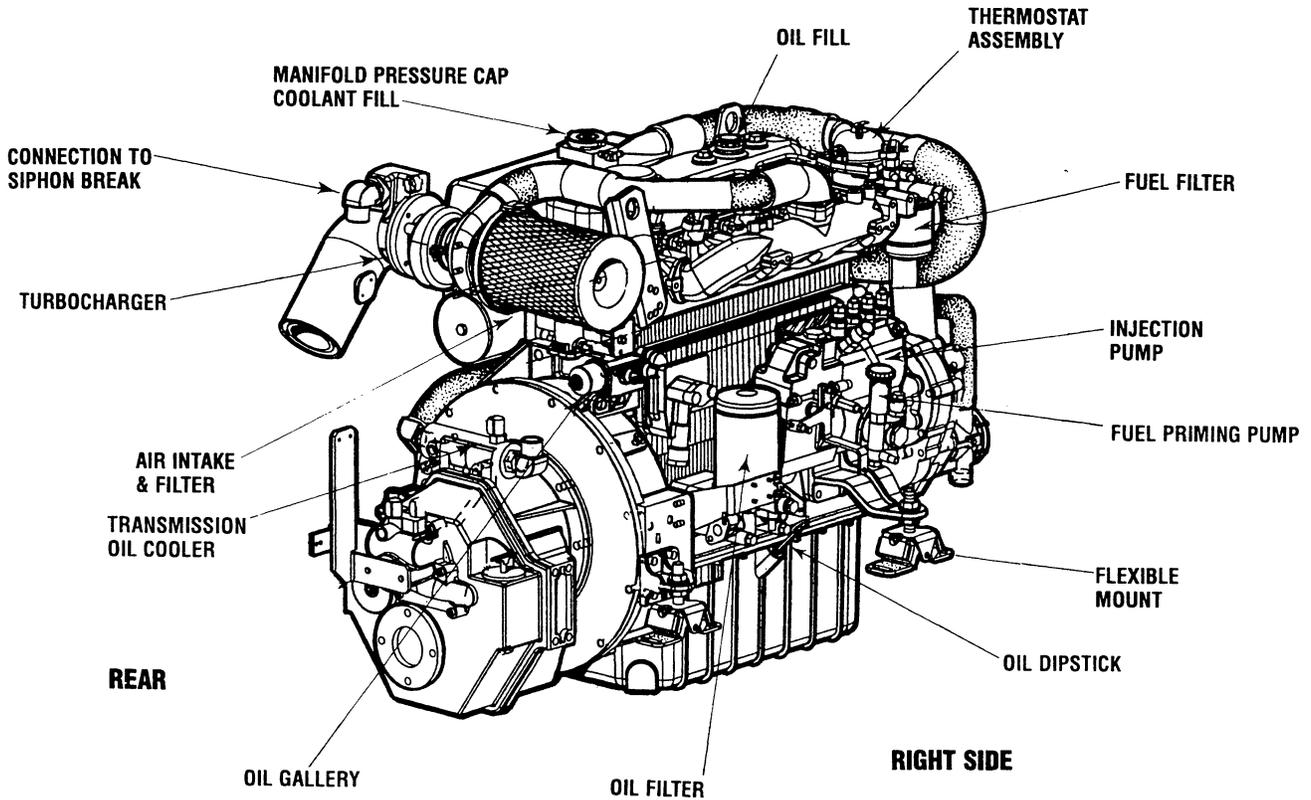
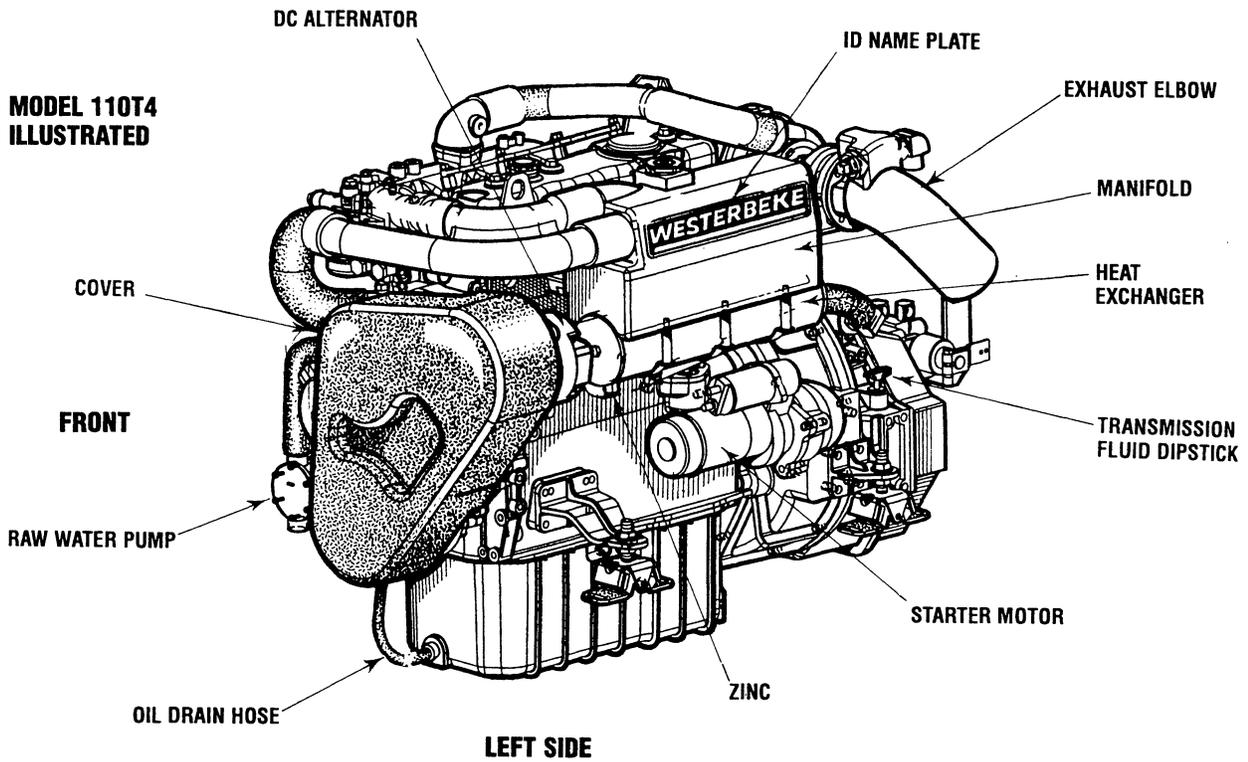
A detailed 40 page Marine Installation Manual covering gasoline and diesel, engines and generators, is available from your WESTERBEKE dealer.

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PARTS IDENTIFICATION

**MODEL 110T4
ILLUSTRATED**



INTRODUCTION

These high performance marine engines are products of WESTERBEKE's long years of experience and advanced technology. We take great pride in the superior durability and dependable performance of our engines and generators. Thank you for selecting WESTERBEKE.

In order to get the full use and benefit from your generator, it is important that you operate and maintain it correctly. This manual is designed to help you do this. Please read this manual carefully and observe all the safety precautions throughout. Should your engine require servicing, contact your nearest WESTERBEKE dealer for assistance.

This is your operators manual. A parts catalog is also provided and a technical manual is available from your WESTERBEKE dealer. If you are planning to install this equipment, contact your WESTERBEKE dealer for WESTERBEKE'S installation manual.

WARRANTY PROCEDURES

Your WESTERBEKE Warranty is included in a separate folder. If, after 60 days of submitting the Warranty Registry form you have not received a customer identification card registering your warranty, please contact the factory in writing with model information, including the unit's serial number and commission date.

Customer Identification Card


Customer Identification
MR. WESTERBEKE OWNER
MAIN STREET
HOMETOWN, USA
Model 80N4 Ser. #U0000-E702
Expires 2/5/2001

The WESTERBEKE serial number is an alphanumeric number that can assist in determining the date of manufacture of your WESTERBEKE engine or generator. The manufacturer's date code is placed at the end of the engine serial number and consists of a character followed by three numbers. The character indicates the decade (A=1960s, B=1970s, C=1980s, D=1990s E=2000s), the first number represents the year in the decade, and the second and third numbers represent the month of manufacture.

PRODUCT SOFTWARE

Product software, (technical data, parts lists, manuals, brochures and catalogs), provided from sources other than WESTERBEKE are not within WESTERBEKE's control.

WESTERBEKE CANNOT BE RESPONSIBLE FOR THE CONTENT OF SUCH SOFTWARE, MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT THERETO, INCLUDING ACCURACY, TIMELINESS OR COMPLETENESS THEREOF AND WILL IN NO EVENT BE LIABLE FOR ANY TYPE OF DAMAGE OR INJURY INCURRED IN CONNECTION WITH OR ARISING OUT OF THE FURNISHING OR USE OF SUCH SOFTWARE.

WESTERBEKE customers should keep in mind the time span between printings of WESTERBEKE product software and the unavoidable existence of earlier WESTERBEKE product software. The product software provided with WESTERBEKE products, whether from WESTERBEKE or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense but is imperative that appropriate representatives of WESTERBEKE or the supplier in question be consulted to determine the accuracy and currentness of the product software being consulted by the customer.

NOTES, CAUTIONS AND WARNINGS

As this manual takes you through the operating procedures, maintenance schedules, and troubleshooting of your marine engine, critical information will be highlighted by NOTES, CAUTIONS, and WARNINGS. An explanation follows:

NOTE: *An operating procedure essential to note.*

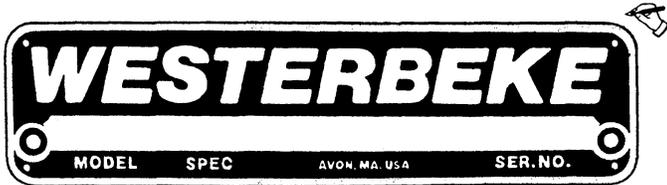
CAUTION: *Procedures which, if not strictly observed, can result in the damage or destruction of your engine.*

WARNING: *Procedures which, if not properly followed, can result in personal injury or loss of life.*

INTRODUCTION

SERIAL NUMBER LOCATION

The engine's model number and serial number are located on a nameplate mounted on the side of the engine's manifold. The engine's serial number is stamped into the engine block (left side) behind the alternator, below the manifold. Take the time to enter this information on the illustration of the nameplate shown below, as this will provide a quick reference when seeking technical information and/or ordering repair parts.



UNDERSTANDING THE DIESEL ENGINE

The diesel engine closely resembles the gasoline engine, since the mechanism is essentially the same. The cylinders are arranged above a closed crankcase. The crankshaft is the same general type as a gasoline engine, and the diesel engine has the same type of valves, camshaft, pistons, connecting rods and lubricating system.

Therefore, to a great extent, a diesel engine requires the same preventive maintenance as a gasoline engine. The most important factors are proper ventilation and proper maintenance of the fuel, lubricating and cooling systems. Fuel and lubricating filter elements must be replaced at the time periods specified, and frequent checking for contaminants (water, sediment, etc.) in the fuel system is also essential. Another important factor is the consistent use of the same brand of high detergent diesel lubrication oil designed specifically for diesel engines.

The diesel engine does differ from the gasoline engine, however, in its method of handling and firing of fuel. The carburetor and ignition systems are replaced by a single component – the fuel injection pump – which performs the function of both.

ORDERING PARTS

Whenever replacement parts are needed, always provide the engine model number and serial number as they appear on the silver and black nameplate located on the manifold. You must provide us with this information so we may properly identify your engine. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). Insist upon WESTERBEKE packaged parts because *will fit* or generic parts are frequently not made to the same specifications as original equipment.

SPARES AND ACCESSORIES

Certain spares will be needed to support and maintain your WESTERBEKE engine. Your local WESTERBEKE dealer will assist you in preparing an inventory of spare parts. See the *SPARE PARTS* page in this manual. For engine accessories, see WESTERBEKE's *ACCESSORIES* brochure.

ADMIRAL CONTROL PANEL

DESCRIPTION

This manually-operated control panel is equipped with a KEY switch and RPM gauge with an ELAPSED TIME meter which measures the engine's running time in hours and in 1/10 hours. The panel also includes a WATER TEMPERATURE gauge which indicates water temperature in degrees Fahrenheit, an OIL PRESSURE gauge which measures the engine's oil pressure in pounds per square inch, and a DC control circuit VOLTAGE gauge which measures the system's voltage. All gauges are illuminated when the key switch is turned on and remain illuminated while the engine is in operation. The panel also contains two rubber-booted pushbuttons, one for PREHEAT and one for START.

When the engine is shut down with the key switch turned off, the water temperature gauge will continue to register the last temperature reading indicated by the gauge before electrical power was turned *off*. The oil pressure gauge will fall to zero when the key switch is turned *off*. The temperature gauge will once again register the engine's true temperature when electrical power is restored to the gauge.

A separate alarm buzzer with harness is supplied with every Admiral Panel. The installer is responsible for electrically connecting the buzzer to the four-pin connection on the engine's electrical harness. The installer is also responsible for installing the buzzer in a location where it will be dry and where it will be audible to the operator should it sound while the engine is running. The buzzer will sound when the ignition key is turned on and should silence when the engine has started and the engine's oil pressure rises above 15 psi (1.1 kg/cm²).

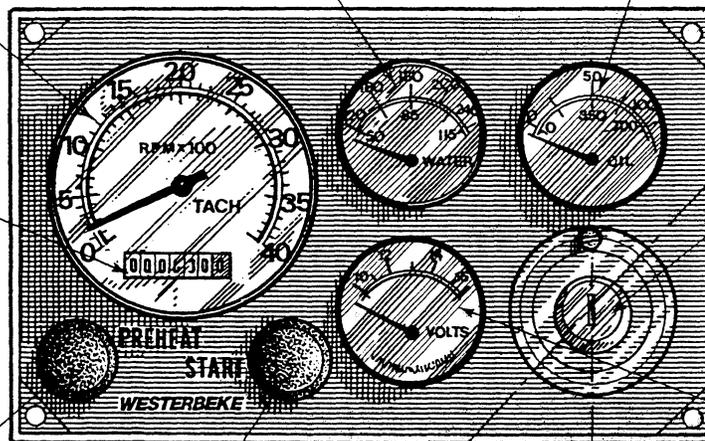
WATER TEMPERATURE GAUGE: THIS GAUGE IS GRADUATED IN DEGREES FAHRENHEIT AND IS ILLUMINATED WHILE THE KEY SWITCH IS TURNED ON. THE ENGINE'S NORMAL OPERATING TEMPERATURE IS 170° - 190° F (77° - 88°C).

OIL PRESSURE GAUGE: THIS GAUGE IS GRADUATED IN POUNDS PER SQUARE INCH (PSI) AND IS ILLUMINATED WHILE THE KEY SWITCH IS TURNED ON. THE ENGINE'S NORMAL OPERATING OIL PRESSURE RANGES BETWEEN 40 - 85 psi.

RPM GAUGE: REGISTERS REVOLUTIONS PER MINUTE OF THE ENGINE AND CAN BE RECALIBRATED FOR ACCURACY FROM THE REAR OF THE PANEL.

HOURMETER: REGISTERS ELAPSED TIME, AND SHOULD BE USED AS A GUIDE FOR THE MAINTENANCE SCHEDULE.

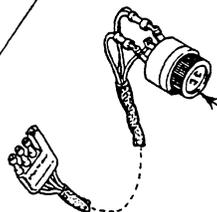
KEY SWITCH: PROVIDES POWER ONLY TO THE INSTRUMENT PANEL CLUSTER.



PREHEAT BUTTON: WHEN PRESSED, ENERGIZES THE ALTERNATOR'S EXCITER, THE FUEL LIFT PUMP, THE FUEL SOLENOID ON THE INJECTION PUMP, AND THE ENGINE'S GLOW PLUGS. IT BYPASSES THE ENGINE'S OIL PRESSURE ALARM SWITCH. IN ADDITION, THIS BUTTON ENERGIZES THE START BUTTON.

START BUTTON: WHEN PRESSED, ENERGIZES THE STARTER'S SOLENOID WHICH CRANKS THE ENGINE. THIS BUTTON WILL NOT OPERATE ELECTRICALLY UNLESS THE PREHEAT BUTTON IS PRESSED AND HELD AT THE SAME TIME.

DC VOLTMETER: INDICATES THE AMOUNT THE BATTERY IS BEING CHARGED. SHOULD SHOW 13V TO 14V.



AUTOMATIC ALARM SYSTEM

COOLANT TEMPERATURE ALARM: AN ALARM BUZZER HAS BEEN SUPPLIED WITH THE INSTRUMENT PANEL. IF THE ENGINE'S COOLANT REACHES 210° F (99°C), THIS SWITCH WILL CLOSE SOUNDING THE ALARM WHICH WILL EMIT A *CONTINUOUS* SIGNAL.

OIL PRESSURE ALARM: AN OIL PRESSURE ALARM SWITCH IS LOCATED OFF THE ENGINE'S OIL GALLERY. THIS SWITCH MONITORS THE ENGINE'S OIL PRESSURE. SHOULD THE ENGINE'S OIL PRESSURE FALL TO 5 - 10 psi (0.4 - 0.7 kg/cm²), THE SWITCH WILL CLOSE SOUNDING THE ALARM. IN THIS EVENT, THE ALARM WILL EMIT A *PULSATING* SIGNAL.

DIESEL FUEL, ENGINE OIL AND ENGINE COOLANT

DIESEL FUEL

Use fuel that meets the requirements or specification of Class 2-D (ASTM), and has a cetane rating of #45 or better.

Care Of The Fuel Supply

Use only clean diesel fuel! The clearance of the components in your fuel injection pump is very critical; invisible dirt particles which might pass through the filter can damage these finely finished parts. It is important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by careless handling or improper storage facilities. To assure that the fuel going into the tank for your engine's daily use is clean and pure, the following practice is advisable:

Purchase a well-known brand of fuel.

Install and regularly service a good, visual-type fuel filter/water separator between the fuel tank and the engine. The *Raycor 445* or larger is a good example of such a filter.

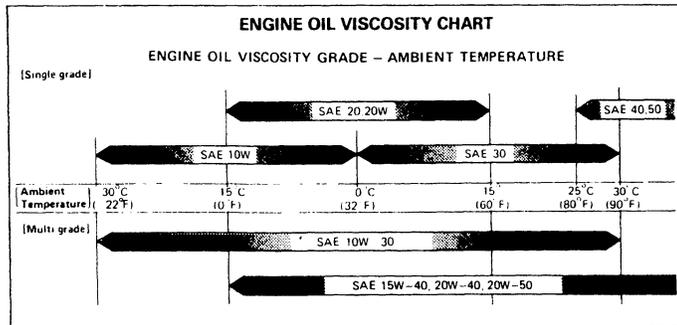
ENGINE OIL

80N4/120N6 API Grade CF or CG-4

110T4/170T6 API Grade CG-4

Use the heavy duty engine oils as specified above. Change the engine oil after an initial 50 hour break-in period and every 100 hours of operation thereafter.

Engine oil viscosity largely affects engine startability, performance, oil consumption, speed of wearing and occurrence of seizure, etc. Using lubricants whose viscosity is selected according to the atmospheric temperature is important.



CAUTION: Do not allow two or more brands of engine oil to mix. Each brand contains its own additives; additives of different brands could react in the mixture to produce properties harmful to your engine.

OIL PRESSURE

The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 25 and 85 psi.

NOTE: A newly started, cold engine can have an oil pressure reading up to 85 psi. A warmed engine can have an oil pressure reading as low as 25 psi. These readings will vary depending upon the temperature of the engine, the load placed on the engine, and the RPM's.

ENGINE COOLANT

WESTERBEKE recommends a mixture of 50% antifreeze and 50% distilled water. Distilled water is free from the chemicals that can corrode internal engine surfaces.

The antifreeze performs double duty. It allows the engine to run at proper temperatures by transferring heat away from the engine to the coolant, and lubricates and protects the cooling circuit from rust and corrosion. Look for a good quality antifreeze that contains Supplemental Cooling Additives (SCAs) that keep the antifreeze chemically balanced, crucial to long term protection.

The distilled water and antifreeze should be premixed before being poured into the cooling circuit.

NOTE: Look for the new environmentally-friendly long lasting antifreeze that is now available.

Antifreeze mixtures will protect against an unexpected freeze and they are beneficial to the engine's cooling system. They retard rust and add to the life of the circulating pump seal.

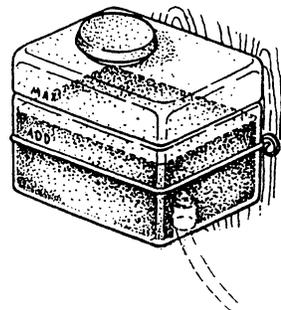
ANTIFREEZE PROTECTION

Antifreeze Concentration	23%	30%	35%	50%
Freezing Temperature	14°F (-10°C)	8°F (-13°C)	-4°F (-20°C)	-40°F (-40°C)

COOLANT RECOVERY TANK

A coolant recovery tank kit is supplied with each WESTERBEKE diesel engine. The purpose of this recovery tank is to allow for engine coolant expansion and contraction during engine operation, without the loss of coolant and without introducing air into the cooling system. This kit is provided and must be installed before operating the engine.

NOTE: This tank, with its short run of plastic hose, must be located above the level of the engine's manifold.



PREPARATIONS FOR INITIAL START-UP

PRESTART INSPECTION

Before starting your engine for the first time or after a prolonged layoff, check the following items:

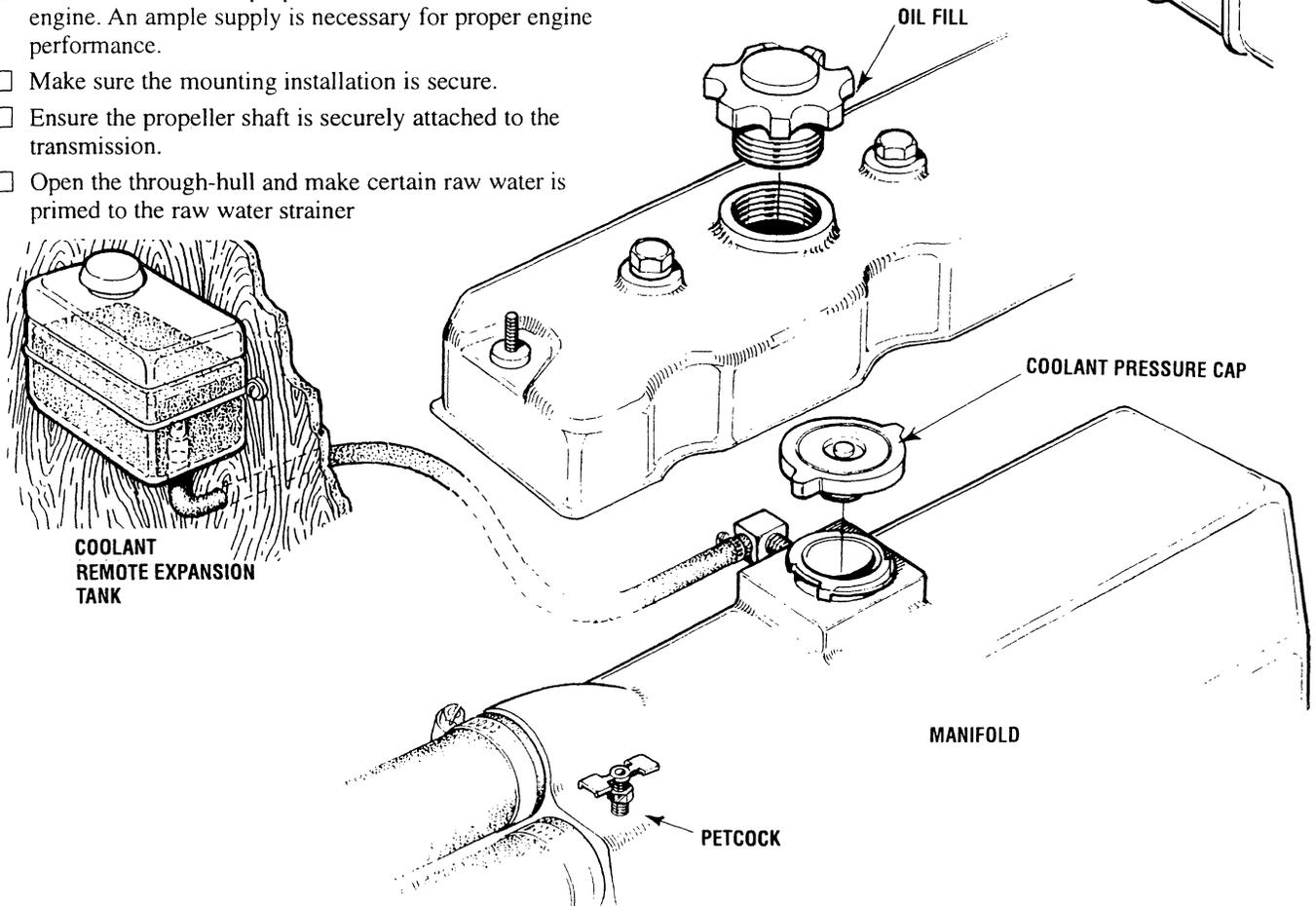
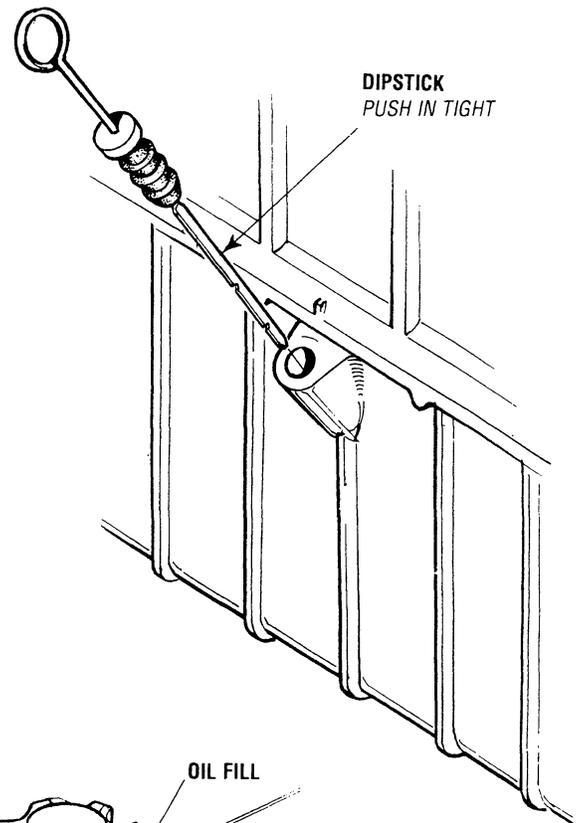
- Check the engine oil level. Add oil to maintain the level at the high mark on the dipstick.
- Turn on the fuel supply, then check the fuel supply and examine the fuel filter/water separator bowl for contaminants.
- Check the transmission fluid level.

NOTE: Refer to the previous page for fuel, oil and transmission fluid.

- Check the DC electrical system. Inspect wire connections and battery cable connections. Make certain the positive (+) battery cable is connected to the starter solenoid and the negative (-) cable is connected to the engine ground stud (this location is tagged).
- Check the coolant level in both the plastic recovery tank and at the manifold.

NOTE: If the engine has not yet been filled with coolant, refer to the *COOLING SYSTEM* section of this manual.

- Visually examine the engine. Look for loose or missing parts, disconnected wires, and unattached hoses. Check the threaded connections and engine attachments.
- Make certain there is proper ventilation around the engine. An ample supply is necessary for proper engine performance.
- Make sure the mounting installation is secure.
- Ensure the propeller shaft is securely attached to the transmission.
- Open the through-hull and make certain raw water is primed to the raw water strainer



STARTING/STOPPING PROCEDURE

THE STARTING SYSTEM

These marine diesel engine have 12V DC electric starters. The start circuitry is designed so that the PREHEAT button must be depressed for the time specified in the preheat chart. Then, while keeping the PREHEAT button engaged, the START button is depressed to crank the engine.

Starting Procedure

1. Place the transmission in neutral and advance the throttle control to slightly open.

CAUTION: Make certain the transmission is in neutral. Starting in gear could result in serious damage to your transmission, your boat, and vessels nearby.

2. Turn the KEY SWITCH to the ON position (2 o'clock).
3. Depress the PREHEAT switch. The voltmeter, panel lights, gauges, meters and fuel solenoid will be activated. The PREHEAT switch should be depressed in accordance with the following chart:

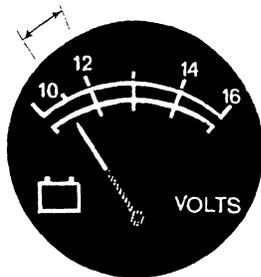
Temperature/Preheat

Atmospheric Temperature	Preheating Time
41°F(5°C) or higher	Approx. 5 seconds
41°F(5°C) to 23°F (-5°C)	Approx. 10 seconds
23°F(-5°C) or lower	Approx. 15 seconds

NOTE: The START button will not energize unless the PREHEAT button is depressed. Depressing the PREHEAT button activates the glow plugs in the cylinder head so use the PREHEAT intermittently to avoid overheating the glow plugs.

4. While still depressing the PREHEAT switch, depress the START switch. This will engage the starter solenoid. Upon engine starting, release the START switch and release the PREHEAT switch.

NOTE: When starting: A voltage drop will occur when the preheat button is depressed.



5. Should the engine not start when the START button is depressed for 10 to 20 seconds, release both buttons and wait 30 seconds; repeat the procedure above and preheat longer. *Never run the starter for more than 30 seconds.*

CAUTION: Prolonged cranking intervals without the engine starting can result in the engine exhaust system filling with raw water. This may happen because the pump is pumping raw water through the raw water cooling system during cranking. This raw water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the raw water supply through-hull shutoff, draining the exhaust muffler, and correcting the cause of the excessive engine cranking. Engine damage resulting from raw water entry is not a warrantable issue; the owner/operator should keep this in mind.

6. Once the engine starts, check the instruments for proper oil pressure and battery charging voltage.

NOTE: Never attempt to engage the starter while the engine is running.

Starting Under Cold Conditions

Make sure the lubricating oil is appropriate for the prevailing temperature. Use oil with an API Specification of CF or CG-4, SAE 30, 10W-30, or 15W-40, or 20W-40.

The battery should be fully charged to minimize voltage drop. Use a sufficient amount of preheat to aid in starting. See the Temperature/Preheat chart elsewhere in this section.

Stopping Procedure

To stop the engine, bring the throttle to an idle position and place the transmission in neutral. Allow the engine to idle for a few moments to stabilize temperatures. Turn the engine off using the stop control cable.

NOTE: Make certain this key switch is in the OFF position (12 o'clock). If the key switch is left ON, the battery will discharge. An engine alarm buzzer is provided to warn the operator of this condition (key switch ON). The best method of preventing the battery from discharging is to remove the key from the key switch after stopping the engine.

ALTERNATOR WARNINGS

The Admiral Control Panel uses a voltmeter to monitor the performance of the alternator.

COOLANT TEMPERATURE SWITCH

A coolant temperature switch is located on the thermostat housing. This switch will activate a continuous alarm if the coolant's operating temperature reaches approximately 210°F (99°C).

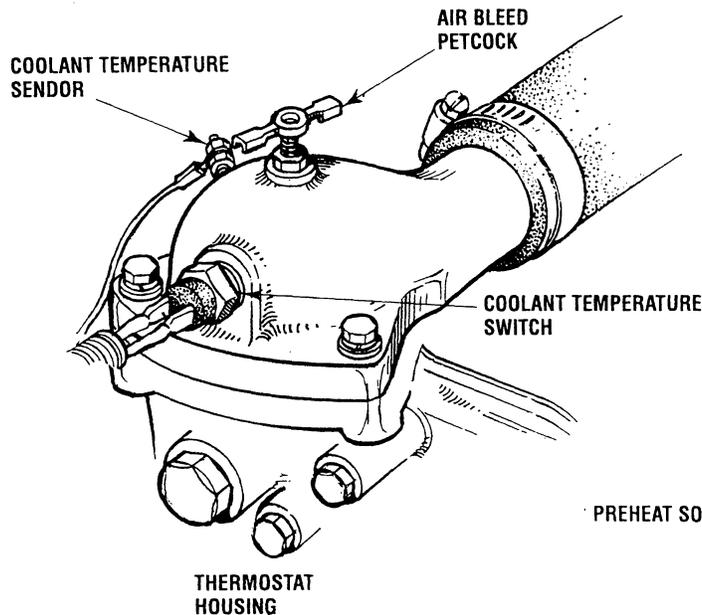
WARNING LIGHTS, ALARMS & CIRCUIT BREAKER

ALTERNATOR WARNINGS

The Admiral Control Panel uses a voltmeter to monitor the performance of the alternator.

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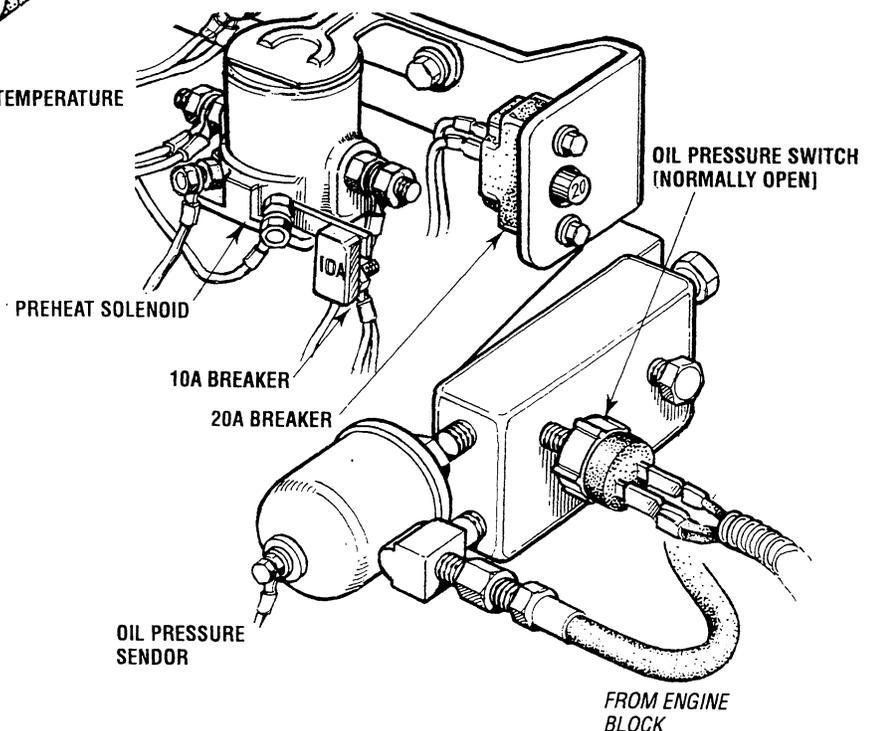


LOW OIL PRESSURE ALARM SWITCH

A low oil pressure alarm switch is located off the engine's oil gallery. This switch's sensor monitors the engine's oil pressure. Should the engine's oil pressure fall to 5 – 10 psi (0.4 – 0.7 kg/cm²), this switch will activate a pulsating alarm.

ENGINE CIRCUIT BREAKER

The DC harness on the engine is protected by an engine-mounted manual reset circuit breaker (20 amps DC). Excessive current draw or electrical overload anywhere in the instrument panel wiring or engine wiring will cause the breaker to trip. In this event most engines will shut down because the opened breaker disconnects the fuel supply. If this should occur, check and repair the source of the problem. After repairing the fault, reset the breaker and restart the engine.



ENGINE BREAK-IN PROCEDURE

DESCRIPTION

Although your engine has experienced a minimum of one hour of test operations at the factory to make sure accurate assembly procedures were followed and that the engine operated properly, a break-in time is required. The service life of your engine is dependent upon how the engine is operated and serviced during its initial 50 hours of use.

Breaking-in a new engine basically involves seating the piston rings to the cylinder walls. Excessive oil consumption and smoky operation indicate that the cylinder walls are scored, which is caused by overloading the engine during the break-in period.

Your new engine requires approximately 50 hours of initial conditioning operation to break in each moving part in order to maximize the performance and service life of the engine. Perform this conditioning carefully, keeping in mind the following:

1. Start the engine according to the *STARTING PROCEDURE* section. Run the engine at fast idle while checking that all systems (raw water pump, oil pressure, battery charging) are functioning.
2. Allow the engine to warm up (preferably by running at fast idle) until the water temperature gauge moves into the 130 – 140°F (55 – 60°C) range.

3. While using the vessel, run the engine at various engine speeds for the first 25 hours. Avoid prolonged periods of idling.
4. Avoid rapid acceleration, especially with a *cold* engine.
5. Use caution not to overload the engine. The presence of a grey or black exhaust and the inability of the engine to reach its full rated speed are signs of an overload.
6. During the next 25 hours, the engine may be operated at varying engine speeds, with short runs at full rated rpm. Avoid prolonged idling during this break-in period.

CHECK LIST

- Monitor the control panel gauges.
- Check for leaks of fuel and engine oil.
- Check for abnormal noise such as knocking, friction, vibration and blow-back sounds.
- Confirm exhaust smoke:
 - When the engine is cold – white smoke.
 - When the engine is warm – almost smokeless.
 - When the engine is overloaded – some black smoke and soot.

NOTE: See the *TRANSMISSION* section of this manual for break-in information on your transmission.

THE DAILY ROUTINE

CHECK LIST

Each day before starting your engine, take a few moments to run this check list:

- Visually inspect the engine for fuel, oil, or water leaks.
- Check the oil level.
- Check the transmission fluid level.
- Check for loose wires at the alternator.
- Check the starting batteries (weekly).
- Check drive belts for wear and proper tension (weekly).
- Log your engine running time. These hours relate to scheduled maintenance.
- Check fuel supply; always keep fuel tank(s) as full as possible.
- Look for clean fuel in the fuel/water separator bowl.
- Check the coolant level in the plastic recovery tank.

NOTE: Excessive loss of coolant indicates a cooling system leak. Check the entire system. If necessary, use a cooling system pressure tester to pressurize the cooling system to locate the area of leakage. In cases of excessive coolant loss, refill the system as outlined in the *ENGINE COOLANT CIRCUIT* section of this manual.

STARTING THE ENGINE

NOTE: See *STARTING/STOPPING PROCEDURE* in this manual for more detailed instructions.

1. Put the transmission in neutral, throttle advanced.

NOTE: *Hydraulically operated transmissions have a neutral safety switch through which the starter solenoid energizing circuit passes. This switch is open when the transmission is in gear so the starter solenoid will not energize.*

2. Turn the KEY to the ON position (2 o'clock).
3. Depress PREHEAT (5 seconds).
4. While pressing PREHEAT, push START. As the engine fires, release START and PREHEAT.

NOTE: *Some unstable running may occur in a cold engine. This condition should abate as normal operating temperature is reached and loads are applied.*

NOTE: *Should the engine fail to start, wait 30 seconds, then repeat the above procedure, and PREHEAT longer.*

5. Allow a few minutes for the engine to warm at a comfortable rpm (approximately 1200 rpm), then reduce the rpm, and get underway.

⚠ CAUTION: *When shifting the transmission, always reduce the engine rpm to idle, then shift the transmission firmly from one direction to another. A slight pause in neutral will allow the propeller to slow. Shifting at high rpm will damage the transmission/damper plate.*

MAINTENANCE SCHEDULE

In order to use this Maintenance Schedule, it will be necessary to log your engine hours. Use your engine hourmeter or record your engine hours by running time.

NOTE: Many of the following maintenance procedures are simple but others are more difficult and may require the expert knowledge of a service mechanic.

⚠ WARNING: *Never attempt to perform any service while the engine is running. Wear the proper safety equipment such as goggles and gloves, and use the correct tools for each job. Disconnect the battery terminals when servicing any of the engine's DC electrical equipment.*

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							MAINTENANCE DESCRIPTION
		50	100	250	500	750	1000	1250	
Fuel Supply	<input type="checkbox"/>								Diesel No. 2 rating of 45 cetane or higher.
Fuel/Water Separator	<input type="checkbox"/>								Check for water and dirt in fuel (drain/replace filter if necessary).
Engine Oil Level	<input type="checkbox"/>								Oil level should indicate between MAX. and LOW on dipstick.
Coolant Level	<input type="checkbox"/>								Check at recovery tank; if empty, check at manifold. Add coolant if needed.
Transmission Fluid Level	<input type="checkbox"/>								Fluid level should indicate between MAX and LOW on dipstick.
Drive Belts	<input type="checkbox"/> weekly								Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt edges for wear.
Visual Inspection of Engine	<input type="checkbox"/>	NOTE: <i>Keep engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.</i>							Check for fuel, oil and water leaks. Inspect wiring and electrical connections. Keep bolts & nuts tight. Check for loose belt tension.
Fuel Filter		<input type="checkbox"/>		<input type="checkbox"/>	Change at 50 hours then every 250 hours.				
Starting Batteries (and House Batteries)	<input type="checkbox"/> weekly								Check electrolyte levels every 50 operating hours and make sure connections are very tight. Clean off excessive corrosion.
Engine Oil and Filter		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Initial engine oil & filter change at 50 hours, then change both every 100 hours.
Heat Exchanger Zinc Anode		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Inspect zinc anode, replace if needed. Clear the heat exchanger end of zinc anode debris.
Fuel/Water Separator			<input type="checkbox"/>	Change filter every 200 hours.					
Exhaust System		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Initial check at 50 hours, then every 250 hours. Inspect for leaks. Check anti-siphon valve operation. Check the exhaust elbow for carbon and/or corrosion buildup on inside passages; clean and replace as necessary. Check that all connections are tight. Check casting integrity.
Engine Hoses			<input type="checkbox"/>	Hose should be hard & tight. Replace if soft or spongy. Check and tighten all hose clamps.					
Throttle and Transmission Control Cable		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Check for loose fittings, cotter pins, etc. Lubricate with WD-40 or equivalent.
Raw Water Pump				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Remove the pump cover and inspect the impeller, gasket, cam and cover for wear. Check the bearings and seals (the shaft can turn, but not wobble). Lubricate when reassembling.

(continued)



MAINTENANCE SCHEDULE

NOTE: Use the engine hourmeter gauge to log your engine hours or record your engine hours by running time.

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							MAINTENANCE DESCRIPTION
		50	100	250	500	750	1000	1250	
Coolant System					<input type="checkbox"/>			<input type="checkbox"/>	Drain, flush, and refill cooling system with appropriate antifreeze mix.
DC Alternator				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Check DC charge from alternator. Check mounting bracket; tighten electrical connections.
Transmission Oil Cooler							<input type="checkbox"/>		Remove; have professionally cleaned and pressure tested.
Engine Transmission Damper Plate							<input type="checkbox"/>		Chattering at idle and low rpms is an indication of damper plate wear. Remove and replace.
*Fuel Injectors						<input type="checkbox"/>			Check and adjust injection opening pressure and spray condition (Refer to your service manual).
*Starter Motor					<input type="checkbox"/>			<input type="checkbox"/>	Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive.
*Preheat Circuit					<input type="checkbox"/>			<input type="checkbox"/>	Check operation of preheat solenoid. Remove and clean glow plugs. Reinstall with anti-seize compound on threads.
*Engine Cylinder Compression					<input type="checkbox"/>			<input type="checkbox"/>	Check compression pressure and timing, (see <i>ENGINE ADJUSTMENTS</i>).
*Adjust the Valve Clearances		<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	Adjust Valve Clearances, (see <i>ENGINE ADJUSTMENTS</i>).
*Heat Exchanger							<input type="checkbox"/>		Remove, have professionally cleaned and pressure tested.
Lubricate Panel Key Switch with "Lockeze"			<input type="checkbox"/>	At first 100 hours, then each year at winterizing.					
Transmission Fluid and Filter		<input type="checkbox"/>		<input type="checkbox"/>	Initial fluid change at 25 hours, then every 300 hours or at winterizing. Replace the filter at each fluid change.				
Feed Pump Strainer				<input type="checkbox"/>	Clean every 250 operating hours.				
Turbocharger		<input type="checkbox"/>						<input type="checkbox"/>	Initial 50 hour check, inspect all connections for oil and exhaust leaks. Check mounting bolts for tightness. Check for air leakage. Inspect the radial and axial play of the rotor shaft. Lubricate the shaft bearings.

*WESTERBEKE recommends this service be performed by an authorized mechanic.

COOLING SYSTEM

DESCRIPTION

Westerbeke marine diesel engines are designed and equipped for fresh water cooling. Heat produced in the engine by combustion and friction is transferred to fresh water coolant which circulates throughout the engine. This circulating fresh water coolant cools the engine block, its internal moving parts, and the engine oil. The heat is transferred externally from the fresh water coolant to raw water by means of a heat exchanger, similar in function to an automotive radiator. Raw water flows through the tubes of the heat exchanger while fresh water coolant flows around the tubes; engine heat transferred to the fresh water coolant is conducted through the tube walls to the raw water which is then pumped into the exhaust system where finally it is discharged overboard. In other words, the engine is cooled by fresh water coolant, this coolant is cooled by raw water, and the raw water carries the transferred heat overboard through the exhaust system. The fresh water coolant and raw water circuits are independent of each other. Using only fresh water coolant within the engine allows the cooling water passages to stay clean and free from harmful deposits.

FRESH WATER COOLING CIRCUIT

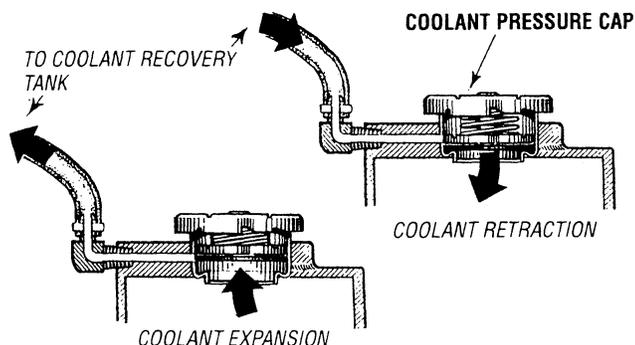
NOTE: Refer to the *ENGINE COOLANT* section for the recommended antifreeze and water mixture to be used as the fresh water coolant.

Fresh water coolant is pumped through the engine by a circulating pump, absorbing heat from the engine. The coolant then passes through the thermostat into the manifold, to the heat exchanger where it is cooled, and returned to the engine block via the suction side of the circulating pump.

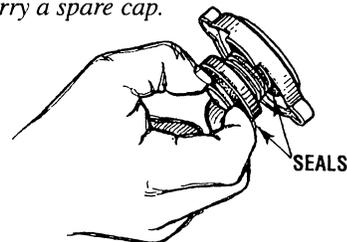
When the engine is started cold, external coolant flow is prevented by the closed thermostat (although some coolant flow is bypassed around the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing full flow of the engine's coolant to flow unrestricted to the external portion of the cooling system.

Coolant Recovery Tank

A coolant recovery tank allows for engine coolant expansion and contraction during engine operation, without any significant loss of coolant and without introducing air into the cooling system. This tank should be located at or above the engine manifold level and should be easily accessible.



NOTE: Periodically check the condition of the manifold pressure cap. Ensure that the upper and lower rubber seals are in good condition and check that the vacuum valve opens and closes tightly. Carry a spare cap.



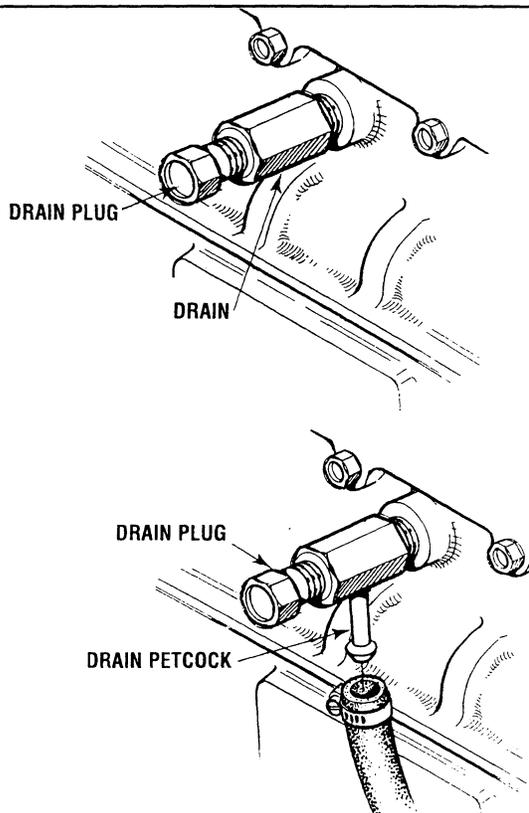
CHANGING COOLANT

The engine's coolant must be changed according to the *MAINTENANCE SCHEDULE*. If the coolant is allowed to become contaminated, it can lead to overheating problems.

CAUTION: Proper cooling system maintenance is critical; a substantial number of engine failures can be traced back to cooling system corrosion.

Drain the engine coolant by loosening the drain plug on the engine block and opening the manifold pressure cap. Flush the system with fresh water, then start the refill process.

WARNING: Beware of the hot engine coolant. Wear protective gloves.



SOME ENGINE MODELS ARE EQUIPPED WITH A PETCOCK THAT ALLOWS FOR A HOSE TO BE ATTACHED

COOLING SYSTEM

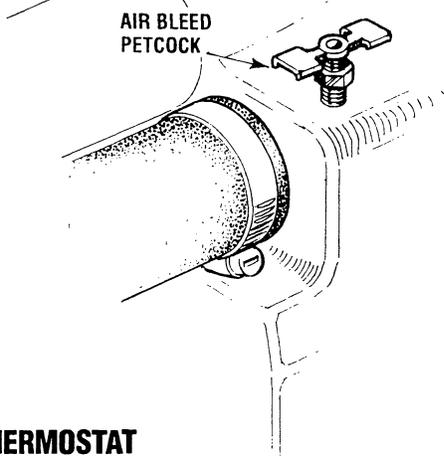
Refilling the Coolant

After closing the engine block drain, pour clean, premixed coolant into the manifold and when the coolant is visible in the manifold, start the engine and run it at slow idle. Open the air bleed petcocks on the manifold and the thermostat housing.

Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and when the coolant flowing from the petcock is free of air bubbles, close the petcock and install the pressure cap.

Remove the cap on the coolant recovery tank and fill with coolant mix to halfway between LOW and MAX and replace the cap. Run the engine and observe the coolant expansion flow into the recovery tank. When the petcock on the thermostat housing is free of air bubbles, close that petcock.

After checking for leaks, stop the engine and allow it to cool. Coolant should draw back into the cooling system as the engine cools down. Add coolant to the recovery tank if needed. Clean up any spilled coolant.



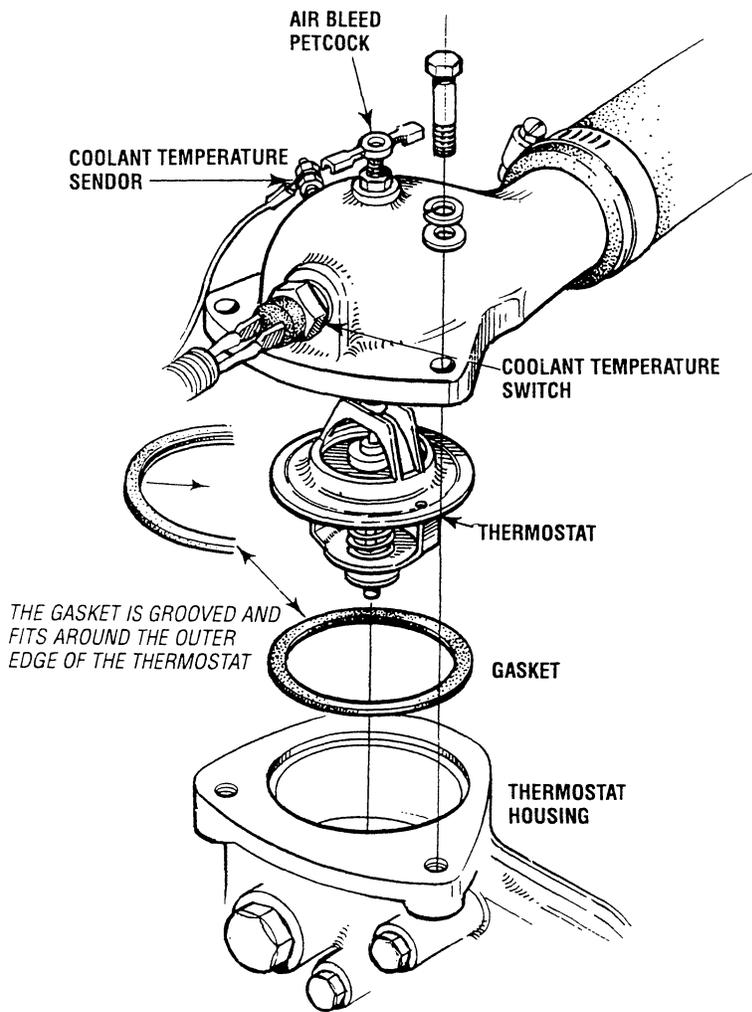
THERMOSTAT

A thermostat, located near the manifold at the front of the engine, controls the coolant temperature as the coolant continuously flows through the closed cooling circuit. When the engine is first started, the closed thermostat prevents coolant from flowing (some coolant is by-passed through a hole in the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens. The thermostat is accessible and can be checked, cleaned, or replaced easily. Carry a spare thermostat and gasket.

Replacing the Thermostat

Remove the cap screws and disassemble the thermostat housing as shown. When installing the new thermostat and gasket, apply a thin coat of sealant on both sides of the gasket before pressing it into place. Do *not* over-tighten the cap screws.

Run the engine and check for normal temperatures and that there are no leaks at the thermostat housing.



CHANGING THE THERMOSTAT

COOLING SYSTEM

RAW WATER COOLING CIRCUIT

The raw water flow is created by a positive displacement impeller pump. This pump draws water directly from the raw water source (ocean, lake, or river) through a hose to the water strainer. The raw water passes from the strainer through the raw water pump to the heat exchanger (through the heat exchanger tubes) where it cools the engine circulating fresh water coolant. The raw water is then discharged into the water-injected exhaust elbow, mixing with and cooling the exhaust gasses. This mixture of exhaust gas and raw water is discharged overboard by the engine's exhaust gas discharge pressure.

Raw Water Pump

The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. On no account should this pump be run dry as water acts as a lubricant for the impeller. There should always be a spare impeller and impeller cover gasket (an impeller kit) aboard. Raw water pump impeller failures occur when lubricant (raw water) is not present during engine operation. Such failures are not warrantable, and operators are cautioned to make sure raw water flow is present at start-up.

NOTE: Should a failure occur with the pump's internal parts (seals and bearings), it may be more cost efficient to purchase a new pump and rebuild the original pump as a spare.

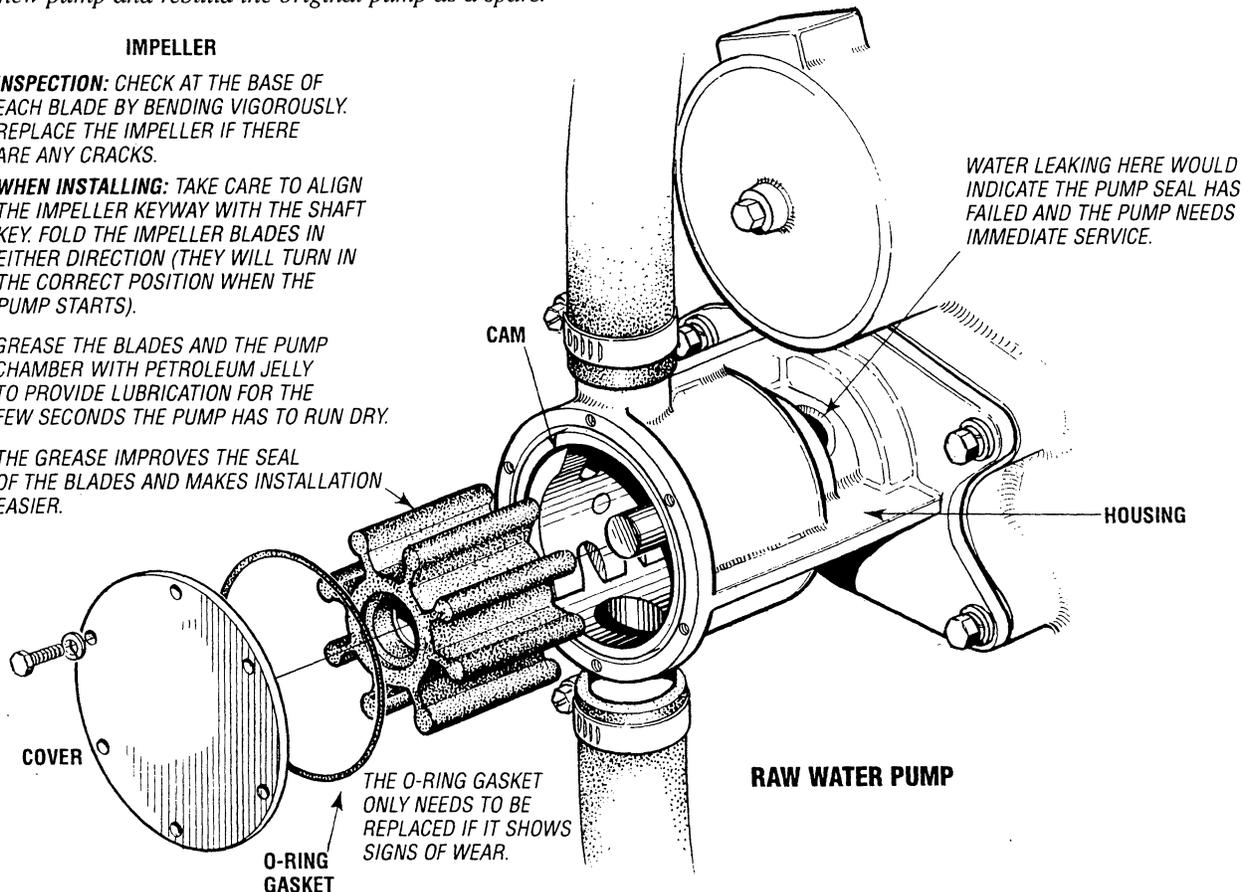
IMPELLER

INSPECTION: CHECK AT THE BASE OF EACH BLADE BY BENDING VIGOROUSLY. REPLACE THE IMPELLER IF THERE ARE ANY CRACKS.

WHEN INSTALLING: TAKE CARE TO ALIGN THE IMPELLER KEYWAY WITH THE SHAFT KEY. FOLD THE IMPELLER BLADES IN EITHER DIRECTION (THEY WILL TURN IN THE CORRECT POSITION WHEN THE PUMP STARTS).

GREASE THE BLADES AND THE PUMP CHAMBER WITH PETROLEUM JELLY TO PROVIDE LUBRICATION FOR THE FEW SECONDS THE PUMP HAS TO RUN DRY.

THE GREASE IMPROVES THE SEAL OF THE BLADES AND MAKES INSTALLATION EASIER.



Changing the Raw Water Pump Impeller

Close the raw water intake valve. Remove the pump cover and, with the aid of an impeller puller, carefully pry the impeller out of the pump. Install the new impeller and gasket. Move the blades to conform to the curved cam plate and push the impeller into the pump's housing. When assembling, apply a thin coating of lubricant to the impeller and gasket. **Open the raw water intake valve.**

To be certain the pump is operating properly, run the engine and check the following:

- Inspect the raw water pump for leaks.
- After warm up, monitor the temperature gauge. It should indicate a normal engine temperature.
- Check aft. There should be a steady flow of water from the stern tube.

CAUTION: If any of the vanes have broken off the impeller, they must be found to prevent blockage in the cooling circuit. They often can be found in the heat exchanger.

Impeller Puller

WESTERBEKE recommends using an impeller puller to remove the impeller, this will prevent damage to the blades and to the edges of the pump housing.

COOLING SYSTEM

HEAT EXCHANGER

The heat exchanger is a copper cylinder which encloses a large number of small copper tubes. Raw water is pumped through the small copper tubes and the fresh water coolant from the engine is circulated around the copper tubes. The raw water removes heat from the fresh water coolant.

Heat Exchanger Service

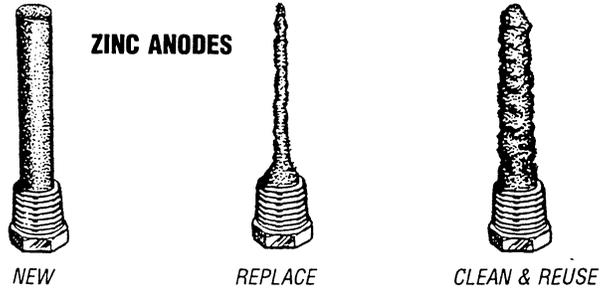
After approximately 1000 hours of operation, remove, clean and pressure test the engine's heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

NOTE: Operating in silty and/or tropical waters may require that a heat exchanger cleaning be performed more often than every 1000 hours.

Zinc Anode

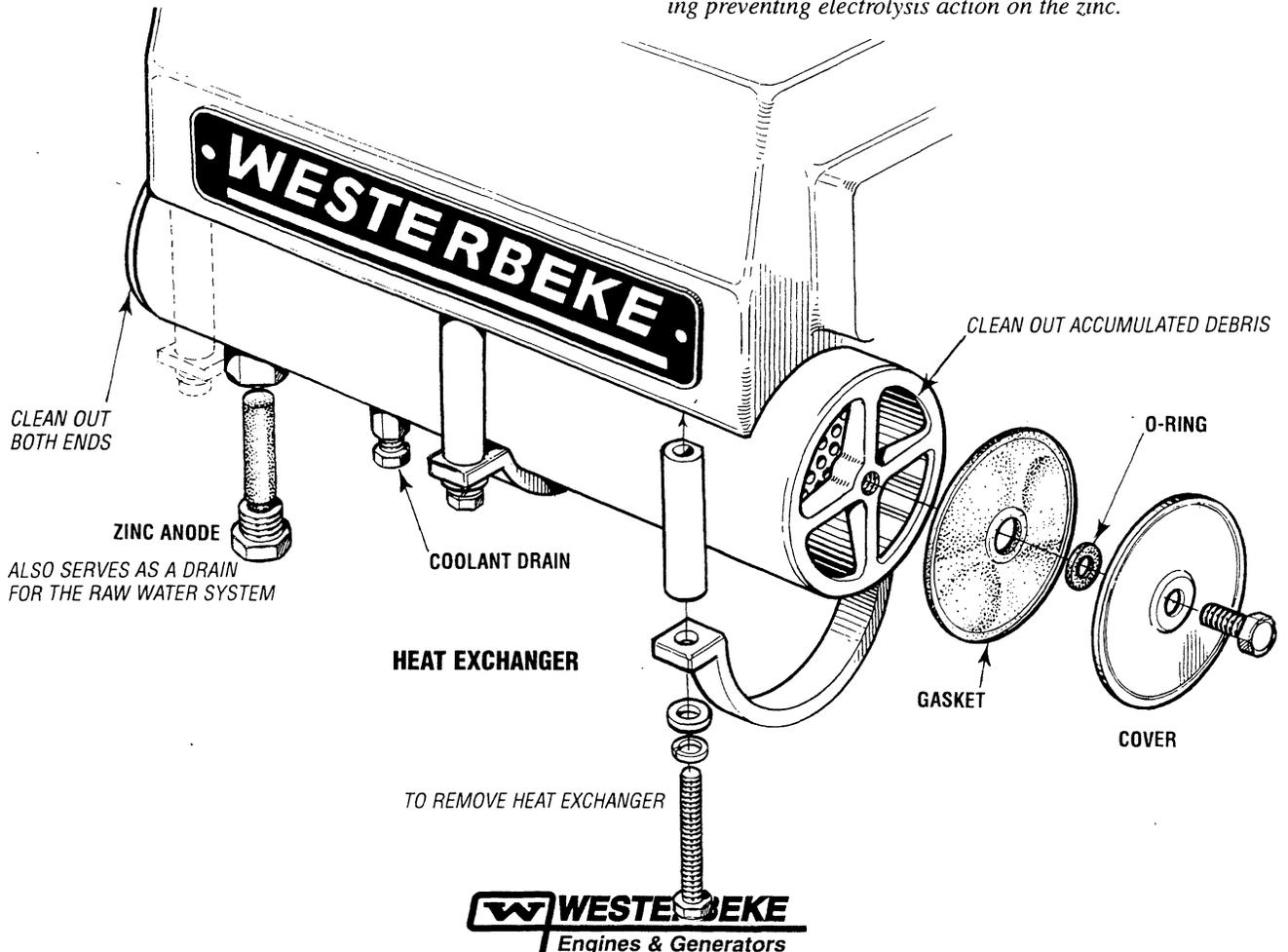
A zinc anode, or *pencil*, is located in the raw water cooling circuit within the heat exchanger. The purpose of having zinc anodes is to sacrifice them to electrolysis action taking place in the raw water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board.

NOTE: Electrolysis action is the result of each particular installation and vessel location; not that of the engine.



If the zinc anodes need replacement, hold the hex boss into which the zinc anode is threaded with a wrench while loosening the anode with another wrench. This prevents the hex boss from possibly tearing off the exchanger shell. After removing the zinc, note the condition of it. If the zinc is in poor condition, there are probably a lot of zinc flakes within the exchanger. Remove the end of the heat exchanger and clean the inside of all zinc debris. Always have a spare heat exchanger end gasket in case the present one becomes damaged when removing the end cover. Replace the gasket (refer to your engine model's heat exchanger end gasket part number), O-ring and cover, and install a new zinc anode.

NOTE: The threads of the zinc anodes are pipe threads and do not require sealant. Sealant should not be used as it may insulate the zinc from the metal of the heat exchanger housing preventing electrolysis action on the zinc.



COOLING SYSTEM

Raw Water Intake Strainer

NOTE: Always install the strainer at or below the waterline so the strainer will always be self-priming.

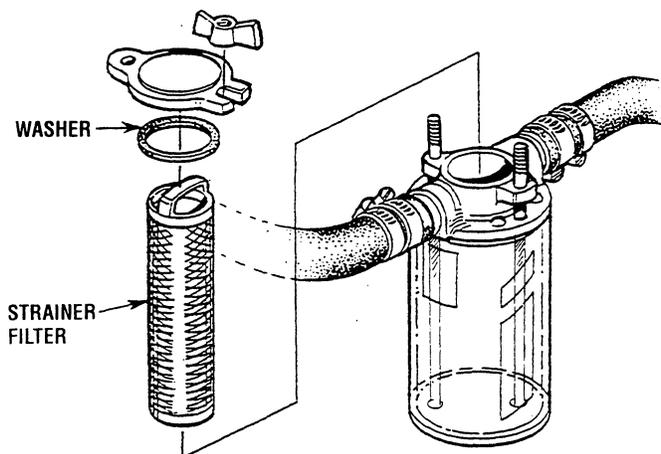
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

Perform the following maintenance after every 100 hours of operation:

1. Close the raw water seacock.
2. Remove and clean the strainer filter.
3. Clean the glass.
4. Replace the washer if necessary.
5. Reassemble and install the strainer.
6. **Open the seacock.**
7. Run the engine and check for leaks.

NOTE: Also follow the above procedure after having run hard aground.

If the engine temperature gauge ever shows a higher than normal reading, the cause may be that silt, leaves or grass may have been caught up in the strainer, slowing the flow of raw water through the cooling system.

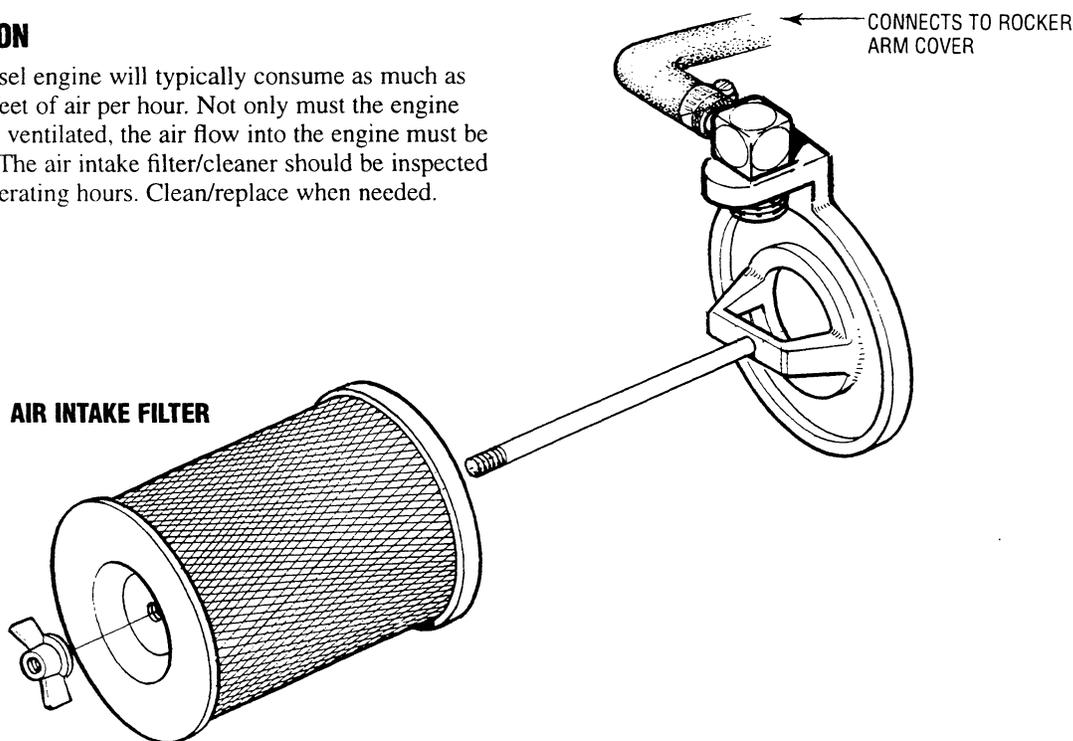


**TYPICAL RAW WATER INTAKE STRAINER
{Owner Installed}**

AIR INTAKE FILTER

DESCRIPTION

A marine diesel engine will typically consume as much as 6,000 cubic feet of air per hour. Not only must the engine room be well ventilated, the air flow into the engine must be unrestricted. The air intake filter/cleaner should be inspected every 100 operating hours. Clean/replace when needed.



FUEL SYSTEM

DIESEL FUEL

Use No. 2 diesel fuel with a cetane rating of 45 or higher. Do not use kerosene or home heating fuel.

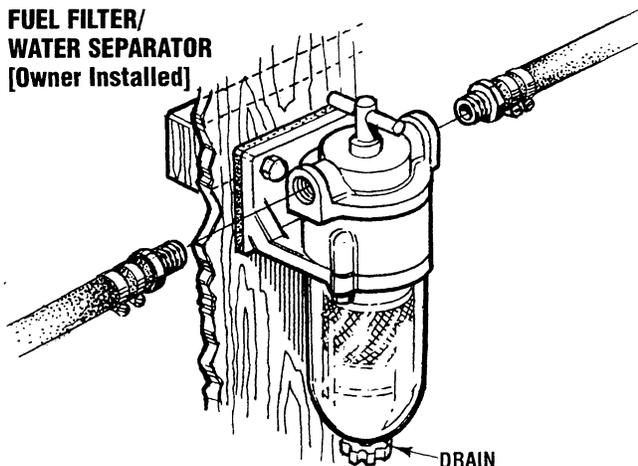
FUEL WATER SEPARATOR

A primary fuel filter of the water separating type must be installed between the fuel tank and the engine to remove water and other contaminants from the fuel before they can be carried to the fuel system on the engine.

Most installers include a type of filter/water separator with the installation package as they are aware of the problems that contaminants in the fuel can cause.

A typical fuel filter/water separator is illustrated below. This is the *Raycor Model 445*. Keep in mind that if a water separator type filter is not installed between the fuel supply tank and engine-mounted fuel system, any water in the fuel will affect the fuel pump, engine filter, and injection equipment. The owner/operator is responsible for making certain the fuel reaching the engine's injection equipment is free of impurities. This process is accomplished by installing and maintaining a proper filtration/separation system.

FUEL FILTER/ WATER SEPARATOR [Owner Installed]



FUEL INJECTION PUMP

The fuel injection pump is a very important component of the diesel engine, requiring the utmost care in handling. The fuel injection pump has been thoroughly bench-tested and the owner-operator is cautioned not to attempt to service it. If it requires servicing, remove it and take it to an authorized fuel injection pump service facility. Do not attempt to disassemble and repair it.

The only adjustment the servicing mechanic should make to the fuel injection pump is the adjustment for engine idle speed.

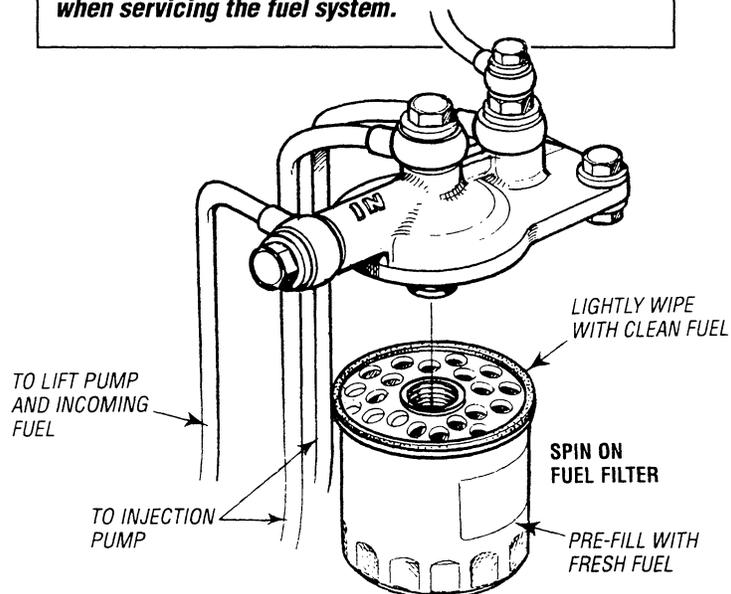
FUEL LIFT PUMP

The fuel lift pump is an integral part of the fuel injection pump.

FUEL FILTERS

The fuel injection pump and the fuel injectors are precisely manufactured and they must receive clean diesel fuel, free from water and dirt. To ensure this flow of clean fuel, the fuel must pass through at least two fuel filters, a fuel/water separator and the engine's spin-on fuel filter. Visually inspect, clean, and change these filters according to the maintenance schedule in this manual.

WARNING: Shut off the fuel valve at the tank when servicing the fuel system. Take care in catching any fuel that may spill. DO NOT allow any smoking, open flames or other sources of fire near the fuel system when servicing. Ensure proper ventilation exists when servicing the fuel system.



Changing the Fuel Filter

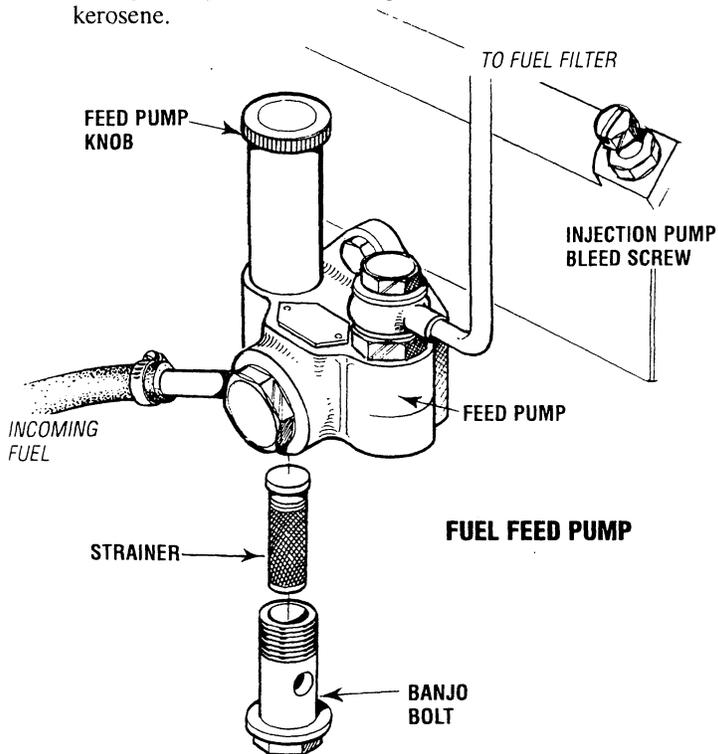
1. Shut the fuel supply off.
2. Loosen the fuel filter, turning counterclockwise with a filter wrench. Place the used filter in a container for proper disposal.
3. Using a rag, wipe clean the sealing face on the housing bracket so the new filter can be seated properly.
4. Lightly oil the sealing O-ring on the new filter. To reinstall, turn the filter assembly counterclockwise carefully until the O-ring contacts the sealing surface of the housing bracket. Turn 2/3 further with the filter wrench.

NOTE: The cartridge contains fuel. Take care not to spill it during disassembly.

FUEL SYSTEM

FUEL FEED PUMP STRAINER

An additional fuel screen is located in the feed pump. This screen (strainer) is removed for cleaning by releasing the banjo bolt at the bottom. This screen should be cleaned every 250 operating hours. Use compressed air and/or clean with kerosene.



After changing the fuel filter and cleaning the fuel feed pump strainer, WESTERBEKE recommends the following procedure for ensuring there is no air trapped in the fuel system.

BLEEDING (PRIMING) THE FUEL SYSTEM

1. Loosen the bleeding screw on the fuel injection pump.
2. Turn the feed pump knob counterclockwise until the pump knob is forced up by the spring.
3. Depressing the pump knob will cause it to drain out the air mixed fuel from the loosened bleeding screws.
4. Repeat the pumping action until no bubbles are visible in the flowing fuel.
5. Tighten the bleed screw and the feed pump knob.

FUEL ADDITIVES

If fungus or bacteria is causing fuel problems, you should have an authorized dealer correct these problems. Then use a diesel fuel biocide to sterilize the fuel (follow the manufacturer's instructions).

SPARE PARTS

While the likelihood of having to service the system at sea is slim, the possibility does exist. Therefore, we recommend that banjo washers, injector seat washers and a fuel filter be carried on board at all times. Purchase needed spare parts from your local WESTERBEKE dealer or distributor. If a leak should develop at a banjo washer that cannot be corrected by a simple tightening of the fitting, replace the sealing washer with a replacement found in the hardware kit for your model.

ENGINE LUBRICATING OIL

DESCRIPTION

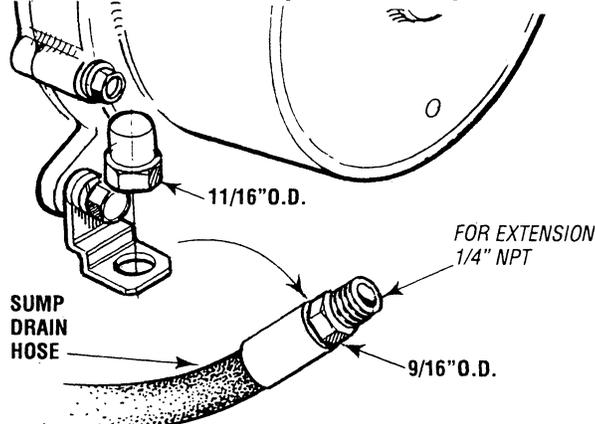
The lubricating system is a pressure feeding system using an oil pump. The engine oil is drawn from the oil sump by the oil pump, which drives the oil, under pressure, through the oil filter, oil cooler and various lubricating points in the engine. The oil then returns to the oil sump to repeat the continuous cycle. When the oil pressure exceeds the specified pressure, the oil pushes open the relief valve in the oil pump and returns to the oil sump, keeping the oil pressure within its specified range.

Oil Pressure

The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 25 and 85 psi.

ENGINE OIL CHANGE

1. **Draining the Oil Sump.** Discharge the used oil through the sump drain hose (attached to the front of the engine) while the engine is warm. Drain the used oil completely, replace the hose in its bracket, and replace the end cap securely.



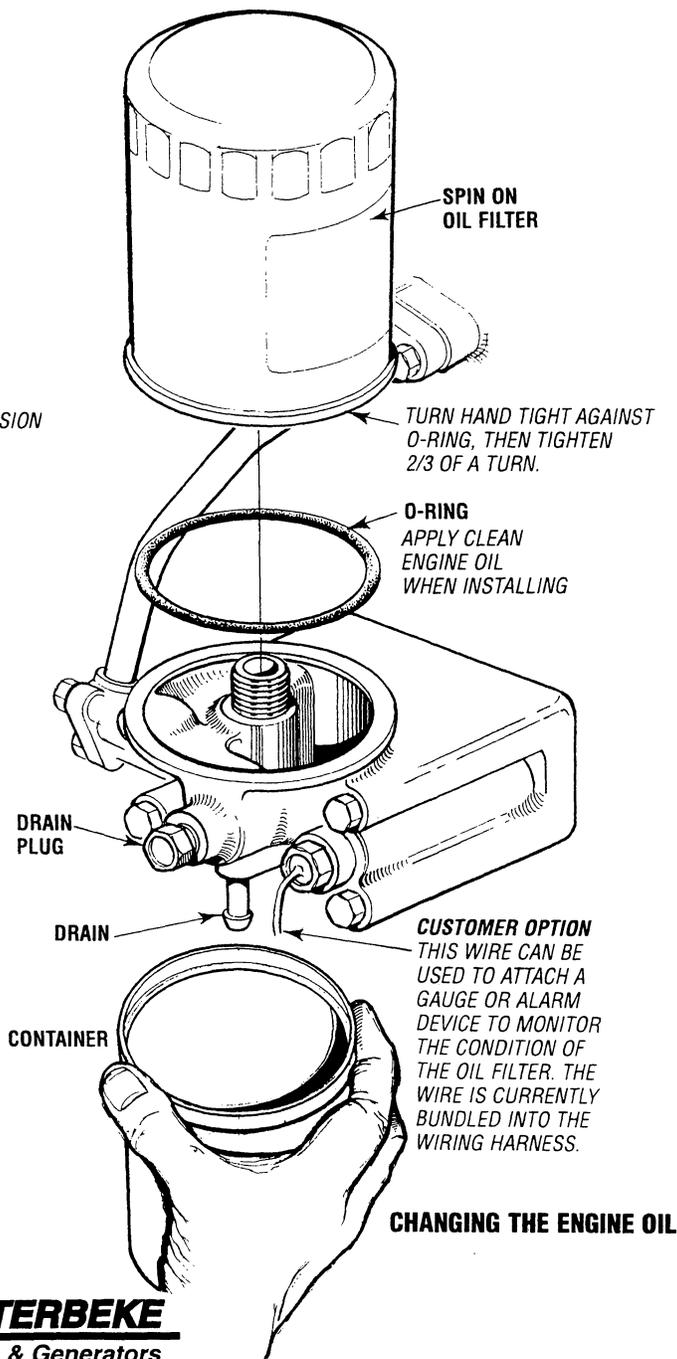
Always observe the used oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a qualified mechanic should water be present in the oil. Raw water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning of raw water through the raw water cooling circuit into the exhaust, filling the engine. This problem is often caused by the absence of an anti-siphon valve, its poor location or lack of maintenance.

2. **Draining the Oil Filter.** Back off the drain plug until oil flows from the drain (into an appropriate container). After draining, remove the filter and wipe off any excess oil.
Tighten the drain plug.

When installing the new oil filter element, wipe the filter's O-ring gasket's sealing surface free of oil and apply a thin coat of clean engine oil to the rubber O-ring on the new oil filter. Screw the filter onto the threaded oil filter nipple on the oil filter bracket, and then tighten the filter firmly by hand.

NOTE: Generic filters are not recommended, as the material standards or diameters of important items on generic parts might be entirely different from genuine parts. Immediately after an oil filter change and oil fill, run the engine to make sure the oil pressure is normal and that there are no oil leaks around the new oil filter.

3. **Filling the Oil Sump.** Add new oil through the oil filler cap on the top of the engine. After refilling, run the engine for a few moments while checking the oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and stop the engine. Then check the quantity of oil with the lube oil dipstick. Fill to, but not over the high mark on the dipstick, should the engine require additional oil.



REMOTE OIL FILTER (OPTIONAL)

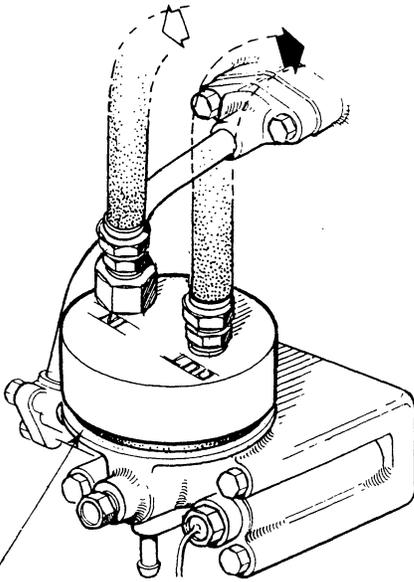
INSTALLATION

This popular accessory is used to relocate the engine's oil filter from the engine to a more convenient location such as an engine room bulkhead.

NOTE: Refer to *ENGINE OIL CHANGE* in this manual for instructions on removing the oil filter.

CAUTION: It is vital to install the oil lines correctly. If the oil flows in the reverse direction, the by-pass valve in the filter assembly will prevent the oil from reaching the engine causing an internal engine failure. If there is no oil pressure reading, shutdown immediately and check the hose connections.

NOTE THE "IN" AND "OUT" MARKINGS ON THE ADAPTER WHEN THE HOSES ARE REMOVED FOR INSTALLATION SO THEY WILL BE RECONNECTED CORRECTLY.



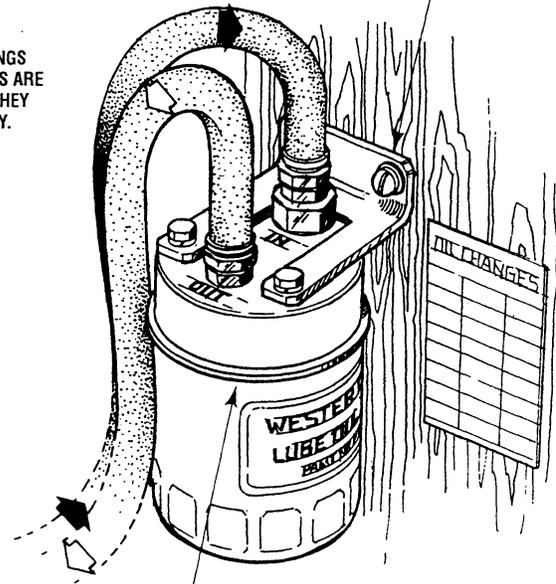
APPLY A THIN COAT OF CLEAN OIL TO THE O-RING WHEN INSTALLING THIS KIT. THREAD THE KIT ON, THEN HAND TIGHTEN AN ADDITIONAL 3/4 TURN AFTER THE O-RING CONTACTS THE BASE.

To install, simply remove the engine oil filter and thread on WESTERBEKE's remote oil filter kit as shown. Always install this kit with the oil filter facing down as illustrated.

Contact your WESTERBEKE dealer for more information.

NOTE: Westerbeke is not responsible for engine failure due to incorrect installation of the Remote Oil Filter.

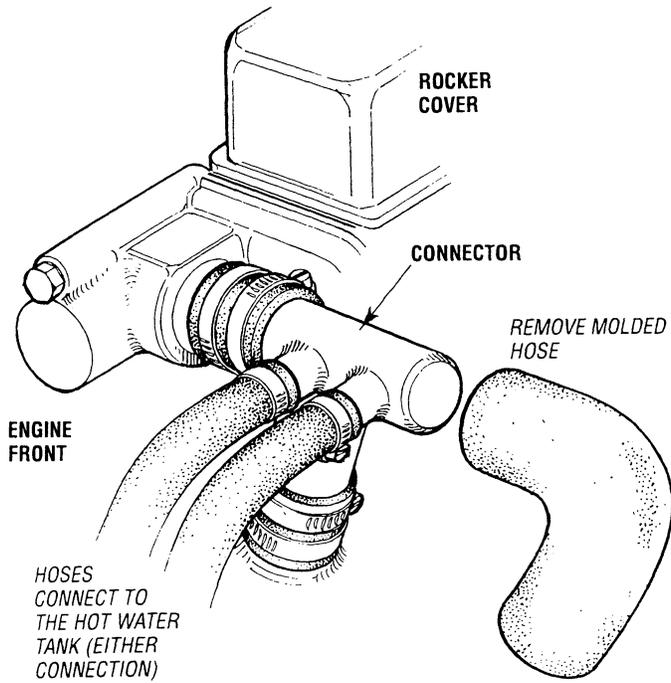
FASTEN SECURELY TO A BULKHEAD
(SCREWS ARE OWNER SUPPLIED)



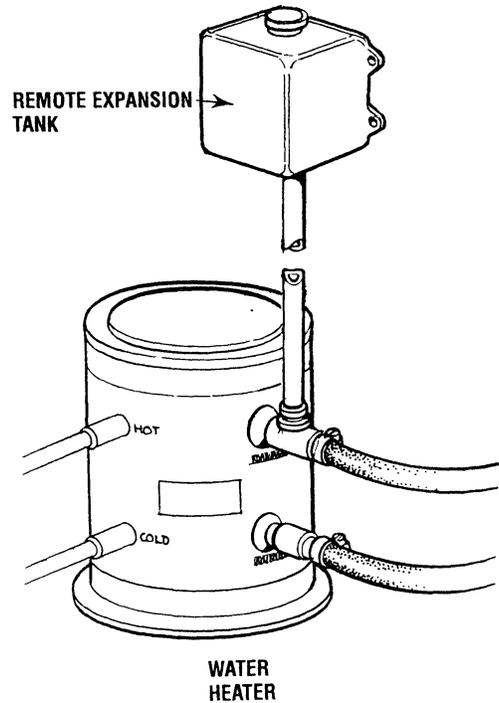
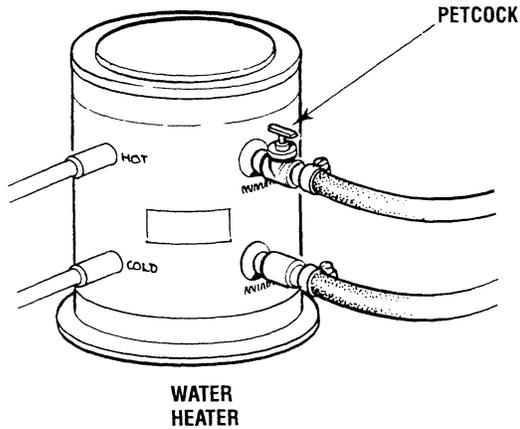
APPLY A THIN COAT OF CLEAN OIL TO THE FILTER GASKET WHEN INSTALLING. AFTER THE FILTER CONTACTS THE BASE, TIGHTEN IT AN ADDITIONAL 3/4 TURN.

WATER HEATER CONNECTION (OPTIONAL)

As an accessory, WESTERBEKE will provide a connector that directs the engines hot water (coolant) flow to heat the fresh water in the ships hot water tank.



CUT THE DISCARDED MOLDED HOSE TO PROVIDE THE TWO HOSE CONNECTIONS THAT ARE NEEDED TO ATTACH THE CONNECTOR TO THE ENGINE



The water heater should be mounted in a convenient location either in a high or low position in relation to the engine, so that the connecting hoses from the heater to the engine can run in a reasonably direct line without any loops which might trap air.

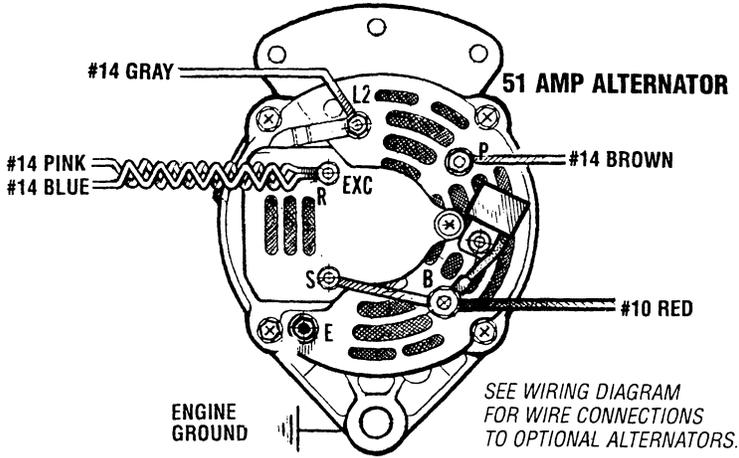
Hoses should rise continuously from their low point at the heater to the engine so that air will rise naturally from the heater to the engine. If trapped air is able to rise to the heater, then an air bleed petcock must be installed at the higher fitting on the heater for bleeding air while filling the system.

NOTE: If any portion of the heating circuit rises above the engine's closed cooling system pressure cap, then a pressurized (aluminum) remote expansion tank (Kit #024177) **must** be installed in the circuit to become the highest point. Tee the remote expansion tank into the heater circuit, choosing the higher of the two connections for the return. Tee at the heater, and plumb a single line up to the tank's location and the other back to the engine's return. Install the remote expansion tank in a convenient location so the fresh water coolant level can easily be checked. The remote expansion tank will now serve as a check and system fill point. **The plastic coolant recovery tank is not used when the remote expansion tank kit is installed, since this tank serves the same function.**

DC ELECTRICAL SYSTEM

ALTERNATOR

The charging system consists of a DC belt driven alternator with a voltage regulator, an engine DC wiring harness, a mounted DC circuit breaker and a battery with connecting cables. Because of the use of integrated circuits (IC's), the electronic voltage regulator is very compact and is mounted internally or on the back of the alternator.



ALTERNATOR TROUBLESHOOTING

WARNING: A failed alternator can become very hot. Do not touch until the alternator has cooled down.

Use this troubleshooting section to determine if a problem exists with the charging circuit or with the alternator. If it is determined that the alternator or voltage regulator is faulty, have a qualified technician check it.

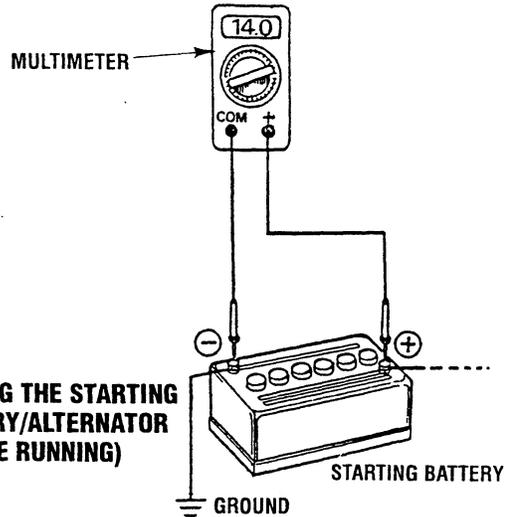
The alternator charging circuit charges the starting battery and the service battery. An isolator with a diode, a solenoid or a battery selector switch is usually mounted in the circuit to isolate the batteries so the starting battery is not discharged along with the service battery. If the alternator is charging the starting battery but not the service battery, the problem is in the service battery's charging circuit and not with the alternator.

Testing the Alternator

CAUTION: Before starting the engine make certain that everyone is clear of moving parts! Keep away from sheaves and belts during test procedures.

WARNING: When testing with a multimeter: DC and AC circuits are often mixed together in marine applications. Always disconnect a shore power cord, isolate DC and AC converters, and shut down the engine before performing DC testing. No AC tests should be made without a proper knowledge of AC circuits.

1. Start the engine.
2. After the engine has run for a few minutes, measure the starting battery voltage at the battery terminals using a multimeter set on DC volts.
 - a. If the voltage is increasing toward 14 volts, the alternator is working; omit Steps 3 through 8 and go directly to "Checking the Service Battery" on the next page.
 - b. If the voltage remains around 12 volts, a problem exists with either the alternator or the charging circuit; continue with Steps 3 through 8.

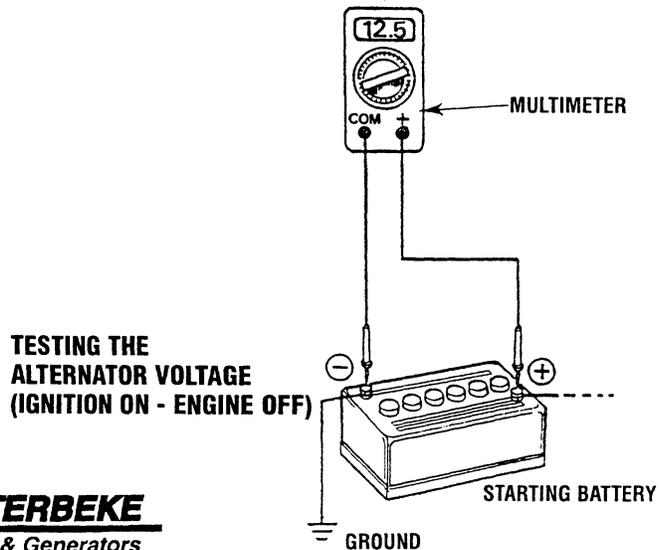


TESTING THE STARTING BATTERY/ALTERNATOR (ENGINE RUNNING)

3. Turn off the engine. Inspect all wiring and connections. Ensure that the battery terminals and the engine ground connections are tight and clean.

CAUTION: To avoid damage to the battery charging circuit, never shut off the engine battery switch when the engine is running!

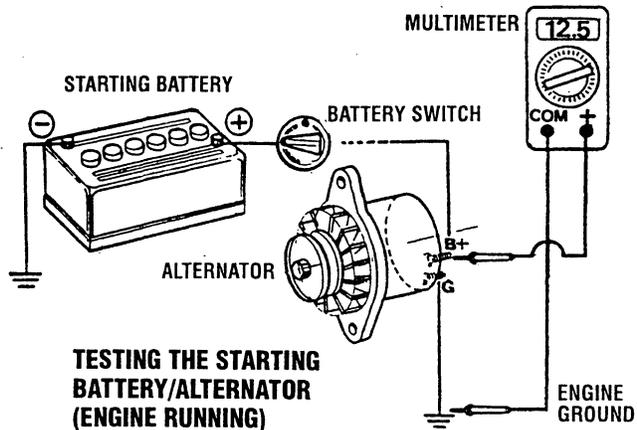
4. If a battery selector switch is in the charging circuit, ensure that it is on the correct setting.
5. Turn on the ignition switch, but do not start the engine.
6. Check the battery voltage. If the battery is in good condition, the reading should be 12 to 13 volts.



TESTING THE ALTERNATOR VOLTAGE (IGNITION ON - ENGINE OFF)

DC ELECTRICAL SYSTEM

7. Now check the voltage between the alternator output terminal (B+) and ground. If the circuit is good, the voltage at the alternator will be the same as the battery, or if an isolator is in the circuit the alternator voltage will be zero. If neither of the above is true, a problem exists in the circuit between the alternator and the battery. Check all the connections — look for an opening in the charging circuit.



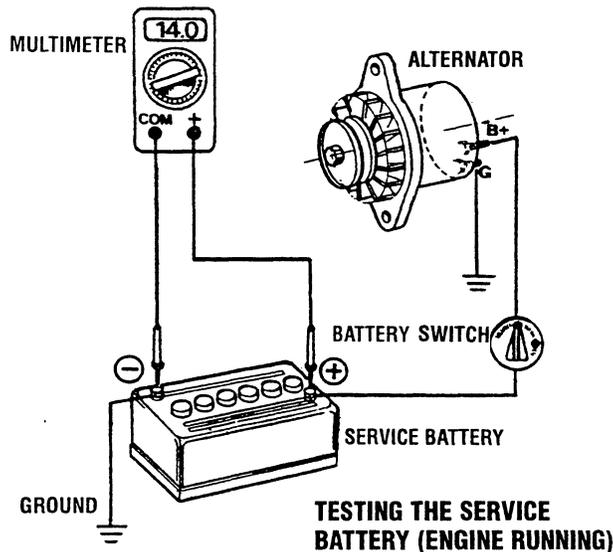
8. Start the engine again. Check the voltage between the alternator output and ground.
The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or under-charging, have it repaired at a reliable service facility.

NOTE: Before removing the alternator for repair, use a voltmeter to ensure that 12 volts DC excitation is present at the EXC terminal if the previous test showed only battery voltage at the B output terminal.

If 12 volts is not present at the EXC terminal, trace the wiring and look for breaks and poor connections.

Checking the Service Battery

Check the voltage of the service battery. This battery should have a voltage between 13 and 14 volts when the engine is running. If not, there is a problem in the service battery charging circuit. Troubleshoot the service battery charging circuit by checking the wiring and connections, the solenoid, isolator, battery switch, and the battery itself.



CAUTION: To avoid damaging the alternator diodes, do not use a high voltage tester (i.e. a megger) when performing tests on the alternator charging circuit.

12 VOLT DC CONTROL CIRCUIT

The engine has a 12 volt DC electrical control circuit that is shown on the wiring diagrams that follow. Refer to these diagrams when troubleshooting or when servicing the DC electrical system.

CAUTION: To avoid damage to the battery charging circuit, never shut off the engine battery switch while the engine is running. Shut off the engine battery switch, however, to avoid electrical shorts when working on the engine's electrical circuit.

BATTERY

The minimum recommended capacity of the battery used in the engine's 12 volt DC control circuit is 600 – 900 Cold Cranking Amps (CCA).

Battery Care

Review the manufacturer's recommendations and then establish a systematic maintenance schedule for your engine's starting batteries and house batteries.

- Monitor your voltmeter for proper charging during engine operation.
- Check the electrolyte level and specific gravity with a hydrometer.
- Use only distilled water to bring electrolytes to a proper level.
- Make certain that battery cable connections are clean and tight to the battery posts (and to your engine).
- Keep your batteries clean and free of corrosion.

WARNING: Sulfuric acid in lead batteries can cause severe burns on skin and damage clothing. Wear protective gear.

GLOW PLUGS

DESCRIPTION

The glow plugs are wired through the preheat solenoid. When PREHEAT is pressed at the control panel this solenoid should “click” on and the glow plug should begin to get hot.

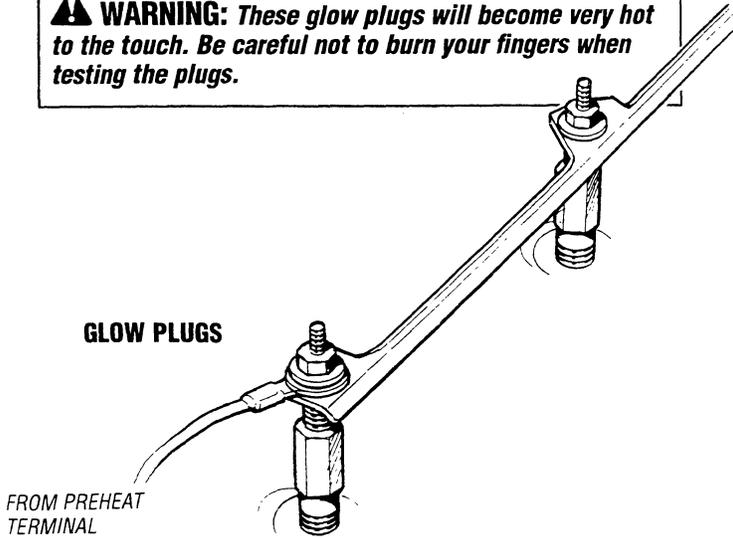
INSPECTION

To inspect the plug, remove the electrical terminal connections, then unscrew or unclamp each plug from the cylinder head. Thoroughly clean each plug’s tip and threads with a soft brush and cleaning solution to remove all the carbon and oil deposits. While cleaning, examine the tip for wear and burn erosion; if it has eroded too much, replace the plug.

TESTING

An accurate way to test glow plugs is with an ohmmeter. Touch one prod to the glow plug’s wire connection, and the other to the body of the glow plug, as shown. A good glow plug will have a 0.4 - 0.6 ohm resistance. This method can be used with the plug in or out of the engine. You can also use an ammeter to test the power drain (5 - 6 amps per plug).

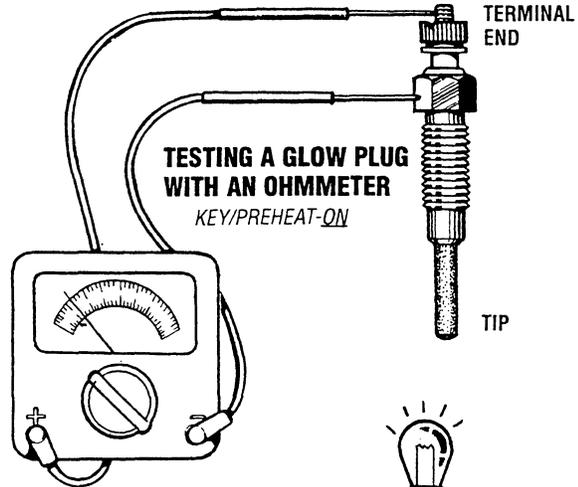
⚠ WARNING: *These glow plugs will become very hot to the touch. Be careful not to burn your fingers when testing the plugs.*



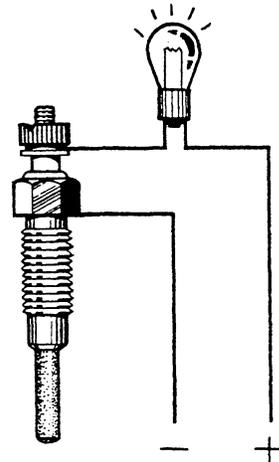
Re-install the plugs in the engine and test them again. The plugs should get very hot (at the terminal end) within 7 to 15 seconds. If the plugs don’t heat up quickly, check for a short circuit. When reinstalling the glow plugs, use anti-seize compound on the threads.

⚠ WARNING: *Do not keep a glow plug on for more than 30 seconds.*

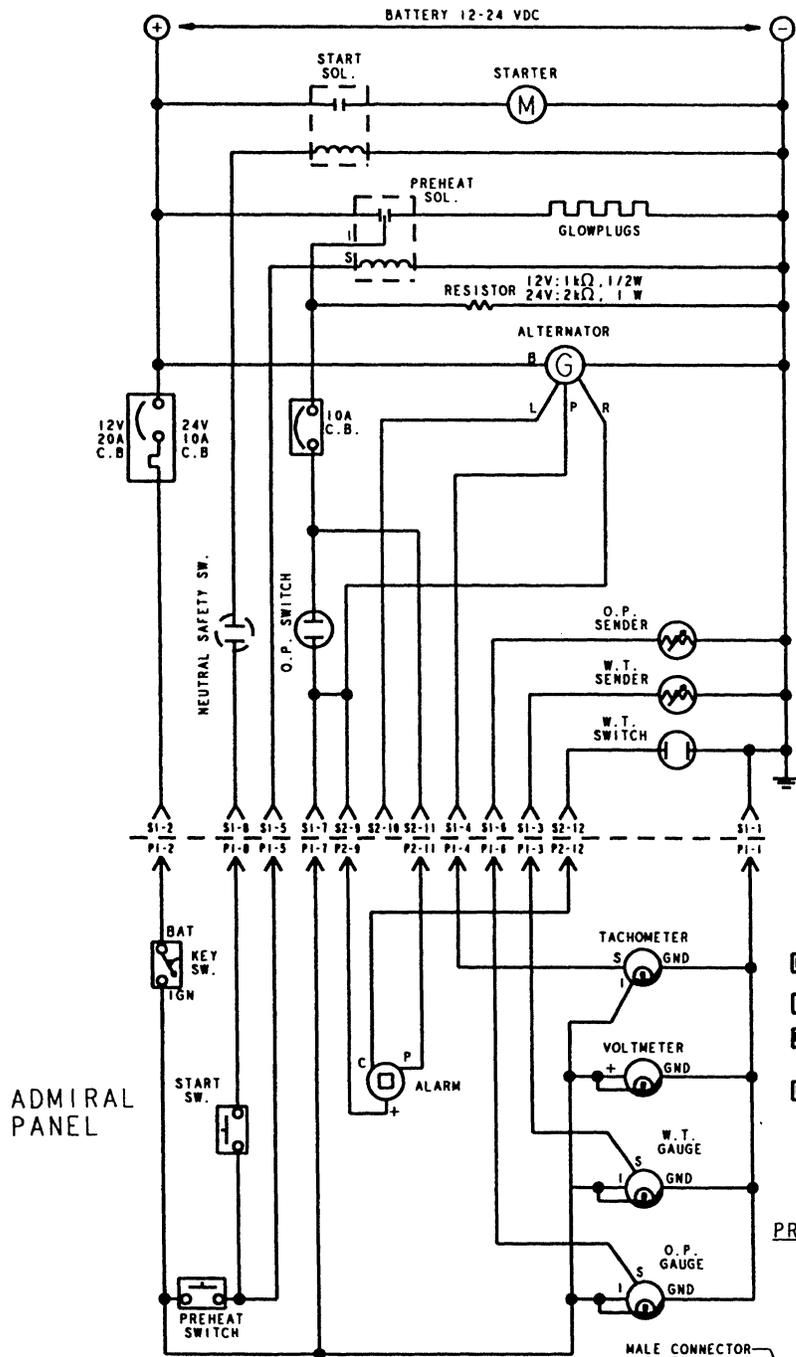
Glow Plug Tightening Torque 19.5 ft-lb (2.7 m-kg)



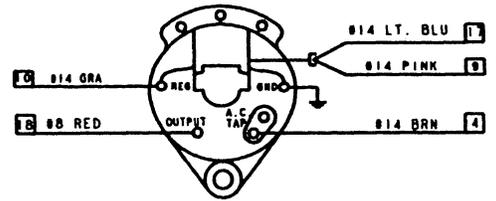
TESTING A GLOW PLUG USING A TEST LIGHT



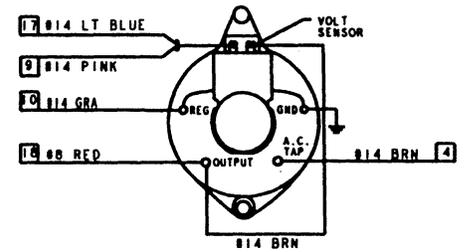
WIRING SCHEMATIC MARINE ENGINES #44781



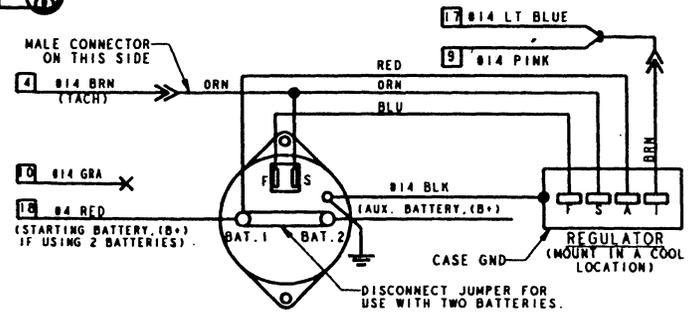
OPTIONAL ALTERNATORS



PRESTOLITE 72 AMP. ALT.

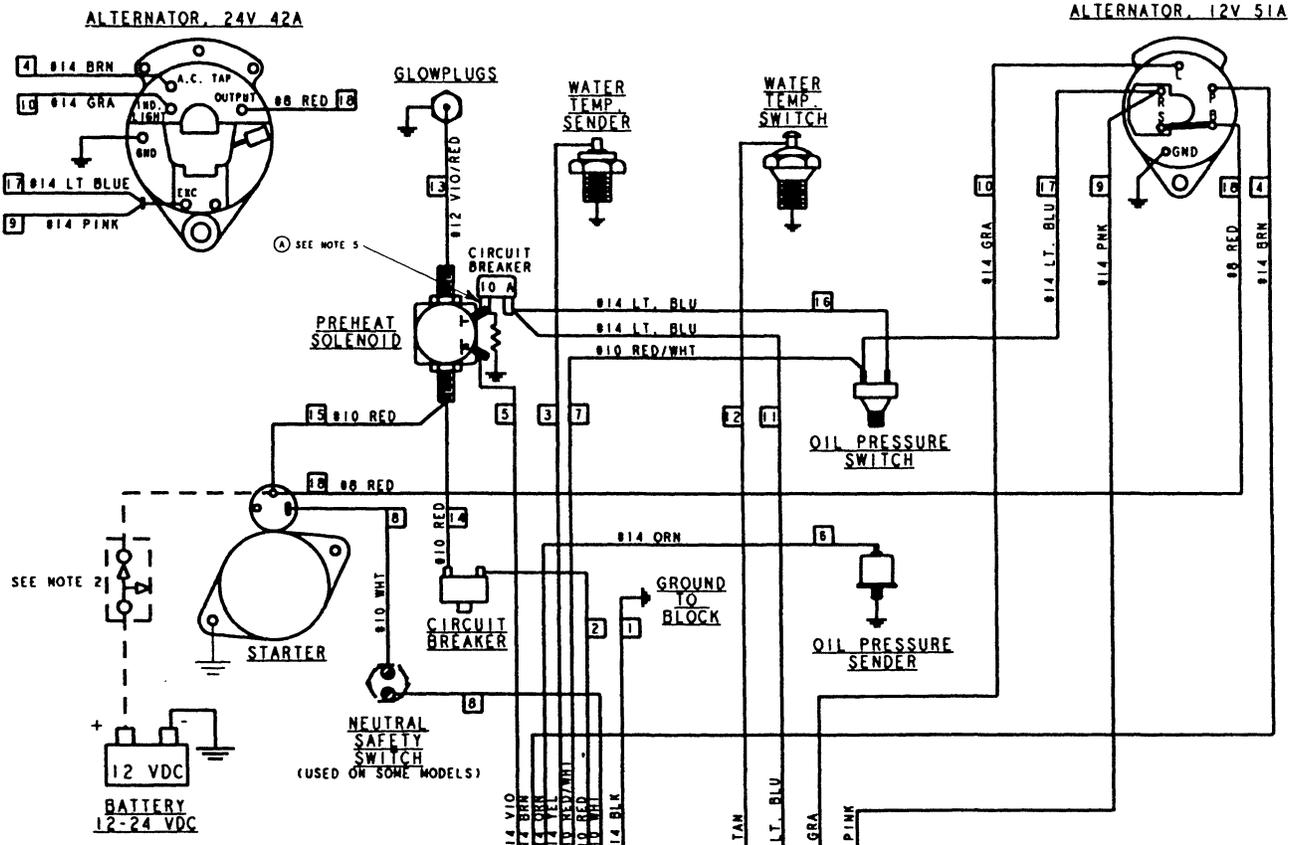


PRESTOLITE/VEECE-NEVILLE 90 AMP. ALT.



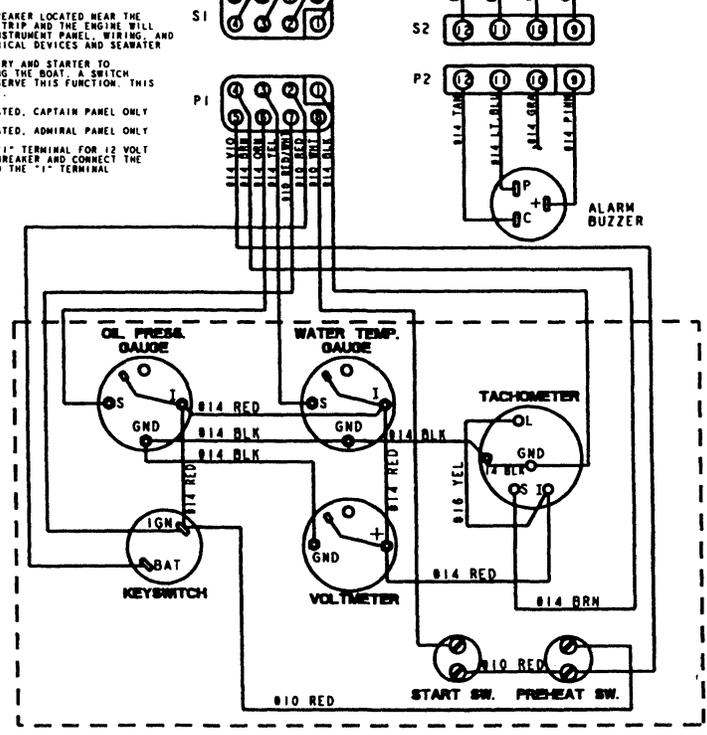
LESTEK 135, 160, 190 AMP. ALT.

WIRING DIAGRAM MARINE ENGINES #44781



NOTES:

- 1 THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER. EXCESSIVE CURRENT WILL CAUSE THE BREAKER TO TRIP AND THE ENGINE WILL SHUT DOWN. THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING, AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SEAWATER.
- 2 AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. A SWITCH WITH A CONTINUOUS RATING OF 135 AMPS AT 12 VDC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.
- 3 THE PINK WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED. CAPTAIN PANEL ONLY.
- 4 THE GRAY WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED. ADMIRAL PANEL ONLY.
- 5 CONNECT THE CIRCUIT BREAKER AND RESISTOR WIRE TO THE "1" TERMINAL FOR 12 VOLT SYSTEMS ONLY. FOR 24 VOLT SYSTEMS REMOVE THE CIRCUIT BREAKER AND CONNECT THE RESISTOR WIRE TO THE 014 LT. BLU WIRES AND THEN GROUND THE "1" TERMINAL.



ENGINE TROUBLESHOOTING

The following troubleshooting table describes certain problems relating to engine service, the probable causes of these problems, and the recommendations to overcome these problems.

NOTE: *The engine's electrical system is protected by a 20 ampere manual reset circuit breaker located on a bracket at the back of the engine. The preheat solenoid is mounted on the same bracket.*

Problem	Probable Cause	Verification/Remedy
No panel indications; fuel solenoid or fuel pump is not working (key switch is on and PREHEAT button is depressed).	<ol style="list-style-type: none"> 1. Battery switch not on. 2. 20-amp circuit breaker tripped. 3. 10-amp breaker tripped on preheat solenoid 4. Loose battery connections. 5. Preheat solenoid not operating. 	<ol style="list-style-type: none"> 1. Check switch and/or battery connections. 2. Reset breaker; if breaker trips again, check preheat solenoid circuit and check circuit for shorts to ground. 3. Check the voltage both at and after the breaker on the preheat solenoid - wait for it to cool then reset. 4. Check (+) connection to starter solenoid and (-) connection to engine ground stud. Check battery cable connections. 5. Check solenoid "S" terminal for voltage.
START button is depressed, no starter engagement.	<ol style="list-style-type: none"> 1. Connection to solenoid faulty. 2. Gear shift not in neutral. 3. Faulty switch. 4. Faulty solenoid. 5. Loose battery connections. 6. Low battery. 	<ol style="list-style-type: none"> 1. Check connection. 2. Gear shift must be in neutral (see <i>NEUTRAL SWITCH</i> under <i>HURTH TRANSMISSIONS</i>). 3. Check switch with ohmmeter. 4. Check that 12 volts are present at the solenoid connection. 5. Check battery connections. 6. Check battery charge state.
Engine cranks, but does not start.	<ol style="list-style-type: none"> 1. Faulty fueling system. 2. Preheat solenoid faulty. 3. Low battery power. 	<ol style="list-style-type: none"> 1. Check that fuel valves are open. <ol style="list-style-type: none"> 1a. Check for air in fuel system. Bleed air from fuel system. 1b. Fuel filters clogged. Replace filters and bleed air from fuel system. 2. Check solenoid. 3. Switch to combine house and start batteries. 3a. Replace batteries.
Engine can't be stopped.	<ol style="list-style-type: none"> 1. Disconnect fuel shut-off cable. off the fuel 	<ol style="list-style-type: none"> 1. Check connection at shut-off lever. Pull lever back to close
Battery runs down.	<ol style="list-style-type: none"> 1. Oil pressure switch. 2. High resistance leak to ground. 3. Low resistance leak. 4. Poor battery connections. 5. DC alternator not charging (tachometer not operating). 	<ol style="list-style-type: none"> 1. Observe if gauges and panel lights are activated when engine is not running. Test the oil pressure switch. 2. Check wiring. Insert sensitive (0 – .25 amp) meter in battery lines. (Do not start engine.) Remove connections and replace after short is located. 3. Check all wires for temperature rise to locate the fault. 4. Check cable connections at battery for loose connections, corrosion 5. Check connections, check belt tension, test alternator. See <i>DC ELECTRICAL SYSTEM/ALTERNATOR</i>.
Battery not charging	<ol style="list-style-type: none"> 1. Alternator drive. 	<ol style="list-style-type: none"> 1. Check drive belt tension; alternator should turn freely. Check for loose connections. Check output with voltmeter. Ensure 12 volts are present at the Exc. terminal.
Engine slows and-stops.	<ol style="list-style-type: none"> 1. Fuel starvation. 2. 20 Amp circuit breaker tripping. 3. Exhaust system is restricted. 4. Water in fuel. 5. Air intake obstruction. 	<ol style="list-style-type: none"> 1. Check fuel supply, fuel valves, fuel lift pump. 2. Check for high DC amperage draw during operation. Ensure breaker is not overly sensitive to heat which would cause tripping. Push button to reset. 3. Check for blockage, collapsed hose, carbon buildup at exhaust elbow. 4. Pump water from fuel tank(s); change filters and bleed fuel system. 5. Check air intake filter cartridge.

(continued)

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine overheats.	<ol style="list-style-type: none"> 1. Raw water not circulating. 2. Coolant not circulating. 	<ol style="list-style-type: none"> 1. Raw water pump failure. Check impeller — replace. 2. Obstruction at raw water intake or raw water filter. <ol style="list-style-type: none"> 2a. Thermostat — remove and test in hot water. Replace thermostat. 2b. Loss of coolant — check hoses, hose clamps, drain plug, etc. for leaks. 2c. Broken or loose belts — tighten/replace. 2d. Air leak in system; run engine and open the pressure cap to bleed air. Add coolant as needed.
Engine alarm sound pulsates.	<ol style="list-style-type: none"> 1. Loss of oil. 2. Oil pressure switch. 	<ol style="list-style-type: none"> 1. Check dipstick, look for oil leaks at oil filter and at oil drain hose connection. 2. Replace oil pressure switch.
Engine alarm sounds continuously.	<ol style="list-style-type: none"> 1. Engine coolant. 2. High temperature switch opens at too low a temperature. 	<ol style="list-style-type: none"> 1. Check engine coolant level. 2. Check for satisfactory operation with switch bypassed, check with ohmmeter, replace if faulty.
Exhaust smoke problems	<ol style="list-style-type: none"> 1. Blue smoke. 2. White smoke. 3. Black smoke. 	<ol style="list-style-type: none"> 1. Incorrect grade of engine oil. <ol style="list-style-type: none"> 1a. Crankcase is overfilled with engine oil (oil is blowing out through the exhaust). 2. Engine is running cold. <ol style="list-style-type: none"> 2a. Faulty injector or incorrect injector timing. 3. Improper grade of fuel. <ol style="list-style-type: none"> 3a. Fuel burn incomplete due to high back-pressure in exhaust or insufficient air for proper combustion (check for restrictions in exhaust system; check air intake). 3b. Improperly timed injectors or valves, or poor compression. 3c. Lack of air — check air intake and air filter. Check for proper ventilation. 3d. Overload.

TROUBLESHOOTING COOLANT TEMPERATURE AND OIL PRESSURE GAUGES

If the gauge reading is other than what is normally indicated by the gauge when the instrument panel is energized, the first step is to check for 12 volts DC between the ignition (B+) and the Negative (B-) terminals of the gauge.

Assuming that there is 12 volts as required, leave the instrument panel energized and perform the following steps:

1. Disconnect the sender wire at the gauge and see if the gauge reads zero, which is the normal reading for this situation.
2. Remove the wire attached to the sender terminal at the sender and connect it to ground. See if the gauge reads full scale, which is the normal reading for this situation.

If both of the above gauge tests are positive, the gauge is undoubtedly OK and the problem lies either with the conductor from the sender to the gauge or with the sender.

If either of the above gauge tests are negative, the gauge is probably defective and should be replaced.

Assuming the gauge is OK, check the conductor from the sender to the sender terminal at the gauge for continuity.

Check that the engine block is connected to the ground. Some starters have isolated ground terminals and if the battery is connected to the starter (both plus and minus terminals), the ground side will not necessarily be connected to the block.

TACHOMETER

TACHOMETER/HOUR METER

The tachometer/hour meter used in propulsion engine instrument panels contains two separate electrical circuits with a common ground. One circuit operates the hour meter and the other the tachometer. The hour meter circuit operates on 12 volts alternator charging voltage supplied to the (+) terminal on the back of the instrument.

The tachometer circuit operates on AC voltage 6-8 volts, fed from one of the diodes in the alternator and supplied to the tachometer input terminal while the engine is running, and the alternator producing battery charging voltage 13.0-14.8 volts DC.

The following are procedures to follow when troubleshooting a fault in either of the two circuits in a tachometer/hour meter.

Hour meter Inoperative

Check for the proper DC voltage between (+) and (-) terminals.

1. Voltage present - meter is defective - repair or replace.
2. Voltage not present - trace (+) and (-) electrical connections for fault. (Jump 12 volts DC to meter (+) terminal to verify the operation.)

Tachometer Inoperative

Check for the proper AC voltage between tachometer input terminal and (-) terminal with the engine running.

1. Voltage present - attempt adjusting meter through calibration access hole. No results, repair or replace meter.
2. AC voltage not present - check for proper alternator DC output voltage.
3. Check for AC voltage at tach terminal on alternator to ground.
4. Check electrical connections from tachometer input terminal to alternator connection.

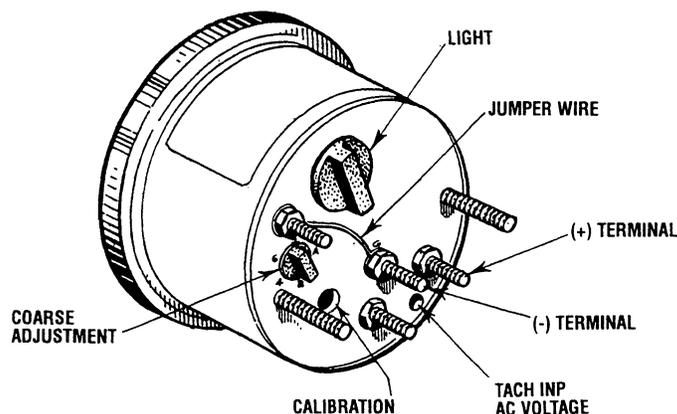
Tachometer Sticking

1. Check for proper AC voltage between "tach inp." terminal and (-) terminal.
2. Check for good ground connection between meter (-) terminal and alternator.
3. Check that alternator is well grounded to engine block at alternator pivot bolt.

Tachometer Inaccurate

- a. With a hand-held tach on the front of the crankshaft pulley retaining nut or with a strobe-type tach, read the front crankshaft pulley rpm at idle.
- b. Adjust the tachometer with a small Phillips type screwdriver through the calibration access hole in the rear of the tachometer. Zero the tach and bring it to the rpm indicated by the strobe or hand tach. (Verify the rpm at idle and at high speed and adjust the tach as needed).

NOTE: Current model tachometers use a coarse adjustment dial to set the tachometer to the crankshaft pulley rpms. The calibrating screw is then used for fine tuning.



TACHOMETER CHECK (New Installation)

NOTE: In a new installation having new instrument panels, the tachometer may not always be correctly calibrated to the engine's rpm. This calibration should be checked in all new installations.

1. Warm up the engine to normal operating temperature. Remove any specks on the crankshaft pulley with a clean cloth and place a piece of suitable reflecting tape on the pulley to facilitate use of a photoelectric type tachometer.
2. Start and idle the engine.
3. Aim the light of the tachometer onto the reflecting tape to confirm the engine speed. Check the instrument panel tachometer reading. Adjust the tachometer in the panel by using the instrument coarse adjustment to calibrate the instrument reading to the closest R.P.M. that the photo tach is showing. Then use the fine calibration adjustment to bring the instrument to the exact reading as the photo tach.

ENGINE ADJUSTMENTS

DRIVE BELT ADJUSTMENT

Proper inspection, service and maintenance of the drive belts is important for the efficient operation of your engine (see *Drive Belts* under *MAINTENANCE SCHEDULE*).

Drive belts must be properly tensioned. Loose drive belts will not provide proper alternator charging and will eventually damage the alternator. Drive belts that are too tight will pull the alternator out of alignment and/or cause the alternator to wear out prematurely. Excessive drive belt tension can also cause rapid wear of the belt and reduce the service life of the coolant pump's bearing. A slack belt or the presence of oil on the belt can cause belt slipping, resulting in high operating temperatures and tachometer variations.

The drive belt is properly adjusted if the belt can be deflected no less than 3/8 inch (10mm) and no more than 1/2 inch (12mm) as the belt is depressed with the thumb at the mid-point between the two pulleys on the longest span of the belt. A spare belt or belts should always be carried on board.

WARNING: *Never attempt to check or adjust the drive belt's tension while the engine is in operation.*

Adjusting Belt Tension

1. Loosen the alternator adjusting strap bolt and the base mounting bolt.
2. With the belt loose, inspect for wear, cracks and frayed edges.
3. Pivot the alternator on the base mounting bolt to the left or right as required, to loosen or tighten.
4. Tighten the base mounting bolt and the adjusting strap bolt.
5. Run the engine for about 5 minutes, then shut down and recheck the belt tensions.

STARTER AND ALTERNATOR SERVICE

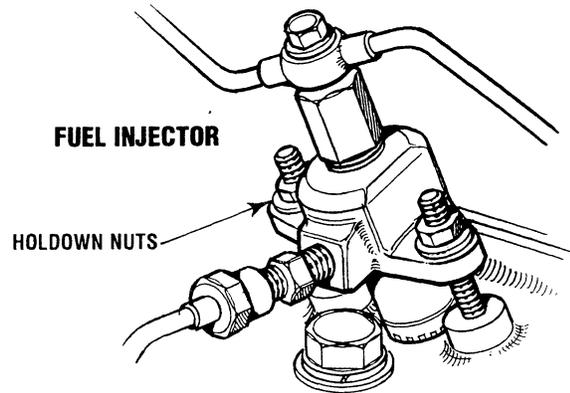
The starter and the alternator should be serviced every 1200 operating hours.

Starter commutator cleaning.

Alternator slip ring cleaning.

Carbon brushes and the brush contact check.

Refer to your *WESTERBEKE SERVICE MANUAL*.



FUEL INJECTORS

In case of severe vibrations and detonation noise, have the injectors checked and overhauled by an authorized fuel injection service center. Poor fuel quality, contaminants and loss of positive fuel pressure to the injection pump can result in injector faults. Since fuel injectors must be serviced in a clean room environment, it is best to carry at least one extra injector as a spare should a problem occur.

Before removing the old injector, clean the area around the base of the injector to help prevent any rust or debris from falling down into the injector hole. If the injector will not lift out easily and is held in by carbon build-up or the like, work the injector side-to-side with the aid of the socket wrench to free it, and then lift it out.

The injector seats in the cylinder head on a copper sealing washer. This washer should be removed with the injector and replaced with a new washer when the new injector is installed.

The fuel injectors should be pressure tested after 750 operating hours.

INJECTION STARTING PRESSURE 2630 psi (18.1 Mpa) (185 Kg/cm²)

INJECTION HOLDDOWN NUTS TORQUE 13.7 ± 1.5 ft-lb (1.9 ± 0.2 Kg-m)

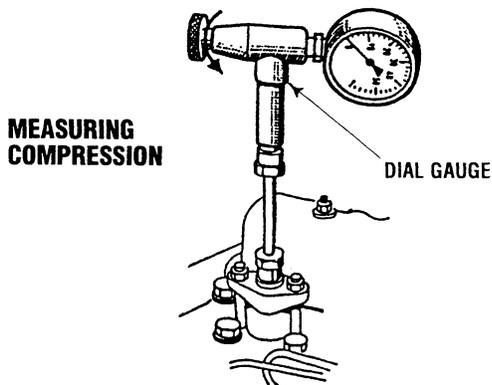
ENGINE ADJUSTMENTS

NOTE: WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.

TESTING ENGINE COMPRESSION

Make certain the oil level (dipstick) is at the correct level and the air intake filter is clean. The battery and starter motor must also be in good condition.

1. Warm the engine to normal operating temperature.
2. Move the control lever to a position for shutting off the fuel. (Disconnect the wires if a fuel shutdown solenoid is used).
3. Remove all the glow plugs from the engine and install the compression gauge/adaptor combination to the cylinder on which the compression is to be measured.



4. Close the raw water seacock (thru-hull).
5. Crank the engine and allow the gauge to reach a maximum reading, then record that reading.
6. Repeat this process for each cylinder.

COMPRESSION PRESSURE 441 psi (31.0 Kg/cm²) at 200 rpm.
ALLOWABLE LIMIT 370 psi (26.0 Kg/cm²).

MAXIMUM PERMISSIBLE DIFFERENCE BETWEEN CYLINDERS
28.44 psi (2.0 Kg/cm²)

NOTE: If the readings are below the limit, the engine needs an overhaul.

7. Re-install the glow plugs and reset the fuel shut-off to the run position.
8. Open the raw water seacock (thru-hull).

Low Compression

When low compression is found, determine the cause by applying a small amount of oil in the cylinder thru the glow plug hole. Allow the oil to settle.

Install the pressure gauge and repeat the above test. If the compression reading rises dramatically, the fault is with the rings. If the compression does not rise, the problem is with the valves.

A slight rise in compression would indicate a problem with both the rings and the valves.

OIL PRESSURE

The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 40 and 85 psi.

NOTE: A newly started, cold engine can have an oil pressure reading up to 85 psi. A warmed engine can have an oil pressure reading as low as 40 psi. These readings will vary depending upon the temperature of the engine, the load placed on the engine, and the RPM's.

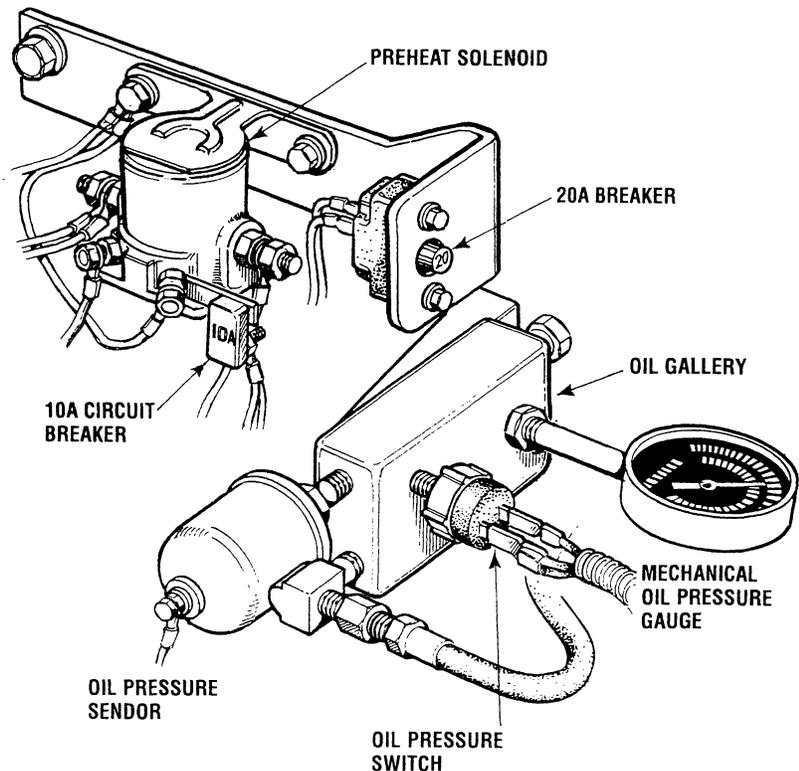
Low Oil Pressure

The specified safe minimum oil pressure is 5 - 10 psi. A gradual loss of oil pressure usually indicates worn bearings. For additional information on low oil pressure readings, see the *ENGINE TROUBLESHOOTING* chart.

Testing Oil Pressure

To test the oil pressure, remove the oil pressure sender, then install a mechanical oil pressure gauge in its place. After warming up the engine, set the engine speed at idle and read the oil pressure gauge.

OIL PRESSURE 15 - 20 psi at idle speed.
SENDER AND SWITCH TORQUE 9 - 13 ft-lb (1.2 - 1.8 m - Kg).

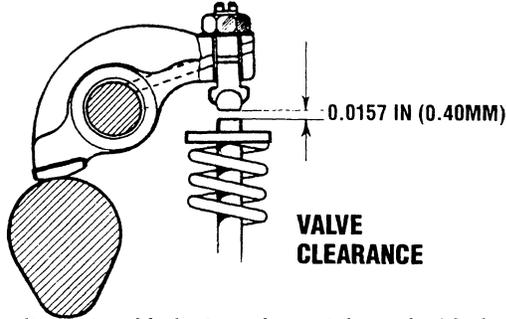


ENGINE ADJUSTMENTS

NOTE: WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.

VALVE CLEARANCE ADJUSTMENT

The valve clearance must be adjusted every 200 operating hours, or whenever the valve rocker is abnormally noisy. Valve adjustment should only be done when engine is cold. Cold engine valve clearance is 0.0157 in (0.40 mm).



NOTE: The cylinder head bolts have been tightened with the "Angular Tightening Method". Therefore, it is not necessary to retighten the cylinder head bolts before adjusting the valve clearances.

ADJUSTMENT PROCEDURE

Chart shows six cylinder model

Cylinder No.	1	2	3	4	5	6
Valve arrangement	I E	I E	I E	I E	I E	I E
When No. 1 cylinder is at TDC in the compression stroke	○ ○	○		○ ○		○
When No. 6 cylinder is at TDC in the compression stroke		⊙ ⊙		⊙ ⊙		⊙ ⊙

- In order to bring No. 1 or No. 6 piston (six cyl.) No. 4 piston (four cyl.) to the top dead center in the compression stroke, align the TDC mark and the crank shaft pulley mark.
- Do the adjustment on the circle marked valves in the above table where No. 1 piston is in the TDC in the compression stroke. After these steps, do the adjustment on the double circle marked valves where the No. 6 piston (six cyl.) No. 4 piston (four cyl.) is on TDC in the compression stroke.

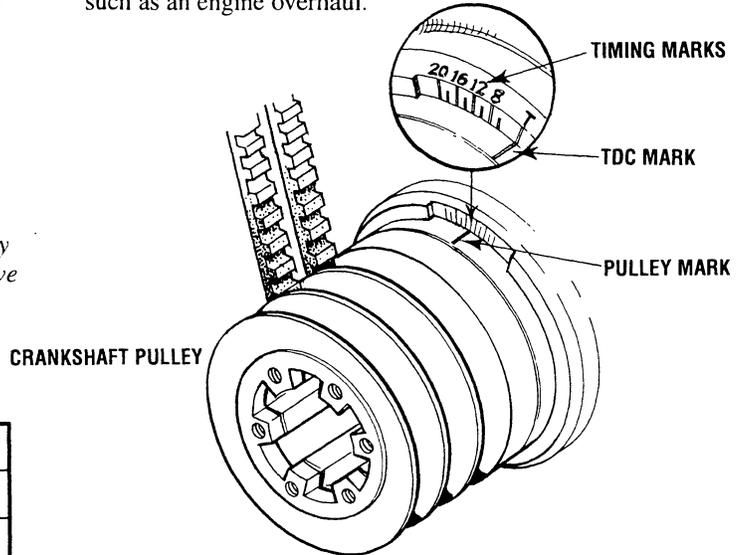
Chart shows four cylinder model

Cylinder No.	1	2	3	4
Valve arrangement	I E	I E	I E	I E
When No. 1 cylinder is at TDC in the compression stroke	○ ○	○		○
When No. 4 cylinder is at TDC in the compression stroke		⊙ ⊙		⊙ ⊙

- After adjusting the valves with piston No. 1 at TDC, rotate the crankshaft 360° again aligning the TDC mark and the pulley mark. This brings piston No. 6 or No. 4 to TDC, then adjust the remaining valves.

INJECTION TIMING CHECK/ADJUSTMENT

Improper injection timing can cause engine failure. In normal servicing, this check and adjustment is unnecessary, however, it might be necessary in conjunction with other related work such as an engine overhaul.

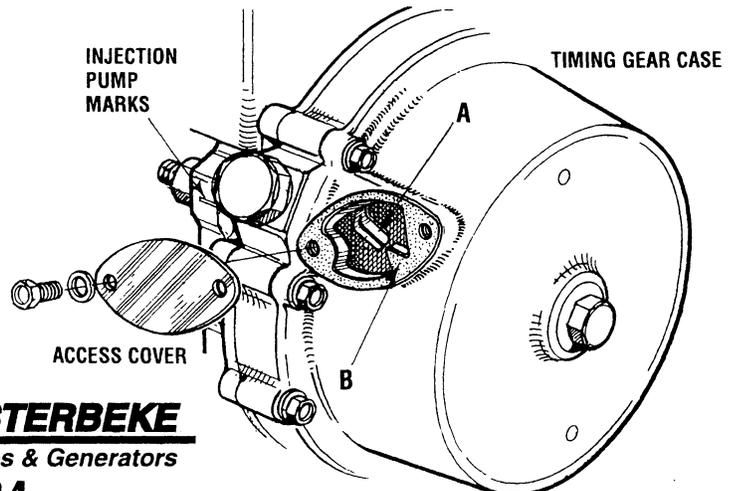


CHECK PROCEDURE

Bring No. 1 piston to the top dead center on the compression stroke. Turn the crankshaft pulley clockwise (viewed at engine front) and align the mark on the crankshaft pulley with the TDC mark.

Remove the access cover at the front of the injection pump and check the alignment between the pointer **A** on the injection pump gear lock plate and the projected pointer **B** on the timing gear case. If **A** and **B** are in alignment, the timing is set correctly.

If they are in alignment, No. 1 cylinder is at the TDC on the compression stroke. If it is in misalignment, recheck by turning the crankshaft pulley one more turn to repeat the procedure to make sure that it is in alignment.

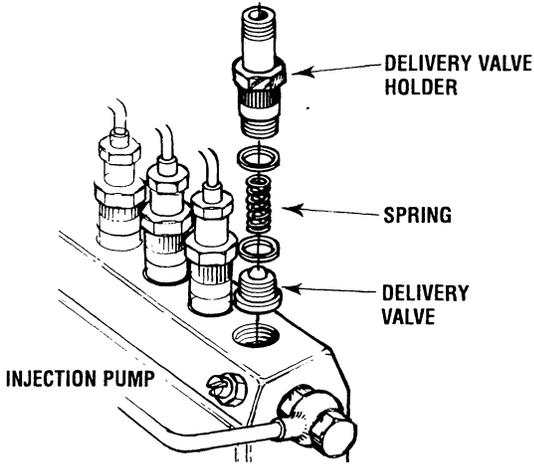


ENGINE ADJUSTMENTS

NOTE: WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.

Check the crankshaft position for the start of fuel injection.

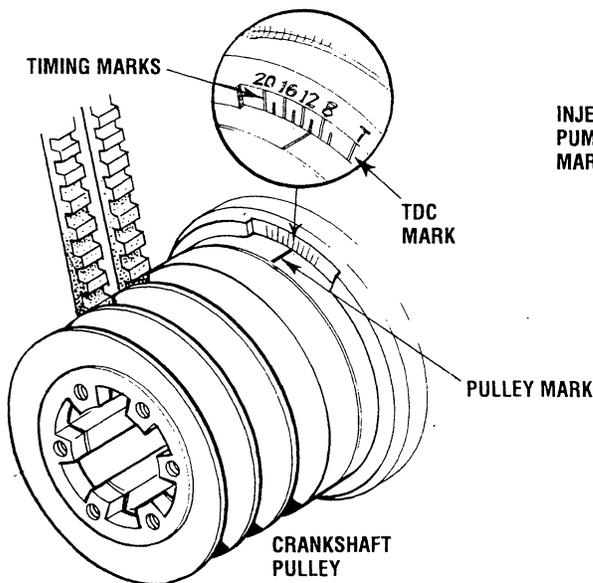
1. Turn the crankshaft pulley counterclockwise viewed from the engine front about 30°.
2. Remove No. 1 high pressure injection line.



3. Remove the injection pump No. 1 delivery valve holder, delivery valve and spring and reinstall the delivery valve holder back into the pump.

DELIVERY VALVE HOLDER TIGHTENING TORQUE:
39 - 44 Nm (4 - 4.5 Kg-m/28.9 - 32.5 ft-lb)

4. Slowly turn the crankshaft pulley clockwise and at the same time, feed fuel to the injection pump by slowly pumping the feed pump. When the fuel stops to flow out from No. 1 delivery valve holder, stop turning the crankshaft pulley and pumping. This is the beginning of fuel injection.



5. Notice which injection timing mark is aligned with the pulley mark. The timing mark in alignment with the pulley mark indicates the degrees before (TDC), the start of fuel injection

The degrees before TDC differs depending on the engine model. Refer to the specifications on the injection timing for the respective model engine. If the timing is incorrect, do the following adjustment.

ADJUSTMENT PROCEDURES

1. Align the pulley mark and the specified timing mark. (Refer to the injection timing specifications.)
2. Loosen the four injection pump attachment nuts.
3. **To advance the timing**, pivot the injection pump at the pump drive shaft away from the engine.

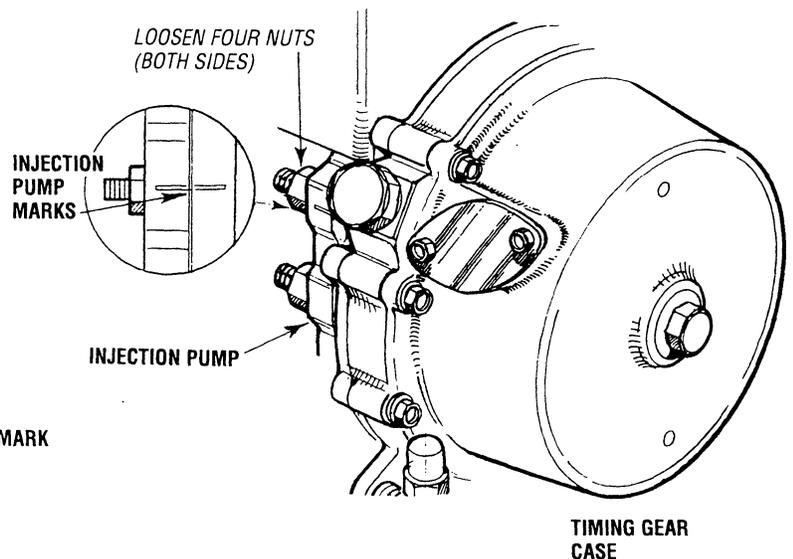
To retard the timing, pivot the injection pump at the pump drive shaft toward the engine.

NOTE: The 1mm misalignment between the timing marks on the crankshaft pulley correspond to about 2° in crank angle.

4. Recheck the timing, following procedures 1 through 5.
5. Tighten the four injection pump attachment nuts.
6. Again remove No. 1 delivery valve holder, and reinstall the delivery valve, spring and the valve holder.

DELIVERY VALVE HOLDER TIGHTENING TORQUE:
39 - 44 Nm (4 - 4.5 Kg-m/28.9 - 32.5 ft-lb)

7. Reinstall the No. 1 high pressure injection line.

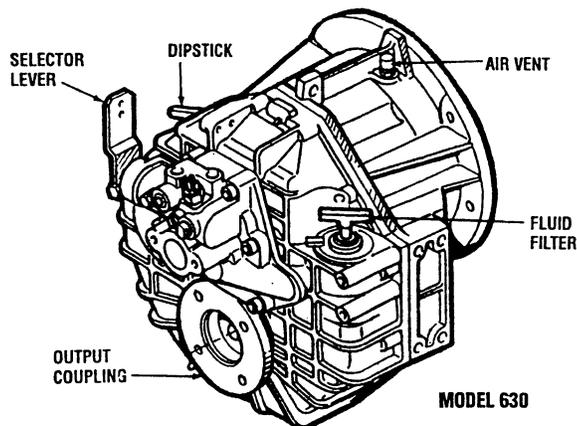


HURTH TRANSMISSIONS

SHIPMENT

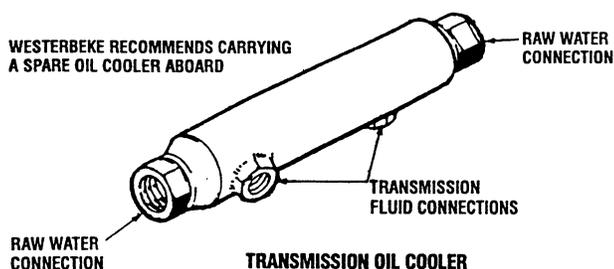
For safety reasons, the transmission is *not* filled with transmission fluid during shipment and the selector lever is temporarily attached to the actuating shaft.

Before leaving the WESTERBEKE plant, each transmission undergoes a test run, with *Dextron III ATF* transmission fluid. The residual fluid remaining in the transmission after draining acts as a preservative and provides protection against corrosion for at least one year if properly stored.



OIL COOLER

The oil cooler, mounted above the transmission, provides continuous cooling for the transmission fluid. Raw water passes through the tubes of the cooler and discharges overboard. The transmission fluid is cooled as it flows around the tubes and back into the transmission.



TRANSMISSION FLUID

Fill the transmission with *Dextron III ATF*. The fluid level should be up to the mark on the dipstick. After checking the level, press the dipstick into the case and turn it to tighten. During the first 25 operating hours, inspect the bell housing, output shaft and transmission cooler for leakage. The fluid should be changed after the first 25 hours and every 300 hours thereafter.

NEUTRAL SWITCH

These transmissions are equipped with a neutral safety switch. This is to prevent the engine from starting in gear. Unless the transmission selector lever is perfectly aligned in neutral, the engine starter will not activate.

INITIAL OPERATION

Set the shifting lever to neutral position (N). Start the engine and let it run long enough in idle to fill the cooler and hoses with transmission fluid. Shift into gear, forward and reverse; shifting should be smooth and positive. Direct changes from forward to reverse are permissible since the multiple disc clutch permits changing at high rpm including sudden reversing at high speeds in the event of danger.

After initial operation, make a visual inspection of the output coupling, oil cooler and hoses, and the cable connections to the transmission.

LOCKING THE PROPELLER

Locking of the propeller shaft by an additional brake is not required: use the gear shift lever position opposite your direction of travel for this purpose. Never put the gear shift in the position corresponding to the direction of travel of the boat.

WHEN UNDER SAIL OR BEING TOWED

Rotation of the propeller without a load, such as when the boat is being sailed, being towed or anchored in a river, as well as operation of the engine with the propeller stopped (for charging the battery), will have no detrimental effects on the transmission.

NOTE: *When the boat is being sailed (engine stopped), the gear shift must be in the neutral position. The propeller is at idle and can free-wheel.*

DAILY OPERATION

- Check the transmission fluid.
- Visually check the gear shift linkage and transmission.
- Start the engine in neutral, allowing a few minutes at idle to warm the fluid.
- Shift into gear.

NOTE: *Too low an idle speed will produce a chattering noise from the transmission gear and damper plate. In such cases the idle speed should be increased.*

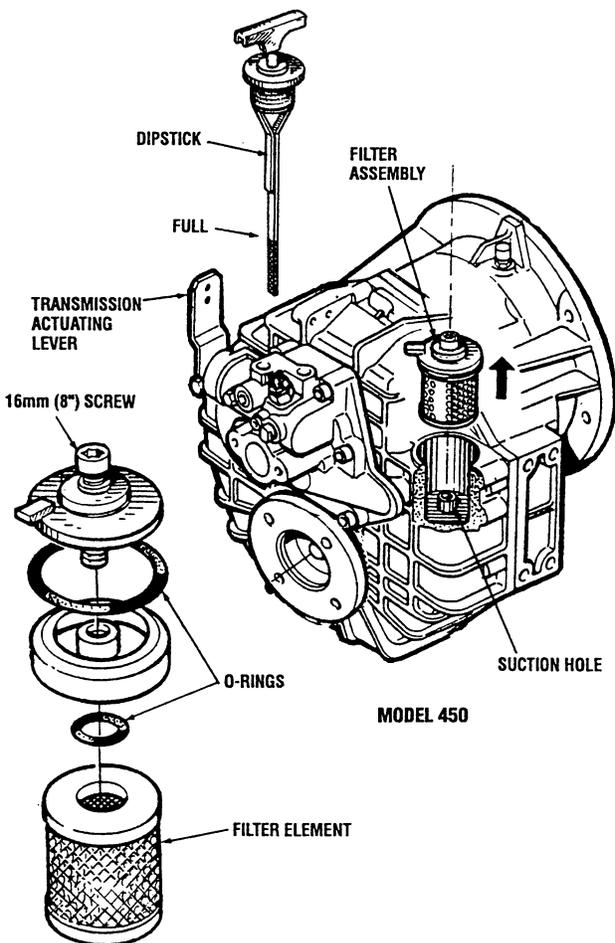
Operating Temperature

The operating temperature of the transmission should not exceed 176°F (80°C) under normal continuous running. A connection for a temperature probe is provided. At maximum output of the engine, the fluid may reach 220°F (104°C).

CAUTION: *If the transmission fluid temperature is too high, stop the engine immediately and check the transmission fluid.*

HURTH TRANSMISSIONS

CHANGING THE TRANSMISSION FLUID



Filter Element

The Hurth transmission has a filter element located opposite the dipstick. This filter must be replaced whenever the fluid is changed.

Remove the filter by loosening the screw on the cover using a 6mm Allen wrench.

Twist and pull out the filter and remove the element. Place the new filter onto the cover and lock it into place by turning it clockwise. Check the O-rings for damage and replace if necessary. Replacement filters can be obtained from your local WESTERBEKE dealer or ZF (Hurth dealer).

Removing the Fluid

Push a suction pump hose down through the pipe hole (under the filter) to the bottom of the housing and suck out the fluid.

Remove the oil return line from the cooler and allow the oil to drain into a container, then reconnect the oil return line.

Wipe down the transmission and properly dispose of the used fluid.

Replacing the Fluid

Pour in new *Dextron III ATF* fluid and check the quantity with the dipstick.

Transmission fluid quantities will vary with the use of coolers, length of hoses and the angle of the transmission.

Approximate Quantities

HURTH 45 — 2.12 quarts (2.0 Liters)

HURTH 63 — 3.2 quarts (3.0 Liters)

Reinsert the filter assembly into the housing. Press it in place and tighten the Allen screw.

NOTE: Some transmissions use a "T" handle in place of a screw on their filter assemblies.

After running the engine, shut down and recheck the fluid level.

WARNING: Never pull out the dipstick while the engine is running. Hot fluid will splash from the dipstick hole. This could cause severe burns.

MAINTENANCE

Transmission maintenance is minimal. Keep the exterior housing clean, check the fluid level as part of your regular routine, and change the fluid every 300 operating hours.

Periodically inspect the transmission and the cooler for leaks and corrosion. Make certain the air vent is clear and when checking the fluid level look for signs of water contamination (fluid will appear as strawberry cream).

Lay-up/Winterize

Storage requires special care. Follow these procedures:

- Drain water from the transmission oil cooler and replace with a proper mixture of antifreeze coolant.

NOTE: This operation will normally occur when the engine raw water cooling system is properly winterized.

- Clean up the transmission and touch up unpainted areas (use heat resistant paint).
- Fill the transmission with *Dextron III ATF* fluid to prevent internal corrosion (extended storage only, twelve months or more).
- Loosen attaching hardware from the transmission output flange and propeller shaft coupling flange before removing the boat from the water. Separate the flanges and spray with lubricant.
- Inspect the gear shift cable, linkage, and attachments. Look for corrosion of the end fittings, cracks or cuts in the conduit, and bending of the actuator rods. Lubricate all moving parts.

NOTE: If the transmission is to be stored for a long time (twelve months or more), it should be topped off with fluid to prevent internal corrosion. Reduce the fluid level before putting the engine back into service.

HURTH TRANSMISSIONS

CABLE CONNECTIONS

The transmission is suitable for a single lever gear shift. Upon loosening the retaining screw, the actuating lever (see illustration) can be moved to any position required for the control elements (cable or rod linkage). Make certain that the actuating lever does not contact the lever hub: the minimum distance between the lever and hub should be 0.02in(0.5mm).

The control cable or rod should be arranged at a right angle to the actuating lever when in the neutral position. The neutral position of the gear shift lever on the control console should coincide with the neutral position of the lever on the transmission.

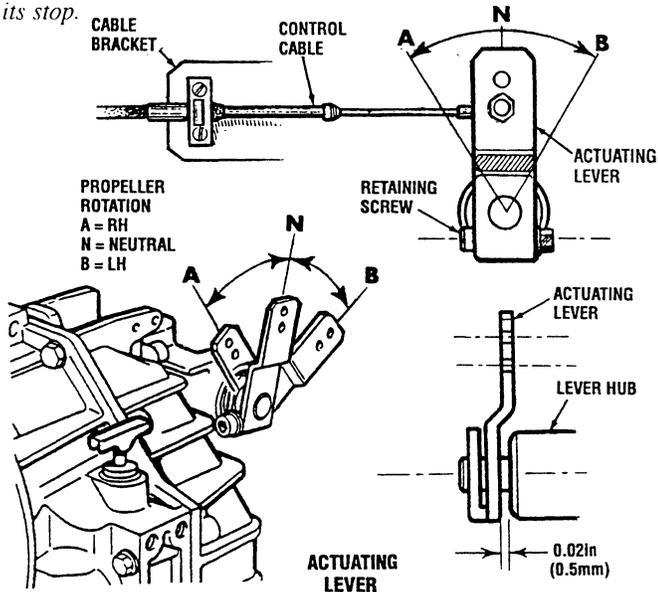
Shifting Positions:

A= Propeller rotation opposite of engine rotation.

N= Neutral position

B= Propeller rotation same as engine rotation.

NOTE: When shifting to "A" or "B" positions, make sure the shift lever travel is sufficient for the actuating lever to contact its stop.



A greater amount of actuating lever travel is in no way detrimental and is recommended. However, if the lever travel is shorter, proper clutch engagement might be impeded which, in turn, would mean premature wear, excessive heat generation and clutch plate failure. This would be indicated by slow clutch engagement or no engagement at all (see *CONTROL CABLES* under *TRANSMISSION TROUBLESHOOTING*).

NOTE: Check for proper actuating lever travel at least each season.

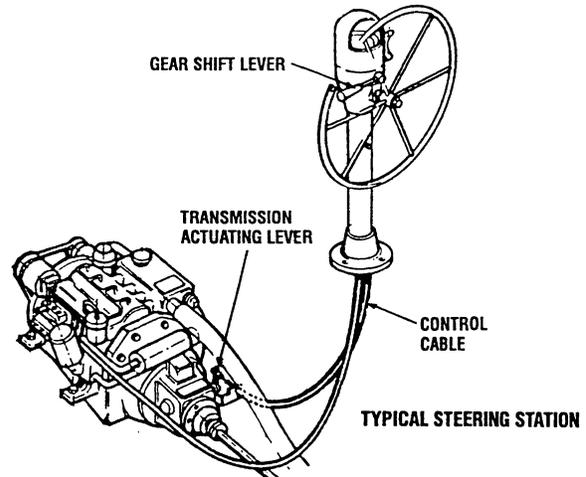
CAUTION: The position of the mechanism behind the actuating lever is factory-adjusted to ensure equal shift lever travel from neutral position to A and B. If this mechanism is in any way tampered with, the transmission warranty will be void.

SHAFT COUPLINGS

WESTERBEKE recommends a flexible connection between the transmission and the propeller shaft if the engine is flexibly mounted, in order to compensate for angular deflections. The installation of a special propeller thrust bearing is not required, since the propeller thrust will be absorbed by the transmission bearing, provided the value specified under *SPECIFICATIONS* is not exceeded. However, the output shaft should be protected from additional loads. Special care should be taken to prevent torsional vibration. When using a universal joint shaft, make certain to observe the manufacturer's instructions.

Even with the engine solidly mounted, the use of a flexible coupling or "DRIVESAVER" will reduce stress in the gearbox bearings caused by hull distortions, especially in wooden boats or where the distance between the transmission output coupling and stern gland is less than about 800mm.

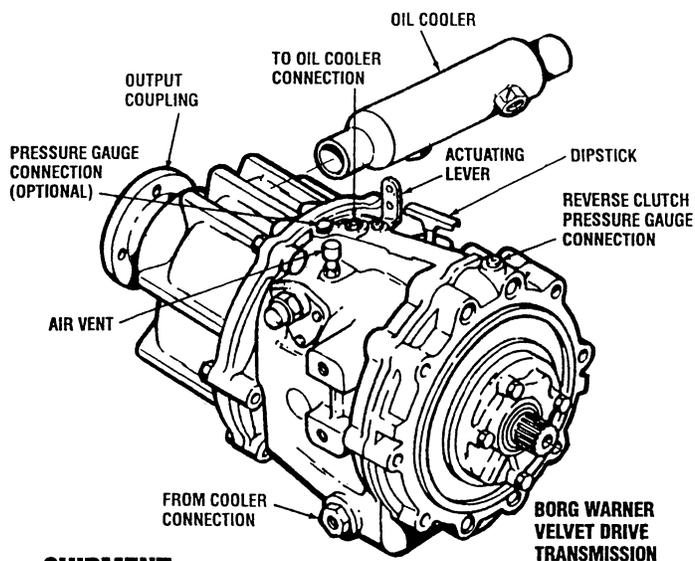
NOTE: When installing the transmission, make certain that shifting is not impeded by restricted movability of the cable or rod linkage, by unsuitably positioned guide sheaves, too small a bending radius or other restrictions. In order to mount a support for shift control cable connections, use the two threaded holes located on the cable bracket mounted on the gear housing. Refer to the WESTERBEKE parts list.



For additional information contact:

HURTH MARINE GEAR
ZF Industries
Marine US Headquarters
3131 SW 42nd Street
Fort Lauderdale, FL 33312
Tel.: (954) 581-4040
Fax: (954) 581-4077

BORG WARNER VELVET DRIVE TRANSMISSION



SHIPMENT

For safety reasons, the transmission is *not* filled with transmission fluid during shipment and the selector lever is temporarily attached to the actuating shaft.

Before leaving the WESTERBEKE plant, each transmission undergoes a test run, with *Dextron III ATF* transmission fluid. The residual fluid remaining in the transmission after draining acts as a preservative and provides protection against corrosion for at least one year if properly stored.

TRANSMISSION FLUID

Check the transmission fluid level on the dipstick. If the transmission has not been filled, fill with *Dextron III* and continue to use this fluid. During the first 25 hours of operation, keep a lookout for any leakage at the bell housing, output shaft and transmission cooler. This fluid should be changed after the first 25 hours and approximately every 300 operating hours thereafter and/or at winter lay-up.

CAUTION: *Be certain the transmission is filled and the correct size cooler is properly installed before starting the engine.*

SHIFT LEVER POSITION

The gear shift control mechanism and linkage must position the actuating lever on the transmission exactly in Forward (F), Neutral (N), and Reverse (R) shifting positions. A detent ball located behind the transmission lever must work freely to center the lever in each position. The gear shift positions at the helm must be coordinated with those of the Velvet Drive actuating lever through shift mechanism adjustments. An improperly adjusted shift mechanism can cause damage to the transmission. The shifting mechanism and transmission actuating lever should be free of dirt and well lubricated to ensure proper operation.

Shifting Into Gear

Place the gear shift in Neutral before starting the engine. Shifting from one selector position to another selector position may be made at any time below 1000 rpm and in any order. Shifts should be made at the lowest *practical* engine speed. Start the engine and set the throttle at idle speed; allow the transmission fluid to warm up for a few minutes.

Neutral

Move the gear shift lever to the middle position. You should feel the detent. This centers the actuating lever on the transmission. With the control in this position, hydraulic power is completely interrupted and the output shaft of the transmission does not turn.

NOTE: *Some transmissions are equipped with a neutral safety switch. Unless the transmission actuating lever is perfectly aligned in neutral, the engine starter will not activate.*

Forward

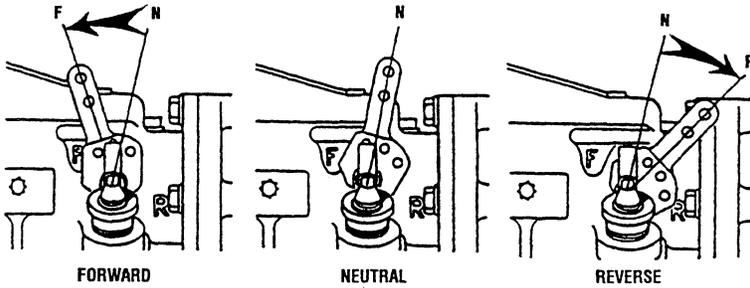
Move the gear shift lever to the forward position. You should feel the detent. The actuating lever on the transmission is in the forward position. The output shaft and the propeller shaft move the boat in a forward direction.

Reverse

Move the gear shift lever to the reverse position. You should feel the detent. The actuating lever on the transmission is in the reverse position. The output shaft and the propeller should move the boat in a reverse direction (astern).

NOTE: *Moving the transmission actuating lever from Neutral Position to Forward is always toward the engine. Reverse is always away from the engine. If boat moves backwards with the gear shift control in the forward position, shut off the engine! This problem may be a result of incorrect movement of the actuating lever by the gear shift lever.*

BORG WARNER VELVET DRIVE TRANSMISSION



FORWARD NEUTRAL REVERSE
TRANSMISSION ACTUATING LEVER POSITIONS

DAILY OPERATION

- Check the transmission fluid.
- Visually check the gear shift linkage and transmission.
- Start the engine in neutral. Allow a few minutes at idle for the fluid to warm.

NOTE: Too low an idle speed will produce a chattering noise from the transmission gear and damper plate. In such cases the idle speed should be increased.

- Shift into gear.

CAUTION: Shifting gears above 1000 rpm can cause damage to the engine damper plate. Pulling the throttle back to idle when shifting gears will save wear on the transmission and the damper plate.

INSPECTION

- Visually check for oil leaks at the hydraulic connections. Check for wear on the hydraulic lines and replace if worn.
- Lubricate the detent ball and shift cable attachments.
- Inspect the shift linkage.
- Inspect the transmission bolts; retorque if necessary.

CAUTION: Clutch failure will occur if the transmission shift lever does not fully engage the detent ball positions.

CHANGING THE TRANSMISSION FLUID

After the initial 50 hour change, the transmission fluid should be changed at every 300 operating hours thereafter or at winter haul-out. However, the fluid must be changed whenever it becomes contaminated, changes color, or smells rancid.

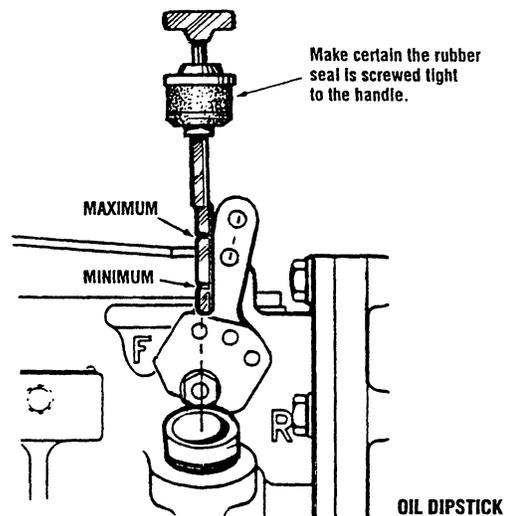
- Remove the oil filler cap and dipstick.
- Remove the oil cooler return line and allow the oil to drain into a container.
- Reconnect the oil cooler return line.
- Use a suction pump to remove the transmission oil through the filler cap/dipstick hole.

- Clean off the transmission and properly dispose of the used fluid.
- Refill the transmission with *DEXTRON III ATF*. The quantity will vary depending on the transmission model and the installation angle. Fill through the dipstick hole.
- Check the dipstick for the proper fluid level.
- Replace the oil filler cap and dipstick. (Press the dipstick into place and turn clockwise until finger-tight.)
- Run the engine, shutdown and recheck the fluid level.

WARNING: Never pull out the dipstick while the engine is running. Hot fluid will splash from the dipstick hole. This could cause severe burns.

Oil Capacity

Approximately 2.5 quarts (2.36 liters) will fill most transmissions to the oil level fill mark on the dipstick. Many variables have a direct relationship to the oil capacity. Additional oil will be required to fill the oil cooler and the cooler lines. The angle of installation will make a difference in the quantity of oil required to fill the transmission.



OIL DIPSTICK

Oil Temperature

A maximum oil temperature of 190°F (88°C) is recommended. Discontinue operation anytime sump oil temperature exceeds 230°F (110°C).

PRESSURE GAUGE

An optional mechanical pressure gauge can be installed at the control panel to constantly monitor the pressure of the transmission fluid. A normal reading at 2000 rpm in forward gear should indicate 95 – 120 lb-in² (6.7 – 8.4 kg-cm²) and be constant.

BORG WARNER VELVET DRIVE TRANSMISSION

MAINTENANCE

Transmission maintenance is minimal. Keep the exterior housing clean, check the fluid level as part of your regular routine, and change the fluid every 300 operating hours.

Periodically inspect the transmission and the cooler for leaks and corrosion. Make certain the air vent is clear and when checking the fluid level look for signs of water contamination (fluid will appear as strawberry cream).

Lay-up/Winterize

Storage requires special care. Follow these procedures:

- Drain the water from the transmission oil cooler and replace it with a proper mixture of antifreeze coolant.

NOTE: *This operation will usually occur when the engine raw water cooling system is properly winterized.*

- Clean up the transmission and touch-up unpainted areas (use heat resistant paint).
- Fill the transmission with *Dextron III ATF* fluid to prevent internal corrosion.
- Loosen attaching hardware from the transmission output flange and propeller shaft coupling flange before removing the boat from the water. Separate the flanges and spray with lubricant.
- Inspect the gear shift cable, linkage, and attachments. Look for corrosion of the end fittings, cracks or cuts in the conduit, and bending of the actuator rods. Lubricate all moving parts.

NOTE: *If the transmission is to be stored for a long time (twelve months or more), it should be topped off with fluid to prevent internal corrosion. Reduce the fluid level before putting the engine back into service.*

WARRANTY NOTES

Service manuals are available from your *BORG WARNER* dealer.

For assistance, contact:

BORG WARNER
200 Theodory Rice Blvd.
New Bedford, MA 02745
Tel.: (508) 979-4881

BORG WARNER is aware of the shock loads that can be placed on its gears as the result of mechanical propeller operation or fully reversing of the propeller blades while shifting. Therefore torque loads and directional changes should be made at low engine speeds. If it is found that a failure was caused by a shock load, any warranty claim will be denied.

⚠ CAUTION: *System-related noises or vibrations can occur at low engine speeds which can cause gear rattle resulting in damage to the engine and/or transmission. BORG WARNER is not responsible for total system-related torsional vibration of this type.*

If any problems occur with the transmission, see *TRANSMISSION TROUBLESHOOTING* in this manual.

TRANSMISSION TROUBLESHOOTING

CONTROL CABLES

The majority of transmission difficulties arise as a result of improper clutch adjustments (manual transmissions) or problems with control cables (hydraulic transmissions) rather than from problems with the transmission itself.

HURTH clutches, in particular, are very sensitive to improper cable adjustments.

If you experience operating problems with the transmission, shut the engine down. First check the transmission-oil level, then have a helper move the cockpit shift lever through the full range — from neutral to full forward, back to neutral, into full reverse, and back to neutral — while you observe the actuating lever on the transmission. If the remote is stiff to operate, break the cable loose at the transmission and try again. If it is still stiff, check the cable for kinks or excessively tight bends, and check any linkage for binding. A new cable and perhaps a new linkage mechanism may be needed. While the cable is loose, shift the transmission in and out of gear using the lever on the side of the transmission to make sure there's no binding inside the case.

If the transmission passes these tests, crank the engine and have a helper put it in forward and reverse while you observe the propeller shaft; if the shaft isn't turning, the transmission needs professional attention. If it does turn but there's no thrust, check to see you still have a propeller on the end of the shaft or, if you have a folding or feathering propeller, that it isn't stuck in the "no pitch" position.

OIL COOLERS

The continued flow of raw water through the cooler will, in time, erode the inside of the cooler causing cross leaks to occur. These internal cooler leaks will cause one of the following two problems:

1. Transmission fluid will leak into the flow of raw water and be discharged overboard through the engine exhaust. *A loss of transmission fluid will cause the transmission to fail.*
2. The raw water will leak into the transmission fluid causing an increase in transmission fluid. This contaminated fluid will appear as strawberry cream. *The transmission will eventually fail.*

Either case requires an immediate response:

1. Install a new oil cooler.
2. Refill the transmission with *DEXTRON III ATF*.

If water has contaminated the fluid, the transmission fluid needs to be cleaned out and replaced with fresh fluid. It will take several fluid changes to get rid of the contamination. Check your dipstick each time until it appears as pure transmission fluid. Change the transmission filter and clean out the fluid lines that connect to the cooler.

If the transmission fails to shift properly, it will most likely need the attention of a qualified transmission service facility.

A transmission cooler may last ten years or more but, in some circumstances, depending on operating hours, tropical waters, maintenance, etc. it might only last half that time.

WESTERBEKE recommends having a spare cooler aboard.

Problem	Probable Cause	Verification/Remedy
Transmission gears cannot be shifted.	<ol style="list-style-type: none"> 1. Shifting lever is loose. 2. Shifting cable is broken, bent or unattached. 3. Loss of transmission fluid. 4. Water in transmission fluid. 	<ol style="list-style-type: none"> 1. Tighten damping bolt on shifting lever. 2. Check the cable, reattach or replace. 3. Check for leaks at transmission seal and output shaft. Tighten gear case bolts. Check all oil hoses for leaks. Oil cooler leak — see <i>OIL COOLER</i>. 4. Replace oil cooler (see <i>OIL COOLER</i>). High water in engine compartment, remedy cause. Shifting pressure too low, see item 2.
Shifting pressure too low.	<ol style="list-style-type: none"> 1. Improper fluid. 2. Filter is dirty (if applicable). 3. Water in transmission fluid. 4. Transmission fluid too low. 5. Air vent is clogged. 	<ol style="list-style-type: none"> 1. Replace with <i>DEXTRON III ATF</i>. 2. Replace filter. 3. Replace oil cooler — see <i>OIL COOLER</i>. 4. Add fluid. 5. Remove paint/dirt from vent.
Transmission noise becomes louder.	<ol style="list-style-type: none"> 1. Fluid level too low, so that pump sucks in air. 2. Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission. 3. Beginning damage of bearings in transmission due to torsional vibrations, running without fluid, overload, wrong alignment of transmission, or excessive engine output. 	<ol style="list-style-type: none"> 1. Top up with fluid to marking on dipstick. 2. Replace flexible coupling. Check alignment between engine and transmission. 3. Transmission needs professional attention.

(continued)

TRANSMISSION TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Chattering transmission noise, mainly at low engine speed.	<ol style="list-style-type: none"> 1. The engine or propeller generates torsional vibrations in the drive unit which produces a "chattering" noise in the transmission. 	<ol style="list-style-type: none"> 1. Mount a flexible coupling with another stiffness factor between the engine and transmission; a coupling with a higher stiffness factor might be sufficient.
Transmission shifts into gear, but fails to propel the boat.	<ol style="list-style-type: none"> 1. Output coupling is not turning. 2. Propeller shaft is not turning. Output coupling is turning. 3. Output coupling and propeller shaft are turning. 	<ol style="list-style-type: none"> 1. Transmission needs professional attention. 2. The coupling bolts are sheared or the coupling is slipping on the propeller shaft. Tighten or replace set screws, keys, pins and coupling bolts as necessary. 3. Inspect the propeller; it may be missing or damaged. A folding propeller may be jammed. Variable pitch propeller may be in "no pitch" position.

NOTE: *If you suspect a major problem in your transmission, immediately contact your WESTERBEKE dealer or an authorized marine transmission facility.*

LAY-UP & RECOMMISSIONING

GENERAL

Many owners rely on their boatyards to prepare their craft, including engines and generators, for lay-up during the off-season or for long periods of inactivity. Others prefer to accomplish lay-up preparation themselves.

The procedures which follow will allow you to perform your own lay-up and recommissioning, or you may use them as a check list if others do the procedures.

These procedures should afford your engine protection during a lay-up and also help familiarize you with the maintenance needs of your engine.

If you have any questions regarding lay-up procedures, call your local servicing dealer; he will be more than willing to provide assistance.

Propeller Shaft Coupling [Propulsion Engine]

The transmission and propeller half couplings should always be opened up and the bolts removed when the boat is hauled out of the water or moved from land to water, and during storage in the cradle. The flexibility of the boat often puts a severe strain on the propeller shaft or coupling or both, while the boat is taken out or put in the water. In some cases, the shaft has actually been bent by these strains. This does not apply to small boats that are hauled out of the water when not in use, unless they have been dry for a considerable period of time.

Fresh Water Cooling Circuit

A 50-50 solution of antifreeze and distilled water is recommended for use in the coolant system at all times. This solution may require a higher concentration of antifreeze, depending on the area's winter climate. Check the solution to make sure the antifreeze protection is adequate.

Should more antifreeze be needed, drain an appropriate amount from the engine block and add a more concentrated mixture. Operate the engine to ensure a complete circulation and mixture of the antifreeze concentration throughout the cooling system. Now recheck the antifreeze solution's strength.

Lubrication System

With the engine warm, drain all the engine oil from the oil sump. Remove and replace the oil filter and fill the sump with new oil. Use the correct grade of oil. Refer to the *ENGINE LUBRICATING OIL* pages in this manual for the oil changing procedure. Run the engine and check for proper oil pressure and make sure there are no leaks.

CAUTION: Do not leave the engine's old engine oil in the sump over the lay-up period. Engine oil and combustion deposits combine to produce harmful chemicals which can reduce the life of your engine's internal parts.

Fuel System [Gasoline]

Top off your fuel tanks with *unleaded* gasoline of 89 octane or higher. A fuel conditioner such as *STABIL* gasoline stabilizer should be added. Change the element in your gasoline/water separator and clean the metal bowl. Re-install and make certain there are no leaks. Clean up any spilled fuel.

Fuel System [Diesel]

Top off your fuel tanks with No. 2 diesel fuel. Fuel additives such as *BIOBOR* and *STABIL* should be added at this time to control algae and condition the fuel. Care should be taken that the additives used are compatible with the primary fuel filter/water separator used in the system. Change the element in your primary fuel filter/water separator, if the fuel system has one, and clean the separator sediment bowl.

Change the fuel filter elements on the engine and bleed the fuel system, as needed. Start the engine and allow it to run for 5 – 10 minutes to make sure no air is left in the fuel system. Check for any leaks that may have been created in the fuel system during this servicing, correcting them as needed. Operating the engine for 5 – 10 minutes will help allow movement of the treated fuel through the injection equipment on the engine.

Raw Water Cooling Circuit

Close the through-hull seacock. Remove the raw water intake hose from the seacock. Place the end of this hose into a five gallon bucket of clean fresh water. Before starting the engine, check the zinc anode found in the primary heat exchanger on the engine and clean or replace it as required, and also clean any zinc debris from inside the heat exchanger where the zinc anode is located. Clean the raw water strainer.

Start the engine and allow the raw water pump to draw the fresh water through the system. When the bucket is empty, stop the engine and refill the bucket with an antifreeze solution slightly stronger than needed for winter freeze protection in your area.

Start the engine and allow all of this mixture to be drawn through the raw water system. Once the bucket is empty, stop the engine. This antifreeze mixture should protect the raw water circuit from freezing during the winter lay-up, as well as providing corrosion protection.

Remove the impeller from your raw water pump (some antifreeze mixture will accompany it, so catch it in a bucket). Examine the impeller. Acquire a replacement, if needed, and a cover gasket. Do not replace the impeller (into the pump) until recommissioning, but replace the cover and gasket.

Cylinder Lubrication [Gasoline]

With the engine running, remove the flame arrester and spray fogging oil into the open air intake. The fogging oil will stall out the engine as it coats the valves, cylinders and spark plugs for winter protection.

LAY-UP & RECOMMISSIONING

Starter Motor

Lubrication and cleaning of the starter drive pinion is advisable, if access to the starter permits its easy removal. Make sure the battery connections are shut off before attempting to remove the starter. Take care in properly replacing any electrical connections removed from the starter.

Cylinder Lubrication *[Diesel]*

If you anticipate a long lay-up period (12 months or more) WESTERBEKE recommends removing the glow plugs or fuel injectors for access to the cylinders. Squirt light lubricating oil into the cylinders to prevent the piston rings from sticking to the cylinder walls. Rotate the engine by hand two revolutions then replace the glow plugs or injectors.

Make sure you have a replacement if removing the injector sealing washer for the injector and fuel line return.

NOTE: *If engine storage is going to be a lengthy one, 12 months or beyond, it is wise to rotate the engine by hand two complete turns every additional 4 months to allow the injection pump components to move. This will help prevent their sticking during extended storage periods.*

Intake Manifold and Thru-Hull Exhaust *[Diesel]*

Place a clean cloth, lightly soaked in lubricating oil, in the opening of the intake manifold to block the opening. Do not shove the cloth out of sight. (If it is not visible at recommissioning, and an attempt is made to start the engine, you may need the assistance of a servicing dealer.) Make a note to remove the cloth prior to start-up. The through-hull exhaust port can be blocked in the same manner.

Intake Manifold *[Gasoline]*

Clean the filter screen in the flame arrester, and place a clean cloth lightly soaked in lube oil around the flame arrester to block any opening. Also place an oil-soaked cloth in the through-hull exhaust port. Make a note to remove cloths prior to start-up!

Transmission *[Propulsion Engine]*

Check or change fluid in the transmission as required. If the engine is to be layed up 12 months or more, fill the transmission to the very top to prevent corrosion. **Lower the fluid to its normal at recommissioning.** Wipe off grime and grease and touch up unpainted areas. Protect coupling and output flange with an anticorrosion coating. Refer to the *TRANSMISSION SECTION* in this manual for additional information.

Batteries

If batteries are to be left on board during the lay-up period, make sure they are fully charged, and will remain that way, to prevent them from freezing. If there exists any doubt that the batteries will not remain fully charged, or that they will be subjected to severe environmental conditions, remove the batteries and store them in a warmer, more compatible environment.

SPARE PARTS

Lay-up time provides a good opportunity to inspect your WESTERBEKE engine to see if external items such as drive belts or coolant hoses need replacement. Check your basic spares kit and order items not on hand, or replace those items used during the lay-up, such as filters and zinc anodes. Refer to the *SPARE PARTS* section of this manual.

RECOMMISSIONING

The recommissioning of your WESTERBEKE engine after a seasonal lay-up generally follows the same procedures as those described in the *PREPARATIONS FOR STARTING* section regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counteracted before starting the engine.

1. Remove any rags that were placed in the exhaust, intake manifold, or flame arrester.
2. Remove the raw water pump cover and gasket and discard the old gasket. Install the raw water pump impeller removed during lay-up (or a replacement, if required). Install the raw water pump cover with a new cover gasket.
3. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to make sure that the batteries are fully charged.
4. Remove the spark plugs, wipe clean, re-gap, and install to proper tightness. *[Gasoline]*
5. Check the condition of the zinc anode in the raw water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/fresh water solution from the raw water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse affects. Also open up the heat exchanger ends and clear out any accumulated debris.
6. Check the transmission fluid, if it had been topped off during the lay-up, lower the level of the fluid to normal. *[Propulsion Engine]*
7. Make certain all electrical connections and switches are in the correct position and there are no-loads on the generator at start up. *[Generator]*
8. Start the engine in accordance with the procedures described in the *PREPARATIONS FOR STARTING* section of this manual.

METRIC CONVERSIONS

INCHES TO MILLIMETERS

MILLIMETERS TO INCHES

Inches	mm	Inches	mm	mm	Inches	mm	Inches
1	25.40	15	381.00	1	0.0394	15	0.5906
2	50.80	20	508.00	2	0.0787	20	0.7874
3	76.20	25	635.00	3	0.1181	25	0.9843
4	101.60	30	762.00	4	0.1575	30	1.1811
5	127.00	35	889.00	5	0.1969	35	1.3780
10	254.00	40	1016.00	10	0.3937	40	1.5748

10 MILLIMETERS = 1 CENTIMETER, 100 CENTIMETERS = 1 METER = 39.37 INCHES (3.3 FEET)

INCHES TO METERS

METERS TO INCHES

Inches	Meters	Inches	Meters	Meters	Inches	Meters	Inches
1	0.0254	7	0.1778	0.1	3.937	0.7	27.559
2	0.0508	8	0.2032	0.2	7.874	0.8	31.496
3	0.0762	9	0.2286	0.3	11.811	0.9	35.433
4	0.1016	10	0.2540	0.4	15.748	1.0	39.370
5	0.1270	11	0.2794	0.5	19.685	1.1	43.307
6	0.1524	12	0.3048	0.6	23.622	1.2	47.244

TO CONVERT METERS TO CENTIMETERS, MOVE DECIMAL POINT TWO PLACES TO THE RIGHT

YARDS TO METERS

METERS TO YARDS

Yards	Meters	Yards	Meters	Meters	Yards	Meters	Yards
1	0.91440	6	5.48640	1	1.09361	6	6.56168
2	1.82880	7	6.40080	2	2.18723	7	7.65529
3	2.74320	8	7.31520	3	3.28084	8	8.74891
4	3.65760	9	8.22960	4	4.37445	9	9.84252
5	4.57200	10	9.14400	5	5.46807	10	10.93614

MOVE DECIMAL POINT FOR HIGHER VALUES — e.g. 6,000 METERS = 6,561.68 YARDS

POUNDS TO KILOGRAMS

KILOGRAMS TO POUNDS

lb	kg	lb	kg	kg	lb	kg	lb
1	0.454	6	2.722	1	2.205	6	13.228
2	0.907	7	3.175	2	4.409	7	15.432
3	1.361	8	3.629	3	6.614	8	17.637
4	1.814	9	4.082	4	8.818	9	19.842
5	2.268	10	4.536	5	11.023	10	22.046

GALLONS TO LITERS

LITERS TO GALLONS

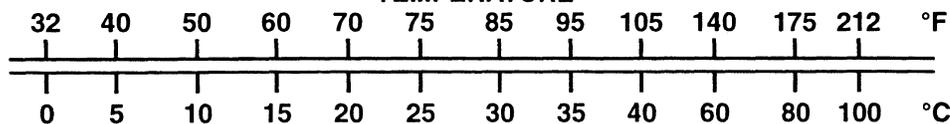
Gallons	Liters	Gallons	Liters	Liters	Gallons	Liters	Gallons
1	3.79	10	37.86	1	0.26	60	15.66
2	7.57	20	75.71	2	0.53	90	23.77
3	11.36	30	113.57	5	1.32	120	31.32
4	15.14	40	151.42	10	2.64	150	39.62
5	18.93	50	189.28	20	5.28	180	47.54

PINTS TO LITERS

LITERS TO PINTS

Pints	Liters	Pints	Liters	Liters	Pints	Liters	Pints
1	0.47	6	2.84	1	2.11	6	12.68
2	0.95	7	3.31	2	4.23	7	14.79
3	1.42	8	3.79	3	6.34	8	16.91
4	1.89	9	4.26	4	8.45	9	19.02
5	2.37	10	4.73	5	10.57	10	21.13

TEMPERATURE



STANDARD AND METRIC CONVERSION DATA

LENGTH-DISTANCE

Inches (in) x 25.4 = Millimeters (mm) x .0394 = Inches

Feet (ft) x .305 = Meters (m) x 3.281 = Feet

Miles x 1.609 = Kilometers (km) x .0621 = Miles

VOLUME

Cubic Inches (in³) x 16.387 = Cubic Centimeters x .061 = in³

Imperial Pints (IMP pt) x .568 = Liters (L) x 1.76 = IMP pt

Imperial Quarts (IMP qt) x 1.137 = Liters (L) x .88 = IMP qt

Imperial Gallons (IMP gal) x 4.546 = Liters (L) x .22 = IMP gal

Imperial Quarts (IMP qt) x 1.201 = US Quarts (US qt) x .833 = IMP qt

Imperial Gallons (IMP gal) x 1.201 = US Gallons (US gal) x .833 = IMP gal

Fluid Ounces x 29.573 = Milliliters x .034 = Ounces

US Pints (US pt) x .473 = Liters(L) x 2.113 = Pints

US Quarts (US qt) x .946 = Liters (L) x 1.057 = Quarts

US Gallons (US gal) x 3.785 = Liters (L) x .264 = Gallons

MASS-WEIGHT

Ounces (oz) x 28.35 = Grams (g) x .035 = Ounces

Pounds (lb) x .454 = Kilograms (kg) x 2.205 = Pounds

PRESSURE

Pounds Per Sq In (psi) x 6.895 = Kilopascals (kPa) x .145 = psi

Inches of Mercury (Hg) x .4912 = psi x 2.036 = Hg

Inches of Mercury (Hg) x 3.377 = Kilopascals (kPa) x .2961 = Hg

Inches of Water (H₂O) x .07355 = Inches of Mercury x 13.783 = H₂O

Inches of Water (H₂O) x .03613 = psi x 27.684 = H₂O

Inches of Water (H₂O) x .248 = Kilopascals (kPa) x 4.026 = H₂O

TORQUE

Pounds-Force Inches (in-lb) x .113 = Newton Meters (Nm) x 8.85 = in-lb

Pounds-Force Feet (ft-lb) x 1.356 = Newton Meters (Nm) x .738 = ft-lb

VELOCITY

Miles Per Hour (MPH) x 1.609 = Kilometers Per Hour (KPH) x .621 = MPH

POWER

Horsepower (Hp) x .745 = Kilowatts (Kw) x 1.34 = MPH

FUEL CONSUMPTION

Miles Per Hour IMP (MPG) x .354 = Kilometers Per Liter (Km/L)

Kilometers Per Liter (Km/L) x 2.352 = IMP MPG

Miles Per Gallons US (MPG) x .425 = Kilometers Per Liter (Km/L)

Kilometers Per Liter (Km/L) x 2.352 = US MPG

TEMPERATURE

Degree Fahrenheit (°F) = (°C X 1.8) + 32

Degree Celsius (°C) = (°F - 32) x .56

80N4 SPECIFICATIONS

GENERAL

Engine Type	Diesel, four cylinder, four-cycle, marine engine. Vertical in-line overhead valve, water cooled direct injection, 80 hp @ 2500 rpm.		
Aspiration	Naturally aspirated.		
Governor	Integral with injection pump.		
Bore & Stroke	4.02 x 4.65 inches (102.0 x 118.0 mm).		
Piston Displacement	262 cubic inches (4.3 liter).		
Firing Order	1 - 3 - 4 - 2.		
Direction of Rotation	Clockwise, when viewed from the front.		
Engine Torque	210 ft-lb @ 1500 rpm.		
Compression Ratio	17:1		
Dimensions - inches (mm) w/out transmission	Height:	32.0 inches (813 mm)	
	Width:	25.2 inches (645 mm)	
	Length:	47.2 inches (1168 mm)	
Weight (dry)	971 lbs (440.8 kgs).		

TUNE-UP SPECIFICATIONS

Compression Pressure (Limit of difference)	441 psi (31 kg/cm ²) at 200 rpm Not to exceed 28.44 psi (20.0 kg/cm ²).		
Injector Pressure	2133 psi (150 k ² /cm ²).		
Valve Seat Angle	Intake 45°. Exhaust 45°.		
Valve Clearance (engine cold)	Intake and exhaust. 0.016 inches (0.40 mm).		
Engine Speed	Idle: 600 - 900 rpm. Cruise: 1800 - 2200 rpm. Max: 2400 -2500 rpm.		

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.		
Operating Temperature	170 - 190° F (77 - 88° C).		
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven.		
Raw Water Pump	Positive displacement, rubber impeller, engine-driven.		
Coolant (Fresh Water) System Capacity	17 US qts (16.1 liters).		

EXHAUST SYSTEM

Exhaust Elbow	45° elbow
Exhaust Hose Size	4" I.D. (101.6 mm) hose

ENGINE AIR REQUIREMENTS

Combustion Air	150 cfm
Note: The pressure differential between the outside of the engine compartment versus the inside of the engine compartment should not exceed 2 inches of water (51 mm) at full open throttle (measure with a manometer).	

FUEL SYSTEM

General	Closed system with bleed points.
Fuel	No. 2 diesel oil (cetane rating of 45 or higher).
Fuel Injection Pump	BOSCH Model A type (In-line).
Fuel Injection Timing	14° BTDC
Nozzle	Multi-hole
Fuel Filter (on engine)	Full flow replaceable.
Air cleaner	Replaceable paper element.
Air Flow (engine combustion)	150 cfm.
Fuel Consumption	4.7 U.S. gph (17.8 lph).

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground.
Battery Capacity	750 - 900 Cold Cranking Amps (CCA).
DC Charging Alternator	51 Amp rated, belt-driven.
Starting Aid	Glow plugs.
Starter	12 Volt, 3 KW.
DC No-load Current	±2% of rated amps.
DC Cranking Current	400 CCA.

LUBRICATION SYSTEM

General	Gear type/pressure circulation.
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	14.5 U.S. qts (13.8 liters).
Operating Oil Pressure (engine hot)	25 - 85 psi.
Oil Grade	API Specification CF or CG-4, SAE 30, 10W-30, 15W-40.

TRANSMISSION

General	(HURTH Standard Transmission) Case-hardened helical gears, hydraulically operated multiple disc clutch.
Gear Ratio (Standard)	2:00:1 (Hurth 45A) or (Hurth 63A)
Propeller Shaft	Right handed-standard transmission.
Propeller Recommendations (using standard transmission)	22x16 P-2 blade or 22x14 P-3 blade propeller should allow the engine to reach its full rated rpm (2500 + 000 -100) at full open throttle while underway in forward gear.
Lubricating Fluid	<i>Dextron III</i>
Transmission Sump Capacity Hurth 45	2.13 US qts (2.0 liters) approximate.

110T4 SPECIFICATIONS

GENERAL

Engine Type	Diesel, four cylinder, four-cycle, turbocharged marine engine. Vertical in-line overhead valve, water cooled direct injection, 110 hp @ 2400 rpm.		
Aspiration	Turbo charged.		
Governor	Integral with injection pump.		
Bore & Stroke	4.02 x 4.65 inches (102.0 x 118.0 mm).		
Piston Displacement	202 cubic inches (4.3 liter).		
Firing Order	1 - 3 - 4 - 2.		
Direction of Rotation	Clockwise, when viewed from the front.		
Engine Torque (max.)	280 ft-lb @ 1500 rpm.		
Compression Ratio	17:1.		
Dimensions - inches (mm) w/out transmission	Height:	32.0 inches (813 mm)	
	Width:	28.3 inches (719 mm)	
	Length:	47.2 inches (1168 mm)	
Weight (dry)	987 lbs (448.0 kgs).		

TUNE-UP SPECIFICATIONS

Compression Pressure (Limit of difference)	441 psi (31 kg/cm ²) at 200 rpm Not to exceed 28.44 psi (20.0 kg/cm ²).
Injector Pressure	2133 psi (150 kf/cm ²).
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake and exhaust 0.016 inches (0.40 mm).
Engine Speed	Idle: 600 - 900 rpm. Cruise: 1800 - 2200 rpm. Max: 2300 -2400 rpm.

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	180 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven.
Raw Water Pump	Positive displacement, rubber impeller, engine-driven.
Coolant (Fresh Water) System Capacity	17 US qts (16.1 liters)

EXHAUST SYSTEM

Exhaust Elbow	45° elbow
Exhaust Hose Size	4" I.D. (101.6 mm) hose

TURBOCHARGER

Model	1H1 RHB6A SER-TC-141
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ENGINE AIR REQUIREMENTS

Combustion Air	230 cfm
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Note: The pressure differential between the outside of the engine compartment versus the inside of the engine compartment should not exceed 2 inches of water (51 mm) at full open throttle (measure with a manometer).

FUEL SYSTEM

General	Closed system with bleed points.
Fuel	No. 2 diesel oil (cetane rating of 45 or higher).
Fuel Injection Pump	BOSCH Model A type (In-line).
Fuel Injection Timing	12° BTDC.
Nozzle	Multi-hole.
Fuel Filter (on engine)	Full flow replaceable.
Air cleaner	Replaceable paper element.
Air Flow (engine combustion)	230 cfm.
Fuel Consumption	6.1 U.S. gph (23.1 lph).

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground
Battery Capacity	750 - 900 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt-driven
Starting Aid	Glow plugs
Starter	12 Volt, 3 KW
DC No-load Current	±2% of rated amps
DC Cranking Current	400 CCA.

LUBRICATION SYSTEM

General	Gear type/pressure circulation
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	14.5 U.S. qts (13.8 liters)
Operating Oil Pressure (engine hot)	25 - 85 psi
Oil Grade	API Specification CF or CG-4, SAE 30, 10W-30, 15W-40

TRANSMISSION

General	(HURTH Standard Transmission) Case-hardened helical gears, hydraulically operated multiple disc clutch.
Gear Ratio (Standard)	2:00:1 (Hurth 45A) or (Hurth 63A)
Propeller Shaft	Right handed-standard transmission.
Propeller Recommendations (using standard transmission)	24x18 P-2 blade or 24x16 P-3 blade propeller should allow the engine to reach its full rated rpm (2400 + 000 -100) at full open throttle while underway in forward gear.
Lubricating Fluid	<i>Dextron III</i>
Transmission Sump Capacity Hurth 45A	2.13 US qts (2.0 liters) approximate.

120N6 SPECIFICATIONS

GENERAL

Engine Type	Diesel, six cylinder, four-cycle, Vertical in-line, overhead valve, fresh water cooled direct injection, marine engine. 120 hp @ 2500 rpm.	
Aspiration	Naturally aspirated.	
Governor	Integral with injection pump.	
Bore & Stroke	4.13 x 4.92 inches (105.0 x 125.0 mm)	
Piston Displacement	296 cubic inches (6.5 liter)	
Firing Order	1 - 5 - 3 - 6 - 2 - 4	
Direction of Rotation	Clockwise, when viewed from the front.	
Engine Torque	298 ft-lb @ 1500 rpm.	
Compression Ratio	17:1	
Dimensions - inches (mm) w/out transmission	Height: 32.5 inches (823 mm) Width: 25.2 inches (645 mm) Length: 56.4 inches (1410 mm)	
Weight (dry)	1175 lbs (534.1 kgs).	

TUNE-UP SPECIFICATIONS

Compression Pressure (Limit of difference)	441 psi (31 kg/cm ²) at 200 rpm Not to exceed 28.44 psi (20.0 kg/cm ²).
Injector Pressure	2631 psi (180 kf/cm ²).
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake and exhaust 0.016 inches (0.40 mm)
Engine Speed	Idle: 600 - 900 rpm Cruise: 1800 - 2200 rpm Max: 2400 -2500 rpm

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	180 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven.
Raw Water Pump	Positive displacement, rubber impeller, engine-driven.
Coolant (Fresh Water) System Capacity	25 US qts (23.7 liters)

EXHAUST SYSTEM

Exhaust Elbow	45° elbow
Exhaust Hose Size	4" I.D. (101.6 mm) hose

ENGINE AIR REQUIREMENTS

Combustion Air	240 cfm
Note: The pressure differential between the outside of the engine compartment versus the inside of the engine compartment should not exceed 2 inches of water (51 mm) at full open throttle (measure with a manometer).	

FUEL SYSTEM

General	Closed system with bleed points.
Fuel	No. 2 diesel oil (cetane rating of 45 or higher).
Fuel Injection Pump	BOSCH Model A type (In-line).
Fuel Injection Timing	14° BTDC
Nozzle	Multi-hole
Fuel Filter (on engine)	Full flow replaceable.
Air cleaner	Replaceable paper element.
Air Flow (engine combustion)	240 cfm
Fuel Consumption	6.5 U.S. gph (24.6 lph).

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground
Battery Capacity	750 - 900 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt-driven
Starting Aid	Glow plugs
Starter	12 Volt, 3 KW actuated shift.
DC No-load Current	±2% of rated amps
DC Cranking Current	400 CCA

LUBRICATION SYSTEM

General	Gear type/pressure circulation
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	22 U.S. qts (20.8 liters)
Operating Oil Pressure (engine hot)	25 - 85 psi (3.5 - 4.2 kg/cm ²)
Oil Grade	API Specification CF or CG-4, SAE 30, 10W-30, 15W-40

TRANSMISSION

General	(HURTH Standard Transmission) Case-hardened helical gears, hydraulically operated multiple disc clutch.
Gear Ratio (Standard)	2:00:1 (Hurth 45A) or (Hurth 63A)
Propeller Shaft	Right handed-standard transmission.
Propeller Recommendations (using standard transmission)	22x16 P-2 blade or 22x14 P-3 blade propeller should allow the engine to reach its full rated rpm (2500 + 000 -100) at full open throttle while underway in forward gear.
Lubricating Fluid	Dextron III
Transmission Sump Capacity Hurth 45 Hurth 63	2.13 US qts (2.0 liters) approximate. 4.2 US qts (4.0 liters) approximate.

170T6 SPECIFICATIONS

GENERAL

Engine Type	Diesel, six cylinder, four-cycle, turbocharged marine engine. Vertical in-line overhead valve, fresh water cooled direct injection, 170 hp @ 2500 rpm.	
Aspiration	Turbocharged.	
Governor	Integral with injection pump.	
Bore & Stroke	4.13 x 4.92 inches (105.0 x 125.0 mm)	
Piston Displacement	423 cubic inches (6.5 liter)	
Firing Order	1 - 5 - 3 - 6 - 2 - 4	
Direction of Rotation	Clockwise, when viewed from the front.	
Engine Torque (max.)	423 ft-lb @ 1800 rpm.	
Compression Ratio	17:1	
Dimensions - inches (mm) w/out transmission	Height:	33.5 inches (823 mm)
	Width:	28.0 inches (711 mm)
	Length:	57.5 inches (1410 mm)
Weight (dry)	1245 lbs (565.23 kgs).	

TUNE-UP SPECIFICATIONS

Compression Pressure (Limit of difference)	441 psi (31 kg/cm ²) at 200 rpm Not to exceed 28.44 psi (20.0 kg/cm ²)	
Injector Pressure	2631 psi (185 kf/cm ²).	
Valve Seat Angle	Intake 45° Exhaust 45°	
Valve Clearance (engine cold)	Intake and exhaust 0.016 inches (0.40 mm)	
Engine Speed	Idle: 600 - 900 rpm Cruise: 1800 - 2200 rpm Max: 2400 - 2500 rpm	

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	180 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven.
Raw Water Pump	Positive displacement, rubber impeller, engine-driven.
Coolant (Fresh Water) System Capacity	25 US qts (23.7 liters)

EXHAUST SYSTEM

Exhaust Elbow	45° elbow
Exhaust Hose Size	4" I.D. (101.6 mm) hose

TURBOCHARGER

Model	1H1 RHC7
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ENGINE AIR REQUIREMENTS

Combustion Air	365 cfm
Note: The pressure differential between the outside of the engine compartment versus the inside of the engine compartment should not exceed 2 inches of water (51 mm) at full open throttle (measure with a manometer).	

FUEL SYSTEM

General	Closed system with bleed points.
Fuel	No. 2 diesel oil (cetane rating of 45 or higher).
Fuel Injection Pump	BOSCH Model A type (In-line).
Fuel Injection Timing	12° BTDC
Nozzle	Multi-hole
Fuel Filter (on engine)	Full flow replaceable.
Air cleaner	Replaceable paper element.
Air Flow (engine combustion)	365 cfm.
Fuel Consumption	9.3 U.S. gph (35.2 lph).

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground
Battery Capacity	750 - 900 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt-driven
Starting Aid	Glow plugs
Starter	12 Volt, 3 KW
DC No-load Current	± 2% of rated amps
DC Cranking Current	400 CCA

LUBRICATION SYSTEM

General	Gear type/pressure circulation
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	22 U.S. qts (20.8 liters)
Operating Oil Pressure (engine hot)	25 - 85 psi
Oil Grade	API Specification CF or CG-4, SAE 30, 10W-30, 15W-40

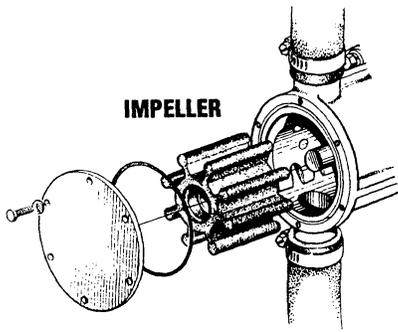
TRANSMISSION

General ended	(HURTH Standard Transmission) Case-hard-helical gears, hydraulically operated multiple disc clutch.
Gear Ratio (Standard)	2:00:1 (Hurth 45A) or (Hurth 63A)
Propeller Shaft	Right handed-standard transmission.
Propeller Recommendations (using standard transmission)	24x18 P-2 blade or 24x16 P-3 blade propeller should allow the engine to reach its full rated rpm (2500 + 000 - 100) at full open throttle while underway in forward gear.
Lubricating Fluid	<i>Dextron III</i>
Transmission Sump Capacity Hurth 63	4.2 US qts (4.0 liters) approximate.

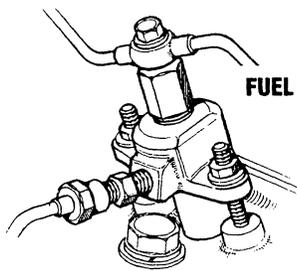
SUGGESTED SPARE PARTS

WESTERBEKE MARINE DIESEL ENGINES

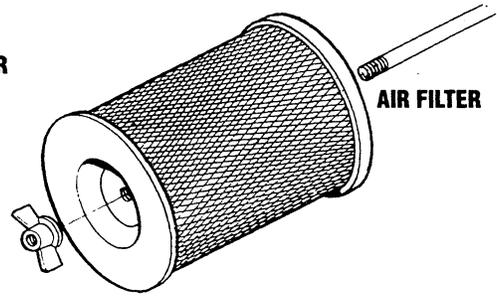
CONTACT YOUR WESTERBEKE DEALER FOR ADDITIONAL SUGGESTIONS AND INFORMATION



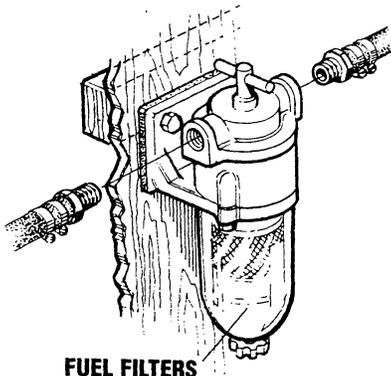
IMPELLER



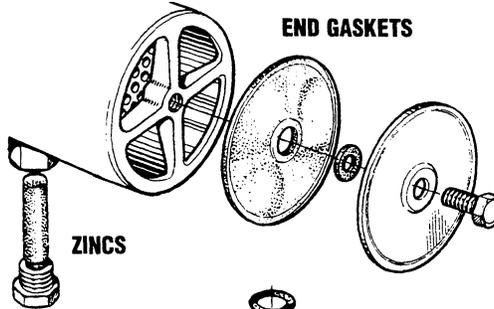
FUEL INJECTOR



AIR FILTER

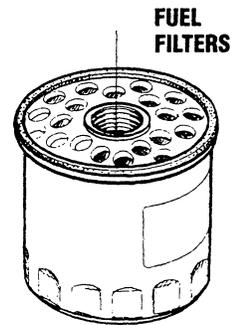


FUEL FILTERS



END GASKETS

ZINCS



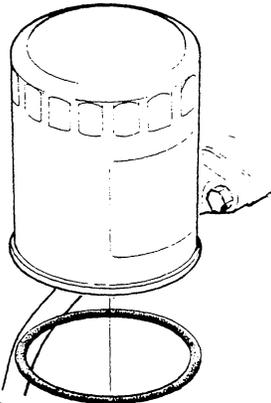
FUEL FILTERS



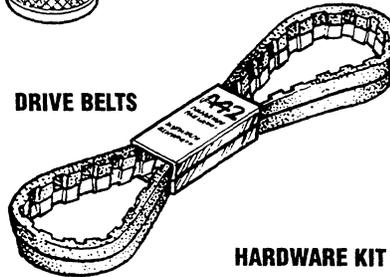
TRANSMISSION FILTER



FUEL STRAINER



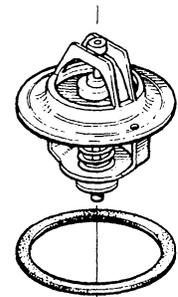
OIL FILTERS



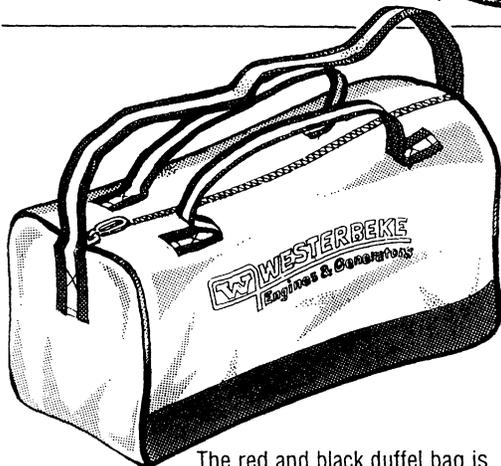
DRIVE BELTS



HARDWARE KIT



THERMOSTATS AND GASKETS



The red and black duffel bag is 18" long with a full zipper, dual handles, and a carrying strap.

SPARE PARTS KITS

WESTERBEKE offers Spare Parts Kits in two versions each packaged in a canvas duffel bag. **Kit A** has the basic spares. **Kit B** is for more complete for offshore cruising.

Kit A

- Impeller
- Heat Exchanger Gasket
- Fuel Filter
- Oil Filter
- Drive Belts
- Zincs
- Thermostat

Kit B

- Impeller
- Heat Exchanger Gasket
- Fuel Filter
- Oil Filter
- Drive Belts
- Zincs
- Thermostat
- Complete Gasket Kit
- Injector
- Air Filter (separate)
- Transmission Filter



