



OPERATORS MANUAL

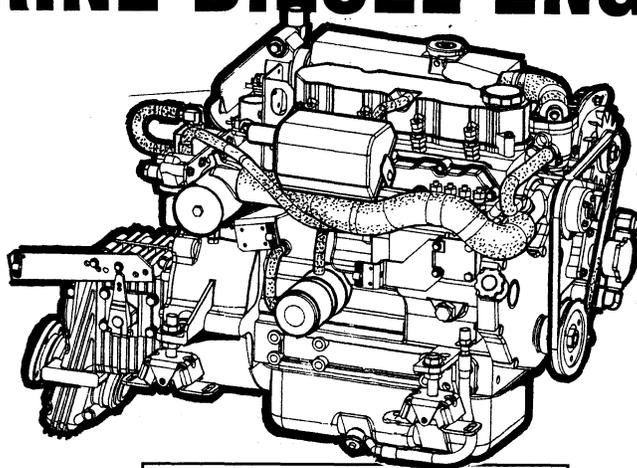
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MARINE DIESEL ENGINES



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 WESTERBEKE

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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. 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.

PREVENT BURNS — HOT ENGINE

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

- Monitor engine antifreeze coolant level at the plastic coolant recovery tank and periodically at the filler cap location on the water jacketed exhaust manifold, but only when the engine is COLD.

⚠ 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 fuel injector, 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 lines or fuel filters.
- 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 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 the cabin after fueling. Check below for fumes/vapor before running the blower. Run the engine compartment blower prior to starting, follow the recommendation of the vessel builder.
- 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 while it 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

- To prevent accidental starting when servicing the generator, turn OFF the DC breaker or remove the fuse from the generators control panel.
- To prevent accidental starting of the generator, when servicing, turn the battery selector switch to the OFF position.
- 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 disconnecting the battery.

⚠ WARNING: Accidental starting can cause injury or death!

BATTERY ACID

⚠ WARNING: Sulfuric 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/water-injected elbow is securely attached.
- Be sure the unit and its surroundings are well ventilated. Run blowers when running the generator set or engine.
- Do not run the generator set or engine unless the boat is equipped with a functioning marine carbon monoxide detector that complies with ABYC A-24. 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 Inability to think coherently
 - Dizziness Throbbing in temples
 - Headache Muscular twitching
 - Nausea Weakness and sleepiness

AVOID MOVING PARTS

⚠ WARNING: Rotating parts can cause injury or death!

- Do not service the engine while it is running. If a situation arises in which it is absolutely necessary to make operating adjustments, use extreme care to avoid touching moving parts and hot exhaust system components.

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 belt's tension while the engine 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 an engine without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.

 **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.

ENGINE AND GENERATOR INSTALLATIONS

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

Sections of the ABYC standards of particular interest are:

- H-32 Ventilation for boats using diesel fuel
- H-33 Diesel Fuel Systems
- P-1 Installation of Exhaust Systems for Propulsion and Auxiliary Engines
- P-4 Marine Inboard Engines and Transmissions
- E-11 AC & DC Electrical Systems on Boats
- TA Batteries and Battery Chargers

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

ABYC, NFPA AND USCG PUBLICATIONS FOR INSTALLING MARINE ENGINES AND GENERATORS

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

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

Order From:

ABYC
613 Third Street, Suite 10
Annapolis, MD 21403
(410) 990-4460
www.abycinc.org

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)
"CFR 33 AND CFR46"
Code of Federal Regulations

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

Strict 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.*



AVAILABLE FROM
YOUR WESTERBEKE
DEALER
SIPHON-BREAK WITH STAINLESS
LOOP

EXHAUST SYSTEM

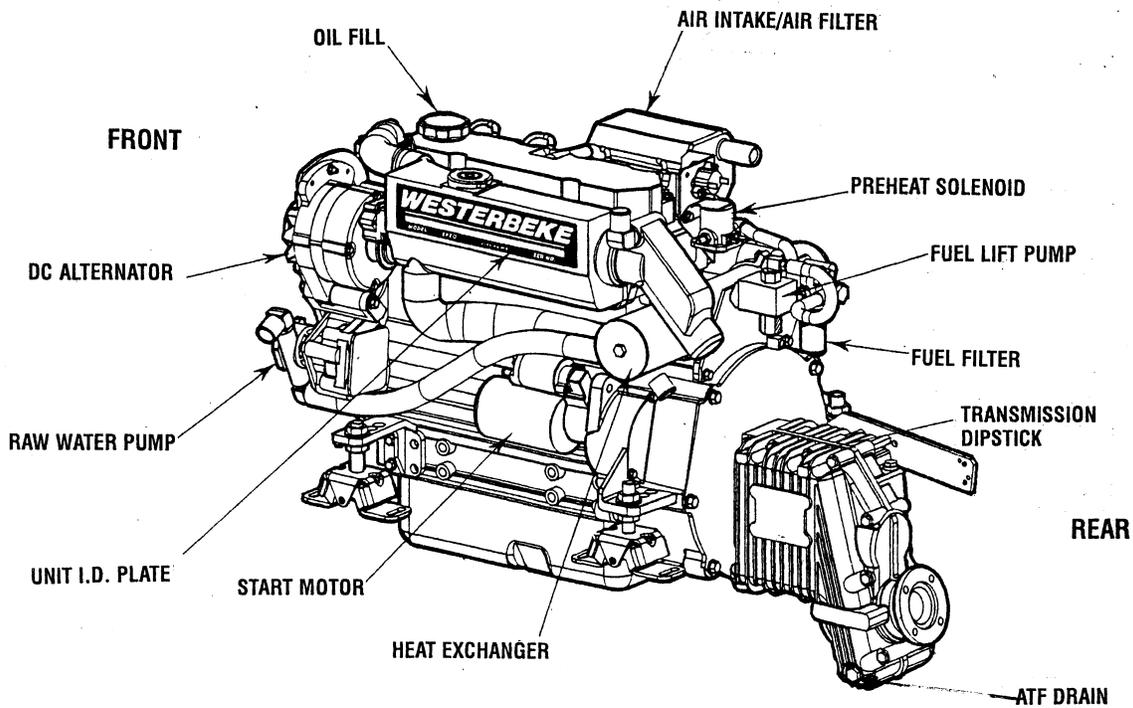
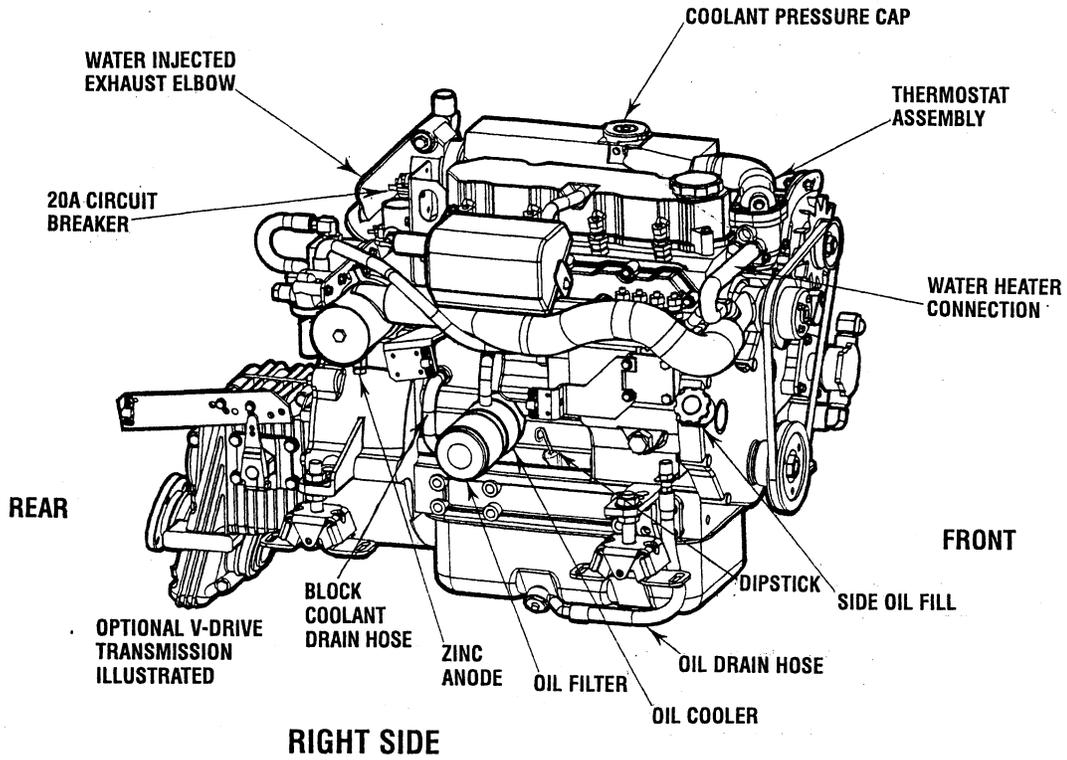
The exhaust system's hose **MUST** be certified for marine use. Corrugated Marine Exhaust Hose is recommended. The use of this type of hose allows for extreme bends and turns without the need of additional fitting and clamps to accomplish these bends and turns. In this regard, a single length of corrugated exhaust hose can be used. The system **MUST** be designed to prevent the entry of water into the exhaust system under any sea conditions and at any angle of vessels heel.

A detailed Marine Installation Manual covering gasoline and diesel, engines and generators, is supplied with each unit. A pdf is available to download from our website at www.westerbeke.com.

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PARTS IDENTIFICATION



INTRODUCTION

This WESTERBEKE Engine is a product 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 engine, 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 Service Manual will also be available from your WESTERBEKE dealer. If you are planning to install this equipment contact yourself, contact your WESTERBEKE dealer for WESTERBEKE'S Installation Manual.

Customer Identification Card

	
Customer Identification	
WESTERBEKE OWNER _____	
MAIN STREET _____	
HOMETOWN, USA _____	
Model _____	Ser. # _____
Expires _____	

WARRANTY PROCEDURES

Your WESTERBEKE Warranty Policy Statement is included in the product documentation package. There is a mail in warranty registration card that you can fill out and mail in to register your warranty or go to our website www.westerbeke.com and register your product's warranty online. You should receive a Customer Warranty Registration Card in the mail within 60 days of registering. If you do not, please contact the factory via help@westerbeke.com advising of this and providing your name, unit model, serial number and date unit was put into service.

PRODUCT SOFTWARE

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

WESTERBEKE customers should also keep in mind the time span between printings of WESTERBEKE product software and the unavoidable existence of earlier WESTERBEKE manuals. In summation, 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.*

PROTECTING YOUR INVESTMENT

Care at the factory during assembly and thorough testing have resulted in a WESTERBEKE engine capable of many thousands of hours of dependable service. However, the manufacturer cannot control how or where the engine is installed in the vessel or the manner in which the unit is operated and serviced in the field. This is up to the buyer/owner-operator.

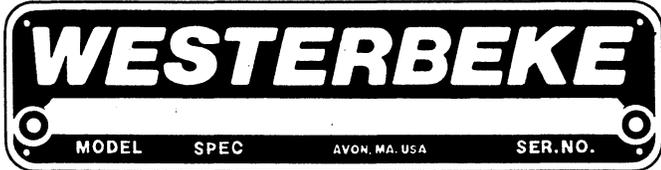
NOTE: *Six important steps to ensure a long engine/generator life.*

- Proper engine installation.
- An efficient, well-designed exhaust system that includes an anti-syphon break to prevent water from entering the engine.
- Changing the engine oil every 250 operating hours.
- Proper maintenance of all engine components according to the maintenance schedule in this manual.
- Use clean, filtered diesel fuel.
- Winterize your engine according to the *LAY-UP AND RECOMMISSIONING* section in this manual.

INTRODUCTION

SERIAL NUMBER LOCATION

The engine's model designation and serial number are located on a nameplate that is mounted on the side of the water jacketed exhaust manifold. The engine's serial number can also be found stamped into the flat block surface located just above the manual shut-off lever. Take the time to enter this information on the illustration of the name plate shown below, as this will provide a quick reference when seeking technical information and/or ordering 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.

CARBON MONOXIDE DETECTOR

WESTERBEKE recommends mounting a carbon monoxide detector in the vessels living quarters. **Carbon monoxide, even in small amounts, is deadly.**

The presence of carbon monoxide indicated an exhaust leak from the engine or generator or from the exhaust elbow/exhaust hose, or the fumes from a nearby vessel are entering your boat.

If carbon monoxide is present, ventilate the area with clean air and correct the problem immediately!

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.

INSTALLATION MANUAL

Publication #43400 provides detailed information for installing generators.

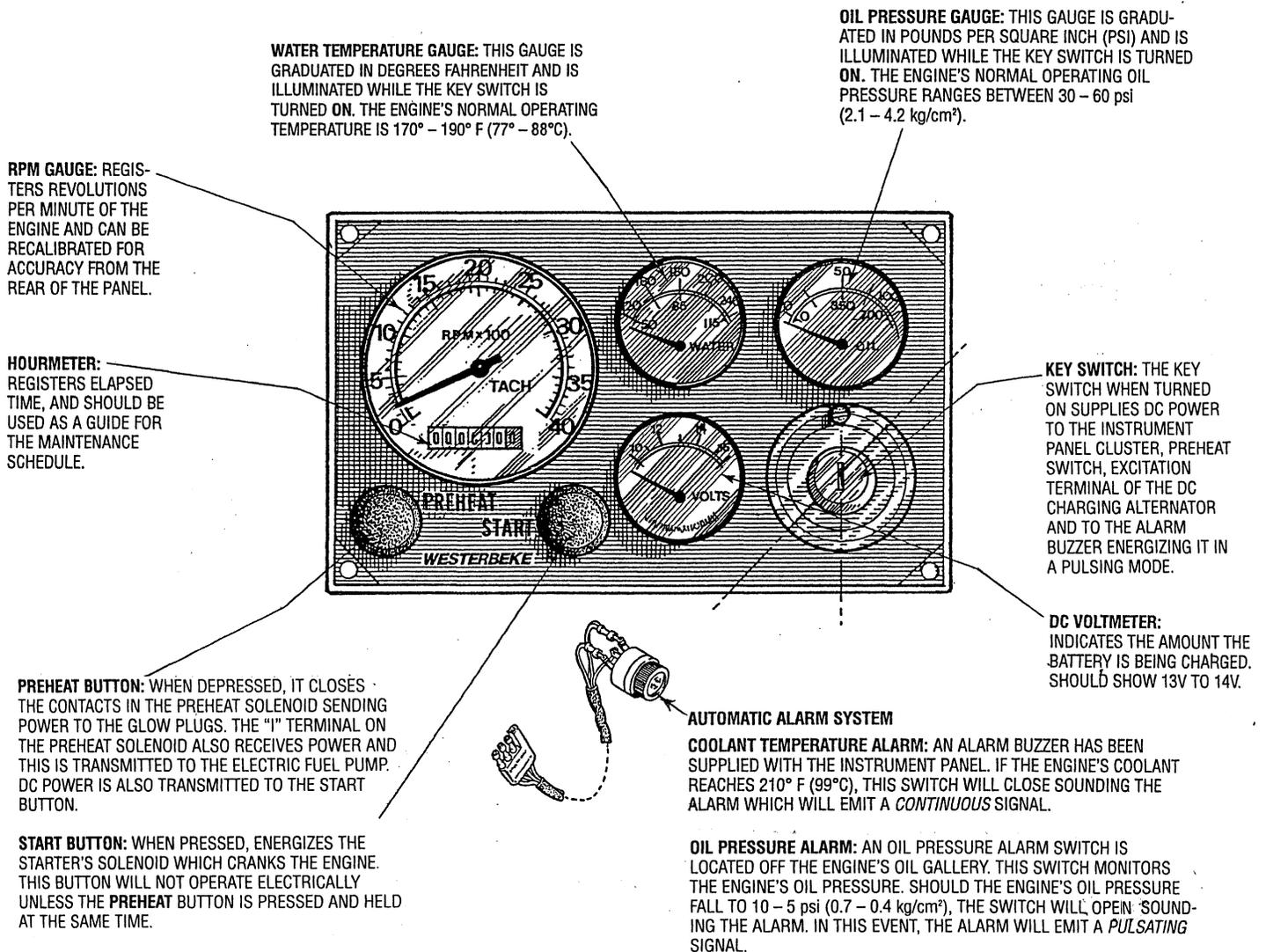
ADMIRAL CONTROL PANEL

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).



CAPTAIN CONTROL PANEL

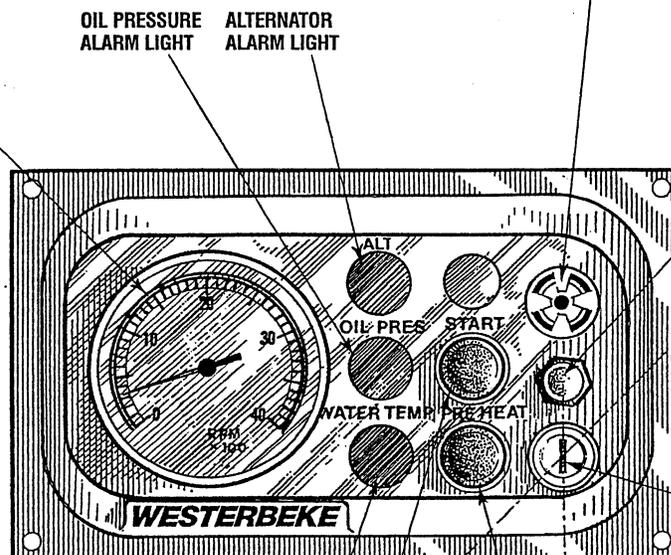
DESCRIPTION

This manually-operated control panel is equipped with a KEY switch, an RPM gauge, PREHEAT and START buttons, an INSTRUMENT TEST button and three indicator lamps, one for ALTERNATOR DISCHARGE, one for low OIL PRESSURE, and one for high ENGINE COOLANT TEMPERATURE.

The panel also includes an alarm buzzer for low OIL PRESSURE or high COOLANT TEMPERATURE. The RPM gauge is illuminated when the KEY switch is turned on and remains illuminated while the engine is in operation.

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

ALARM: THE ALARM WILL SOUND IF THE ENGINE'S OIL PRESSURE FALLS BELOW 10 - 5 psi (0.7 - 0.4 kg/cm²). IN THIS EVENT, THE ALARM WILL EMIT A PULSATING SIGNAL. THE ALARM WILL ALSO SOUND IF THE COOLANT TEMPERATURE IN THE FRESHWATER COOLING CIRCUIT RISES TO 210°F (99°C). IN THIS EVENT, THE ALARM WILL EMIT A CONTINUOUS SIGNAL. **NOTE:** THE ALARM WILL SOUND WHEN THE KEY SWITCH IS TURNED ON. THIS SOUNDING IS NORMAL. ONCE THE ENGINE STARTS AND THE ENGINE'S OIL PRESSURE REACHES 15 psi (1.1 kg/cm²), THE ALARM WILL SILENCE.



OIL PRESSURE ALARM LIGHT ALTERNATOR ALARM LIGHT

TEST BUTTON: WHEN PRESSED, TESTS THE ALTERNATOR, THE OIL PRESSURE, AND THE COOLANT TEMPERATURE CONTROL CIRCUITS. WHEN PRESSED, THE ALTERNATOR, THE OIL PRESSURE, AND THE WATER TEMPERATURE INDICATOR LIGHTS ILLUMINATE IN ADDITION TO SOUNDING THE ALARM BUZZER.

KEY SWITCH: THE KEY SWITCH WHEN TURNED ON SUPPLIES DC POWER TO THE INSTRUMENT PANEL CLUSTER, PREHEAT SWITCH, EXCITATION TERMINAL OF THE DC CHARGING ALTERNATOR AND TO THE ALARM BUZZER ENERGIZING IT IN A PULSING MODE.

WATER TEMPERATURE ALARM LIGHT

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.

PREHEAT BUTTON: WHEN DEPRESSED, IT CLOSES THE CONTACTS IN THE PREHEAT SOLENOID SENDING POWER TO THE GLOW PLUGS. THE "I" TERMINAL ON THE PREHEAT SOLENOID ALSO RECEIVES POWER AND THIS IS TRANSMITTED TO THE ELECTRIC FUEL PUMP. DC POWER IS ALSO TRANSMITTED TO THE START BUTTON.

DIESEL FUEL, ENGINE OIL AND ENGINE COOLANT

DIESEL FUEL

USE A DIESEL FUEL WITH A CETANE RATING OF #45 OR HIGHER.
(No. 2-D (SAE J313) diesel fuel according to ASTM D975).

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 500 MA or 230 RMAM are good examples of such filters. **10 MICRON FILTER ELEMENT RECOMMENDED**

ENGINE OIL

Use a heavy duty engine oil with an API classification of CF, CG-4, CH-4 or CI-4. Change the engine oil and filter after an initial 50 hours of break-in operation. Then follow the oil and filter change intervals as specified in the **MAINTENANCE SCHEDULE** in this manual. Westerbeke Corporation does not approve or disapprove of the use of synthetic oils. If synthetic oils are used, engine break-in must be performed using conventional oil. Oil change intervals must be as in the **MAINTENANCE SCHEDULE**, not extended because synthetic oils are used.

SAE OIL VISCOSITY GRADES

For all temperatures use SAE 10W-40 or 15W-40.

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 35 and 65 psi (2.5 and 3.9 kg/cm²).

NOTE: A newly started, cold engine can have an oil pressure reading upwards of 60 psi (4.2 kg/cm²). A warmed engine can have an oil pressure reading as low as 25 psi (1.8 kg/cm²). These readings will vary depending upon the temperature of the engine, the load placed on the engine, and the RPM's.

TRANSMISSION FLUID

Refer to the **TRANSMISSION SECTION** of this manual for type of fluid and quantity for each transmission model.

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.

PURCHASING ANTIFREEZE

Select a brand of antifreeze specified for diesel engines. Antifreeze specified for diesel engines contain a special additive to protect against cavitation erosion of the engine's cylinder walls. Prestone and Zerex are two nationally known brands that offer antifreeze specifically for use in diesel engines. Select the pre-mix variety so that the correct mixture will always be added to the cooling system when needed. Change the antifreeze mixture according to the **MAINTENANCE SCHEDULE** in this manual.

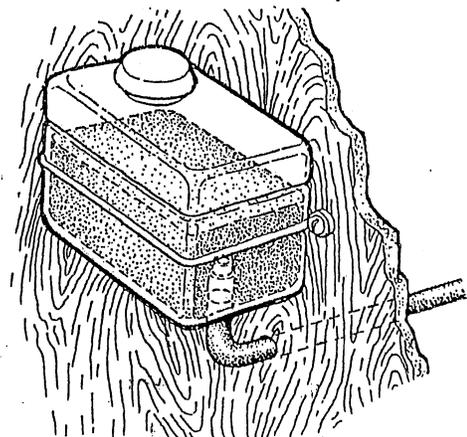
MAINTENANCE

Change the engine coolant every five years regardless of the number of operating hours as the chemical additives that protect and lubricate the engine have a limited life.

COOLANT RECOVERY TANK

A coolant recovery tank kit is supplied with each engine or generator. 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, is best located at or above the level of the engine's manifold, but it can be located below the level of the engine's manifold if the particular installation makes this necessary.



PREPARATIONS FOR INITIAL START-UP

PRESTART INSPECTION

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

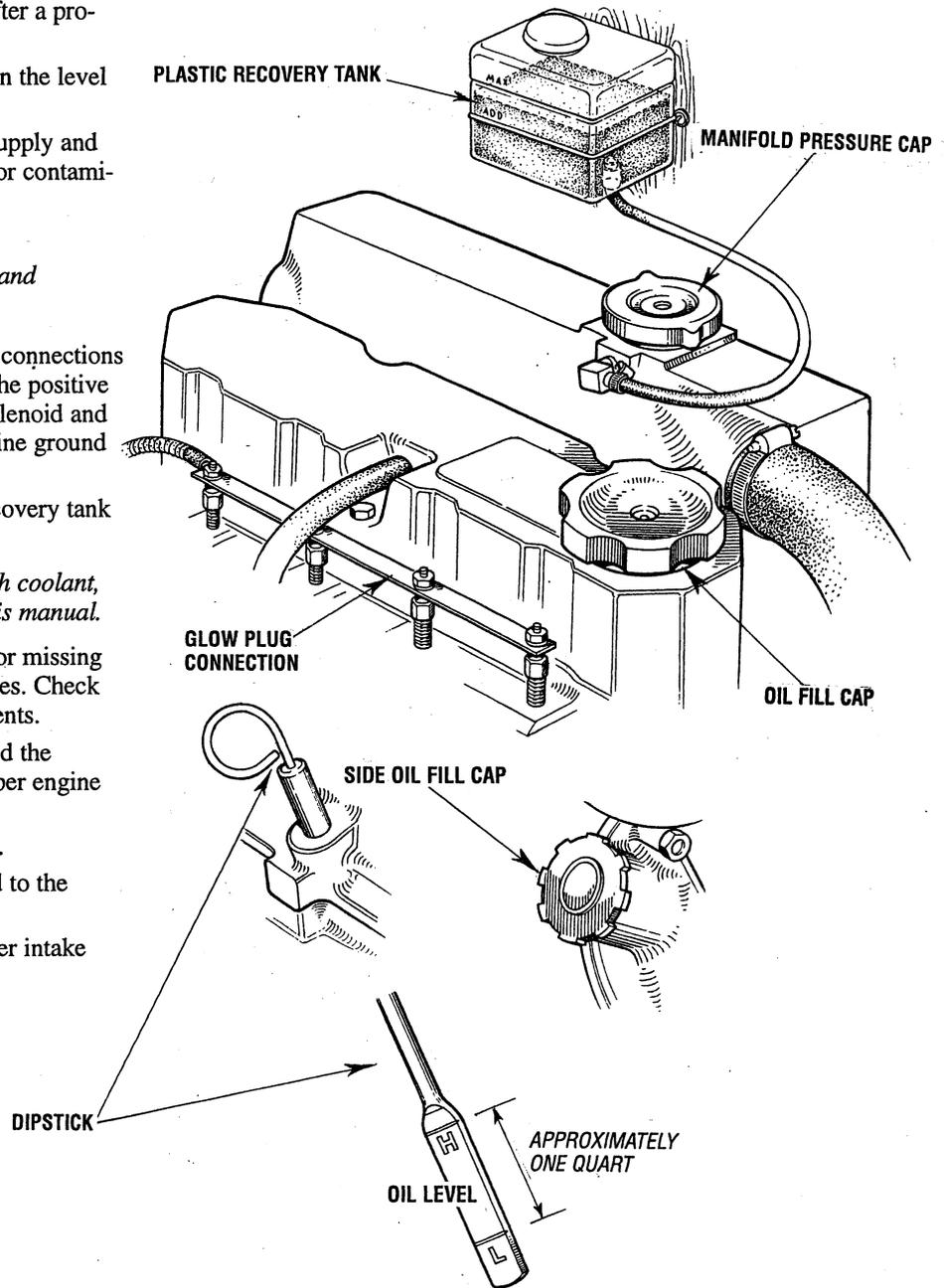
- Check the engine oil level. Add oil to maintain the level at the high mark on the dipstick.
- Turn on the fuel supply, then check the fuel supply and examine the fuel filter/water separator bowl for contaminants.
- Check the transmission fluid level.

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 prime the raw water intake strainer. Inspect the raw water supply.



STARTING/STOPPING PROCEDURE

THE STARTING SYSTEM

The models in this manual have a 12V DC electric starter assisted by a DC air intake heater for both normal and cold weather starting. The air heater heats the engine intake air, providing a rapid start with less wear on the starter.

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 button and hold it. The instrument panel will energize. The alarm buzzer will pulse and the electric fuel pump will energize. The Preheat button should be depressed in accordance with the chart below:

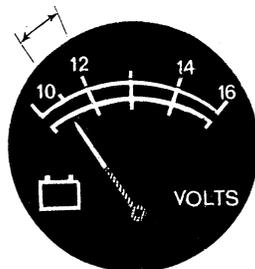
Temperature/Preheat

Atmospheric Temperature	Preheating Time
41°F(5°C) or higher	Approx. 10 seconds
41°F(5°C) to 23°F (-5°C)	Approx. 15 seconds
23°F(-5°C) or lower	Approx. 20 seconds
Limit of continuous use	30 seconds before cranking

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 button, depress the START button. This will engage the starter solenoid. When the engine starts, release the start switch and preheat button. The pulsing alarm will silence once the oil pressure reaches 5-10 psi.

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.

NOTE: Some unstable running may occur in a cold engine. Depressing the PREHEAT button for 10 – 15 second intervals will help stabilize the engine rpm until the engine operating temperature reaches 170 – 190°F (77 – 88°C) and a propeller load is applied to the engine. When the engine is running and the PREHEAT button is depressed, a charging load on the DC alternator will be discernible.

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, CH-4 or CI-4, SAE 15W-40 or 10W-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. If your engine is equipped with an optional fuel shut off solenoid, turn off the key switch at the control panel.

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.

WARNING LIGHTS, ALARMS & CIRCUIT BREAKER

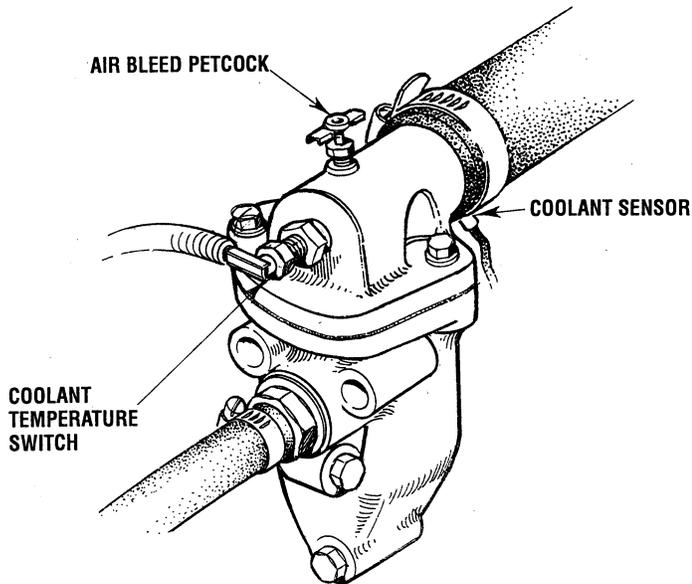
ALTERNATOR WARNINGS

The Captain Control Panel indicates alternator low discharge with a red warning light.

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).



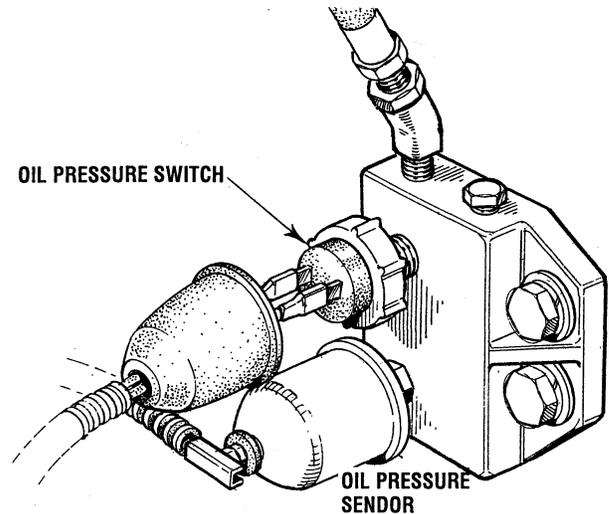
SENDORS

The coolant temperature and oil pressure sendors are not installed in the engines as standard equipment. Both sendors are, however, included in the Admiral Instrument Panel Kit.

These sendors (with connecting gauges) can be added as accessories to either engine at any time and are easily installed to the prewired engine.

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 10 – 5 psi (0.7 – 0.4 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 OPERATION

CHECK LIST

Follow this check list each day before starting your engine.

- Record the hourmeter reading in your log (engine hours relate to the maintenance schedule.)
- Visually inspect the engine for fuel, oil, or water leaks.
- Check the oil level (dipstick).
- Check the coolant level in the coolant recovery tank. Periodically check the manifold coolant level.
- Check the transmission fluid level.
- Check your diesel fuel supply.
- Look for clean fuel in the fuel filter/water separator transparent bowl.
- Check for loose wires at the alternator and make sure its mounting is secure.
- Check the starting batteries (weekly).
- Check drive belts for wear and proper tension (weekly).
- Check the raw water pump to make sure its mounting is secure.

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 (10 to 15 seconds).
4. While pressing PREHEAT, push START. As the engine fires, release START.
5. Hold PREHEAT until the oil pressure reaches 15 psi and/or the alarm shuts off.

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.*

6. Allow a few minutes for the engine to warm at a comfortable rpm (approximately 1000 rpm), then reduce the rpm, and get underway.

MAINTENANCE SCHEDULE

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. When servicing/replacing DC components, ensure the key switch in the instrument panel is in the OFF position or turn OFF the DC starting battery.

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

INSPECTION AND PREPARATION FOR INITIAL START-UP (Also refer to the PREPARATIONS for START-UP in the manual).

Coolant Level	Check at recovery tank, if empty, check at manifold. Add coolant if needed.
Engine Oil Level	Oil level should indicate between MAX and LOW on dipstick. Do not overfill!
Fuel Filter/Water Separator (owner installed)	The fuel in the filter should be clean and the valves open. Replace filter every 250 operating hours or once a year.
Fuel Supply	Fuel tank must have the proper amount of clean diesel fuel and the fuel valve must be open.
*Visual Inspection of Engine	Check for fuel, oil and water and exhaust leaks. Check that the water injected exhaust elbow securing v-clamp is tight. No exhaust leaks around the elbow. Inspect wiring and electrical connections. Look for loose bolts/hardware and correct as needed.
Transmission Fluid Level	Fluid level should be at the top mark on the dipstick.
Drive Belts	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed.

AFTER THE FIRST 50 HOURS OF OPERATION

*Inlet Fuel Filter	Initial change, then every 250 hours or once a year.
*Fuel Filter and "O" Rings	Initial change, then every 250 hours or once a year.
Engine Oil and Filter	Initial engine oil and filter change at 50 hours, then change both every 250 hours.
*Exhaust System	Initial check at 50 hours, then every 250 hours or once a year. Carefully inspect for leaks. Check that the exhaust hoses are properly attached and that the securing clamps are tight. Check the integrity/mounting security of the water injected exhaust elbow.
Engine Idle Speed	Adjust as needed. (Ref. page #32).
Transmission Fluid	Initial change, then at 300 hours or once a season.
Heat Exchanger	Open end caps and clean out debris. Change zinc anode if necessary. Determine zinc service interval for your area.

EVERY 50 OPERATING HOURS OR MONTHLY

*Drive Belts (Fresh Water/Raw Water Pumps as applicable)	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt for slipping, cracking and wear. Adjust tension or replace as needed. Replace cover.
Starting Batteries	Check electrolyte levels Make sure cables and connections are in good order. Clean off corrosion if needed. Apply petroleum jelly to terminals for corrosion protection.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.

EVERY 100 OPERATING HOURS OR YEARLY

Air Intake Filter	Remove and clean filter, replace if contaminated.
Heat Exchanger	Inspect and clean zinc anode. Note the condition, then determine your own schedule. If zinc anode needs replacing, you should remove the end cap and clean out the debris. Replace zinc if necessary.
Panel Key Switch	Lubricate with "lockeze".
*Drive Belts (Fresh Water/Raw Water Pumps as applicable)	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt for slipping, cracking and wear. Adjust tension or replace as needed. Replace cover.
Starting Batteries	Check electrolyte levels Make sure cables and connections are in good order. Clean off corrosion if needed. Apply petroleum jelly to terminals for corrosion protection.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.
Throttle and Transmission Cables	Check security of cables to brackets. Lubricate cables.

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

MAINTENANCE SCHEDULE

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

EVERY 250 OPERATING HOURS OR YEARLY

Transmission	Change Change fluid at 300 operating hours. Lubricate control cable and check attachment.
Engine Oil	Change the engine oil and oil filter (always together)
Fuel Filter and O-Rings	Remove and replace fuel filter and all sealing O-rings.
Inlet Fuel Filter	Remove and replace inlet fuel filter.
Air Intake Filter	Remove and clean, replace if contaminated.
DC Alternator	Check mounting bracket, tighten electrical connections.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
*Vibration Isolators/Engine Mounts	Check vibration isolators, brackets and mounting hardware. Replace as needed.
Heat Exchanger	Inspect zinc anode replace if necessary.
*Exhaust Elbow/Exhaust System	Check the structural integrity of the water injected exhaust elbow casting. Check the integrity of the exhaust system attached to the elbow. All hose connections should be secure. No chaffing. No exhaust leaks. Hoses and muffler are in good serviceable condition. NOTE: An exhaust leak will cause exposure to diesel exhaust!

EVERY 500 OPERATING HOURS OR FIVE YEARS

*Fuel Injectors	Check and adjust injection opening pressure and spray conditions.
Coolant System	Drain, flush and re-fill the cooling system with appropriate antifreeze mix. Replace the thermostat and cooling pressure cap.
*Valve Clearances	Adjust valves. (Incorrect valve clearance will result in poor engine performance)
*Starter Motor	Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.
*Preheat Circuit	Check operation of the pre-heat. Remove and clean the glow plugs. Re-install with anti-seize compounds on threads.
*Engine/Shaft Alignment	Check security of the shaft coupling and check shaft alignment.

EVERY 1000 OPERATING HOURS OR OR EVERY FIVE YEARS

*Heat Exchanger	Remove the heat exchanger for professional cleaning and pressure testing. Change the antifreeze and flush the system.
*Adjusting the Valve Clearances	Adjust the valves.
*Positive Crankcase Ventilation Valve	Disassemble and clean.
*Fuel Injectors	Pressure test injectors/re-build at 1500 hours.
*Transmission Oil Cooler	Remove, inspect casting, clean and replace as needed.
*Transmission Damper Plate	Inspect the damper plate, replace if necessary (damper plate chatter at idle speed is an indication of damper spring wear).

WARNING: Never attempt to perform any service while the unit is operating. Wear the proper safety equipment such as goggles and gloves, and use the correct tools for each type of maintenance performed. Shut OFF the control panel's DC breaker when servicing any of the engines DC electrical components.

NOTE: Keep the engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.

*WESTERBEKE recommends this service be performed by an knowledgeable 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.

CHANGING COOLANT

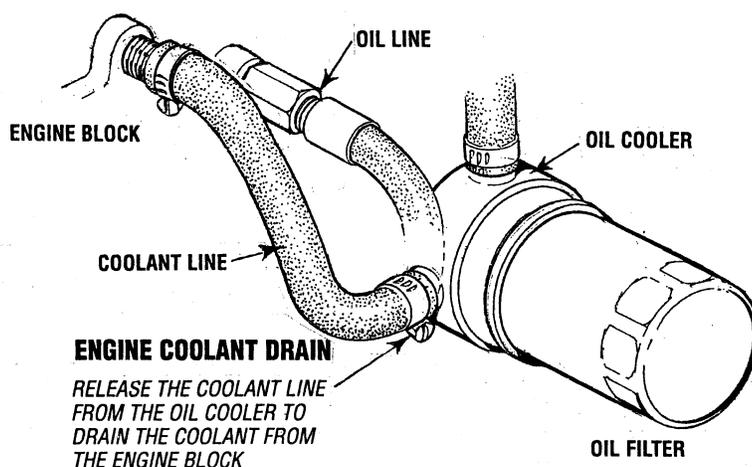
The engine's coolant must be changed according to the *MAINTENANCE SCHEDULE*. If the coolant is allowed to become contaminated, it can lead to overheating problems.

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

To drain out the old engine coolant, loosen the manifold pressure cap and unfasten the drain hose as shown below.

NOTE: *The drain petcock on the heat exchanger should also be used to help drain engine coolant.*

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



COOLING SYSTEM

Refilling the Coolant

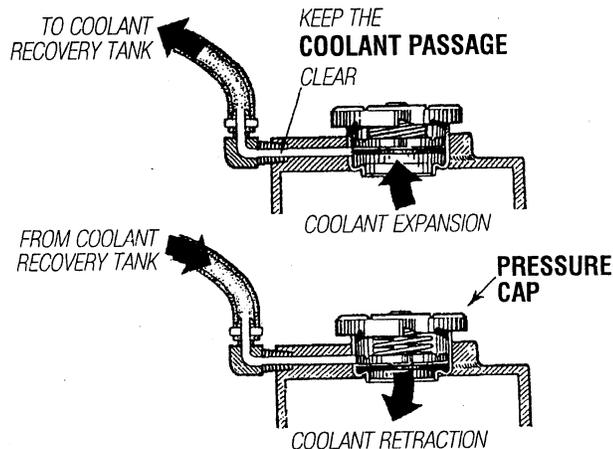
After replacing the engine block drain plug, close the heat exchanger's coolant petcock. Then pour clean, premixed coolant into the manifold and when the coolant is visible in the manifold, start the engine and run it at slow idle.

NOTE: *Open the air-bleed petcock on the heat exchanger. When a steady flow of coolant appears at the petcock, close the petcock and fill the system until the manifold remains full.*

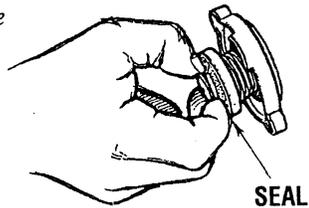
Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and install the manifold pressure cap.

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.

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.



NOTE: *Periodically check the condition of the manifold pressure cap. Ensure the upper and lower rubber seals are in good condition. Check to ensure the vacuum valve opens and closes tightly. Carry a spare cap. Check also to ensure the coolant passage is clear so coolant within the system is able to expand and contract to and from the coolant recovery tank.*



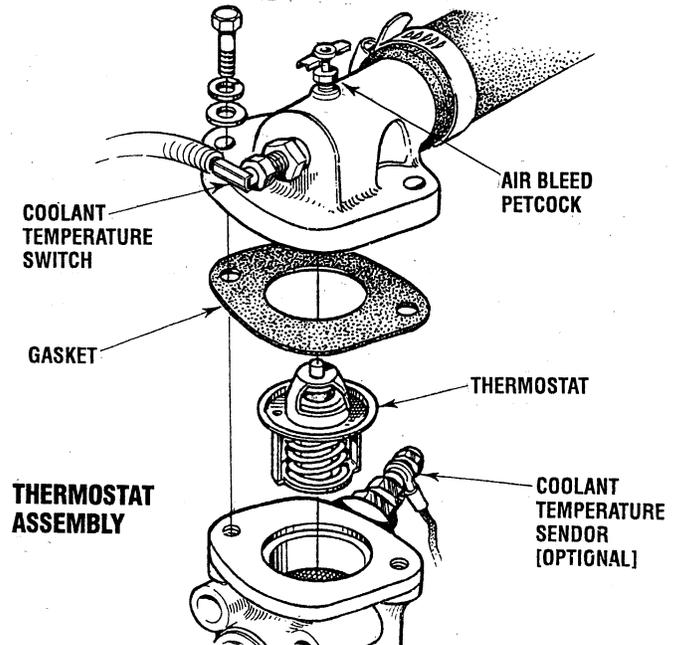
THERMOSTAT

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.



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

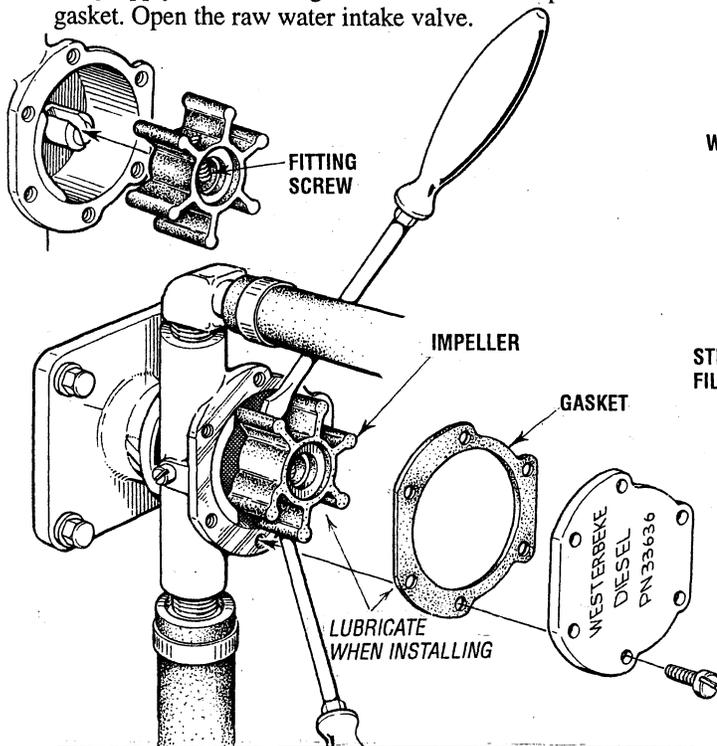
The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. On no account should this pump be run dry as water acts as a lubricant 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.*

COOLING SYSTEM

Changing the Raw Water Pump Impeller

Close the raw water intake valve. Remove the pump cover and, with the aid of two small screwdrivers, 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.



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.

Raw Water Intake Strainer

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

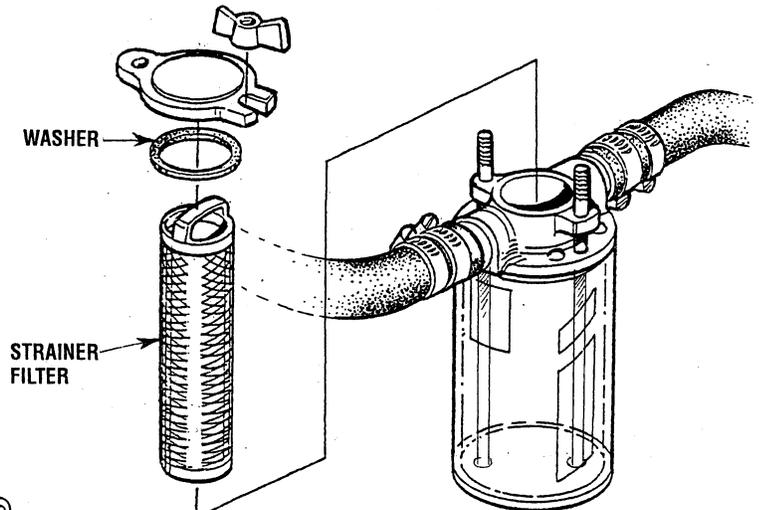
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

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.

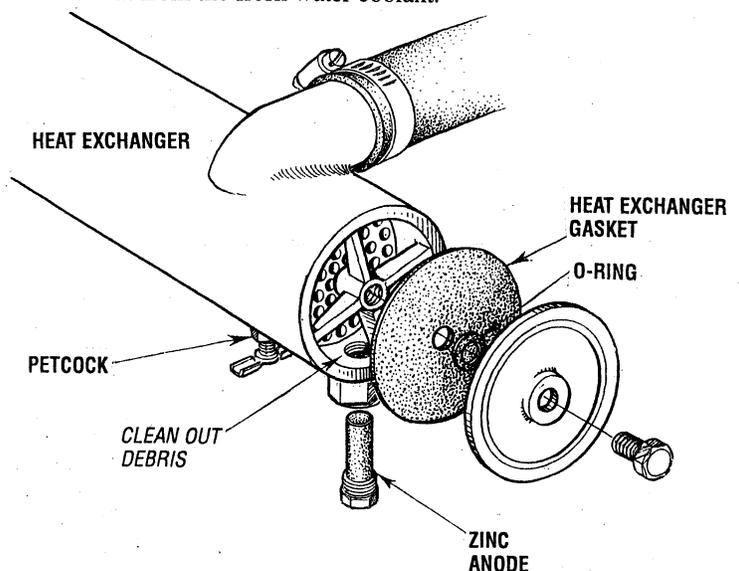
If the engine temperature gauge ever shows a higher than normal reading, the cause may be that silt, leaves or grass may have been caught up in the strainer, slowing the flow of raw water through the cooling system.



TYPICAL RAW WATER INTAKE STRAINER
Owner Installed

HEAT EXCHANGER

The heat exchanger is a copper cylinder which encloses a 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.



COOLING SYSTEM

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.



NEW



REPLACE



CLEAN & REUSE

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.

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.

AIR INTAKE / SILENCER

DESCRIPTION

A marine diesel engine running at high speed will typically consume more than 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.

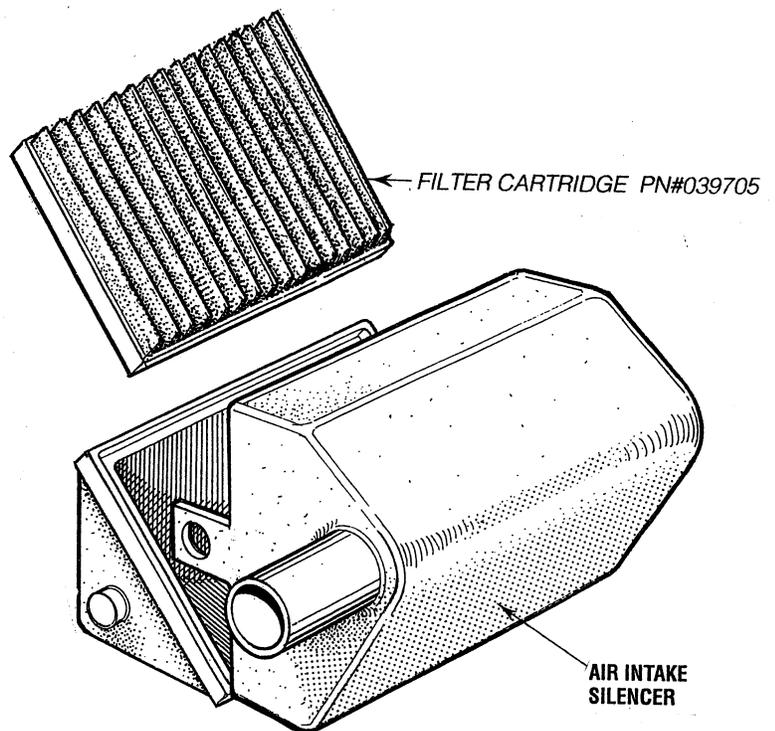
AIR FILTER

The air filter cartridge prevents engine room dust and dirt from entering the engine, it also extends engine life, and quiets the engine.

MAINTENANCE

The filter should be cleaned every 100 operating hours. Tap the cartridge on a flat surface to dislodge loose dirt or clean off with compressed air. If the cartridge is badly contaminated or oily, replace it.

NOTE: Regular air filter cartridge maintenance is essential to support proper engine operation. Failure to maintain the filter cartridge will result in air obstruction into the engine, causing poor fuel combustion, loss of power and resulting in smokey/sooty exhaust discharge along with lube oil consumption and possible filter deterioration which could result in the filter being ingested into the engine causing internal engine damage.



FUEL SYSTEM

DIESEL FUEL

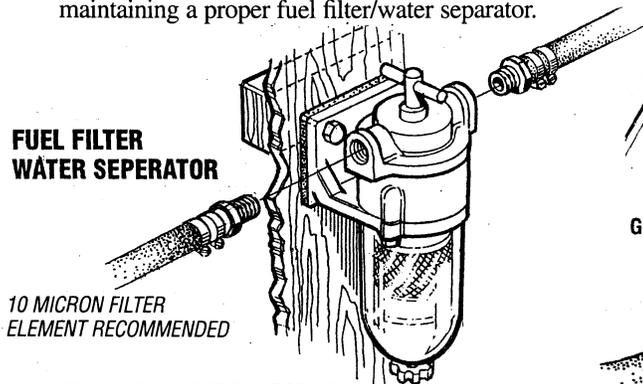
Use No. 2-D (SAE J313) diesel fuel with a Cetane rating of #45 or higher. Grade of diesel fuel according to ASTM D975.

FUEL FILTER/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 fuel 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 500 MA*. 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 fuel filter/water separator.



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 (see *IDLE SPEED ADJUSTMENT* under *ENGINE ADJUSTMENTS*).

FUEL LIFT PUMP

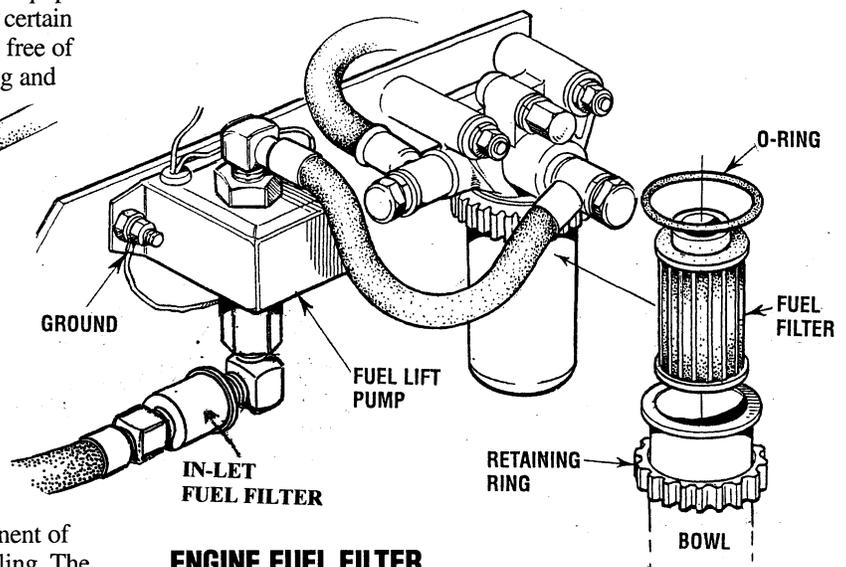
Periodically check the fuel connections to and out of the pump and make sure that no leakage is present and that the fittings are tight and secure. The DC ground connection at one of the pump's mounting bolts should be clean and well secured by the mounting bolt to ensure proper pump operations.

When energized thru the preheat circuit, the fuel lift pump will purge air from the fuel system and provide a continuous flow of fuel as the engine is running.

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 filter/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.



ENGINE FUEL FILTER

Periodically check the fuel connections and the bowl for leakage. Replace the filter element after the first 50 hours then follow the *MAINTENANCE SCHEDULE*.

Changing/cleaning the filter element

1. Shut off the fuel supply.
2. Unscrew the retainer ring that holds the filter bowl to the housing and allow the bowl to come away from the housing,
3. Remove and replace the filter element and clean the bowl.
4. Replace the sealing "O" ring and reassemble the bowl to the housing. Thread the retainer ring on carefully so as not to cross thread. When retainer contacts the "O" ring, tighten 1/4 - 1/2 turns by hand. Open the fuel supply and run the engine to inspect for leaks.

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

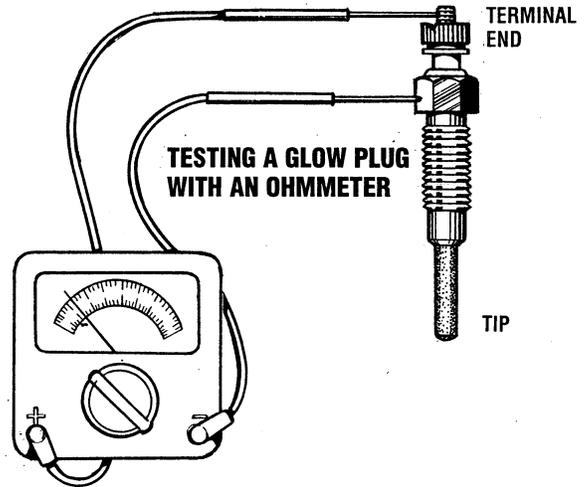
An accurate way to test glow plugs is with an ohmmeter. Touch one prod to the glow plug's wire connection, and the other to the body of the glow plug, as shown. A good glow plug will have a 0.4 - 0.6 ohm resistance. This method can be used with the plug in or out of the engine. You can also use an ammeter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

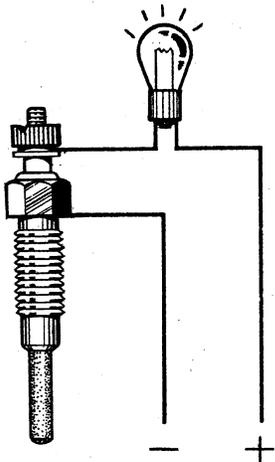
Re-install the plugs in the engine and test them again. The plugs should get very hot (at the terminal end) within 7 to 15 seconds. If the plugs don't heat up quickly, check for a short circuit. When reinstalling the glow plugs, use anti-seize compound on the threads.

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

Glow Plug Tightening Torque 7 - 11 ft-lb (1.0 - 1.5 m-kg)



TESTING A GLOW PLUG USING A TEST LIGHT



FUEL INJECTORS

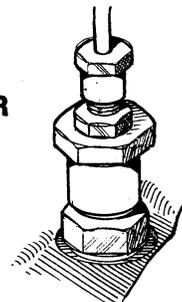
In case of severe vibrations and detonation noise, have the injectors checked and overhauled by an authorized fuel injection service center. Poor fuel quality, contaminants and loss of positive fuel pressure to the injection pump can result in injector faults. Since fuel injectors must be serviced in 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.

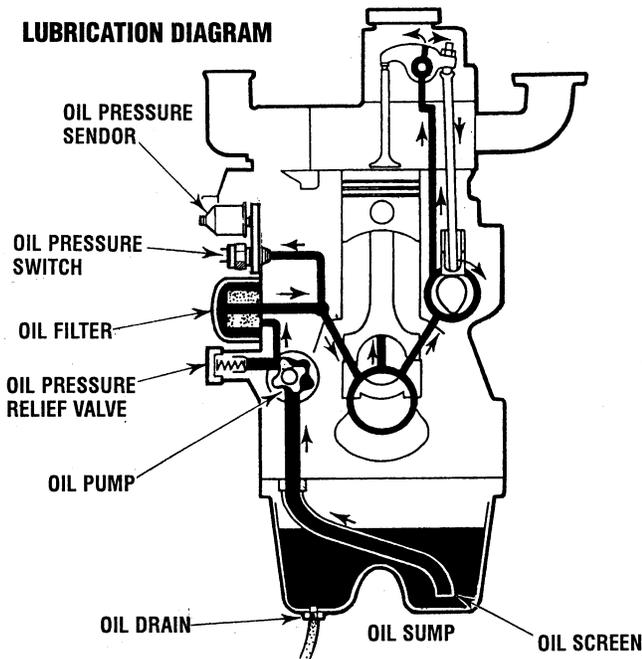
Injector to Cylinder Head Tightening Torque 40 ± 4 ft-lb (5.5 ± 0.5 kgf-m)

FUEL INJECTOR



ENGINE LUBRICATING OIL

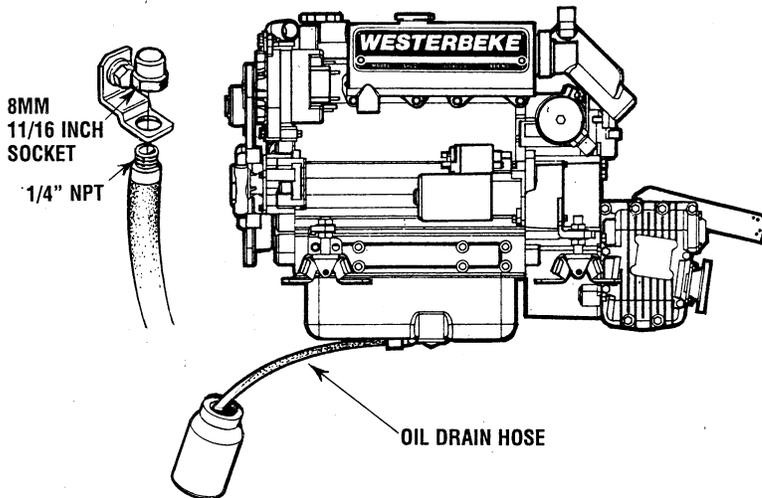
LUBRICATION DIAGRAM



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.

NOTE: Thread size for the lube oil drain hose capped end is 1/4 NPT.

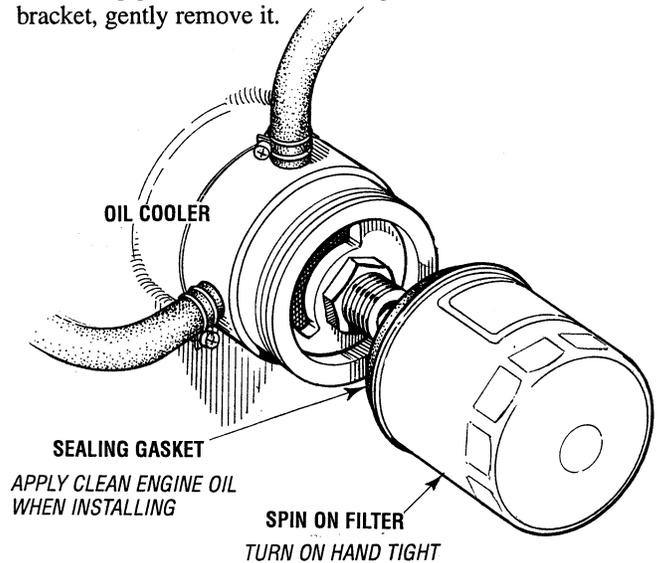


Always observe the used oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a qualified mechanic should water be present in the oil. Raw water present in the oil can 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. **Replacing the Oil Filter.** When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. A small automotive filter wrench should be helpful in removing the old oil filter.

NOTE: Do not punch this hole without first loosening the filter to make certain it can be removed.

Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil left in the filter. (Oil or any other fluid on the engine reduces the engine's cooling ability. Keep your engine clean.) Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket comes off with the old oil filter. If this rubber sealing gasket remains sealed against the filter bracket, gently remove it.



When installing the new oil filter element, wipe the filter gasket's sealing surface on the bracket free of oil and apply a thin coat of clean engine oil to the rubber gasket 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.

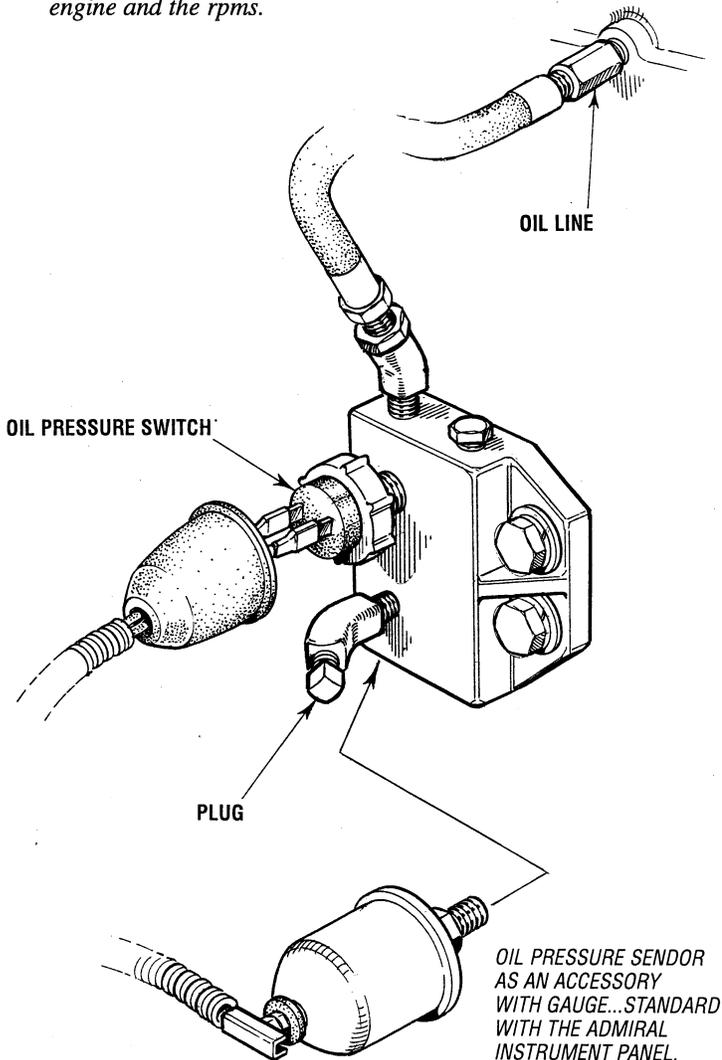
3. **Filling the Oil Sump.** Add new oil through the oil filler cap on the top of the engine or through the side oil fill. After refilling, run the engine for a few moments while checking the oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and stop 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.

OIL PRESSURE

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 60 psi (2.8 and 4.2 kg/cm²).

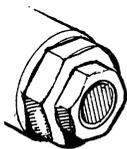
NOTE: A newly started, cold engine can have an oil pressure reading up to 60 psi (4.2 kg/cm²). A warmed engine can have an oil pressure reading as low as 35 psi (2.5 kg/cm²). These readings will vary depending upon the temperature of the engine and the rpms.



OIL PRESSURE RELIEF VALVE

An oil pressure relief valve is located on the engine block just below the injection pump. This valve opens at approximately 50 psi [343 kpa] and maintains that pressure.

LOCATED JUST UNDER THE FUEL INJECTION PUMP ON THE ENGINE BLOCK.



TESTING OIL PRESSURE

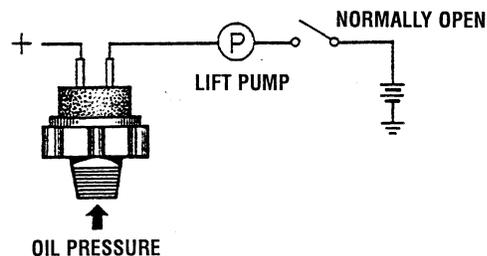
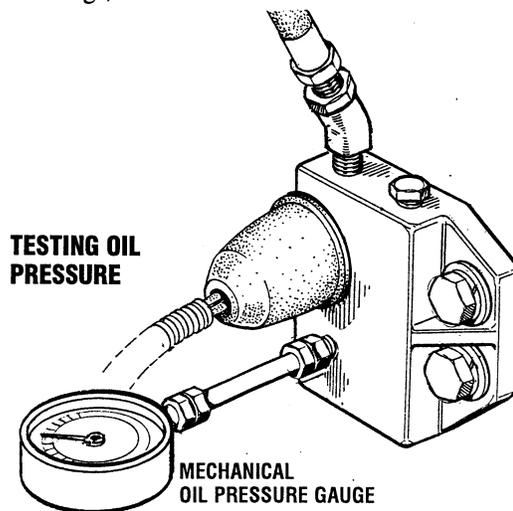
The lubricating system is a pressure feeding system using an oil pump. The engine oil is drawn from the oil sump by the oil pump, which drives the oil, under pressure, through the oil filter, oil cooler and various lubricating points in the engine. The oil then returns to the oil sump to repeat the continuous 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.

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 3000 rpm and read the oil pressure gauge.

Oil Pressure 35.0 lb/in² (3.8 kg/cm²) or more at 3000 rpm.
Sender and Switch Torque 9 - 13 ft-lb (1.2 - 1.8 m - kg).

LOW OIL PRESSURE

The specified safe minimum oil pressure is 4.3 + 1.4 psi (0.3 + 0.1 kg/cm²). A gradual loss of oil pressure usually indicates a worn bearings. For additional information on low oil pressure readings, see the *ENGINE TROUBLESHOOTING* chart.



REMOTE OIL FILTER (OPTIONAL)

PN# 040078

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.

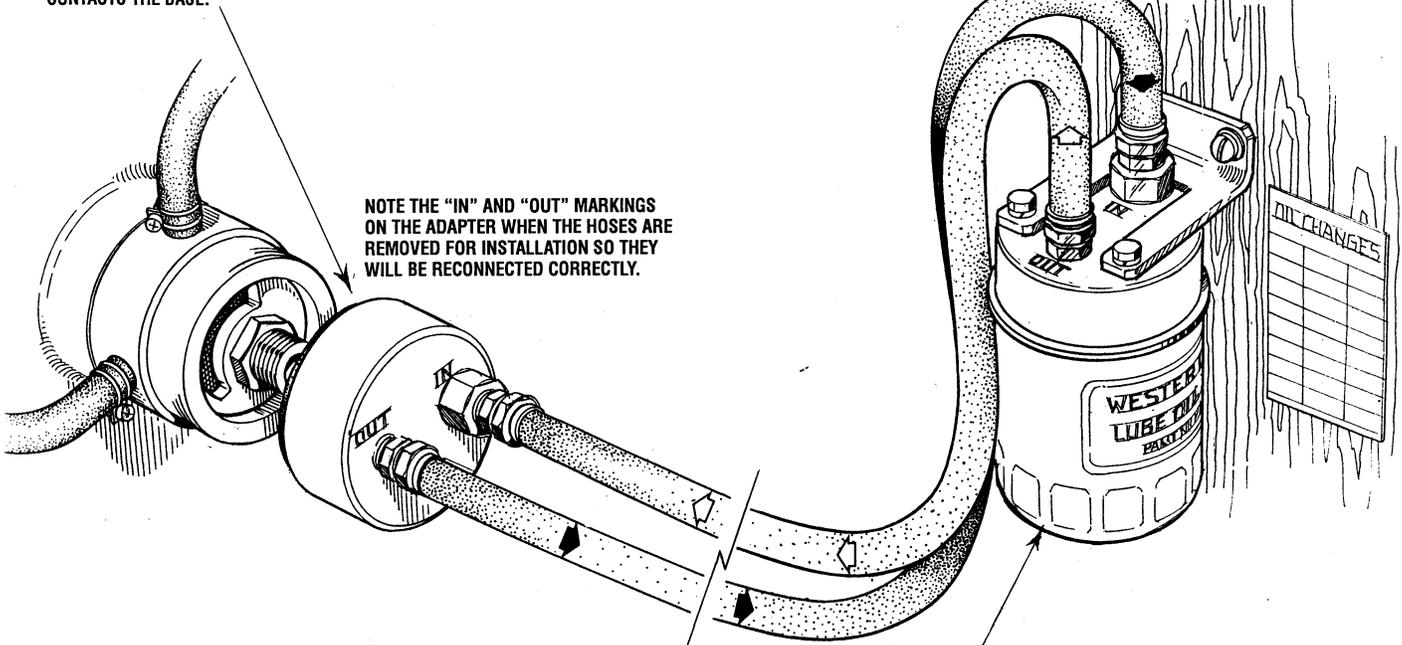
To install, simply remove the engine oil filter and thread on WESTERBEKE's remote oil filter kit as shown. Always install this kit with the oil filter facing down as illustrated.

Contact your WESTERBEKE dealer for more information.

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

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.

FASTEN SECURELY TO A BULKHEAD
(SCREWS ARE OWNER SUPPLIED)



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

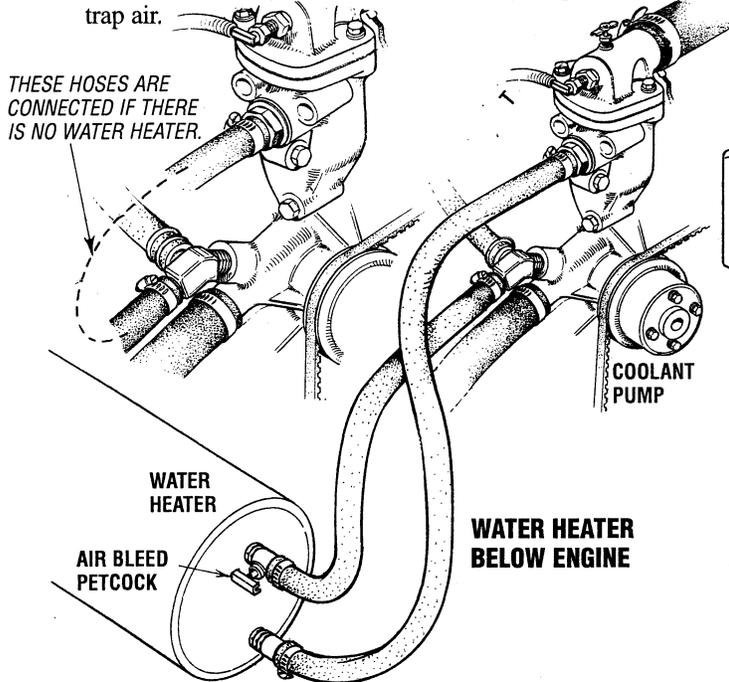
APPLY A THIN COAT OF CLEAN OIL TO THE FILTER GASKET WHEN INSTALLING. AFTER THE FILTER CONTACTS THE BASE, TIGHTEN IT AN ADDITIONAL 3/4 TURN.

CAUTION: It is vital to install the oil lines correctly. If the oil flows in the reverse direction, the bypass 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.

WATER HEATER

WATER HEATER INSTALLATIONS

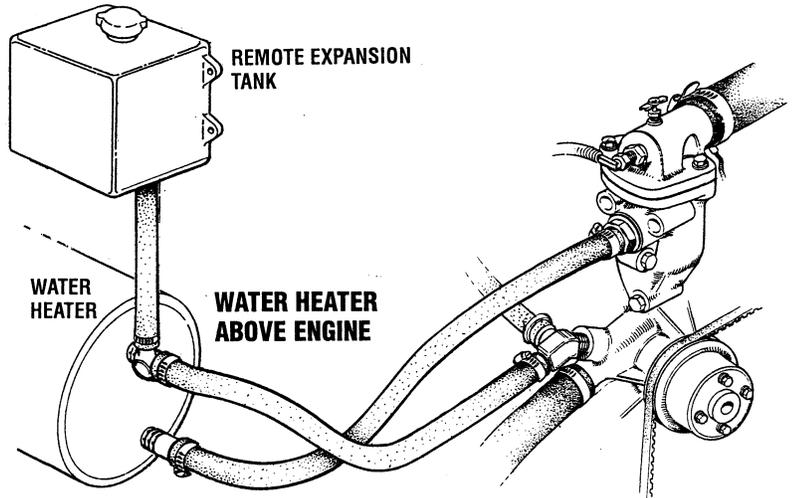
This engine is equipped with connections for the plumbing of engine coolant to transfer heat to an on-board water heater. The water heater should be mounted in a convenient location either in a high or low position in relation to the engine, so that the connecting hoses from the heater to the engine 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 own 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 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. Remove and store the plastic recovery tank if it has been already installed.

The pressure cap on the engine's manifold should be installed after the engine's cooling system is filled with coolant. Finish filling the cooling system from the remote tank after the system is filled and is free of air and exhibits good coolant circulation. During engine operation, checking the engine's coolant should be done at the remote tank and not at the engine manifold cap. The hose connection from the heater to the remote expansion tank should be routed and supported so it rises continuously from the heater to the tank, enabling any air in the system to rise up to the tank and out of the system.

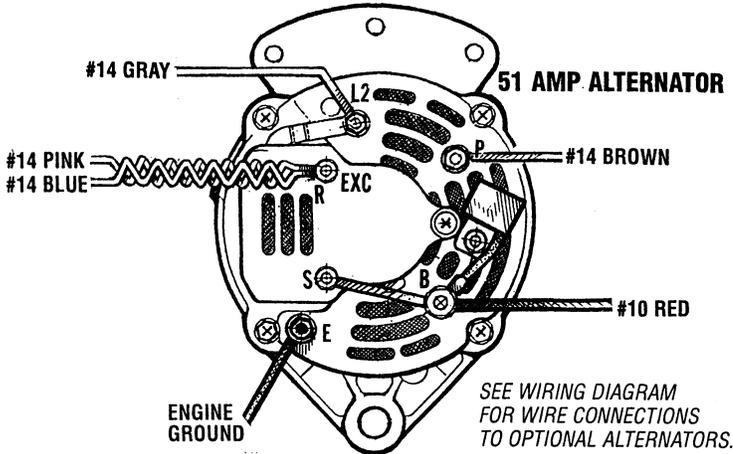


NOTE: An air bleed petcock is located on the engine's heat exchanger. Open this petcock when filling the engine's coolant system to allow air in the exchanger to escape. Close tightly after all the air is removed.

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.

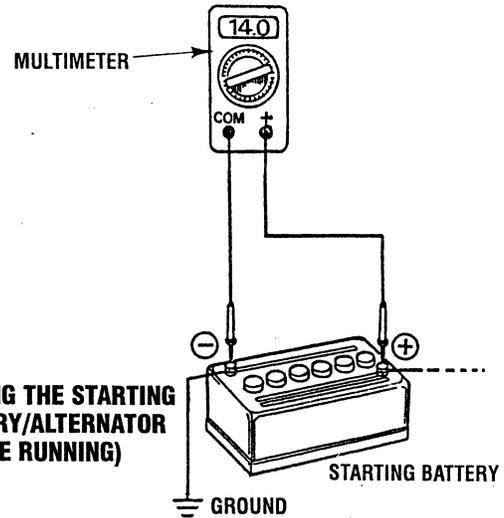
The alternator charging circuit charges the starting battery and the service battery. An isolator with a diode, a solenoid or a battery selector switch is usually mounted in the circuit to isolate the batteries so the starting battery is not discharged along with the service battery. If the alternator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

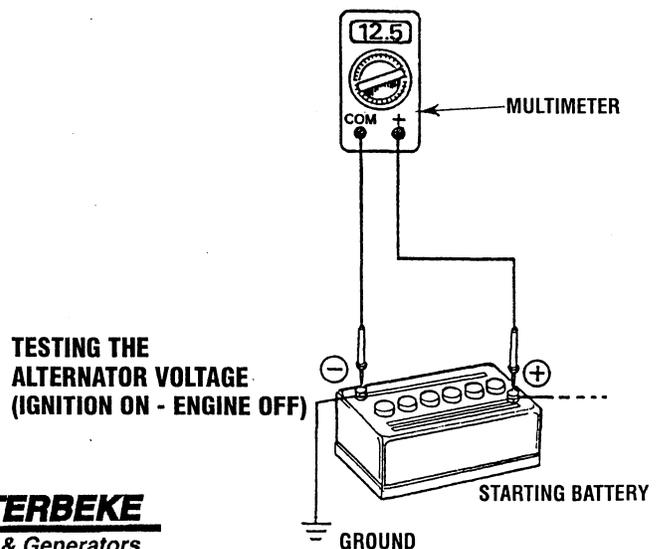


TESTING THE STARTING BATTERY/ALTERNATOR (ENGINE RUNNING)

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!

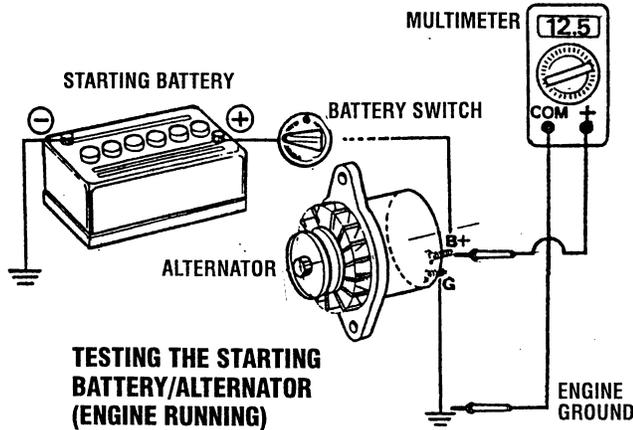
4. If a battery selector switch is in the charging circuit, ensure that it is on the correct setting.
5. Turn on the ignition switch, but do not start the engine.
6. Check the battery voltage. If the battery is in good condition, the reading should be 12 to 13 volts.



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.



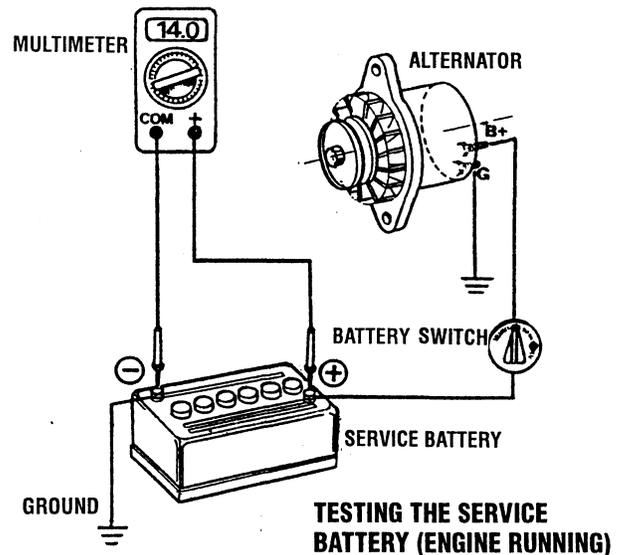
8. Start the engine again. Check the voltage between the alternator output and ground. The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or under-charging, have it repaired at a reliable service facility.

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.

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. 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 HSW 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.
START button is depressed; panel indications OK; starter solenoid OK; fuel pump not functioning.	<ol style="list-style-type: none"> 1. Poor connections to fuel pump. 2. Defective fuel pump. 	<ol style="list-style-type: none"> 1. Check connections. 2. Check that 12 volts are present at the (+) connection on the fuel pump.
Engine cranks, but does not start, fuel pump energized.	<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. <ol style="list-style-type: none"> 3a. Replace batteries.
Engine can't be stopped.	<ol style="list-style-type: none"> 1. Disconnected fuel shut-off cable. 2. Fuel run solenoid will not de-energize. (optional) 	<ol style="list-style-type: none"> 1. Check connection at shut-off lever. Pull lever back to close off the fuel 2. Manually shutdown the engine using the manual shut-off lever.
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. DC alternator. 2. Alternator drive. 	<ol style="list-style-type: none"> 1. Perform DC voltage check of the DC alternator. 2. 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 lift pump failure. 	<ol style="list-style-type: none"> 1. Fuel lift pump should make a distinct ticking sound. Replace

(continued)



ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine slows and stops.	<ol style="list-style-type: none"> 1. Fuel lift pump failure. 2. Switches and/or wiring loose or disconnected. 3. Fuel starvation. 4. 20 Amp circuit breaker tripping. 5. Exhaust system is restricted. 6. Water in fuel. 7. Air intake obstruction. 	<ol style="list-style-type: none"> 1. Fuel lift pump should make a distinct ticking sound. Replace pump with spare. 2. Inspect wiring for short circuits and loose connections. Inspect switches for proper operation. 3. Check fuel supply, fuel valves, fuel lift pump. 4. Check for high DC amperage draw during operation. Ensure breaker is not overly sensitive to heat which would cause tripping. 5. Check for blockage, collapsed hose, carbon buildup at exhaust elbow. 6. Pump water from fuel tank(s); change filters and bleed fuel system. 7. Check air intake filter cartridge.
Engine overheats/shuts down.	<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. 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. 1a. Crankcase is overfilled with engine oil (oil is blowing out through the exhaust). 2. Engine is running cold. 2a. Faulty injector or incorrect injector timing. 3. Improper grade of fuel. 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.

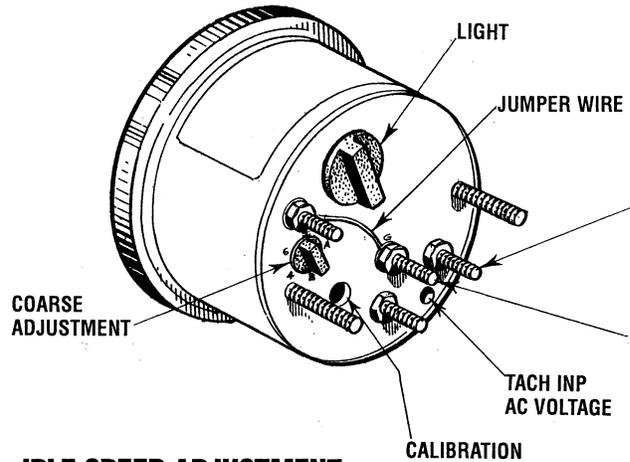
Tachometer Sticking

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. Using a hand held strobe tachometer reading front crank pulley speed. Adjust the speed to 1/2 rated engine rpm.
- b. Using the coarse adjustment, select A, B, 4, 6, or 8 that puts the panel tachometer rpm reading the closest to the strobe tachometers rpm reading.
- c. Using a 5/64 (2mm) allen wrench, adjust the calibration pod on the panel tachometer to read the same as the strobe tachometer's rpm.

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.

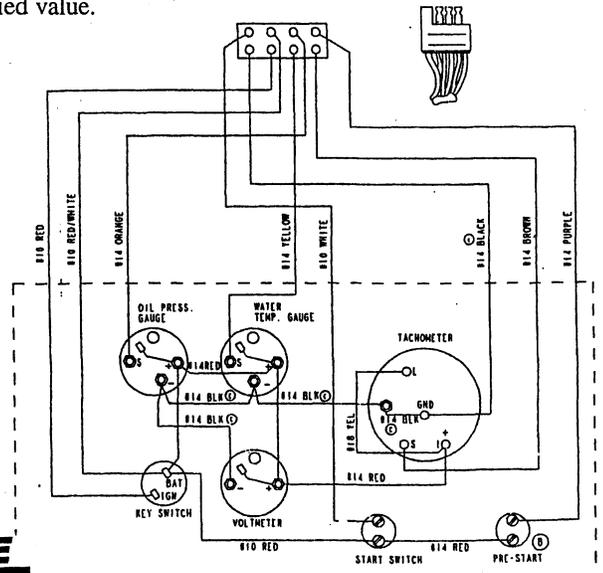


IDLE SPEED ADJUSTMENT & TACHOMETER CHECK (New Installation)

Checking the idle speed

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.
4. Adjust the idle speed if the engine speed is not within the specified value.

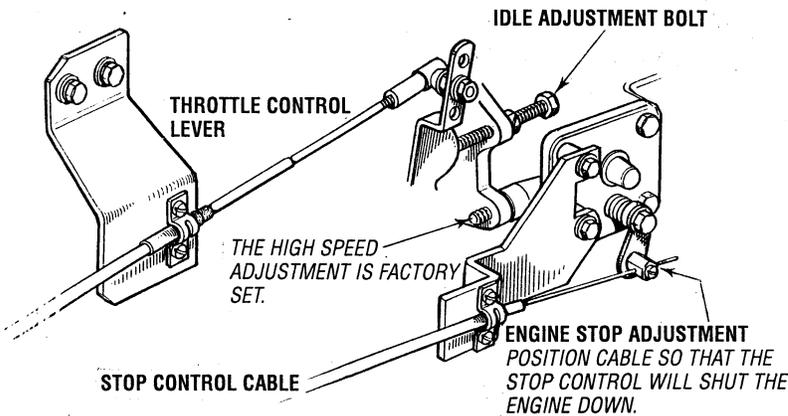


ENGINE ADJUSTMENTS

ADJUSTING THE IDLE SPEED

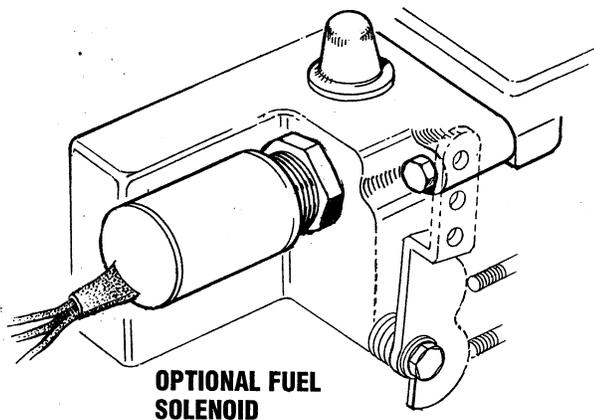
1. Loosen the locknut on the idle adjustment bolt on the fuel injection pump.
2. Adjust the bolt so that the throttle control lever will hold the engine at a quiet idle.
3. Tighten the locknut.
4. Race the engine several times to ensure the idle speed remains as set.

NOTE: Should the engine rpm be in question, verify the tachometer readings as shown at the instrument panel with a mechanical or strobe-type tachometer at the engine crankshaft. See TACHOMETER.



FUEL SHUTOFF SOLENOID [OPTIONAL]

The optional fuel shutoff solenoid allows the engine to be shut down using the instrument panel key switch. The solenoid has been factory set and does not require adjustment.



NOTE: Should the engine fail to shutdown when the key switch is turned off (goes to very slow idle), loosen the fuel solenoid's jam nut and screw the solenoid in 1/4 to 1/2 turn until shutdown is achieved.

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 midpoint 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.

RECOMMENDED RPM RANGE

Model	idle RPM	Cruise RPM	Max. RPM
44A/FOUR	800-1000	2500-3000	3500-3600
44B/FOUR	800-1000	2000-2500	2900-3000
35C/THREE	1000-1200	2500-3000	3500-3600
35D/THREE	1000-1200	2000-2500	2900-3000
44C/FOUR	800-1000	2000-2500	2900-3000
35E/THREE	1000-1200	2000-2500	2900-3000

ENGINE ADJUSTMENTS

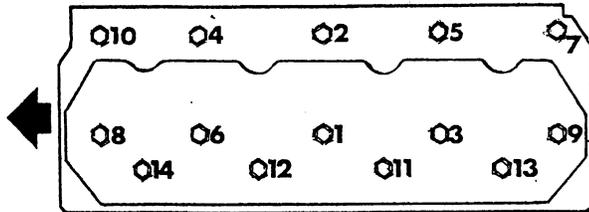
NOTE: WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.

VALVE CLEARANCE ADJUSTMENT

Make the following adjustments when the engine is cold.

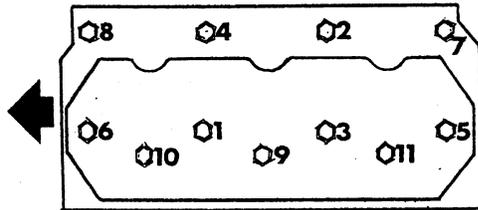
1. Remove the cylinder head cover.
2. Prior to checking valve clearances, re-torque the cylinder head hold down bolts. This is done by slightly loosening the bolt and then re-tightening the bolt to the specified torque in the sequence shown below.

Tightening Torque 65 ± 4 lb-ft (88 ± 5 Nm)



FOUR CYLINDER

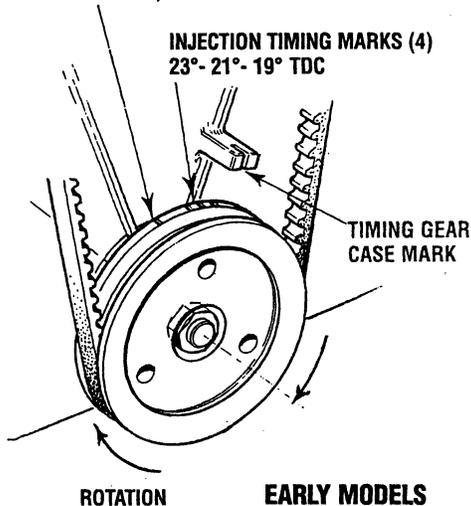
FRONT



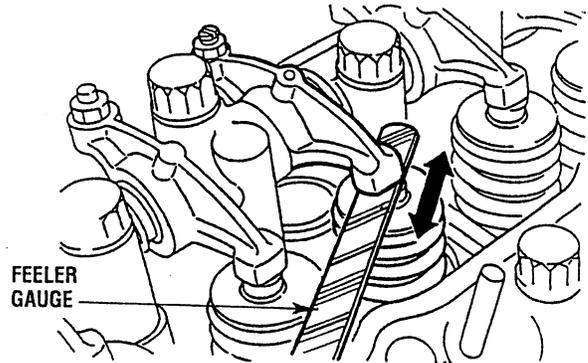
THREE CYLINDER

3. Find top dead center compression position for No. 1 piston by using the procedure that follows:
 - (a) Remove the glow plugs from the engine to ease the rotation of the crankshaft manually to position the various cylinders pistons at TDC (Top Dead Center).

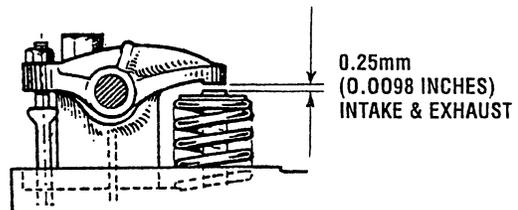
TDC (TOP DEAD CENTER)



- (b) Rotate the crankshaft to position #1 cylinder piston at TDC. The TDC mark on the crank pulley should align with the timing mark on the gear case. Adjust the valves for cylinder #1.
- (c) Rotate the crankshaft to position the next cylinder in the engines firing order at TDC of its compression stroke. Adjust the valves for that cylinder.
- (d) Rotate the crankshaft to position the next cylinder in the engines firing order at TDC. Adjust the cylinders valves and repeat this procedure until all the cylinder valves are adjusted.



4. Loosen the lock nut for the adjusting screw. With a feeler gauge inserted between the rocker arm and valve cap, adjust the valve clearance by turning the adjusting screw. Make certain to adjust all the valves.

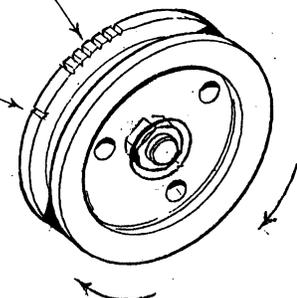


5. Install the cylinder head cover.
Head Cover Bolt Torque $2 - 3$ ft-lb ($0.3 - 0.45$ m-kg)

FIRING ORDER:
3 CYLINDER: 1-3-2
4 CYLINDER: 1-3-4-2

INJECTION TIMING MARKS (7)
21°- 20°- 19°- 18°- 17°- 16° TDC

TDC (TOP DEAD CENTER)



44A, 44B, 44C FOUR ENGINE SPECIFICATIONS

SPECIFICATIONS

Engine Type	Diesel, four-cycle, four-cylinder, fresh water-cooled, vertical in-line overhead valve mechanism.
Displacement	107.3 cubic inches (1.758 liter)
Aspiration	Naturally aspirated.
Combustion Chamber	Swirl type.
Bore & Stroke	3.07 x 3.62 inches (78 x 92 mm)
Firing Order	1 - 3 - 4 - 2
Direction of Rotation	Clockwise, when viewed from the front.
Compression Ratio	22:1
Dimensions - inches (mm) Engine Only	Height: 18.6 inches (472.4 mm) Width: 23.0 inches (584.2 mm) Length: 25.6 inches (914.4 mm)
Weight	331 lbs (150 kgs) without transmission.
Fuel Consumption	44A 2.5 g/hr (9.7 ltr/hr) at 3600 rpm 44B 1.6 g/hr (6.0 ltr/hr) at 3000 rpm 44C 2.4 g/hr (9.0 ltr/hr) at 3000 rpm
Inclination	Continuous 15° Temporary 25° (not to exceed 30 min.)

TUNE-UP SPECIFICATIONS

Compression Pressure Minimum	427 psi (30 kg/cm ²) at 280 rpm 384 psi (27 kg/cm ²)
Valve Timing	Intake Opens Intake Closes
Valve Seat Angle	45°
Engine Timing	17° BTDC (44A/Four) 21° BTDC (44B/Four and 44C/Four)
Injector Pressure	1991 + 71 - 0 psi (140 + 5 - 0 kgf/cm ²).
Valve Seat Angle	Intake 45° Exhaust 30°
Valve Clearance (engine cold)	0.25 inches (0.0098 mm)
Engine Speed	3600 rpm (44A/Four) 3000 rpm (44B/Four and 44C/Four)
Horsepower Rating	44A/Four : 40 Hp at 3600 rpm 44B/Four : 44 Hp at 3000 rpm 44C/Four : 38 Hp at 3000 rpm

FUEL SYSTEM

General	Open flow, self priming.
Fuel	No. 2-D (Cetane rating of 45 or higher). SAE J313, grade of diesel fuel according to ASTM D975
Fuel Injection Pump	In-line plunger type (BOSCH).
Nozzle	Throttle type.
Fuel Filter	Cartridge type.
Air cleaner	Replaceable paper filter cartridge.
Air Flow (engine combustion)	140 cfm (3.9 cmm) at 3600 rpm. 93 cfm (26.2 cmm) at 3000 rpm.
Fuel Lift Pump	12 volt DC lift capacity of 5' (1.5 mm) solid state

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground
Battery Capacity	400 - 600 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt-driven
Starting Aid	Glow plugs, sheathed type
Starter	12 Volt, reduction gear
Cold Cranking Amp Draw	150 - 175 DC Amps

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, belt-driven.
Raw Water Flow (Measured before discharge into elbow approximately)	44A/Four 9.5 gpm at 3600 rpm 44B/Four 8.0 gpm at 3000 rpm 44C/Four 8.0 gpm at 3000 rpm
System Capacity (Fresh Water)	8.0 US qts (7.6 liters)

LUBRICATION SYSTEM

General	Pressure fed system.
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	5.7 U.S. qts (5.4 liters)
Operating Oil Pressure (engine hot)	50 - 60 psi (3.5 - 4.2 kg/cm ²)
Oil Grade	API Specification CF, CG-4, CH-4 or CI-4 SAE 15W-40, 10W-40

35C, 35D, 35E THREE ENGINE SPECIFICATIONS

SPECIFICATIONS

Engine Type	Diesel, four-cycle, three-cylinder, fresh water-cooled, vertical in-line overhead valve mechanism..		
Displacement	80.4 cubic inches (1.318 liter)		
Aspiration	Naturally aspirated.		
Combustion Chamber	Swirl type.		
Bore & Stroke	3.07 x 3.62 inches (78 x 92 mm)		
Firing Order	1 - 3 - 2		
Direction of Rotation	Clockwise, when viewed from the front.		
Compression Ratio	22:1		
Dimensions - inches (mm) Engine Only	Height:	21.6 inches	(540.6 mm)
	Width:	20.1 inches	(510.5 mm)
	Length:	22.4 inches	(596 mm)
Fuel Consumption	35C	2.0 g/hr (7.5 ltr/hr) at 3600 rpm	
	35D	1.7 g/hr (6.4 ltr/hr) at 3000 rpm	
	35E	1.8 g/hr (6.8 ltr/hr) at 3000 rpm	
Weight	276 lbs (276 kgs) without transmission		
Inclination	Continuous 15°		
	Temporary 25° (not to exceed 30 min.)		

TUNE-UP SPECIFICATIONS

Compression Pressure Minimum	427 psi (30 kg/cm ²) at 280 rpm
	384 psi (27 kg/cm ²)
Valve Timing	Intake Opens
	Intake Closes
Valve Seat Angle	45°
Engine Timing	17° BTDC (35C/Three)
	21° BTDC (35D/Three and 35E/Three)
Injector Pressure	1991 + 71 - 0 psi (140 + 5 - 0 kgf/cm ²).
Valve Seat Angle	Intake 45°
	Exhaust 30°
Valve Clearance (engine cold)	0.0098 inches (0.25 mm)
Engine Speed	3600 rpm (35C/Three)
	3000 rpm (35D/Three and 35E/Three)
Horsepower Rating	35C/Three: 29 Hp at 3600 rpm
	35D/Three: 31 Hp at 3000 rpm
	35E/Three: 28 Hp at 3000 rpm

FUEL SYSTEM

General	Open flow, self priming.
Fuel	No. 2-D (Cetane rating of 45 or higher).SAE J313, grade of diesel fuel according to ASTM D975
Fuel Injection Pump	In-line plunger type (BOSCH).
Nozzle	Throttle type.
Fuel Filter	Cartridge type.
Air Cleaner	Replaceable paper filter cartridge.
Air Flow (engine combustion)	83.7 cfm (2.3 cmm) at 3600 rpm.
	69.7 cfm (1.9 cmm) at 3000 rpm.
Fuel Lift Pump	12 volt DC lift capacity of 5' (1.5 mm) solid state

ELECTRICAL SYSTEM

Starting Battery	12 Volt, (-) negative ground
Battery Capacity	400 - 600 Cold Cranking Amps (CCA)
DC Charging Alternator	51 Amp rated, belt-driven
Starting Aid	Glow plugs, sheathed type
Starter	12 Volt, reduction gear
Cold Cranking Amp Draw	150 - 175 DC Amps

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, belt-driven.	
Raw Water Flow (Measured before discharge into elbow approximately)	35C/Three	9.5 gpm at 3600 rpm
	35D/Three	8.0 gpm at 3000 rpm
	35E/Three	8.0 gpm at 3000 rpm
System Capacity (Fresh Water)	5.0 US qts (4.7 liters)	

LUBRICATION SYSTEM

General	Pressure fed system.
Oil Filter	Full flow, paper element, spin-on type.
Sump Capacity (not including filter)	3.9 U.S. qts (3.7 liters)
Operating Oil Pressure (engine hot)	50 - 60 psi (3.5 - 4.2 kg/cm ²)
Oil Grade	API Specification CF, CG-4, CH-4 or CI-4 SAE 15W-40, 10W-40

J.S. AND B.W. TRANSMISSIONS

DESCRIPTION

The transmission's gear ratio is 2.47:1. The manual transmission turns a righthand propeller when engaged in forward. The JS/BW transmits it power with case-hardened helical gears and in reverse an intermediate gear. The reversing process is carried out by a servo double disc system. For safety reasons, the transmission is **NOT** shipped with lubricant in it. Before leaving the factory, each transmission is thoroughly tested with oil in the transmission. This testing among other things provides all internal parts with a coating of oil. This oil acts as a preservative, providing reliable protection against corrosion for at least a year if the transmission is stored properly.

The transmission is an immersion-lubricated type. Fill the transmission up to or near the top of the machined notch cut on the dipstick with SAE20W or SAE30W engine oil exclusively. Multigrade oils are not to be used in this transmission. **DO NOT** mix grades of oil! Lubricating oils may have an API spec. of CF, CG-4, CH-4 or CI-4.

LUBRICATION

The oil capacity for the transmission is approximately 1.0 quart (1.0 liter). Check the oil level daily after the engine has been warmed and stopped. The oil level should be maintained at the top of the machined flat on the dipstick when the dipstick is completely inserted into the transmission housing. Make sure the two O-ring gaskets on the dipstick are in good shape. These O-rings will keep the dipstick in place.

Change the transmission oil after the first 25 hours of engine operation and thereafter every 250 hours or once a year, minimum. The transmission has a 6 mm Allen Hex wrench drain plug for draining the oil. To make sure most of the oil will drain from the transmission, warm the oil by running the engine in **NEUTRAL** for approximately 10 to 15 minutes. This oil may also be removed by attaching a pump into the dipstick opening so the oil may be sucked out. The operating oil temperature must not exceed 250°F (120°C).

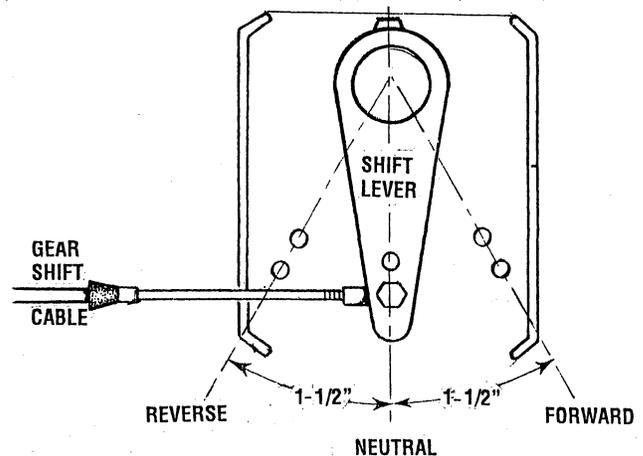
CONTROLS

The only controls required to operate the transmission is a single level remote controlled cable. The cable should be attached to the gear box lever using the cable bracket supplied with the unit. Both the gear box lever and the remote control lever must be in the **NEUTRAL** position when the cable is attached to the gear box lever. This allows the remote cable an equal throw distance to shift the gear box into **FORWARD** or into **REVERSE** from the **NEUTRAL** position without running out of cable. Allow approximately 1-1/2 inches of cable throw from the **NEUTRAL** position on the transmission's gear box lever to each of the two drive positions.

If the throw distance (or travel) of the remote cable is too short, the gear box lever cannot fully engage the transmission into **FORWARD** or **REVERSE**. In this situation, the transmission's internal clutches will wear prematurely and the transmission may over heat and eventually fail.

Excessive throw distance in the remote control level is not detrimental to the transmission. Note that the position of the remote control lever should align with the **NEUTRAL** marking on its bracket when the transmission is really in **NEUTRAL**.

JS GEAR BOX SHIFT LEVER



SHIFTING

To shift the transmission from **NEUTRAL** into **FORWARD**, exert a *heavy push* to the remote control lever. A gentle throw may not carry enough force to actually shift the transmission's internal gears. A gentle throw is signalled by the transmission not engaging into the desired drive. Make sure the remote control lever is lubricated at least once each operating season. Shift the transmission while the engine is running at 1200 rpm or below.

CAUTION: NEVER remove or loosen the two-bolt gear box lever cover from transmission. The position of this plate and the actuating level inside of the transmission has been finely adjusted at the factory to ensure equal throw distance of internal mechanisms. Loosening of this cover's capscrews voids the transmission warranty.

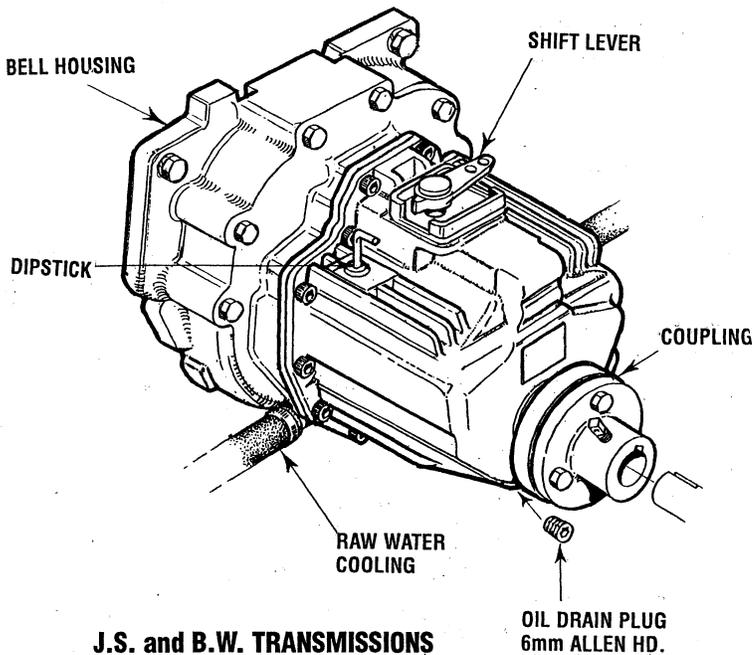
J S AND B W TRANSMISSION

SAILING OPERATION

It is recommended the transmission be left in **NEUTRAL** position while sailing. Leaving the transmission in **NEUTRAL** while sailing alleviates unnecessary drag on the vessel because the propeller is able to freewheel (spin). However, to stop the propeller shaft from rotating while under sail, place the transmission in **REVERSE**.

COOLING

The transmission is raw water-cooled. Raw water enters the transmission through a stainless steel inlet pipe located at the base of the bell housing. This water helps to cool the transmission's lubricating oil.



J.S. and B.W. TRANSMISSIONS

SERVICE

If any seal on the transmission shows signs of leaking, have the transmission looked at by a qualified WESTERBEKE dealer. This problem, especially concerning the rear seal, is often contributed to an improper alignment of the transmission's coupling and the propeller shaft's coupling.

Disassembly of the transmission in the field is not recommended. If an overhaul or repair is needed, the work should be done by an authorized WESTERBEKE service center.

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:

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

- Clean up the transmission and touch-up any unpainted areas (use heat resistant paint).
- Fill the transmission with SAE 30 engine oil to prevent internal corrosion. (Extended storage only, 12 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.

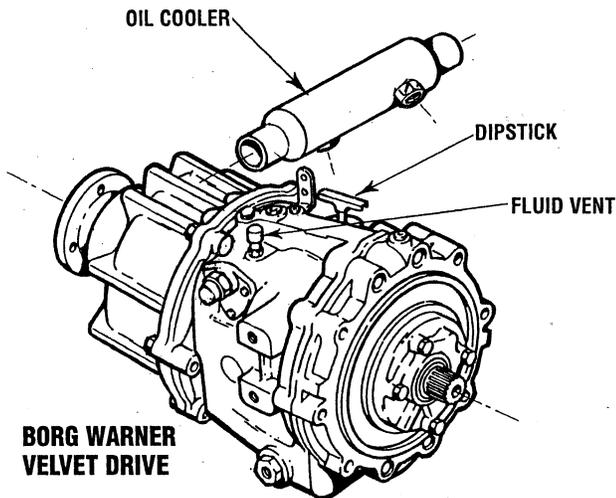
NOTE: If the transmission is to be stored for a long time (twelve months or more), it should be topped off with oil to prevent internal corrosion. Reduce the oil level before putting the engine back into service.

JS TRANSMISSIONS SPECIFICATIONS

General	Case-hardened helical gears with an intermediate reverse gear. Reversing out by servo double disc system
Gear Ratio (Standard)	2.47 : 1
Propeller Shaft (Direction of Rotation)	Right handed - standard transmission.
Propeller	See propeller recommendation chart
Lubricating Oil	SAE 20W/20 or SAE 30 exclusively (Do not mix grades of oil or use multi grades). API, CF, CG-4, or SJ.
Transmission Sump Capacity	1 qts (1 liters)

BORG WARNER VELVET DRIVE TRANSMISSION

OPTIONAL TRANSMISSION / 44 FOUR ONLY



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

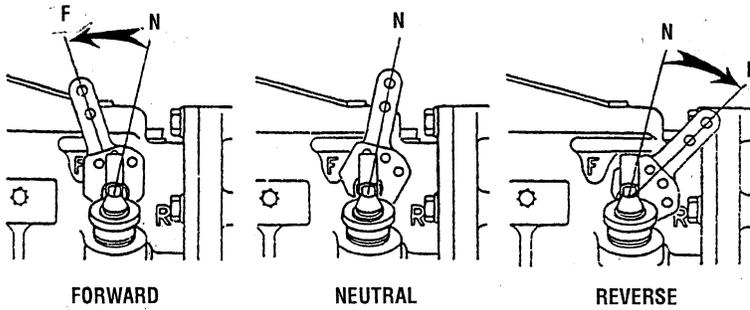
Move the gear shift lever to the forward position. You should feel the detent. The actuating lever on the transmission is in the forward position. The output shaft and the propeller shaft move the boat in a forward direction.

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



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.

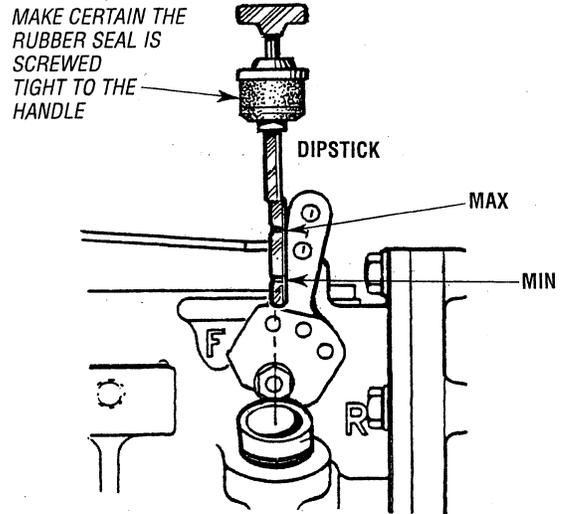
- Remove the oil filler cap and dipstick.
- Remove the oil cooler return line and allow the oil to drain into a container.
- Reconnect the oil cooler return line.
- Use a suction pump to remove the transmission oil through the filler cap/dipstick hole.

- 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 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:

Richmond and Velvet Drive
1208 Old Norris Road
Liberty, SC 29657
Tel.: (800) 583-4327

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.

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.

ZF MARINE TRANSMISSIONS

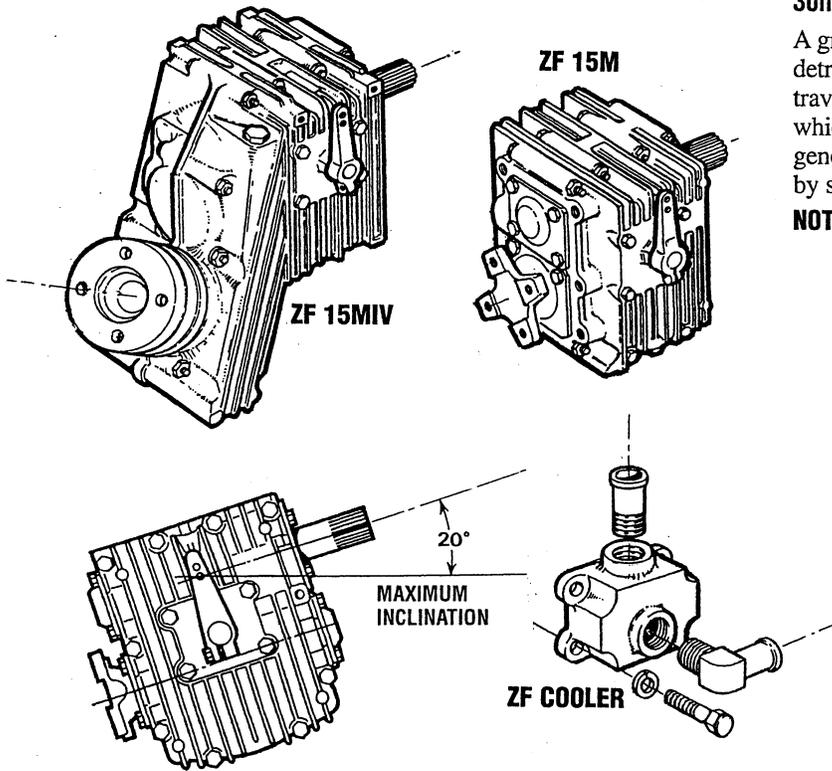
DESCRIPTION

The information below is specific to the ZF Transmissions, the *TRANSMISSION TROUBLESHOOTING SECTION* applies to all models.

CONNECTION OF GEAR BOX WITH PROPELLER

HBW recommend a flexible connection between the transmission gearbox 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 taken 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 manufacturers instructions.

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



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

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

CONTROL CABLES

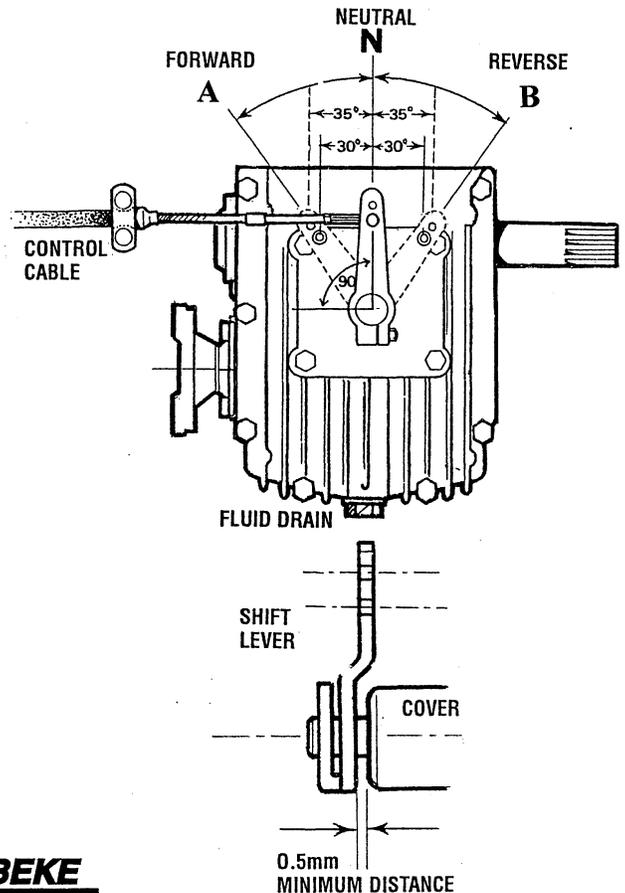
The transmission is suitable for single lever remote control. Upon loosening the retaining screw, the actuating lever can be moved to any position required for the control elements (cable or rod linkage). Make certain that the shift lever does not contact the actuating lever cover plate: the minimum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

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

The shifting travel, as measured at the pivot point of the actuating lever, between the neutral position and end positions **A** and **B** should be at least **35mm** for the outer and **30mm** for the inner pivot point.

A greater amount of shift 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.

NOTE Check for proper lever travel at least each season.

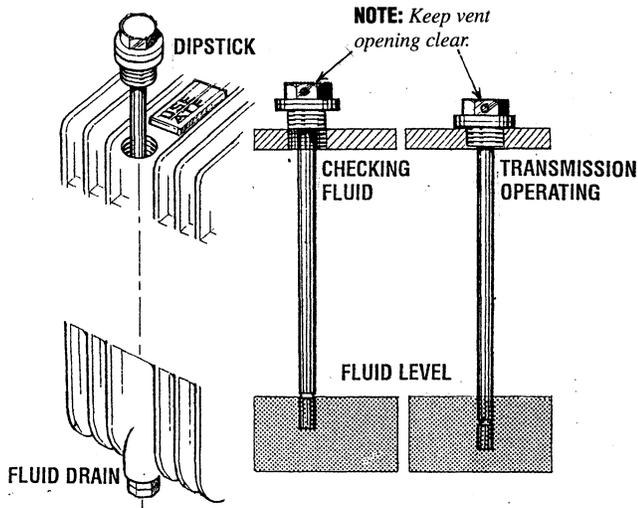


ZF MARINE TRANSMISSIONS

INITIAL OPERATION

All HBW marine transmissions are test-run on a test stand with the engine at the factory prior to delivery. For safety reasons the fluid is drained before shipment.

Fill the gearbox with Automatic Transmission Fluid (DEXRON II or DEXTRON III). The fluid level should be up to the index mark on the dipstick. To check the fluid level, just insert the dipstick, do not screw it in. Screw the dipstick into the case after the fluid level is checked and tighten. Do not forget the sealing ring under the hexhead of the dipstick. Check for leaks and change the fluid after the first 25 hours, also make a visual inspection of the coupling, oil cooler and hoses, and shift cables.



FLUID CHANGE

Change the fluid for the first time after about 25 hours of operation, then every 250 operating hours or at least once a year or when you change engine oil.

Removing the fluid

Push a suction pump hose down through the dipstick hole to the bottom of the housing and suck out the fluid. (If space allows, use the transmission drain). Remove the drain plug from the bottom of the transmission and allow the fluid to drain into a container, then reinstall the plug with its sealing washer. Wipe down the transmission and properly dispose of the used fluid. After running the engine, shut down and recheck the fluid level.

Drain plug torque 20 - 25 ft/lbs

NOTE: When changing the fluid, take care not to lose the drain plug sealing washer. The drain plug will leak without this sealing washer.

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

OPERATING TEMPERATURE

The maximum permissible ATF temperature should not exceed 230° (110°). This temperature can only be reached for a short time.

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

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 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.

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.

For additional information refer to the following text in this Transmission Section: *SHAFT COUPLINGS, MAINTENANCE AND TRANSMISSION TROUBLESHOOTING.*

ZF TRANSMISSIONS SPECIFICATIONS

General	(ZF Standard Transmission) Case hardened helical gears, with a servo-operated multiple disc clutch
Gear Ratio (optional)	ZF 15MA (1.88:1 or 2.63:1)
Note: There are a variety of gear ratios available. Only a few are listed.	ZF 10MA (1.79:1)
	ZF 12MA (2.63:1)
	ZF 15MIV (2.13:1 or 2.72:1)
Lubricating Fluid	ATF - Type A or Dextron - II or III
Propeller Shaft	Right-hand rotation for above models listed.
Direction of Rotation	

ZF MARINE TRANSMISSIONS

OPERATING TEMPERATURE

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

Normal operating temperature of the transmission fluid should be in the range of 122° F (50° C) to 212° F (100° C). A maximum temperature of 266° F (130° C) may be only reached for a short time.

Make certain there is enough space around the transmission to provide good ventilation and cooling.

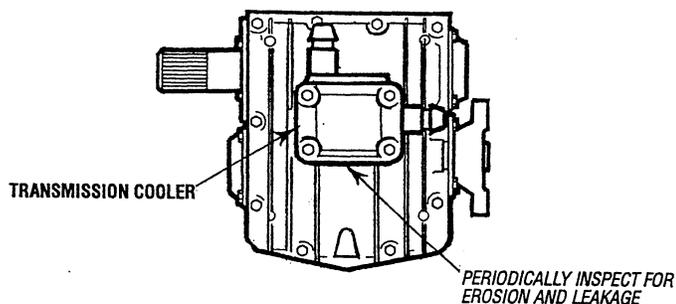
TRANSMISSION COOLER

Coolers are standard equipment for the ZF 10M, ZF 12M, ZF 15M, ZF 15MA, ZF 15MIV, and the ZF 25M.

The cooler is a separate part of the transmission which prevents any possibilities of coolant diluting the transmission fluid. However, the continued flow of coolant thru the cooler will, in time, erode the inside of the cooler causing external leaks.

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.



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

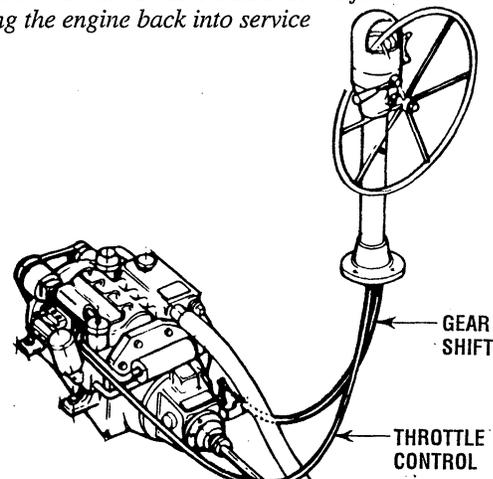
Storage requires special care. Follow these procedures:

- 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.

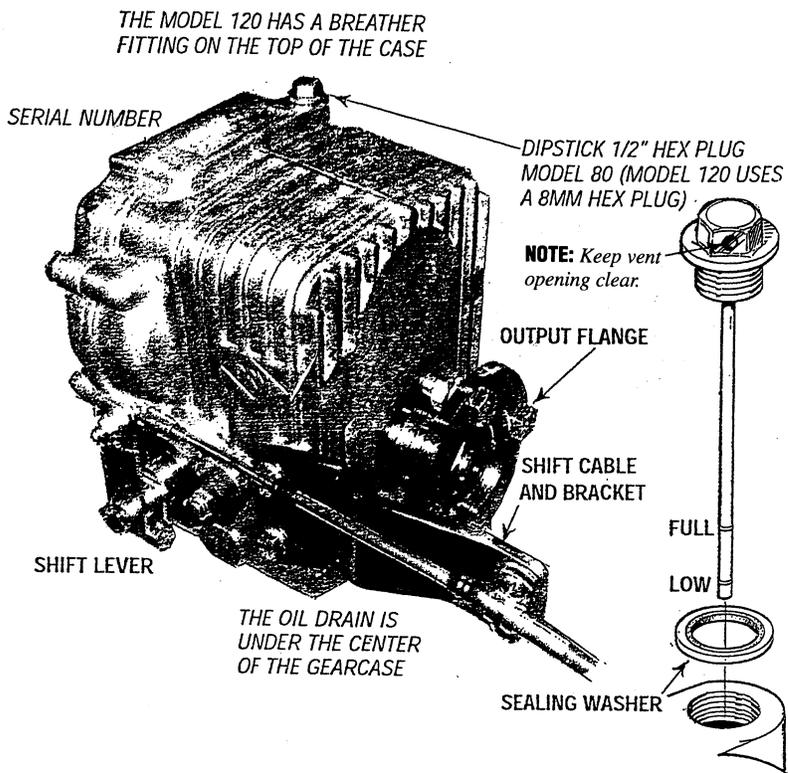
NOTE: *If the transmission is to be stored for a long time (twelve months or more), it should be topped off with fluid to prevent internal corrosion. Reduce the fluid level before putting the engine back into service*



For additional information contact:

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

PRM NEWAGE TRANSMISSIONS MODELS 80 AND 120



Push a suction pump hose down through the dipstick hole to the bottom of the housing and suck out the fluid. (If space allows, use the transmission drain). Remove the drain plug from the bottom of the transmission (1" with sealing washer) and allow the fluid to drain into a container, then reinstall the plug with its sealing washer. Wipe down the transmission and properly dispose of the used fluid. After running the engine, shut down and re-check the fluid level.

NOTE: When changing the fluid, take care not to lose the drain plug sealing washer. The drain plug will leak without this sealing washer.

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

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.

GEAR SHIFTING

The engine must be at idle. Pause in neutral before selecting ahead or astern. Transmission models PRM 80 and 120 are ideal for single lever engine controls, controlling both the throttle and the gear shift at one time.

WARNING: When shifting gears, bring the engine throttle to idle and pause in neutral before shifting ahead or astern.

INITIAL OPERATION

Remove the dipstick and fill the gear box with automatic transmission fluid (ATF) Dexron III. Fill the transmission with the recommended capacity of fluid.

Model PRM 80-1.0 U.S. pints (0.6L)

Model PRM 120-1.4 U.S. pints (0.8L)

NOTE: Always clean the area around the dipstick plug before filling with fluid. Replace the dipstick by screwing it down.

Run the engine to warm up the fluid and after shutting down the engine, re-check the fluid level.

CHANGING THE TRANSMISSION FLUID

Change the fluid for the first time after about 25 hours of operation, then every 250 operating hours or at least once a year or when you change engine oil. Check for leaks and make a visual inspection of the shift cables and shaft coupling.

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 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.

PRM NEWAGE TRANSMISSIONS

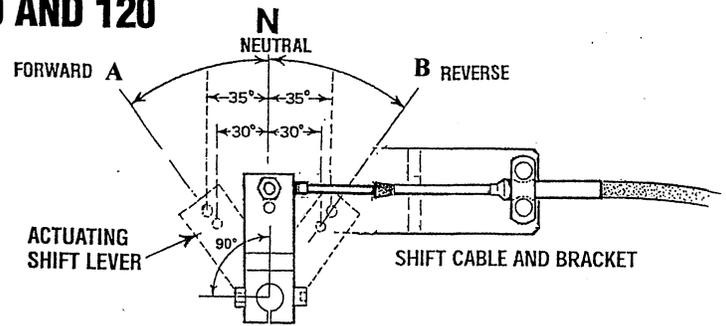
MODELS 80 AND 120

CONTROL CABLES

NOTE: When installing the transmission, make certain that shifting is not impeded by restricted movability of the Bowden cable or rod linkage, by unsuitably positioned guide sheaves, too small a bending radius, etc.

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

The shifting travel, as measured at the pivot point of the actuating lever, between the neutral position and end positions **A** and **B** should be at least **35mm** for the outer and **30mm** for the inner pivot point.



A greater amount of shift 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.

NOTE Check for proper lever travel at least each season.

TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Excessive noise at low speeds	1. Engine idle speed too low	1. Increase idling speed
Excessive noise at all speeds	1. Defective coupling 2. Shaft misalignment 3. Prop out of balance	1. Inspect/replace coupling if necessary 2. Check alignment with feeler gauge 3. Remove, check pitch, balance and weight
Fluid needs constant topping off	1. Power too high 2. Fluid leak	1. Compare engine and transmission data 2. Inspect seals, drain, check for fluid leaks
Difficulty in moving lever control	1. Poor installation of cable 2. Faulty cable	1. Inspect/replace coupling if necessary 2. Check alignment with feeler gauge
Escape of pressure from gearbox when dipstick is removed	1. Defective breather (Model 120)	1. Inspect breather (Model 120), contact a Distributor or your WESTERBEKE dealer

MAINTENANCE/SERVICE

Make certain the transmission fluid is changed annually. If the fluid should become contaminated by water or the gearbox suffers major mechanical damage, the gearbox must be thoroughly flushed out and re-filled with fresh fluid to the correct specifications.

NEWAGE TRANSMISSIONS LTD. has distributors around the world. Listed here are those in the United States.

Atlantis Marine Gear Supply Inc.
418 Boston Street
Topsfield, MA 01933
Tel: 978-887-0001
Fax: 978-887-5599

Harbor Marine Transmission
1402 West Marine View Drive
Everett, WA 98021
Tel: 425-259-3285

Transmission Marine
223 Southwest 33 Court
P.O. Box 21086
Ft. Lauderdale, FL 33335-1086
Tel: 954-467-1540
Fax: 954-467-1525

Or contact your Westerbeke dealer.

If a major problem should occur, contact your Westerbeke dealer or a NEWAGE distributor. To avoid prejudicing warranty rights, do not undertake repair work on the gearbox without first contacting NEWAGE TRANSMISSIONS LIMITED or a NEWAGE distributor or your WESTERBEKE dealer.

Warranty

Newage transmission limited warrants that all PRM Newage Transmissions will be free from defects in material and workmanship under normal use and service for a period or twenty-four months.

All PRM Transmissions must be correctly installed, aligned, and maintained.

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.

PRM 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-fluid 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.

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

Problem	Probable Cause	Verification/Remedy
Transmission gears cannot be shifted. Fails to move into gear.	<ol style="list-style-type: none"> 1. Actuating lever is loose. 2. Shifting cable is broken, bent or unattached. Cable radius is too severe. 3. Shift lever is binding against cover plate. 	<ol style="list-style-type: none"> 1. Tighten damping bolt on shifting lever. 2. Check the cable, reattach or replace. 3. Detach the shift cable and operate the lever by hand. Clearance should be 0.02 in (0.5mm).
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. A variable pitch propeller may be in "no pitch" position.
Delay of gear engagement or engages only after an increase in speed.	<ol style="list-style-type: none"> 1. Lever travel N to B not equal to N to A. Refer to diagram. 2. Shift level travel is insufficient. 3. Shift lever is binding against cover plate. 	<ol style="list-style-type: none"> 1. Adjust cover plate until the lever is exact mid-position. Refer to <i>SHIFT LEVER TEXT AND DIAGRAM</i>. 2. Check shift lever cable length. See <i>SHIFT LEVER DIAGRAM</i>. 3. Check clearance, adjust if necessary.
Transmission noise becomes louder.	<ol style="list-style-type: none"> 1. Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and driveshaft. 2. 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. Check alignment, inspect flexible coupling. If noise persists, inspect the damper plate between the transmission and the engine. Replace if necessary. 2. Transmission needs professional attention.
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 transmission coupling with and the driveshaft. A higher stiffness factor might be sufficient. 2. Inspect the damper plate between the engine and the transmission. Replace if necessary.
Boat fails to attain specified max. speed.	<ol style="list-style-type: none"> 1. Operating temperature is high. 2. Operating without cooling. 	<ol style="list-style-type: none"> 1. Wrong type of fluid. Use ATF. Check fluid level. 2. Check cooler. Inspect coolant hoses and coolant flow.
Oil Leakage.	<ol style="list-style-type: none"> 1. Corrosion at radial sealing ring and shaft. Damaged sealing ring. 2. Misalignment of output flanges. 	<ol style="list-style-type: none"> 1. Transmission needs professional attention. 2. Check alignment. Must be within 0.003 in (0.08mm).

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

PROPELLER RECOMMENDATION CHART

	TRANSMISSION RATIO	PROPELLER DIAMETER/PITCH	PROPELLER BLADE	
44A FOUR (40 hp/3600 rpm)	2.0:1.....	17D x 11P.....	2 Blade	
		17D x 8P.....	3 Blade	
	2.47:1.....	18D x 11P.....	2 Blade	
		18D x 9P.....	3 Blade	
	2.72:1.....	18D x 13P.....	2 Blade	
		18D x 11P.....	3 Blade	
	2.99:1.....	20D x 13P.....	2 Blade	
		20D x 11P.....	3 Blade	
	35C THREE (29 hp/3600 rpm)	2.0:1.....	14D x 10P.....	2 Blade
			14D x 8P.....	3 Blade
2.47:1.....		16D x 11P.....	2 Blade	
		16D x 9P.....	3 Blade	
2.63:1.....		17D x 13P.....	2 Blade	
		17D x 11P.....	3 Blade	
2.99:1.....		18D x 13P.....	2 Blade	
		18D x 11P.....	3 Blade	
44B Four (39 hp/3000 rpm)		2.0:1.....	17D x 11P.....	2 Blade
			17D x 9P.....	3 Blade
	2.47:1.....	20D x 13P.....	2 Blade	
		20D x 11P.....	3 Blade	
	2.72:1.....	20D x 14P.....	2 Blade	
		20D x 12P.....	3 Blade	
	2.99:1.....	22D x 15P.....	2 Blade	
		22D x 13P.....	3 Blade	
	44C Four (38 hp/3000 rpm)	2.0:1.....	16D x 10P.....	2 Blade
			16D x 8P.....	3 Blade
2.47:1.....		18D x 13P.....	2 Blade	
		18D x 11P.....	3 Blade	
2.72:1.....		20D x 12P.....	2 Blade	
		20D x 10P.....	3 Blade	
2.99:1.....		22D x 13P.....	2 Blade	
		22D x 11P.....	3 Blade	
35D THREE (31 hp/3000 rpm)		2.0:1.....	16D x 9P.....	2 Blade
			16D x 7P.....	3 Blade
	2.47:1.....	18D x 12P.....	2 Blade	
		18D x 10P.....	3 Blade	
	2.72:1.....	20D x 11P.....	2 Blade	
		20D x 9P.....	3 Blade	
	2.99:1.....	22D x 12P.....	2 Blade	
		22D x 10P.....	3 Blade	
	35E THREE (28 hp/3000 rpm)	2.0:1.....	16D x 9P.....	2 Blade
			16D x 7P.....	3 Blade
2.47:1.....		18D x 12P.....	2 Blade	
		18D x 10P.....	3 Blade	
2.72:1.....		20D x 11P.....	2 Blade	
		20D x 9P.....	3 Blade	
2.99:1.....		22D x 12P.....	2 Blade	
		22D x 10P.....	3 Blade	

NOTE: For reductions not included, consult the WESTERBEKE factory for recommendations.

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 [Propulsion Engine]

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. Lubricating 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 *Sta-Bil* 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. 2D diesel fuel. Fuel additives should be added prior to topping off to ensure they mix with the fuel being added and fuel still in the tank. Additives, such as Bio-bor and Diesel Kleen + Cetane Boost should be added at this time to control bacteria growth 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 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.

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 removal of the glow plugs for access to the cylinders. Squirt some Marvel Mystery Oil into the cylinder walls. Rotate the engine crankshaft by hand two revolutions and re-install the glow plugs.

If your engine does not have glow plugs, the injectors will have to be removed. Be sure to have replacement sealing washers for the injectors and return fuel line as needed.

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!

Cylinder Lubrication [Gasoline]

Remove the flame arrester and clean. Operate the engine and spray fogging oil into the intake stalling the engine. This will coat the intake, valves and cylinders with a protecting oil. Reinstall the flame arrester.

NOTE: At re-commissioning, remove the spark plugs and clean and gap them. Rotate the engine by hand two complete revolutions. Re-install the spark plugs and tighten securely and firmly attach the high tension leads.

Batteries

If batteries are to be left on board during the lay-up period, make sure that they are fully charged, and will remain that way, to prevent them from freezing. If there is 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.

⚠ WARNING: Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

Transmission [Propulsion Engine]

Check or change the fluid in the transmission as required. Wipe off grime and grease and touch up any unpainted areas. Protect the coupling and the output flange with an anti-corrosion coating. Check that the transmission vent is open. For additional information, refer to the TRANSMISSION SECTION.

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 the oil-soaked cloths from the intake manifold.
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.

⚠ CAUTION: Wear rubber gloves, a rubber apron, and eye protection when servicing batteries. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

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. It is advisable, as either an end of season or recommissioning service, to inspect the area where the zinc is located in the heat exchanger and clear any and all zinc debris from that area.
6. Start the engine in accordance with procedures described in the PREPARATIONS FOR STARTING section of this manual.

44 FOUR AND 35 THREE TORQUE SPECIFICATIONS

MAJOR BOLTS AND NUTS

Bolt or Nut	Diameter	Pitch	Width across flats	Clamp length	TORQUE		
					kg -m	ft - lb	N -m
Alternator Bracket	---	---	---	---	3.8-5.3	27-38	36.6
Back Plate	---	---	---	---	3.3-4.8	24-35	32.5
Connecting Rod Cap	M9	1.0	14	---	3.55±0.25	27±7.2	34.8±2.5
Coolant Pump	---	---	---	---	1.6±2.4	12-17	17.2
Coolant Pump Pulley	---	---	---	---	1.6±2.4	12-17	17.2
Coolant Temperature Sender	---	---	---	---	1.2±1.8	9-13	12.2
Coolant Temperature Switch	---	---	---	---	1.2±1.8	9-13	12.2
Crankshaft Pulley Nut	M18	1.5	27	---	17.5±2.5	127±18	172±25
Cylinder Head Bolt	M10	1.25	14	87	9±0.5	65±4	88±5
Damper Plate	---	---	---	---	1.9±2.7	14-20	8.9
Delivery Valve Holder	---	---	19	---	4.5±0.5	32±5.4	44±5
Engine Mounts	---	---	---	---	3.2±4.7	23-34	31.1
Exhaust Manifold	---	---	---	---	1.6±2.4	12-17	7.2
Flywheel Bolt	M12	1.25	19	29	13.5±0.5	98±4	132±5
Fuel Filter Assembly	---	---	---	---	4.6±6.8	33-49	44.7
Fuel Injection Nozzle Holder	M20	1.5	21	---	5.5±0.5	40±4.4	54±5
Fuel Injection Pipe Nut	M12	1.5	---	---	3±0.5	22±4	29±5
Fuel Leak-Off Pipe Nut	M12	1.5	18	---	2.75±0.25	20±2	27±2.5
Fuel Solenoid Locknut	---	---	---	---	4.0±0.5	28.9±36.2	39.18
Glow Plug	M10	1.25	12	60	1.75±0.25	12±7.2	17.2±2.5
Glow Plug Connection Plate	M4	0.7	8	---	0.125±0.025	0.9±0.2	1.2±0.2
Intake Manifold	---	---	---	---	1.6±2.4	12-17	16.2
Main Bearing Cap Bolt	M10	1.25	17	81	5.25±0.25	38±2	51.5±2.5
Oil Filter	M20	1.5	---	---	1.2±0.1	8.7±0.7	12±1
Oil Pan Bolt	M8	1.25	12	25	2.8±0.3	20.3±2.2	27±5.3
Oil Pan Drain Plug	M14	1.5	22	10	4.0±0.5	29±4	39±5
Oil Pressure Sender	---	---	---	---	1.2±1.8	9-13	12.2
Oil Pressure Switch	PT1/8	---	26	11	1±0.2	7.2±1.4	10±2
Pressure Relief Valve	M22	1.5	22	33	5.0±5	36±4	49±5
Rear Plate Bolt (stamping)	M8	1.25	12	16	1.15±0.15	8.3±1.1	11.3±1.5
Rear Plate Bolt (standard)	M12	1.25	17	28	6.5±1	47±7	64±10
Retaining Nut for Delivery Valve Holder Body	M16	0.75	19	---	3.75±0.25	27±2	37±2.5
Rocker Cover Bolt	M8	1.25	12	40	1.15±0.15	8.3±1.1	11.3±1.5
Rocker Shaft Bracket Bolt	M8	1.25	12	581	1.5±0.5	11±4	14.7±5
Sliding Sleeve Shaft	M10	1.25	14	29.5	3.6±0.6	26±4	35±6
Special Nut for Torque Spring Set	M12	1.0	17	---	2±0.5	14±4	20±5
Starter B Terminal	M8	1.25	12	---	1.1±0.1	8.0±7	10.8±1
Stop Solenoid	M30	1.5	36	---	4.5±0.5	32±5.4	44±5
Thermostat Housing	---	---	---	---	0.3-0.45	2-3	2.7
Thermoswitch	M16	1.5	17	31.5	2.3±0.4	16.6±3	22.6±4

STANDARD HARDWARE

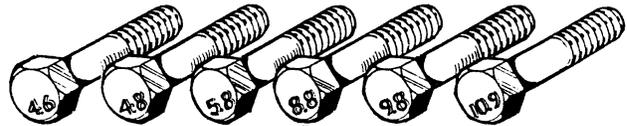
BOLT HEAD MARKINGS

Bolt strength classes are embossed on the head of each bolt.

Customary (inch) bolts are identified by markings two to grade eight (strongest). The marks correspond to two marks less than the actual grade, i.e.; a grade seven bolt will display five embossed marks.



Metric bolt class numbers identify bolts by their strength with 10.9 the strongest.



- NOTES:**
1. Use the torque values listed below when specific torque values are not available.
 2. These torques are based on clean, dry threads. Reduce torque by 10% when engine oil is used.
 3. Reduce torques by 30% or more, when threading capscrews into aluminum.

STANDARD BOLT & NUT TORQUE SPECIFICATIONS			
Capscrew Body Size (Inches) - (Thread)	SAE Grade 5 Torque Ft-Lb (Nm)	SAE Grade 6-7 Torque Ft-Lb (Nm)	SAE Grade 8 Torque Ft-Lb (Nm)
1/4 - 20 - 28	8 (11) 10 (14)	10 (14)	12 (16) 14 (19)
5/16 - 18 - 24	17 (23) 19 (26)	19 (26)	24 (33) 27 (37)
3/8 - 16 - 24	31 (42) 35 (47)	34 (46)	44 (60) 49 (66)
7/16 - 14 - 20	49 (66) 55 (75)	55 (75)	70 (95) 78 (106)
1/2 - 13 - 20	75 (102) 85 (115)	85 (115)	105 (142) 120 (163)
9/16 - 12 - 18	110 (149) 120 (163)	120 (163)	155 (210) 170 (231)
5/8 - 11 - 18	150 (203) 170 (231)	167 (226)	210 (285) 240 (325)
3/4 - 10 - 16	270 (366) 295 (400)	280 (380)	375 (508) 420 (569)
7/8 - 9 - 14	395 (536) 435 (590)	440 (597)	605 (820) 675 (915)
1 - 8 - 14	590 (800) 660 (895)	660 (895)	910 (1234) 990 (1342)

METRIC BOLT & NUT TORQUE SPECIFICATIONS					
Bolt Dia.	Wrench Size	Grade 4.6 Ft-Lb (Nm)	Grade 4.8 Ft-Lb (Nm)	Grade 8.8 - 9.8 Ft-Lb (Nm)	Grade 10.9 Ft-Lb (Nm)
M3	5.5 mm	0.3 (0.5)	0.5 (0.7)	1 (1.3)	1.5 (2)
M4	7 mm	0.8 (1.1)	1 (1.5)	2 (3)	3 (4.5)
M5	8 mm	1.5 (2.5)	2 (3)	4.5 (6)	6.5 (9)
M8	10 mm	3 (4)	4 (5.5)	7.5 (10)	11 (15)
M9	13 mm	7 (9.5)	10 (13)	18 (25)	35 (26)
M10	16 mm	14 (19)	18 (25)	37 (50)	55 (75)
M12	18 mm	26 (35)	33 (45)	63 (85)	97 (130)
M14	21 mm	37 (50)	55 (75)	103 (140)	151 (205)
M16	24 mm	59 (80)	85 (115)	159 (215)	232 (315)
M18	27 mm	81 (110)	118 (160)	225 (305)	321 (435)
M20	30 mm	118 (160)	166 (225)	321 (435)	457 (620)
M22	33 mm	159 (215)	225 (305)	435 (590)	620 (840)
M24	36 mm	203 (275)	288 (390)	553 (750)	789 (1070)
M27	41 mm	295 (400)	417 (565)	811 (1100)	1154 (1565)
M30	46 mm	402 (545)	568 (770)	1103 (1495)	1571 (2130)
M33	51 mm	546 (740)	774 (1050)	1500 (2035)	2139 (2900)
M36	55 mm	700 (950)	992 (1345)	1925 (2610)	2744 (3720)

NOTE: Formula to convert Ft-Lbs to Nm (Newton Meters) multiply Ft-Lbs by 1.356.

SEALANTS & LUBRICANTS

GASKETS/SEALANTS

Oil based PERMATEx #2 and it's HIGH TACK equivalent are excellent all purpose sealers. They are effective in just about any joint in contact with coolant, raw water, oil or fuel.

A light coating of OIL or LIQUID TEFLON can be used on rubber gaskets and O-rings.

LOCTITE hydraulic red sealant should be used on oil adapter hoses and the oil filter assembly.

Coat both surfaces of the oil pan gasket with high temp RED SILICONE sealer.

When installing gaskets that seal around water (coolant) passages, coat both sides with WHITE SILICONE grease.

High-copper ADHESIVE SPRAYS are useful for holding gaskets in position during assembly.

Specialized gasket sealers such as HYLOMAR work well in applications requiring non-hardening properties. HYLOMAR is particularly effective on copper cylinder-head gaskets as it resists fuel, oil and water.

Use LIQUID TEFLON for sealing pipe plugs and fillings that connect coolant passages. **Do not use tape sealants!**

BOLTS & FASTENERS/ASSEMBLIES

Lightly oil head bolts and other fasteners as you assemble them. Bolts and plugs that penetrate the water jacket should be sealed with PERMATEx #2 or HIGH TACK.

When assembling the flywheel, coat the bolt threads with LOCTITE blue.

Anti-seize compounds and thread locking adhesives such as LOCTITE protect threaded components yet allows them to come apart when necessary. LOCTITE offers levels of locking according to the job.

LITHIUM based grease is waterproof, ideal for water pump bearings and stuffing boxes.

Heavily oil all sliding and reciprocating components when assembling. **Always use clean engine oil!**

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

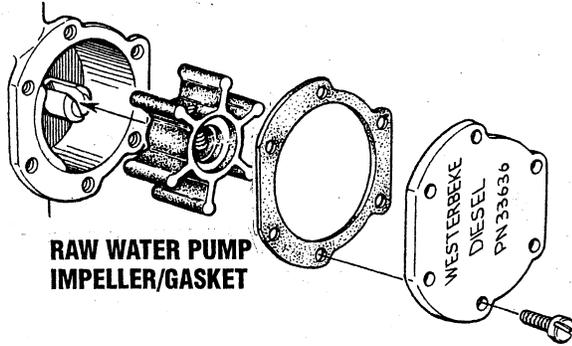
Degree Fahrenheit (°F) = (°C X 1.8) + 32

Degree Celsius (°C) = (°F - 32) x .56

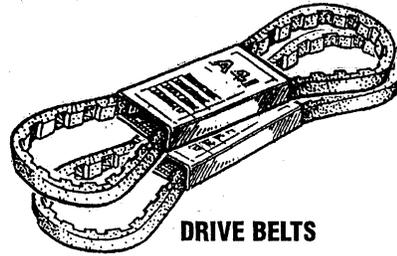
SUGGESTED SPARE PARTS

WESTERBEKE MARINE DIESEL ENGINES

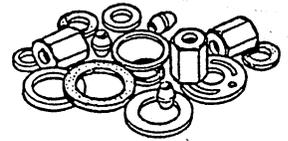
CONTACT YOUR WESTERBEKE DEALER FOR SUGGESTIONS AND ADDITIONAL INFORMATION



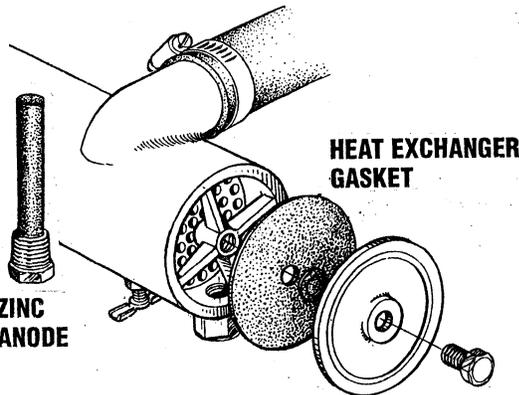
**RAW WATER PUMP
IMPELLER/GASKET**



DRIVE BELTS

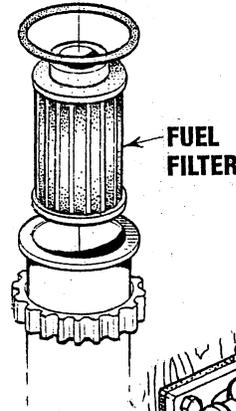


HARDWARE KIT

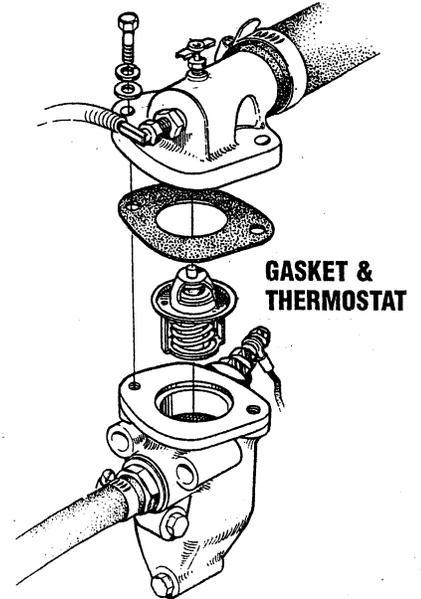


**HEAT EXCHANGER
GASKET**

**ZINC
ANODE**



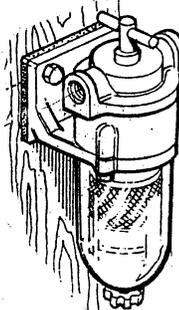
**FUEL
FILTER**



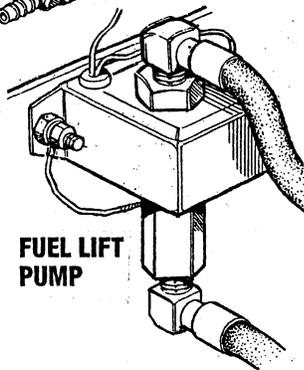
**GASKET &
THERMOSTAT**



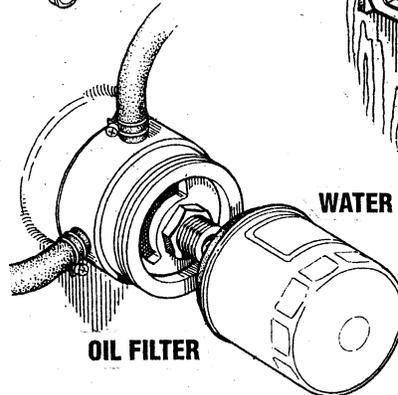
**INLET
FUEL
FILTER**



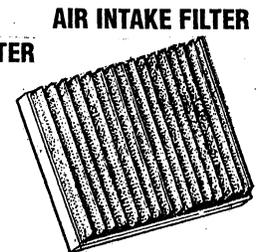
WATER SEPERATOR FILTER



**FUEL LIFT
PUMP**



OIL FILTER



AIR INTAKE FILTER

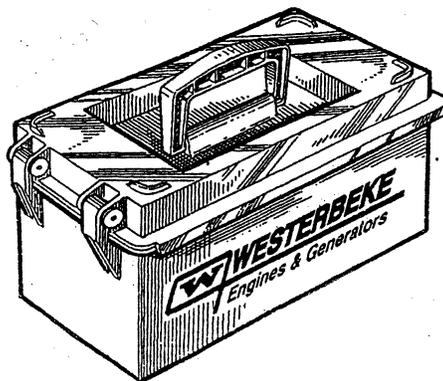
WESTERBEKE RECOMMENDS CARRYING ENOUGH SPARE ENGINE OIL (YOUR BRAND) FOR AN OIL CHANGE (5 QTS.) AND A GALLON OF PREMIXED COOLANT.

SPARE PARTS KITS

WESTERBEKE also offers two Spare Parts Kits, each packaged in a rugged hinged toolbox. Kit "A" includes the basic spares. Kit "B" is for more extensive off-shore cruising.

A Kit

- Impeller Kit
- Heat Exchanger Gasket
- Fuel Filter with Gasket
- Oil Filter
- Drive Belt
- Zinc Anodes



B Kit

- Impeller Kit
- Water Pump Repair Kit
- Thermostat Kit
- Zinc Anodes
- Complete Gasket Kit
- Heat Exchanger Gasket
- Injector
- Fuel Filter with Gasket
- Oil Filter
- Drive Belt



5/2015- 1204