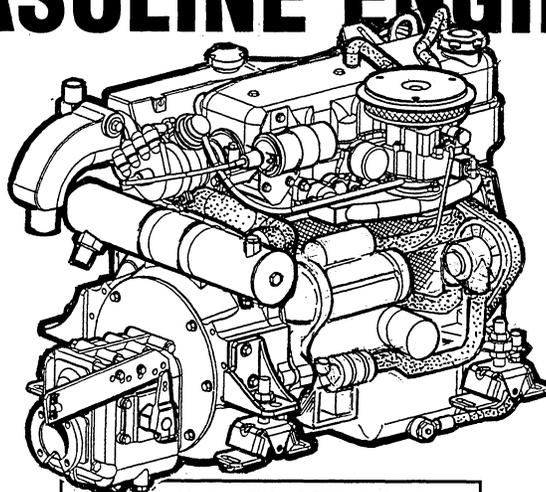




OPERATORS MANUAL

W-70GA MARINE GASOLINE ENGINE



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WESTERBEKE

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Member National Marine Manufacturers Association

⚠ WARNING

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

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

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



A WARNING DECAL is provided by WESTERBEKE and should be fixed to a bulkhead near your engine or generator.

WESTERBEKE also recommends installing CARBON MONOXIDE DETECTORS in the living/sleeping quarters of your vessel. They are inexpensive and easily obtainable at your local marine store.

**CALIFORNIA
PROPOSITION 65 WARNING**

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

SAFETY INSTRUCTIONS

INTRODUCTION

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

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

PREVENT ELECTRIC SHOCK

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

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.
- Do not connect utility shore power to vessels AC circuits, except through a ship-to-shore double throw transfer switch. Damage to vessels 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 vessels 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 disconnecting the battery.

BATTERY ACID

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

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

TOXIC EXHAUST GASES

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

- Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check the exhaust system regularly for leaks and make sure the exhaust manifolds/water-injected elbow is securely attached.
- Be sure the unit and its surroundings are well ventilated. Run blowers when running the generator set or engine.
- Do not run the generator set or engine unless the boat is equipped with a functioning marine carbon monoxide detector that complies with ABYCA-24. Consult your boat builder or dealer for installation of approved detectors.
- For additional information refer to ABYC T-22 (educational information on Carbon Monoxide).

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

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

Vomiting	Inability to think coherently
Dizziness	Throbbing in temples
Headache	Muscular twitching
Nausea	Weakness and sleepiness

AVOID MOVING PARTS

⚠ WARNING: Rotating parts can cause injury or death!

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

SAFETY INSTRUCTIONS

- Do not wear loose clothing or jewelry when servicing equipment; tie back long hair and 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 is operating.
- Stay clear of the drive shaft and the transmission coupling when the engine is running; hair and clothing can easily be caught in these rotating parts.

HAZARDOUS NOISE

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

- Never operate an engine without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.
- Do not run engines 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 an engine should begin with a thorough examination of the American Boat and Yacht Council's (ABYC) standards. These standards are a combination of sources including the USCG and the NFPA.

Sections of the ABYC standards of particular interest are:

- H-2 Ventilation
- 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 DIESEL ENGINES

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

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

Order from:

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

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

Order from:

NFPA
11 Tracy Drive
Avon Industrial Park
Avon, MA 02322

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

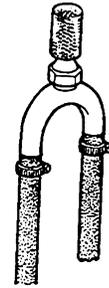
Strict federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

SIPHON-BREAK

For installations where the exhaust manifold/water injected exhaust elbow is close to or will be below the vessel's waterline when the vessel is static or under various operating conditions, 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 24" above the vessel's waterline. *Failure to use a siphon-break when the exhaust manifold injection port is at or below the load waterline will result in raw water damage to the engine and possible flooding of the boat.*

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

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



AVAILABLE FROM
YOUR WESTERBEKE
DEALER

EXHAUST SYSTEM

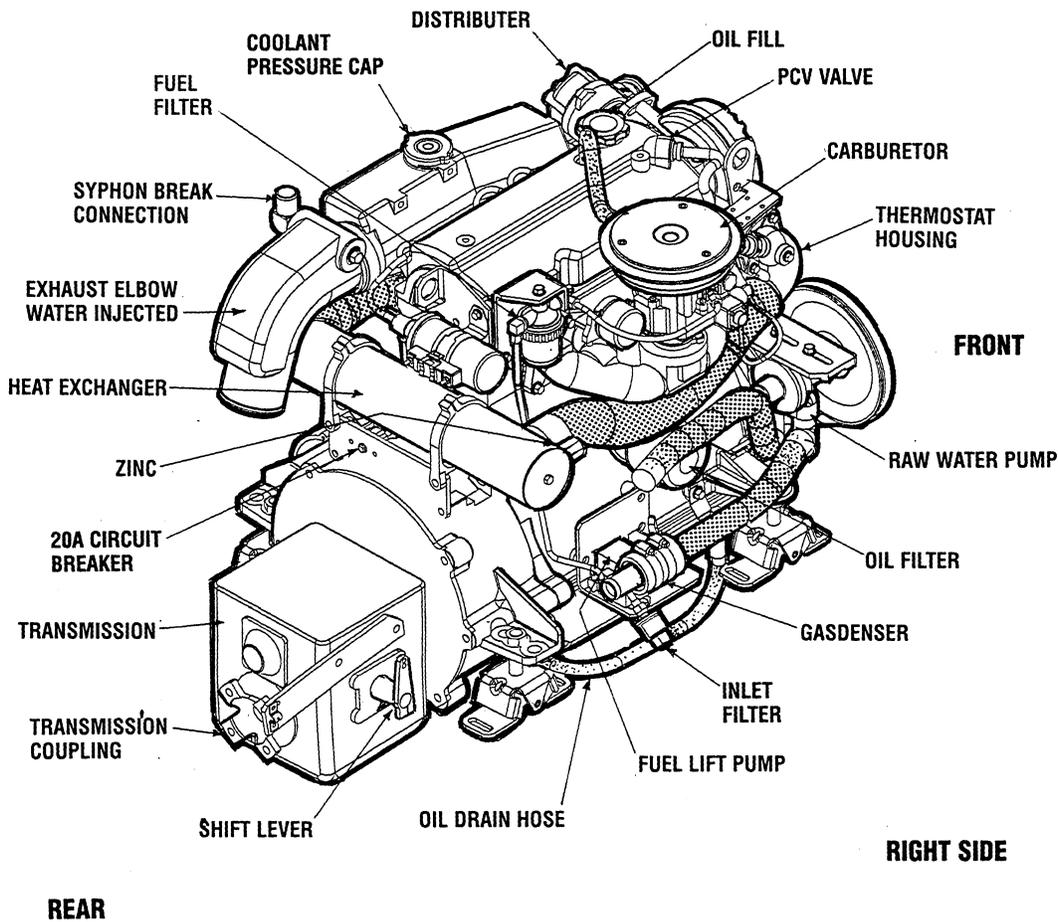
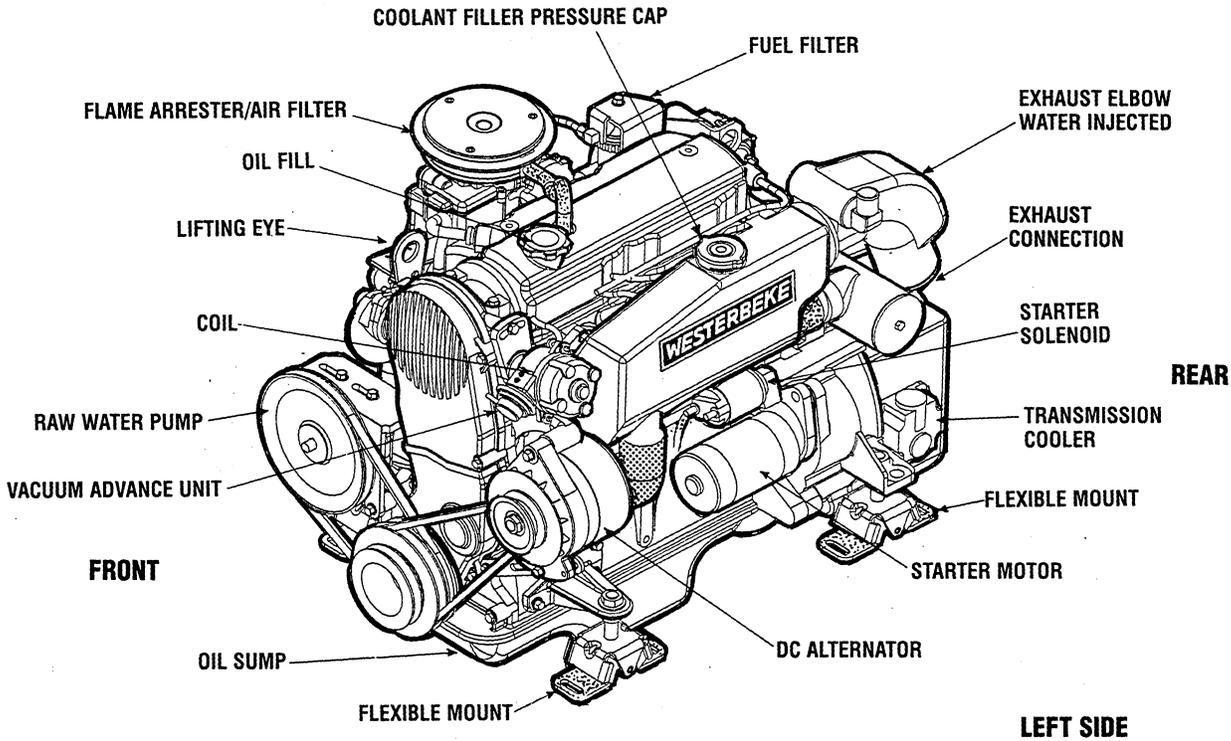
The exhaust hose must be certified for marine use. The system must be designed to prevent water from entering the exhaust under any sea conditions and at any angle of the vessels hull.

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

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W-70GA PARTS IDENTIFICATION



INTRODUCTION

This WESTERBEKE marine 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. 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 yourself, 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.

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

PRODUCT SOFTWARE

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

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

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

SERIAL NUMBER LOCATION

The engine's model number and serial number are located on a nameplate mounted on the side of the engine's manifold. The engine's serial number can also be found etched into the engine near the top of the engine back plate.

The generator serial number is stamped on the left side of the generator housing and on the flat surface above the rotary carrier bearings.

Take the time to enter this information on the illustration of the nameplate shown below, as this will provide a quick reference when seeking technical information and/or ordering repair parts.



Fill in the information for your reference. 

INTRODUCTION

ORDERING PARTS

Whenever replacement parts are needed, always provide the engine model and serial numbers. 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.

NOTES, CAUTIONS AND WARNINGS

As this manual takes you through the operating procedures, maintenance schedules, and troubleshooting of your 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 the engine.*

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

NOTE: *A carbon monoxide warning decal has been provided by WESTERBEKE. Affix this decal in a visible location in the engine room.*

SPARES AND ACCESSORIES

Certain spare parts will be needed to support and maintain your WESTERBEKE engine when cruising (see *SUGGESTED SPARE PARTS*). Often even simple items such as proper fuel and oil filter can be difficult to obtain along the way. WESTERBEKE will provide you with a suggested spares and accessories brochure to assist you in preparing an on-board inventory of the proper WESTERBEKE parts.

PROTECTING YOUR INVESTMENT

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

NOTE: *Six important steps to ensure 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 100 operating hours.*
- *Proper maintenance of all engine components according to the maintenance schedule in this manual.*
- *Use clean, filtered unleaded fuel.*
- *Winterize your engine according to the "Lay-up and Recommissioning" section in this manual.*

UNDERSTANDING THE GASOLINE ENGINE

The gasoline marine engine is in many ways similar to a gasoline automobile engine. The cylinders are vertical in-line, and the engine's cylinder head has an overhead camshaft which is chain-driven. The engine utilizes a solid-state distributor which is horizontally mounted and camshaft-driven. The engine incorporates a pressure type lubrication system, and a fresh water-cooled engine block which is thermostatically-controlled. To a large degree, the marine engine requires the same preventive maintenance that is required of a gasoline automobile engine. The most important factors to the engine's longevity are proper ventilation, maintenance of the fuel system, ignition system, cooling system and the lubrication system.

FUEL, ENGINE OIL AND ENGINE COOLANT

GASOLINE

CAUTION: *Only use unleaded fuel with an octane rating of 89 or higher. Leaded fuel will cause serious harm to your engine and violate your warranty.*

Care Of The Fuel Supply

Use only clean 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, Coast Guard approved metal bowl type filter/water separator between the fuel tank and the engine.

ENGINE OIL

Use a heavy duty engine oil with an API classification of SJ. Change the engine oil and filter after an initial 50 hours of break-in operation, and every 100 hours of operation thereafter. An oil viscosity of SAE 15W-40 is recommended for this engine in all conditions.

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.*

NOTE: *The engine compartment should have a gasoline fume detector/alarm properly installed and working.*

ENGINE COOLANT

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

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

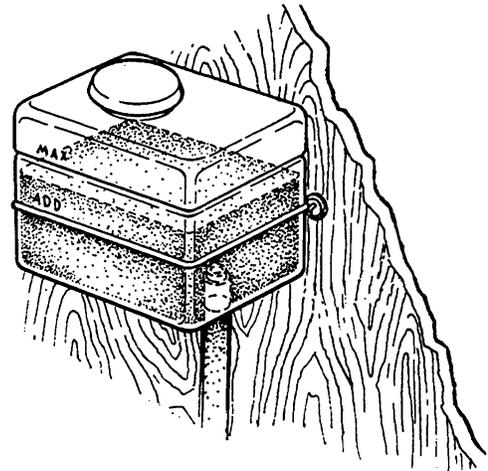
The water and antifreeze should be premixed before being poured into the cooling circuit.

NOTE: *Use the new environmentally-friendly, long lasting, antifreeze that is now available.*

A proper 50/50 mixture as recommended will protect the engine coolant to temperatures of -40°F

COOLANT RECOVERY TANK

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



GASOLINE ENGINE INSTRUMENT PANEL

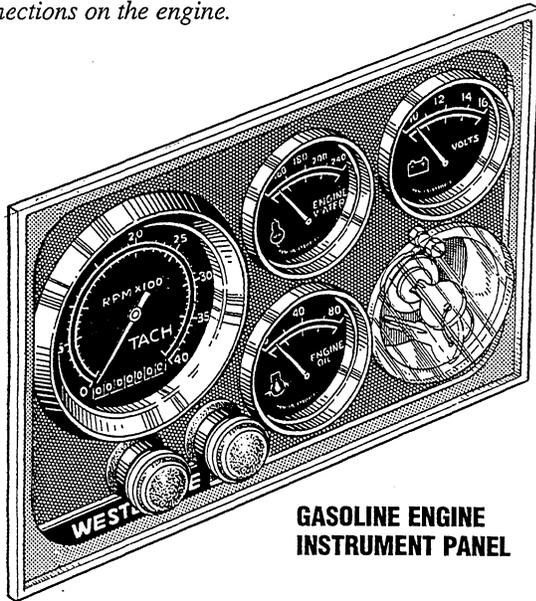
NOTE: Be certain to install the instrument panel in a location that is accessible and where the gauges can be continually monitored by the helmsman.

DESCRIPTION

The marine gasoline engine is equipped with an [optional] key start instrument panel. This panel connects to the engine wiring harness thru a 15 foot plug-in harness.

Included with the panel is an alarm buzzer. This alarm buzzer will sound when the ignition key is turned on and should silence when the engine has started and the oil pressure rises above 5 psi. The installer is responsible for installing this alarm buzzer in a dry location where it will be audible to the operator with the engine running.

NOTE: It is the responsibility of the installer to make certain the alarm wiring is properly routed and supported to its connections on the engine.



**GASOLINE ENGINE
INSTRUMENT PANEL**

The following is a description of the panel components.

Tachometer - Registers revolutions per minute of the engine and measures the engines total elapsed time in hours and 1/10 hours. Refer to *TACHOMETER* for calibration.

Key switch - Turned to the 2 o'clock position [on], the key switch energizes the panel. {Illuminates the gauges and activates the start button.}

Prestart Button - A "push-to-start" rubber booted pushbutton that is energized by the key switch. Pressing this button activates the fuel lift pump.

Start Button - Identical to the prestart button, the start button, when pressed, energizes the starter which cranks the engine.

Oil Pressure Gauge - Measures the engines oil pressure in pounds per square inch. The alarm buzzer will sound if the oil pressure falls below 10 psi. This alarm will briefly sound when the engine is first started prior to oil pressure being produced.

Voltage Gauge - Measures the voltage in the DC circuit [the amount the battery is being charges 13V to 14V].

Water Temperature Gauge - Indicates the temperature of the engine coolant. If the coolant temperature reaches 210°F [99°C], the alarm buzzer will sound a *continuous signal*.

NOTE: The water temperature gauge and oil temperature will register the last reading when the engine is shut down. The true temperatures will register when the power is turned back on.

PREPARATIONS FOR INITIAL START-UP

PRESTART INSPECTION

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

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

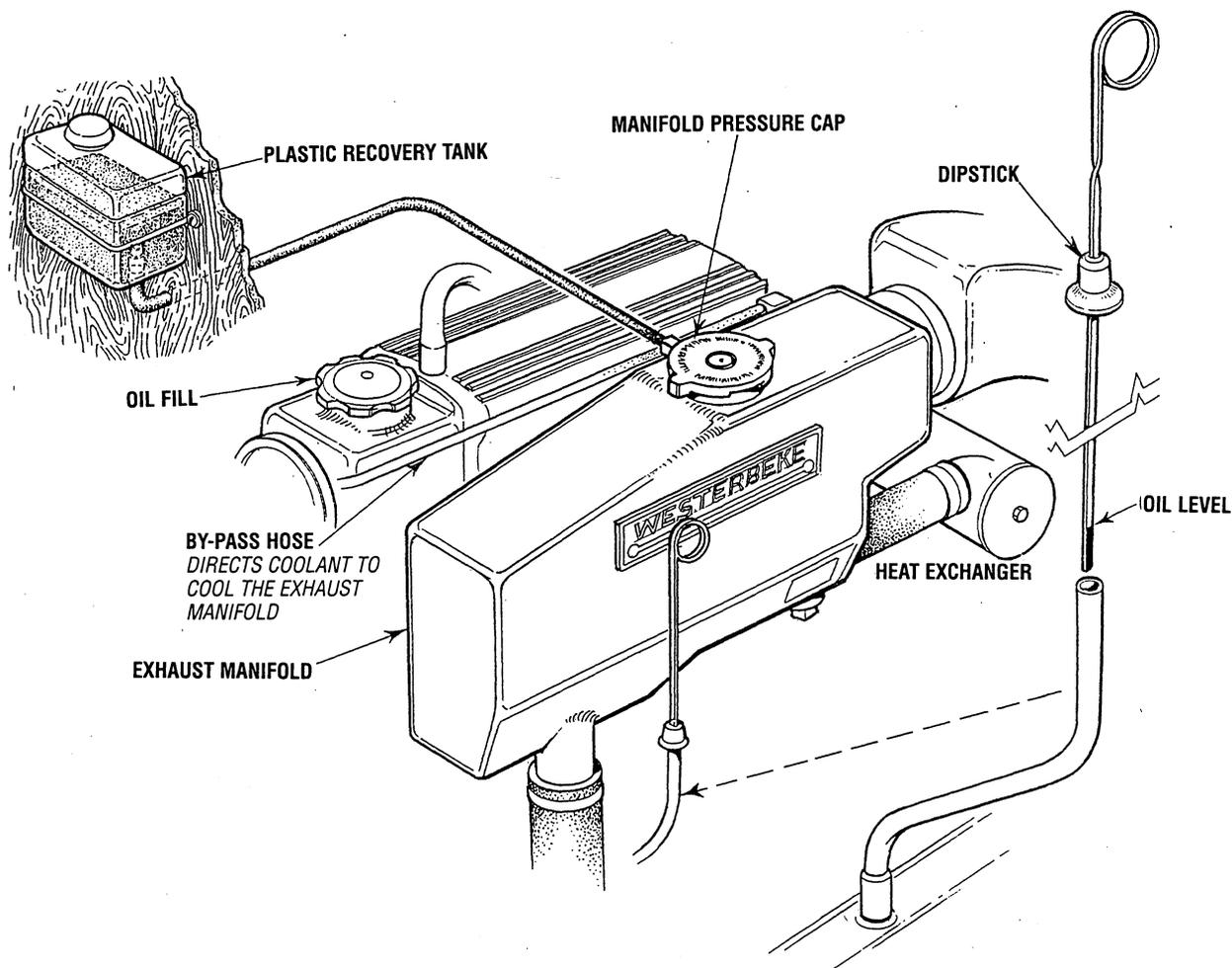
NOTE: Refer to the specifications pages in this manual for fuel, oil and transmission fluid types and quantities.

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

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

- Visually examine the engine. Look for loose or missing parts, disconnected wires, and unattached hoses. Check the threaded connections and engine attachments.
- Examine the air inlet and outlet for air flow obstructions. Good ventilation and an ample air supply are necessary for proper engine performance.
- Make sure the mounting installation is secure.
- Ensure the propeller shaft is securely attached to the transmission.
- Open the through-hull and prime the raw water intake strainer. Inspect the raw water supply.

CAUTION: Do not pull the dipstick when the engine is running.



STARTING - STOPPING PROCEDURE

STARTING PROCEDURE

1. Place the transmission in neutral and advance the throttle control to slightly open.
2. Turn the KEY SWITCH to the ON position (2 o'clock). (If the panel is energized, the gauges are on.)
3. Press the PREHEAT BUTTON, and hold for 5 seconds. (The fuel lift pump is priming the engine fuel system.)
4. Release the PRESTART BUTTON and press the START BUTTON. (The starter motor is cranking the engine).
5. Release the START BUTTON as the engine starts.
6. With the engine running, check the instruments for proper oil pressure and battery charging voltage. The water temperature will rise slowly and then stabilize when the thermostat opens.

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

It is important to closely monitor the panel gauges. Become aware of the normal engine readings and take immediate action if these readings start to vary.

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, then shut the engine down by turning off the key switch.

NOTE: *Make certain this key switch is in the OFF position (12 o'clock). If the key switch is left ON, the energized instrument panel will put a drain on the battery. The alarm will pulsate warning that the key is still in the ON position.*

Starting Under Cold Conditions

Make certain the lubricating oil is appropriate for the prevailing temperature. Use oil with an API Specification of SJ or better, SAE 30, 10W-30, or 15W-40.

FAILURE TO START

If the engine fails to start when the start button is pressed for 5 seconds, wait for at least 30 seconds and repeat the starting procedure. Make certain the transmission control is in the neutral position as some engines have a neutral safety switch to prevent starting in gear.

Never run the starter for more than 30 seconds. If the engine fails to start, refer to the *TROUBLESHOOTING CHART* in this manual.

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

ENGINE BREAK-IN PROCEDURE

DESCRIPTION

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

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

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

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

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

CHECK LIST

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

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

THE DAILY OPERATION

CHECK LIST

Follow this check list each day before starting your engine.

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

STARTING THE ENGINE

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

1. Put the transmission in neutral, throttle advanced.

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

2. Turn the KEY SWITCH to the ON position (2 o'clock). *[The panel is energized, gauges are lit].*
3. Depress the PRESTART BUTTON, hold for 5 seconds. *[The fuel lift pump is priming the engine].*
4. Release the PRESTART BUTTON and press the START BUTTON. *[The start motor is cranking the engine].*
5. Release the START BUTTON as the engine starts.
6. With the engine running, check the instruments for proper oil pressure and battery charging voltage. The water temperature will rise slowly until the thermostat opens.

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

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. Then shut the engine down by turning off the key switch at the same time put the throttle at full open..

NOTE: *Make certain this key switch is in the OFF position(12o'clock). If the key switch is left ON, the energized instrument panel will put a drain on the battery. The engine pulse alarm will sound as a reminder that the key switch has been left on.*

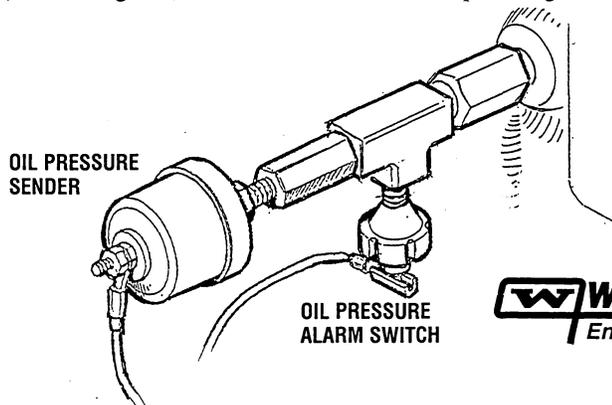
ALARMS AND CIRCUIT BREAKER

ENGINE CIRCUIT BREAKER

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

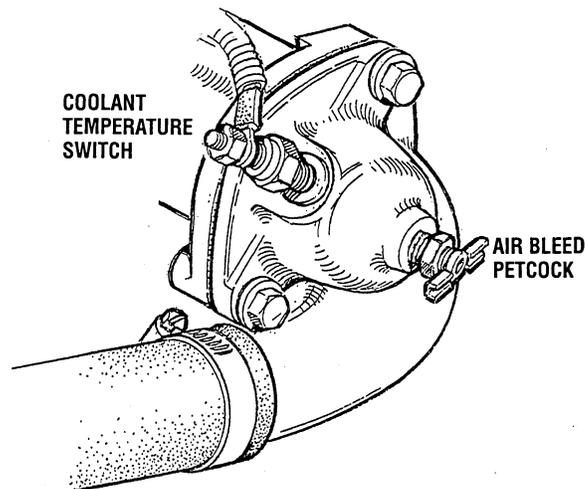
LOW OIL PRESSURE ALARM SWITCH

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



COOLANT TEMPERATURE SWITCH

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



WESTERBEKE
Engines & Generators

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.*

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							EXPLANATION OF SCHEDULED MAINTENANCE
		50	100	250	500	750	1000	1250	
Fuel Supply	<input type="checkbox"/>								Unleaded gasoline with octane rating of 89 or higher.
Fuel/Water Separator	<input type="checkbox"/>								Check for water and dirt in fuel (drain/replace filter if necessary).
Engine Oil Level	<input type="checkbox"/>								Oil level should indicate between FULL 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"/> weekly								Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt edges for wear.
Visual Inspection of Engine	<input type="checkbox"/>	NOTE: <i>Please keep engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.</i>							Check for fuel, oil and water leaks. Inspect wiring and electrical connections. Keep bolts & nuts tight. Check for loose belt tension.
Spark Plugs		<input type="checkbox"/>		<input type="checkbox"/>	Check gap; inspect for burning and corrosion.				
Generator (if applicable)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Check that AC connections are clean and secure with no chafing - see <i>GENERATOR INFORMATION</i> (if applicable) for addition information.
Fuel Filter (Lift Pump)		<input type="checkbox"/>		<input type="checkbox"/>	Inspect for fuel leaks. Check wire connections.				
Starting Batteries (and House Batteries)	<input type="checkbox"/> weekly	<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"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Initial engine oil & filter change at 50 hrs., then change both every 100 hours.
Re-torque Cylinder Head		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		Retorque at 50 hrs., then every 500 hours.
*Adjust the Valve Clearances		<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		Initial adjustment at 50 hrs., then every 500 hrs.
Air Screen (Flame Arrester)		<input type="checkbox"/>							Clean at 50 hours, then every 100 hours.
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. Check siphon brake operation. Check the exhaust elbow for carbon and/or corrosion buildup on inside passages; clean and replace as necessary. Check that all connections are tight.
Engine Hoses			<input type="checkbox"/>	Hose should be hard & tight. Replace if soft or spongy. Check and tighten all hose clamps.					
Inlet Fuel Filter		<input type="checkbox"/>		<input type="checkbox"/>	Replace every 200 operating hours.				

continued

MAINTENANCE SCHEDULE

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

SCHEDULED MAINTENANCE	CHECK EACH DAY	HOURS OF OPERATION							EXPLANATION OF SCHEDULED MAINTENANCE
		50	100	250	500	750	1000	1250	
Heat Exchanger		<input type="checkbox"/>	Clean or replace anode. Open heat exchanger end cap and clean out debris. remove every 1000 hours for professional cleaning and pressure testing.						
Raw Water Pump				<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	Remove the pump cover and inspect the impeller for wear, replace if needed. Also replace the gasket. Lubricate both when re-assembling.
Coolant System						<input type="checkbox"/>			Drain, flush, and refill cooling system with appropriate antifreeze mix.
*Starter Motor					<input type="checkbox"/>			<input type="checkbox"/>	Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive.
Distributor		<input type="checkbox"/>			<input type="checkbox"/>				Check ignition timing. Check condition of distributor cap and rotor.
*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.
*Exhaust Elbow					<input type="checkbox"/>				Test exhaust elbow for casting integrity. Replace if casting is corroded or deteriorated. WARNING: A defective exhaust elbow can cause carbon monoxide leakage.
Lubricate Panel Key Switch with "Lockeze"			<input type="checkbox"/>						At first 100 hours. Then each year at winterizing or once a season.
Carburetor Filter Screen		<input type="checkbox"/>			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Clean at first 50 hours and every 250 hours.
Transmission Fluid									Refer to the <i>TRANSMISSION</i> section.
Transmission Damper Plate							<input type="checkbox"/>		Seperate the transmission from the engine and inspect the damper plate, look for wear or broken springs, replace if necessary.
Transmission Cooler					<input type="checkbox"/>		<input type="checkbox"/>		Inspect for leaks and condition of the casting, replace if needed.
Engine Mounts/Isolators							<input type="checkbox"/>		Inspect engine mounting/isolators. If upper cap is contacting the base replace the mount.

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

COOLING SYSTEM

DESCRIPTION

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

FRESH WATER COOLING CIRCUIT

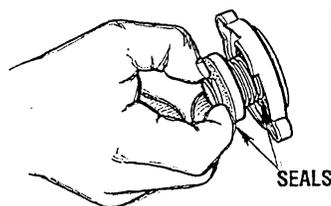
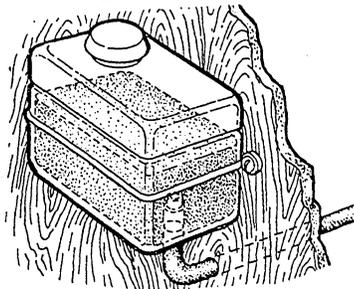
NOTE: Refer to the *ENGINE COOLANT* section for the recommended antifreeze and water mixture to be used as the fresh water coolant.

Fresh water coolant is pumped through the engine by a circulating pump, absorbing heat from the engine. The coolant then passes through the thermostat into the manifold, to the heat exchanger where it is cooled, and returned to the engine block via the suction side of the circulating pump. When the engine is started cold, external coolant flow is prevented by the closed thermostat (although some coolant flow is bypassed around the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing full flow of the engine's coolant to flow unrestricted to the external portion of the cooling system.

Coolant Recovery Tank

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

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



CHANGING COOLANT

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

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

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

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

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

Refilling the Coolant

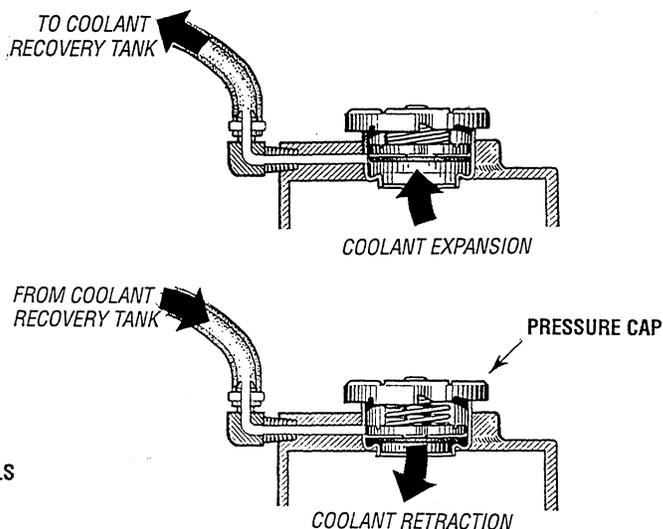
After replacing the engine block drain plug, close the heat exchanger's coolant petcock. Then run the engine at idle and slowly pour clean, premixed coolant into the manifold.

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

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

Remove the cap on the coolant recovery tank and fill with coolant mix to halfway between LOW and MAX and replace the cap. Run the engine and observe the coolant expansion flow into the recovery tank.

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



COOLING SYSTEM

RAW WATER INTAKE STRAINER

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

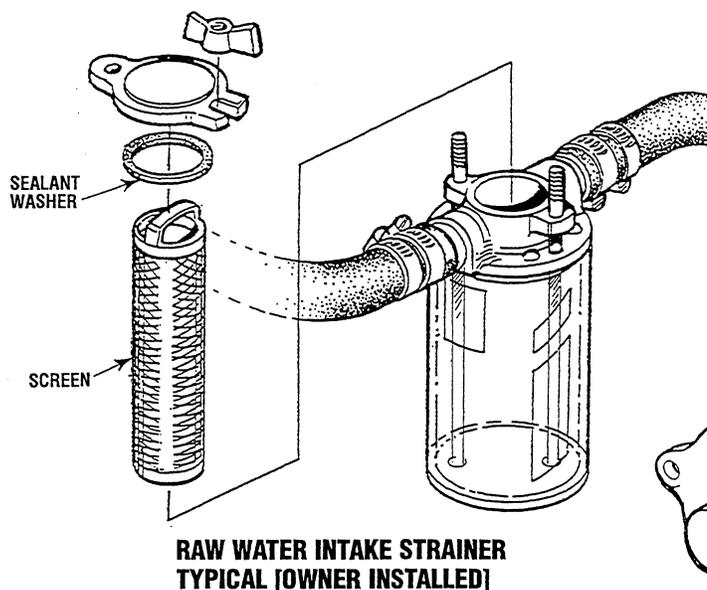
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

Perform the following maintenance after every 100 hours of operation:

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

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

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



RAW WATER PUMP

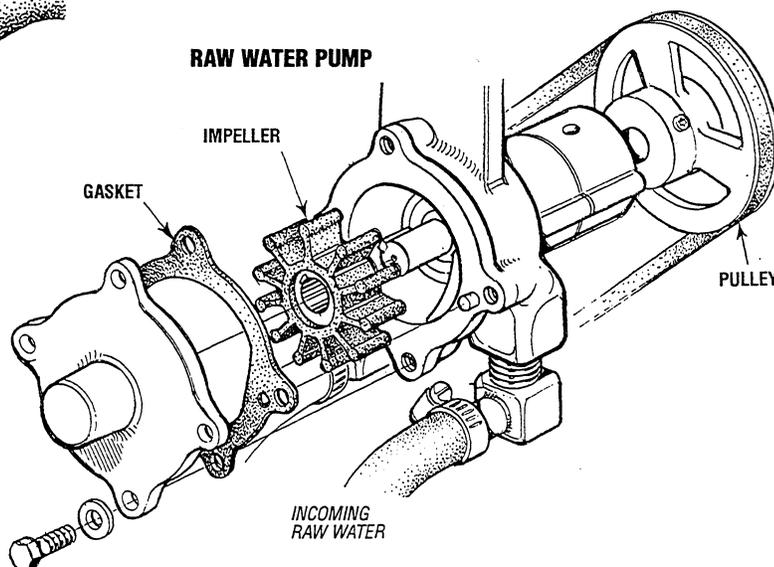
The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a Neoprene impeller. The impeller has flexible blades which wipe against a curved cam plate within the impeller housing, producing the pumping action. **On no account should this pump be run dry.** There should always be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

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

Changing the Raw Water Pump Impeller

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

Run the engine and check for leaks around the pump. Also check for water discharge at the stern tube. Absence of water flow indicates the pump has not primed itself properly.

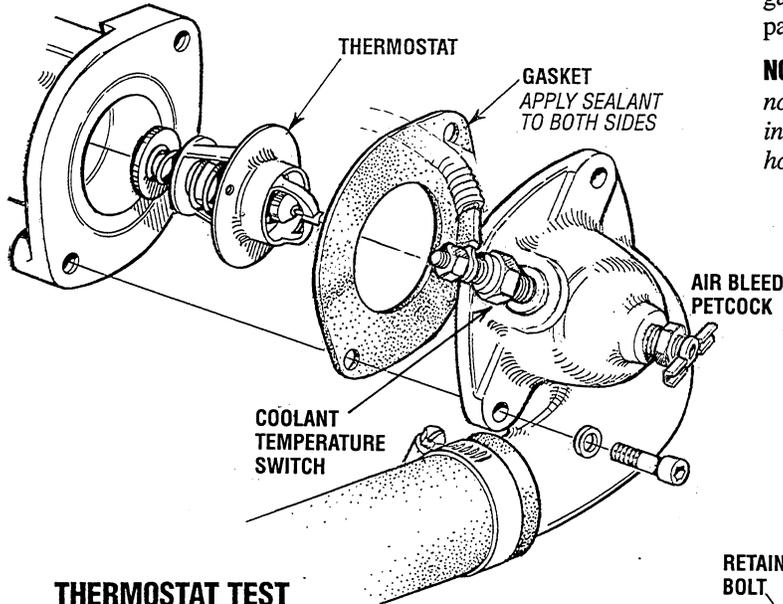


CAUTION: If any of the vanes have broken off the impeller, they must be located to prevent blockage in the cooling circuit. They often can be found in the heat exchanger

COOLING SYSTEM

THERMOSTAT

A thermostat controls the coolant temperature as the coolant continuously flows through the closed cooling circuit. When the engine is first started the closed thermostat prevents coolant from flowing (some coolant is by-passed through 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.

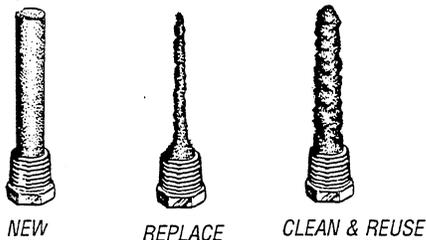


THERMOSTAT TEST

If you suspect a faulty thermostat, place it in a pan of water and bring to a boil. A working thermostat should open about 1/2".

ZINC ANODE

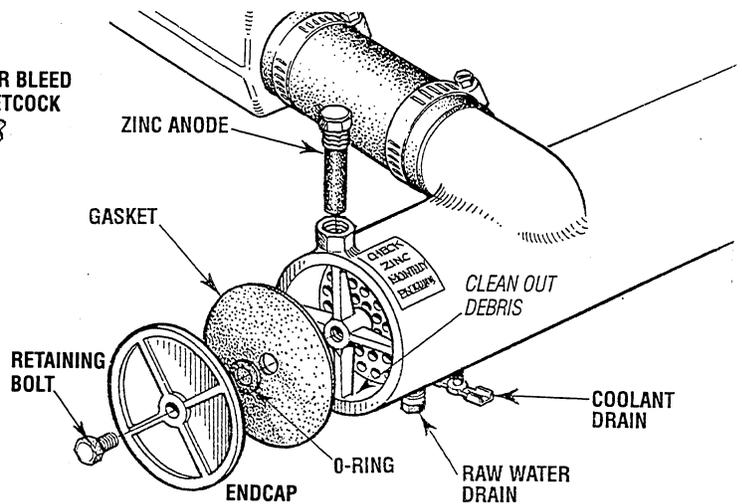
A zinc anode (or pencil) is located in the raw water cooling circuit within the heat exchanger. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the raw water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The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



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

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

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



HEAT EXCHANGER

Cool raw water flows through the inner tubes of the heat exchanger. As the engine coolant passes around these tubes the heat of the internal engine is conducted to the raw water which is then pumped into the exhaust system and discharged. The engine coolant (now cooled) flows back through the engine and the circuit repeats itself.

The engine coolant and raw water are independent of each other; this keeps the engine's water passages clean from the harmful deposits found in raw water.

Heat Exchanger Service

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

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

FUEL SYSTEM

GASOLINE

Use *unleaded* 89 octane or higher gasoline. When fueling, follow U.S. Coast Guard regulations, close off all hatches and companionways to prevent fumes from entering the boat, and ventilate after fueling.

NOTE: *The generator compartment should have a gasoline fume detector/alarm properly installed and working.*

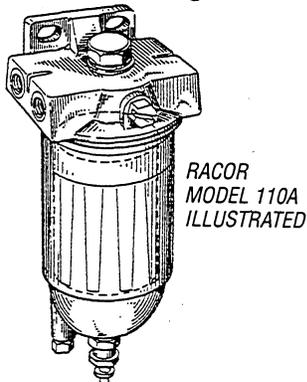
⚠ WARNING: *Shut off the fuel valve at the tank when servicing the fuel system. Take care in catching any fuel that may spill. DO NOT allow any smoking, open flames or other sources of fire near the fuel system when servicing. Ensure proper ventilation exists when servicing the fuel system.*

GASOLINE/WATER SEPARATOR AND FILTER

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 generator installation package as they are well aware of the problems that contaminants in the fuel can cause.

These gasoline filters must have *metal* bowls (not “see-through”) to meet U.S. Coast Guard requirements. The metal bowls have drain valves to use when checking for water and impurities.



**FUEL FILTER
WATER SEPARATOR**
Owner Installed

RACOR
MODEL 110A
ILLUSTRATED

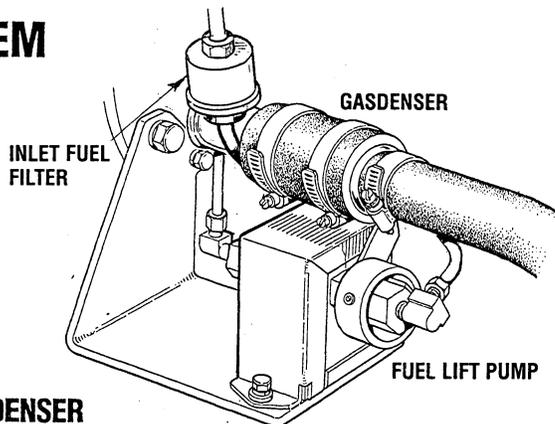
FUEL LIFT PUMP

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

The engine mounted fuel lift pump is maintenance free.

INLET FUEL FILTER

To ensure clean fuel enters the fuel lift pump, there is an in-line filter at the incoming fuel line. This filter should be replaced every 200 operating hours.



GASDENSER

The gasdenser consists of a portion of the fuel line that is coiled around the raw water intake line and insulated. It is located between the raw water intake and the raw water pump. The gasdenser cools the fuel to prevent vapor lock.

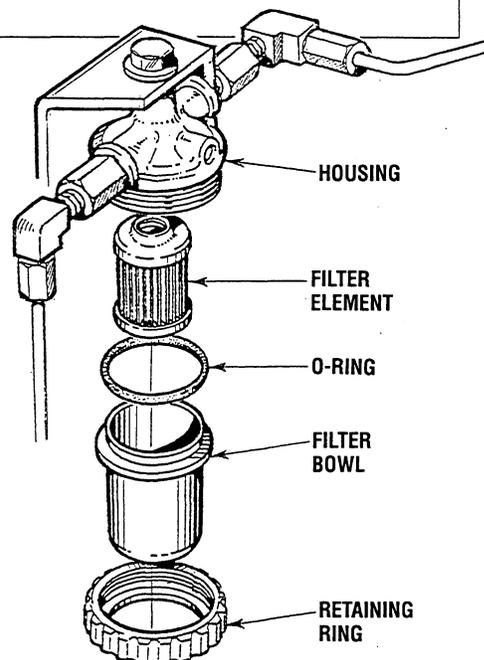
ENGINE FUEL FILTER

Periodically check the fuel connections and the filter bowl for leakage. Change the filter element after the first 50 hours. See *MAINTENACE SCHEDULE*.

Changing the Filter Element

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

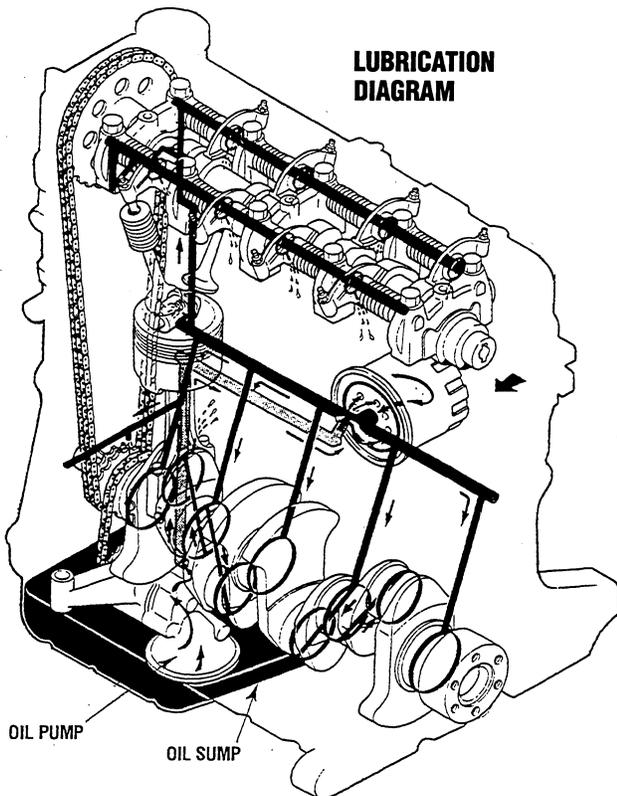
⚠ WARNING: *Fuel is present in the housing and lines. Use extreme care to prevent spillage.*



ENGINE LUBRICATING OIL

DESCRIPTION

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



ENGINE OIL

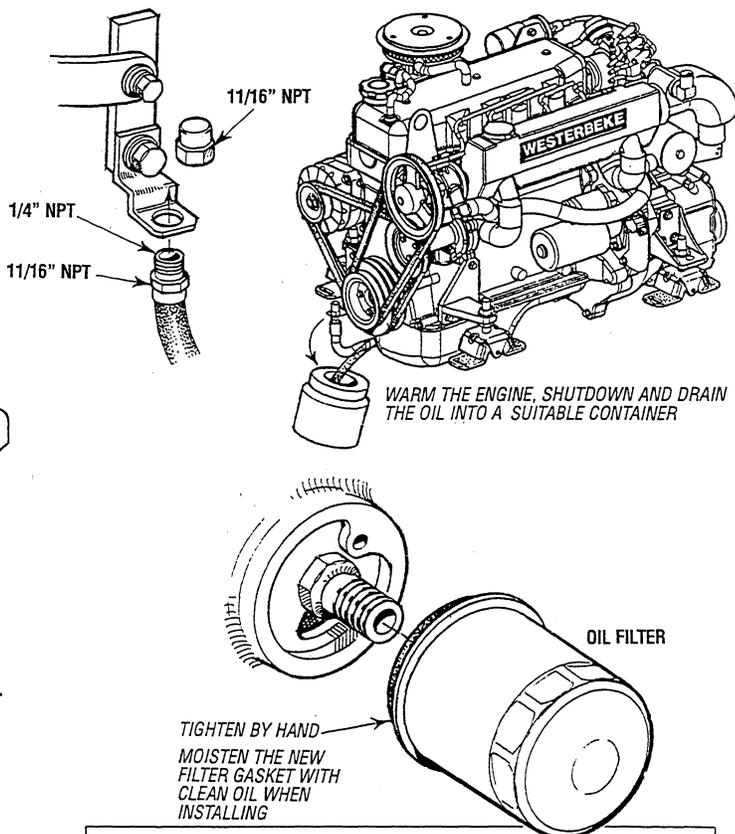
Use a heavy duty engine oil with an API classification of SJ. Change the engine oil and filter after an initial 50 hours of break-in operation, and every 100 hours of operation thereafter. An oil viscosity of SAE 15W-40 is recommended for this engine in all conditions.

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.

CHANGING THE ENGINE OIL

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 the old oil out. Make sure the oil drain hose is properly secured in its holder after all of the old oil has been drained.

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 through the raw water cooling circuit into the exhaust, filling into the engine.



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.

ENGINE LUBRICATING OIL

REPLACING THE OIL FILTER

When removing the used oil filter, you may find it helpful to punch a hole in the upper and lower portion of the old filter to drain the oil into a container before removing it. This helps to lessen spillage. An automotive filter wrench should be helpful in removing the old filter. Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil that's in the filter. Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket comes off with the filter. If this rubber sealing gasket remains sealed against the oil filter adapter, gently remove it. When installing the new filter element, wipe the filter gasket's sealing surface on the filter adapter free of oil and apply a thin coat of clean engine oil to the rubber sealing gasket. Screw on the filter and tighten the filter firmly by hand.

NOTE: Use genuine WESTERBEKE oil filters. Generic filters are not recommended.

REFILLING THE OIL SUMP

Add fresh oil through the valve cover. 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. Fill to, but not over, the FULL mark.

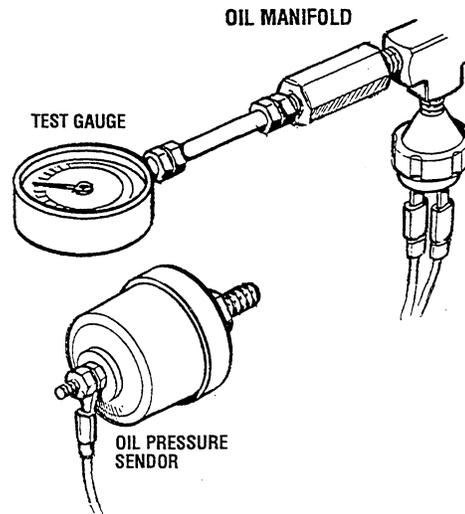
OIL PRESSURE

The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 40 and 75 psi (2.8 and 5.2 kg/cm²).

NOTE: A newly started, cold engine can have an oil pressure reading up to 80 psi (5.6 kg/cm²). A warmed engine can have an oil pressure reading as low as 35 psi (2.5 kg/cm²). These readings will vary depending upon the temperature of the engine and the rpms.

LOW OIL PRESSURE

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



TESTING OIL PRESSURE

To test the oil pressure, remove the oil pressure sender, then install a mechanical oil pressure gauge in its place. After warming up the engine, set the engine speed at 3000 rpm and read the oil pressure gauge.

OIL PRESSURE 35.0 lb/in² (3.8 kg/cm²) or higher at 3000 rpm.
SENDER AND SWITCH TORQUE 9 - 13 ft-lb (1.2 - 1.8 m - kg).

REMOTE OIL FILTER (OPTIONAL)

INSTALLATION

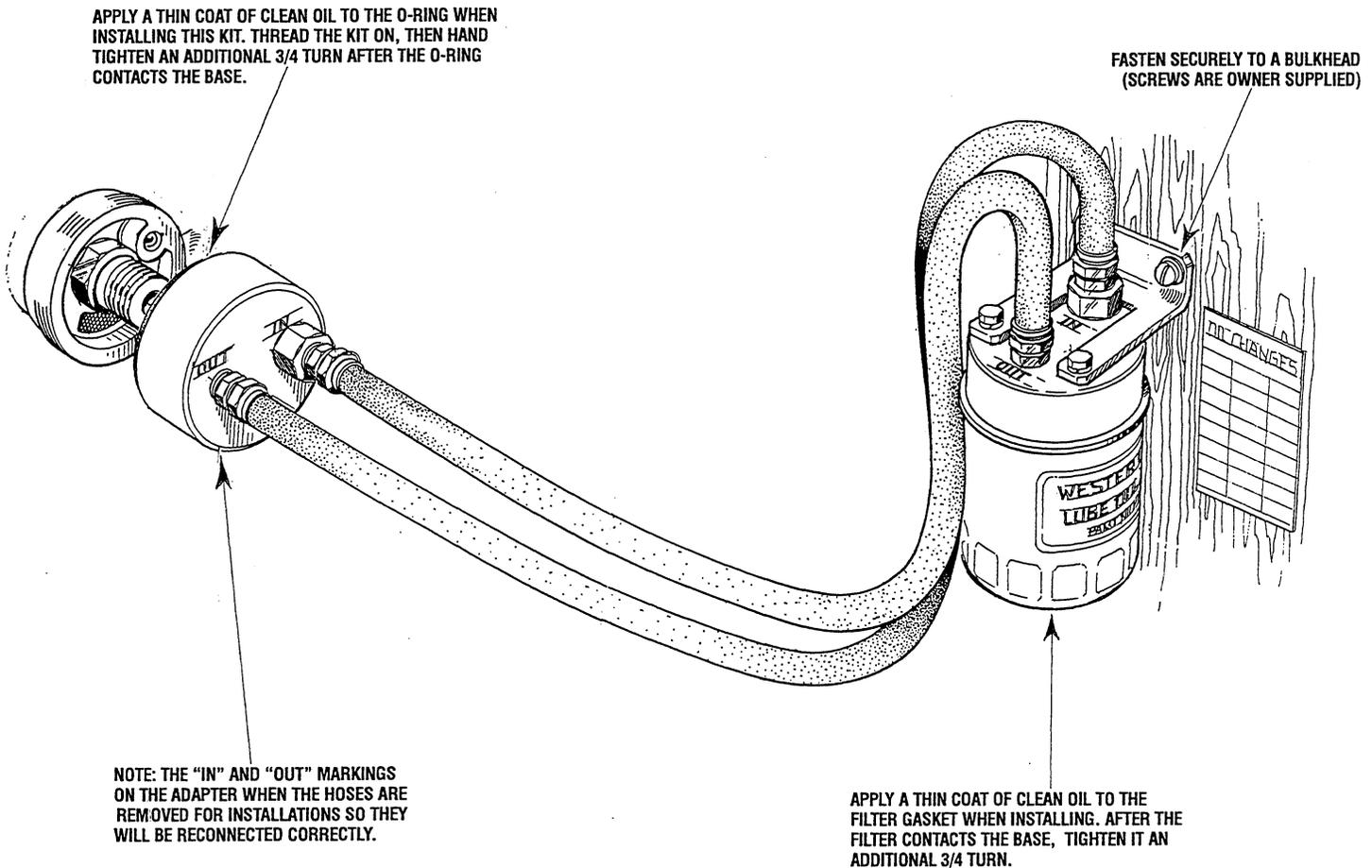
This popular accessory is used to relocate the engine's oil filter from the engine to a more convenient location such as an engine room bulkhead.

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

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

Contact your WESTERBEKE dealer for more information.

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



CARBURETOR ADJUSTMENTS

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

CARBURETOR

The carburetor is a single barrel, down-draft type with a cleanable metal screen air intake.

The choke is operated by a 12V DC current. After the engine starts (cold start), the choke circuit is kept activated opening the choke. This helps prevent stalling on a cold start. The circuit remains active until shutdown.

Air Screen/Flame Arrester

The air screen/flame arrester can easily be removed by releasing the hold-down clamp. Clean after the first 50 hours of operation, every 100 hours from then on. Clean the air screen in kerosene and blow dry with air.

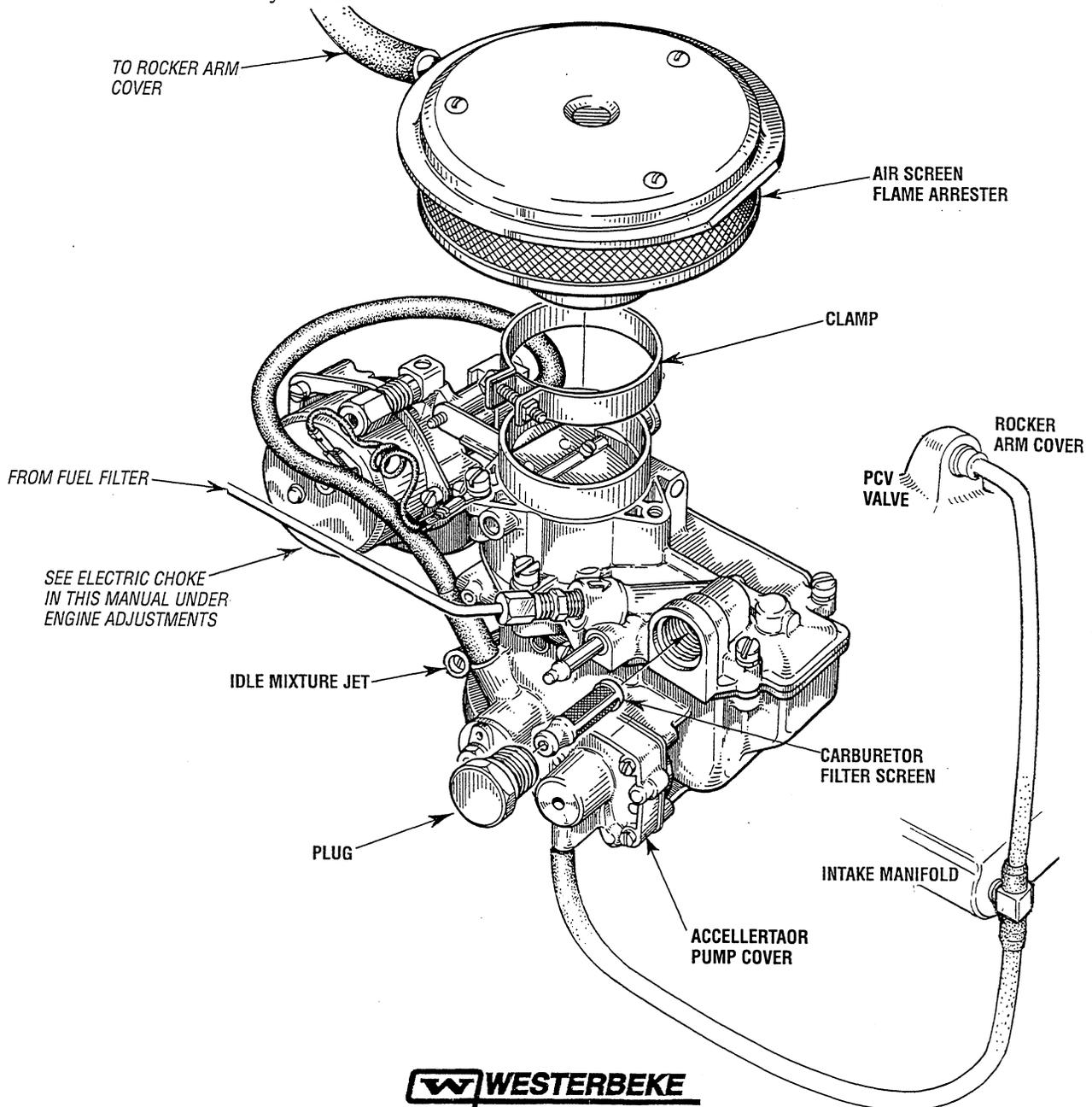
Carburetor Filter Screen

Clean this filter element after the first 50 hours of operation, then clean and inspect every 250 operating hours. Replace the screen if necessary. Tighten the plug and make certain there are no leaks.

Idle Mixture Jet

Adjustment is performed with the engine operating. Screw the jet slowly in until it seats, then back it out 1-1/2 to 2 turns.

Note: An idle mixture jet adjusted too far off its seat can induce a sooty exhaust discharge at engine start-up and shut-down.



WATER HEATER CONNECTIONS

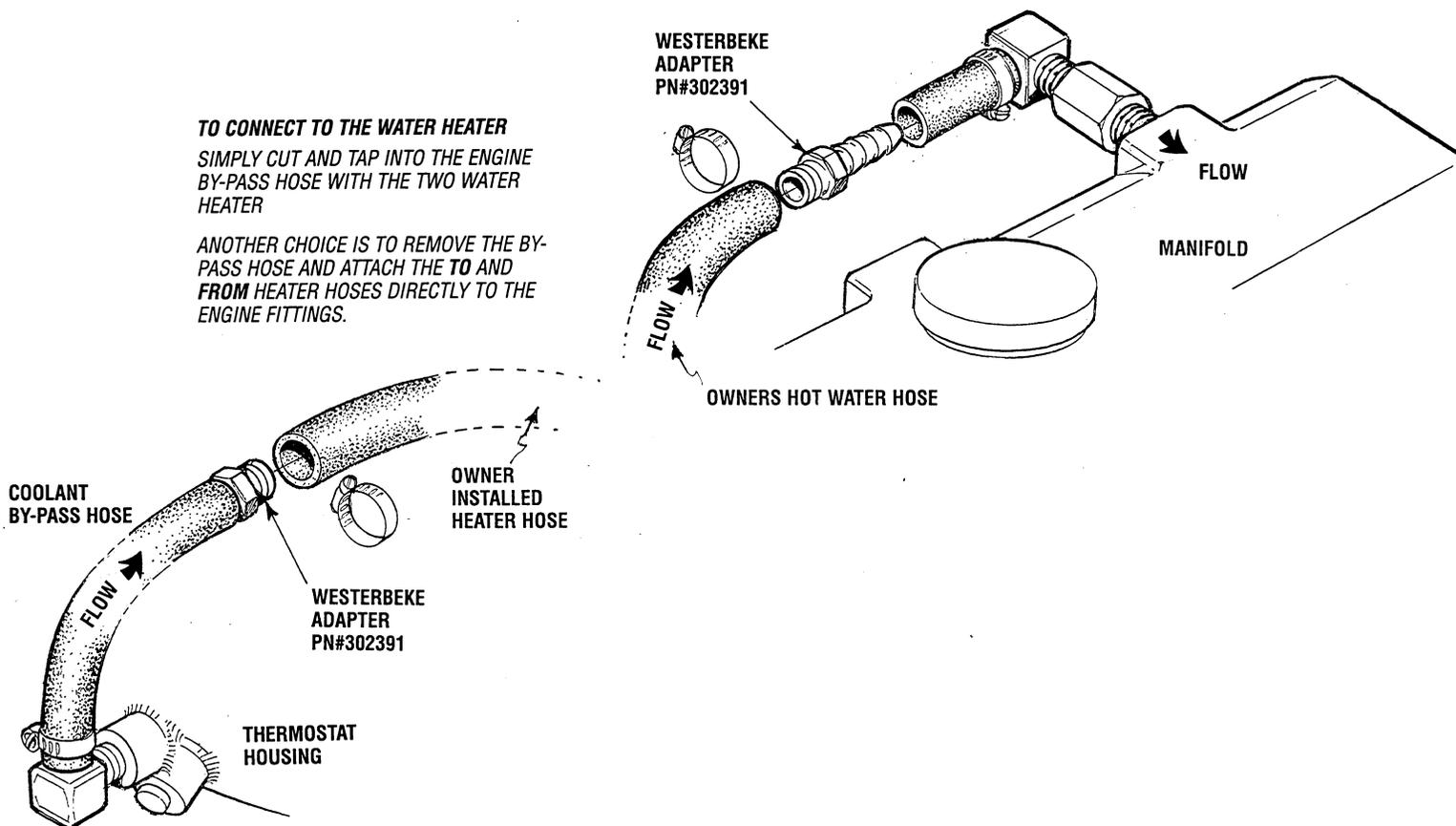
WESTERBEKE provides easy access for connecting to an on-board hot water system. These connections allow for the engine's hot water (coolant) to flow to the ship's hot water tank, heating the fresh water and then cycling back to the engine.

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

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

NOTE: An air bleed petcock is located on the engine's heat exchanger and on the thermostat housing. Open these petcocks when filling the engine's coolant system to allow air to escape. Close both tightly after all the air is removed.

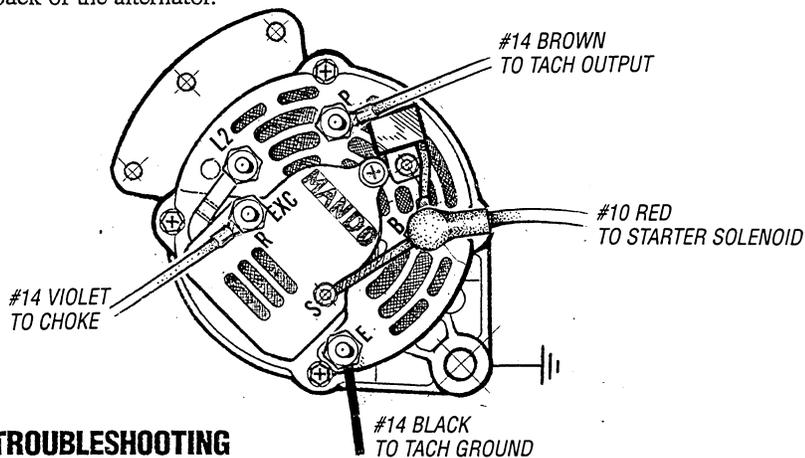
NOTE: If any portion of the heating circuit rises above the engine's closed cooling system pressure cap, then a pressurized (aluminum) remote expansion tank (Kit #024177) must be installed in the circuit to become the highest point. Tee the remote expansion tank into the heater circuit, choosing the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



ALTERNATOR TESTING

DESCRIPTION

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



TROUBLESHOOTING

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

This troubleshooting section is to determine if a problem exists with the charging circuit or with the alternator. If it is determined that the alternator or voltage regulator is bad, it is best to have a qualified technician check it out.

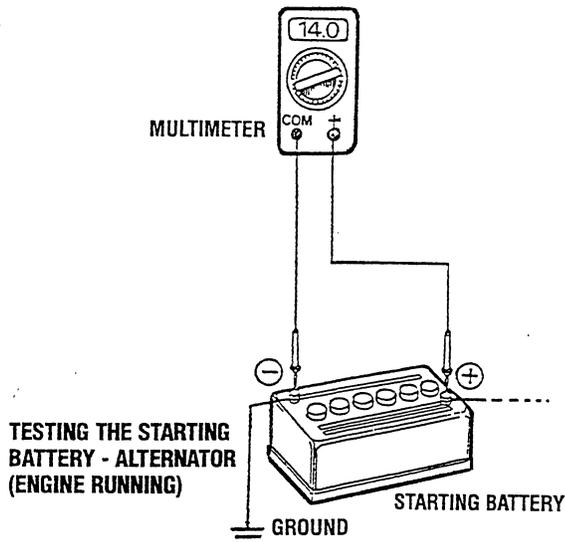
The alternator charging circuit charges the starting battery and the service battery. An isolator with a diode, a solenoid, or a battery selector switch is usually mounted in the circuit to isolate the batteries so the service battery is not discharged along with the starting battery. If the alternator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

Testing the Alternator

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

⚠ WARNING: MULTIMETERS AND DC CIRCUITS: DC and AC circuits are often mixed together in marine applications. Always disconnect shore power cords, isolate DC and AC converters and shut down generators before performing DC testing. No AC tests should be made without proper knowledge of AC circuits.

1. Start the Engine.
2. After a few minutes of running measure the starting battery voltage at the battery terminals using a multi-meter set on DC volts. The voltage should be increasing toward 14 volts. If it is, the alternator is working. Turn to Step 4

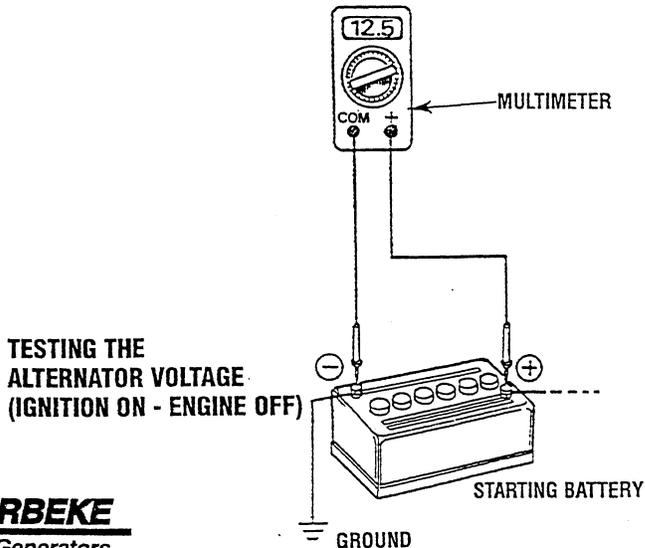


TESTING THE STARTING BATTERY - ALTERNATOR (ENGINE RUNNING)

3. If the starting battery voltage remains around 12 volts after the engine is started and run for a few minutes, a problem exists with the alternator or the charging circuit.
 - a. Turn off the engine. Inspect all wiring and connections. Ensure that the battery terminals and the engine ground connections are tight and clean.

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

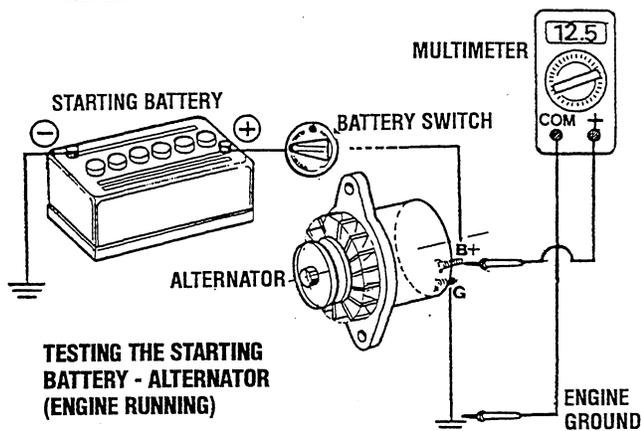
- b. If a battery selector switch is in the charging circuit, ensure that it is on the correct setting.
- c. Turn on the ignition switch, but do not start the engine.
- d. Check the battery voltage. If your battery is in good condition the reading should be 12 to 13 volts.



TESTING THE ALTERNATOR VOLTAGE (IGNITION ON - ENGINE OFF)

ALTERNATOR TESTING

- e. Now check the voltage between the alternator output terminal (B+) and ground. If the circuit is good, the voltage at the alternator should be the same as the battery, or if an isolator is in the circuit the alternator voltage will be zero. If not, a problem exists in the circuit between the alternator and the battery. Check all the connections - look for an opening in the charging circuit.



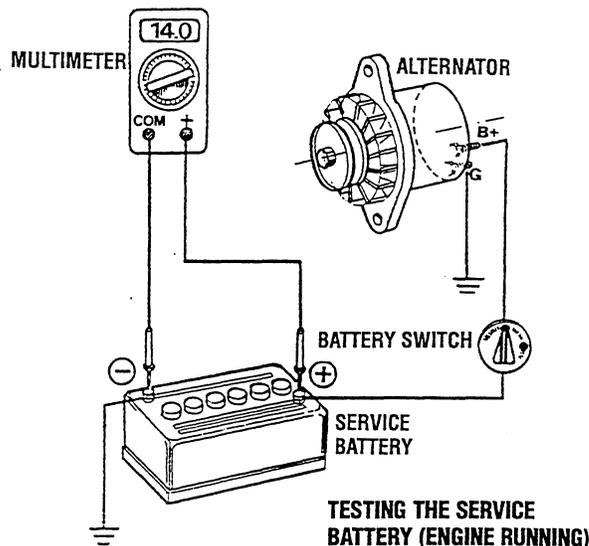
- f. Start the engine again. Check the voltage between the alternator output and ground. The voltage reading for a properly operating alternator should be between 13.5 and 14.5 volts. If your alternator is over- or under-charging, have it repaired at a reliable service shop.

NOTE: Before removing the alternator for repair, use a voltmeter to ensure that 12 volts DC excitation is present at the EXC terminal if the previous test showed only battery voltage at the B output terminal. If 12 volts are not present at the EXC terminal, trace the wiring looking for breaks and poor connections.

Jump 12 V to the Exc. terminal from a known 12V source and operate the alternator. If the voltage output is 13-14 volts, the alternator is o.k. Trace the cause for 12 volts not being present at the Exc. terminal.

Alternator is Working

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



CAUTION: When performing tests on the alternator charging circuit do not use a high voltage tester (i.e. Megger). You can damage the alternator diodes

ALTERNATOR INSPECTION

When rebuilding the engine, the alternator should be cleaned and inspected. The housing can be wiped off with a solvent and the alternator terminal studs should be cleaned with a wire brush. Make certain the studs are tight and clean the wiring connections that connect to the wiring harness.

Turn the rotor pulley by hand. It should turn smoothly.

Depending on when the alternator was last serviced, the brushes may need replacing. If the alternator is at all suspect, send it to a service shop for testing and overhaul.

DUAL OUTPUT ALTERNATORS

DESCRIPTION

Dual output and high output alternators are available as optional equipment on most WESTERBEKE engines. These alternators can be installed during factory assembly or as add-on equipment at anytime.

Dual alternators can be configured to charge two banks of batteries at the same time or, using a battery selector switch, charge each set of batteries separately.

INSTALLATION

If an optional dual alternator has already been factory installed, simply follow the WESTERBEKE wiring diagram and the engine installation instructions.

If the new dual alternator is being added to an existing "in-the-boat" engine, carefully follow the alternator installation instructions below:

1. Disconnect the alternators negative cable from the battery.
2. Remove the alternator and disconnect or tape off the output [positive] cable. Do not reuse.
3. Install the new alternator.
4. Attach a new heavy gauge output cable[s] from the alternator's output terminal [s]. Using the cable sizes indicated.

LENGTH REQUIRED	UP TO 6'	#4 WIRE
	UP TO 12'	#2 WIRE
	UP TO 20'	#0 WIRE

[ALWAYS USE FINE STRAND CABLE]

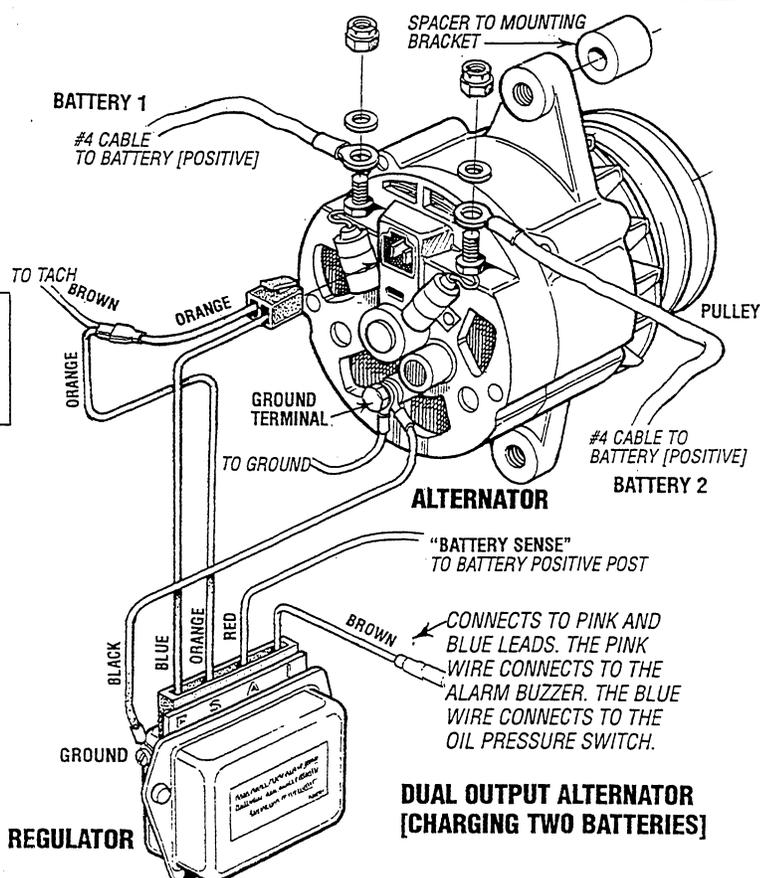
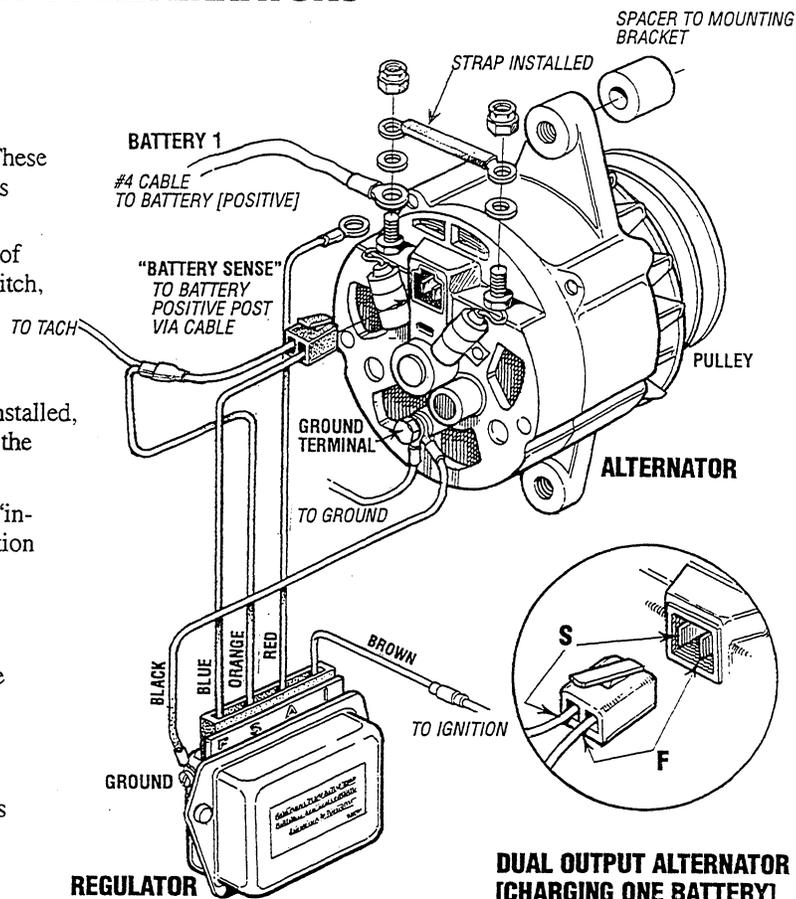
5. Make certain that the batteries negative post ground cable to the engine block is the same heavy gauge as the positive cable.
6. Mount the regulator to a flat surface in a cool dry location.
 - a. Connect the black wire to the ground terminal on the alternator.

CAUTION: Do not connect any power source without first grounding the regulator.

- b. Plug the 2-pin connector into the alternator, make certain it is firmly seated.
- c. The red "battery sense" wire should be connected to the batteries positive [+] post [or the positive cable].
- d. The brown wire "keyed ignition" is the key circuit which actuates the regulator, this wire must connect to a switched [+] 12 volt source. Refer to the WESTERBEKE WIRING DIAGRAM for the proper connection.

Dual Pulleys

A variety of accessory pulleys for high powered and dual charging alternators are available from your dealer.



DUAL OUTPUT ALTERNATORS

TROUBLESHOOTING

NOTE: Before troubleshooting, make certain that the drive belts are tight and the batteries are in good condition.

Regulator Testing

The red "battery sensing" wire **A** connects to the battery, it must always read battery voltage. If battery voltage is not present, trace the wire for a bad connection.

The orange wire **S** should read 0 volts with the key off, 12 volts [approximately] with the key on. If the readings are incorrect, trace the wire for a bad connection.

The blue wire **F** supplies current to the alternator fields, its voltage will vary depending on the battery charge or actual load/rpm. The readings can vary from 4 to 12 volts with the key on, 0 volts with the key off.

KEY ON - NO VOLTAGE REGULATOR IS DEFECTIVE
KEY OFF - BATTERY VOLTAGE REGULATOR IS DEFECTIVE

REGULATOR TEST POINTS AND PROPER VOLTAGE

Terminal/Color	Ignition Off	Ignition On	Engine Running
I Brown	0 volts	2 -12 volts	14.2 volts
A Red	12.6 volts	12 volts	14.2 volts
S Orange	0 volts	0 volts	6 - 8 volts
F Blue	0 volts	10 - 11 volts	4 - 12 volts
Alt. Output	12.6 volts	12 volts	14.2 volts

Alternator Testing

The regulator is functioning properly and the batteries are in good condition.

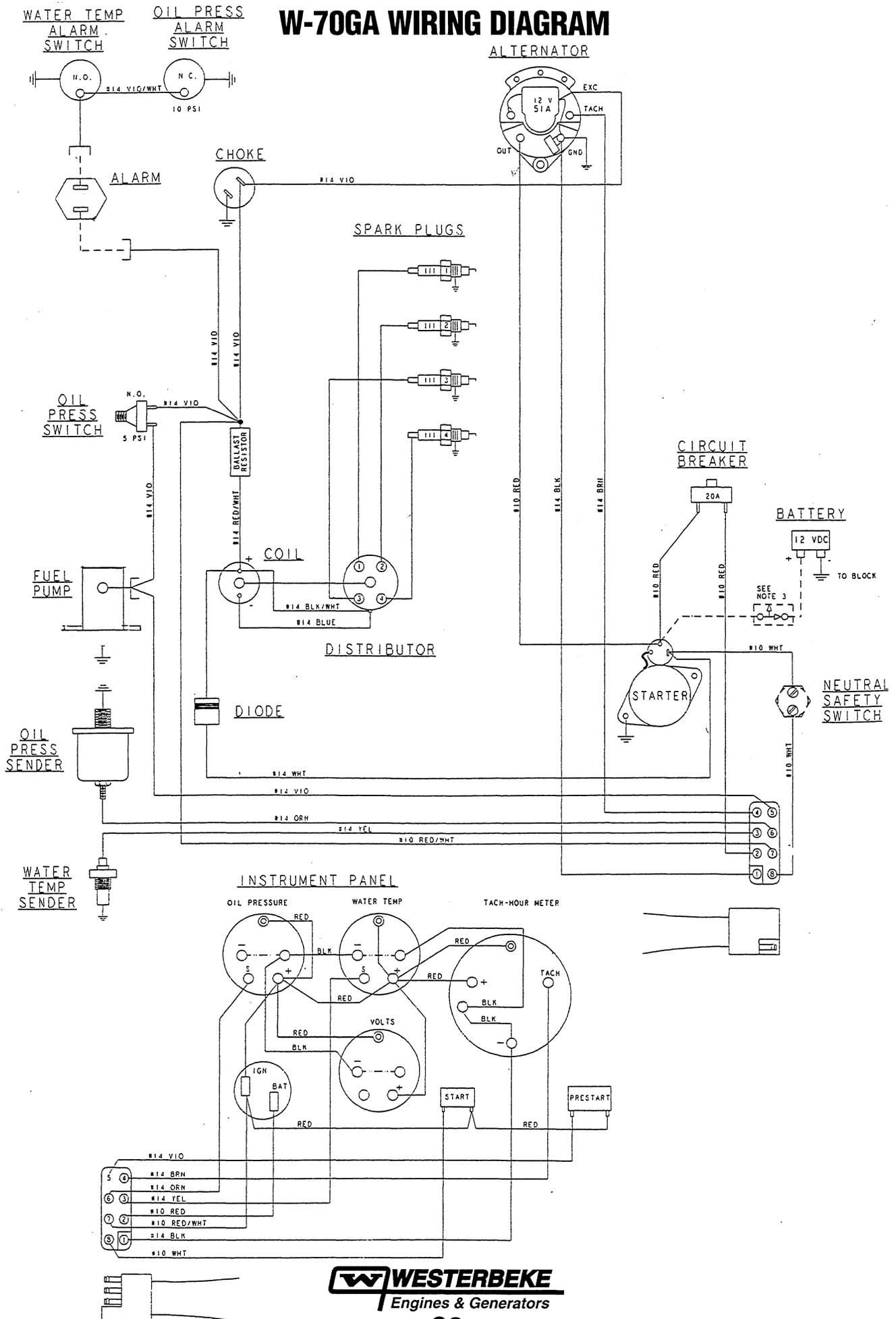
1. Test the voltage at the alternator plug with the engine off-key on. The voltage at the alternator terminal **F** and the voltage in the plug [blue wire **F**] from the regulator should read the same.
2. Hold a screw driver close [1/2"] to the alternator pulley. If voltage is present you should feel the magnetic field. If not, the problem may be the brushes [worn] or the rotor [open circuit].
3. Start the engine, at fast idle the output terminals should indicate 14.2 volts [no load]. A reading of 12.6 would indicate the alternator is not performing properly.

Apply a load such as an electric bilge pump, the voltage should maintain at least 13.8 volts. 13 volts or less indicates the alternator is faulty.

NOTES:

- When the engine is first started, it takes a few moments for the alternator to "kick in" and take the load. There is a noticeable change in the sound of the engine and the RPM gauge will excite.
- A slight whine is normal when running with a full load on the alternator.
- When the alternator is producing high amperage, it will become very hot.
- When replacing the alternator drive belts, always purchase and replace dual belts in matched pairs.

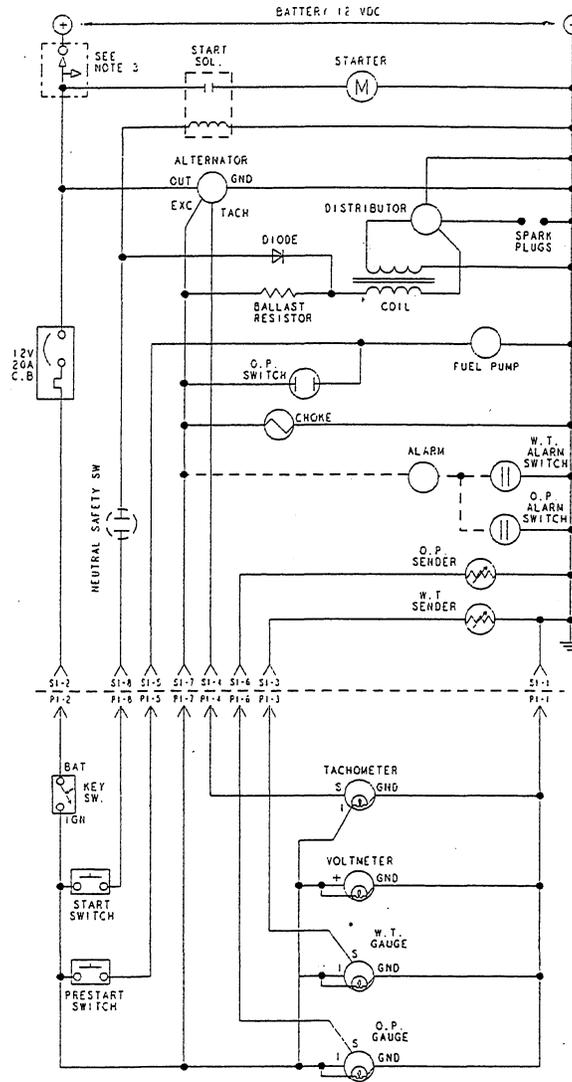
W-70GA WIRING DIAGRAM



W-70GA WIRING SCHEMATIC

RESPONSIBILITY FOR SAFETY REGULATIONS

1. THE WESTERBEKE 70GA GASOLINE MARINE PROPULSION ENGINE AS SHIPPED FROM THE FACTORY AND EXCLUSIVE OF ITS INSTRUMENT PANEL COMPLIES WITH U.S. COAST GUARD REGULATION 33 CFR-183. THE STANDARD INSTRUMENT PANEL DOES NOT NECESSARILY SO COMPLY AND IS INTENDED TO BE INSTALLED ABOVE DECK AND ISOLATED FROM GASOLINE SOURCES IN ACCORDANCE WITH 33CFR 183.410 (b).
2. IT IS THE RESPONSIBILITY OF THE BOAT MANUFACTURER TO INSURE THAT THE INSTALLATION OF THIS ENGINE AND ITS INSTRUMENT PANEL COMPLY WITH 33CFR-183.
3. AN ON-OFF SWITCH MUST BE INSTALLED IN THIS LINE TO DISCONNECT THE STARTER CIRCUIT FROM THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. TWELVE VOLT STARTERS TYPICALLY DRAW 200 TO 300 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VOLTS WILL NORMALLY SERVE THESE FUNCTIONS BUT SUCH A SWITCH MUST NEVER BE USED TO "MAKE" THE STARTER CIRCUIT.
4. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE SOURCE OF CURRENT AS POSSIBLE. EXCESSIVE CURRENT DRAIN ANYWHERE IN THE INSTRUMENT PANEL WIRING OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT MOST ENGINE MODELS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISCONNECTS THEIR FUEL SUPPLY. THEREFORE THE BUILDER OWNER MUST BE SURE THAT THE INSTRUMENT PANEL WIRING AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.



TACHOMETER

TACHOMETER/HOUR METER

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

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

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

Hour meter Inoperative

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

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

Tachometer Inoperative

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

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

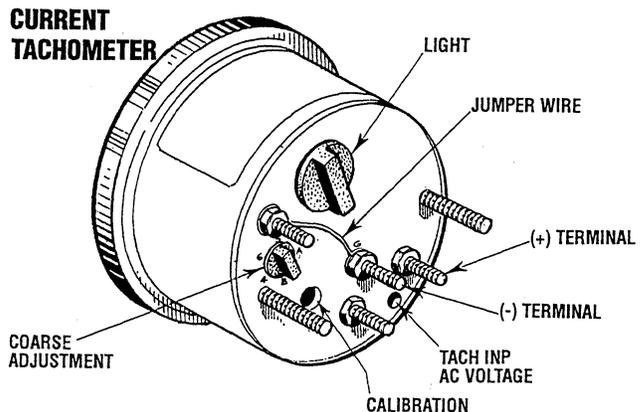
Tachometer Sticking

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

Tachometer Inaccurate

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

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



TACHOMETER CALIBRATION & IDLE SPEED ADJUSTMENT (New Installation)

NOTE: In a new installation (commissioning) the tachometer in the instrument panel will not always be correctly calibrated to the engine's RPM. The tachometers calibration must be checked in a new installation (commissioning)..

1. Place a piece of reflective tape on the outer edge of the front crankshaft pulley.
2. Start the engine and allow the engine to warm up and then set the engine speed at a high idle 1500 rpm, using a strobe type tachometer shooting the front crankshaft pulleys reflective tape for an accurate engine rpm reading.
3. Positive the "coarse" adjustment at each of the six selections. Select the one that sets the tachometer reading closest to the 1500 rpm.
4. Using a small phillips screw driver, adjust the calibration pod to set the tachometer exactly on 1500 rpm.
5. Check the tachometer readings at idle and at high rpm.
6. Adjust the idle speed at a comfortable rpm, but not at too low a speed to induce vibration and stalling when shifting the transmission.

ENGINE ADJUSTMENTS

SPARK PLUGS

The spark plugs should be cleaned and regapped after the first 50 hour break-in period, then inspected every 250 hours thereafter and replaced as needed.

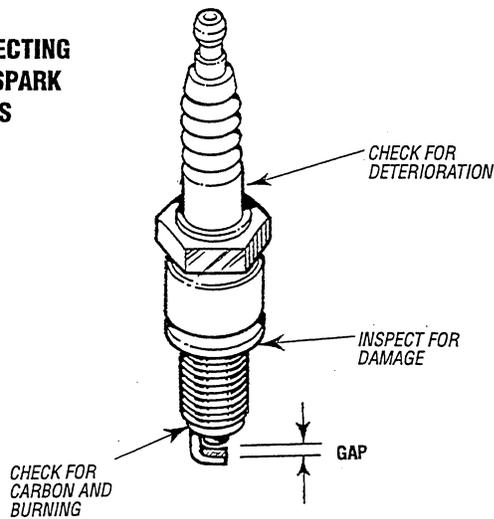
WARNING: Do not remove the spark plugs while the engine is hot. Allow the engine to cool before removing them.

SPARK PLUG GAP: 0.031-0.028 ± 0.0002 in. (0.8-0.7mm)

SPARK PLUG TORQUE: 10 - 15 lb-ft (1.5 - 2.31 kg-m)

NOTE: Loctite Anti-Seize applied to the threaded portion of the spark plugs will retard corrosion, making future removal of the spark plugs easier.

INSPECTING THE SPARK PLUGS



DRIVE BELT ADJUSTMENT

The drive belts must be properly tensioned. Excessive drive belt tension can cause rapid wear of the belts and reduce the service life of the bearing and the alternator, raw water pump, and engine coolant pump. A slack belt or the presence of oil on the belt can cause belt slipping, resulting in high operating temperatures and the failure of the same components.

1. To adjust the alternator and the engine coolant belts, loosen the alternator mounting bolts and pivot the alternator as needed. Retighten the bolts.
2. To adjust the raw water pump belt, loosen the mounting bolts and slide the pump up and down as needed. Retighten the bolts.

NOTE: When the belts are loose, inspect for wear, cracks and frayed edges, and replace if necessary.

3. The drive belts are properly adjusted if it can be deflected no less than 3/8 inch (10mm) and no more than 1/2 inch (12mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt.
4. Operate the engine for about 5 minutes, then shut down the engine and recheck the belts tension.

NOTE: Maintain a 22 lb pressure to the belt's outer face for proper belt operation. Spare belts should always be carried on board.

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

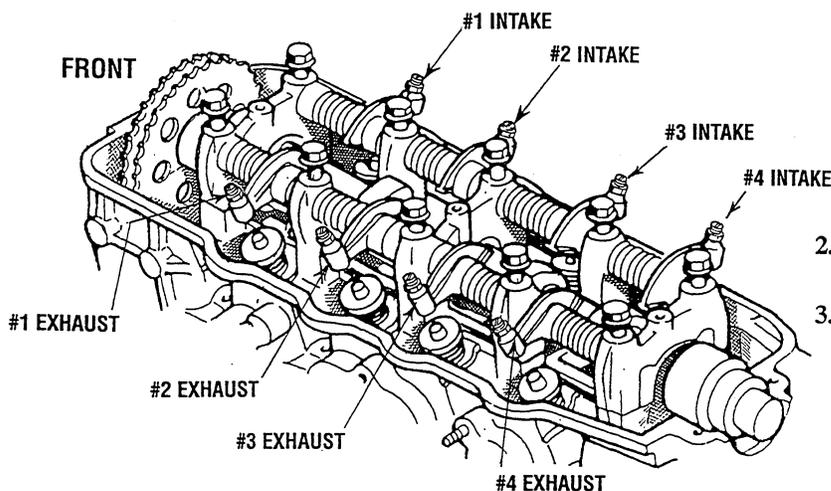
ENGINE ADJUSTMENTS

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

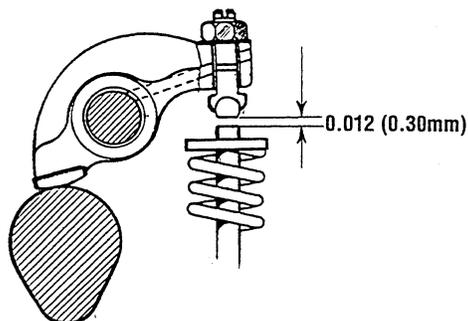
VALVE CLEARANCE ADJUSTMENT

NOTE: Retorque the cylinder head bolts before adjusting the engine's valves (see **TORQUING THE CYLINDER HEAD BOLTS**).

1. Remove the rocker cover and gasket.
2. Position the No.1 piston at Top Dead Center (TDC) of its compression stroke and adjust the #1 and #3 exhaust No.1 and No.2 valves on the intake side of the cylinder head and the No.1 and No.3 on the exhaust side. Rotate the crankshaft 360° in a clockwise direction and adjust the remaining four valves.



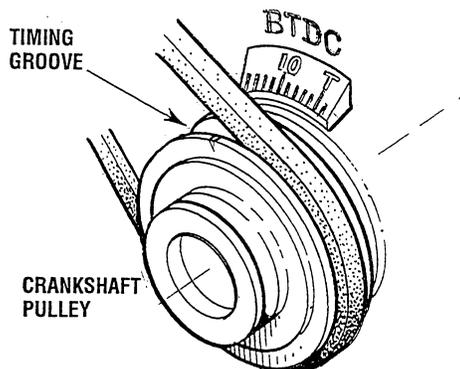
3. Replace the rocker cover and the rocker cover gasket..
Rocker cover torque: 2.9–5.1 lb-ft (0.4–0.7 kg-m)
4. Adjust all values to 0.012 (0.30mm) with the engine hot.



IGNITION TIMING

1. Attach a timing light to the #1 spark plug and mark the front crankshaft timing groove and the timing mark on the scale embossed on the engine's front cover.

Each timing mark represents 2°.



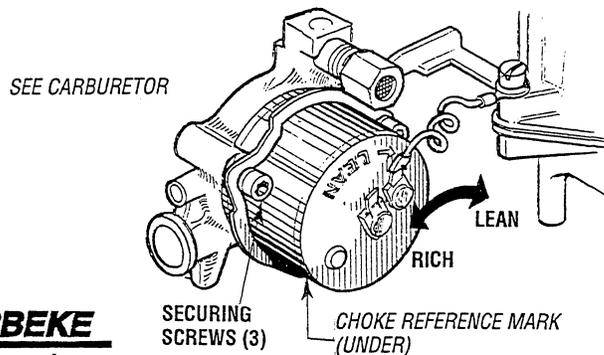
2. Start the engine and warm the engine to its normal operating temperature.
3. Using the timing light, align the timing groove in the front crankshaft pulley with the proper timing mark on the ignition timing scale embossed on the engine's front cover. Do this by loosening and slowly rotating the distributor body. Refer to the timing specifications:

TIMING SPECIFICATIONS 0° TDC AT 625 RPM

ELECTRIC CHOKE

The electric choke uses a 12 volt heating element which opens the choke automatically when the engine starts.

The choke is adjusted with the engine off and cooled. Adjust the choke by loosening the three cover-securing screws and rotating the cover clockwise to **LEAN** the choke and counterclockwise to **RICH** the choke. The choke is initially set at the factory for an average of 70°F (21°C) room temperature. The choke may need readjustment at engine commissioning for the ambient temperature of the area the engine is operating in. The choke reference mark is located on the underside of the choke cover.



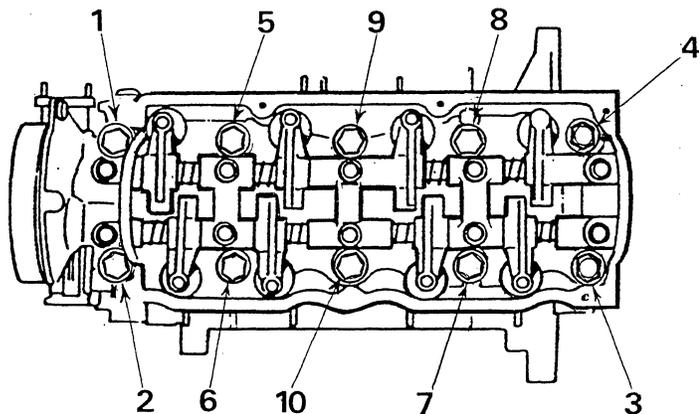
ENGINE ADJUSTMENTS

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

TORQUING THE CYLINDER HEAD BOLTS

After the initial break-in period (approximately 50 hours), the cylinder head bolts should be re-torqued.

Tighten the cylinder head bolts according to the sequence shown. Make sure the engine is cold when this is done, and loosen one head bolt one-half turn and then tighten it between 55 - 59 lb-ft (8.2 - 8.8 Kg-m). Then proceed to the next head bolt in the sequence. Tighten the RS (rocker cover stud) securely.

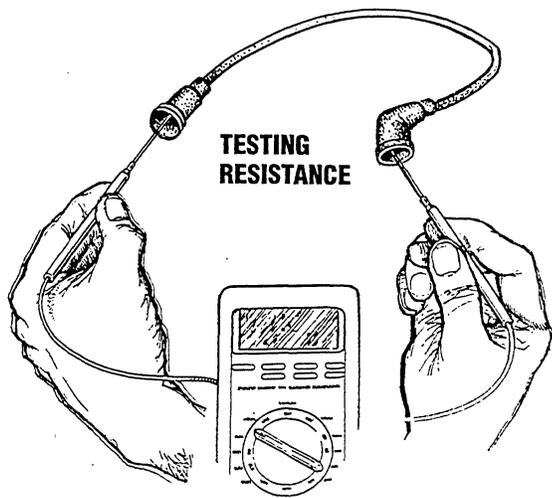


HIGH TENSION CORDS (IGNITION WIRES)

Check the ignition wires every 500 operating hours as engine compartment heat can deteriorate the wires.

Check the resistance of each wire. Do not pull on the wire because the wire connection inside the cap may become separated or the insulator may be damaged. When removing the wires from the spark plugs, grasp and twist the molded cap, then pull the cap off the spark plug.

THE RESISTANCE VALUE IS 410 OHM PER INCH.



ENGINE COMPRESSION

If it becomes necessary to check the engines cylinder compression, warm the engine and shut it down.

Remove the spark plugs and install a compression adapter (screws into a plug hole) with a gauge.

Crank the engine (close off the raw water) and unplug the ignition coil. Allow the compression gauge to reach a maximum reading and record.

Measure the compression pressure for each cylinder. Ensure that the pressure differential for each cylinder is within the specifications.

COMPRESSION PRESSURE AT 1400 RPM	198.1 psi (14 kg/cm ²)
LIMIT OF DIFFERENCE BETWEEN CYLINDERS	28.0 psi (2.0 kg/cm ²)

If a cylinder's compression or pressure differential is below the limit, add a small amount of engine oil through the spark plug hole and repeat the test. If the oil causes an increase of pressure, the piston ring and/or cylinder wall may be worn or damaged. If the added oil does not increase compression pressure suspect poor valve contact, valve seizure, or valve wear. Reinstall the plugs, ignition wires, and coil. **Open the raw water thru seacock.**

ENGINE TROUBLESHOOTING

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

When troubleshooting indicates an electrical problem, refer to the *ELECTRICAL SYSTEM WIRING DIAGRAMS*.

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

Problem	Probable Cause	Verification/Remedy
No panel indications; fuel solenoid or fuel pump is not working (key switch is on and PRESTART button is depressed).	<ol style="list-style-type: none"> 1. Battery switch not on. 2. 20-amp circuit breaker tripped. 3. Loose battery connections. 	<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 (+) connection to starter solenoid and (-) connection to engine ground stud. Check battery cable connections.
START button is depressed, no starter engagement.	<ol style="list-style-type: none"> 1. Connection to solenoid faulty. 2. Gear shift not in neutral. 3. Faulty switch. 4. Faulty starter solenoid. 5. Loose battery connections. 6. Low battery. 	<ol style="list-style-type: none"> 1. Check connection. 2. Gear shift must be in neutral (see <i>NEUTRAL SWITCH</i> under <i>HURTH HSW TRANSMISSIONS</i>). 3. Check switch with ohmmeter. 4. Check that 12 volts are present at the solenoid connection. 5. Check battery connections. 6. Check battery charge state.
Engine cranks, but does not start.	<ol style="list-style-type: none"> 1. Faulty fueling system. <ol style="list-style-type: none"> 1. Fuel lift pump failure. 2. Choke. 3. Low battery power. 4. Carburetor filter screen is clogged. 5. Engine is flooded. 7. Worn or faulty spark plugs. 8. High tension wires grounding. 9. Faulty ignition coil. 10. Faulty distributor. 11. Faulty wire connection. 12. No engine compression. 13. Faulty idle adjustment. 	<ol style="list-style-type: none"> 1. Check that fuel valves are open. Check fuel supply. <ol style="list-style-type: none"> 1a. Check for air in fuel system. Bleed air from fuel system. 1b. Fuel filters clogged. Replace filters and bleed air from fuel system. 2. Pump should be "ticking". Check connections, check for 12 volts. Replace pump. 3. Check choke operation. Adjust tension. 4. Switch to combine house and start batteries. Replace batteries. 5. Clear with compressed air or clean with kerosene. 6a. Carburetor float needle valve open or damaged. Clean or replace the needle valve. 6b. Float in carburetor is leaking. Repair or replace float. 6c. Float chamber gasket damaged or securing screws are loose. Replace gasket and/or tighten screws. 7. Replace. 8. Inspect wires and test. 9. Test coil. 10. Test distributor, see manual. 11. Inspect wires. 12. test compression, see manual. 13. Adjust idle, see manual.
Poor running performance.	<ol style="list-style-type: none"> 1. Carburetor inlet clogged. 2. Main jet clogged. 3. Air intake, carburetor screen dirty. 4. Carburetor inlet filter clogged. 5. Fuel lines clogged. 	<ol style="list-style-type: none"> 1. Remove and clean. 2. Remove and clean. 3. Remove and clean. 4. Remove and clean. 5. Inspect lines. replace inlet fuel filter.

(continued)

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine starts, runs and then shuts down.	<ol style="list-style-type: none"> 1. Dirty fuel/water separator filter. 2. Faulty fuel lift pump. 	<ol style="list-style-type: none"> 1. Change filters. 2. Pump should be "ticking". Check connections, test for 12 volts.
Engine starts, runs but does not throttle up.	<ol style="list-style-type: none"> 1. Fuel line restriction. 2. Throttle plate binding. 3. Faulty fuel lift pump. 4. Air intake restriction. 5. High exhaust back pressure. 	<ol style="list-style-type: none"> 1. Inspect all fuel lines. 2. Adjust linkage. 3. Lift pump should "tick". Check connections, test for 12 volts. 4. Check air intake. Clean/replace filter screen. 5. Inspect exhaust elbow for corrosion. Check exhaust elbow hose. Test back pressure.
Engine hunts	<ol style="list-style-type: none"> 1. Low battery voltage. 2. Cracked distributor cap. 3. Faulty high tension wires. 4. Faulty fuel lift pump. 5. High exhaust back pressure. 6. Valves are out of adjustment. 7. Dirty fuel filters. 	<ol style="list-style-type: none"> 1. Check batteries. 2. Replace distributor cap. 3. Test wires. 4. Lift pump should "tick". Check connections, test for 12 volts. 5. Inspect exhaust elbow for corrosion. Check exhaust elbow hose. Test back pressure. 6. Adjust valves. 7. Change filters.
Battery runs down.	<ol style="list-style-type: none"> 1. Oil pressure switch. 2. High resistance leak to ground. 3. Low resistance leak. 4. Poor battery connections. 5. DC alternator not charging (tachometer not operating). 	<ol style="list-style-type: none"> 1. Observe if gauges and panel lights are activated when engine is not running. Test the oil pressure switch. 2. Check wiring. Insert sensitive (0 – .25 amp) meter in battery lines. (Do not start engine.) Remove connections and replace after short is located. 3. Check all wires for temperature rise to locate the fault. 4. Check cable connections at battery for loose connections, corrosion 5. Check connections, check belt tension, test alternator. See <i>ALTERNATOR TESTING</i>.
Battery not charging	<ol style="list-style-type: none"> 1. DC charge circuit faulty. 2. Alternator drive. 	<ol style="list-style-type: none"> 1. Perform DC voltage check of generator charging circuit. See <i>Testing the Battery Charging Circuit</i>. 2. Check drive belt tension; alternator should turn freely. Check for loose connections. Check output with voltmeter. Ensure 12 volts are present at the Exc. terminal.
Engine misfires.	<ol style="list-style-type: none"> 1. Poor quality fuel. 1a. Fuel blockage. 2. Incorrect timing. 3. Dirty flame arrester. 4. Cracked distributor cap. 5. Faulty ignition wires. 6. Spark plugs are worn. 7. High exhaust back-pressure. 8. Valve clearances are incorrect. 	<ol style="list-style-type: none"> 1. Check filters for water. Change fuel. 1a. Replace inlet fuel filter, check fuel lines. 2. Adjust timing. 3. Clean with compressed air or kerosene. 4. Replace distributor. 5. Test, replace. 6. Replace spark plugs. 7. Test back pressure. 8. Check clearances.

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine backfires.	<ol style="list-style-type: none"> 1. Spark plug wires are connected wrong. 2. Incorrect timing. 3. Engine is flooded. See <i>Engine is flooded</i> under <i>Engine cranks but fails to start</i>. 4. Dirty flame arrester. 5. Cracked distributor cap. 6. High exhaust back-pressure. 7. Choke is stuck closed. 	<ol style="list-style-type: none"> 1. Reconnect correctly. 2. Adjust engine timing. See manual. 3. See <i>Engine cranks but fails to start</i> column. 4. Clean with compressed air or kerosene. 5. Replace distributor. 6. Test back-pressure. 7. Inspect carburetor.
Engine overheats.	<ol style="list-style-type: none"> 1. Coolant loss. 2. Faulty raw water pump impeller. 3. Belts are loose or broken. 4. Faulty thermostat. 5. Heat exchanger is clogged. 6. Collapsed hose. 7. Faulty coolant pump. 8. Coolant tank or pressure cap faulty. 	<ol style="list-style-type: none"> 1. Check for leaks, pressure test system. 2. Replace impeller. 3. Tighten, check belts. 4. Replace. 5. Service heat exchanger. 6. Replace. 7. Remove and replace. 8. Inspect, replace.
Low oil pressure.	<ol style="list-style-type: none"> 1. Low oil level. 2. Faulty oil pressure switch, sender, gauge. 3. Wrong SAE type oil in the engine. 4. Wrong type oil filter. 5. Relief valve is stuck. 6. Faulty oil pump/strainer. 7. Faulty engine bearings. 8. Faulty oil filter. 9. Oil in sump is slugged. 	<ol style="list-style-type: none"> 1. Add oil. 2. Test and replace. 3. Change oil. 4. Change filter. 5. Service engine. 6. Service engine. 7. Service engine. 8. Change filter. 9. Service engine. Flush Sump.
High oil pressure.	<ol style="list-style-type: none"> 1. Dirty oil or wrong SAE type oil in the engine. 2. Relief valve is stuck. 	<ol style="list-style-type: none"> 1. Change oil. 2. Service engine.
No DC charge to the starting battery.	<ol style="list-style-type: none"> 1. Faulty connections to battery. 2. Connections to the alternator are loose or faulty. 3. Faulty alternator. 	<ol style="list-style-type: none"> 1. Tighten and clean connections. 2. Tighten and clean connections. 3. Test alternator.
Oil leak.	<ol style="list-style-type: none"> 1. Oil drain hose loose. 2. Damaged or loose timing chain cover or rocker arm. 3. Loose or damaged oil pressure switch or sender. 4. Loose or damaged oil filter. 5. Oil pan leaking. 	<ol style="list-style-type: none"> 1. Tighten, replace. 2. Tighten, replace. 3. Tighten, replace. 4. Tighten, replace. 5. Tighten bolts, replace pan gasket.
Engine alarm sound pulsates.	<ol style="list-style-type: none"> 1. Loss of oil. 2. Oil pressure switch. 	<ol style="list-style-type: none"> 1. Check dipstick, look for oil leaks at oil filter and at oil drain hose connection. 2. Replace oil pressure switch.
Engine alarm sounds continuously.	<ol style="list-style-type: none"> 1. Engine coolant. 2. High temperature switch opens at too low a temperature. 	<ol style="list-style-type: none"> 1. Check engine coolant level. 2. Check for satisfactory operation with switch bypassed, check with ohmmeter, replace if faulty.

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Engine slows and stops.	<ol style="list-style-type: none"> 1. Fuel lift pump failure. 2. Switches and/or wiring loose or disconnected. 3. Fuel starvation. 4. 20 Amp circuit breaker tripping. 5. Exhaust system is restricted. 6. Water in fuel. 7. Air intake obstruction. 	<ol style="list-style-type: none"> 1. Fuel lift pump should make a distinct ticking sound. Replace pump with spare. 2. Inspect wiring for short circuits and loose connections. Inspect switches for proper operation. 3. Check fuel supply, fuel valves, fuel lift pump. 4. Check for high DC amperage draw during operation. Ensure breaker is not overly sensitive to heat which would cause tripping. 5. Check for blockage, collapsed hose, carbon buildup at exhaust elbow. 6. Pump water from fuel tank(s); change filters and bleed fuel system. 7. Check air intake.
Engine overheats/shuts down.	<ol style="list-style-type: none"> 1. Raw water not circulating. 2. Coolant not circulating. 	<ol style="list-style-type: none"> 1. Raw water pump failure. Check impeller - replace. 2. Obstruction at raw water intake or raw water filter. 2a. Thermostat - remove and test in hot water. Replace thermostat. 2b. Loss of coolant - check hoses, hose clamps, drain plug, etc. for leaks. 2c. Broken or loose belts - tighten/replace. 2d. Air leak in system; run engine and open the pressure cap to bleed air. Add coolant as needed.
Exhaust smoke problems	<ol style="list-style-type: none"> 1. Blue smoke. 2. White smoke. 3. Black smoke. 	<ol style="list-style-type: none"> 1. Incorrect grade of engine oil. Oil is diluted. 1a. Crankcase is overfilled with engine oil (oil is blowing out through the exhaust). 1b. Crankcase breather hose is clogged. 1c. Valves and/or piston rings are worn. 2. Engine is running cold. 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. Dirty flame arrester. 3c. Faulty carburetor. Choke is stuck. 3d. Lack of air-check air intake and air filter. Check for proper ventilation. 3e. Idle mixture jet too rich. 3f. Overload.

TROUBLESHOOTING COOLANT TEMPERATURE AND OIL PRESSURE GAUGES

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

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

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

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

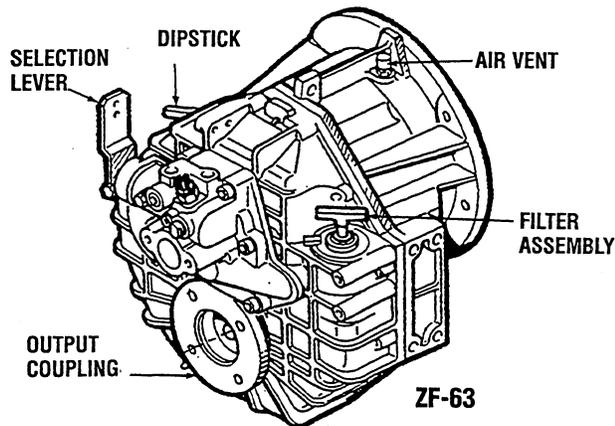
Assuming the gauge is OK, check the conductor from the sender to the sender terminal at the gauge for continuity. Check that the engine block is connected to the ground. Some starters have isolated ground terminals and if the battery is connected to the starter (both plus and minus terminals), the ground side will not necessarily be connected to the block.

ZF TRANSMISSIONS

SHIPMENT

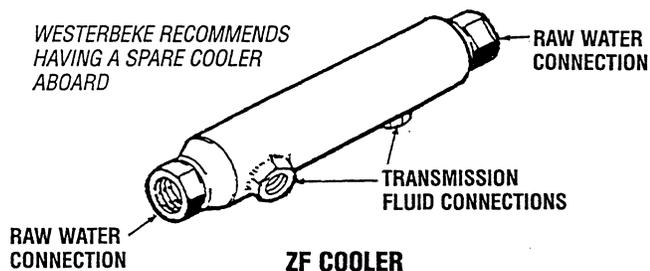
For safety reasons, the transmission is *not* filled with transmission fluid during shipment and the selector lever is temporarily attached to the actuating shaft.

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



OIL COOLER

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



TRANSMISSION FLUID

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

NEUTRAL SWITCH

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

INITIAL OPERATION

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

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

LOCKING THE PROPELLER

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

WHEN UNDER SAIL OR BEING TOWED

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

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

DAILY OPERATION

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

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

Operating Temperature

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

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

ZF TRANSMISSIONS

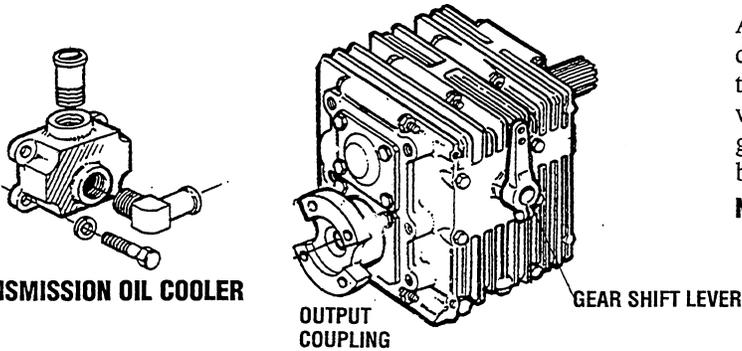
DESCRIPTION

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

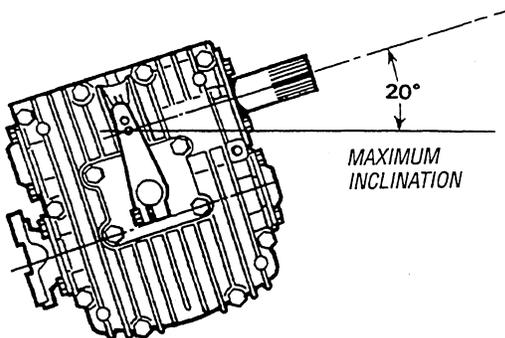
CONNECTION OF GEAR BOX WITH PROPELLER

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

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



ZF TRANSMISSION



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

* DRIVESAVER is a product of Globe Marine, Rockland, MA.

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

CONTROL CABLES

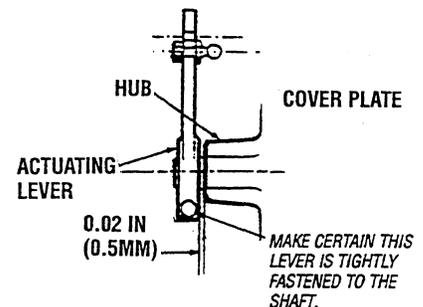
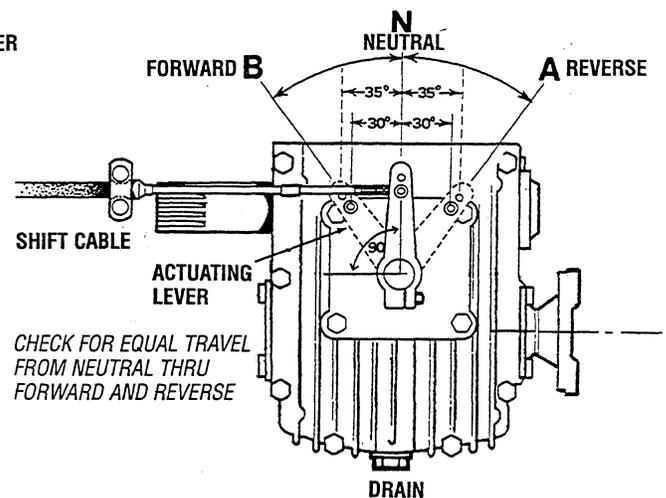
The transmission is suitable for single lever remote control. Upon loosening the retaining screw, the actuating lever can be moved to any position required for the control elements (cable or rod linkage). Make certain that the shift lever does not contact the actuating lever cover plate: the minimum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

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

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

A greater amount of shift lever travel is in no way detrimental and is recommended. However, if the lever travel is shorter, proper clutch engagement might be impeded which, in turn, would mean premature wear, excessive heat generation and clutch plate failure. This would be indicated by slow clutch engagement or no engagement at all.

NOTE Check for proper lever travel at least each season.

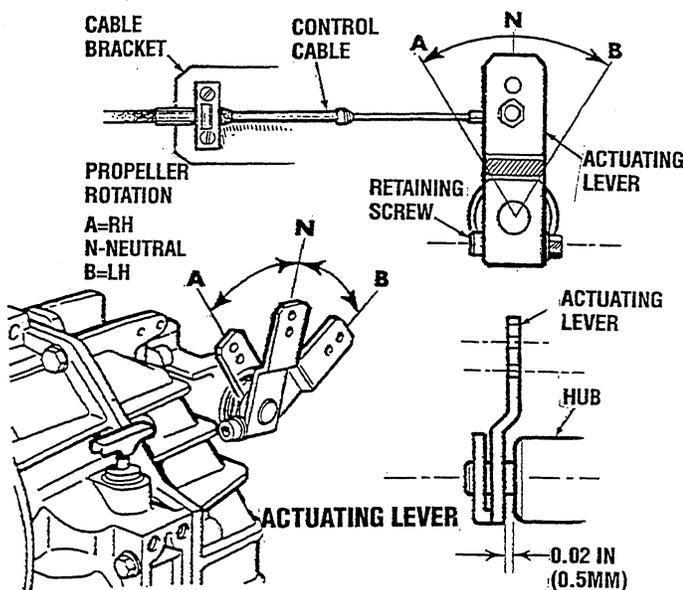


CABLE CONNECTIONS

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

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

The shifting travel, as measured at the pivot point of the actuating lever between the neutral position and end positions A and B, should be at least 1-3/8in (35mm) for the outer and 1-3/16in (30mm) for the inner pivot point.



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

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

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

SHAFT COUPLINGS

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

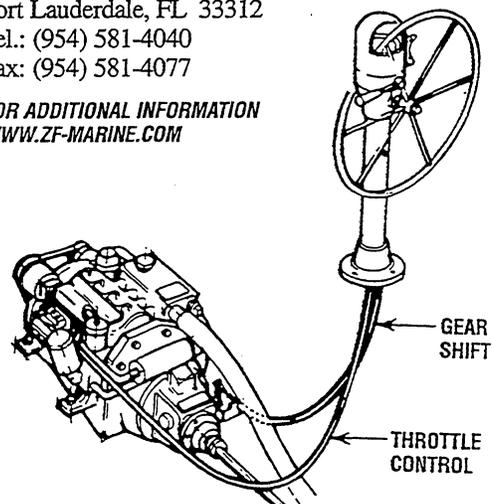
Even with the engine solidly mounted the use of a flexible coupling or "DRIVESAVER" will reduce stress in the gear-box bearings caused by hull distortions, especially in wooden boats or where the distance between the transmission output coupling and stern gland is less than about 800mm.

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

For additional information contact:

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Fort Lauderdale, FL 33312
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FOR ADDITIONAL INFORMATION
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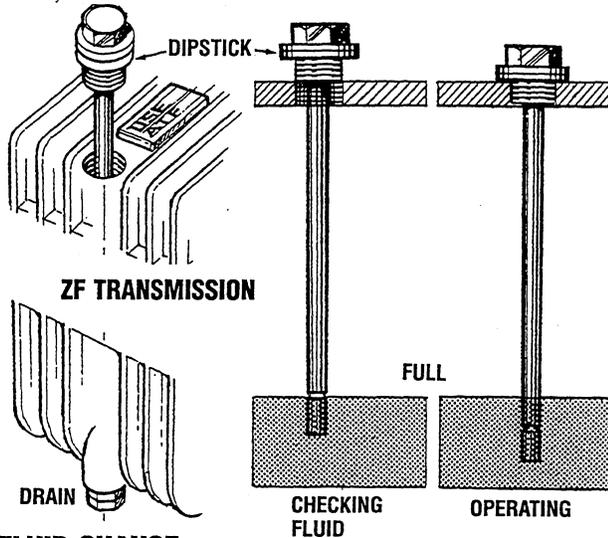
TYPICAL STEERING STATION

ZF TRANSMISSIONS

INITIAL OPERATION

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

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



FLUID CHANGE

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

Removing the fluid

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

Drain plug torque 20 - 25 ft/lbs

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

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

OPERATING TEMPERATURE

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

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

LOCKING THE PROPELLER

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

WHEN UNDER SAIL OR BEING TOWED

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

DAILY OPERATION

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

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

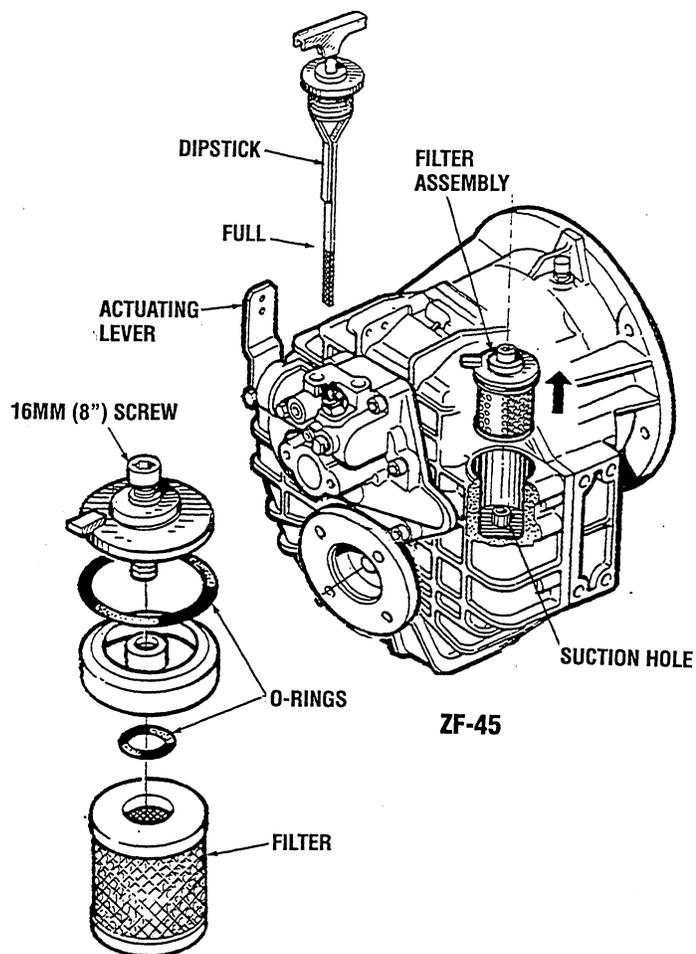
For additional information refer to the following text in this Transmission Section: *SHAFT COUPLINGS, MAINTENANCE AND TRANSMISSION TROUBLESHOOTING.*

ZF TRANSMISSIONS SPECIFICATIONS

General	Case-hardened helical gears, with a servo-operated multiple disc clutch.
Gear ratio (optional)	2.63 : 1 (ZF 15 MA - 3R) 2.99 : 1 (ZF 15 MIV - 3R) 2.74 : 1 (ZF 25 M - 3R)
Lubricating Fluid	ATF - type A or Dextron - II or III
Transmission Sump Capacity	ZF 15 MA 0.59 U.S. qts (0.561 liters) ZF 15 MIV 1.11 U.S. qts (1.05 liters) ZF 25 M 0.75 U.S. qts (0.79 liters)
Propeller Shaft Direction of Rotation	Right hand- Standard Transmission

ZF TRANSMISSIONS

CHANGING THE TRANSMISSION FLUID



Filter Element

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

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

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

Removing the Fluid

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

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

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

Replacing the Fluid

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

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

Approximate Quantities

ZF 45 — 2.12 quarts (2.0 Liters)

ZF 63 — 3.2 quarts (3.0 Liters)

ZF 63V — 4.2 quarts (4.0 Liters)

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

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

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

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

MAINTENANCE

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

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

Lay-up/Winterize

Storage requires special care. Follow these procedures:

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

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

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

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

TRANSMISSION TROUBLESHOOTING [ZF]

CONTROL CABLES

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

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

If you experience operating problems with the transmission, shut the engine down. First check the transmission-fluid level, then have a helper move the cockpit shift lever through the full range — from neutral to full forward, back to neutral, into full reverse, and back to neutral — while you observe the actuating lever on the transmission. If the remote is stiff to operate, break the cable loose at the transmission and try again. If it is still stiff, check the cable for kinks or excessively tight bends, and check any linkage for binding.

A new cable and perhaps a new linkage mechanism may be needed. While the cable is loose, shift the transmission in and out of gear using the lever on the side of the transmission to make sure there's no binding inside the case.

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

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

Problem	Probable Cause	Verification/Remedy
Transmission gears cannot be shifted. Fails to move into gear.	<ol style="list-style-type: none"> 1. Actuating lever is loose. 2. Shifting cable is broken, bent or unattached. Cable radius is too severe. 3. Actuating lever is binding against the 	<ol style="list-style-type: none"> 1. Tighten damping bolt on shifting lever. 2. Check the cable, reattach or replace. 3. Detach the shift cable and operate the actuating lever by hand. Clearance should be 0.02 in (0.5mm).
Transmission shifts into gear, but fails to propel the boat.	<ol style="list-style-type: none"> 1. Output coupling is not turning. 2. Propeller shaft is not turning. Output coupling is turning. 3. Output coupling and propeller shaft are turning. 	<ol style="list-style-type: none"> 1. Transmission needs professional attention. 2. The coupling bolts are sheared or the coupling is slipping on the propeller shaft. Tighten or replace set screws, keys, pins and coupling bolts as necessary. 3. Inspect the propeller. It may be missing or damaged. A folding propeller may be jammed. A variable pitch propeller may be in "no pitch" position.
Delay of gear engagement or engages only after an increase in speed.	<ol style="list-style-type: none"> 1. Actuating lever travel N to B not equal to N to A. 2. Actuating level travel in insufficient. 3. Actuating lever is binding against cover plate. 	<ol style="list-style-type: none"> 1. Adjust cover plate until the lever is exact mid-position. See <i>ACTUATING LEVER TEXT AND DIAGRAM</i>. 2. Check shift lever cable length. See <i>ACTUATING LEVER DIAGRAM</i>. 3. Check clearance, adjust if necessary.
Transmission noise becomes louder.	<ol style="list-style-type: none"> 1. Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission. 2. Beginning damage of bearings in transmission due to torsional vibrations, running without fluid, overload, wrong alignment of transmission, or excessive engine output. 	<ol style="list-style-type: none"> 1. Check alignment, inspect flexible coupling. If noise persists, inspect the damper plate between the transmission and the engine. Replace if necessary. 2. Transmission needs professional attention.
Chattering transmission noise, mainly at low engine speed.	<ol style="list-style-type: none"> 1. The engine or propeller generates torsional vibrations in the drive unit which produces a "chattering" noise in the transmission. 	<ol style="list-style-type: none"> 1. Mount a flexible coupling with another stiffness factor between the engine and transmission; a coupling with a higher stiffness factor might be sufficient. 2. Inspect the damper plate between the engine and the transmission. Replace if necessary.
Boat fails to attain specified max. speed.	<ol style="list-style-type: none"> 1. Operating temperature is high. 2. Operating without cooling. 	<ol style="list-style-type: none"> 1. Wrong type of fluid. Use Dextron III, check fluid level. 2. Check cooler. Inspect coolant hoses and coolant flow.
Oil Leakage.	<ol style="list-style-type: none"> 1. Corrosion at radial sealing ring and shaft. Damaged sealing ring. 2. Misalignment of output flanges. 	<ol style="list-style-type: none"> 1. Transmission needs professional attention. 2. Check alignment. Must be within 0.003 in (0.08mm).

ZF TRANSMISSIONS

OPERATING TEMPERATURE

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

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

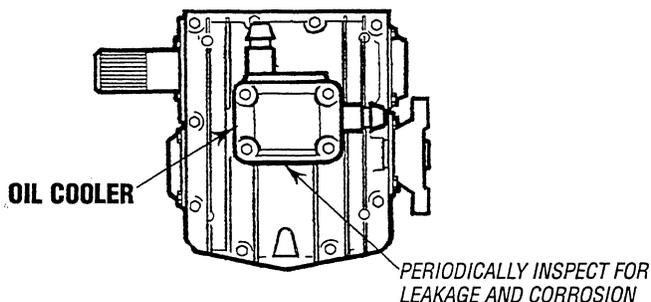
Make certain there is enough space around the transmission to provide good ventilation and cooling.

TRANSMISSION COOLER

Coolers are standard equipment for the ZF 10 M, 12 M, 15 M, 15 MA, 15 MIV, and the 25 M (no cooler is necessary for the ZF 5 M).

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

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



MAINTENANCE

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

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

Lay-up/Winterize

Storage requires special care. Follow these procedures:

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

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

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

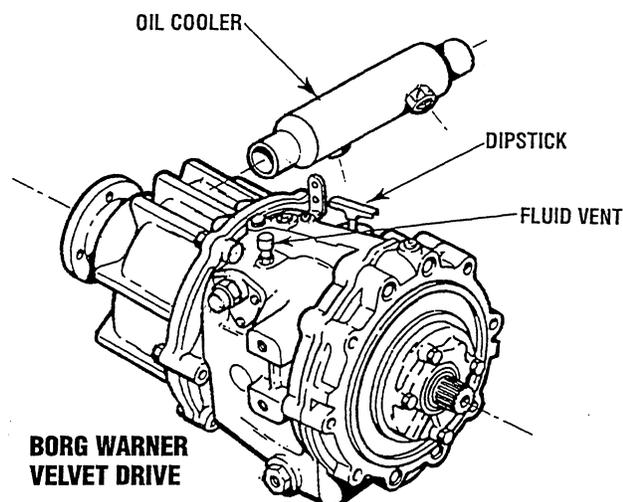
NOTE: If the transmission is to be stored for a long time (twelve months or more), it should be topped off with fluid to prevent internal corrosion. Reduce the fluid level before putting the engine back into service.

For additional information contact:

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

FOR ADDITIONAL INFORMATION
WWW.ZF-MARINE.COM

BORG WARNER VELVET DRIVE TRANSMISSION



SHIPMENT

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

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

TRANSMISSION FLUID

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

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

SHIFT LEVER POSITION

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

Shifting Into Gear

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

Neutral

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

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

Forward

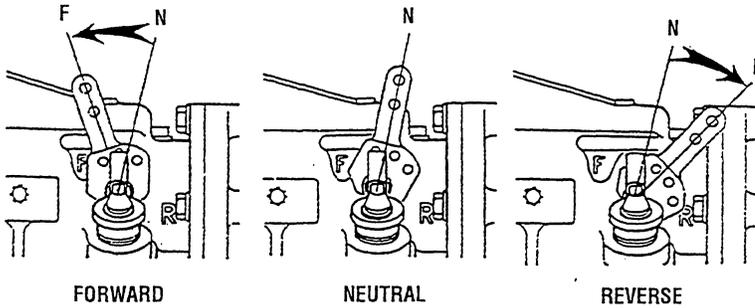
Move the gear shift lever to the forward position. You should feel the detent. The actuating lever on the transmission is in the forward position. The output shaft and the propeller shaft move the boat in a forward direction.

Reverse

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

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

BORG WARNER VELVET DRIVE TRANSMISSION



DAILY OPERATION

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

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

- Shift into gear.

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

INSPECTION

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

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

CHANGING THE TRANSMISSION FLUID

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

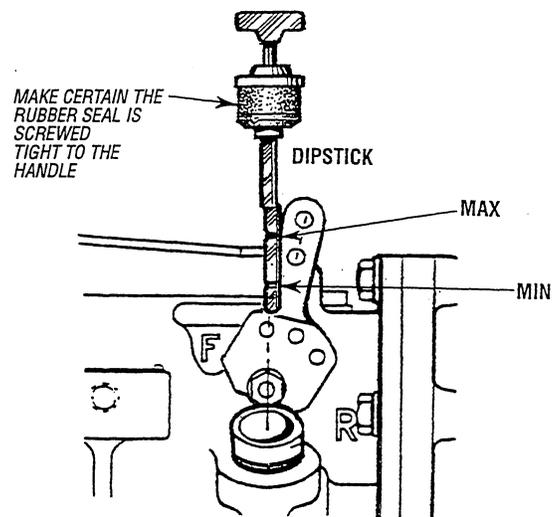
- Remove the oil filler cap and dipstick.
- Remove the oil cooler return line and allow the oil to drain into a container.
- Reconnect the oil cooler return line.
- Use a suction pump to remove the transmission oil through the filler cap/dipstick hole.

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

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

Oil Capacity

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



Oil Temperature

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

PRESSURE GAUGE

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

BORG WARNER VELVET DRIVE TRANSMISSION

MAINTENANCE

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

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

Lay-up/Winterize

Storage requires special care. Follow these procedures:

- Drain the water from the transmission oil cooler and replace it with a proper mixture of antifreeze coolant.
NOTE: *This operation will usually occur when the engine raw water cooling system is properly winterized.*
- Clean up the transmission and touch-up unpainted areas (use heat resistant paint).
- Fill the transmission with *Dextron III ATF* fluid to the fill mark.
- Loosen attaching hardware from the transmission output flange and propeller shaft coupling flange before removing the boat from the water. Separate the flanges and spray with lubricant.
- Inspect the gear shift cable, linkage, and attachments. Look for corrosion of the end fittings, cracks or cuts in the conduit, and bending of the actuator rods. Lubricate all moving parts.

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

WARRANTY NOTES

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

For assistance, contact:

BORG WARNER
1208 Old Norris Blvd.
Liberty, SC 29657
Tel.: 800-583-4327 ext.129

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

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

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

TRANSMISSION TROUBLESHOOTING

CONTROL CABLES

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

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

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

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

OIL COOLERS

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

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

Either case requires an immediate response:

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

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

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

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

WESTERBEKE recommends having a spare cooler aboard

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

TRANSMISSION TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Chattering transmission noise, mainly at low engine speed.	1. The engine or propeller generates torsional vibrations in the drive unit which produces a "chattering" noise in the transmission.	1. Mount a flexible coupling with another stiffness factor between the engine and transmission; a coupling with a higher stiffness factor might be sufficient.
Transmission shifts into gear, but fails to propel the boat.	1. Output coupling is not turning. 2. Propeller shaft is not turning. Output coupling is turning. 3. Output coupling and propeller shaft are turning.	1. Transmission needs professional attention. 2. The coupling bolts are sheared or the coupling is slipping on the propeller shaft. Tighten or replace set screws, keys, pins and coupling bolts as necessary. 3. Inspect the propeller; it may be missing or damaged. A folding propeller may be jammed. Variable pitch propeller may be in "no pitch".

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

LAY-UP & RECOMMISSIONING

GENERAL

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

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

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

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

Propeller Shaft Coupling [Propulsion Engine]

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

Fresh Water Cooling Circuit [Propulsion Engine]

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

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

Lubrication System

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

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

Fuel System [Gasoline]

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

Fuel System [Diesel]

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

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

Raw Water Cooling Circuit

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

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

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

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

Intake Manifold and Thru-Hull Exhaust

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

LAY-UP & RECOMMISSIONING

Starter Motor

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

Cylinder Lubrication [Diesel]

If you anticipate a long lay-up period (12 months or more) WESTERBEKE recommends removing the fuel injectors for access to the cylinders. Squirt light lubricating oil into the cylinders to prevent the piston rings from sticking to the cylinder walls.

Make sure you have replacements for the injector and return line sealing washers.

Intake Manifold [Gasoline]

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

Cylinder Lubrication [Gasoline]

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

NOTE: *The spark plugs will need to be removed for cleaning and re-gapping at spring commissioning.*

Batteries

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

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

Transmission [Propulsion Engine]

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

Spare Parts

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

Recommissioning

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

1. Remove the oil-soaked cloths from the intake manifold.
2. Remove the raw water pump cover and gasket and discard the old gasket. Install the raw water pump impeller removed during lay-up (or a replacement, if required). Install the raw water pump cover with a new cover gasket.
3. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to make sure that the batteries are fully charged.

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

4. Remove the spark plugs, wipe clean, re-gap, and install to proper tightness [*gasoline*].
5. Check the condition of the zinc anode in the raw water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/fresh water solution from the raw water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse affects. It is advisable, as either an end of season or recommissioning service, to inspect the area where the zinc is located in the heat exchanger and clear any and all zinc debris from that area.
6. Start the engine in accordance with procedures described in the *PREPARATIONS FOR STARTING* section of this manual.

W-70GA GASOLINE ENGINE

SPECIFICATIONS

Engine Type	Gasoline, four-cycle, four-cylinder, fresh water-cooled, Vertical, in-line overhead valve mechanism 66 hp@3600 rpm	
Combustion Chamber	Multi-sphere type	
Bore & Stroke	3.38 x 3.70 inches (86.0 x 94.0 mm)	
Piston Displacement	133.3 cubic inches (2.2 liters)	
Firing Order	1 - 3 - 4 - 2	
Direction of Rotation	Clockwise, when viewed from the front	
Compression Ratio	8:6:1	
Dimensions	Height:	25.0 inches (634 mm)
	Width:	21.2 inches (538 mm)
	Length:	35.1 inches (893 mm)
Weight	421 lbs (190.9 kgs)	
Maximum angle of Installation	Not to exceed 14°	
Maximum angle of Operation	Not to exceed 20°	

TUNE-UP SPECIFICATIONS

Compression Pressure (Limit of difference between cylinders)	198.1 psi (14 kg/cm ²) at 400 rpm 28.0 psi (2.0 kg/cm ²)
Valve Timing	Intake Opens 2° BTDC Intake Closes 53° ABDC Exhaust Opens 57° BBDC Exhaust Closes 2° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine warm)	Intake 0.012 inches (0.3 mm) Exhaust 0.012 inches (0.3 mm)
Engine Timing	0° TDC at 625 rpm

EXHAUST EMISSIONS SYSTEMS

Emission Control Systems	Meets U.S.C.G. Regulation 33 CFR 183
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IGNITION SYSTEMS

General	Battery ignition 12V negative ground. Distributor with ignitor module and ignitor, ignition coil, and spark plugs.
Distributor	Solid state type with signal generator and ignitor
Spark Plug Thread Size	14mm X 1.25 pitch
Carburetor (STD Type)	Down draft type, single barrel, USCG approved flame arrester

FUEL SYSTEM

General	Conventional carburetor type with electric fuel pump
Fuel	Regular or unleaded gasoline with an octane rating of 89 or better
Fuel Lift Pump	Electric-lift capacity of 6ft (18mm)
Fuel Consumption	6.0 U.S. GPH at 3600 rpm
Fuel Filter (on engine)	Replaceable cartridge-screw on
Air cleaner (Flame Arrester)	Metal screen type-cleanable
Air Flow (engine combustion)	140.0 cfm (3.9 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger
Operating Temperature	130 - 150° F (55 - 66° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Raw Water Pump	Positive displacement, rubber impeller, belt driven
System Capacity (coolant)	9.0 qts (8.5 liters)

LUBRICATION SYSTEM

General	Pressure fed system
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity (not including filter)	4.0 U.S. qts (3.7 liters)
Operating Oil Pressure (engine hot)	55-75 psi (3.8 - 5.2 kg/cm ²)
Oil Grade	API Specification of SJ

ELECTRICAL SYSTEM

Starting Battery	12-Volt, (-) negative ground
Battery Capacity	300 - 600 Cold Cranking Amps (CCA)
Starter	12-Volt, reduction-solenoid mounted
DC Charging	12 VDC belt driven alternator
DC Amperage Draw Cranking	175-200 amps (cold engine)

TORQUE SPECIFICATIONS

MAJOR BOLTS AND NUTS

COMPONENT	FT-LB (M-KG)	COMPONENT	FT-LB (M-KG)
Air Cleaner Bracket.....	12.7 - 17.4 (1.9 - 2.6)	Main Bearing Cap.....	56.4 - 60.4 (8.4 - 9.0)
Alternator Bracket.....	25.5 - 35.6 (3.8 - 5.3)	Oil Pan.....	4.7 - 8.0 (7.0 - 12.0)
Alternator Flange Bolt.....	12.7 - 20.8 (1.9 - 3.1)	Oil Pressure Sender.....	9 - 13 (1.2 - 1.8)
Alternator Strap.....	12.7 - 17.4 (1.9 - 2.6)	Oil Pressure Switch.....	9 - 13 (1.2 - 1.8)
Camshaft Pulley Lock Bolt.....	32.2 - 44.3 (4.8 - 6.6)	Oil Pump	
Carburetor.....	8.0 - 11.4 (1.2 - 1.7)	M8.....	12.7 - 17.4 (1.9 - 2.6)
Connecting Rod Cap.....	44.3 - 47.0 (6.6 - 7.0)	M10.....	25.5 - 35.6 (3.8 - 5.3)
Coolant Pump.....	12 - 17 (1.6 - 2.4)	Oil Strainer	
Coolant Pump Pulley.....	12 - 17 (1.6 - 2.4)	M6.....	5.3 - 8.0 (8.0 - 12.0)
Coolant Temperature Sender.....	9 - 13 (1.2 - 1.8)	M8.....	10.7 - 15.4 (1.6 - 2.3)
Coolant Temperature Switch.....	9 - 13 (1.2 - 1.8)	Rear Cover Assembly.....	5.3 - 8.0 (8.0 - 12.0)
Crank Shaft Pulley.....	22.1 - 25.5 (3.3 - 3.8)	Rocker Shaft Assembly.....	12.0 - 18.1 (1.8 - 2.7)
Cylinder Head		Spark Plug.....	10.0 - 15.4 (1.5 - 2.3)
Cold.....	55 - 59 (8.2 - 8.8)	Timing Belt Crank Pulley Bolt.....	120.9 - 134.4 (18.0 - 20.0)
Hot.....	63 - 67 (9.5 - 10.0)	Timing Belt Cover	
Cylinder Head Cover.....	2.6 - 4.0 (4.0 - 6.0)	Upper.....	4.7 - 6.7 (7.0 - 10.0)
Drive Plate.....	16.1 - 18.1 (2.4 - 2.7)	Lower.....	4.7 - 6.7 (7.0 - 10.0)
Exhaust Manifold.....	12 - 17 (1.6 - 2.4)	Timing Tension Lock Bolt.....	25.5 - 35.6 (3.8 - 5.3)
Front Housing Assembly.....	12.7 - 17.4 (1.9 - 2.6)	Thermostat Cover.....	12.7 - 20.8 (1.9 - 3.1)
Intake Manifold.....	12 - 17 (1.6 - 2.4)	Water Pump.....	12.7 - 17.4 (1.9 - 2.6)

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

STANDARD HARDWARE

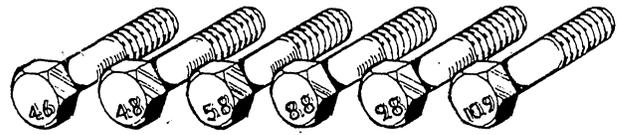
BOLT HEAD MARKINGS

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

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



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



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

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

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

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

SEALANTS & LUBRICANTS

GASKETS/SEALANTS

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

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

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

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

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

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

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

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

BOLTS & FASTENERS/ASSEMBLIES

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

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

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

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

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



STANDARD AND METRIC CONVERSION DATA

LENGTH-DISTANCE

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

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

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

DISTANCE EQUIVALENTS

1 Degree of Latitude = 60 Nm = 111.120 km

1 Minute of Latitude = 1 Nm = 1.852 km

VOLUME

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

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

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

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

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

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

Fluid Ounces x 29.573 = Milliliters x .034 = Ounces

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

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

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

MASS-WEIGHT

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

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

PRESSURE

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

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

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

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

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

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

TORQUE

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

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

VELOCITY

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

POWER

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

FUEL CONSUMPTION

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

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

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

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

TEMPERATURE

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

Degree Celsius (°C) = (°F - 32) x .56

LIQUID WEIGHTS

Diesel Oil = 1 US gallon = 7.13 lbs

Fresh Water = 1 US gallon = 8.33 lbs

Gasoline = 1 US gallon = 6.1 lbs

Salt Water = 1 US gallon = 8.56 lbs

METRIC CONVERSIONS

INCHES TO MILLIMETERS

MILLIMETERS TO INCHES

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

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

INCHES TO METERS

METERS TO INCHES

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

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

YARDS TO METERS

METERS TO YARDS

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

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

POUNDS TO KILOGRAMS

KILOGRAMS TO POUNDS

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

GALLONS TO LITERS

LITERS TO GALLONS

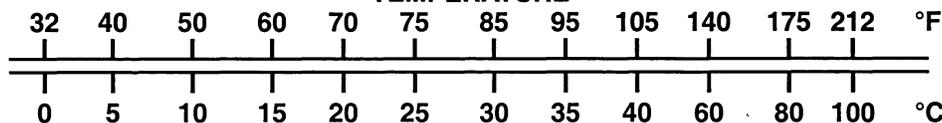
Gallons	Liters	Gallons	Liters	Liters	Gallons	Liters	Gallons
1	3.79	10	37.86	1	0.26	60	15.66
2	7.57	20	75.71	2	0.53	90	23.77
3	11.36	30	113.57	5	1.32	120	31.32
4	15.14	40	151.42	10	2.64	150	39.62
5	18.93	50	189.28	20	5.28	180	47.54

PINTS TO LITERS

LITERS TO PINTS

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

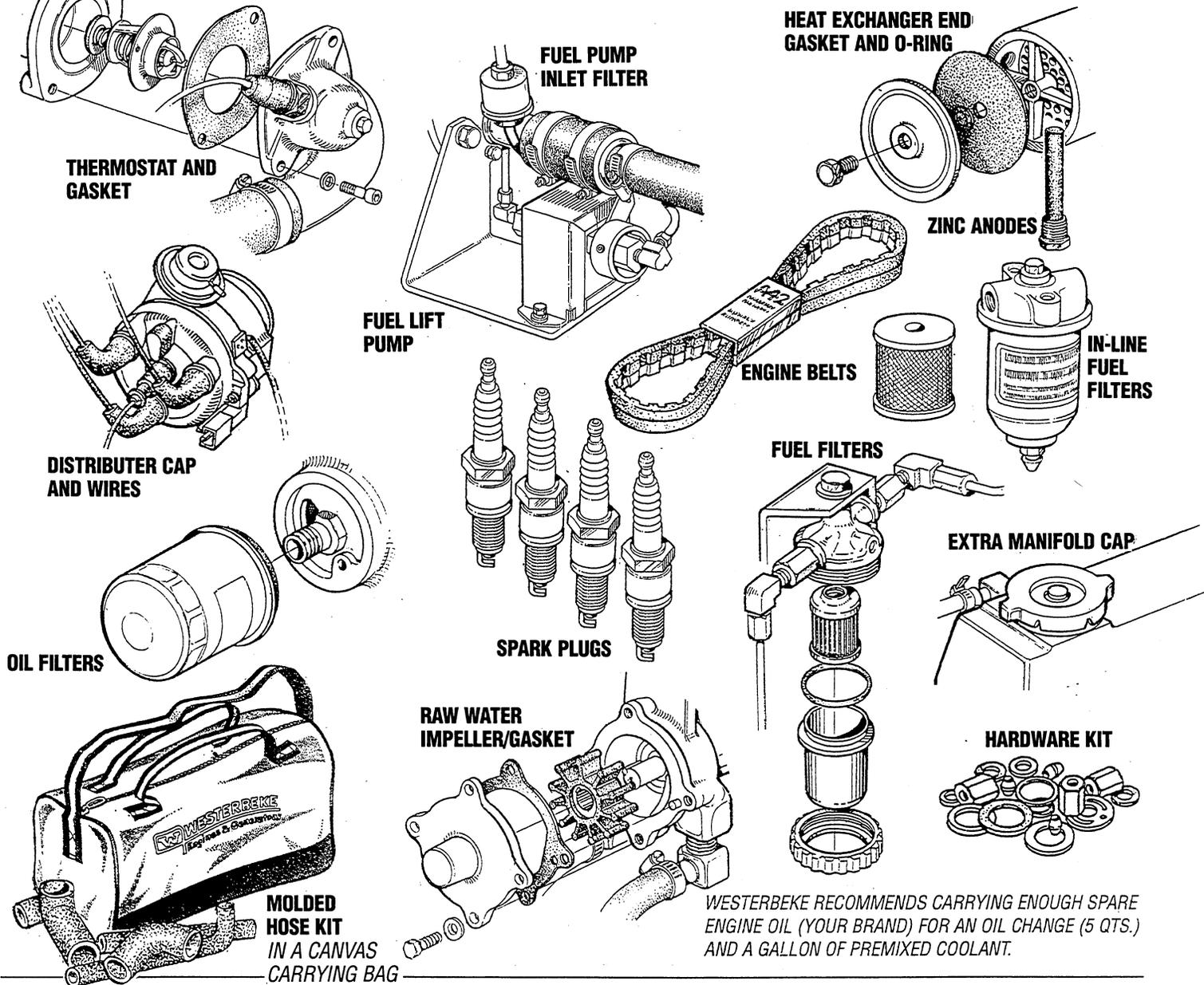
TEMPERATURE



SUGGESTED SPARE PARTS

WESTERBEKE MARINE GASOLINE ENGINES

CONTACT YOUR WESTERBEKE DEALER FOR SUGGESTIONS AND ADDITIONAL INFORMATION



SPARE PARTS KITS

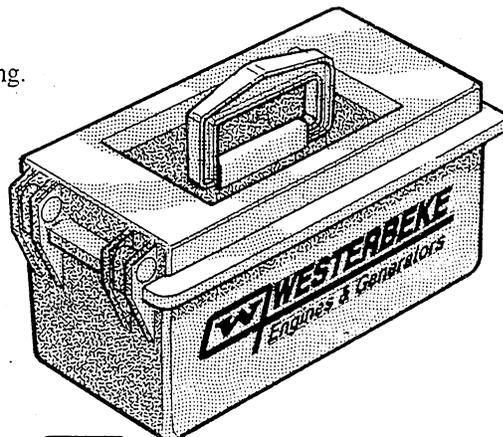
WESTERBEKE also offers two Spare Parts Kits, each packaged in a rugged, rust free toolbox.

KIT A includes the basic spares.

KIT B is for more extensive off-shore cruising.

KIT A

- Impeller Kit
- Heat Exchanger Gasket
- Oil Filter
- Drive Belt
- Zinc Anodes
- Spark Plugs



KIT B

- Impeller Kit
- Water Pump Repair Kit
- Thermostat Kit
- Zinc Anodes
- Complete Gasket Kit
- Heat Exchanger Gasket
- Oil Filter
- Drive Belt
- Spark Plugs

WESTERBEKE
Engines & Generators

