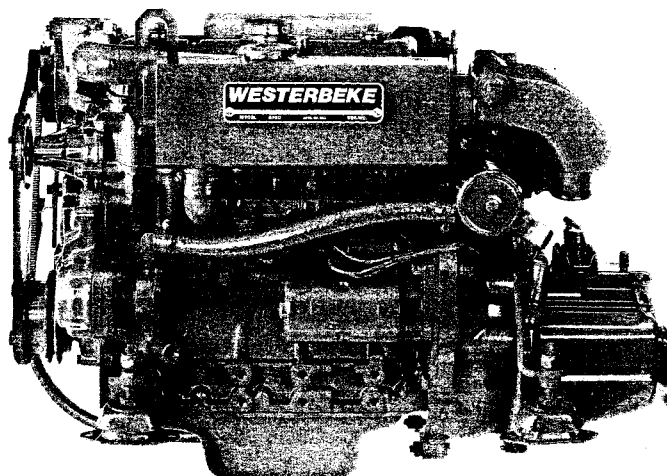




# **OPERATORS MANUAL**

## **35B Three, 38B Four, 42B Four**

### **MARINE DIESEL ENGINES**



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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**

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

# SAFETY INSTRUCTIONS

## INTRODUCTION

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

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

## PREVENT ELECTRIC SHOCK

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

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.

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

## PREVENT BURNS — EXPLOSION

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

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

# SAFETY INSTRUCTIONS

## ACCIDENTAL STARTING

 **WARNING: Accidental starting can cause injury or death!**

- Turn OFF the DC breaker on the control panel or turn the unit's battery selector switch to OFF before servicing the engine.
- Make certain all personnel are clear of the engine before starting.
- Make certain all covers, guards, and hatches are re-installed before starting the engine.

## BATTERY EXPLOSION

 **WARNING: Battery explosion can cause injury or death!**

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

## BATTERY ACID

 **WARNING: 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 manifold/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 TH-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 Auxilliary 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 Dstreet, 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

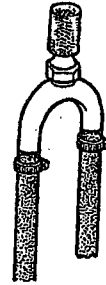
Strict federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

## 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](http://www.westerbeke.com).**

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# INTRODUCTION

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

## WARRANTY PROCEDURES

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

### Customer Identification Card



Customer Identification

MR. ENGINE OWNER

MAIN STREET

HOMETOWN, USA

Model 35B Three. Serial # \_\_\_\_\_ D402

Expires 10/15/02

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

## PRODUCT SOFTWARE

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

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## NOTES, CAUTIONS AND WARNINGS

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

**NOTE:** *An operating procedure essential to note.*

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

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



# INTRODUCTION

## SERIAL NUMBER LOCATION

The engine's model 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.

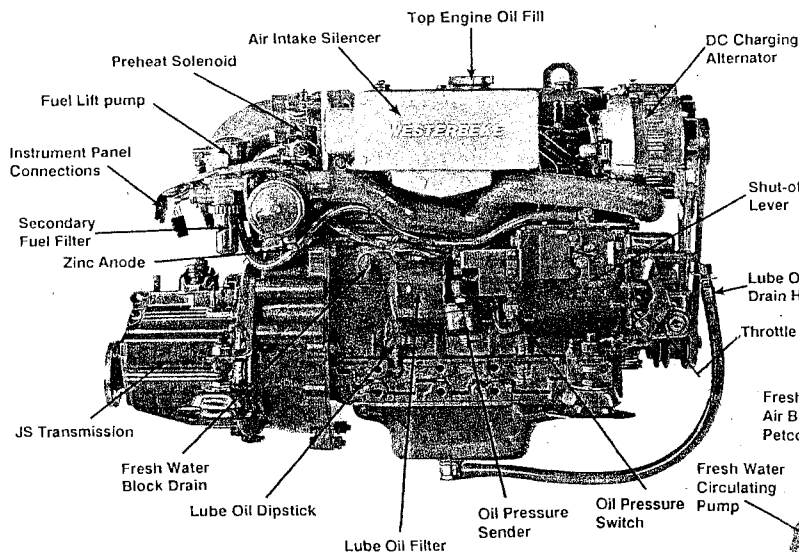
## ORDERING PARTS

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

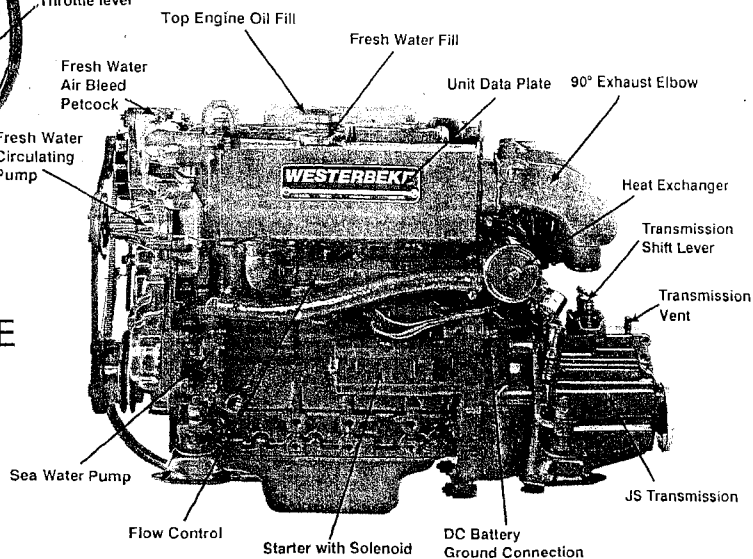
Certain spares will be needed to support and maintain your WESTERBEKE engine. Your local WESTERBEKE dealer will assist you in preparing an inventory of spare parts. See the *SPARE PARTS* page in this manual. For engine accessories, see WESTERBEKE's *ACCESSORIES* brochure.

# PARTS IDENTIFICATION

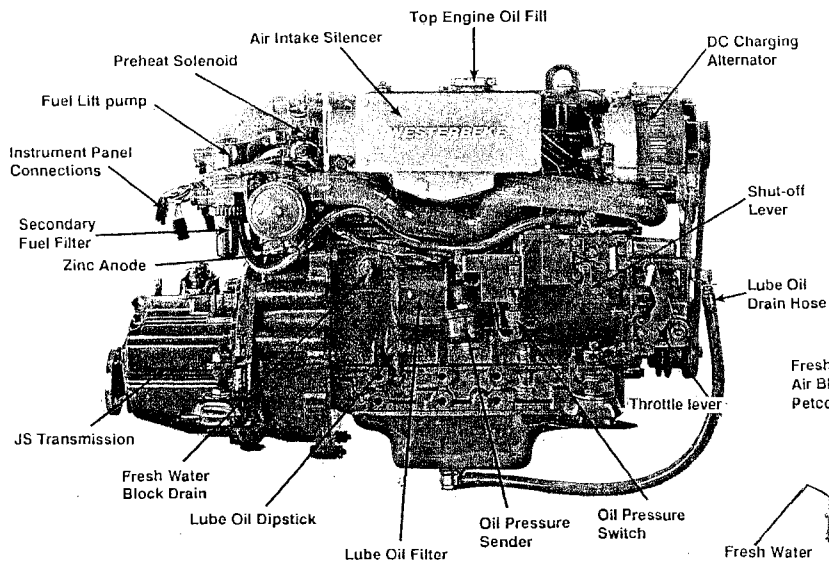


RIGHT SIDE

LEFT SIDE.

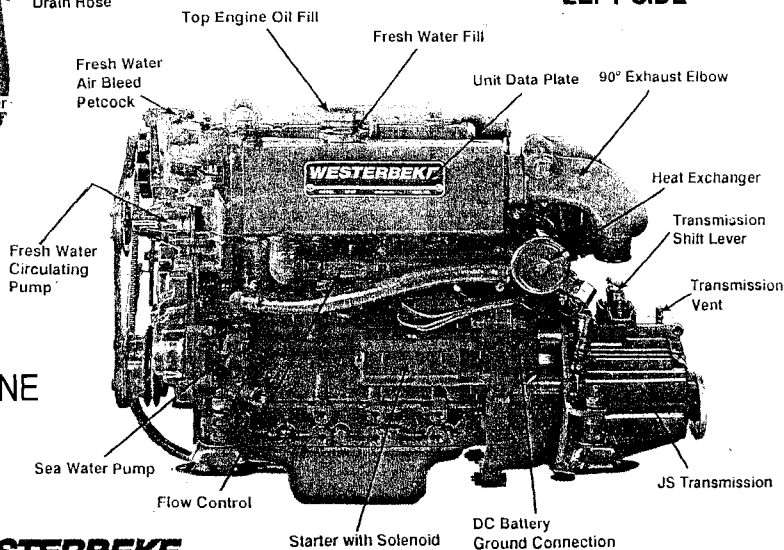


W 42B FOUR MARINE DIESEL ENGINE



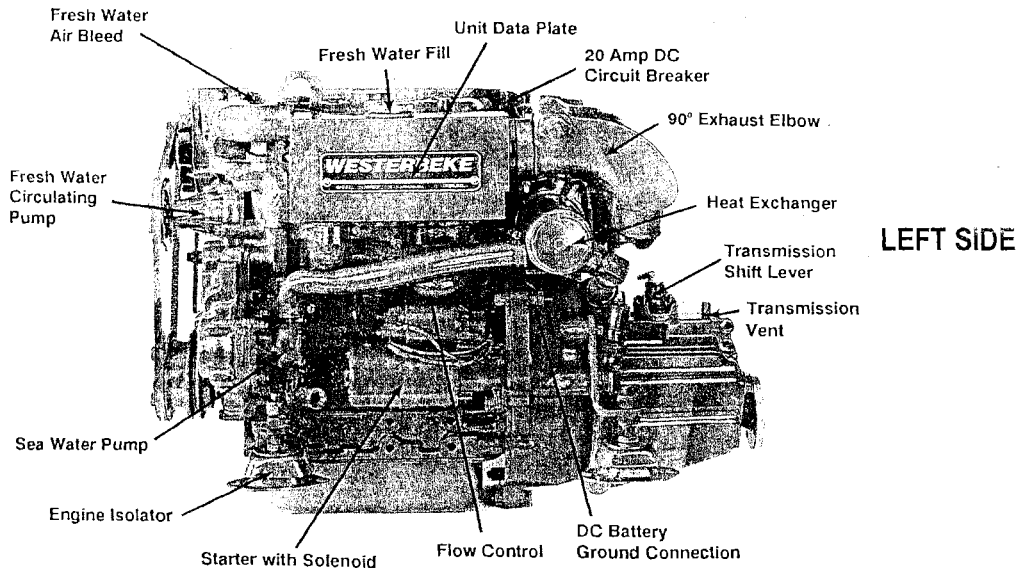
RIGHT SIDE

LEFT SIDE

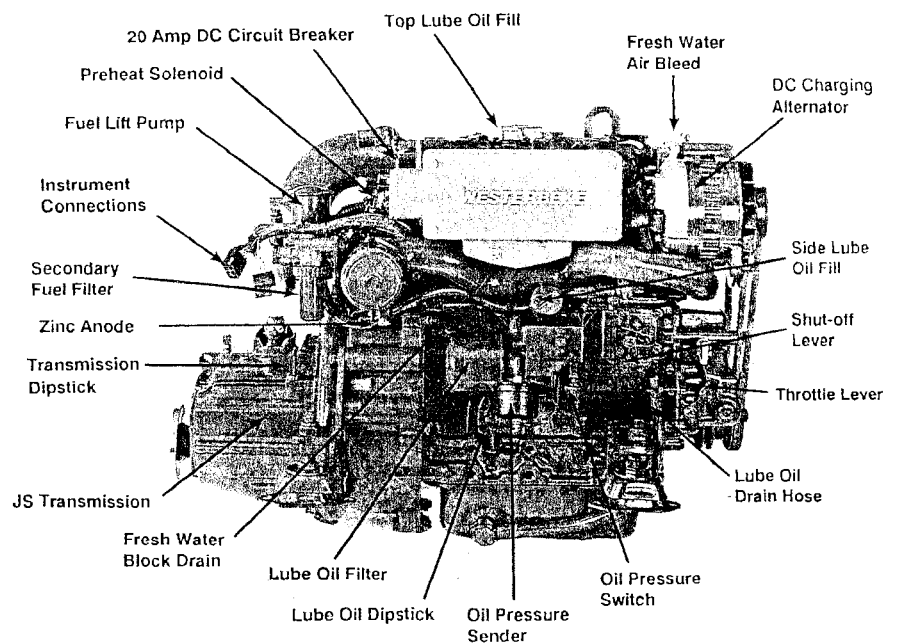


W 38B FOUR MARINE DIESEL ENGINE

# PARTS IDENTIFICATION



**RIGHT SIDE**



## W 35B THREE MARINE DIESEL ENGINE

### TRANSMISSION DATA ( standard JS Transmission )

ALL MODELS.

General:	Case-hardened helical gears with an intermediate reverse gear. Reversing is carried out by a servo double disc system.
Standard Gear Ratio:	2.47 : 1.
Propeller Shaft Rotation:	Right Hand.
Transmission Oil. and Grade.	API Spec. CG-4, CH-4, CI-4, SJ, SL, SM, or better. SAE 20W or SAE 30 exclusively. Do not mix grades of oil and do not use multigrades oils
Transmission Sump Capacity:	1 Quart ( 1 Liter ).
Propeller Recommendations:	42B FOUR ... 18D x 12P, two blade or 18D x 10P three blade 38B THREE... 16D x 12P, two blade or 16D x 10P three blade. 35B THREE... 16D x 10P, two blade or 16D x 8P, three blade. <i>Propeller should allow the engine to reach its full rated RPM ( 3600 +/- 100 ) at full open throttle while underway.</i>

# DIESEL FUEL, ENGINE OIL AND ENGINE COOLANT

## DIESEL FUEL

**USE A DIESEL FUEL WITH 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 diesel fuel. The use of additives to combat BACTERIAL growth in the fuel tank is recommended such as Bio-Bor and e such as Diesel Kleen + cetane Boost to help restore lubricity back into the diesel fuel when an Ultra Low Sulfur diesel is being used. DO NOT use any additives containing ALCOHOL.

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. A **10 micron filter element is recommended.**

## ENGINE OIL

Use a heavy duty engine oil with an API classification and SAE as specified in the Specifications section of this manual for the engine model you have. The engine oil and filter must be changed after the 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.

## 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 may range from 25 psi (1.75 kg/cm<sup>2</sup>) at idle upwards of 80 psi (5.6 kg/cm<sup>2</sup>) at rated rpm.

**NOTE:** A newly started, cold engine can have an oil pressure reading up to 60 psi (4.2 kg/cm<sup>2</sup>). A warmed engine can have an oil pressure reading as low as 25 psi (1.8 kg/cm<sup>2</sup>). These readings will vary depending upon the temperature of the engine and the load placed on the engine.

## 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 the 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.

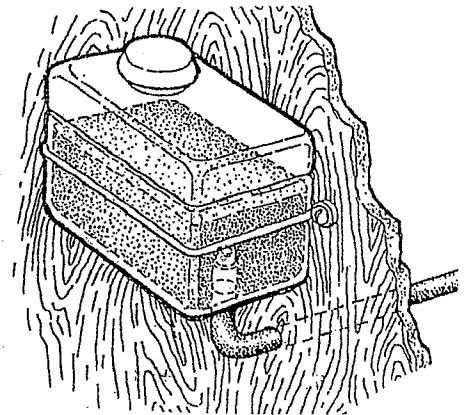
## MAINTENANCE

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:

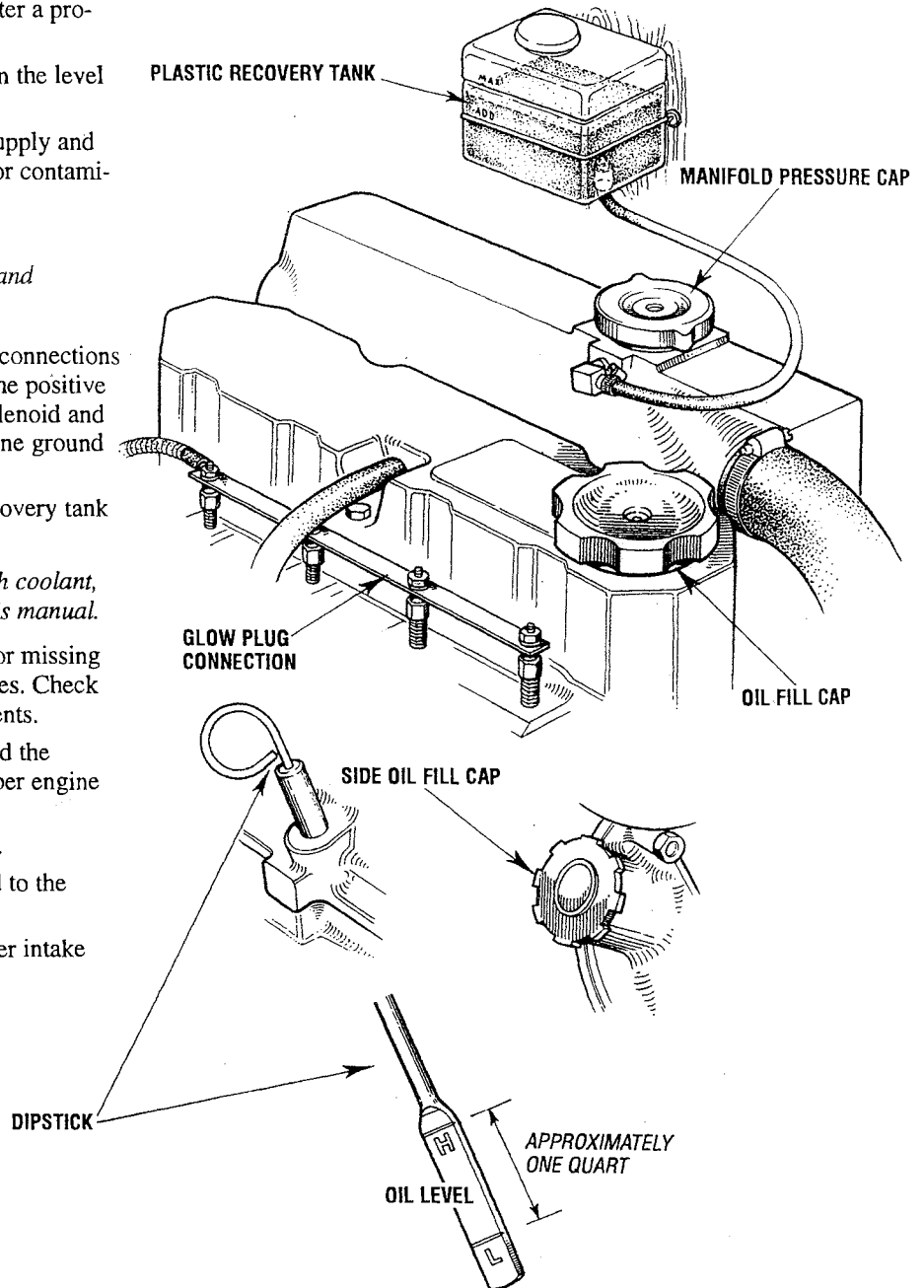
- Check the engine oil level. Add oil to maintain the level at the high mark on the dipstick.
- Turn on the fuel supply, then check the fuel supply and examine the fuel filter/water separator bowl for contaminants.
- Check the transmission fluid level.

**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.



# 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.

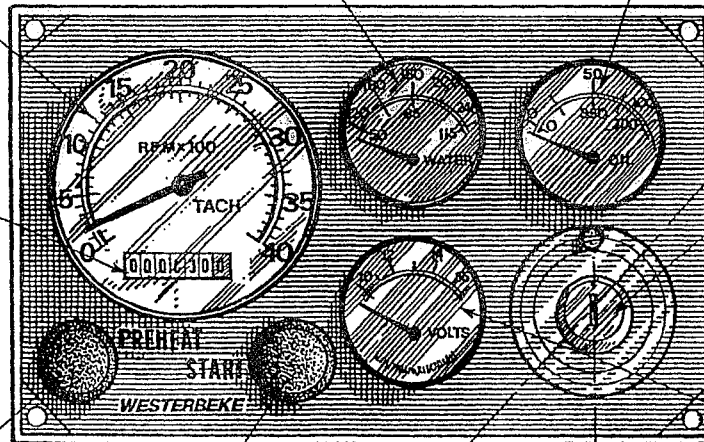
A separate alarm buzzer with harness is supplied with every Admiral Panel. The installer is responsible for electrically connecting the buzzer to the four-pin connection on the engine's electrical harness. The installer is also responsible for installing the buzzer in a location where it will be dry 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/cm<sup>2</sup>).

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

**OIL PRESSURE GAUGE:** THIS GAUGE IS GRADUATED IN POUNDS PER SQUARE INCH (PSI) AND IS ILLUMINATED WHILE THE KEY SWITCH IS TURNED ON. THE ENGINE'S NORMAL OPERATING OIL PRESSURE RANGES BETWEEN 30 - 60 psi (2.1 - 4.2 kg/cm<sup>2</sup>).

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

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

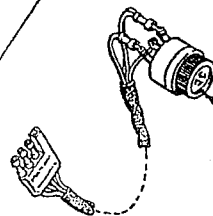


**KEY SWITCH:** THE KEY SWITCH WHEN TURNED ON SUPPLIES DC POWER TO THE INSTRUMENT PANEL CLUSTER, PREHEAT SWITCH, EXCITATION TERMINAL OF THE DC CHARGING ALTERNATOR AND TO THE ALARM BUZZER ENERGIZING IT IN A PULSING MODE.

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

**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.

**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.



**AUTOMATIC ALARM SYSTEM**

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

**OIL PRESSURE ALARM:** AN OIL PRESSURE ALARM SWITCH IS LOCATED OFF THE ENGINE'S OIL GALLERY. THIS SWITCH MONITORS THE ENGINE'S OIL PRESSURE. SHOULD THE ENGINE'S OIL PRESSURE FALL TO 10 - 5 psi (0.7 - 0.4 kg/cm<sup>2</sup>), THE SWITCH WILL CLOSE SOUNDING THE ALARM. IN THIS EVENT, THE ALARM WILL EMIT A PULSATING SIGNAL.

# CAPTAIN CONTROL PANEL

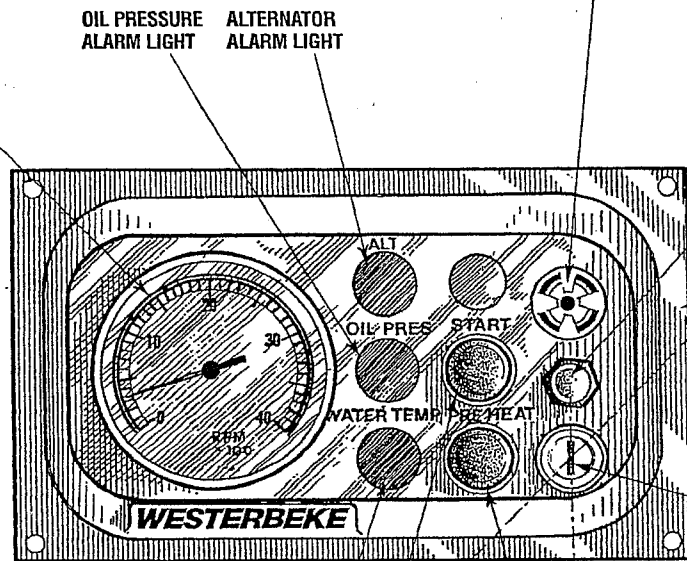
## DESCRIPTION

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/cm<sup>2</sup>). 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/cm<sup>2</sup>), 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.

# 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 following chart:

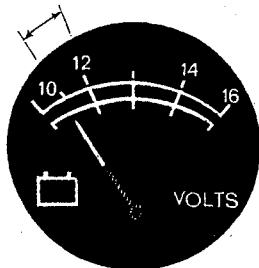
**Temperature/Preheat**

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 an, SAE rating as specified in the **Specifications** section of this manual.

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 key to the OFF position. This opens the DC circuit to the instrument panel and engine, de-energizing the fuel solenoid on the injection pump, stopping fuel flow from it and stopping the engine.

Make certain the 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.



# 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 and that the fuel valve is turned on.
- Look for clean fuel in the fuel filter/water separator transmission 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.
- Check that the raw water thru hull is open.

## 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.

# WARNING LIGHTS, ALARMS & CIRCUIT BREAKER

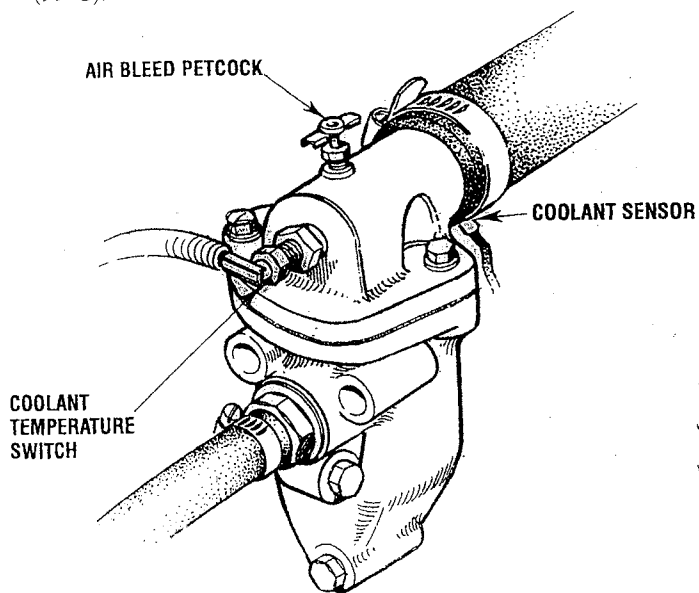
## ALTERNATOR WARNINGS

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.

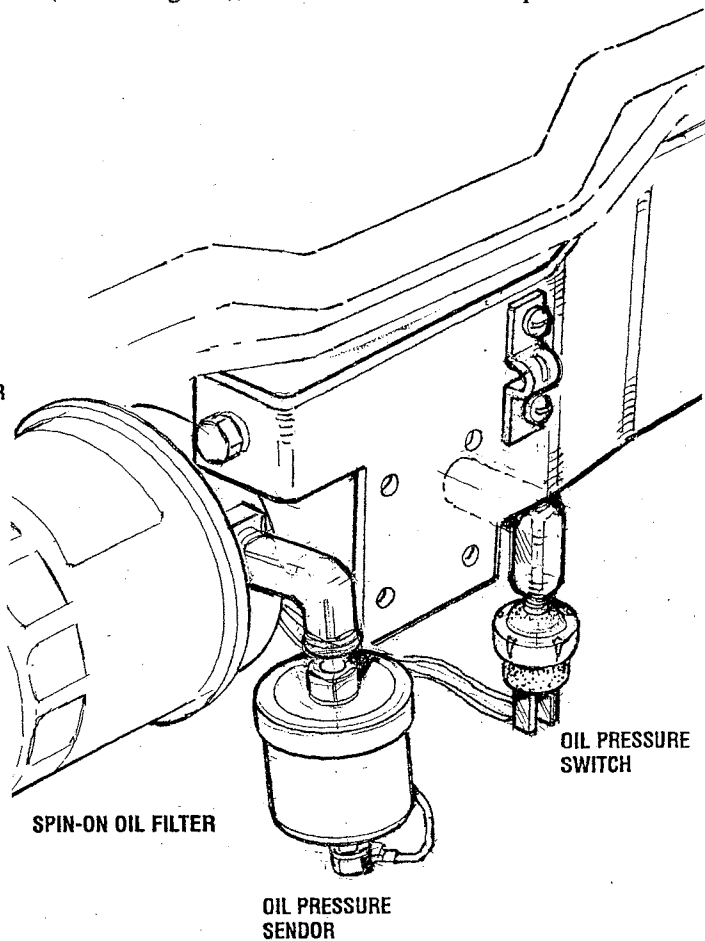
## COOLANT TEMPERATURE SWITCH

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).



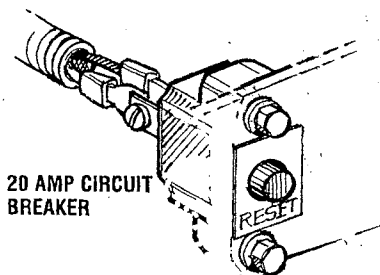
## LOW OIL PRESSURE ALARM SWITCH

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/cm<sup>2</sup>), 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.



# 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, turn off the DC circuit breaker on the control panel, or turn off the battery switch.*

SCHEDULED MAINTENANCE	EXPLANATION OF SCHEDULED MAINTENANCE
<b>DAILY CHECK BEFORE START-UP</b>	
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/Water Separator (owner installed)	Check for water and dirt in fuel. Drain filter if necessary. Replace filter every 250 operating hours or once a year.
Fuel Supply	Use properly filtered #2 diesel with a Cetane rating of #45 or higher. Check that there is adequate fuel for the vessel's needs.
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.
Drive Belts	Inspect for frayed edges. Belts must be <b>properly tensioned</b>
<b>INITIAL 50 HOURS OF OPERATION</b>	
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 Throttle, Transmission and Shutoff Lever Cables	Check Check all connections are secure, proper travel and lubricate with WD-40.
*Head Bolt Torque/Adjust Valves	Torque Bolts and Adjust Valves (cold)
*Fuel Filter	Initial change, then every 250 hours or once a year.
Engine Idle Speed	Refer to Specifications.
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.
<b>EVERY 50 OPERATING HOURS OR MONTHLY</b>	
*Drive Belt (Fresh Water/Raw Water Pumps)	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, no leaks. Connections are clean and tight. Clean/replace filter element if applicable.
Zinc Anode	Inspect and clean zinc anode. Replace if necessary. Note the condition, then determine your own inspection schedule.
<b>EVERY 100 OPERATING HOURS OR YEARLY</b>	
Air Intake Filter	Inspect, clean and replace as needed.
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.
Key Switch (Instrument Panel)	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, no leaks. Connections are clean and tight. Clean/replace filter element if applicable.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.
Engine Oil and Filter	Change the engine oil and oil filter (always together)

# MAINTENANCE SCHEDULE

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

## SCHEDULED MAINTENANCE

## EXPLANATION OF SCHEDULED MAINTENANCE

EVERY 250 OPERATING HOURS OR YEARLY	
Transmission	Change fluid at 300 operating hours. Lubricate control cable and check attachment.
Fuel Filter and O-Rings	Remove and replace fuel filter and all sealing O-rings.
Inlet Fuel Filter	Remove and replace inlet fuel filter.
DC Alternator	Check mounting bracket, tighten electrical connections.
*Electric Fuel Pump	Inspect, no leaks. Connections are clean and tight. Clean/replace filter element if applicable.
*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. <b>NOTE:</b> An exhaust leak will cause exposure to diesel exhaust!
EVERY 500 OPERATING HOURS OR YEARLY	
*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.
*Head Bolt Torque/Adjust Valves	Torque Bolts and Adjust Valves (cold)
*Starter Motor	Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive.
Raw Water Pump	Remove from engine, remove cover and inspect cam and wear plates. Replace any components showing wear. If needed, replace impeller and gasket. Lubricate when re-assembling.
*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.
Crank Case Vent	Clean crank case vent components located inside the rocker cover. Replace filter element as needed.
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.
Crankcase Ventilation Valve	Disassemble and clean. Replace as needed.
*Fuel Injectors	Pressure test injectors/re-build at 1500 hours.
*Transmission Oil Cooler (as applicable)	Remove and have professionally tested and cleaned.
*Starter Motor	Remove, clean and lubricate the drive.
*Transmission Damper Plate	Inspect the damper plate, replace if necessary (damper plate chatter at idle speed is an indication of damper spring wear).

**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

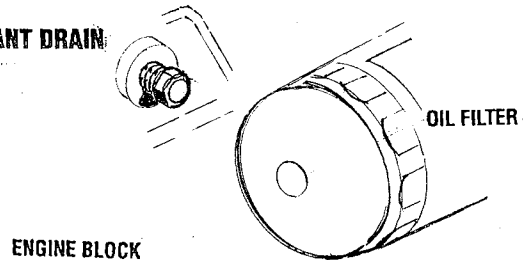
The engine's coolant must be changed according to the *MAINTENANCE SCHEDULE*. If the coolant is allowed to become contaminated, it can lead to overheating problems.

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

To drain the engine coolant, Loosen the manifold pressure cap, and remove the coolant drain located on the engine block. Releasing the coolant drain on the heat exchanger will also help the coolant flow.

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

ENGINE COOLANT DRAIN



# COOLING SYSTEM

## Refilling the Coolant

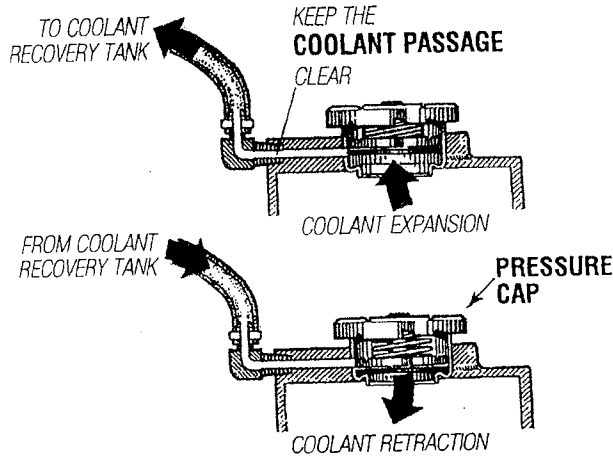
After replacing the engine block drain plug, close the heat exchanger's coolant petcock. Then pour clean, premixed coolant into the manifold and when the coolant is visible in the manifold, start the engine and run it at slow idle.

**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.

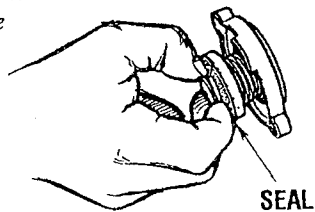
Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and install the manifold pressure cap.

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.



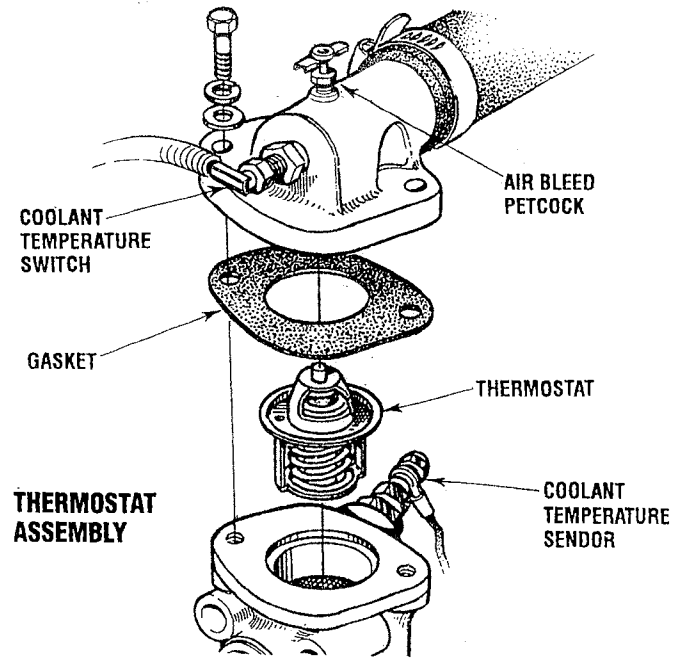
## THERMOSTAT

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

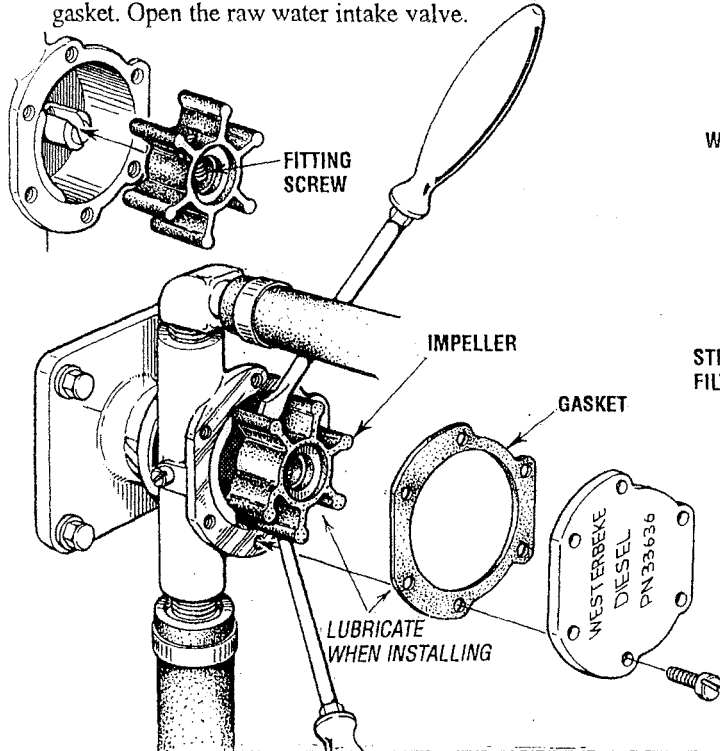
The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. On no account should this pump be run dry as water acts as a lubricant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

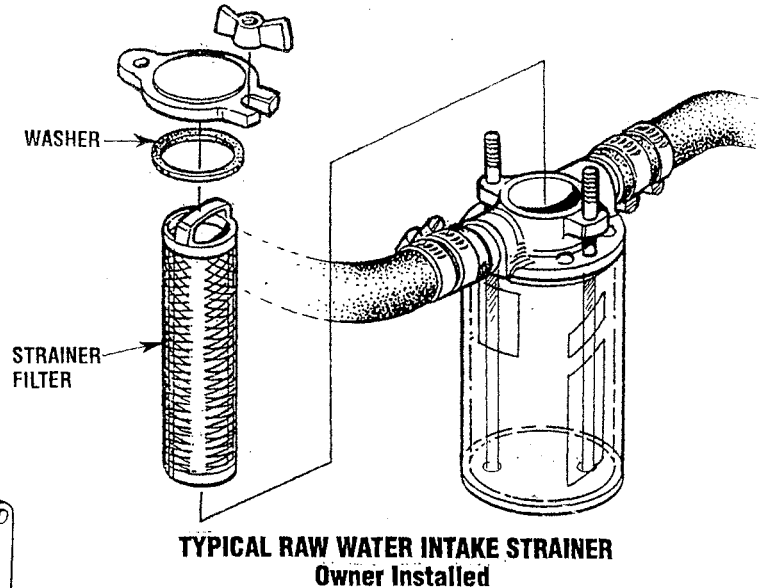
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

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.

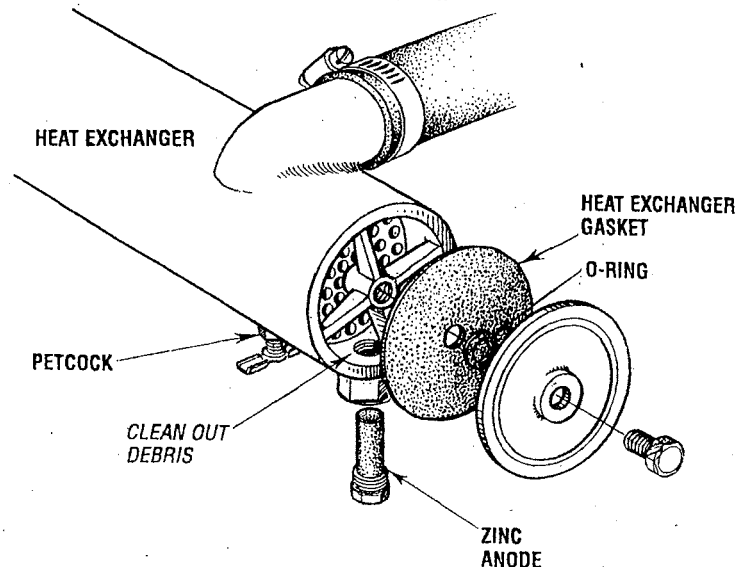
**NOTE:** Also follow the above procedure after having run hard aground.

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.



## 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.





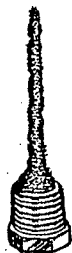
# COOLING SYSTEM

## Zinc Anode

Two zinc anodes, or *pencils*, are located in the raw water cooling circuit within the heat exchanger. The purpose of having the 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 anodes should be checked monthly and the anodes 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

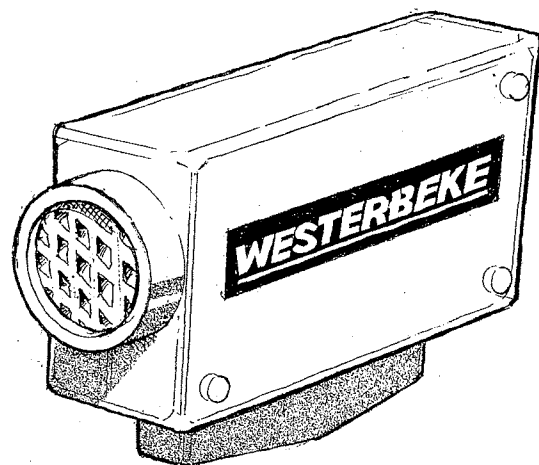
After approximately 1000 hours of operation, remove, clean and pressure test the engine's heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

**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. The intake silencer allows for unrestricted air flow into the engine while lessening the air intake pulsing noise typical of a diesel engine. The intake silencer needs little maintenance other than ensuring its air intake opening remains unobstructed. There is no filter element in the silencer to service. The marine environment has little if any air born contaminants that can effect the engine.



# FUEL SYSTEM

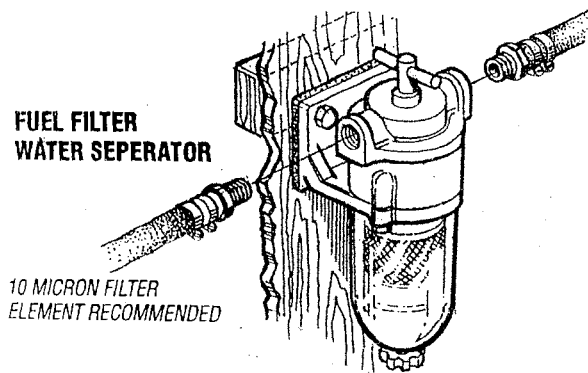
## DIESEL FUEL

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

## FUEL/WATER SEPARATOR

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

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 filtration/separation system.



## FUEL FILTERS

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

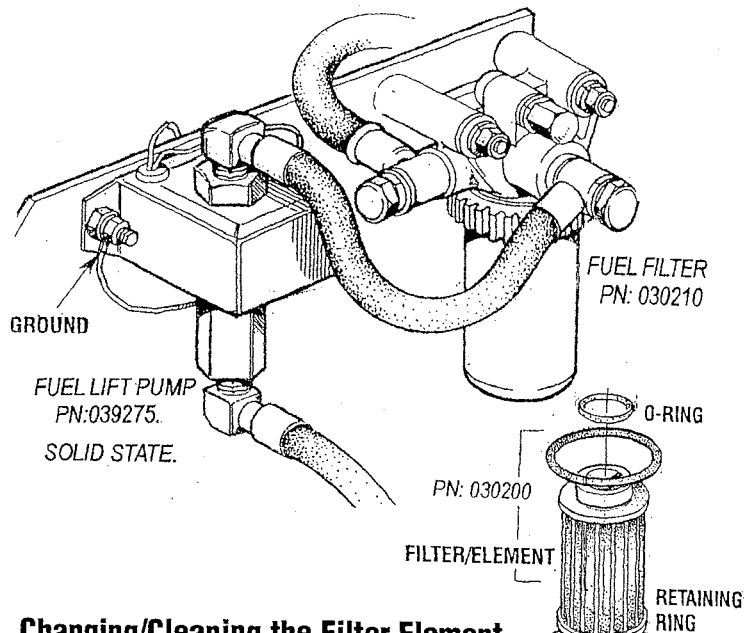
## ENGINE FUEL FILTER

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

## FUEL LIFT PUMP (#039275)

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 operation.

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.



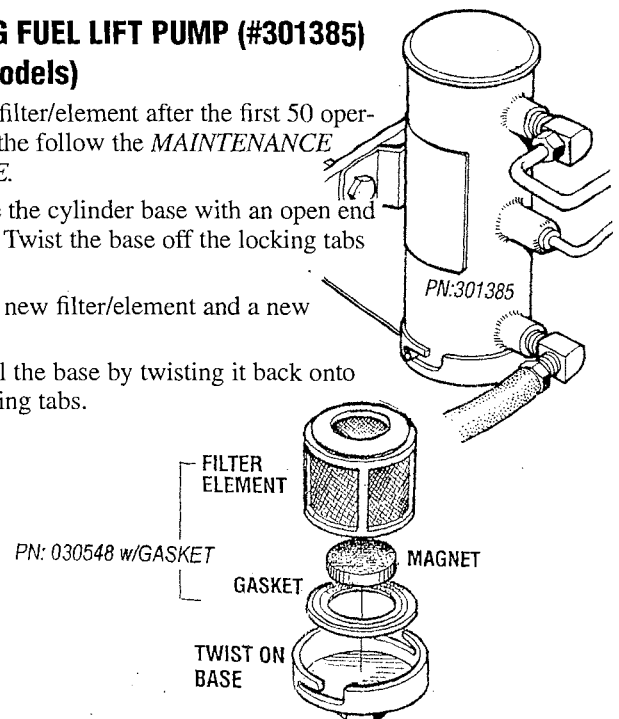
## Changing/Cleaning the Filter Element

1. Shut off the fuel supply.
2. Unscrew the retaining ring and lower the filter bowl away from the housing (careful not to spill fuel).
3. Clean the bowl and replace the filter element.
4. Replace the sealing O'ring and assemble the bowl to the housing. Thread the retaining ring onto the housing carefully so as not to cross thread.
5. Open the fuel supply and run the engine to inspect for leaks.

## SERVICING FUEL LIFT PUMP (#301385) (Earlier Models)

Change the filter/element after the first 50 operating hours the follow the *MAINTENANCE SCHEDULE*.

1. Remove the cylinder base with an open end wrench. Twist the base off the locking tabs to open.
2. Install a new filter/element and a new gasket.
3. Reinstall the base by twisting it back onto the locking tabs.



# FUEL SYSTEM

## FUEL INJECTORS

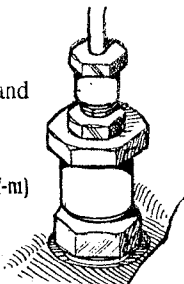
In case of severe vibrations and detonation noise, have the injectors checked and overhauled by an authorized fuel injection service center. Poor fuel quality, contaminants and loss of positive fuel pressure to the injection pump can result in injector faults. Since fuel injectors must be serviced in 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  $40 \pm 4$  ft-lb ( $5.5 \pm 0.5$  kgf-m)

INJECTOR



## 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*).

## 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

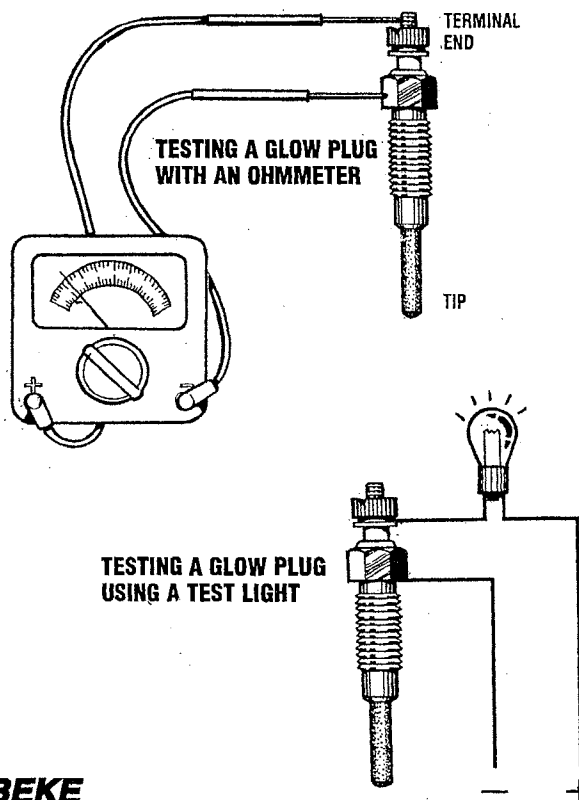
An accurate way to test glow plugs is with an ohmmeter. Touch one prod to the glow plug's wire connection, and the other to the body of the glow plug, as shown. A good glow plug will have a 1.0-1.2 ohm resistance. This method can be used with the plug in or out of the engine. You can also use an ammeter to test the power drain 10-12 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.

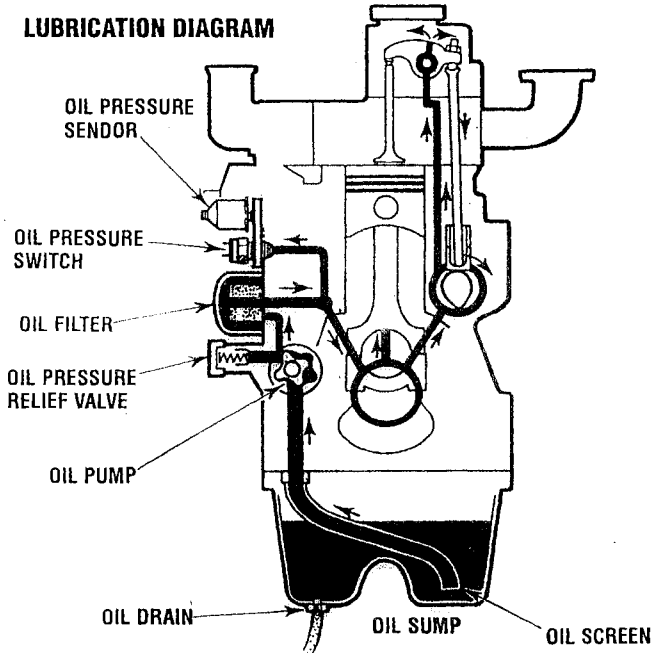
**WARNING:** Do not keep a glow plug on for more than 30 seconds.

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



# ENGINE LUBRICATING OIL

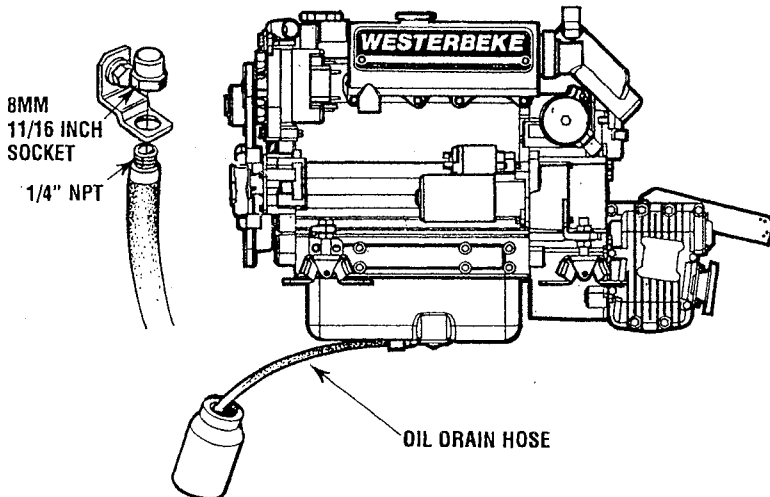
## LUBRICATION DIAGRAM



## 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.

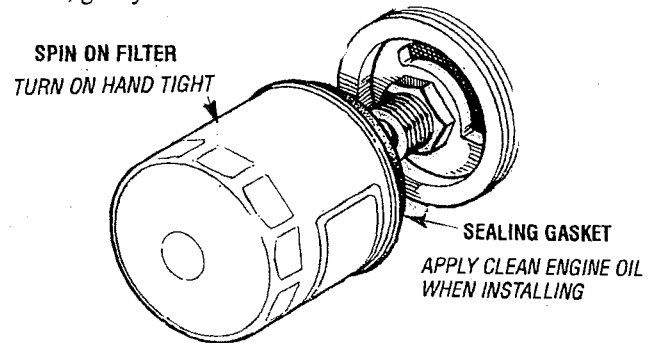


Always observe the used oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a qualified mechanic should water be present in the oil. Raw water present in the oil can 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

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

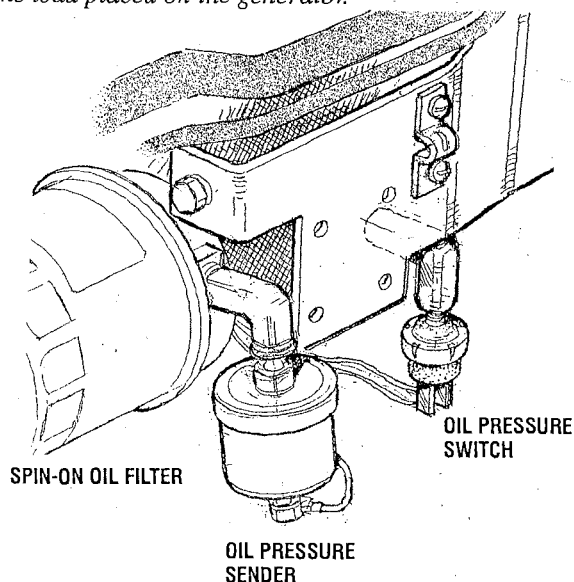
## DESCRIPTION

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

During normal operation, the oil pressure may range from 25psi (1.75kg/cm) at idle upwards of 80psi (5.6kg/cm) at rated rpm.

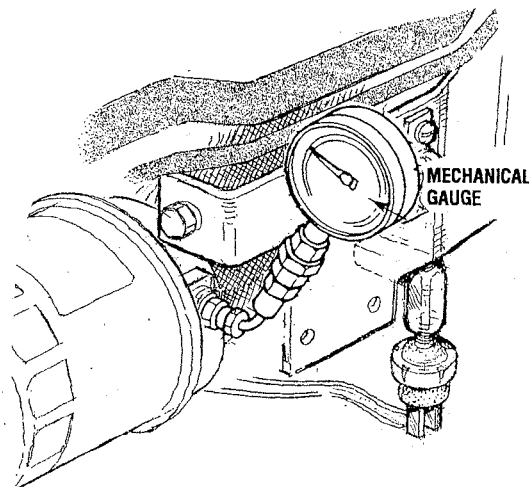
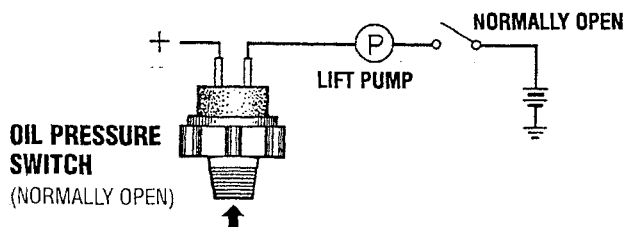
An oil pressure relief valve is located on the fixture the oil filter threads onto. This valve functions to maintain normal engine operating oil pressure.

**Note:** A newly started (cold) engine may have an oil pressure up to 70 or 80 psi. A warmed engine can have an oil pressure as low as 30 psi. Oil pressure will vary depending on the load placed on the generator.



## OIL PRESSURE SWITCH

There is an oil pressure switch connected into the engine's oil gallery to monitor the engine oil pressure and to sound the panel alarm buzzer should a low oil pressure issue occur (10-5 psi). The engine alarm buzzer in such cases will sound continuously.



## TESTING THE OIL PRESSURE

**NOTE:** Insure that the oil meets the following standards: API Specification CF or CG-4, SAE 30, 10W-30, 15W-40.

1. Remove the oil pressure sender and then install a mechanical oil pressure gauge in its place.
2. Start the engine and let it thoroughly warm up.
3. Check for oil leaks at the filter and pump assembly.
4. Maintain the engine rpm at 3,000 and note the gauge reading.

Oil Pressure 35.0 lb/in<sup>2</sup> (3.8 kg/cm<sup>2</sup>) or more at 3000 rpm.

5. If the pressure does not come up to the specified pressure, check the lubrication system and repair if necessary (see *ENGINE TROUBLESHOOTING*).

A gradual loss of oil pressure usually indicates a specific bearing failure. For additional information on low oil pressure readings, see "OIL PRESSURE DROP" under "ENGINE TROUBLESHOOTING."

## OIL PRESSURE SWITCH/SENDER

When installing an oil pressure switch or sender, apply a teflon sealant to the threads being careful not to close off the oil hole in the sender.

SENDER AND SWITCH TORQUE 9 - 13 ft-lb (1.2 - 1.8 m - Kg).

**CAUTION:** OIL PRESSURE SWITCH-Do not use lock pliers, vise grips or pipe wrenches on the oil pressure switch. Use the correct socket which is available from Snap-on, Proto, New Britain and others. Damage to the switch will cause oil leaks and/or switch failure.

# REMOTE OIL FILTER (OPTIONAL)

(PN. 032149)

## INSTALLATION

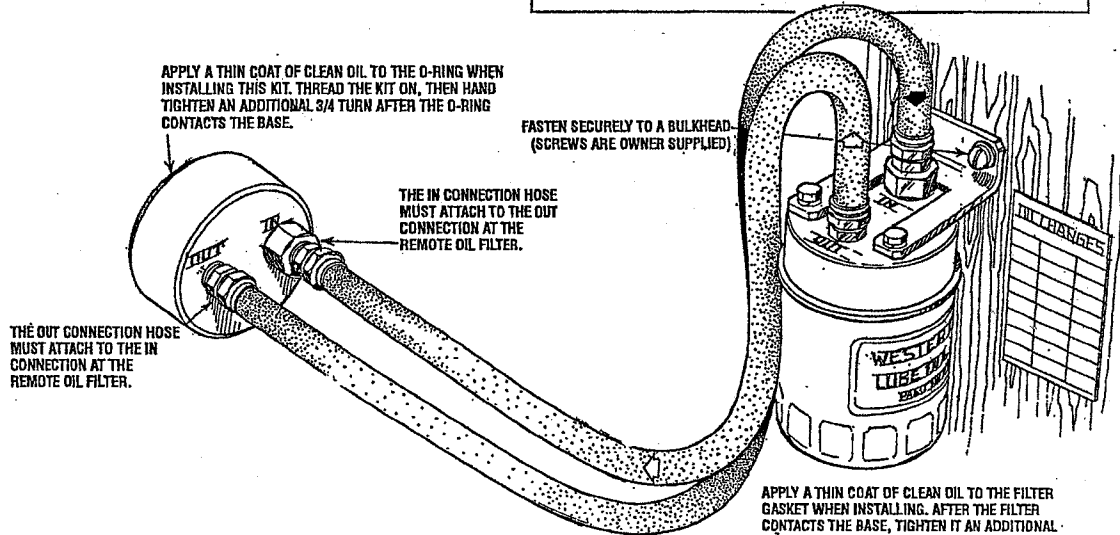
This popular accessory is used to relocate the engine's oil filter from the engine to a more convenient location such as an engine room bulkhead.

**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.

**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.



## TORQUE SPECIFICATIONS

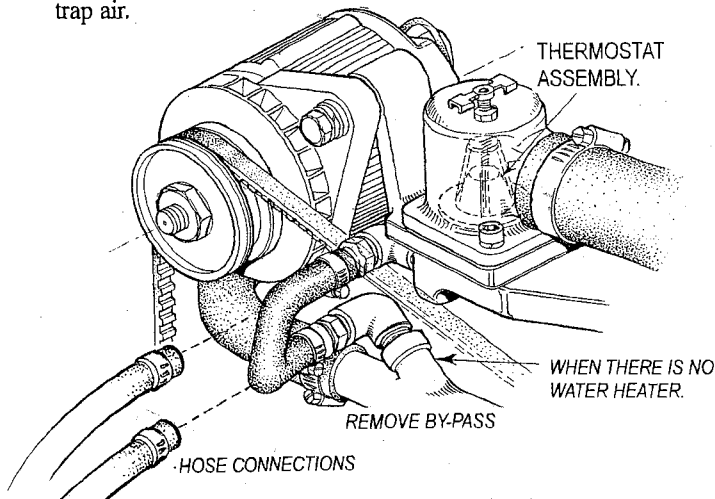
		Lb-ft	Kg-m
Cylinder Head Bolt	(M10)	47.0 - 57.9	6.5 - 8.0
	(M12)	83.2 - 90.4	11.5 - 12.5
(See the <i>Torquing Cylinder Head Bolts</i> section of this manual.)			
<i>M8 indicates Metric, 8mm thread diameter.</i>			
Crankshaft Pulley Nut		108.5 - 144.7	15.0 - 20.0
Main Bearing Cap Nut		36.2 - 39.7	5.0 - 5.5
Connecting Rod Cap Nut		23.1 - 25.3	3.2 - 3.5
Flywheel Bolt - with separate washers.		83.2 - 90.4	11.5 - 12.5
Flywheel Bolt - washer attached		94.0 - 101.3	13.0 - 14.0
Oil Pan Drain Plug		36.2 - 43.4	5.0 - 6.0
Oil Filter		8.0 - 9.4	1.1 - 1.3
(or tighten firmly by hand)			
Delivery Valve Holder (injection pump)		28.9 - 36.2	4.0 - 5.0
Nozzle Mounting Bolt		10.8 - 14.5	1.5 - 2.0
Nozzle Holder and Retaining Nut		43.4 - 57.9	6.0 - 8.0
Glow Plug		10.8 - 14.5	1.5 - 2.0



# WATER HEATER

## WATER HEATER INSTALLATIONS

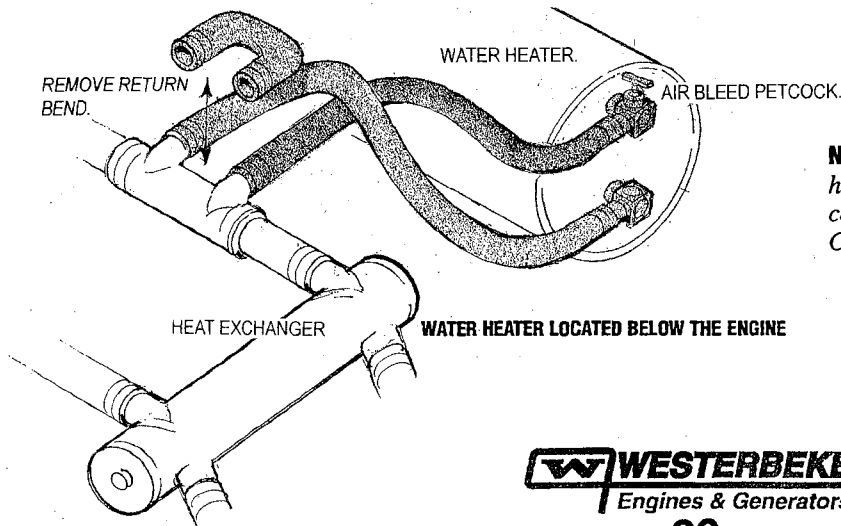
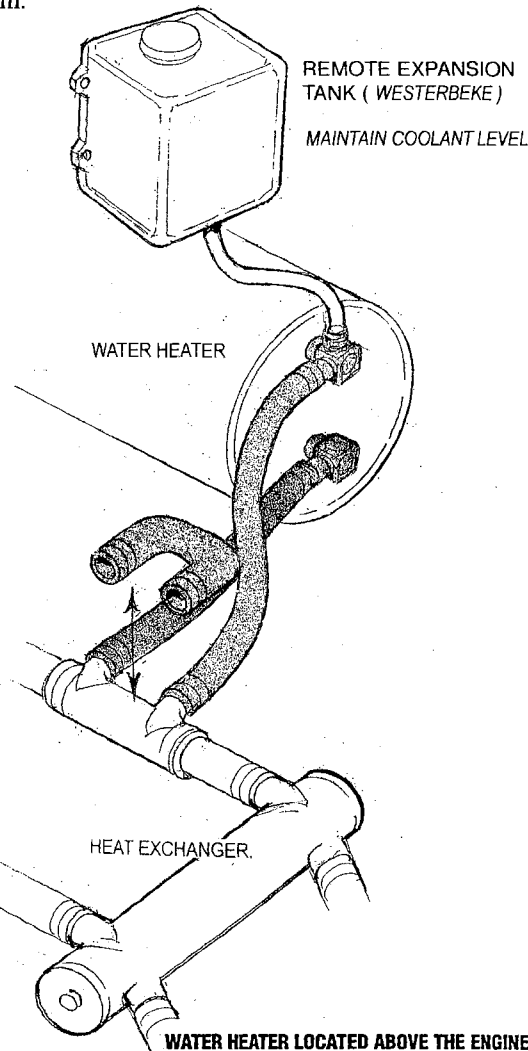
This engine is equipped with connections for the plumbing of engine coolant to transfer heat to an on-board water heater. The water heater should be mounted in a convenient location either in a high or low position in relation to the engine, so that the connecting hoses from the heater to the engine 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.

**CAUTION:** Beware of the hot engine coolant - wear proper gloves.



# STARTER MOTOR

## PN.053295

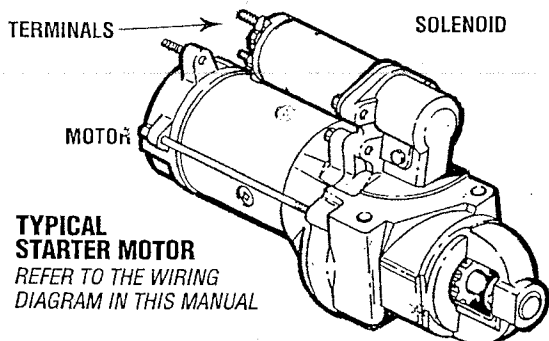
### DESCRIPTION

The starting system includes the battery, starter motor, solenoid, and starter button.

When the starter button on the instrument panel is depressed, current flows and energizes the starter's solenoid coil. The energized coil becomes an electromagnet, which pulls the plunger into the coil, and closes a set of contacts which allow high current to reach the starter motor. At the same time, the plunger also serves to push that starter pinion to mesh with the teeth on the flywheel.

To prevent damage to the starter motor when the engine starts, the pinion gear incorporates an over-running (one-way) clutch which is splined to the starter armature shaft. The rotation of the running engine may speed the rotation of the pinion but not the starter motor itself.

Once the started button is released, the current flow ceases, stopping the activation of the solenoid. The plunger is pulled out of contact with the battery-to-start cables by a coil spring, and the flow of electricity is interrupted to the starter. This weakens the magnetic fields and the starter ceases its rotation. As the solenoid plunger is released, its movement also pulls the starter drive gear from its engagement with the engine flywheel.



**TYPICAL STARTER MOTOR**  
REFER TO THE WIRING DIAGRAM IN THIS MANUAL

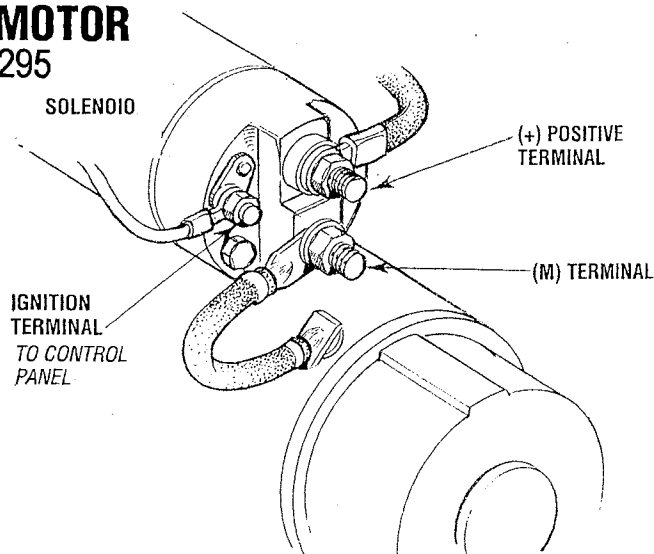
### TROUBLESHOOTING

Prior to testing, make certain the ship's batteries are at full charge and that the starting system wiring connections (terminals) are clean and tight. Pay particular attention to the ground wire connections on the engine block.

To check the wiring, try cranking the starter for a few seconds, never more than 10 seconds at a time, then run your hand along the wires and terminals looking for warm spots that indicate resistance. Repair or replace any trouble spots.

Using a multimeter, test the voltage between the positive terminal stud on the start solenoid and the engine block (ground).

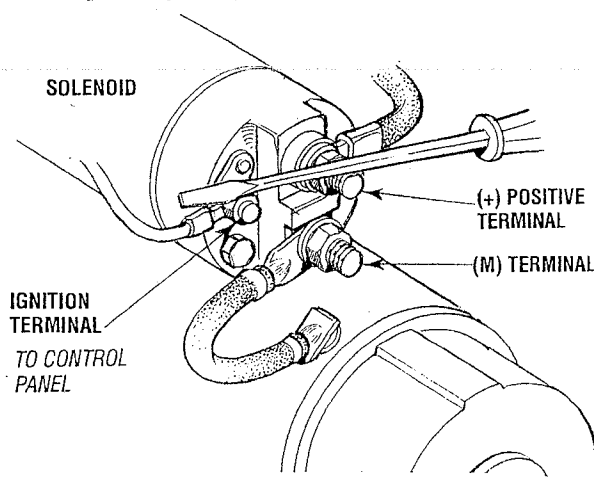
If you read 12 volts, the starter is faulty.



To test the ignition circuit, locate the ignition(s) terminal (it is one of the small terminal studs and is wired to the ignition circuit). Use a screwdriver, don't touch the blade, to jump from that ignition terminal to the positive battery connection terminal on the solenoid.

**If the starter cranks, the fault lies with the ignition circuit.**

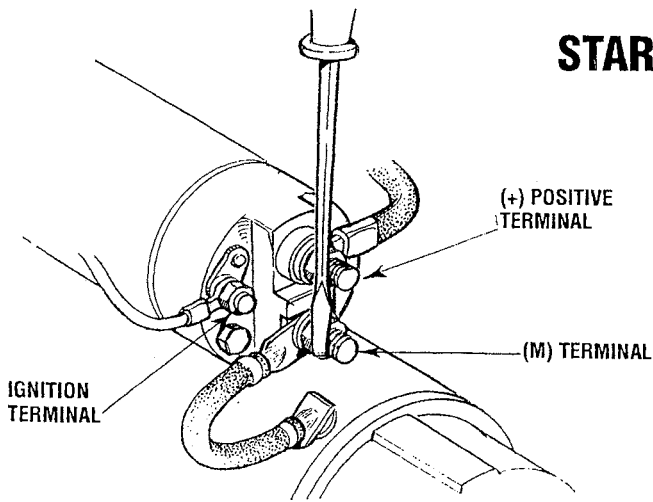
**If the solenoid clicks but nothing else happens, the starter motor is probably faulty.**



**If nothing at all happens the solenoid isn't getting current.** Check the battery isolation switch and inspect the wiring connections. It is also possible that the solenoid is defective.

**⚠ WARNING:** *There will be arcing and sparks will fly when jumping terminals. Be certain the engine space is free of potentially explosive fumes, especially gasoline.*

# STARTER MOTOR



Test again by jumping the two large terminal studs. Hold the screwdriver blade firmly between the studs. Do not allow the screwdriver blade to touch the solenoid or starter casing, this would cause a short.

**⚠ WARNING:** *There will be arching as the full starting current should be flowing thru the blade of the screwdriver.*

If the starter spins, the solenoid is faulty.

If the starter fails to spin, the motor is probably faulty.

If no arching occurred. There is no juice reaching the solenoid.

**NOTE:** *Starter motors are either inertia type or pre-engaged. In the pre-engaged model, the solenoid also moves an arm that engages the starter motor to the flywheel of the engine. Using a screwdriver to bypass the solenoid on such a starter will run the motor without engaging the flywheel. Turn the starter switch on to provide the power to the solenoid. Hopefully it will create enough magnetic field for the arm to move even though the contacts inside the solenoid are bad.*

## SERVICE

Westerbeke uses a standard marine starter motor which can be serviced or rebuilt at any starter motor automotive service center.

If replacing the starter motor, make certain the new motor is certified for marine use. Automotive starters do not meet USCG standards. If in doubt, contact your WESTERBEKE dealer.

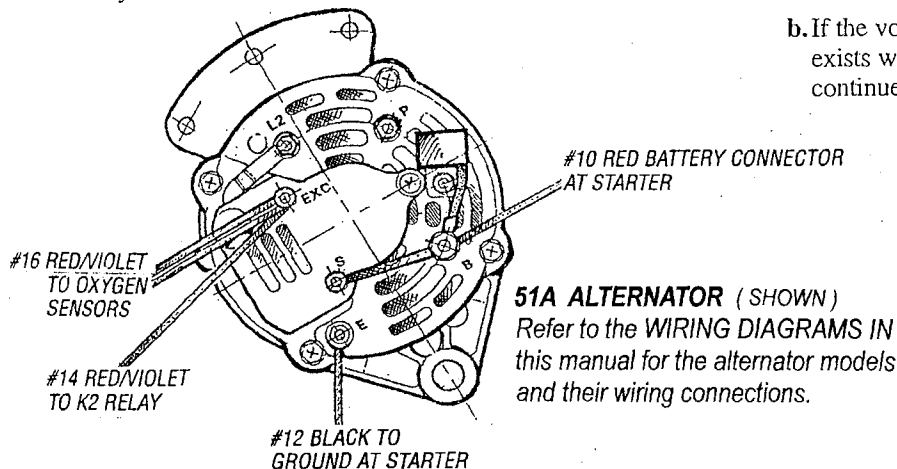
## TO REMOVE FOR SERVICE

1. Disconnect the negative battery cable.
2. If necessary, remove any components to gain full access to the starter motor.
3. Label and disconnect the wiring from the starter. (Do not allow wires to touch, tape over the terminals).
4. Remove the starter mounting bolts.
5. Remove the starter from the engine. In some cases the starter will have to be turned to a different angle to clear obstructions.

# 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.

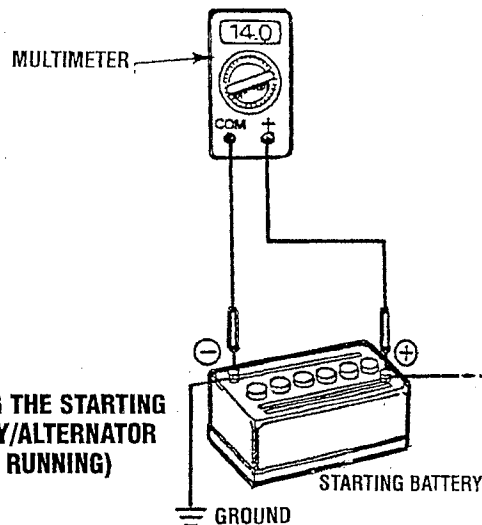
## Testing the Alternator

**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)

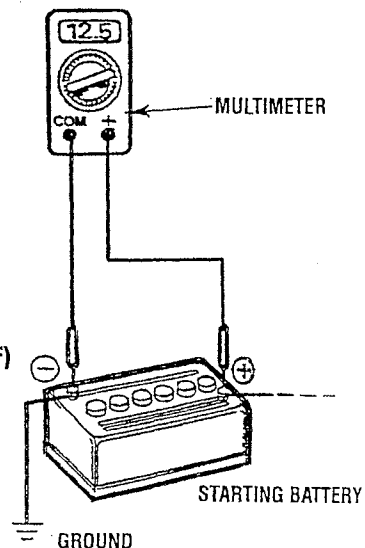


3. Turn off the engine. Inspect all wiring and connections. Ensure that the battery terminals and the engine ground connections are tight and clean.

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

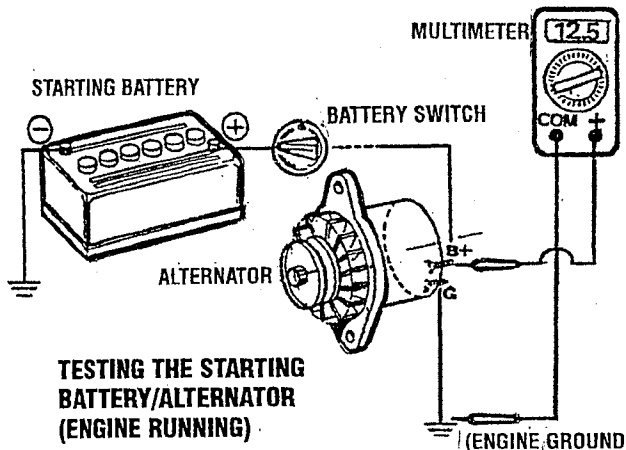
4. If a battery selector switch is in the charging circuit, ensure that it is on the correct setting.
5. Turn on the ignition switch, but do not start the engine.
6. Check the battery voltage. If the battery is in good condition, the reading should be 12 to 13 volts.

## 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.



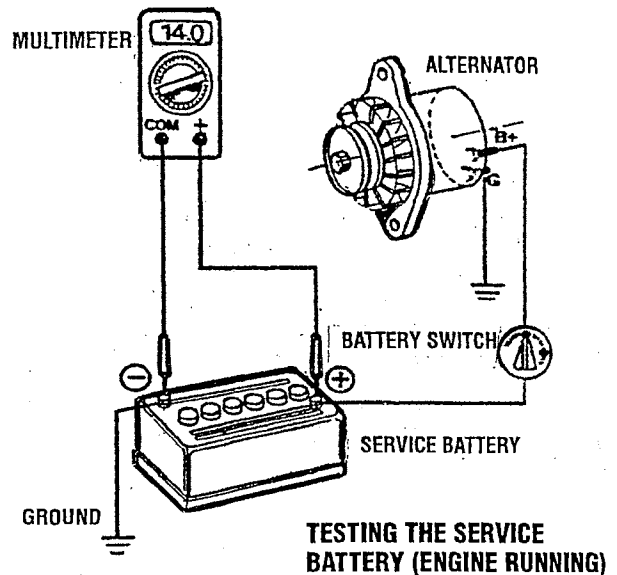
8. Start the engine again. Check the voltage between the alternator output and ground. The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or under-charging, have it repaired at a reliable service facility.

**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 recommended "dedicated" battery used for the engine's starting 12 volt DC control circuit should be 800-1000 Cold Cranking Amps (CCA) rated.

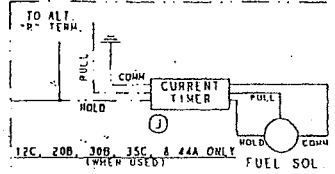
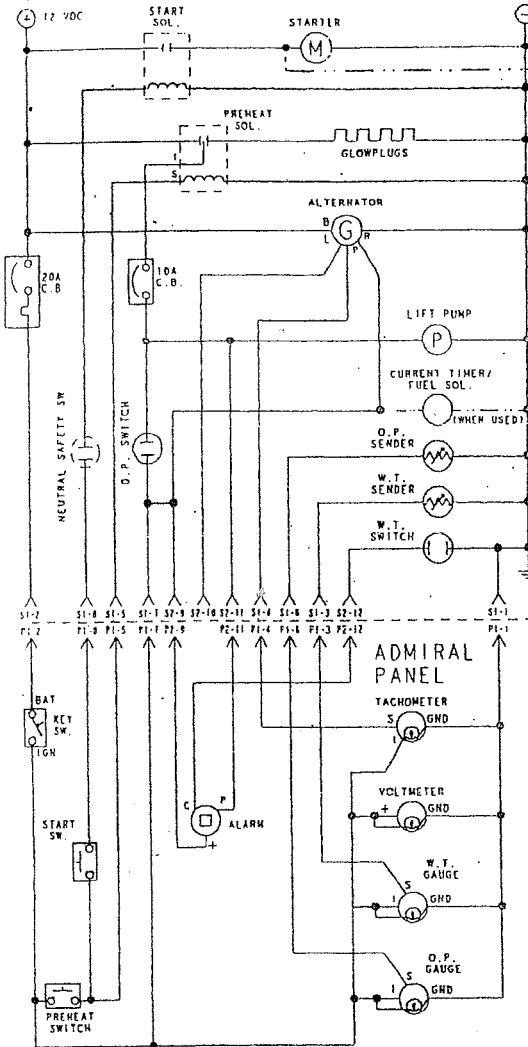
## Battery Care

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

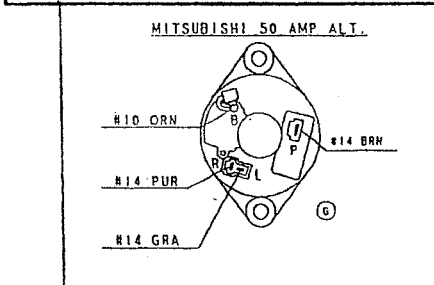
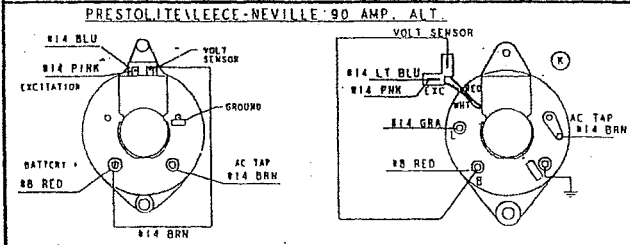
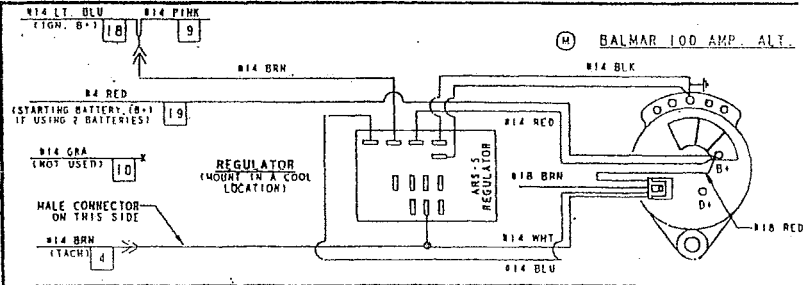
- Monitor your voltmeter for proper charging during engine operation.
- Check the electrolyte level and specific gravity with a hydrometer.
- Use only distilled water to bring electrolytes to a proper level.
- Make certain that battery cable connections are clean and tight to the battery posts (and to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

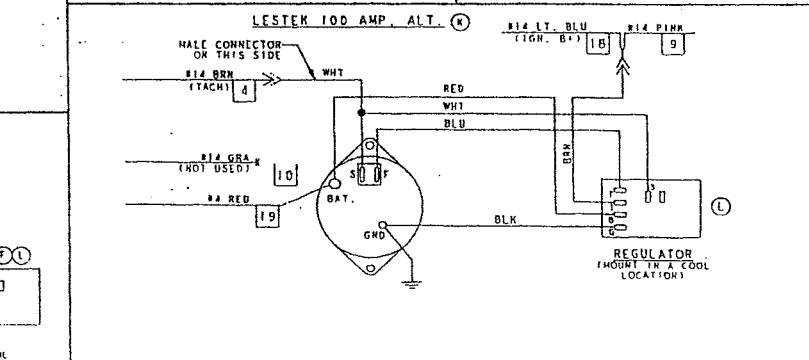
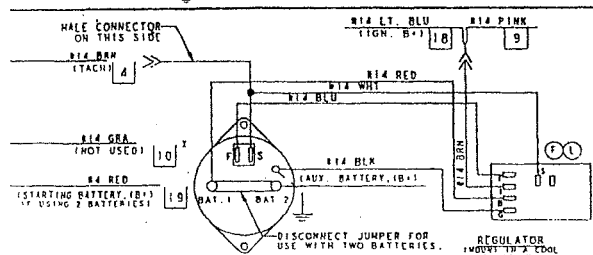
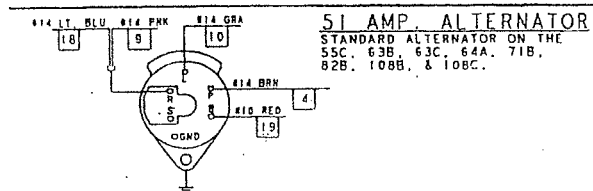
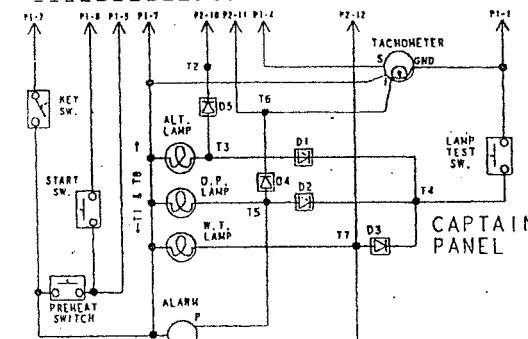
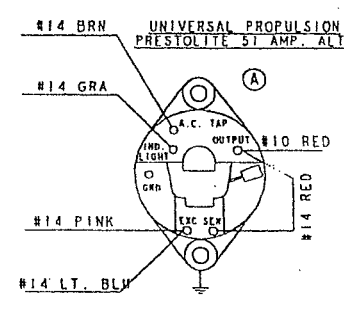
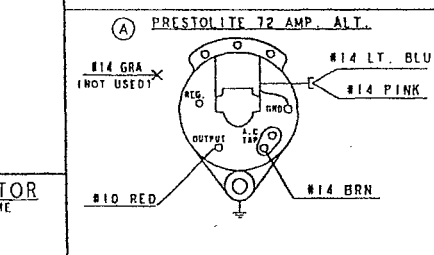
# PROPULSION ENGINE WIRING SCHEMATIC #039144



- NOTES:**
1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER. EXCESSIVE CURRENT WILL CAUSE THE BREAKER TO TRIP AND THE ENGINE WILL SHUT DOWN. THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING, AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SEAWATER.
  2. AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VDC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.
  3. THE PINK WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED. CAPTAIN PANEL ONLY.
  4. THE GRAY WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED. ADMIRAL PANEL ONLY.



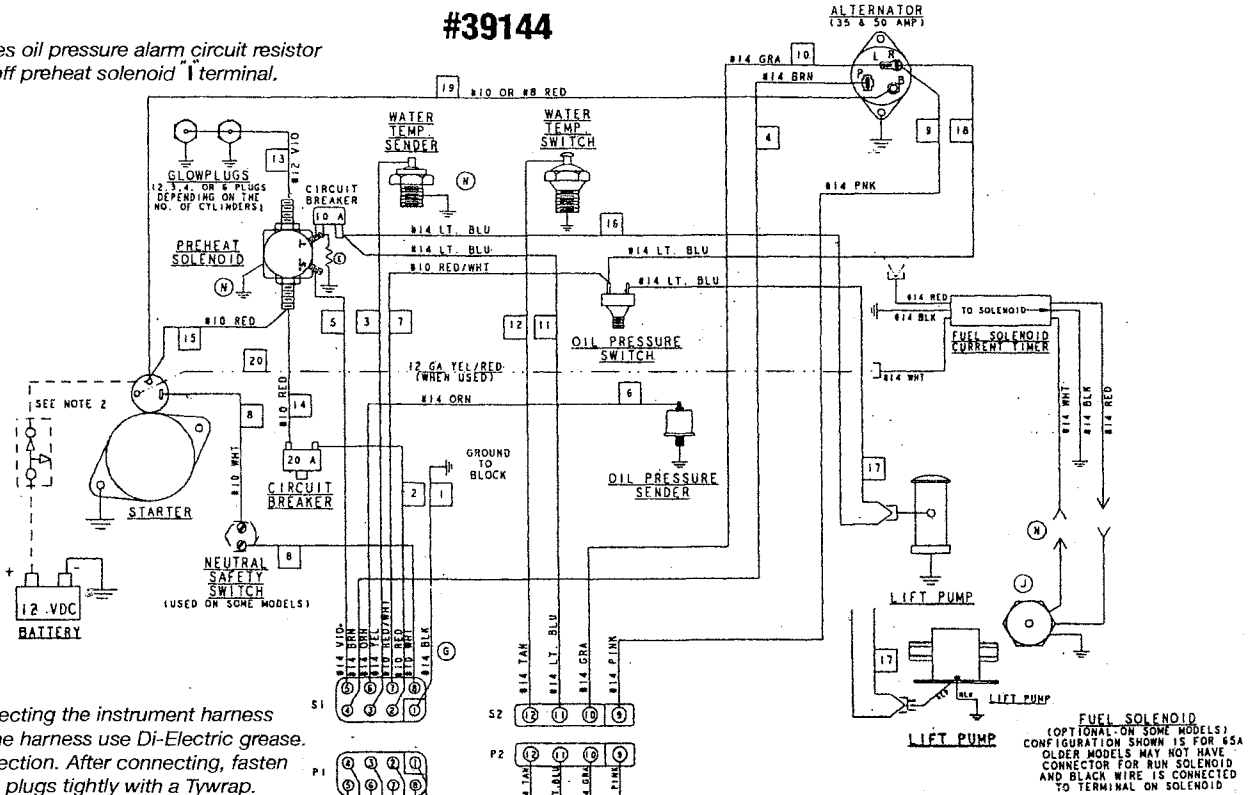
NOTE: WIRE FOR BATTERY ATTACHMENT WILL NEED TO BE UPGRADED TO AN 8 GAUGE FROM 10 GAUGE



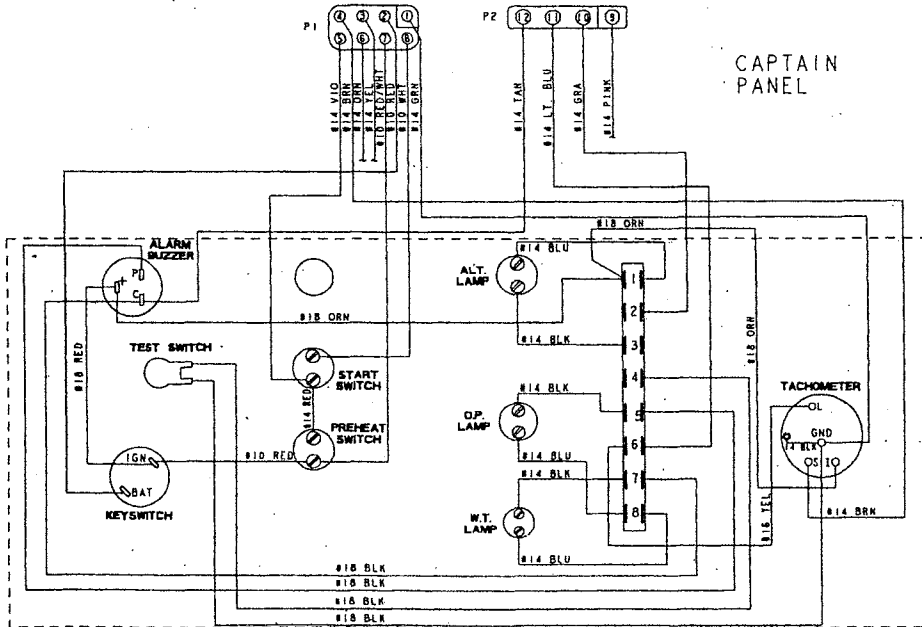
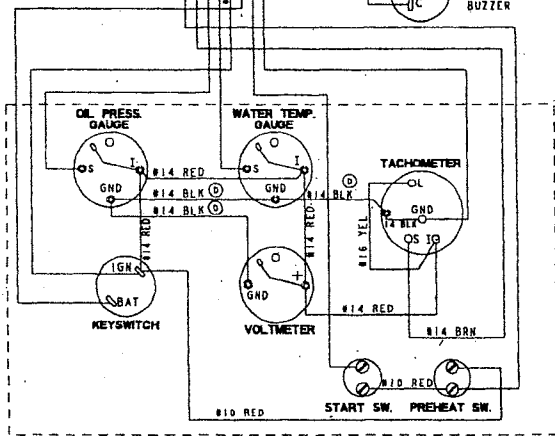
# WIRING DIAGRAM

## #39144

(E) denotes oil pressure alarm circuit resistor #03906 off preheat solenoid 1 terminal.



When connecting the instrument harness to the engine harness use Di-Electric grease at the connection. After connecting, fasten the harness plugs tightly with a Tywrap.



# 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. The preheat solenoid is mounted on the same bracket.*

Problem	Probable Cause	Verification/Remedy
No panel indications; fuel pump is not working (key switch is ON and PREHEAT button is depressed).	<ol style="list-style-type: none"> <li>1. Battery switch not on.</li> <li>2. 20-amp circuit breaker tripped.</li> <li>3. Loose connections between the panel</li> </ol>	<ol style="list-style-type: none"> <li>1. Check switch and/or battery connections.</li> <li>2. Reset breaker; if breaker trips again, check preheat solenoid circuit and check circuit for shorts to ground.</li> <li>3. Check the plug connection and secure with tie wrap.</li> </ol>
START button is depressed, no starter engagement.	<ol style="list-style-type: none"> <li>1. Connection to solenoid faulty. (Hydraulic Transmission)</li> <li>2. Gear shift not in neutral.</li> <li>3. Faulty switch.</li> <li>4. Faulty solenoid.</li> <li>5. Loose battery connections.</li> <li>6. Low battery.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check connection.</li> <li>2. Gear shift must be in neutral (see <i>NEUTRAL SWITCH</i> under <i>WARNER TRANSMISSIONS</i>)</li> <li>3. Check switch with ohmmeter.</li> <li>4. Check that 12 volts are present at the solenoid activation terminal.</li> <li>5. Check battery connections.</li> <li>6. Check battery charge state.</li> </ol>
Engine cranks, but does not start.	<ol style="list-style-type: none"> <li>1. Faulty fueling system.</li> <li>2. Preheat solenoid faulty.</li> <li>3. Low battery power.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check that fuel valves are open. <ol style="list-style-type: none"> <li>1a. Check for air in fuel system. Bleed air from fuel system.</li> <li>1b. Fuel filters clogged. Replace filters and bleed air from fuel system.</li> </ol> </li> <li>2. Check solenoid.</li> <li>3. Switch to combine house and start batteries.</li> <li>3a. Replace batteries.</li> </ol>
Engine can't be stopped.	<ol style="list-style-type: none"> <li>1. Disconnected fuel shut-off cable.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check connection at shut-off lever. Pull lever back to close off the fuel.</li> </ol>
Battery runs down.	<ol style="list-style-type: none"> <li>1. Oil pressure switch.</li> <li>2. High resistance leak to ground.</li> <li>3. Low resistance leak.</li> <li>4. Poor battery connections.</li> <li>5. DC alternator not charging (tachometer not operating).</li> </ol>	<ol style="list-style-type: none"> <li>1. Observe if gauges and panel lights are activated when engine is not running. Test the oil pressure switch.</li> <li>2. Check wiring. Insert sensitive (0 – .25 amp) meter in battery lines. (Do not start engine.) Remove connections and replace after short is located.</li> <li>3. Check all wires for temperature rise to locate the fault.</li> <li>4. Check cable connections at battery for loose connections, corrosion</li> <li>5. Check connections, check belt tension, test alternator. See <i>SERVICE MANUAL</i>.</li> </ol>
Battery not charging	<ol style="list-style-type: none"> <li>1. DC alternator</li> <li>2. Alternator drive.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform DC voltage check of the DC alternator</li> <li>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.</li> </ol>

# ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine slows and stops.	<ol style="list-style-type: none"> <li>1. Fuel lift pump failure.</li> <li>2. Oil switch and/or wiring loose or disconnected.</li> <li>3. Fuel starvation.</li> <li>4. 20 Amp circuit breaker tripping.</li> <li>5. Water in fuel.</li> </ol>	<ol style="list-style-type: none"> <li>1. Fuel lift pump should make a distinct ticking sound. Replace pump with spare.</li> <li>2. Inspect wiring for short circuits and loose connections. Inspect switch for proper operation.</li> <li>3. Check fuel supply, fuel valves, fuel lift pump.</li> <li>4. Check for high DC amperage draw during operation. Ensure breaker is not overly sensitive to heat which would cause tripping.</li> <li>5. Pump water from fuel tank(s); change filters and bleed fuel system.</li> </ol>
Engine overheats/alarm sounds.	<ol style="list-style-type: none"> <li>1. Raw water not circulating.</li> <li>2. Coolant not circulating.</li> </ol>	<ol style="list-style-type: none"> <li>1. Raw water pump failure. Check impeller — replace.</li> <li>2. Obstruction at raw water intake or raw water filter.               <ol style="list-style-type: none"> <li>2a. Thermostat — remove and test in hot water. Replace thermostat.</li> <li>2b. Loss of coolant — check hoses, hose clamps, drain plug, etc. for leaks.</li> <li>2c. Broken or loose belts — tighten/replace.</li> <li>2d. Air leak in system; run engine and open the pressure cap to bleed air. Add coolant as needed.</li> </ol> </li> </ol>
Engine alarm sound pulsates.	<ol style="list-style-type: none"> <li>1. Loss of oil.</li> <li>2. Oil pressure switch.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check dipstick, look for oil leaks at oil filter and at oil drain hose connection.</li> <li>2. Replace oil pressure switch.</li> </ol>
Engine alarm sounds continuously. (Low or High Volume)	<ol style="list-style-type: none"> <li>1. Faulty Resistor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Resistor off. Preheat solenoid ⚡ terminal (1K ohm value).</li> </ol>
Exhaust smoke problems	<ol style="list-style-type: none"> <li>1. Blue smoke.</li> <li>2. White smoke.</li> <li>3. Black smoke.</li> </ol>	<ol style="list-style-type: none"> <li>1. Incorrect grade of engine oil.               <ol style="list-style-type: none"> <li>1a. Crankcase is overfilled with engine oil (oil is blowing out through the exhaust).</li> </ol> </li> <li>2. Engine is running cold.               <ol style="list-style-type: none"> <li>2a. Faulty injector or incorrect injector timing.</li> </ol> </li> <li>3. Improper grade of fuel.               <ol style="list-style-type: none"> <li>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).</li> <li>3b. Improperly timed injectors or valves, or poor compression.</li> <li>3c. Lack of air — check air intake and air filter. Check for proper ventilation.</li> <li>3d. Overload.</li> </ol> </li> </ol>

## 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.

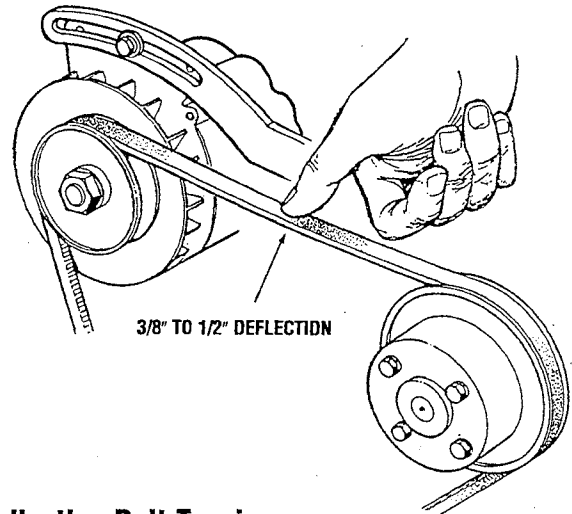


# ENGINE ADJUSTMENTS

## 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.



## 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.

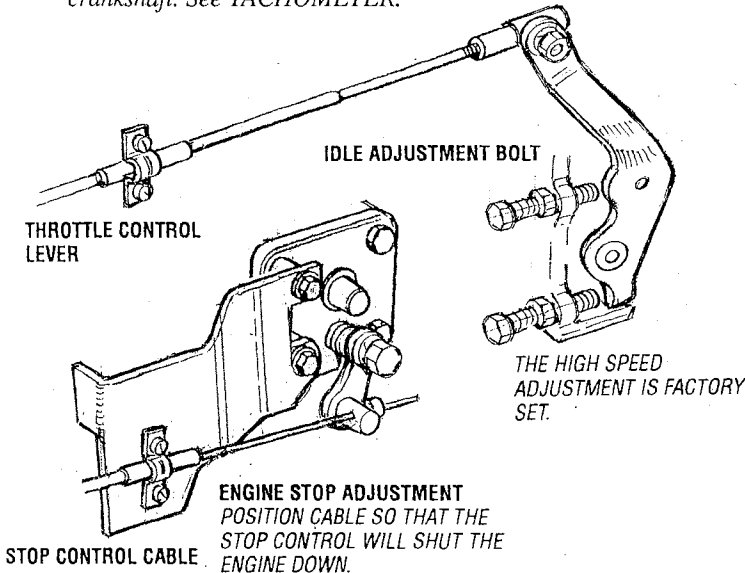
**⚠ WARNING:** Never attempt to check or adjust the drive belt's tension while the engine is in operation.

## BELT INSPECTION/MAINTENANCE

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.



## RECOMMENDED RPM RANGE

Model	Idle RPM	Cruise RPM	Max. RPM
35B/THREE	800 - 1000	2500 - 3000	3500 - 3600
38B/FOUR	750 - 900	2500 - 3000	3500 - 3600
43B/FOUR	750 - 900	2500 - 3000	3500 - 3600

**NOTE:** What ever style propeller is being used. To properly load the engine it **MUST** allow the engine to reach its rated RPM of 3600 + 0 - 100 at full open throttle while underway in forward gear for the correct propeller load on then engine.

# 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.

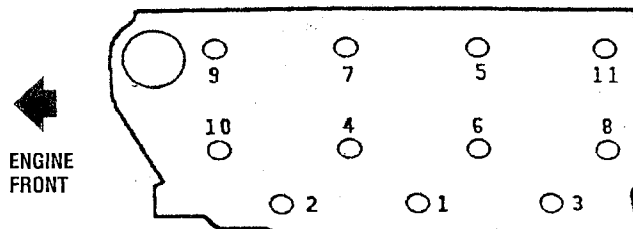
## Torquing Cylinder Head Bolts (W 35B Three Engine)

Tighten the cylinder head bolts according to the sequence shown. Make sure the engine is cold when this is done. Before applying the specified torque to the bolt, loosen it 1/4 - 1/2 of a turn and then apply the torque. Follow this procedure according to the numbered sequence shown.

**NOTE:** M10 Head Bolts require a 14mm socket.  
M12 Head Bolts require a 17mm socket.

Bolts #4, #5, #6, #7, #8, #9, #10 and #11 are tightened between 83.2 - 90.4 lb-ft (11.5 - 12.5 kg-m) wet.

Bolts #1, #2, and #3 are tightened between 47.0 - 57.8 lb-ft (6.5 - 8.0 kg-m) wet.

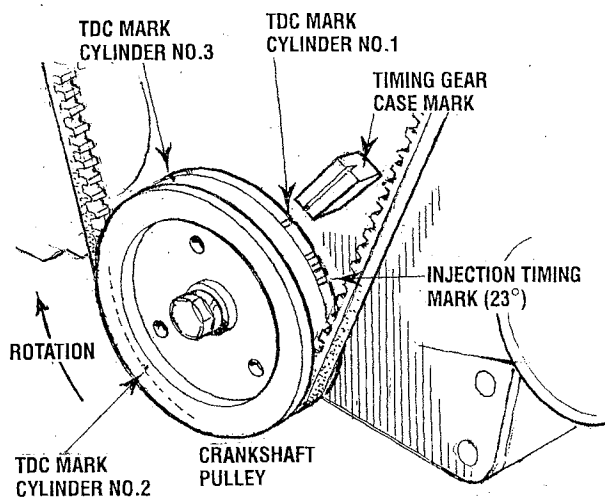


## VALVE CLEARANCE ADJUSTMENT 35B THREE ENGINE

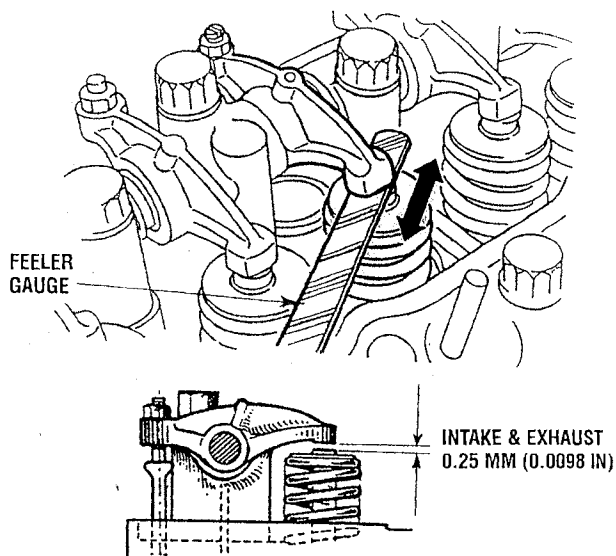
Adjust the valve clearance when the engine is cold. Valves are adjusted by the cylinder in the firing order of the engine, (1-3-2). Tightening the cylinder head bolts to the specified torque before adjusting the valves (see previous pages).

1. Pull off the air breather pipe from the rocker cover and take off the rocker cover bolts and the rocker cover.
2. Adjust the valve clearances at TDC (Top Dead Center) for each cylinder when they are on their compression stroke. Remember the engines firing order is 1-3-2. You may find that tuning the engine's crankshaft is more easily accomplished when the engine's glow plugs are removed before the crankshaft is rotated.
3. Align the timing mark on the gear case with the timing mark pulley indicated for cylinder #1 (the one next to the three injection timing marks). In this position, the No.1 cylinder is at its top Timing mark while dead center on its compression stroke. Check both the intake and exhaust valve clearances for this cylinder. If the valves have no specified clearance, adjust by means of the adjusting screws. Remember to align the timing marks properly, if not the valve may be pushed up by the piston, depending on the position of the cam lobe. Be sure to check the valves for this cylinder as they both should be closed.
4. Next the No.3 cylinder, turn the crankshaft clockwise 240° so the TDC mark for the No.3 cylinder on the front crankshaft pulley is approximately at the position shown in the illustration. Adjust the intake and exhaust valves for cylinder No.3. Be sure to check the valves for this cylinder as they both should be closed.
5. Last is the No.2 cylinder, turn the crankshaft clockwise 240° to position the TDC mark on the crankshaft pulley approximately at the position shown in the illustration. Adjust the intake and exhaust valves for cylinder No.2. Be sure to check the valves for this cylinder as they both should be closed.

Adjust each valve's clearance by inserting a 0.010 in (0.25 mm) feeler gauge between the rocker arm and the valve stem.



## VALVE CLEARANCE ADJUSTMENT



# ENGINE ADJUSTMENTS

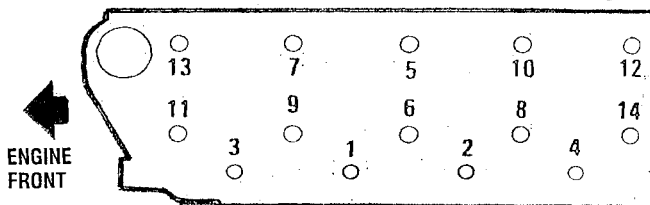
**NOTE:** WESTERBEKE recommends that the following engine adjustments be performed by a competent engine mechanic. The information below is provided to assist the mechanic.

## Torquing Cylinder Head Bolts W 38B FOUR Engine and W 42B FOUR engine

Tighten the cylinder head bolts according to the sequence shown in the illustration. Make sure the engine is cold when this is done. Before applying the specified torque to the bolt, loosen it 1/4 to 1/2 of a turn and then apply the torque. Follow this procedure according to the numbered sequence shown.

Bolts #5, #6, #7, #8, #11, #12, #13 and #14 are tightened between 83.2 - 90.4 lb-ft (11.5 - 12.5 kg-m) wet.

Bolts #1, #2, #3 and #4 are tightened between 47.0 - 57.8 lb-ft (6.5 - 8.0 kg-m) wet.

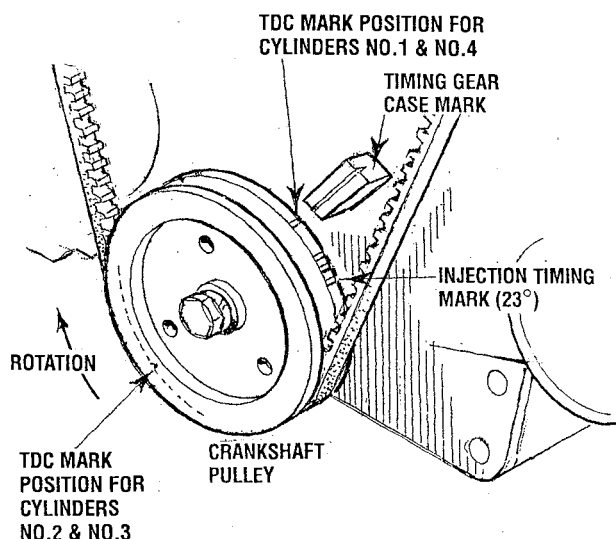


## VALVE CLEARANCE ADJUSTMENT W 38B FOUR AND W 42B FOUR ENGINE

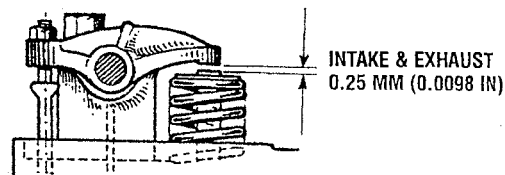
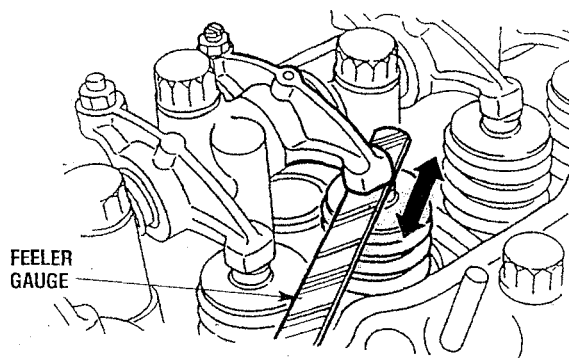
Adjust the valve clearance when the engine is cold.  
Tightening the cylinder head bolts to the specified torque before adjusting the valves.

1. Pull off the air breather pipe from the rocker cover and take off the rocker cover bolts and the rocker cover.
2. Adjust the valve clearances at TDC (Top Dead Center) for each cylinder when they are on their compression stroke. Remember the engine's firing order is 1-3-4-2. The engine's valves must be adjusted in this order while the valves are closed. You may find that tuning the engine's crankshaft is more easily accomplished when the engine's glow plugs are removed before the crankshaft is rotated.
3. Rotate the engine in the normal direction of rotation placing the No.1 cylinder at the top of its compression stroke. The TDC mark on the crankshaft pulley should be in line with the pointer on the front of the gear case cover and the valves for the No.1 cylinder should be closed. Now adjust the intake and exhaust valves for cylinder No.1.
4. After adjusting the valves for cylinder No.1, rotate the front crankshaft pulley clockwise 180° so the TDC mark on the pulley is positioned approximately in the position shown for cylinder No.3. Now adjust the intake and exhaust valves for cylinder No.3.
5. Rotate the crankshaft pulley clockwise another 180° and adjust the valve clearances for the intake and exhaust valves for cylinder No.4.
6. Rotate the crankshaft pulley clockwise another 180° and adjust the valve clearances for the intake and exhaust valves for cylinder No.2.

Adjust each valve's clearance by inserting a 0.010 in (0.25 mm) feeler gauge between the rocker arm and the valve stem.



### VALVE CLEARANCE ADJUSTMENT



# HBW-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.

**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

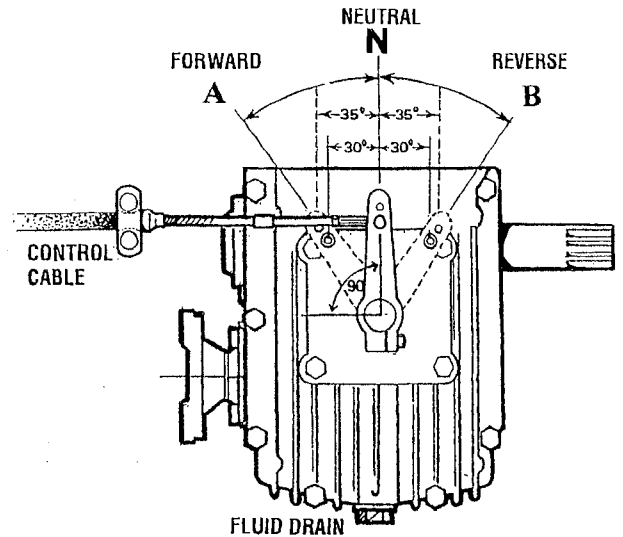
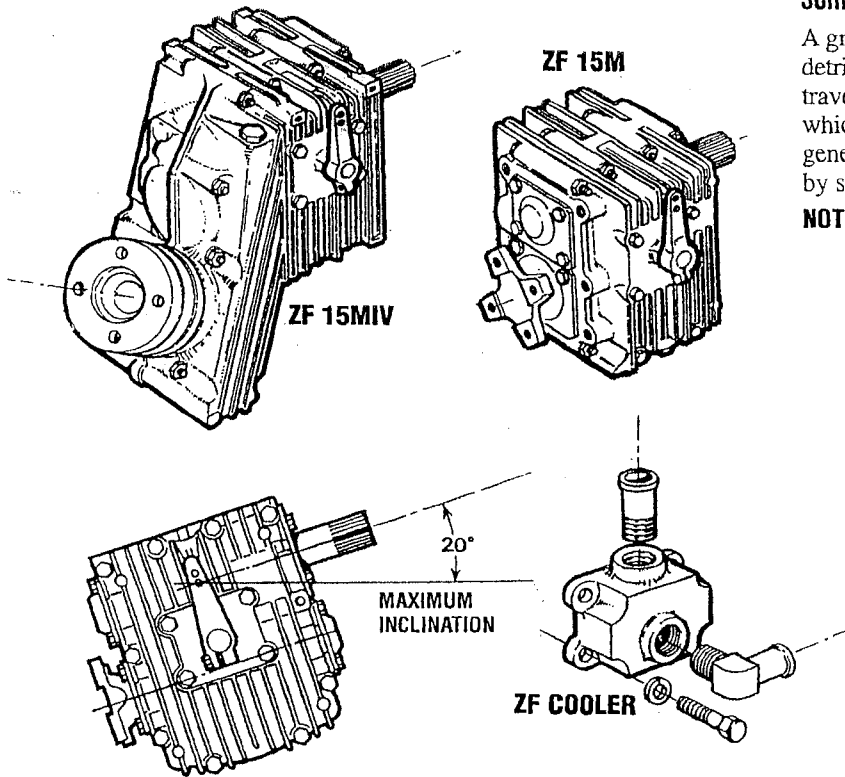
The transmission is suitable for single lever remote control. Upon loosening the retaining screw, the actuating lever can be moved to any position required for the control elements (cable or rod linkage). Make certain that the shift lever does not contact the actuating lever cover plate: the minimum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

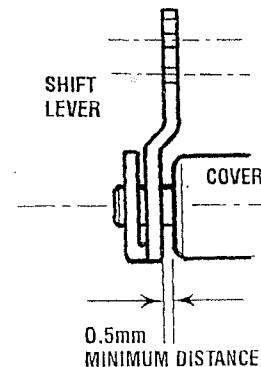
The shifting travel, as measured at the pivot point of the actuating lever, between the neutral position and end positions **A** and **B** should be at least **35mm** for the outer and **30mm** for the inner pivot point.

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.



**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.

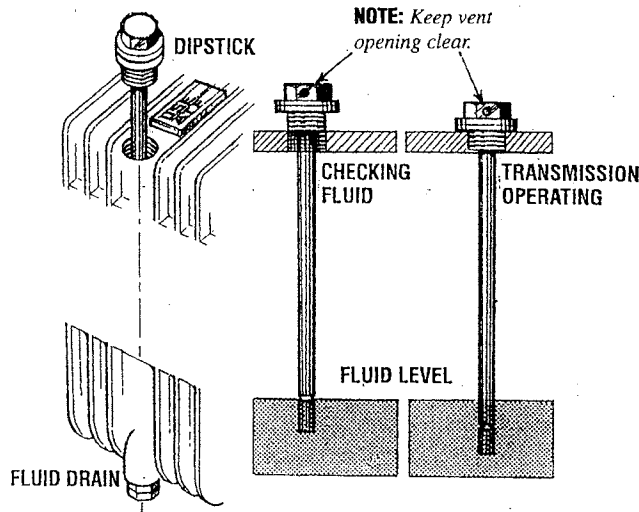


# HBW-ZF MARINE TRANSMISSIONS

## 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 DEXRON 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

## 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

<b>General</b>	(ZF Standard Transmission) Case-hardened helical gears, with a servo-operated multiple disc clutch.
<b>Gear ratio (optional)</b>	ZF 15MA (1.88:1 or 2.63:1)
<b>Note:</b> 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)
<b>Lubricating Fluid</b>	ATF - Type A or Dexron - II or III
<b>Propeller Shaft</b>	Right-hand rotation for above models
<b>Direction of Rotation</b>	listed

# HBW-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.

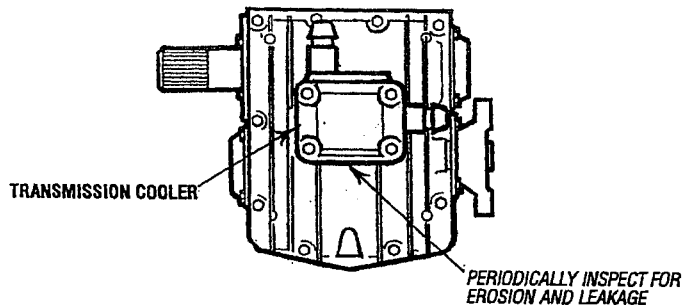
## TRANSMISSION COOLER

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

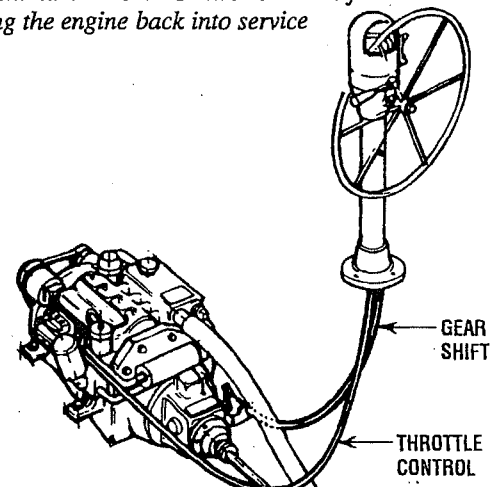
Storage requires special care. Follow these procedures:

- 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:

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# HBW - ZF TRANSMISSION TROUBLESHOOTING

## CONTROL CABLES

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

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"> <li>1. Actuating lever is loose.</li> <li>2. Shifting cable is broken, bent or unattached. Cable radius is too severe.</li> <li>3. Shift lever is binding against cover plate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten damping bolt on actuating lever.</li> <li>2. Check the cable, reattach or replace.</li> <li>3. Detach the shift cable and operate the lever by hand. Clearance should be 0.02 in (0.5mm).</li> </ol>
Transmission shifts into gear, but fails to propel the boat.	<ol style="list-style-type: none"> <li>1. Output coupling is not turning.</li> <li>2. Propeller shaft is not turning. Output coupling is turning.</li> <li>3. Output coupling and propeller shaft are turning.</li> </ol>	<ol style="list-style-type: none"> <li>1. Transmission needs professional attention.</li> <li>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.</li> <li>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.</li> </ol>
Delay of gear engagement or engages only after an increase in speed.	<ol style="list-style-type: none"> <li>1. Actuating lever travel <b>N</b> to <b>B</b> not equal to <b>N</b> to <b>A</b>.</li> <li>2. Actuating lever travel is insufficient.</li> <li>3. Actuating lever is binding against cover plate.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust cover plate until the lever is exact mid-position. See <i>ACTUATING LEVER TEXT AND DIAGRAM</i>.</li> <li>2. Check shift lever cable length. See <i>ACTUATING LEVER DIAGRAM</i>.</li> <li>3. Check clearance, adjust if necessary.</li> </ol>
Transmission noise becomes louder.	<ol style="list-style-type: none"> <li>1. Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission.</li> <li>2. Beginning damage of bearings in transmission due to torsional vibrations, running without fluid, overload, wrong alignment of transmission, or excessive engine output.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check alignment, inspect flexible coupling. If noise persists, inspect the damper plate between the transmission and the engine. Replace if necessary.</li> <li>2. Transmission needs professional attention.</li> </ol>
Chattering transmission noise, mainly at low engine speed.	<ol style="list-style-type: none"> <li>1. The engine or propeller generates torsional vibrations in the drive unit which produces a "chattering" noise in the transmission.</li> </ol>	<ol style="list-style-type: none"> <li>1. Mount a flexible coupling with another stiffness factor between the engine and transmission; a coupling with a higher stiffness factor might be sufficient.</li> <li>2. Inspect the damper plate between the engine and the transmission. Replace if necessary.</li> </ol>
Boat fails to attain specified max. speed.	<ol style="list-style-type: none"> <li>1. Operating temperature is high.</li> <li>2. Operating without cooling.</li> </ol>	<ol style="list-style-type: none"> <li>1. Wrong type of fluid. Use ATF Dextron III, check fluid level.</li> <li>2. Check cooler. Inspect coolant hoses and coolant flow.</li> </ol>
Oil Leakage.	<ol style="list-style-type: none"> <li>1. Corrosion at radial sealing ring and shaft. Damage sealing ring.</li> <li>2. Misalignment of output flanges.</li> </ol>	<ol style="list-style-type: none"> <li>1. Transmission needs professional attention.</li> <li>2. Check alignment. Must be within 0.003 in (0.08mm).</li> </ol>

# JS AND BW TRANSMISSION

## DESCRIPTION

The transmission's gear ratio is 2.47 to 1. This manual transmission turns a righthand propeller when engaged in forward gear. The JS/BW transmits its 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** filled with lubricating for shipment. 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 one year if the transmission is properly stored.

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 SAE 20W or SAE 30W 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 specification 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 that 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 per 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, run the engine in **NEUTRAL** for approximately 10 to 15 minutes. This oil may also be removed by attaching a pump onto the dipstick opening so the oil may be sucked out. The operating oil temperature must not exceed 250°F (120° C).

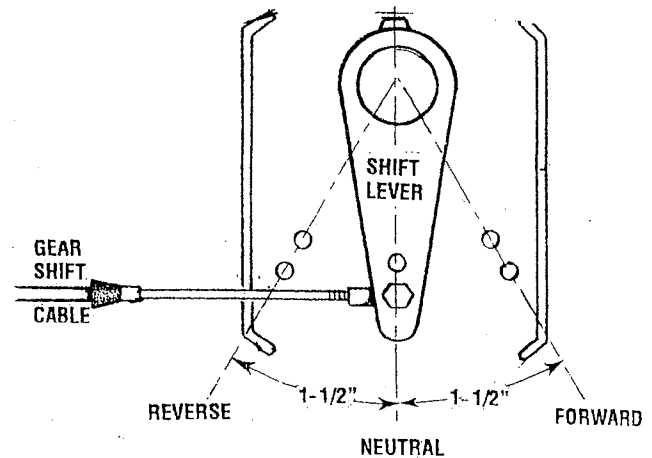
## CONTROLS

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 AND BW 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.



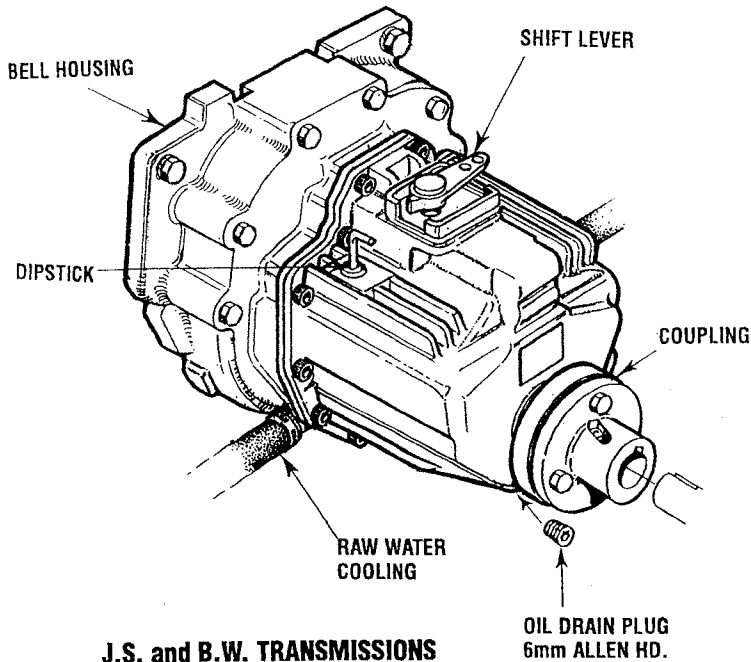
# JS AND BW TRANSMISSION

## SAILING OPERATION

The JS and BW transmissions can be left in its **NEUTRAL** position while sailing. Leaving the transmission in **NEUTRAL** while sailing alleviates unnecessary drag on the vessel by allowing the propeller is able to freewheel (spin). However, if one wishes to stop the propeller/shaft rotation while under sail, place the transmission into **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**

## JS AND BW 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)

## 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:

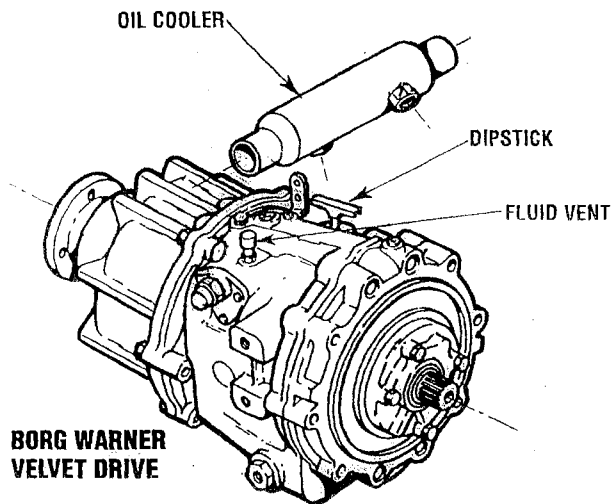
**NOTE:** This operation will usually occur when the engine raw water water cooling system is properly winterized.

- 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.

# BORG WARNER VELVET DRIVE TRANSMISSION

## OPTIONAL TRANSMISSION / 38B/FOUR AND 42B/FOUR



### 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 *Dexron 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 *Dexron 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

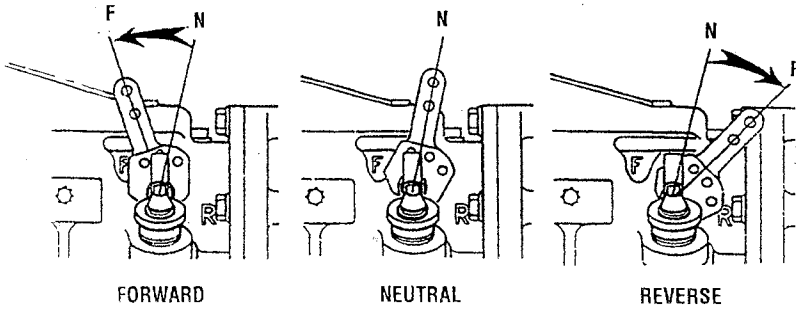
Move the gear shift lever to the forward position. You should feel the detent. The actuating lever on the transmission is in the forward position. The output shaft and the propeller shaft move the boat in a forward direction.

### 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.

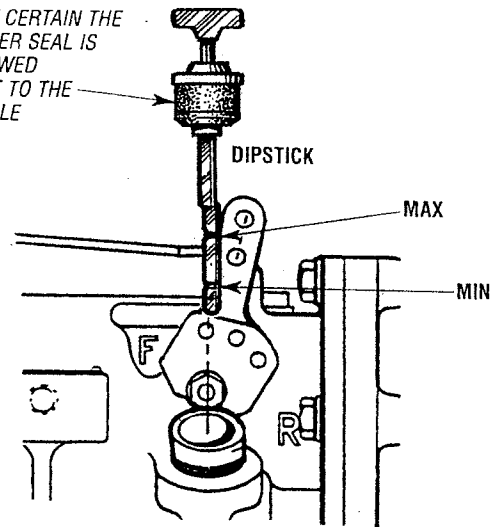
- Clean off the transmission and properly dispose of the used fluid.
- Refill the transmission with *DEXRON III ATF*. The quantity will vary depending on the transmission model and the installation angle. Fill through the dipstick hole.
- Check the dipstick for the proper fluid level.
- Replace the oil 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.

MAKE CERTAIN THE RUBBER SEAL IS SCREWED TIGHT TO THE HANDLE



## 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-in<sup>2</sup> (6.7 – 8.4 kg-cm<sup>2</sup>) 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 *Dexron 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 *DEXRON 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.

# STANDARD AND METRIC CONVERSION DATA

## 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 (H<sub>2</sub>O) x .07355 = Inches of Mercury x 13.783 = H<sub>2</sub>O  
 Inches of Water (H<sub>2</sub>O) x .03613 = psi x 27.684 = H<sub>2</sub>O  
 Inches of Water (H<sub>2</sub>O) x .248 = Kilopascals (kPa) x 4.026 = H<sub>2</sub>O

## 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

## 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 .621 = Miles

## VOLUME

Cubic Inches (in<sup>3</sup>) x 16.387 = Cubic Centimeters x .061 = in<sup>3</sup>  
 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

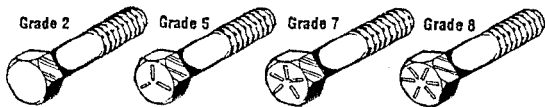
## TEMPERATURE

Degree Fahrenheit (°F) = (°C x 1.8) + 32  
 Degree Celsius (°C) = (°F - 32) x .56

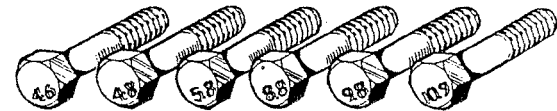
# STANDARD HARDWARE

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

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

# SPECIFICATIONS

## W 35B THREE MARINE DIESEL ENGINE

Engine Type	Diesel, four-cycle, three-cylinder, fresh water -cooled, vertical, in-line (32 hp at 3600 rpm, maximum)
Governor	Mechanical, centrifugal weight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.07 × 3.07 inches (78 × 78 mm)
Piston Displacement	68.23 cubic inches (1.118 liters)
Firing Order	1-3-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2300 rpm)	41 lbs-ft (5.67 kgs-m)
Compression Ratio	23 : 1
Compression Pressure	455 psi (32 kg/cm <sup>2</sup> ) at 320 rpm
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.010 inches (0.25 mm) Exhaust 0.010 inches (0.25 mm)
Inclination	Height: 21.25 inches (539.75 mm) Width: 18.37 inches (466.60 mm) Max. Length: 30.10 inches (764.54 mm) Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	368 lbs (166.9 kgs)
Fuel Consumption	1.2 U.S. gph (4.54 lph) running at 2500 rpm (approximate)
Idle Speed	800 - 1000 rpm
Cruise RPM	2500 - 3000 rpm Maximum load, RPM. 3500 - 3600 RPM

### LUBRICATION SYSTEM

General	Forced lubrication by gear pump
Oil Filter	Paper element, spin-on type
Sump Capacity (includes filter)	4.22 U.S. qts (4 liters)
Operating Oil Pressure	50 - 80 psi (3.5 - 5.6 kg/cm <sup>2</sup> ) Oil pressure will vary with engine R.P.M.
Oil Grade	API Specification CF, CG-4, CF-4, CH-4, or CI-4 or better. SAE 10W-40, or 15W-40

# SPECIFICATIONS

## W 35B THREE MARINE DIESEL ENGINE

### ELECTRICAL SYSTEM

Starting Battery	12-Volt, (-) negative ground
Battery Capacity	400 - 600 C.C.A.
Starting Aid	12-Volt sheathed type glow plug
Starter Motor	12-Volt, 1.2 KW, solenoid, actuated shift
DC No-Load Current	60 Amps at 11.5 volts (6500 rpm, min.)
Cold Cranking Current	190 Amps at 12 volts
Alternator	12-Volt DC, 50 Amps
Regulator	Internal regulator, built into alternator 14.1 Volts DC +/- .3 Volts

### FUEL SYSTEM

	Open flow, totally self-bleeding
Fuel	No.2D ( SAE J313 ) #45 Cetane or higher grade of diesel according to ASTM D975.
Injection Pump	Nippondenso (Bosch M type)
Injection Timing	23° ± 0.5° BTDC (Static)
Nozzle	Throttle type
Injection Starting Pressure	2275 psi (160 kg/cm <sup>2</sup> )
Lift Pump (with filter element)	12-Volt DC; lift capacity 6 ft (1.8 m)
Fuel Filter (on engine)	Canister type, with replacable element
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	71 cfm (2.0 cmn)

### COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with sea water exchanger system
Operating Temperature	150-170°F ( 66-77°C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	10 gpm (37.8 lpm) approximate
System Capacity (fresh water)	6 U.S. qts (5.68 liters)

# SPECIFICATIONS

## W 38B FOUR MARINE DIESEL ENGINE

Engine Type	Diesel, four-cycle, four-cylinder, fresh water-cooled, vertical, in-line (37 hp at 3600 rpm, maximum)
Governor	Mechanical, centrifugal weight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	2.87 x 3.07 inches (73 x 78 mm)
Piston Displacement	79.64 cubic inches (1.305 liters)
Firing Order	1-3-4-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2400 rpm)	53 lbs-ft (7.33 kgs-m)
Compression Ratio	23 : 1
Compression Pressure	455 psi (32 kg/cm <sup>2</sup> ) at 320 rpm
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Dimensions	Height: 23.70 inches (601.98 mm) Width: 18.37 inches (466.60 mm) Max. Length: 33.77 inches (857.76 mm)
Inclination	Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	419 lbs (190 kgs)
Fuel Consumption	1.6 U.S. gph (6.05 lph) running at 2500 rpm (approximate)
Idle Speed	750 - 950 rpm
Cruise RPM	2500 - 3000 rpm Maximum load, RPM. 3500 - 3600 RPM

### LUBRICATION SYSTEM

General	Forced lubrication by gear pump
Oil Filter	Paper element, spin-on type
Sump Capacity (includes filter)	4.75 U.S. qts (4.5 liters)
Operating Oil Pressure	50 - 80 psi (3.5 - 5.6 kg/cm <sup>2</sup> )
Oil Grade	API Specification CF, CG-4, CF-4, CH-4, or CI-4 or better.



# SPECIFICATIONS

## W 38B FOUR MARINE DIESEL ENGINE

### FUEL SYSTEM

	Open flow, totally self-bleeding
Fuel	No.2D ( SAE J313 ) #45 Cetane or higher grade of diesel according to ASTM D975.
Injection Pump	Nippondenso (Bosch M type)
Injection Timing	23° ± 0.5° BTDC (Static)
Nozzle	Throttle type
Injection Starting Pressure	2275 psi (160 kg/cm <sup>2</sup> )
Lift Pump	12-Volt DC; lift capacity 6 ft (1.8 m)
Fuel Filter (on engine)	Canister type, with replaceable element
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	82.9 cfm (2.34 cmm)

### COOLING SYSTEM

General	Fresh water cooled block, thermostatically-controlled with sea water exchanger system.
Operating Temperature	150-170°F ( 66-77°C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	10 gpm (37.8 lpm) approximate
System Capacity (fresh water)	7 U.S. qts (6.6 liters)

### ELECTRICAL SYSTEM

Starting Battery	12-Volt, (-) negative ground
Battery Capacity	400 - 600 C.C.A.
Starting Aid	12-Volt sheathed type glow plug
Starter Motor	12-Volt, 1.2 KW, solenoid, actuated shift
DC No-Load Current	60 Amps at 11.5 Volts (6500 rpm, min.)
Cold Cranking Current	190 Amps at 12 Volts
Alternator	12-Volt DC, 50 Amps
Regulator	Internal regulator, built into alternator 14.1 Volts DC +/- .3 Volts

# SPECIFICATIONS

## W 42B FOUR MARINE DIESEL ENGINE

Engine Type	Diesel, four-cycle, four-cylinder, fresh water-cooled, vertical in-line (42 hp at 3600 rpm, maximum)
Governor	Mechanical, centrifugal weight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.07 × 3.07 inches (78 × 78 mm)
Piston Displacement	90.93 cubic inches (1.49 liters)
Firing Order	1-3-4-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2500 rpm)	56 lb-ft (7.74 kg-m)
Compression Ratio	23 : 1
Compression Pressure	455 psi (32 kg/cm <sup>2</sup> ) at 320 rpm
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Dimensions	Height: 23.70 inches (601.98 mm) Width: 18.37 inches (466.60 mm) Length: 33.77 inches (857.76 mm)
Inclination	Continuous 14° Temporary 25° ( not to exceed 30 min.)
Dry Weight	419 lbs (190 kgs)
Fuel Consumption	1.8 U.S. gph (6.81 lph) running at 2500 rpm (approximate)
Idle Speed	750 - 950 rpm
Cruise RPM	2500 - 3000 rpm
Maximum load RPM.	3500 - 3600 RPM.

### LUBRICATION SYSTEM

General	Forced lubrication by gear pump
Oil Filter	Paper element, spin-on type
Sump Capacity (includes filter)	4.75 U.S. qts (4.5 liters)
Operating Oil Pressure	50 - 80 psi (3.5 - 5.6 kg/cm <sup>2</sup> )

**NOTE:** Oil Pressure will vary with engine RPM.

Oil Grade	API Specification CF, CG-4, CF-4, CH-4, or CI-4 or better. SAE 10W-40, or 15W-40.
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# SPECIFICATIONS

## W 42B FOUR MARINE DIESEL ENGINE

### FUEL SYSTEM

	Open flow, totally self-bleeding
Fuel	No.2D ( SAE J313 ) #45 Cetane or higher grade of diesel according to ASTM D975.
Injection Pump	Nippondenso (Bosch M type)
Nozzle	Throttle type
Injection Starting Pressure	2275 psi (160 kg/cm <sup>2</sup> )
Lift Pump	12-Volt DC; lift capacity 6 ft (1.8 m) (Wet).
Fuel Filter (on engine)	Canister type, with replaceable element
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	94.0 cfm (2.66 cmm)

### COOLING SYSTEM

General	Fresh water cooled block, thermostatically-controlled with sea water exchanger system
Operating Temperature	150-170. (66-77 c )
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	10 gpm (37.8 lpm) approximate
System Capacity (fresh water)	7 U.S. qts (6.6 liters)

### ELECTRICAL SYSTEM

Starting Battery	12-Volt, (-) negative ground
Battery Capacity	400 - 600 C.C.A.
Starting Aid	12-Volt sheathed type glow plug
Starter Motor	12-Volt, 1.2 KW, solenoid, actuated shift
DC No-Load Current	60 Amps at 11.5 Volts (6500 rpm, min.)
Cold Cranking Current	190 Amps at 12 Volts
Alternator	12-Volt DC, 50 Amps
Regulator	Internal regulator, built into alternator 14.1 Volts DC +/- .3 Volts

# LAY-UP & RECOMMISSIONING

## GENERAL

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

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

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

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

## Propeller Shaft Coupling [Propulsion Engine]

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

## Fresh Water Cooling Circuit

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

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

## Lubrication System

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

**⚠ CAUTION:** Do not leave the engine's old engine oil in the sump over the lay-up period. 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.

## Cylinder Lubrication [Gasoline]

Spray fogging oil into the open air intake, with the flame arrester removed, while the engine is running. The fogging oil will stall out the engine and coat the valves, cylinders and spark plugs for winter protection.

# LAY-UP & RECOMMISSIONING

## 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 light 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!

## 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.

## 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.

## Drive Belts

Loosen the alternator, water pump and governor drive belts. Inspect and re-tighten at recommissioning. Clean off loose paint and corrosion, prime and repaint.

## 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.

## 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.

## 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.

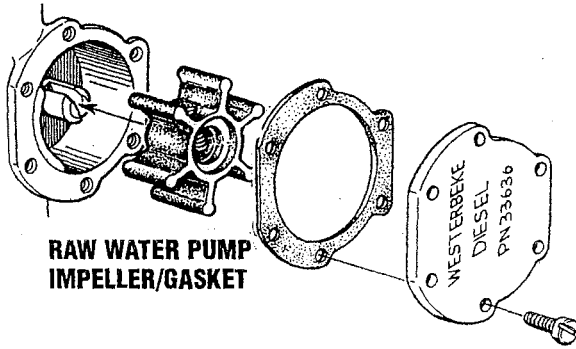
**⚠ CAUTION:** Wear rubber gloves, a rubber apron, and eye protection when servicing batteries. Lead acid batteries emit hydrogen, a highly explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced.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

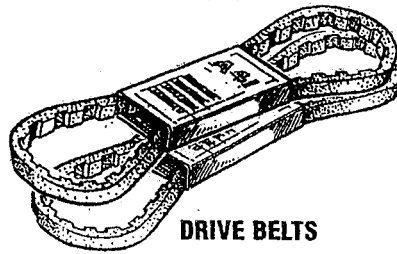
# SUGGESTED SPARE PARTS

## WESTERBEKE MARINE DIESEL ENGINES

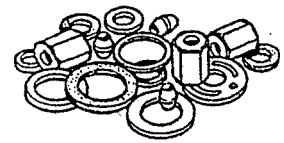
CONTACT YOUR WESTERBEKE DEALER FOR SUGGESTIONS AND ADDITIONAL INFORMATION



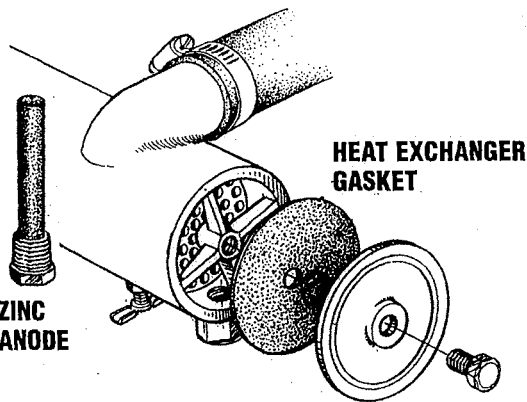
RAW WATER PUMP  
IMPELLER/GASKET



DRIVE BELTS

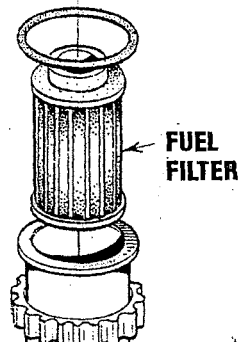


HARDWARE KIT

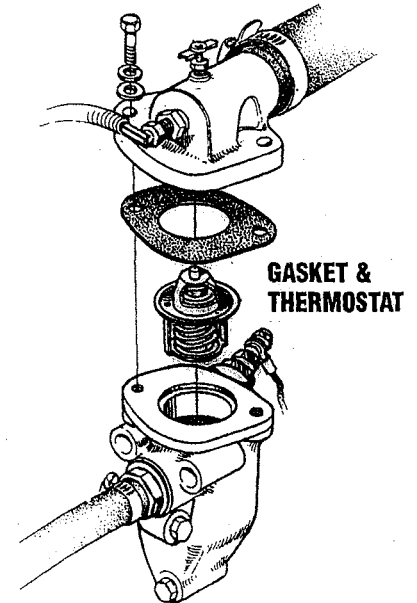


HEAT EXCHANGER  
GASKET

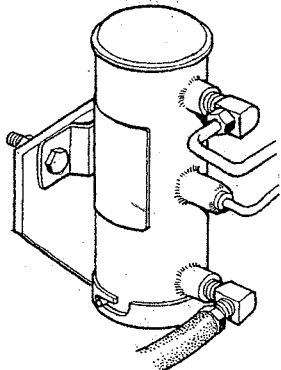
ZINC  
ANODE



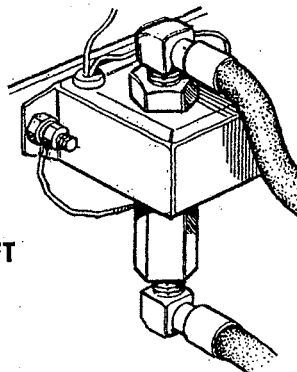
FUEL  
FILTER



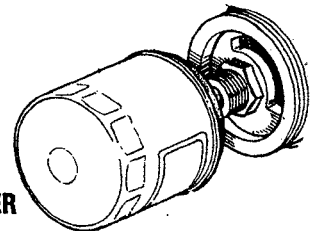
GASKET &  
THERMOSTAT



FUEL LIFT  
PUMP



WATER SEPERATOR FILTER



OIL FILTER

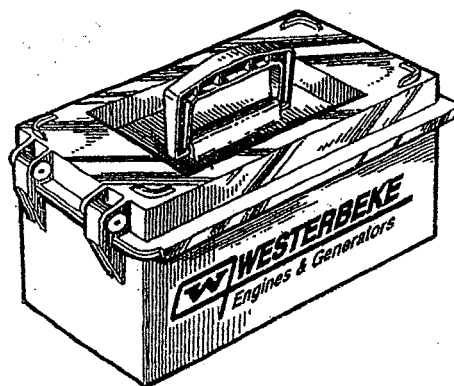
WESTERBEKE RECOMMENDS CARRYING ENOUGH SPARE ENGINE OIL (YOUR BRAND) FOR AN OIL CHANGE (5 QTS.) AND A GALLON OF PREMIXED COOLANT.

## 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





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