



OPERATORS MANUAL

WESTERBEKE MARINE DIESEL ENGINE 55A FOUR

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 *Member National Marine Manufacturers Association*

CALIFORNIA

Proposition 65 Warning

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



SAFETY INSTRUCTIONS

INTRODUCTION

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

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

PREVENT ELECTRIC SHOCK

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

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

PREVENT BURNS — HOT ENGINE

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

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

⚠ WARNING: Steam can cause injury or death!

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

PREVENT BURNS — FIRE

⚠ WARNING: Fire can cause injury or death!

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

PREVENT BURNS — EXPLOSION

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

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

SAFETY INSTRUCTIONS

ACCIDENTAL STARTING

⚠ WARNING: Accidental starting can cause injury or death!

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

BATTERY EXPLOSION

⚠ WARNING: Battery explosion can cause injury or death!

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

BATTERY ACID

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

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

TOXIC EXHAUST GASES

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

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

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

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

Vomiting
Dizziness
Throbbing in temples
Muscular twitching
Intense headache
Weakness and sleepiness

AVOID MOVING PARTS

⚠ WARNING: Rotating parts can cause injury or death!

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



SAFETY INSTRUCTIONS


operating adjustments, use extreme care to avoid touching moving parts and hot exhaust system components.

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

HAZARDOUS NOISE

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

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

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

OPERATORS MANUAL

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

GASOLINE ENGINE AND GENERATOR INSTALLATIONS

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

Sections of the ABYC standards of particular interest are:

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

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

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

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

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

Order From:
ABYC
15 East 26th Street
New York, NY 10010

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

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

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

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



INSTALLATION

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

CODES AND REGULATIONS

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 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 18" 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.*

EXHAUST SYSTEM

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

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

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This WESTERBEKE Marine 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. Also, 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 you have not received a customer identification card registering your warranty 60 days after submitting the warranty registration form, please contact the factory in writing with model information, including the unit's serial number and commission date.

TYPICAL CUSTOMER IDENTIFICATION CARD

 <small>WESTERBEKE CORPORATION • AVON INDUSTRIAL PARK AVON, MA 02322 • TEL: (508) 558-7700 • FAX: (508) 559-9323</small>	
Customer Identification	
WESTERBEKE OWNER	
MAIN STREET	
HOMETOWN, USA	
Model 55A Four	Ser. #U53890-48
Expires 7/20/97	

PRODUCT SOFTWARE

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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

(Continued)

SERIAL NUMBER LOCATION

An identification nameplate that displays the engine model number and engine serial number is mounted on the side of the engine manifold. Take the time to enter this information on the blank decal provided below. 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 of the same general type as that of a gasoline engine, and the diesel engine has the same types of valves, camshaft, pistons, connecting rods and lubricating system.

To a great extent, a diesel engine requires the same preventive maintenance as a gasoline engine. Most important are proper ventilation and proper maintenance of the fuel, lubricating and cooling systems. Replacement of fuel and lubricating filter elements at the time periods specified and frequent checking for contamination (water, sediment, etc.) in the fuel system are essential. Also important is the consistent use of a 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 done away with and in their place is 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 engine serial number as they appear on the silver and black identification nameplate located on the manifold. You must provide us with this information so we can identify your engine. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts Catalog). Also insist upon WESTERBEKE packaged parts because *will fit* or generic parts are frequently not made to the same specifications as original equipment.

NOTE: *Component locations in this manual are referenced from the front of the engine which is the pulley/drive belt end. Left and right sides are determined as follows: imagine straddling the engine, facing in the same direction as the front of the engine: the left side is at your left, the right side is at your right.*

PROTECTING YOUR INVESTMENT

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

NOTE: *Six important steps to ensure long engine life:*

- Proper engine installation and alignment.*
- An efficient well-designed exhaust system that includes an anti-siphon break to prevent water from entering the engine.*
- Changing the engine oil and oil filters every 200 operating hours.*
- Proper maintenance of all engine components according to the maintenance schedule in this manual.*
- Use clean, filtered diesel fuel.*
- Winterize your engine according to the "Lay-up and Recommissioning" section in this manual.*



WESTERBEKE offers two optional panels— select the instruction page that applies to the panel you purchased.

ADMIRALS PANEL

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 push buttons, one for PREHEAT and one for START.

You will notice that 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 also hold its reading. The temperature gauge will once again register the engine's true temperature when electrical power is restored to the gauge.

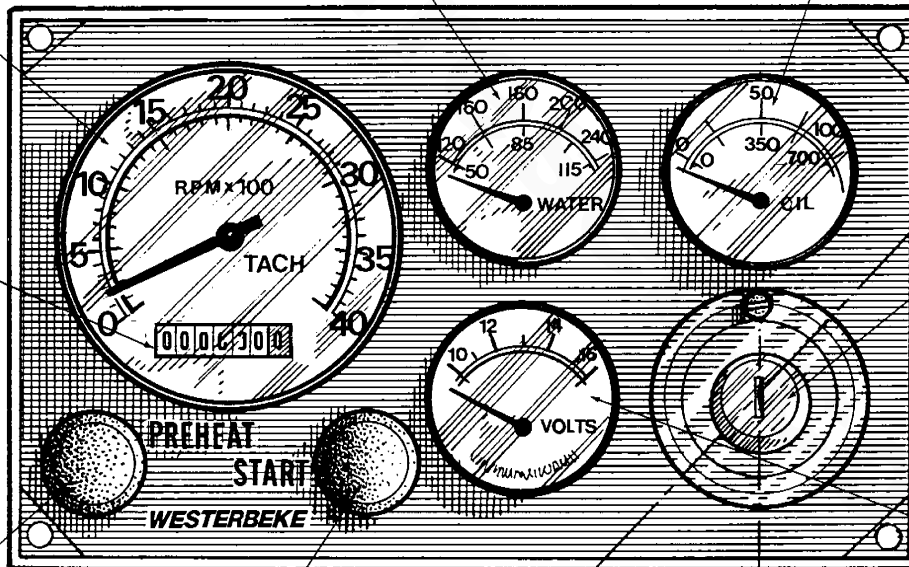
A separate alarm buzzer with harness is supplied with every Admiral Panel. The installer is responsible for electrically connecting the buzzer to the four-pin connection on the engine's electrical harness. The installer is also responsible for installing the buzzer in a location where it will be dry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

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.

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

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

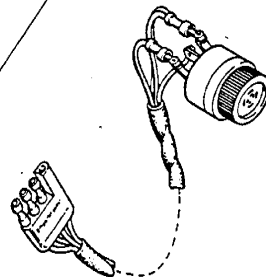


KEY SWITCH: PROVIDES POWER ONLY TO THE INSTRUMENT PANEL CLUSTER. THE KEY SWITCH SHUTS THE ENGINE DOWN WHEN THE KEY IS TURNED OFF.

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

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

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



AUTOMATIC ALARM SYSTEM

HIGH WATER TEMPERATURE ALARM: AN ALARM BUZZER HAS BEEN SUPPLIED WITH THE INSTRUMENT PANEL. IF THE ENGINE'S FRESH WATER COOLANT REACHES 210° F (98°C), THIS SWITCH WILL CLOSE SOUNDING THE ALARM WHICH WILL EMIT A CONTINUOUS SIGNAL.

LOW OIL PRESSURE ALARM: A LOW OIL PRESSURE ALARM SWITCH IS LOCATED OFF THE ENGINE'S OIL GALLERY. THIS SWITCH MONITORS THE ENGINE'S OIL PRESSURE. SHOULD THE ENGINE'S OIL PRESSURE FALL TO 5 - 10 PSI, THE SWITCH WILL CLOSE SOUNDING THE ALARM. IN THIS EVENT, THE ALARM WILL EMIT A PULSATING SIGNAL.



CONTROL PANELS

(Continued)

CAPTAINS PANEL

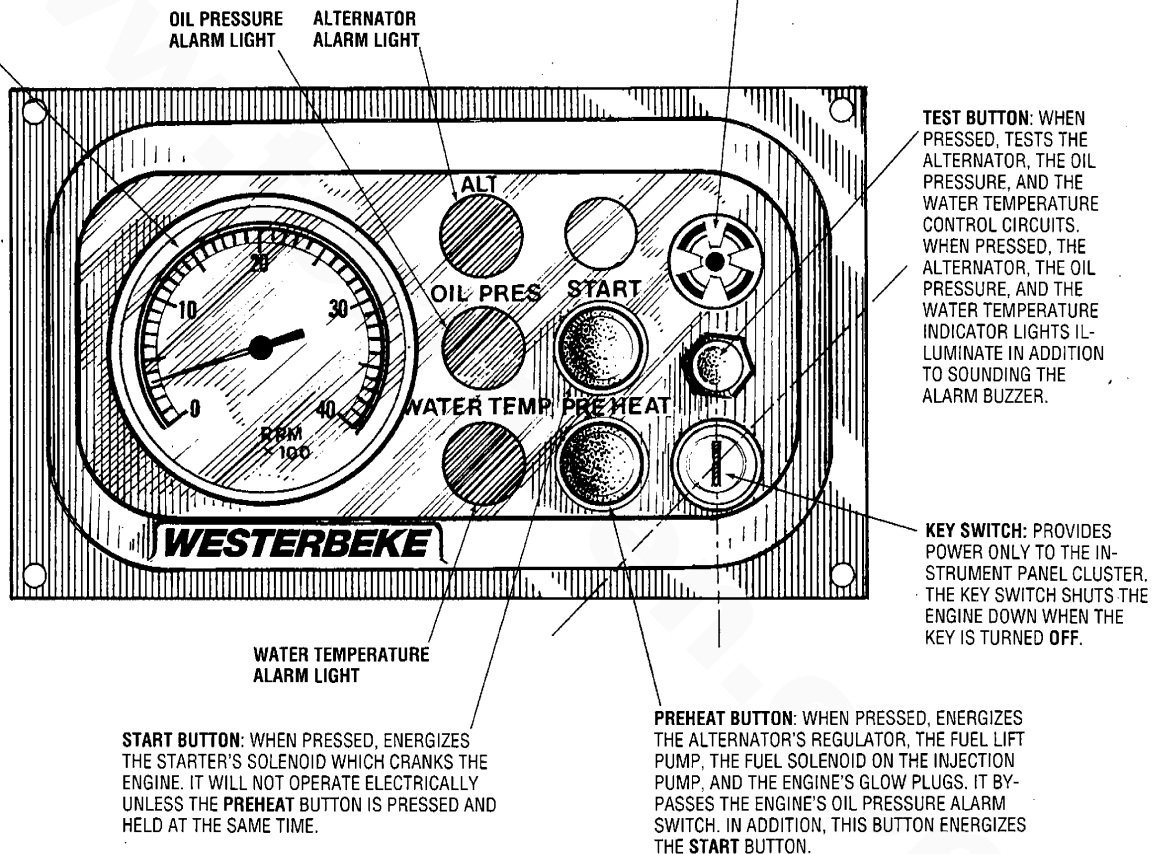
This manually-operated control panel is equipped with a KEY SWITCH; an RPM gauge; PREHEAT and START buttons; an INSTRUMENT TEST button; three indicator lamps, one for ALTERNATOR DISCHARGE, one for low OIL PRESSURE, and one for high ENGINE

COOLANT TEMPERATURE; and an alarm buzzer for low OIL PRESSURE or high WATER 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 15 PSI. IN THIS EVENT, THE ALARM WILL EMIT A PULSATING SIGNAL. THE ALARM WILL ALSO SOUND IF THE WATER TEMPERATURE IN THE FRESHWATER COOLING CIRCUIT RISES TO 205°F. 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, THE ALARM WILL SILENCE.



DIESEL FUEL, ENGINE OIL AND ENGINE COOLANT

DIESEL FUEL

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

Care Of The Fuel Supply

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

Purchase a well-known brand of fuel.

Install and regularly service a good, visual-type filter/water separator between the fuel tank and the engine. Raycor 500 FG or 900 FG is a good example of such a filter.

ENGINE OIL

Use a heavy duty engine oil with an API classification of CF or CG4 or better. Change the engine oil after an initial 50 hours of break-in operation, and every 200 hours of operation thereafter. For recommended oil viscosity, see the following chart:

Operating Temperature	Oil Viscosity
Above 68°F (20°C)	SAE 30 or 10W-30
41°-68°F (5-20°C)	SAE 20 or 10W-30
Below 41°F (5°C)	SAE 10W-30



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

ENGINE COOLANT

The use of an antifreeze mixture of 50/50 is recommended for year-round use. Use antifreeze that is compatible with aluminium components, and never mix different brands of antifreeze. *Do not use straight water*, this can be detrimental to the cooling system components.

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

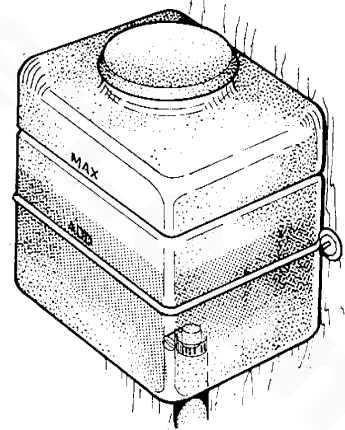
Antifreeze mixtures will protect against an unexpected freeze and they are beneficial to the engine's cooling system. They retard rust and add to the life of the circulating pump seal.

ANTIFREEZE PROTECTION

Antifreeze concentration	23%	35%	50%	60%
Freezing Temperature	14°F (-5°C)	-4°F (-20°C)	-40°F (-40°C)	-58°F (-50°C)

COOLANT RECOVERY TANK

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



COOLANT RECOVERY TANK



PRESTART INSPECTION

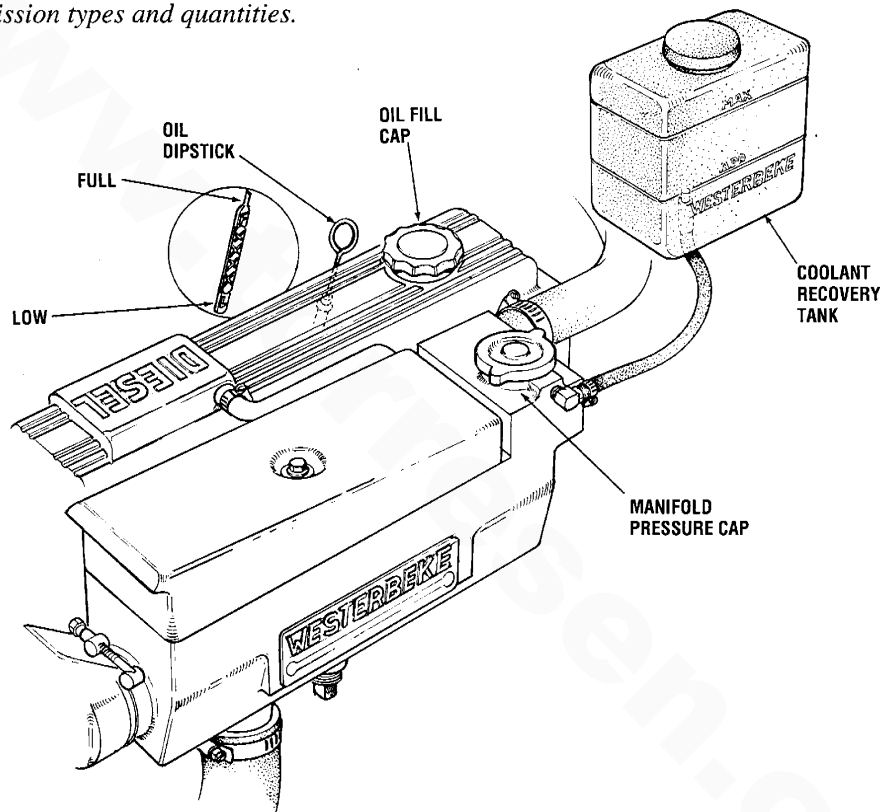
Before starting your engine for the first time or after a prolonged layoff — check the following items.

- Check the engine oil level; add oil to maintain the level at the high mark on the dipstick.
- Check the fuel supply and examine the fuel filter/separator bowls for contaminants.
- Check the transmission fluid level.

NOTE: Refer to the specifications pages in this manual for fuel, oil, and transmission types and quantities.

- Check the DC electrical system. Inspect wire connections and battery cable connections.
- Visually examine the unit. Look for loose or missing parts, disconnected wires, unattached hoses, and check threaded connections.
- Check the coolant level in the plastic recovery tank and at the manifold.

NOTE: If the engine has not yet been filled with coolant, refer to the “Engine Coolant” section of this manual.



STARTING PROCEDURE

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.

Turn the KEY SWITCH to the ON position (2 o'clock)

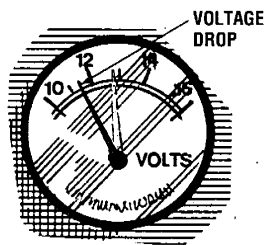
PREHEAT: Depress the PREHEAT switch. The voltmeter, panel lights, gauges and meters, and fuel solenoid will be activated. The PREHEAT switch should be depressed in accordance with the following chart:

Temperature/Preheat

Atmospheric Temperature	Preheating Time
+41°F(+5°C) or higher	Approx. 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

START: While still depressing the PREHEAT switch, depress the START switch. This will engage the start solenoid. Upon engine firing, release the START switch. Do not release the PREHEAT switch until the oil pressure reaches 15 psi. Then as long as the high water temperature and low oil pressure protective circuits do not activate, the engine will remain energized and continue to run.

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



Should the engine not start when the START switch is depressed for 10 to 20 seconds, release both switches 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 shut-off, 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.

Once the engine starts, check 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 switch for 10-15 second intervals will help stabilize the engine RPM until the 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 switch is depressed, a charging load on the DC alternator will be discernible.

STARTING UNDER COLD CONDITIONS

Make certain the lubricating oil conforms with the ratings for the prevailing temperature. Check the table on the engine oil 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 Temperature/Preheat chart on this page.

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 discharge is to remove the key from the Key Switch after stopping the engine.



THE FIRST 50 HOURS

Although your engine has experienced a minimum of one hour of test operations to ensure accurate assembly and proper operation of all systems, 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.

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 in this manual; 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 range.
3. While using the vessel, run the engine at varying engine speeds for the first 25 hours.

4. Avoid rapid acceleration, especially with a cold engine.
5. Use caution not to overload the engine. The presence of a gray 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.

Breaking-in a new engine basically involves seating the piston rings to the cylinder walls. This cannot be accomplished by long periods of running at idle, nor by early running at full rpm. Idle running may glaze the cylinder walls, resulting in excessive oil consumption and smoky operation. Excessive speed or heavy overloading, especially with a cold engine, may cause scoring of the cylinder walls, producing similar results. Operate the engine in moderation during the 50-hour break-in period. (Don't baby the engine, but do not abuse it.)

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

THE DAILY ROUTINE

CHECK LIST

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

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

NOTE: Excessive loss of coolant indicates a cooling system leak. Check the entire system. If necessary, use a cooling system pressure tester to pressurize the cooling system to locate the area of leakage. In cases of excessive coolant loss, refill the system as outlined in Preparations for Initial Start-Up in this manual.

START YOUR ENGINE

NOTE: See Starting/Stopping Procedure in this manual for more detailed instructions.

1. Put transmission in neutral, throttle advanced.
 2. Turn KEY to the ON position (2 o'clock)
 3. Depress PREHEAT (10 to 15 seconds).
 4. While pressing PREHEAT, push START. As engine fires – release START.
 5. Hold PREHEAT until oil pressure reaches 15 psi and/or alarm shuts off.
- NOTE:** Should engine fail to start, wait 30 seconds, repeat the above procedure, and PREHEAT longer.
6. Allow a few minutes for the engine to warm at a comfortable rpm (approx. 1200 rpm), then reduce the rpm, shift into gear, and get underway.

MAINTENANCE SCHEDULE

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

NOTE: Many of the following maintenance jobs are simple but others are more difficult and may require the expert knowledge of a service mechanic. A complete service manual is available from your WESTERBEKE dealer.

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							EXPLANATION OF SCHEDULED MAINTENANCE
		50	100	250	500	750	1000	1250	
Fuel Supply	<input type="checkbox"/>								Diesel No. 2 octane rating of 45 cetane or better.
Fuel/Water Separator	<input type="checkbox"/>								Check for water and dirt in fuel (drain/replace if necessary).
Engine Oil Level	<input type="checkbox"/>								Oil level should indicate between MAX. and LOW on dipstick.
Transmission Fluid Level	<input type="checkbox"/>								Fluid level should indicate between MAX. and LOW on dipstick
Coolant Level	<input type="checkbox"/>								Check at recovery tank; if empty, check at manifold. Add coolant if needed.
Drive Belts	<input type="checkbox"/>								Inspect for proper tension (1/2" to 3/8" depression) and adjust if needed. Check belt edges for wear.
Visual Inspection of Engine	<input type="checkbox"/>	NOTE: Please keep engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.							Check for fuel, oil and water leaks. Inspect wiring and electrical connections. Keep bolts & nuts tight.
Throttle and Transmission Control Cable		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Check for loose fittings, cotter pins, etc. Lubricate with WD-40 or equivalent.
Adjust Engine Idle Speed		<input type="checkbox"/>							Adjust to (750-1000 rpm).
Fuel Filter		<input type="checkbox"/>		<input type="checkbox"/>				<input type="checkbox"/>	Initial change at 50 hrs, then change every 250 hrs.
Starting Batteries (and House Batteries)		<input type="checkbox"/>	Every 50 operating hours check electrolyte levels and make sure connections are very tight. Clean off excessive corrosion.						
Engine Oil		<input type="checkbox"/>	Initial engine oil & filter change at 50 hrs., then change both every 100 hours.						
*Adjust the Valve Clearances		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		Initial adjustment at 50 hrs., then every 500 hrs. (Do not retorque the cylinder head)
Lubricate Panel Key Switch with "Lockeze"			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	At 1st 100 hrs. then each year at winterizing.
Transmission Fluid		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	Initial fluid change at 50 hrs., then every 250 hrs. or at winterizing.
Air Cleaner					<input type="checkbox"/>			<input type="checkbox"/>	Replace element filter. Clean or replace elements.
Exhaust System		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Initial check at 50 hrs., then every 250 hrs. Inspect for leaks. Tight connections check, siphon brake operation. Check the exhaust elbow for carbon and/or corrosion buildup on inside passages; clean and replace as necessary.

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



MAINTENANCE SCHEDULE

(Continued)

NOTE: Use engine hour meter gauge to log your engine hours or record your engine hours by running time.

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							EXPLANATION OF SCHEDULED MAINTENANCE
		50	100	250	500	750	1000	1250	
Engine Hoses			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Hose should be hard & tight. Replace if soft or spongy. Check & tighten all hose clamps.
Heat Exchanger Zinc Anode		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Clean or replace. Open heat exchanger end cap and clean out debris.
Electric Fuel Lift Pump Filter (if applicable)		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Initial filter change at 50 hours, then change filter every 250 hours.
Raw Water Pump				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Remove pump cover and inspect impeller for wear; replace if needed. Also replace gasket. Lubricate both when reassembling.
Coolant System					<input type="checkbox"/>			<input type="checkbox"/>	Drain, flush, and refill cooling system with appropriate anti-freeze mix.
*Fuel Injectors						<input type="checkbox"/>			Check and adjust injection opening pressure and spray condition (see <i>Engine Adjustments</i>).
*Starter Motor					<input type="checkbox"/>			<input type="checkbox"/>	Check solenoid and motor for corrosion. Remove and lubricate. Start motor pinion drive. Clean and lubricate.
*Preheat Circuit					<input type="checkbox"/>			<input type="checkbox"/>	Check operation of preheat solenoid. Remove and clean glow plugs; check resistance (4-6 ohms).
*Engine Cylinder Compression and Valve Clearance					<input type="checkbox"/>			<input type="checkbox"/>	Incorrect valve clearance will result in poor engine performance; check compression pressure and timing, and adjust valve clearances.
DC Alternator				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Check DC charge from alternator. Check mounting bracket; tighten electrical connections.
Heat Exchanger							<input type="checkbox"/>		Remove; have professionally cleaned and pressure tested.
Transmission Oil Cooler							<input type="checkbox"/>		Remove; have professionally cleaned and pressure tested.
Engine Transmission Damper Plate							<input type="checkbox"/>		Chattering at idle and low rpms is an indication of damper plate wear. Remove and replace.
Engine Timing Belt							<input type="checkbox"/>		Remove and replace. NOTE: Failure to replace the timing belt at the recommended interval could result in timing belt failure resulting in major damage to the engine.

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

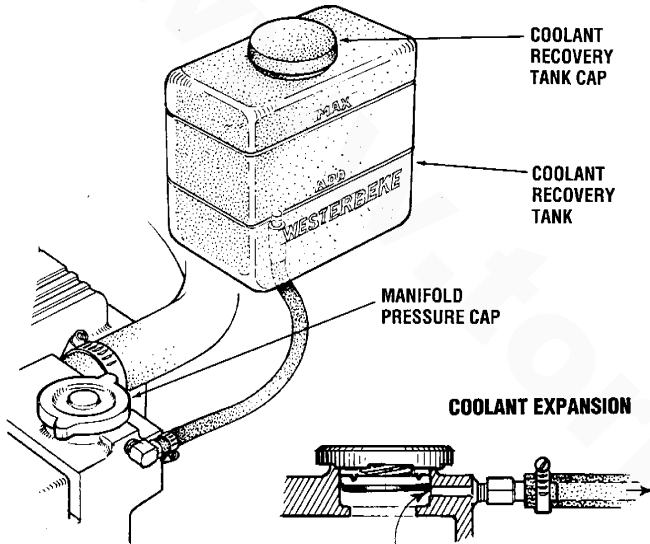


ENGINE COOLANT

CHANGING THE COOLANT

The engine's coolant must be changed every eight to twelve months depending on the engine's use. If the coolant is allowed to become contaminated, it can lead to overheating problems.

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 be easily accessible.



Drain the engine coolant by loosening the drain plug on the engine block and opening the manifold pressure cap. Flush the system with fresh water, then start the refill process. See the *Parts Identification* photos in this manual for locations.

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

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

TO REFILL WITH COOLANT

With the engine running in idle, slowly pour clean premixed coolant into the manifold.

NOTE: Open the air bleed petcock on the heat exchanger to help remove air from the system. When a steady flow of coolant appears at the drain plug opening, close the water drain plug and continue to fill the system until the manifold remains full. Close the petcock on the heat exchanger when antifreeze flows from it.

Start the engine and bring it to operating temperature. Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and install the pressure cap.

Remove the cap on the coolant recovery tank, fill with coolant to halfway between LOW and MAX, and replace the cap.

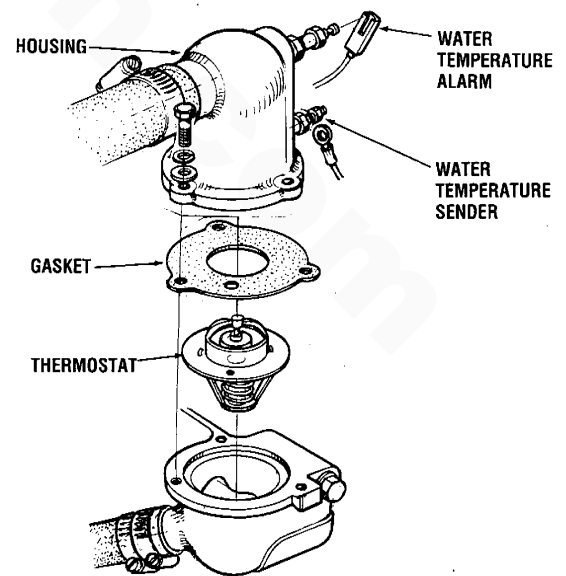
Run the engine and observe the coolant expansion flow into the recovery tank.

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

THERMOSTAT

A thermostat, located near the manifold at the front of the engine, controls the coolant temperature as it 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.



THERMOSTAT

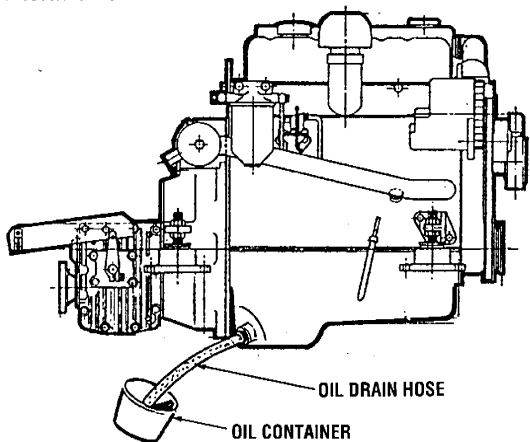


DRAIN THE SUMP

The engine oil should be warm. Remove the oil drain hose from its attachment bracket and lower it into a container and allow the oil to drain, or attach a pump to the end of the drain hose and pump out the old oil. Make sure the oil drain hose is capped and properly secured in its holder after all the old oil has been drained.

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

Always observe the old 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 competent mechanic if water is 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 poor location of the syphon brake. See WESTERBEKE'S *Installation Manual*.

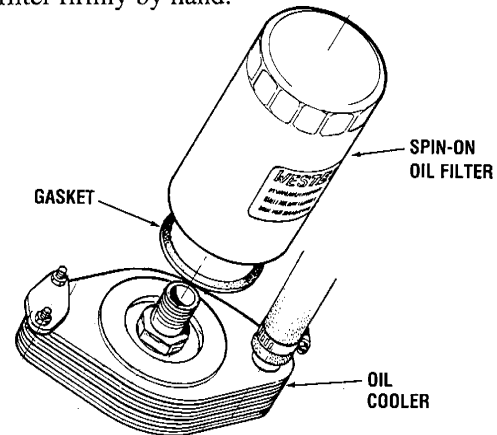


WARNING: Used engine oil contains harmful contaminants. Avoid prolonged skin contact. Clean skin and nails thoroughly using soap and water. Launder or discard clothing or rags containing used oil. Discard used oil properly.

REPLACE 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. An automotive filter wrench should be helpful in removing the old oil filter. Place some paper towels and a plastic bag around the

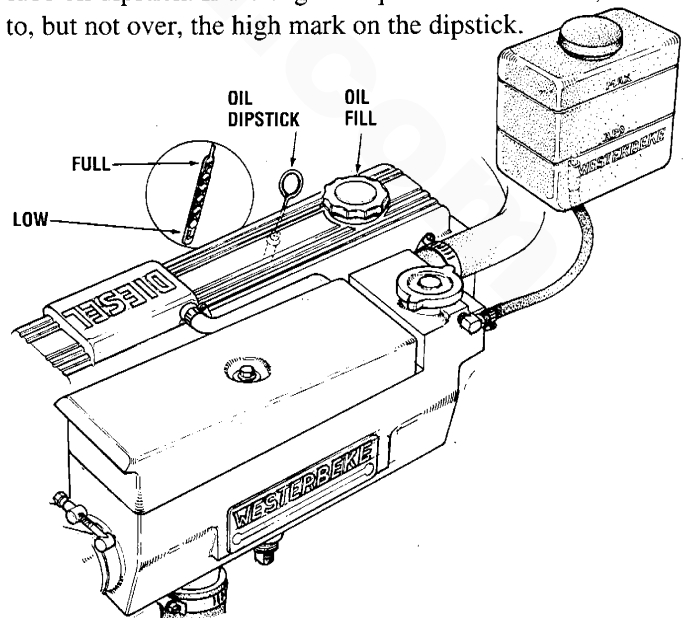
filter when unscrewing it to catch any oil left in the filter. Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket comes off with the old oil filter. If this rubber sealing gasket remains sealed against the engine block, gently remove it. When installing the new oil filter element, wipe the filter gasket's sealing surface on the engine block 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 stub, and tighten the filter firmly by hand.



NOTE: Use genuine WESTERBEKE oil filters – generic filters are not recommended.

REFILL THE OIL SUMP

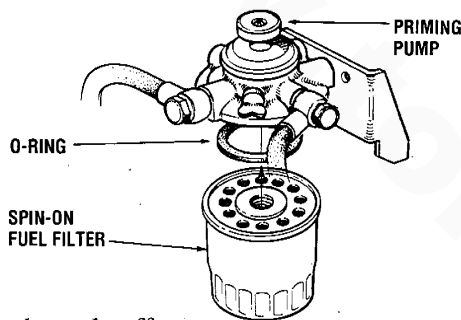
Add fresh oil through the filler cap. After refilling the oil, run the engine for a few moments while checking the engine's oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and then stop the engine. Then check the quantity of oil with the lube oil dipstick. If the engine requires additional oil, fill to, but not over, the high mark on the dipstick.



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

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 engines spin-on fuel filter. Visually inspect, clean, and change these filters according to the maintenance schedule in this manual.



1. Shut fuel supply off.
2. Loosen the fuel filter, turning counterclockwise with a filter wrench.
3. Using a rag, wipe clean the sealing face on the housing bracket so the new filter can be seated properly.
4. Lightly oil the sealing O-ring on the new filter. To reinstall, turn the filter assembly counterclockwise carefully until the O-ring contacts the sealing surface of the housing bracket. Turn 2/3 further with the filter wrench.
5. Turn on the fuel and manually prime the fuel filter using the priming pump on top of the housing. Use a slow steady pumping action until resistance is felt. The filter is now primed and the engine is ready to start.

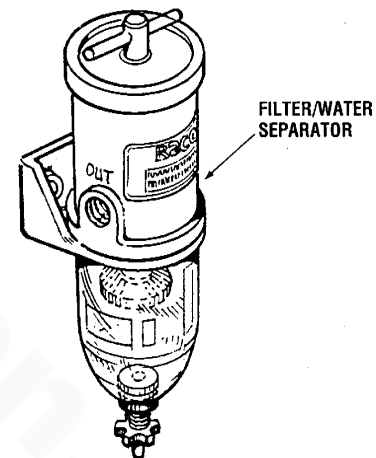
NOTE: The cartridge contains fuel. Take care not to spill it during disassembly. Perform the "fuel system air bleeding" after replacing the spin-on filter.

FUEL WATER SEPARATOR

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

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

A typical fuel filter/water separator is illustrated in this diagram. 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 INJECTION PUMP CONTROL

The fuel injection pump is precisely adjusted; most of the adjustments are sealed, so be careful not to break them. When an adjustment is necessary, contact your WESTERBEKE dealer.

NOTE: There is no warranty on engines with broken high rpm governor adjustment seals.

NOTE: The idle adjustment screw can be readjusted to provide for a satisfactory idle speed with each specific installation.

FUEL SYSTEM

(Continued)

FUEL ADDITIVES

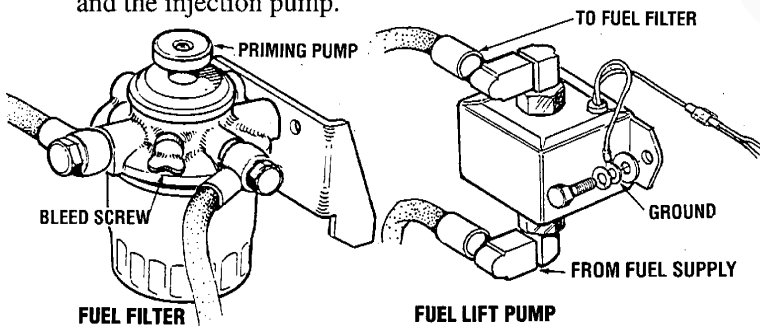
If fungus or bacteria is causing fuel problems, you should have an authorized dealer correct these problems. Then use a diesel fuel biocide to sterilize the fuel (follow the manufacturer's instructions).

SPARES

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

PRIMING (BLEEDING) THE FUEL SYSTEM

The on-engine fuel system is virtually self priming. Under ordinary circumstances the engine's electric fuel lift pump, which is energized by the key switch/preheat button, will supply a continuous flow of fuel from the tank. This fuel is drawn through the fuel/water separator to the engine lift pump, the primary spin-on fuel filter, and the injection pump.



WARNING: Do not allow smoking or open flames near the fuel system when servicing. Also provide proper ventilation.

If it becomes necessary to bleed air from the system, use the following procedure:

Open the bleed screw by turning the thumbscrew on the fuel filter 1 or 2 turns. Energize the preheat button (key ON) for 10 to 20 seconds or do it manually using the palm of your hand to pump the primer pump on the top of the fuel filter housing. When fuel flows freely from the bleed screw, tighten, but do not overtighten, the screw.

CAUTION: When using the preheat function, keep in mind that the preheat elements (glow plugs) are also energized; take care not to overheat them!

Once the fuel filter assembly is free of air and the bleed screw tightened, use the preheat button or slowly pump the primer pump for 10 to 20 seconds to force any air between the filter housing and injection pump out of the system to the tank via the return line.

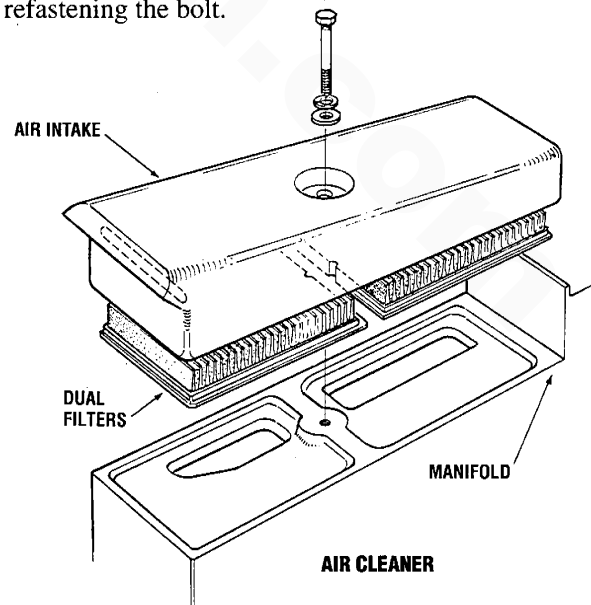
In cases where excessive amounts of air exist in the fuel system, follow the above procedure but in addition, loosen all the high pressure injector lines (not injectors) and crank the engine starter motor; as fuel spurts from between the nut and the line, tighten the injector lines in sequence and then tighten the bleed screw.

NOTE: Do not attempt this procedure on a hot engine.

WARNING: Always wear protective clothing, safety glasses and gloves when bleeding high pressure injector lines.

AIR CLEANER

Dual air cleaner filters are located on the top of the engine manifold. These filters should be inspected, cleaned, and/or replaced at maintenance periods. With the engine turned off, remove the single hex bolt, lift the manifold top, and the dual air cleaner filters become accessible. When reassembling, make certain the filters are positioned properly, and do not overtighten when refastening the bolt.



DC ELECTRICAL SYSTEM

DESCRIPTION

The charging system consists of an alternator with a mounted voltage regulator, an engine DC wiring harness, a mounted DC circuit breaker, and a battery and connection wires. 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

If you suspect that the alternator is not producing enough voltage to charge the engine's battery, check the following:

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

- Make certain your alternator is securely mounted.
- Check the drive belts for proper tension.
- Inspect for loose or disconnected wires at the alternator.

NOTE: 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 house batteries. If the isolator is charging the starting battery but not the house battery, the alternator is OK and the problem is in the battery charging circuit.

⚠ WARNING: Shut off the engine battery switch or disconnect from the battery when working on the engine electrical system.

Checking for Proper Voltage

If you suspect the alternator has failed perform the following tests with the engine off:

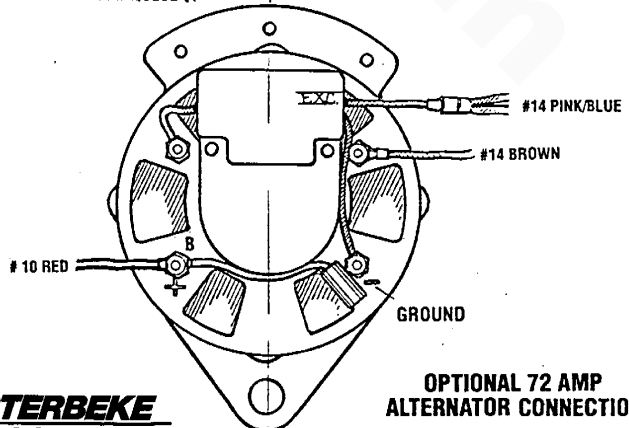
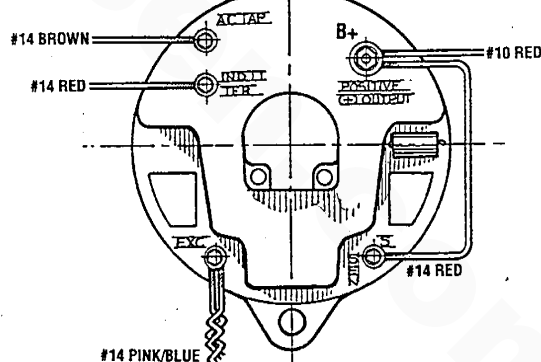
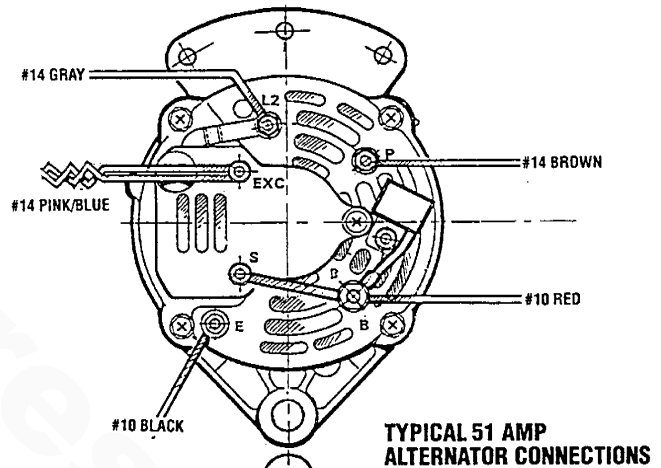
1. Using a voltmeter, connect the voltmeter red wire clip to the output terminal B+.
2. Connect the voltmeter negative wire to any ground on the engine.
3. Check the battery voltage. It should read 12 to 12 volts.
4. Check the voltage between the alternator (+) positive terminal B and any engine ground. If the circuit is good, the voltage at the alternator should be the same as the battery (unless there's an isolator in the circuit, then the reading would be zero).

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

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

5. Start the engine.
6. The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or undercharging, have it repaired at a reliable service shop.

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



DC ELECTRICAL SYSTEM

(Continued)

DRIVE BELT ADJUSTMENT

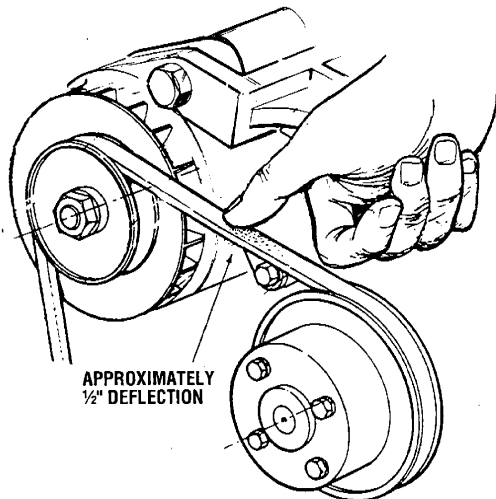
⚠ CAUTION: *Drive belts must be properly tensioned. Loose drive belts will not provide proper alternator charging and will eventually damage the alternator.*

Drive belts that are too tight will pull the alternator out of alignment and/or cause the alternator to wear out prematurely.

Belt tension adjustment is made by pivoting the alternator on its base mounting bolt.

1. Loosen the alternator adjusting strap bolt and the base mounting bolt.
2. Pivot the alternator on the base mounting bolt to the left or right as required.
3. Tighten the base mounting bolt and the adjusting strap bolt.
4. Operate the engine for about 5 minutes at idle, then shut down and recheck belt tension.

⚠ CAUTION: *Use only genuine WESTERBEKE Drive Belts; poor quality belts will lead to premature wear and belt elongation resulting in alternator damage.*



BELT TENSION

BATTERY CARE

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

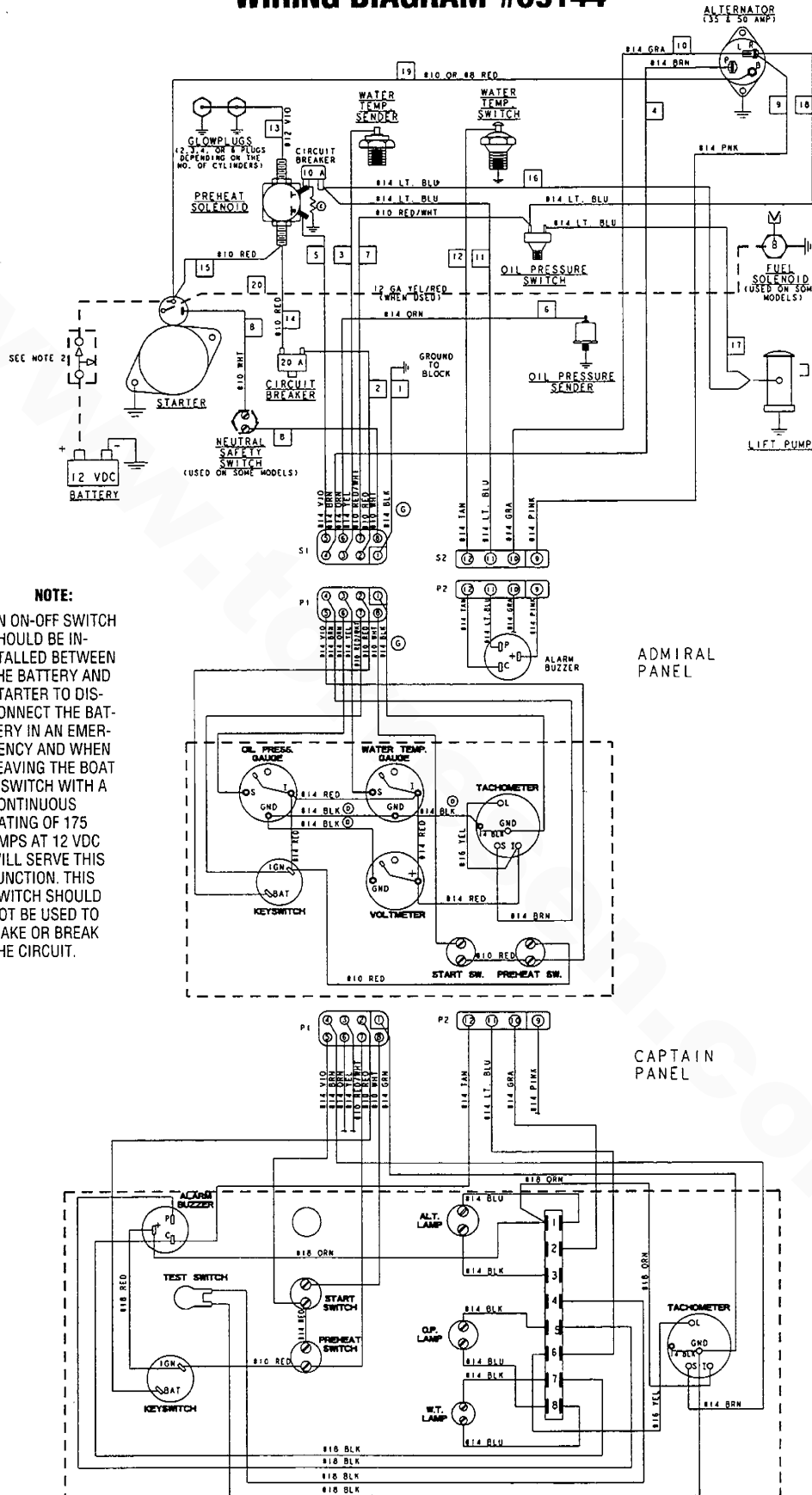
- Monitor your voltmeter for proper charging during engine operation.
- Check the electrolyte level and specific gravity with a hydrometer.
- Use only distilled water to bring electrolytes to a proper level.
- Make certain that battery cable connections are clean and tight to the battery posts (and to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



DC ELECTRICAL SYSTEM

WIRING DIAGRAM #39144

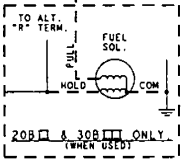
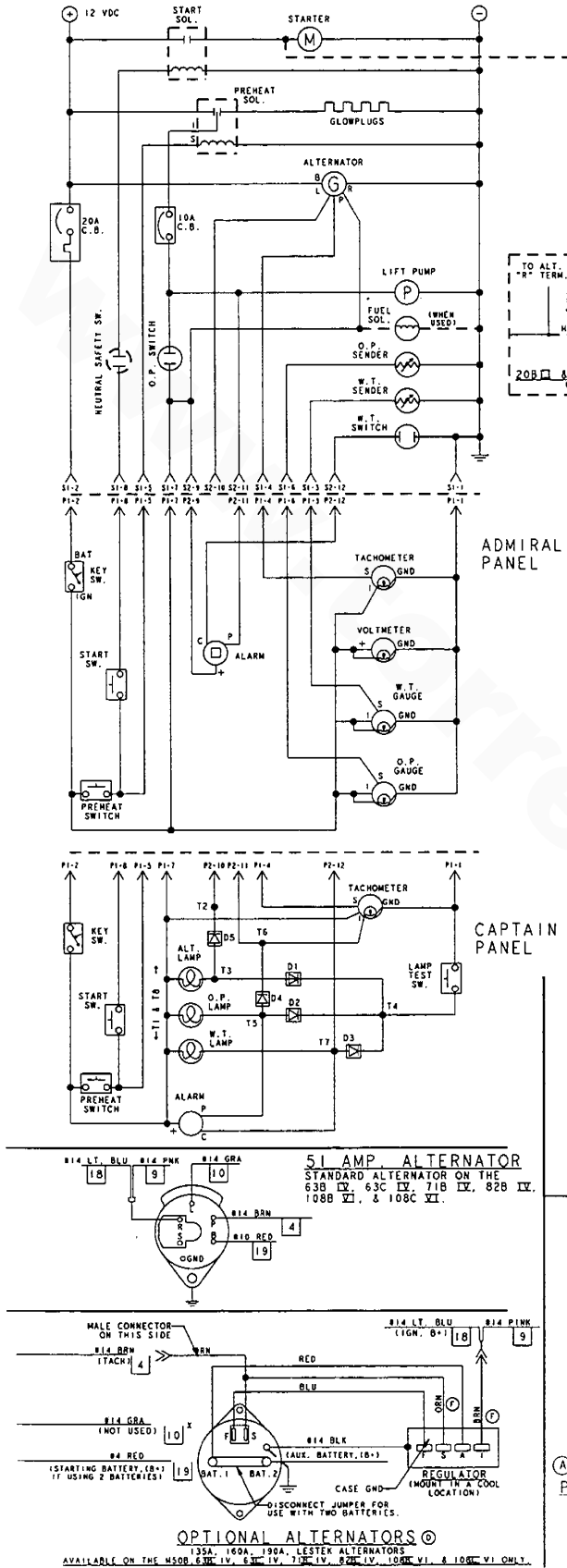


NOTE:
AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VDC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.



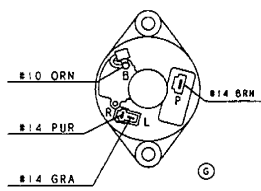
DC ELECTRICAL SYSTEM

WIRING DIAGRAM #39144

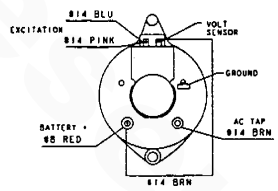


- NOTES:**
1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER. EXCESSIVE CURRENT WILL CAUSE THE BREAKER TO TRIP AND THE ENGINE WILL SHUT DOWN. THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING, AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL 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 15 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.

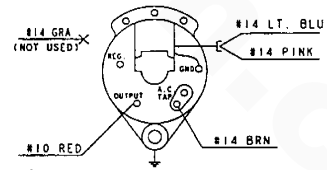
MITSUBISHI 50 AMP. ALT.



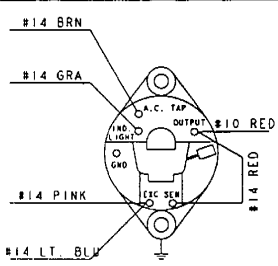
PRESTOLITE/LEECE-NEVILLE 90 AMP. ALT.



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



PRESTOLITE 72 AMP. ALT.



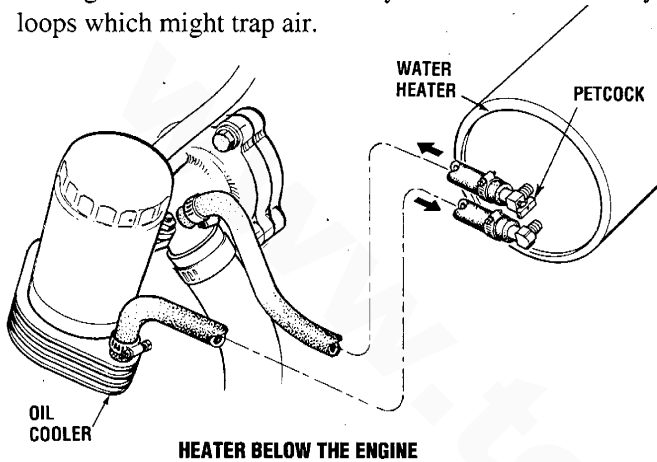
UNIVERSAL PROPULSION PRESTOLITE 51 AMP. ALT.



Revised October 2000

WATER HEATER INSTALLATIONS

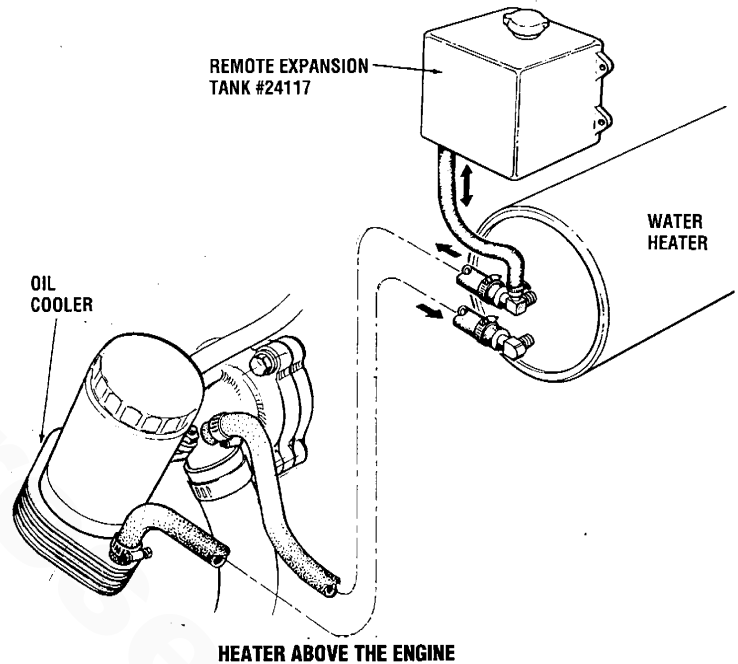
This engine is equipped with connections for the plumbing of engine coolant to heat an on-board water heater. The water heater should be mounted in a convenient location either in a high or low position in relation to the engine, so that the connecting hoses from the heater to the engine can run in a 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 fresh water coolant level can easily be checked. The remote expansion tank will now serve as a check and system fill point. **The plastic coolant recovery tank is not used when the remote expansion tank kit is installed, since this tank serves the same function.**

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.

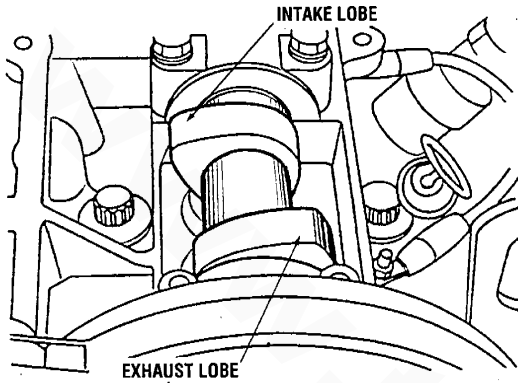


NOTE: An air bleed petcock is located on the engine's heat exchanger. Open this petcock when filling the engine's fresh water system to allow air in the exchanger to escape. Close tightly after all the air is removed.

ADJUSTING VALVE CLEARANCES

1. Remove the cylinder head rocker cover.
2. Manually rotate the engine crankshaft and bring #1 piston up on TDC of its compression stroke.

NOTE: When this occurs, the intake and exhaust cam lobes will face upwards.

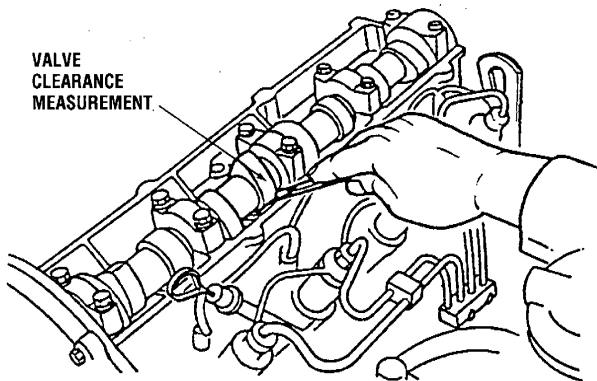


3. Measure the valve clearance of #1 cylinder by using a thickness gauge.

Standard Valve Clearances (Engine Cold):

Intake: 0.20 – 0.30mm (0.008 – 0.012 in)

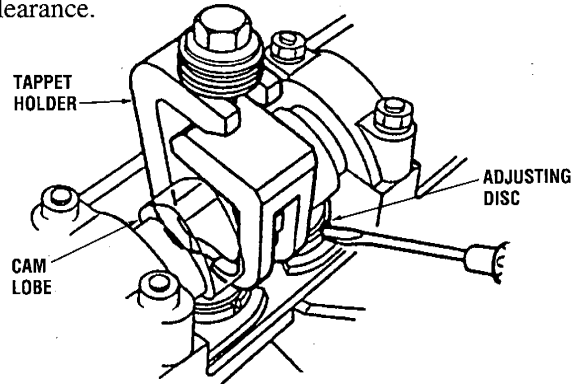
Exhaust: 0.30 – 0.40mm (0.012 – 0.016 in)



If the valves clearances are not within standard values, continue using the following procedure to adjust the valves.

4. Rotate the valve cam lobe so that it points straight upward.
5. Rotate the tappet so that one of the notches is facing the exhaust manifold. This allows for better access to the adjusting disc.
6. Using the tappet holder WESTERBEKE #41978, press the tappet down to the position where the adjusting disc becomes accessible.

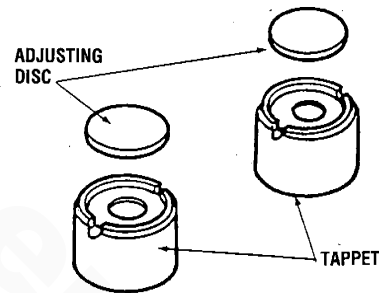
7. Using a small screwdriver or magnet, remove the adjusting disc.
8. Select an appropriate disc thickness depending on the clearance measured. Install it and verify proper clearance.



EXAMPLE (Intake Valve): The thickness of the disc removed plus the clearance measured minus the standard clearance will give the thickness of the new adjusting disc.

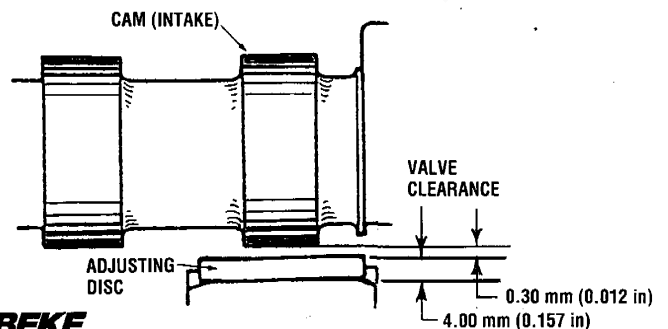
$$4.0 \text{ mm} + (0.30 - 0.25 \text{ mm}) = 4.05 \text{ mm}$$

$$0.157 \text{ in} + (0.012 - 0.010 \text{ in}) = 0.159 \text{ in}$$



NOTE: The number marked on the disc indicates its thickness. Example: 3825 means 3.825mm (0.1056 in). Adjusting discs are available in 25 different thicknesses between 3.40 and 4.60mm (0.1339–0.1811 in) range, at variations of 0.050 mm (0.002 in).

9. Measure and adjust as needed the valves in cylinders #3, #4 and #2 following the instructions above.



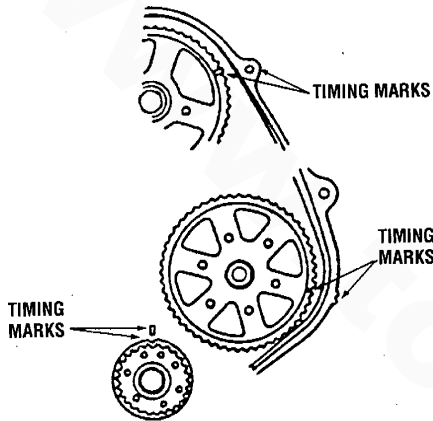
ENGINE ADJUSTMENTS

(Continued)

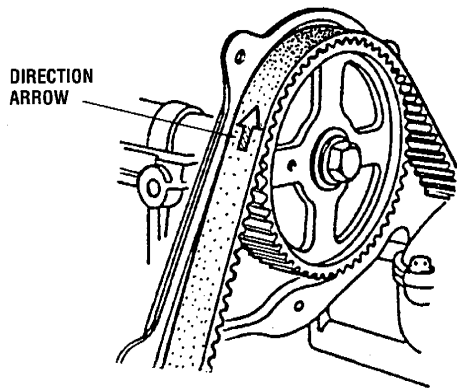
TIMING BELT INSPECTION AND REPLACEMENT

1. Before removing the timing belt and timing belt tensioner, rotate the engine crankshaft by hand and align the three timing marks as shown in the illustration.

CAUTION: After removal of the timing belt, **DO NOT** rotate the crankshaft or camshaft; the pistons will damage the opened valves.



NOTE: If the timing belt is to be reused, draw an arrow on the belt pointing in the direction of the belts rotation. Replace it in the same direction .



Inspection

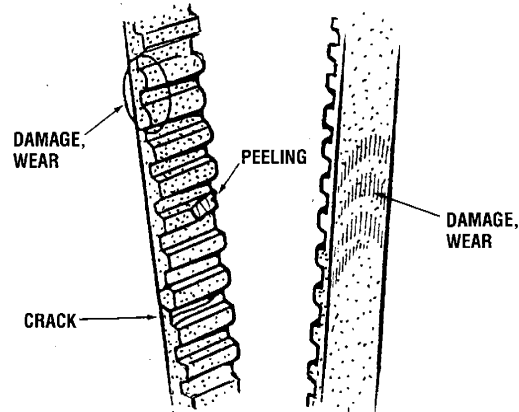
1. Replace the timing belt if it is contaminated with oil, grease or water.
2. Check for damage, wear, peeling, cracks or hardening. Replace if suspect.

NOTE: Never forcefully twist the timing belt; turn it inside out or bend it.

Timing Belt Tensioner

1. Check the rotation of the timing belt tensioner pulley. Check for play or abnormal noise.

NOTE: Do not clean the timing belt tensioner with cleaning solvents. If dirty, use a clean rag to wipe it clean. Avoid scratching the surface the belt travels over.

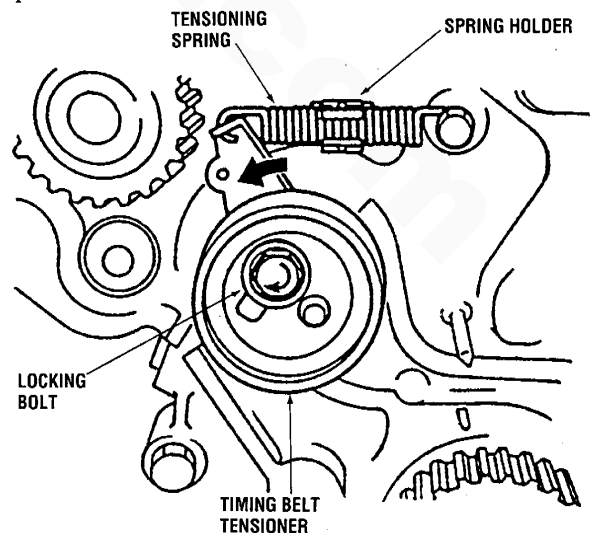


Timing Belt, Camshaft And Injection Pump Gears

1. Check the gear teeth for any indication of damage, wear, deformation, etc. Replace if any faults are found.

Timing Belt Installation

1. Check to ensure that the timing marks on the gears are properly aligned with the marks on the case.
2. Loosely install the timing belt tensioner, locking bolt and spring. Push the timing belt tensioner toward the lock bolt to the left as far as it will go and then tighten the locking bolt to temporarily hold the tensioner in place.

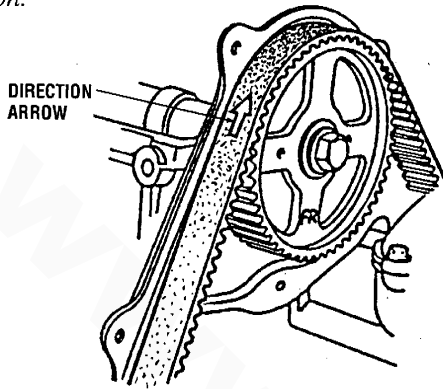


ENGINE ADJUSTMENTS

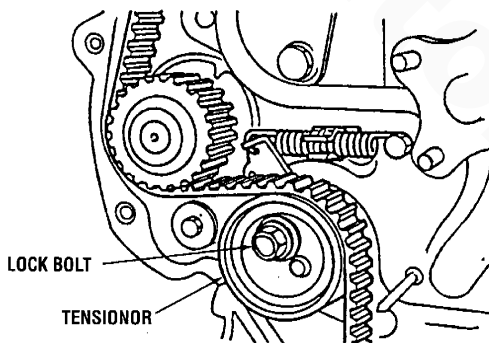
(Continued)

3. Install the timing belt.

NOTE: If reinstalling the original belt, be sure to install with the arrow in the correct direction of belt rotation.



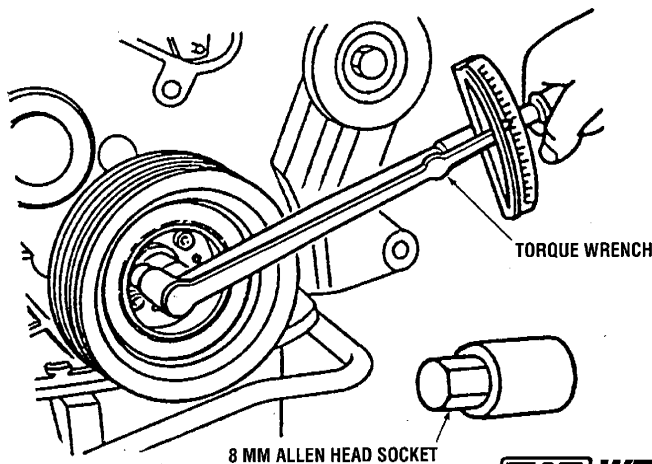
4. Release the timing belt tensioner lock bolt to allow the tensioning spring tensioner to bring pressure on the timing belt.



5. Turn the crankshaft twice in the direction of normal engine rotation (clockwise) to equalize tension on the timing belt.

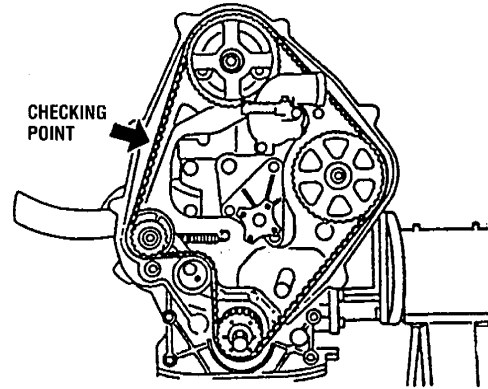
NOTE: Do not turn the engine in reverse of its normal rotation.

6. Tighten the timing belt tensioner lock bolt.
Lock bolt torque: 3.2–4.7 m·kg (23–34 ft·lb)



7. Re-check the timing mark positions between the three gears and the gear case. Check the timing belt deflection at the point on the belt shown in the illustration with a pushing force of 10 kg (22 lb).

Standard Deflection (unit cold):
10.8–12.9 mm (0.43–0.51 in)



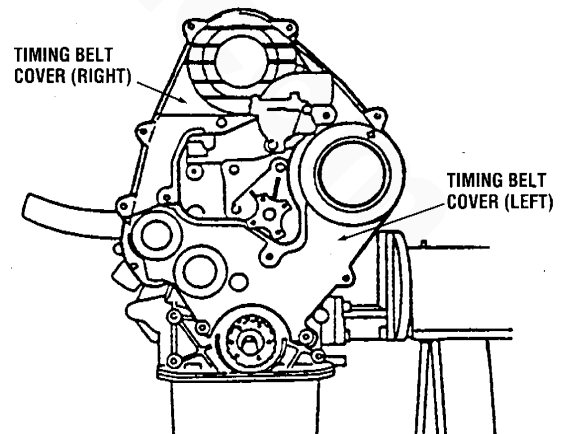
8. Install the timing belt left cover with its rubber seal.
9. Install the timing belt right cover with its rubber seal.

Bolt torque for timing belt cover bolts:
0.7–1.0 m·kg (5–7 ft·lb)

10. Install the crankshaft pulley and torsional damper onto the timing belt drive gear with the semicircular (woodruff) key. Tighten the attachment.

Crankshaft pulley bolt torque:
2.3–3.3 m·kg (17–24 ft·lb)

NOTE: When installing the torsional damper onto the timing belt drive gear, align the mark on the damper with the knock pin on the gear.



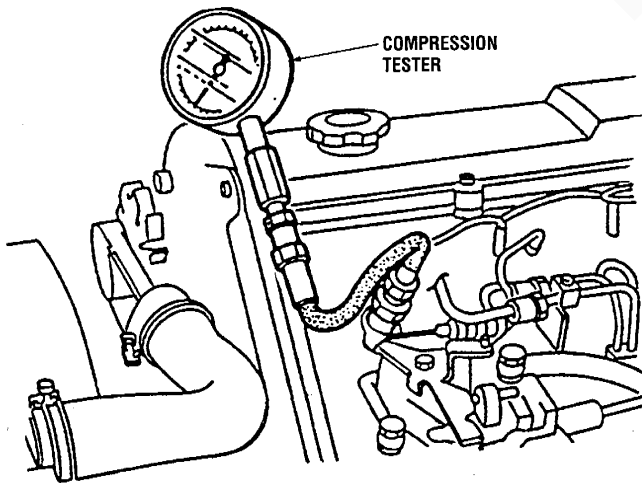
ENGINE ADJUSTMENTS

(Continued)

COMPRESSION TEST

1. Warm the engine up to operating temperature.
2. Stop the engine.
3. Remove all four glow plugs.
4. Disconnect the DC power connection to the fuel shutoff solenoid on the injection pump.
5. Install the compression tester glow plug adapter in the glow plug opening of #1 cylinder. Connect the compression gauge to the glow plug adapter.
6. Crank the engine with the starter and allow the gauge to reach its maximum reading.
7. Record the reading and proceed to the next cylinder.
8. Compare readings to the table below. Take corrective action as needed.

Compression pressure	kg/cm ² (lb/in ²)-rpm
Standard	30 (426) — 200
Limit	27 (384) — 200



NOTE: When performing the compression test, shut off the raw water supply to the engine mounted raw water pump. This is to prevent filling of the exhaust system with raw water while performing the test.

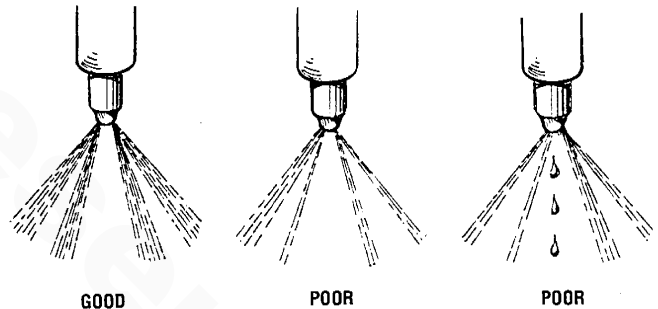
FUEL INJECTION NOZZLE TEST

When the injection starting pressure is too high or too low or the fuel spray pattern is improper, an abnormal fuel combustion takes place in the engine leading to lowered power output, blackish exhaust smoke and unwanted combustion noise. Further, it can cause a piston seizure or piston damage if not corrected. In such cases, the injection nozzle test should be performed and the faulty nozzle(s) replaced as required.

Use an injection nozzle tester to check the static injection starting pressure and condition of the spray pattern every 800 operating hours.

Injection nozzle pressure is 1920 psi + 71 psi
(135 kg/cm² + 5 kg/cm²).

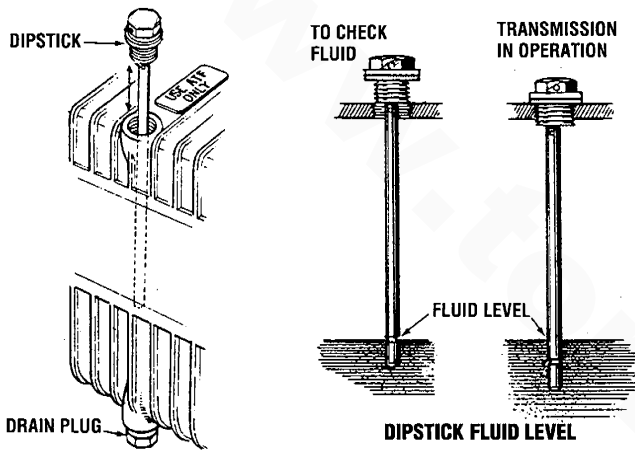
⚠ WARNING: When testing a nozzle beware that high pressure might blow off the light oil and cause injury. Keep away from the nozzle end!



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 hex-head of the dipstick. Check for leaks and change the fluid after the first 25 hours.



GEARBOX OPERATION

The neutral position of the operating lever on the control console must coincide with the neutral position of the actuating lever on the transmission. Shifting is initiated by a cable or rod linkage via the actuating lever and an actuating cam. The completion of the gear changing operation is servo-automatically controlled within the gear. Gear changing should be smooth, not too slow, and continuous (without interruption). Direct changes from forward to reverse are permissible, since the multiple-disc clutch permits gear changing at high rpm, including sudden reversing at top speeds in the event of danger.

WHEN UNDER SAIL OR BEING TOWED

Rotation of the propeller without load such as when the boat is sailing, 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 gearbox.

NOTE: When the boat is sailing (engine stopped), the gear lever must be in neutral position. The propeller is at idle and can free wheel.

LOCKING THE PROP

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

CONTROL CABLES

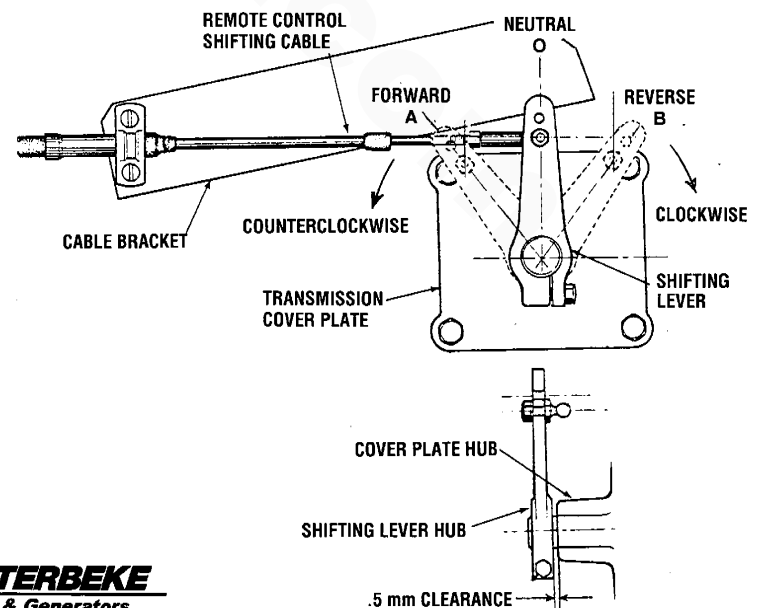
The gearbox is suitable for single lever remote control. Upon loosening the retaining screw, the shift lever can be moved to any position required for the control elements (cable or rod linkage). Make certain that the shift lever does not contact the shift lever cover plate: the minimum distance between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

The control cable or rod should be arranged at a right angle to the 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 the shift lever on the gear box.

The shifting travel, as measured at the pivot point of the shift 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 shift 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 shift lever travel at least each season.



HBW TRANSMISSION

(Continued)

⚠ CAUTION: *The position of the cover plate underneath the actuating lever is factory-adjusted to ensure equal shift lever travel from neutral position to A and B. If this side shift cover is removed or in any way tampered with, the transmission warranty will be void. Authorized Hurth personnel only may adjust or remove this cover.*

NOTE: *When installing the gearbox, 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.*

MAINTENANCE

Transmission Fluid

To ensure trouble-free operation of the gearbox, only use Automatic Transmission Fluid (ATF), (*Dexron II or III*).

Capacity

Add the fluid quantity for the proper model transmission to the gearbox. After filling, check the fluid level with the dipstick. Adjust level as needed. Install the dipstick with the sealing washer, operate unit, check fluid, check for leaks.

Transmission Fluid	Quantity
HBW 150	0.59 Quarts (0.56 Liters)
HBW 150V	1.10 Quarts (1.05 Liters)
HBW 250	1.84 Quarts (1.75 Liters)

Fluid Change

Change the fluid for the first time after about 50 hours of operation, then every 250 operating hours or at least once a year or when you change engine oil. When changing the fluid, also check the gearbox cooling device and clean or replace it as necessary.

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

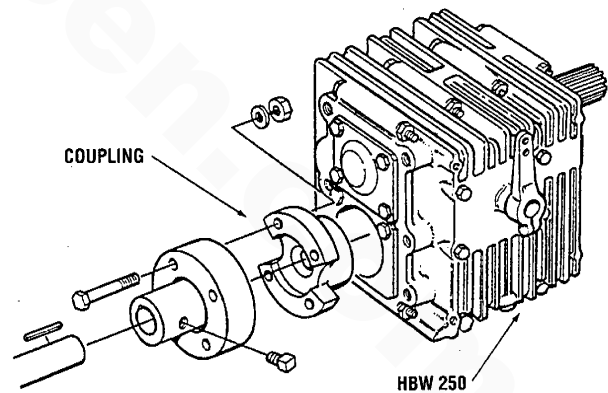
Checking the Bowden Cable or Rod Linkage

The Bowden cable or rod linkage should be checked at regular intervals. Check the neutral position of the operating lever (on the control console) and the actuating lever (on the gearbox). The minimum lever travel from the neutral position to the operating positions ($0 - A = 0 - B$) should be 35mm for the outer and 30mm for the inner pivot point. Make certain that these minimum values are safely reached. Check the cable or rod linkage for easy movability and proper attachment.

Connection of Gearbox with Propeller

HBW recommends a flexible connection between the 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 manufacturer's instructions.

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



Lay-up/Winterize

If the transmission is not used for periods of more than one year, it should be completely filled with fluid of the same grade to prevent corrosion. Protect the input shaft and the output flange by means of an anticorrosive coating, as required.



BORG WARNER VELVET DRIVE TRANSMISSION

INITIAL OPERATION

Transmission Fluid

Check transmission fluid level on the dipstick. If the transmission has not been filled, fill with *Dextron III* and continue to use this fluid. During the first 50 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 50 hours and approximately every 1000 operating hours or at winter lay-up.

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

Shifting Into Gear

Place the transmission selector control 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 selector lever to the middle position. You should feel the detent. Center the shift lever on the transmission through the linkage to the selector lever. With the control in this position, hydraulic power is completely interrupted and the output shaft of the transmission does not turn.

Forward

Move selector lever to the forward position. You should feel the detent. The shift 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 selector lever to the reverse position. You should feel the detent. The shift 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 shift lever from Neutral Position to Forward is always towards the engine. Reverse is always away from the engine.

NOTE: Be aware of any unusual noises or vibrations and investigate to determine the cause.

NOTE: If the boat moves backwards with the selector control in the forward position, shut off the engine! This problem may be the result of incorrect movement of the shift lever by the shift control.

DAILY OPERATION

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

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

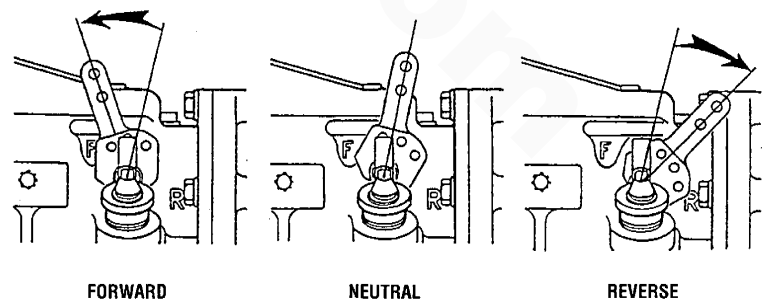
- Shift into gear.

WARNING: Shifting gears above 1000 rpm can damage the engine and transmission.

SHIFT LEVER POSITION

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

NOTE: Do not remove detent ball!



BORG WARNER VELVET DRIVE TRANSMISSION (Continued)

MAINTENANCE

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

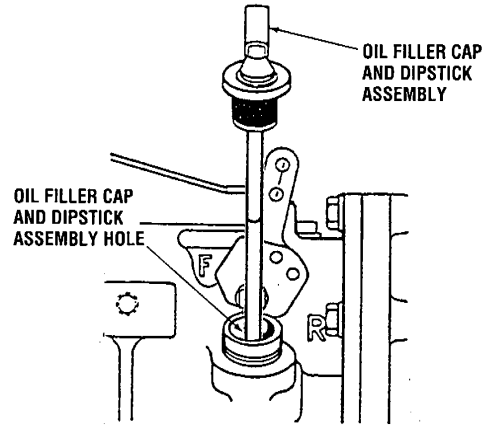
CAUTION: Clutch failure will occur if the transmission shift lever does not fully engage the detent ball positions.

Changing Transmission Fluid

After the initial 50 hour change, the transmission fluid should be changed at 1000 operating hours or at winter haul-out. However, fluid must be changed whenever it becomes contaminated, changes color or smells rancid.

- Remove oil filler cap and dipstick.
- Remove oil cooler return line and allow oil to drain into a container.
- Reconnect oil cooler return line.
- Use a suction pump to remove transmission oil through the filler cap/dipstick hole.
- Clean off the transmission and properly dispose of the used fluid.
- Refill the transmission with *Dextron II or III* transmission fluid. The quantity will vary depending on the transmission model and installation angle. Fill through the dipstick hole.
- Check dipstick for proper fluid level.
- Replace oil filler cap/dipstick. (Dipstick is pressed into place and turned clockwise until finger-tight.)
- Run engine — then shutdown and recheck fluid level.

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



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 occur normally 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 II or III* 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.
- Spray the flanges with an anticorrosive coating.

WARRANTY NOTES

Service manuals are available from your BORG WARNER dealer.

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 propeller blades while shifting. Therefore torque loads and directional changes should be made at low engine speeds. If it is found that the failure was caused by a shock load, the warranty claim will be denied.

Oil temperature maximum is 190°F (105°C) during operation. If oil temperature runs too high, consult your BORG WARNER distributor.

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.

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

NOTE: *The engine's electrical system is protected by a 20-Ampere manual reset circuit breaker located on a bracket on the left front side of the engine. The preheat solenoid is mounted on the same bracket.*

Problem	Probable Cause	Verification/Remedy
Key Switch on, PREHEAT switch depressed; no panel indications; fuel solenoid, electrical fuel pump and preheat solenoid not energized.	<ol style="list-style-type: none"> 1. Battery switch not on. 2. 20-Amp circuit breaker tripped. 3. 10 Amp breaker tripped. 4. Loose battery connections. 5. Preheat solenoid not operating. 	<ol style="list-style-type: none"> 1. Check switch and/or battery connections. 2. Reset breaker; if breaker trips again, check preheat solenoid circuit and check circuit for shorts to ground. 3. Check voltage at and after breaker. 4. Check (+) connection on starter solenoid and (-) connection to engine ground stud. Check battery cable connections. 5. Check Solenoid.
Key Switch on, PREHEAT switch depressed; START switch depressed; no starter engagement.	<ol style="list-style-type: none"> 1. Connection to solenoid faulty. 2. Faulty START switch. 3. Faulty solenoid. 4. Neutral safety switch open. 5. Loose battery connection. 8. Low batteries. 	<ol style="list-style-type: none"> 1. Check connection at solenoid. 2. Check switch with ohmmeter. 3. Check that 12 volts are present at starter solenoid activation connection. 4. Shift lever in neutral — check switch. 5. Check battery connection. 6. Check battery charge state.
START switch is depressed; panel indications OK; start solenoid OK; fuel solenoid not functioning.	<ol style="list-style-type: none"> 1. Poor connections to fuel solenoid. 2. Defective fuel solenoid. 	<ol style="list-style-type: none"> 1. Check connections. 2. Check that 12 volts are present at the (+) connection on the fuel run solenoid.
No ignition; cranks, but does not start; fuel solenoid energized.	<ol style="list-style-type: none"> 1. Faulty fueling system. 2. Preheat solenoid faulty. 	<ol style="list-style-type: none"> 1. Check that fuel valves are open. <ol style="list-style-type: none"> 1a. Check for air in fuel system. Bleed air from engine fuel system. 1b. Filters clogged. (Replace filters and bleed fuel system of air.) 2. Check solenoid.
No ignition. Fuel solenoid energized. Engine cranks slowly, then fails.	<ol style="list-style-type: none"> 1. Starting battery failure 2. Water in engine 	<ol style="list-style-type: none"> 1. Check start batteries. <ol style="list-style-type: none"> 1a. Switch to combine house and start batteries. 1b. Replace batteries. 2. Exhaust system failure — raw water has backed into cylinders. Water must be removed from engine — a serious problem that can be corrected.
Engine can't be stopped.	<ol style="list-style-type: none"> 1. STOP switch failure. 2. Fuel run solenoid will not de-energize. 3. Check DC alternator for feedback through regulator circuit. 	<ol style="list-style-type: none"> 1. Check switch will not open run circuit. Manually move the shutoff lever on the injection pump side. Test switch with ohmmeter. 2a. Manually disconnect the 12 volt connection to the fuel run solenoid at the injection pump. 2b. Loosen high pressure injector lines at each injector. Beware of fuel spray. 3. Disconnect the R terminal.
Engine stops.	<ol style="list-style-type: none"> 1. Fuel lift pump failure. 2. Switches and/or wiring loose or disconnected. 3. Fuel Starvation 4. 20-amp. circuit breaker tripping. 5. Exhaust system is restricted. 6. Water in fuel. 	<ol style="list-style-type: none"> 1. Fuel lift pump should make a distinct ticking sound. Replace pump with spare. 2. Inspect all wiring for short circuits and loose connections. Inspect switches for proper operation. 3. Check fuel supply, fuel valves, fuel lift pump. 4. Check for high DC amperage draw during operation. Ensure switch is not overly sensitive to heat which would cause tripping. 5. Check for blockage, collapsed hose, carbon buildup at exhaust elbow. 6. Pump water from fuel tank(s); change filters and bleed fuel system.
Battery not charging.	<ol style="list-style-type: none"> 1. Alternator drive 	<ol style="list-style-type: none"> 1. Check drive belt tension. Alternator should turn freely. Check for loose connections. Check output with voltmeter.



ENGINE TROUBLESHOOTING

(Continued)

Problem	Probable Cause	Verification/Remedy
Battery runs down.	<ol style="list-style-type: none"> 1. Oil pressure switch. 2. High resistance leak to ground. 3. Low resistance leak. 4. Alternator. 5. Poor battery connections. 	<p style="text-align: right;">Ensure 12 volts are present at the "R" terminal.</p> <ol style="list-style-type: none"> 1. Observe if gauges and panel lights are activated when engine is not running. Test the oil pressure switch. 2. Check wiring. Insert sensitive (0-.25 amp) meter in battery lines. (Do not start engine.) Remove connections and replace after short is located. 3. Check all wires for temperature rise to locate the fault. 4. Disconnect alternator at output, after a good battery charging. If leakage stops, remove alternator and bench test. Repair or replace. 5. Check cable connections at battery.
Engine overheat. NOTE: Shut engine down immediately.	<ol style="list-style-type: none"> 1. Raw water not circulating. 2. Coolant not circulating. 	<ol style="list-style-type: none"> 1. Broken or loose belt at raw water pump. 2. Raw water pump failure. Check impeller – replace. 2a. Obstruction at raw water intake or raw water filter. 2b. Thermostat — remove and test in hot water. Replace thermostat. 2c. Loss of coolant — check hoses, hose clamps, drain plug, etc. for leaks. 2d. Broken or loose belts — tighten/replace. 2e. Air leak in system; run engine and open cooling system petcocks, heat exchanger, manifold, etc. to bleed air. Add coolant as needed.
Exhaust smoking problems.	<ol style="list-style-type: none"> 1. Blue smoke. 2. White smoke. 3. Black or gray smoke. 	<ol style="list-style-type: none"> 1. Incorrect grade of engine oil. 1a. Crankcase overfilled with engine oil (oil is blowing out through the exhaust). 2. Engine is running cold. 2a. Faulty injector or incorrect injector timing. 3. Improper grade of fuel. 3a. Fuel burn incomplete due to high back pressure in exhaust or insufficient air for proper combustion. (Check for restrictions in exhaust system; check air intake.) 3b. Improperly timed injectors or valves or poor compression.
Transmission will not shift in or out of gear, or drive the vessel.	<ol style="list-style-type: none"> 1. Transmission failure. 2. Transmission oil cooler failure. 	<ol style="list-style-type: none"> 1a. Check cable connections at steering station and at transmission lever. 1b. Check transmission fluid. 1c. Check shaft couplings or engine damper plate. 1d. Check drive damper 2a. Replace oil cooler.

TROUBLESHOOTING WATER 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. Connect the sender terminal at the gauge to ground and see if the gauge reads full scale, which is the normal reading for this situation.

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

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

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

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



LAY-UP AND 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 following procedures will allow you to perform your own lay-up and recommissioning, or you may use them as a check list for others. 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

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 a 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 SYSTEM

A 50-50 solution of antifreeze and fresh water is recommended for use in the freshwater cooling 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. (Place some paper towels and a plastic bag around the filter to catch the oil during its removal.)

When installing the new oil filter, be sure to apply a

small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine model. (Refer to the *SPECIFICATIONS* section of this manual.) Use an oil with an API specification of CF or CG4. Run the engine and check for proper oil pressure and make sure there are not leaks. Stop the engine, check oil level and add oil as needed to bring level to dipstick full mark.

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

FUEL SYSTEM

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

Change the fuel filter elements on the engine and bleed the 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.

RAW WATER CIRCUIT

Close the through-hull fitting. Remove the raw water intake hose from the fitting. Place the end of this hose into a 5-gallon bucket of clean fresh water. Before starting the engine, check the zinc anode found in the heat exchanger on the engine and clean or replace it as required. Clean the raw water strainer, if one is installed in the inside of the hull.

Start the engine and allow the raw water pump to draw 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 again 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



LAY-UP AND RECOMMISSIONING

(Continued)

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 anti-freeze mixture will accompany it, so catch it in a bucket). Examine the impeller. Acquire replacement, if needed, and a cover gasket. Do not replace the impeller (into the pump) until recommissioning, but replace the cover and gasket.

INTAKE MANIFOLD

Open the intake manifold and inspect the filter elements inside. Clean with low pressure compressed air or replace if needed. Do not leave filters installed during lay-up period. Filter elements should be stored in a clean dry area. Place an oil rag in the intake opening to keep dampness out.

STARTER MOTOR

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

CYLINDER LUBRICATION

It is not necessary to remove the glow plugs from the cylinder head to squirt light engine oil into the cylinders for the few months of normal lay-up. However, if you anticipate a longer lay-up period (12 months or more), we recommend that this procedure be performed. The light oil in the cylinders will prevent the pistons' rings from sticking to the cylinder walls. With oil in the cylinders, turn the engine over by hand two revolutions.

TRANSMISSION

Check or change fluid in the transmission as required. Wipe off grime and grease and touch up unpainted areas. Protect coupling and output flange with anticorrosion coating. Check that transmission vent is open.

SPARES

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.

BATTERIES

If batteries are to be left on board during the lay-up period, make sure they are fully charged and will remain that way, to prevent them from freezing. If you have 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 lighted tobacco products. 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. Wear rubber gloves, a rubber apron and eye protection when servicing batteries.

RECOMMISSIONING

The recommissioning of your WESTERBEKE engine after a seasonal lay-up generally follows the same procedures as those presented in the *PREPARATION 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 and from the through-hull exhaust port.
2. Remove the raw water pump cover and gasket. Discard the 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. Reconnect the shaft coupling and check for proper alignment.
4. 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 the batteries are fully charged.
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.
6. Start the engine in accordance with procedures in the *PREPARATION FOR INITIAL START-UP* section of this manual.



WESTERBEKE 55A FOUR TORQUE SPECIFICATIONS

	lb-ft	kg-m
Cylinder Head Bolts	<i>Cylinder head bolts are not retorqued. Bolts are torqued only during engine assembly.</i>	
Connecting Rod Cap Bolts	51-54	7.0-7.5
Main Bearing Cap Bolts	61-65	8.4-9.0
Injection Pump Drive Gear	43-52	6.0-7.0
Oil Pan Bolts	5-7	0.7-1.0
Crankshaft Pulley Bolts	17-24	2.3-3.3
Glow Plugs	11-15	1.5-2.0
Intake Manifold Bolts	12-20	1.6-2.7
Exhaust Manifold Bolts	16-20	2.2-2.7
Switches and Senders	9-13	1.2-1.8
Injector H/P Line Nuts	13-17	1.8-2.3
Freshwater Pump Mounting Bolts	23-34	3.2-4.7
Timing Belt Covers	5-7	0.7-1.0
Flywheel Bolts	130-137	18-19
Camshaft Cap Bolts	15-20	2.0-2.7
Block Oil Jets	9-13	1.2-1.8
Rocker Cover Bolts	5-7	0.7-1.0
Back Plate Bolts	12-17	1.6-2.3
Rear Oil Seal Housing	5-7	0.7-1.0
Oil Strainer Pick-Up	5-7	0.7-1.0
Timing Belt Drive Gear Bolt	116-123	16-17
Thermostat Assembly	12-17	1.6-2.3
Oil Cooler Assembly Bolts	M10 23-24	3.2-4.7
	M6 5-7	0.7-1.0

STANDARD HARDWARE TORQUES

NOTE: Unless stated otherwise for a specific assembly, use the following torque values when tightening standard hardware.

	Pitch	lb-ft	kg-m
Grade 4			
6mm bolt head/nut	1	2.9-5.1	0.4-0.7
8mm bolt head/nut	1.25	7.2-11.6	1.0-1.6
10mm bolt head/nut	1.25	13.7-22.4	1.9-3.1
10mm bolt head/nut	1.5	13.0-21.7	1.8-3.0
12mm bolt head/nut	1.25 (ISO)	25.3-39.8	3.5-5.5
12mm bolt head/nut	1.5	25.3-39.8	3.5-5.5
12mm bolt head/nut	1.75	21.7-36.2	3.0-5.0
13mm bolt head/nut	1.5	32.5-50.6	4.5-7.0
14mm bolt head/nut	1.5	36.2-57.9	5.0-8.0
14mm bolt head/nut	2	34.0-55.7	4.7-7.7
16mm bolt head/nut	1.5	54.2-79.6	7.5-11.0
16mm bolt head/nut	2	51.4-76.7	7.1-10.6
Grade 6T			
6mm bolt head/nut	1	4.3-6.5	0.6-0.9
8mm bolt head/nut	1.25	10.8-15.9	1.5-2.2
10mm bolt head/nut	1.25	21.7-32.5	3.0-4.5
10mm bolt head/nut	1.5	19.5-30.4	2.7-4.2
12mm bolt head/nut	1.25 (ISO)	36.2-57.9	5.0-8.0
12mm bolt head/nut	1.5	36.2-50.6	5.0-7.0
12mm bolt head/nut	1.75	34.7-49.2	4.8-6.8
Grade 7T, 8T and 8.8			
6mm bolt head/nut	1	5.8-8.7	0.8-1.2
8mm bolt head/nut	1.25	14.5-21.7	2.0-3.0
10mm bolt head/nut	1.25	28.9-39.8	4.0-5.5
10mm bolt head/nut	1.5	26.8-37.6	3.7-5.2
12mm bolt head/nut	1.25 (ISO)	54.2-75.9	7.5-10.5
12mm bolt head/nut	1.5	50.6-65.1	7.0-9.0
12mm bolt head/nut	1.75	43.4-61.5	6.0-8.5
13mm bolt head/nut	1.5	57.9-86.8	8.0-12.0
14mm bolt head/nut	1.5	72.3-108.5	10.0-15.0
14mm bolt head/nut	2	68.7-101.3	9.5-14.0
16mm bolt head/nut	1.5	108.5-166.4	15.0-23.0
16mm bolt head/nut	2	101.3-159.1	14.0-22.0
Grade 5 Cap Screw			
1/4 UNC		9-11	1.2-1.5
1/4 UNF		11-13	1.5-1.8
5/16 UNC		18-20	2.5-2.8
5/16 UNF		21-23	2.9-3.2
3/8 UNC		28-33	3.7-4.6
3/8 UNF		30-35	4.1-4.8
7/16 UNC		44-49	6.1-6.8
7/16 UNF		50-55	6.9-7.6
1/2 UNC		68-73	9.4-10.1
1/2 UNF		73-80	10.1-11.1



Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596
WESTERBEKE 55A FOUR SPECIFICATIONS

ENGINE SPECIFICATIONS	
Engine Type	Diesel, four-cycle, four-cylinder, freshwater-cooled, vertical, in-line (55 hp at 3600 rpm maximum)
Governor	Integral of the injection pump, mechanical flyweight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.38 × 3.70 inches (86.0 × 94.0 mm)
Piston Displacement	133.2 cubic inches (2.18 liters)
Firing Order	1 - 3 - 4 - 2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1920 rpm)	93 lb-ft (12.9 kg-m)
Compression Ratio	22.7 :1
Compression Pressure	427 psi (30 kg/cm ²) at 200 rpm
Valve Seat Angle	Intake 45°, Exhaust 45°
Valve Clearance (engine cold)	Intake .008 – 0.012 in. (0.20 – 0.30mm) Exhaust 0.012 – 0.016 in. (0.30 – 0.40mm)
Dimensions	Height: 26.78 inches (680.2 mm) Width: 50.0 inches (546.1 mm) Length: 35.0 inches (889.0 mm)
Inclination	Continuous 14°, Temporary 25° (not to exceed 30 min.)
Dry Weight	470 lbs (213.2 kgs)
Engine Speed	Idle speed: 750 – 1000 rpm Cruising speed: 2500 – 3000 rpm No load: 4200 – 4500 rpm
Fuel Consumption	1.5 U.S. gph (5.6 lph) running at 2500 rpm (approximate) when the propeller allows 3600 rpm at full open throttle while underway in forward gear.

FUEL SYSTEM	
Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injection Pump	Zexel mechanical governed
Injection Timing	0° TDC
Injectors	Throttle type
Injection Pressure	1920 psi + 71 psi (135 kg/cm ² + 5 kg/cm ²)
Lift Pump	12 volt – plunger type
Fuel Filter (on engine)	Spin-on type (replaceable)
Air Cleaner	Replaceable paper filter element
Air Flow (engine combustion) (engine cooling)	140 cfm (3.9 cmm) at 3600 rpm 250 cfm (7.0 cmm)

EXHAUST SYSTEM	
Exhaust Elbow	45° elbow
Exhaust Hose Size	2-1/2 inch I.D. hose
Muffler Size (min.)	14 inch x 14 inch

COOLING SYSTEM	
General	Freshwater-cooled block, thermostatically-controlled with raw water exchanger system.
Operating Temperature	170 – 190°F (77 – 88°C)
Fresh Water Pump	Centrifugal type, metal impeller belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	16.0 gpm (60.5 lpm) approximate
System Capacity (fresh water)	9.5 U.S. qts (10.0 liters)

ELECTRICAL SYSTEM	
Starting Battery	12-volt, (–) negative ground
Battery Capacity	300 – 400 Cold Cranking amps (CCA) (min.)
Starter Motor	12-volt, 1.6kw, solenoid, actuated shift reduction gear
Starting Aid	Glow plug
DC No-Load Current	100 amps at 11.5 volts (3000 rpm, min.)
Cold Cranking Current	280 – 300 amps at 10 volts (250 rpm, min.)
Alternator (Standard)	12-volt, DC, 50 amps
Regulator	Internal regulator, built into alternator

TRANSMISSION	
General	(<i>Hurth Standard Transmission</i>) Case-hardened helical gears, with a servo-operated multiple disc clutch.
Gear ratio (standard)	2.74 : 1 (HBW250 - 3R)
Propeller Shaft Direction of Rotation	Right handed – standard transmission
Propeller Recommendations (using standard transmission 2.74:1 reduction)	20 D × 13 P - 2 blade or 20 D × 11 P - 3 blade propeller should allow the engine to reach its full rated rpm (3600 ± 000 – 100) at full open throttle while underway in forward gear.
Lubricating Fluid	ATF - type A or Dextron - II OR III
Transmission Sump Capacity	0.79 U.S. qts (0.75 liters) approximate

ENGINE OIL SYSTEM	
General	Pressure feed, rotor type, driven by spiral gears from camshaft
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity	4.5 U.S. qts (5.9 liters) including filter
Operating Oil Pressure	30 – 60 psi (2.1 – 4.2 kg/cm ²) at maximum engine rpm and at normal operating temperature
Oil Grade	API Specification CF or CG4



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