OPERATOR'S MANUAL

AND

INSTALLATION GUIDE

WESTERBEKE

63(B)&(C) FOUR - 71B FOUR - 82B FOUR - 108(B) & (C) SIX

MARINE DIESEL ENGINES

Publication #038922
Edition Three

November 1994

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

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SAFETY PRECAUTIONS

The following symbols appear in this manual to call attention to and emphasize conditions potentially dangerous to the operator.

WARNING

The above symbol is used in the manual to warn of possible serious personal injury or loss of life.

CAUTION

The above symbol is used in the manual to caution personnel of possible damage to equipment.

Read the manual carefully and thoroughly before attempting to operate the equipment. Know when dangerous conditions can exist and take necessary precautions to protect personnel and equipment.

Fuels, exhaust gases, batteries, electrical equipment, and moving and hot parts are potential hazards that could result in serious personal injury or death. Follow recommended procedures carefully.

Always operate bilge blowers for at least five minutes before starting a gasoline-fueled engine; ensure no gasoline fumes are present before starting.

- Prevent Electric Shock

  Shut off electric power before accessing electrical equipment.

  Use insulated mats whenever working on electrical equipment.

  Make sure your clothing is dry, not damp (particularly shoes), and keep your skin surfaces dry when handling electrical equipment.

  Remove wristwatch and jewelry when working on electrical equipment.

  Do not connect utility shore power to vessel's AC circuits, except through a ship-to-shore double-throw transfer switch. Damage to vessel's AC generator may result if this is not done.

  Be extremely careful when working on electrical components. High voltage can cause injury or death.

- Exhaust Gases Are Toxic

  Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists.

  Be sure the unit and its surroundings are well-ventilated.

- Use Extreme Care When Handling Engine Fuel **(A constant danger of explosion or fire exists)**

  Do not fill fuel tank(s) while the engine is running.

  Do not smoke or use an open flame near the engine or the fuel tank.

- Do Not Alter or Modify the Fuel System

  Be sure all fuel supplies have a positive shut-off 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.

- Use Extreme Care When Servicing Batteries

  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 by 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.

- Avoid Moving Parts

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

  Do not wear loose clothing or jewelry when servicing equipment; avoid wearing loose jackets, shirts or sleeves, rings, necklaces, or bracelets that might be caught in moving parts.

  Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective place at all times.

  Do not check fluid levels or the drive-belt's tension while the unit is operating.

  Do not work on the equipment when mentally or physically incapacitated by fatigue.

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FOREWORD

Thank you for selecting a Westerbeke marine product for your use. We at Westerbeke are pleased to have you as a customer.

Read this manual carefully and observe all of the safety precautions indicated. Operating procedures, periodic preventive maintenance procedures, installation checks, system descriptions and minor adjustment procedures are included so you can operate your equipment safely and properly, maintain the equipment at a high level of efficiency, and expect dependable performance and long service life in return.

Product Software Disclaimer

Product software of all kind; such as brochures, drawings, technical data, operator's and workshop manuals, parts lists and parts price lists, and other information, instructions and specifications provided from sources other than Westerbeke, is not within Westerbeke's control and; accordingly, is provided to Westerbeke customers only as a courtesy and service. **Westerbeke cannot be responsible for the content of such software, makes no warranties or representations with respect thereto, including the accuracy, timeliness or completeness thereof, and will in no event be liable for any type of damages or injury incurred in connection with, or arising out of, the furnishing or use of such software.**

For example, components and subassemblies incorporated in Westerbeke's products and supplied by others (such as engine blocks, fuel systems and components, transmissions, electrical components, pumps and other products) are generally supported by their manufacturers with their own software, and Westerbeke must depend on such software for the design of Westerbeke's own product software. Such software may be outdated and no longer accurate. Routine changes made by Westerbeke's suppliers, of which Westerbeke rarely has notice in advance, are frequently not reflected in the supplier's software until after such changes take place.

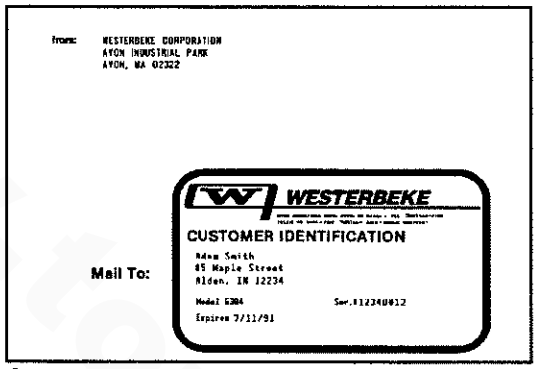
Westerbeke customers should also keep in mind the time span between printings of Westerbeke product software and the unavoidable existence of earlier, non-current, Westerbeke software editions in the field. Additionally, most Westerbeke products include customer-requested special features that frequently do not include complete documentation.

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 currency of the product software being consulted by the customer.

Warranty Procedures

Should your unit require special attention, contact your Westerbeke dealer for assistance. The Westerbeke Service Organization is trained to provide the support necessary to ensure long-term dependable performance.

If, within 60 days of submitting the Warranty Registration Form for your unit, you have not received a Customer Identification Card, shown below, registering your warranty, please contact the factory in writing with model information, including the unit's serial number and commission date.



Customer Identification Card

Unit I.D. Plates

For future service, repair or warranty reference, Westerbeke suggests that you fill in the blank spaces in the diagram below with the information from your machine.

Unit I.D. Plates

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GENERAL INFORMATION

Introduction

This manual contains the equipment operating procedures as well as additional information needed to help the operator keep the marine equipment in proper working order. Study and follow the instructions carefully. A planned maintenance program is included in this manual. Adhering to the program will result in better equipment performance and longer equipment life. Proper diagnosis of a problem is the most important step to satisfactory repair; therefore, a troubleshooting table is included.

Understanding the Diesel Engine

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

Therefore, to a great extent, a diesel engine requires the same preventitive maintenance as a gasoline engine. The most important factors are proper ventilation and proper maintenance of the fuel lubricating and cooling systems. Replacement of fuel and lubricating filter elements at the time periods specified is a must, and frequent checking for contamination (that is, water, sediment, or algae) in the fuel system is also essential. Another important factor is the use of the same brand of high detergent diesel lubricating oil designed specifically for diesel engines. Be careful not to put gasoline in the diesel fuel tank(s). Gasoline does not have the same lubricating qualities as diesel fuel; consequently, gasoline in the fuel lines will damage components in the fuel injection pump and fuel injectors.

The diesel engine does differ from the gasoline engine; however, in its handling and firing of fuel. The carburetor and ignition systems are done away with and it their place are two components - the fuel injection pump and the fuel injectors.

Protecting Your Investment

The five most important steps to insure long engine life are:

1. Proper installation. In particular, the use of an anti-siphon break to preclude raw water intrusion into the engine via the exhaust elbow is essential.
2. Avoid Overcranking. This can fill the engine with raw water .
3. Change the lubricating oil.
4. Maintain the cooling system.
5. Winterizing your Westerbeke product.

Ordering Parts

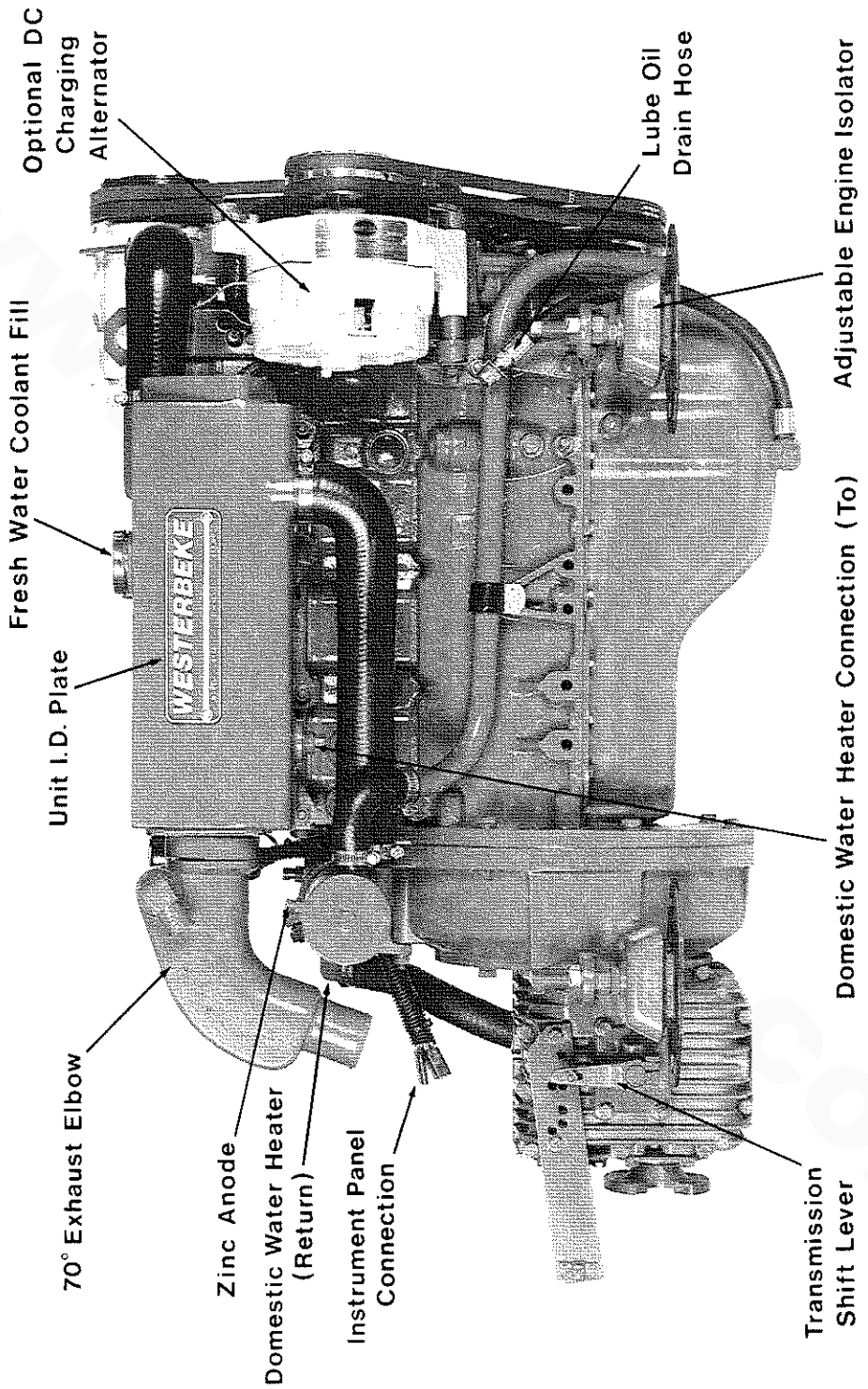
Whenever replacement parts are needed, always provide the generator model number designation (i.e. 63B FOUR), engine serial number, and generator serial number as they appear on the data plates located on the exhaust manifold and on the generator end. You *must* provide us with this information so we may properly identify your generator set. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). Also, be sure to insist upon Westerbeke factory packaged parts because "will fit" or generic parts are frequently not made to the same specifications as original equipment.

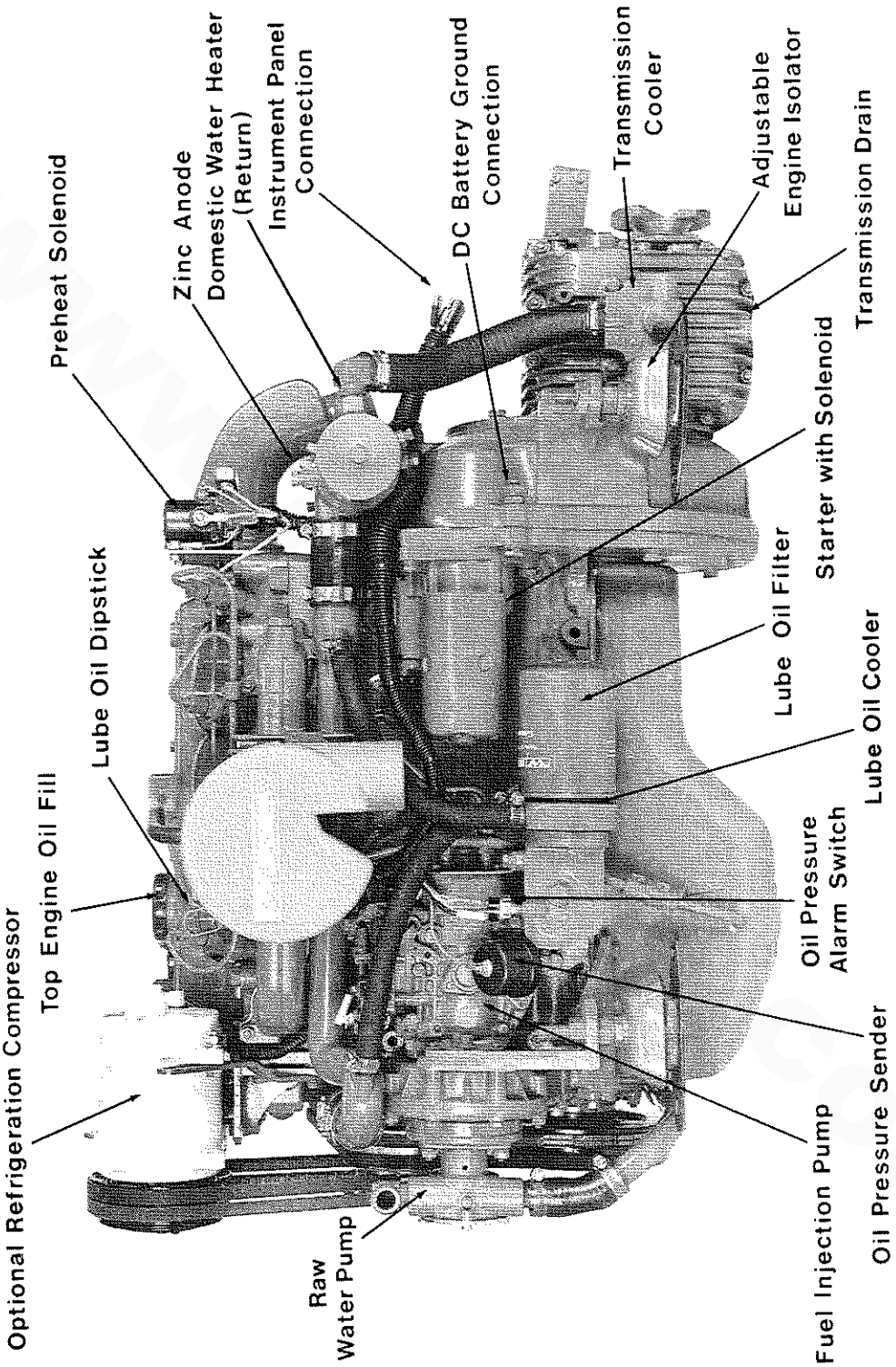
General Information (continued)

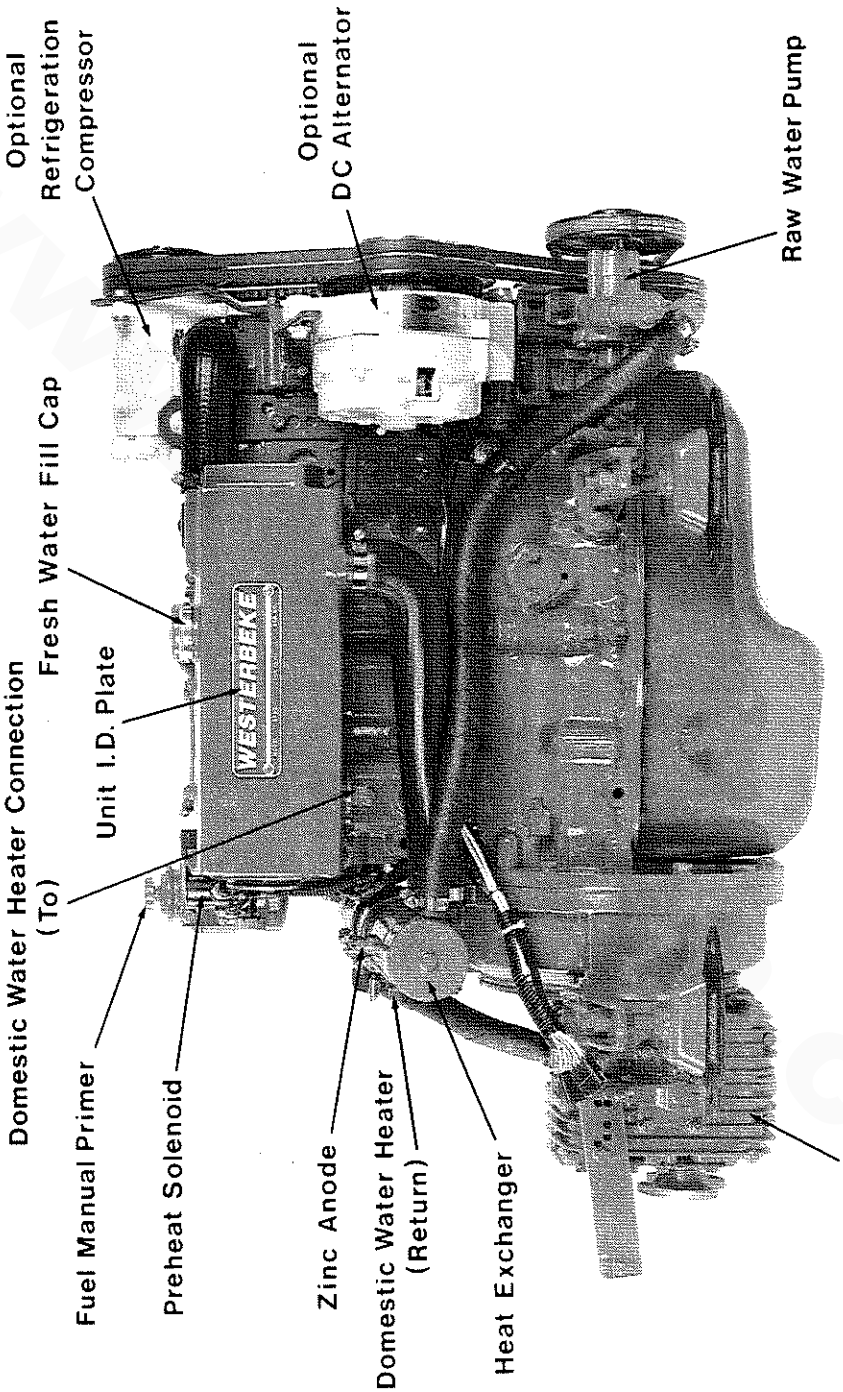
Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/generator end is the rear end.) Left and right sides are deteremined by the engine; imagine straddling the engine and facing in the same direciton as the front of the engine: the left side is at your left, the right side is at your right.

Westerbeke generator sets are thoroughly checked and given a final run under various load conditions before leaving the factory. Test running the generator ensures dependable operation, long service life, and a satisfied owner.

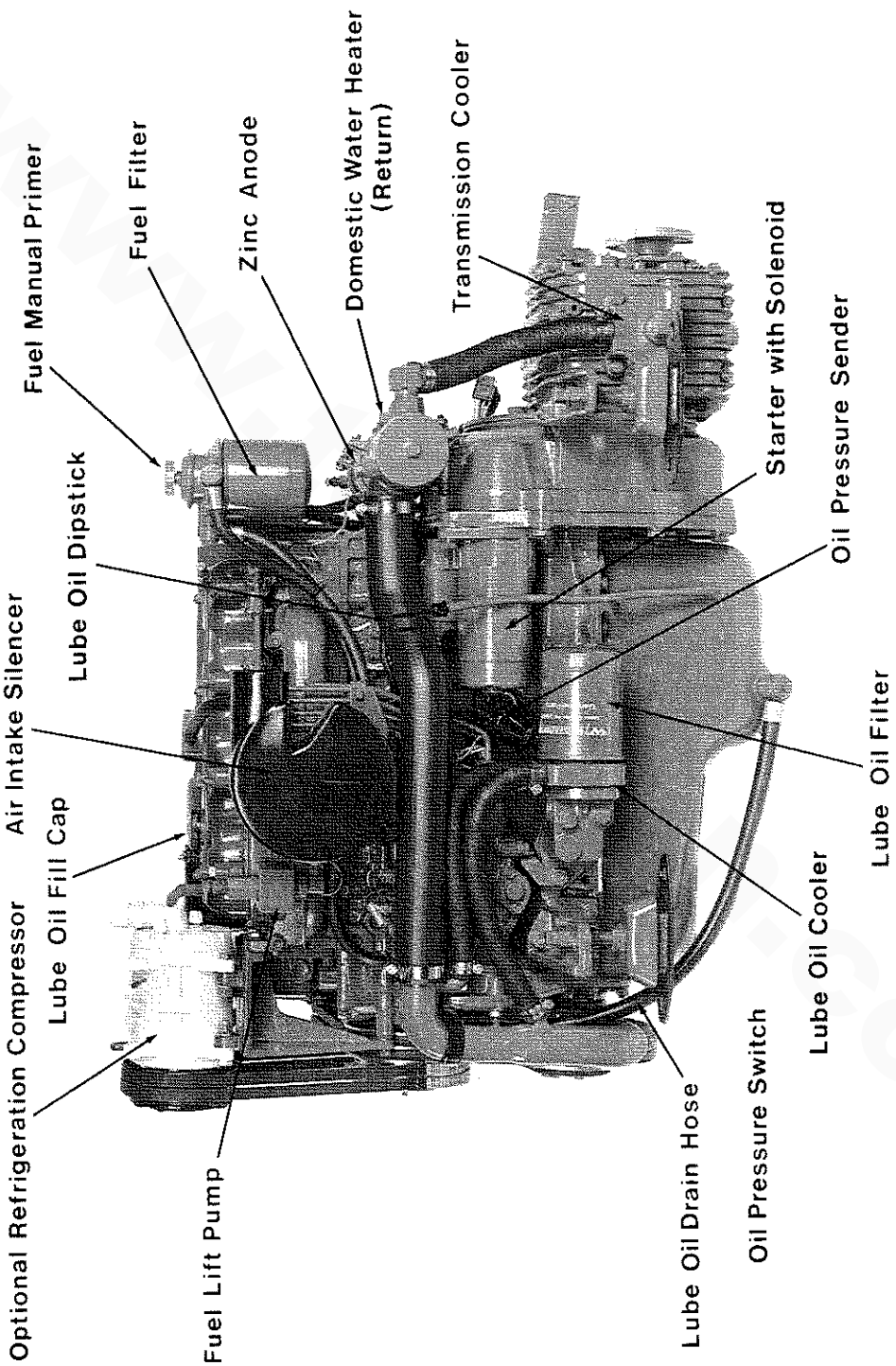
Care at the factory during assembly and thorough testing have resulted in a Westerbeke diesel engine-driven generator capable of many thousands of hours of dependable service. However, what the manufacturer cannot control is the manner or location the generator is installed in the vessel or the manner in which the unit is operated and serviced in the field. That part is up to the buyer/owner-operator.

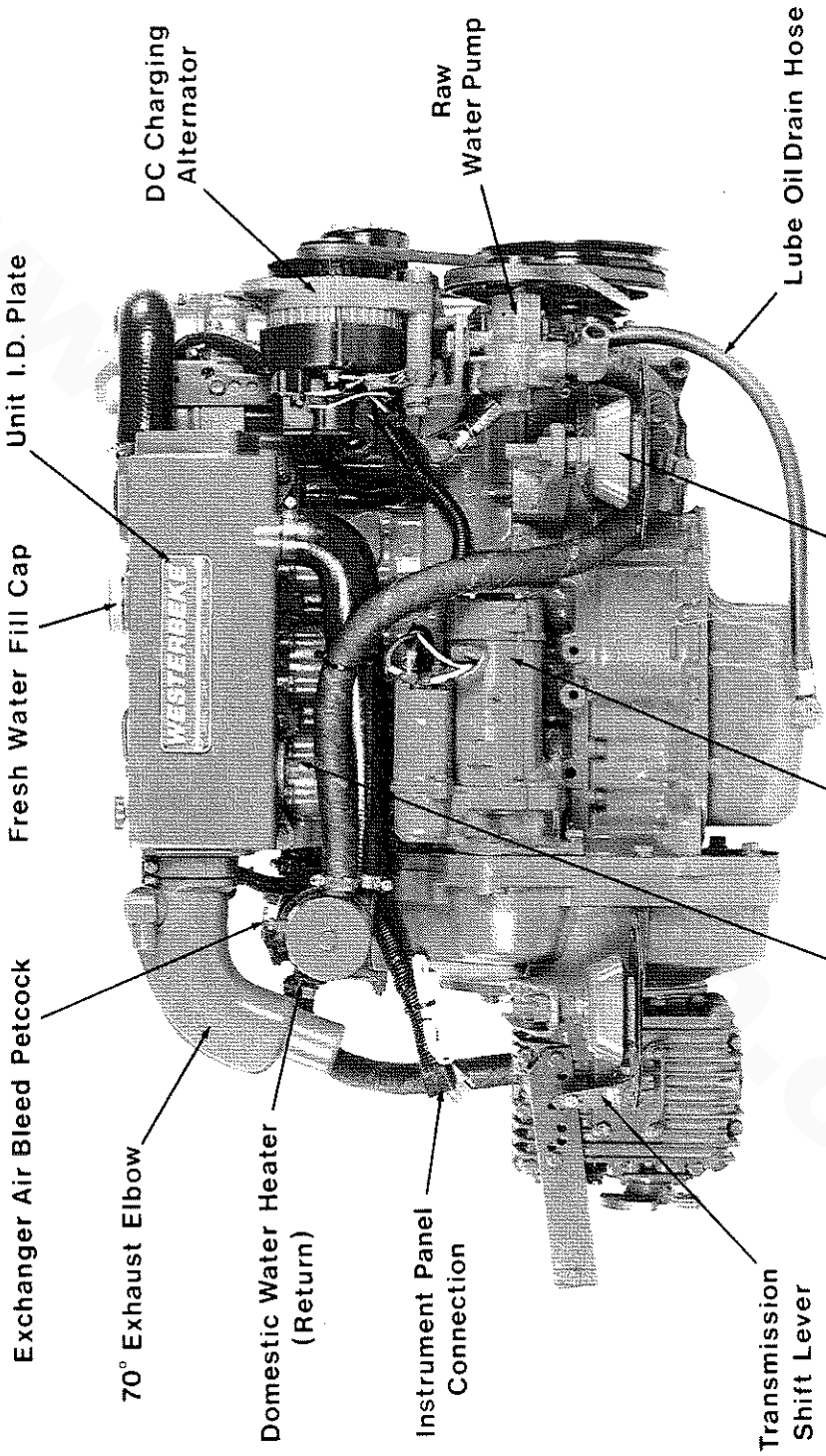






71 B FOUR





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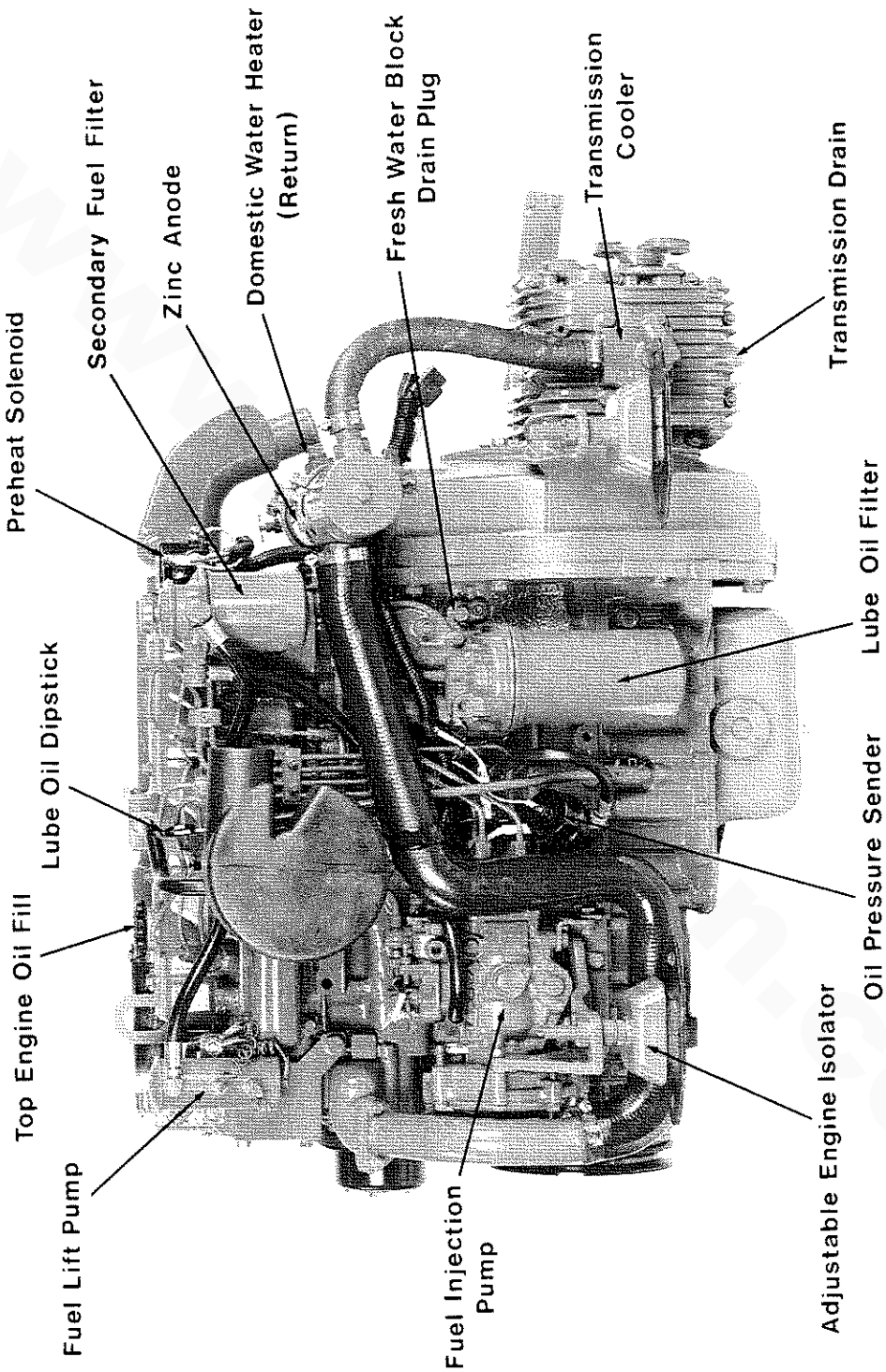

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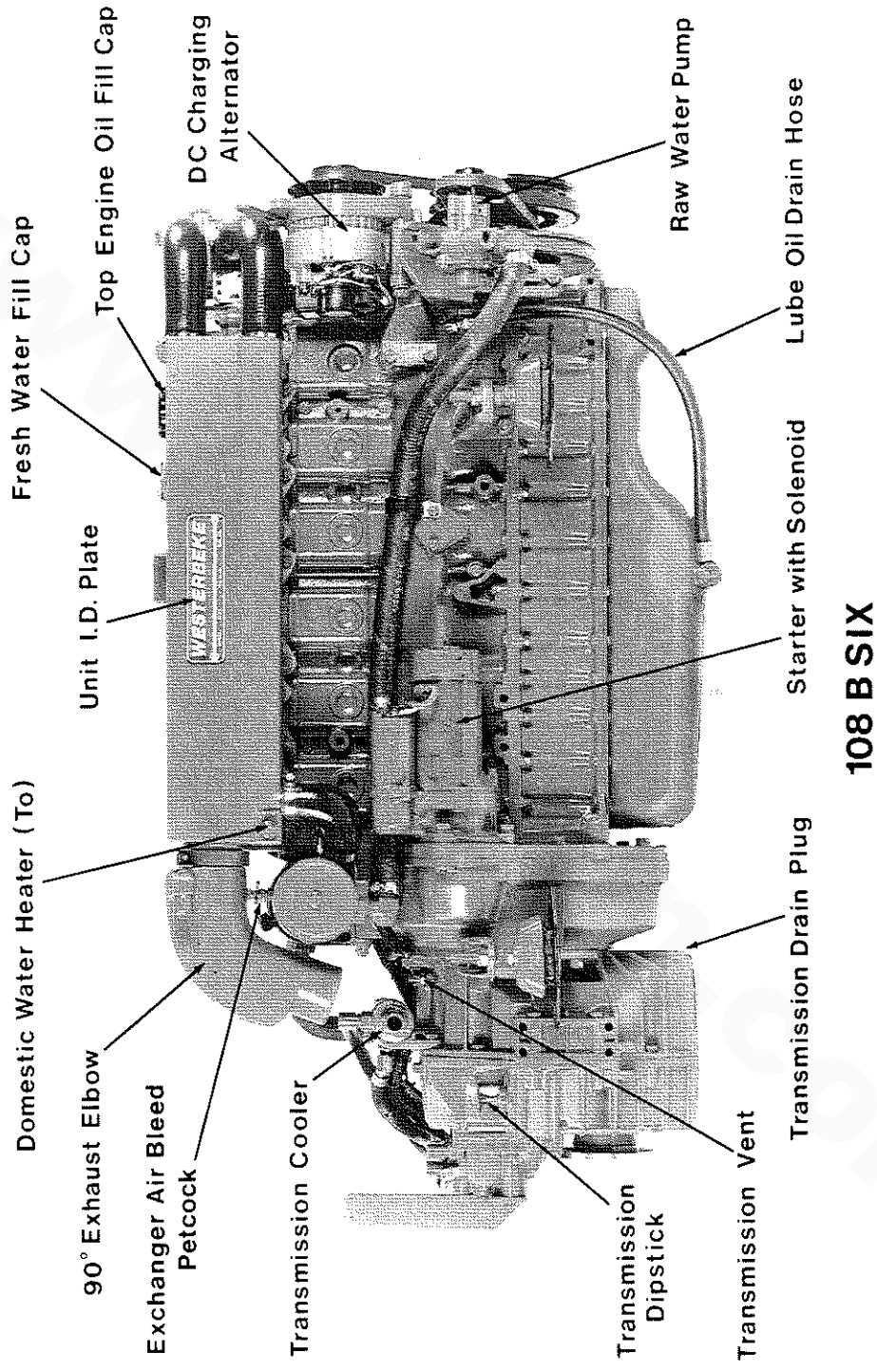
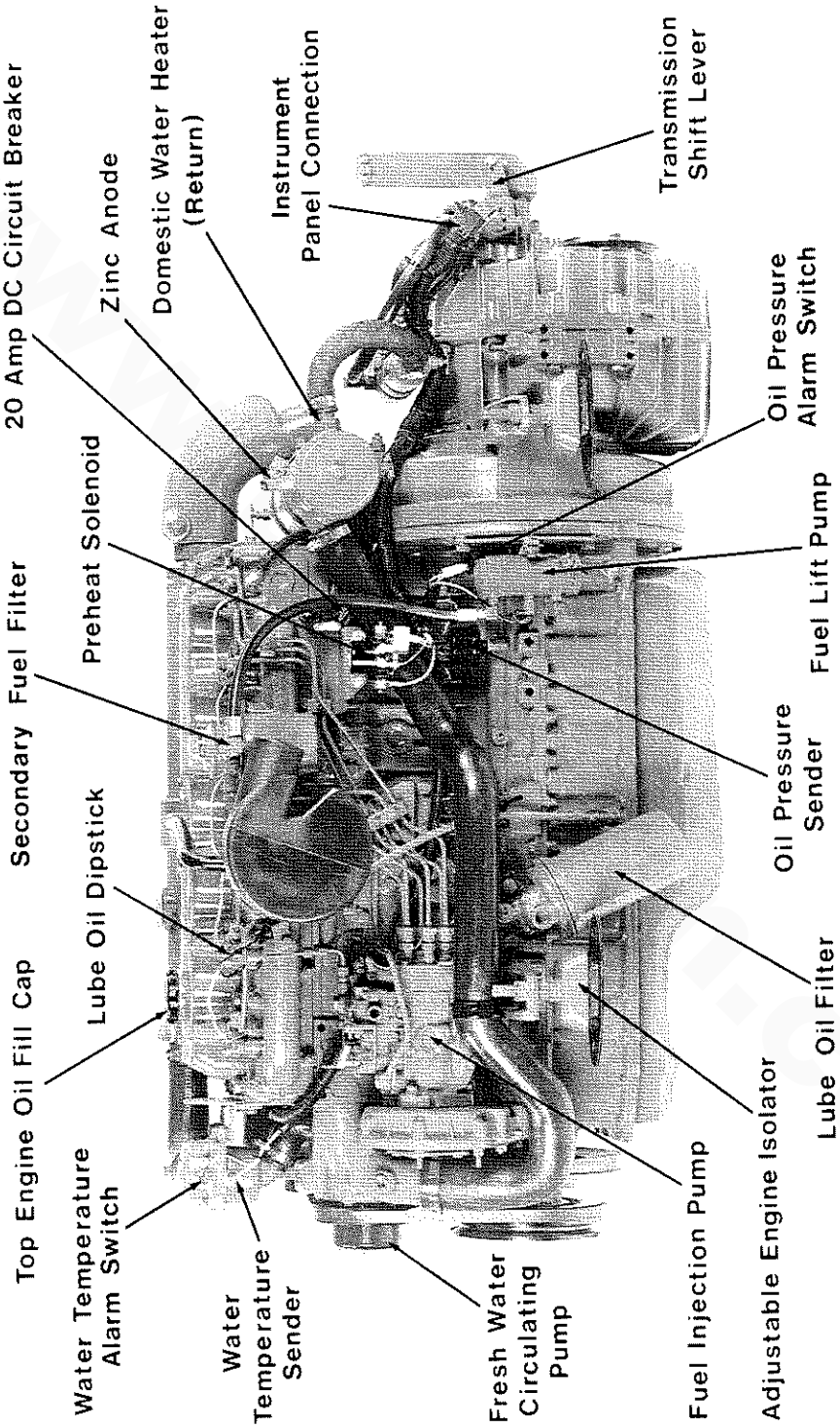




63(B) & (C) Four Marine Diesel Engine General Specifications

Engine Type	Diesel, four-cycle, fresh water-cooled, vertical, in-line (63 hp at 3600 rpm maximum)
Governor	Integral of the injection pump, mechanical flyweight type.
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.50 × 3.51 inches (88.9 × 89.9 mm)
Piston Displacement	134.8 cubic inches (2.21 liters)
Firing Order	1 - 3 - 4 - 2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2900 rpm)	93 lb-ft (10.92 kg-m)
Compression Ratio	21:1
Compression Pressure	427 psi (30.0 kg/cm^2) at 200 rpm
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.12 inches (0.3 mm) Exhaust 0.012 inches (0.3 mm)
Dimensions	Height: 25.30 inches (642.6 mm) Width: 21.19 inches (538.2 mm) Length: 38.75 inches (984.3 mm)
Inclination	Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	611 lbs (192 kgs)
Engine Speed	Idle speed: 750 - 1000 rpm Cruising speed: 2500 - 3000 rpm
Fuel Consumption	1.2 US gph (4.5 lph) running at 2500 rpm (approximate) when the propeller allows 3600 rpm at full open throttle while underway in forward gear.

63(B) & (C) Four Marine Diesel Engine General Specifications (Continued)

Fuel System

Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injection Pump	Diesel KIKI Mechanical Governed
Injection Timing	0° TDC
Nozzle	Throttle type
Injection Pressure	1920 psi (135 kg/cm^2)
Lift Pump	12 volt plunger type
Fuel Filter (on engine)	Spin-on (replaceable)
Air Cleaner	Metal screen type-cleaner
Air Flow (engine combustion) (engine cooling)	140 cfm (3.9 cmm) at 3600 rpm 250 cfm (7.0 cmm)

Cooling System

General	Fresh water-cooled block, thermostatically-controlled with sea water exchanger system.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	12.0 gpm (45.4 lpm) approximate
System Capacity (fresh water)	10 U.S. qts. (9.9 liters)

Lubrication System

General	Pressure feed, rotor type, driven by spiral gears from camshaft
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity	5.3 U.S. qts. (5.0 liters) not including filter
Operating Oil Pressure	30 - 60 psi (2.1 - 4.2 kg/cm^2) at maximum engine rpm and at normal operating temperature.
Oil Grade	API specification CC or CD

63(B) & (C) Four Marine Diesel Engine General Specifications (Continued)

Electrical System	
Starting Battery	12-Volt, (-) negative ground (recommended)
Battery Capacity	300 - 400 cold cranking amp (CCA)
Starter Motor	12-volt, 1.6KW, solenoid, actuated shift reduction geared
Starting Aid	Glow plugs
DC No-Load Current	100 Amps at 11.5 volts (3000 rpm, min)
Cold Cranking Current	280 - 300 Amps at 10 volts (250 rpm, min)
Alternator	12-volt DC, 50 Amps
Regulator	Internal regulator, built into alternator
Transmission	
General	(Hurth Standard Transmission) Case-hardened helical gears, with servo-operated multiple disc clutch
Gear Ratio (Standard)	2.7 : 1
Propeller Shaft, Direction of Rotation	Right handed - standard transmission
Propeller Recommendations (using standard transmission 2.7:1 reduction)	20 D x 14 P-2 blade or 18 D x 16 P-3 blade. Propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway
Lubricating Fluid	ATF - type A or Dextron II
Transmission Sump Capacity	0.79 U.S. qts (0.75 liters approximate) (Fill to "Full" mark on dipstick)
Exhaust	
Exhaust elbows	90° Elbow, 45° Elbow and Exhaust riser
Hose Size	2 inch I.D. hose

71B Four Marine Diesel Engine General Specifications

Engine Type	Diesel, four-cycle, four-cylinder, fresh water-cooled, vertical, in-line (71 hp at 3600 rpm maximum)
Governor	Intergral of the injection pump, mechanical flyweight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.50 x 4.0 inches (88.9 x 101.6 mm)
Piston Displacement	154.0 cubic inches (2.5 liters)
Firing Order	1-3-4-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2200 rpm)	118 lb-ft (16.31 kg-m)
Compression Ratio	21:1
Compression Pressure	427 psi (30 kg/cm^2) at 200 rpm
Valve Seat Angle	Intake 45°, Exhaust 30°
Valve Clearance (engine cold)	Intake 0.012 inches (0.3 mm) Exhaust 0.012 inches (0.3 mm)
Dimensions	Height: 26.9 inches (684.2 mm) Width: 22.2 inches (563.6 mm) Length: 39.5 inches (1003.3 mm)
Inclination	Continuous 14°, Temporary 25° (not to exceed 30 min.)
Dry Weight	652 lbs (295.9 kgs)
Engine Speed	Idle speed: 750 - 1000 rpm Cruising speed: 2500 - 3000 rpm
Fuel Consumption	1.4 U.S. gph (5.2 lph) running at 2500 rpm (approximate) when the propeller allows 3600 rpm at full open throttle while underway in forward gear.

71B Four Marine Diesel Engine System Specifications

Fuel System

Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injection Pump	Diesel KiKi mechanical governed
Injection Timing	0° TDC
Injectors	Throttle type
Injection Pressure	1920 psi (135 kg/cm^2)
Lift Pump	12 volt - plunger type
Fuel Filter (on engine)	Spin-on type (replaceable)
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	160.4 cfm (4.5 cmm) at 3600 rpm

Cooling System

General	Fresh water cooled block, thermostatically-controlled with sea water exchanger system
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	10 gpm (37.8 lpm) approximate
System Capacity (fresh water)	11.5 U.S. qts (10.9 liters)

Lubrication System

General	Pressure feed, rotor type, driven by sprial gears from camshaft
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity	6.3 U.S. qts (6.0 liters) not including filter
Operating Oil Pressure	30 - 60 psi (2.1 - 4.2 kg/cm^2) at maixmum engine rpm and at normal operating temperature
Oil Grade	API specification CC or CD

71B Four Marine Diesel Engine System Specifications (continued)

Electrical System	
Starting Battery	12-Volt, 125 AH, (-) negative ground (recommended) (150 A-H cold areas)
Battery Capacity	125 - 155 (Ampere-Hours)
Starter Motor	12-Volt, 1.6KW, solenoid, actuated shift reduction gear
Starting Aid	Glow plug
DC No-Load Current	100 Amps at 11.5 Volts (3000 rpm, min.)
Cold Cranking Current	250 - 300 Amps at 10 Volts (250 rpm, min.)
Alternator (Standard)	12-Volt DC, 50 Amps
Regulator	Internal regulator, built into alternator
Transmission	
General	(Hurth Standard Transmission) Case-hardened helical gears, with a servo-operated multiple disc clutch.
Gear ratio (Standard)	2.7:1
Propeller Shaft Direction of Rotation	Right handed - standard transmission
Propeller Recommendations (using standard transmission 2.7:1 reduction)	20 D x 14 P - 2 blade or 20 D x 12 P - 3 blade propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway in forward gear.
Lubricating Fluid	ATF - type A Dextron II
Transmission Sump Capacity	0.79 U.S. qts (0.75 liters) approximate
Exhaust	
Exhaust Elbow	70° elbow
Exhaust Hose Size	2 inch I.D. hose

82B Four Marine Diesel Engine General Specifications

Engine Type	Diesel, four-cycle, four-cylinder, fresh water cooled, vertical, in-line (82 hp at 3600 rpm maximum)
Governor	Integral of the injection pump, mechanical flyweight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.74 X 4.13 inches (95 X 105 mm)
Piston Displacement	18.2 cubic inches (2.977 liters)
Firing Order	1-3-4-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (2200 rpm)	147 lb-ft (20.4 kg-m)
Compression Ratio	21:1
Compression Pressure	427 psi (30..0 kg/cm^2) at 200 rpm
Valve Seat Angle	Intake 45°, Exhaust 30°
Valve Clearance (engine cold)	Intake 0.012 inches (0.3 mm) Exhaust 0.012 inches (0.3 mm)
Dimensions	Height: 27.3 inches (694.0 mm) Width: 23.3 inches (590.6 mm) Length: 38.8 inches (985.8 mm)
Inclination	Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	678 lbs (307.5 kgs)
Engine Speed	Idle speed: 750-1000 rpm Cruising speed: 2500-3000 rpm
Fuel Consumption	1.6 U.S. gph (6.1 lph) running at 2500 rpm (approximate) when the propeller allows 3600 rpm at full open throttle while underway in forward gear

82B Four Marine Diesel Engine System Specifications

FUEL SYSTEM

Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injeciton Pump	Diesel Kiki
Injection Timing	0° TDC (Static Timing)
iInjectors	Throttle
Injection Pressure	1920 psi (135 kg/cm^2)
Lift Pump	12 Volt plunger tyupe
Fuel Filter (on engine)	Spin-on (replaceable)
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion) (engine cooling)	189.5 cfm (5.3 cmm) at 3600 rpm 250 cfm (7.0 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, Thermostatically-controlled with sea water exchanger system
Operating Temperature	170-190° F (77-88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	14 gpm (53 lpm) approximate
System Capacity (fresh water)	13 U.S. qts (12.3 liters)

LUBRICATING SYSTEM

General	Pressure feed, rotor type, driven by sprial gears from camshaft
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity	6.3 U.S. qts (6.0 liters) not including filter

82B Four Marine Diesel Engine System Specifications (continued)

Operating Oil Pressure	30-60 psi (2.1-4.2 kg/cm^2) at maximum engine rpm and at normal operating temperature
Oil Grade	API Specification CC or CD
ELECTRICAL SYSTEM	
Starting Battery	12-Volt, 125 A-H, (-) negative ground (recommended) (150 A-H cold areas)
Battery Capacity	125-155 (Ampere-Hours)
Starting Aid	Glow plugs
Starter Motor	12-Volt, 3.0KW, solenoid, actuated shift, reduction gear
DC No-Load Current	100 Amps at 11.5 volts (3000 rpm, min.)
Cold Cranking Current	250-300 Amps at 10 Volts (250 rpm, min.)
Alternator (Standard)	12-Volt DC, 51 Amps
Regulator	Internal regulator, mounted on alternator
TRANSMISSION	
General	(Hurth Standard Transmission) Case-hardened helical gears, with servo-operated multiple disc clutch
Gear Ratio (Standard)	2.04:1
Propeller Shaft	Right handed - standard transmission
Propeller Recommendations (using strandard Transmission 2.0:1 reduction)	20 D X 12 P-2 blade or 20 D X 10 P-3 blade propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway in forward gear
Lubricating Fluid	ATF-type A or Dextron II
Transmission Sump Capacity	0.79 U.S. qts (0.75 liters) approximate
EXHAUST	
Exhaust Elbow	70° elbow
Exhaust Hose Size	2 inch I.D. hose

108(B) & (C) Four Marine Diesel Engine General Specifications

Engine Type	Diesel, four-cycle, fresh water-cooled, vertical, in-line (108 hp at 3600 rpm maximum)
Governor	Integral of the injection pump, mechanical flyweight type.
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	3.62 × 3.40 inches (91.9 × 101.6 mm)
Piston Displacement	247.2 cubic inches (4.05 liters)
Firing Order	1 - 5 - 3 - 6 - 2 - 4
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2900 rpm)	188 lb-ft (26.0 kg-m)
Compression Ratio	21:1
Compression Pressure	427 psi (30.0 kg/cm^2) at 200 rpm
Valve Seat Angle	Intake 45° Exhaust 30°
Valve Clearance (engine cold)	Intake 0.12 inches (0.3 mm) Exhaust 0.012 inches (0.3 mm)
Dimensions	Height: 29.3 inches (742.9 mm) Width: 26.9 inches (682.6 mm) Length: 53.3 inches (1353.8 mm)
Inclination	Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	932 lbs (422.8 kgs)
Engine Speed	Idle speed: 750 - 1000 rpm Cruising speed: 2500 - 3000 rpm
Fuel Consumption	2.1 US gph 7.9 lph) running at 2500 rpm (approximate) when the propeller allows 3600 rpm at full open throttle while underway in forward gear.

108(B) & (C) Four Marine Diesel Engine General Specifications (Continued)

Fuel System

Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injection Pump	Diesel KIKI Mechanical Governed
Injection Timing	0° TDC
Nozzle	Throttle type
Injection Pressure	1920 psi (135 kg/cm^2)
Lift Pump	12 volt plunger type
Fuel Filter (on engine)	Spin-on (replaceable)
Air Cleaner	Metal screen type-cleaner
Air Flow (engine combustion) (engine cooling)	257 cfm (7.9 cmm) at 3600 rpm 250 cfm (7.0 cmm)

Cooling System

General	Fresh water-cooled block, thermostatically-controlled with sea water exchanger system.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, gear-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	14.0 gpm (53 lpm) approximate
System Capacity (fresh water)	16 U.S. qts. (15.1 liters)

Lubrication System

General	Pressure feed, rotor type, driven by spiral gears from camshaft
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity	11.9 U.S. qts. (11.3 liters) not including filter
Operating Oil Pressure	30 - 60 psi (2.1 - 4.2 (135 kg/cm^2) at maximum engine rpm and at normal operating temperature.
Oil Grade	API specification CC or CD

108(B) & (C) Four Marine Diesel Engine General Specifications (Continued)

Electrical System	
Starting Battery	12-Volt, (-) negative ground (recommended)
Battery Capacity	400 - 500 cold cranking amp (CCA)
Starter Motor	12-volt, 1.6KW, solenoid, actuated shift reduction geared
Starting Aid	Glow plugs
DC No-Load Current	100 Amps at 11.5 volts (3000 rpm, min)
Cold Cranking Current	250 - 300 Amps at 10 volts (250 rpm, min)
Alternator	12-volt DC, 50 Amps
Regulator	Internal regulator, built into alternator
Transmission	
General (Hurth Standard Transmission)	Case-hardened helical gears, with servo-operated multiple disc clutch
Gear Ratio (Standard)	2.04 : 1
Propeller Shaft, Direction of Rotation	Right handed - standard transmission
Propeller Recommendations (using standard transmission 2.7:1 reduction)	20 D x 12 P-2 blade or 20 D x 10 P-3 blade. Propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway
Lubricating Fluid	ATF - type A or Dextron II
Transmission Sump Capacity	0.79 U.S. qts (0.75 liters approximate) (Fill to "Full" mark on dipstick)
Exhaust	
Exhaust elbows	70° Elbow
Hose Size	3 inch I.D. hose

NOTES

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

INSTALLATIONS and INSTALLATION CHECKS

General

Since the boats in which Westerbeke engines are installed vary in design, installation procedures will vary according to your craft's specific design. The intent of this section is not to advise boatyards or installers on procedures already well-developed and well-understood. However, the owner/operator must realize there are details of the installation which require periodic checks to ensure the best operating conditions for the equipment and safe operating conditions for the personnel on board. Proper location and installation of the diesel engine in the vessel are of prime importance.

Factors in the installation that must be considered are; (**1**) ventilation, to aid in cooling and to provide air for engine combustion, (**2**) the exhaust system, to properly discharge raw cooling water, to guiet the exhaust and to expel exhaust gas, (**3**) the cooling water supply, (**4**) the fuel supply, (**5**) the electrical connections and (**6**) the transmission/propeller connections.

CAUTION

For safety reasons, the engine is **not** filled with lubricating oil for shipment. Before leaving the factory, however, each engine and transmission is thoroughly tested with oil. This testing, among other things, provides all internal parts with a coating of oil. This oil acts as a preservative, providing reliable protection against corrosion for at least one year if the engine and transmission is properly stored.

Inspection of Equipment

The engine is shipped from the factory securely mounted and properly crated. Accessory equipment is shipped in a separate small box, usually packed within the engine's crate.

Before accepting shipment of the engine from the transportation company, the crate should be opened and the contents inspected for concealed damage. If either visible or concealed damage is noted, you should require the delivery agent sign "Received in damaged condition" on the proper delivery receipt. Also check the contents of the shipment against the packing list and make sure that the proper notation is made if any discrepancies exist. These noted discrepancies are your protection against loss or damage. Claims concerning loss or damage *must* be made to the *carrier*, **not** to Westerbeke Corporation.

Please note that the engine's installation angle cannot exceed 14° from the horiziontal plane.

Rigging and Lifting

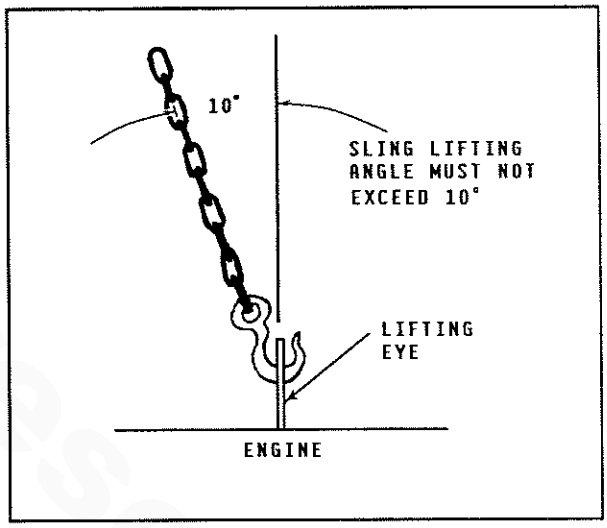
The engine is fitted with lifting eyes. Rope or chain slings capable of supporting the engine's weight should be attached to the eyes and the engine lifted by means of tackle attached to these slings. The lifting eyes have been designed to carry the full weight of the engine; therefore, auxiliary slings are not required or desired.

CAUTION

Slings must **not** be so short as to place significant stress on the engine's lifting eyes. Strain placed on the engine's lifting eyes by the lifting sling must **not** be in excess of 10° from the vertical plane.

The general rule in moving engines is to see that all equipment used is amply strong and firmly fixed in place. Move the engine a little at a time and see that it is firmly supported. Eliminate the possibility of accidents by avoiding haste. **Do not** lift the engine by its crankshaft pulley.

In certain situations it may be necessary to lift the engine in positions other than the horizontal position. Certain situations exist by which the engine must be lowered endwise through a small hatchway which cannot be made larger. Under these conditions, if the opening of the hatchway is extremely small, it is possible to reduce, to some extent, the outside dimensions of the engine by removing external components such as the cooling system's piping, the heat exchanger, certain filters, the mounting rails and other obstructive equipment. This accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damage to any exposed parts. In addition, be careful not to allow dirt to enter any opening created by the removal of equipment. Removed parts should be returned to their respective position once the engine is in its installation area. Replace gaskets as needed for the parts that were removed.



In case it becomes necessary to hoist the engine front-end upwards or transmission-end upwards, the attachment of lifting slings must be done *carefully* to avoid the possibility of damaging the parts on which the weight of the slings may bear. Special rigging work is best done by someone experienced and competent in handling heavy machinery.

Engine Bolts

Bronze or stainless steel hanger bolts of appropriate size are recommended for use through the engine's flexible mounts. Less preferred are lag screws because their hold on the wood is weakened every time they are moved, whereas the hanger bolts stay in position. If the nut on top of the hanger bolt is removed to allow the engine to be lifted from its resting place, the hanger bolt itself remains in place as a stud. Consequently, the bond between the hanger bolt and the wood or fiberglass is not weakened by the removal of the nut or the engine.

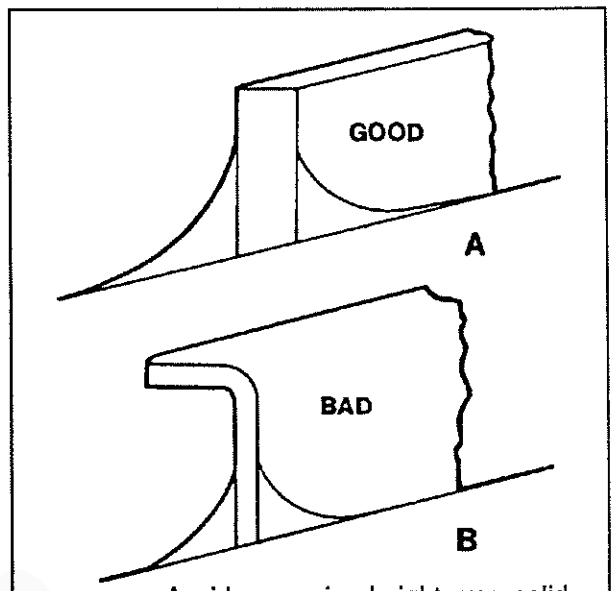
Foundation for the Engine

A good engine bed contributes much toward the satisfactory operation of the engine. The engine's bed must be rigidly constructed and neither deflect nor twist when it is subjected to the engine's weight or to the pressures that the boat may experience while operating in rough seas. The bed must keep the engine's alignment within one or two thousandths of an inch of this position at all times. The bed has to withstand the forward push of the propeller shaft which pushes against the thrust washer bearing which finally pushes against the engine's bolts and bed.

In fiberglass hulls, we recommend that similar wooden stringers as in wooden hulls be formed and fitted, then glassed securely to the hull. This allows the hanger bolts to be installed firmly in the wood, thereby reducing noise and transmitted vibration.

The engine support stringers must be as wide or wider than the engine mounting isolator. Isolator overhang and/or rounded stringer surfaces are detrimental to the isolators' ability to retain vibration.

Preformed fiberglass engine beds, when used, should be of sufficient thickness to properly support the engine and should be well-glassed to the hull when installed.



Avoid excessive height, use solid stringer construction (A).

The temptation to install the engine on a pair of fiberglass angle irons must be resisted. Such construction will allow engine vibration to pass through to the hull. Flexible mounts require a firm foundation against which they must act if they are to perform their function. When possible, follow bed design **A** and avoid bed design **B** (refer to the illustration).

Supports between the bed stringers, and extending from the stringers to the hull, may be required for proper support and to aid in the absorption of vibrations.

Propeller Shaft Coupling

The propeller shaft coupling fitted to the transmission's output flange must transmit not only the power of the engine to turn the propeller shaft and propeller, but must also transmit the thrust of the engine/transmission either ahead or astern.

The coupling should be carefully machined for a slight forced fit onto the shaft and an accurate mating surface for the coupling to the output flange of the transmission.

For all engine models, a propeller half-coupling, bored to shaft size for the specific order, is supplied. The coupling either has a keyway with set screws or is of the clamping type.

The forward end of the propeller shaft has a long straight keyway. Any burrs should be removed from the shaft's end. The coupling should be a light drive fit on the shaft and the shaft should not have to be scraped down or filed in order to get a fit. It is important that the key be properly fitted both to the shaft and to the coupling. The key should fit the side of the keyway closely, but should not touch the top of the keyway in the hub of the coupling.

If driving the coupling over the shaft is difficult, the coupling can be expanded by heating it in a pail of boiling water. The face of the propeller coupling must be exactly perpendicular to the centerline or axis of the propeller shaft.

Propeller

The type and size of propeller varies with the gear ratio and must be selected to fit the application, based upon boat tests. To utilize the full power of the engine, and to achieve ideal loading conditions, use a propeller which will permit the engine to reach its full rated RPM at full throttle while under a normal load and while it is moving the boat forward through the water.

Alignment of the Engine

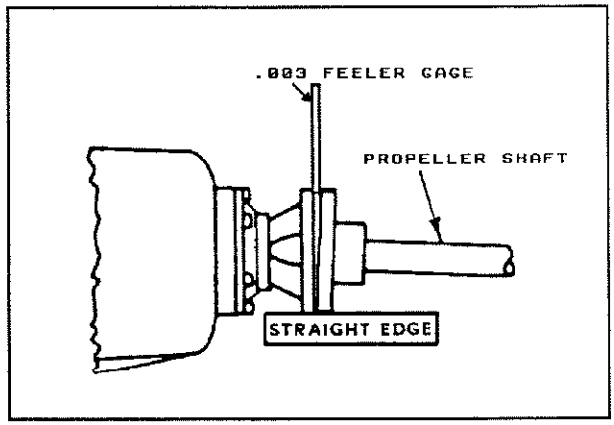
The engine must be exactly aligned with the propeller shaft in the proper fashion. No matter what material is used to build a boat the material will be found to be flexible to some extent; hence, the boat's hull will change its shape to a greater extent than is usually realized when the boat is launched and operated in the water. Therefore, it becomes extremely important to check the engine's alignment at frequent intervals and to correct any errors when they appear.

Misalignment between the engine and the propeller shaft often creates serious problems which are often blamed on other areas suspected of causing the trouble. Misalignment will cause excessive bearing wear, rapid shaft wear and will, in many cases, reduce the life of the boat's hull by loosening the hull's fastenings. A bent propeller shaft will have the exact effect as those just stated; therefore, a perfectly straight propeller shaft is absolutely necessary. One particularly annoying result of misalignment may be leakage of transmission oil through the transmission's rear oil seal. If oil is leaking from this seal, check and make sure that the alignment is within the limits prescribed below.

Never attempt a final alignment with the boat on land. The boat should be in the water and have had an opportunity to assume its final water form. The best time to perform the propeller shaft/transmission coupling alignment is with the fuel and water tanks about half full and all the usual equipment on board, and after the main mast has been stepped and the final rigging has been accomplished.

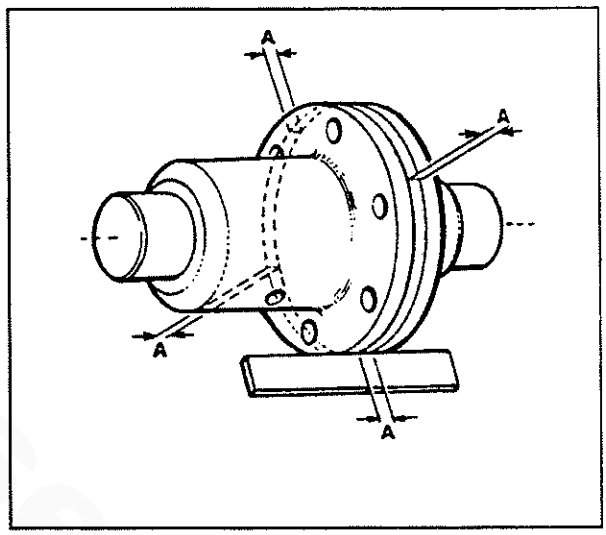
Take plenty of time in making this alignment and do not be satisfied with anything less than perfect results.

The alignment is correct when the shaft can be easily slipped backward and forward into the counterbore, and when a feeler gauge indicates that the flanges come together at all points. The alignment between the propeller shaft coupling and the engine's coupling can contain an error no greater than one thousandth of an inch per inch of the coupling diameter. For example,
if your propeller shaft coupling is three inches in diameter, the maximum error that can be allowed in the alignment is three thousandths of an inch (.003).



Engine -Propeller Alignment

In making the final check for alignment, the engine's half coupling should be held in one position and the alignment with the propeller coupling tested with the propeller coupling in each of four positions (**A**), while rotated 90° between each position. This test will also check whether the propeller's half-coupling is in exact alignment on its shaft. Then, keeping the propeller coupling in one position, the alignment should be checked by rotating the engine's half-coupling in 90° increments, checking dimension **A** while in each 90° position until the half-coupling has been rotated full circle.



Alignment Testing

The engine's alignment should be rechecked after the boat has been in service for one to three weeks and, if necessary, perform the alignment again. Usually it will be found that the engine is no longer in alignment. This does not mean that the work has been done improperly at first; rather, it means that the boat has taken some time to take its final shape and that the engine's bed and stringers have probably absorbed some moisture. It may even be necessary to realign the coupling halves again at a later time.

Fuel System

The fuel system should be installed in such a manner as to allow the engine-mounted fuel pump to maintain a positive inlet pressure to the injection pump under all operating conditions. The minimum size of the fuel supply line and fuel return line is 1/4 inch, inside diameter, and there should be a primary fuel filter installed between the fuel tank and the fuel pump. Only one fuel filter is installed on the engine, between the fuel pump and the injection pump; this filter has a replaceable filter element.

The fuel tank's fuel pickup tube should be clear and unobstructed. No screens or gauze strainers should be incorporated in the fuel pickup tube.

Make sure that the fuel supply and return lines are securely anchored to prevent chafing and that all fittings are sufficiently tightened to prevent leaking. Also, Make sure your fuel system has a positive shut-off valve; know its location and how it operates.

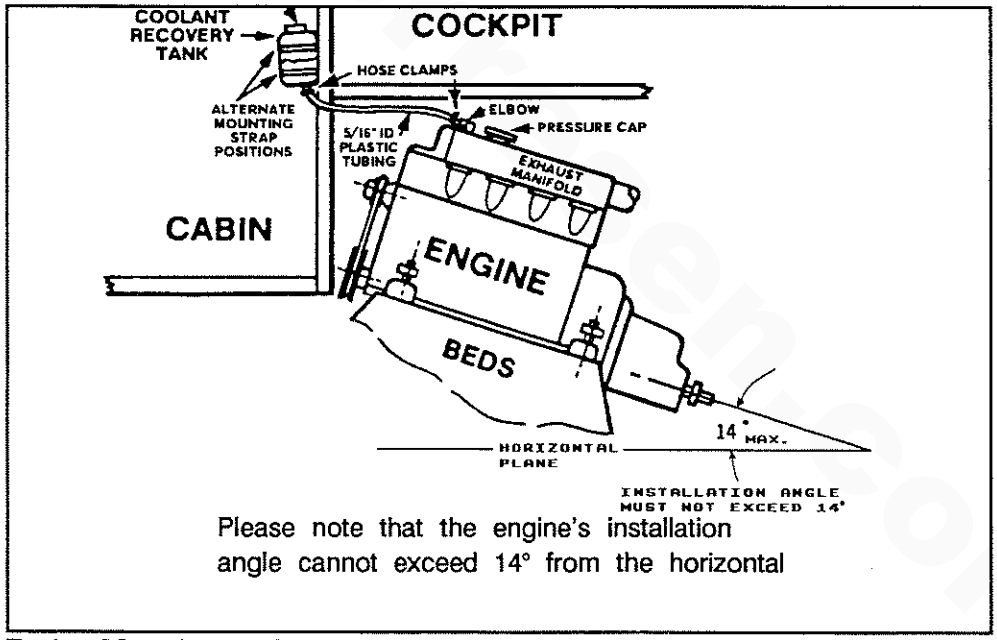
Ventilation

The ventilation requirements of the engine include the following: combustion air is required for the engine cylinders; cooling air is required for the engine and also for removing the heat produced during operation; and ventilating air is required to clear the bilges, as well as the compartment in which the engine is located, of potentially toxic and flammable diesel vapors.

Keep in mind that hot air rises, so heated air should be removed from the upper area of the engine compartment and cool fresh air should be directed to the lower areas of the compartment. Ventilation should be accomplished with the aid of blowers especially when the vessel is not underway.

NOTE: DO NOT use spring-loaded check valves in the fuel supply line in lieu of mechanical shut-off valves. This type valve can create fuel starvation problems for the engine's fuel system.

Fuel tanks that are located below the engine's fuel system level *must* have their fuel return connection at the tank extending down into the tank in the same manner as the pickup tube; otherwise, air will replace fuel siphoning out of the engine's fuel system through the return.



Engine Mounting Angle

Make sure the fuel tank filler is properly sealed to prevent water entry should it become awash. The fuel tank's vent should be routed so as to prevent water entry as well.

Be sure there is a fire extinguisher installed near the unit and that it is properly maintained. Be familiar with its use. An extinguisher with the NFPA rating of ABC is appropriate for all applications in this environment.

Oil Drain Hose

An oil sump drain hose is installed on the engine with the discharge end secured by a bracket at the front of the engine. Oil may be drained from this hose by removing the cap and the discharge end of the hose from the support bracket and lowering the hose into a container.The hose cap fitting is 1/4 inch NPT (National Pipe Tap) and can be extended, or have a pump added, for easier removal of the old oil, if desired.

Connecting Pressure Sensing Devices to Oil Galleries

Oil pressure sensing devices, such as senders and switches, must **not** be connected to an engine's oil gallery with the use of extended nipples or tees. The reason is simply that continued engine vibration causes fatigue of the fittings used to make such a connection. If these fittings fail during engine operation, lubricating oil will be lost and internal engine damage will result.

When additional sensing devices such as switches or sensors need to be installed that function on engine oil pressure, these devices *must* be bulkhead-mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the gallery *must* be of steel or malleable iron composition. Brass must **not** be used for this application.

Electrical System

The electrical system should be checked to make sure all wiring harnesses are tied down properly with clamps or plastic ties, spaced at intervals close enough to prevent chafing from vibration. Check to make sure all the engine's harness connections are tight and that they are made to the appropriate terminals.

WARNING

Do Not Smoke Near Batteries!

Do not smoke or allow an open flame near the batteries. Lead acid batteries emit hydrogen, a highly-explosive gas. Turn off the emergency switch in the battery's positive line.

Make sure the positive (+) battery connection is connected to the battery connection of the starting solenoid. The negative (-) battery connection should be connected to the system ground (engine block).

WARNING

Protect Yourself When Servicing The Battery

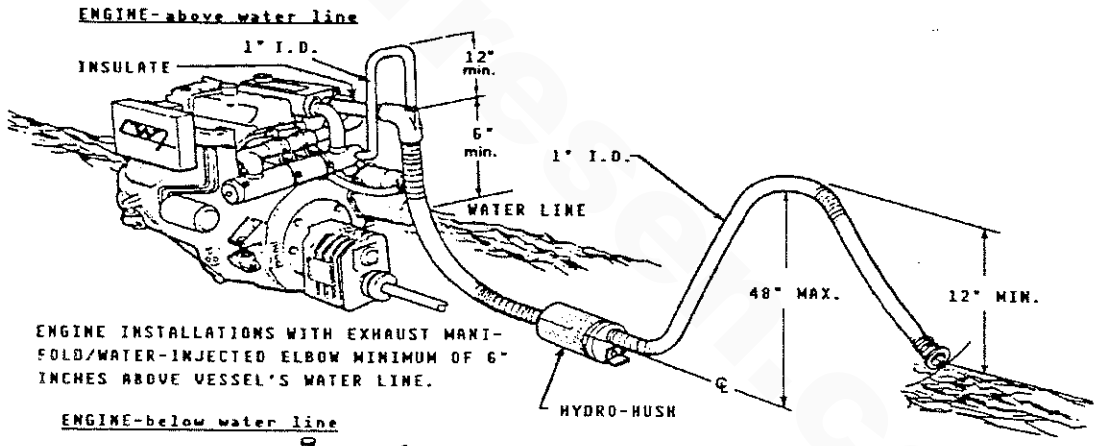
When servicing the battery or checking electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Battery acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

Check level and specific gravity of battery electrolyte to ensure maximum engine starting efficiency. Make sure terminals are clean and tight.

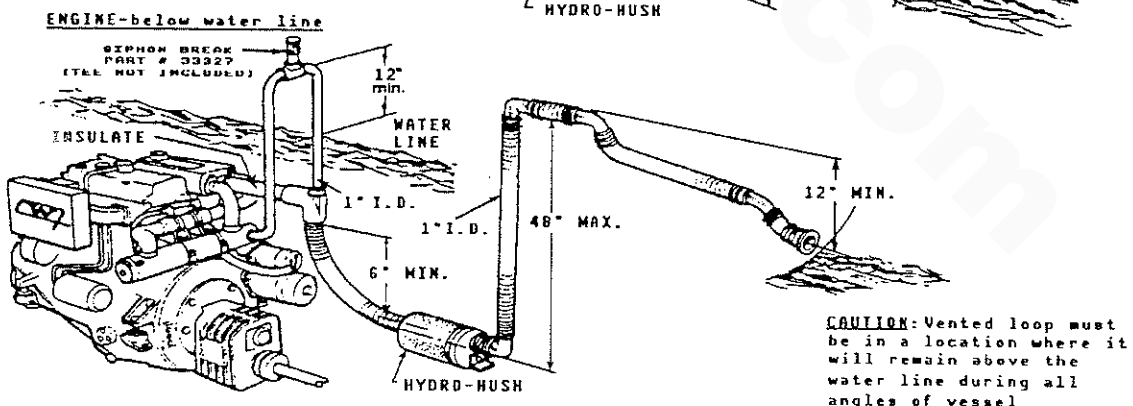
Exhaust System

The exhaust system provides an outlet line to vent engine exhaust gases out of and away from the vessel. The system also discharges raw water which has passed through the engine's sea water circuit by mixing it with hot exhaust gases. This mixing helps cool the exhaust gases and exhaust system from the water injected elbow to the through-hull discharge. The exhaust system and the raw water supply to the exhaust *must* be configured to prevent the siphoning of raw water into the exhaust through the sea water cooling circuit and to prevent the entry of raw water into the exhaust through the circuit's through-hull discharge port. The raw water supply hose to the exhaust system water injection elbow should be routed (looped) a minimum of 12 inches above the vessel water line.

For installations where the exhaust manifold/water-injected exhaust elbow is close to or below the vessel's water line, provisions *must* be made to install a siphon-break or a vent in the raw water supply hose to the water-injected exhaust elbow. This stops the flow of raw water that runs through the raw water cooling system from filling the exhaust and engine cylinders when the engine is shut down. This raw water supply hose *must* be looped above the water line and the siphon-break or vent installed in the high point of the loop above the water line. This siphon-break or vent *must* always be above the water line during all angles of vessel operation to prevent siphoning. The vent, when used, *must* have its vent hose or tube routed so it can remain above the water line and empty of water when the engine is shut down. This allows air to enter through this vent to prevent siphoning.



ENGINE INSTALLATIONS WITH EXHAUST MANIFOLD/WATER-INJECTED ELBOW MINIMUM OF 6" INCHES ABOVE VESSEL'S WATER LINE.



ENGINE INSTALLATIONS WITH EXHAUST MANIFOLD/WATER INJECTED ELBOW AT OR BELOW VESSEL'S WATER LINE.

CAUTION: Vented loop must be in a location where it will remain above the water line during all angles of vessel operation.

The raw water supply through-hull sea cock fittings *must* be of the flush-hull type. High-speed scoop type of fittings should not be used as they tend to encourage siphoning when the vessel is under sail or being towed. The exhaust discharge from the water lift muffler should be routed well above the water line then downward to the through-hull discharge. This routing will prevent raw water entry if the through-hull discharge fitting becomes submerged when the vessel heels or rolls while under way. The exhaust through-hull discharge fitting must not be restrictive, otherwise it will create unwanted back-pressure in the system.

Exhaust Back-Pressure

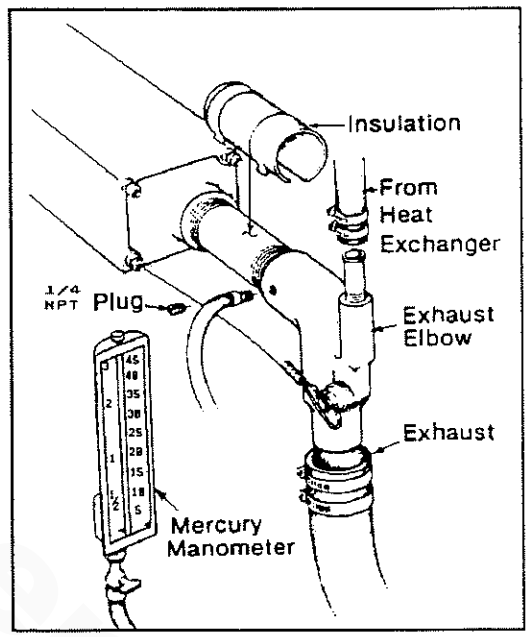
The exhaust discharge hose must be of adequate size and minimal run to prevent excessive exhaust back-pressure. Exhaust back-pressure should be checked before the engine is put into service. Excessive back-pressure will affect the engine's performance.

Measure back-pressure at the exhaust elbow when the engine is running at 3600 rpm. Back-pressure, as measured by a manometer, a pressure gauge, or water column, should not be over the specifications listed below

To measure for back-pressure, use a mercury manometer, a pressure gauge, or a water column. A boatyard or marine mechanic should have a manometer or a pressure gauge.

A water column can be made by taking a clear plastic tube and taping one end of the tube along a yardstick and fitting the other end of the tube with a 1/4 inch NPT (National Pipe Tap) pipe fitting.

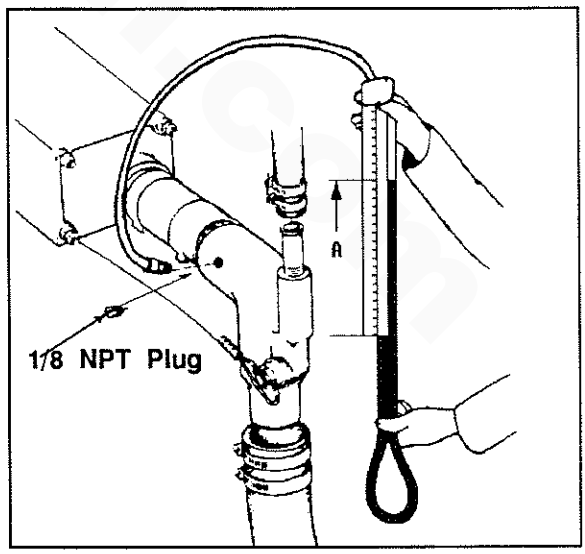
Measure back-pressure at the exhaust elbow when the engine is running at 3600 rpm under load.



Measuring Back Pressure

Back-pressure, as measured by a gauge instrument, should not exceed the following specifications:

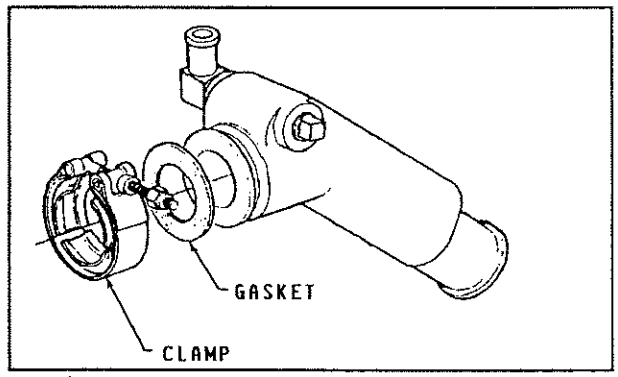
2 inches of mercury
27 inches of water in a water column
15.6 ounces PSI
1.0 PSI



Water Column

Excessive back-pressure can be caused by a small diameter exhaust hose, a small muffler, sharp bends in the exhaust hose, improper fittings, water pockets, and a high volume of water in the exhaust system due to the length of the exhaust discharge hose. The use of elbows and fittings in the exhaust discharge hose's routing should be limited since these

will create flow restrictions and contribute to exhaust back-pressure. The engine's exhaust system must be separate from any other engine's exhaust system. Dry portions of the exhaust system between the engine's exhaust manifold and the water injected exhaust elbow must be insulated to hold in the heat.

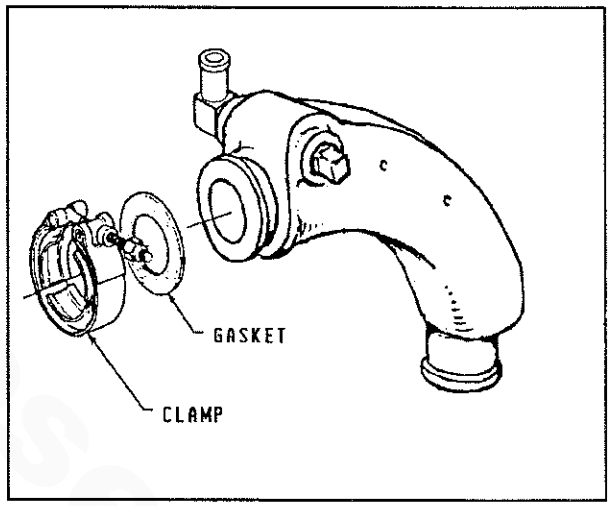


45° Elbow

EXHAUST ELBOW INSTALLATION

Westerbeke Corporation offers a 45° and 70° exhaust elbow as well as an exhaust riser that you can install on your propulsion engine. Refer to the instructions below when installing the exhaust elbow you purchased for your engine.

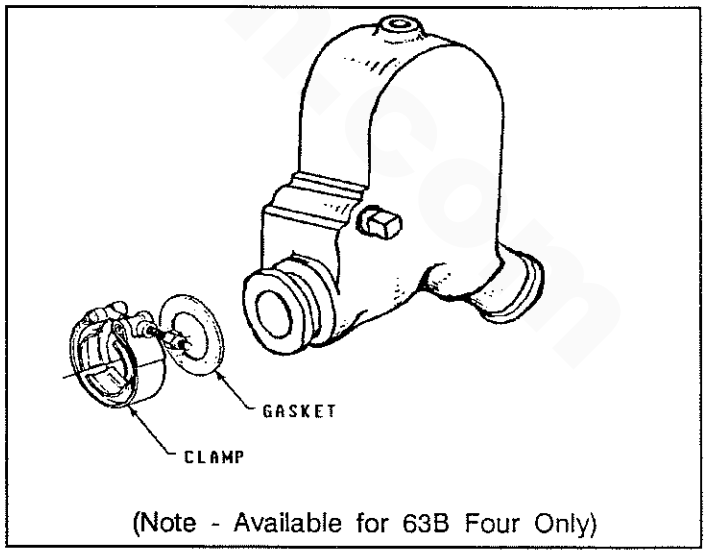
NOTE: Fabricated exhaust elbows or risers attached to the exhaust manifold **shall not exceed 8 lbs when unsupported.**



70° Elbow / 90° Elbow

1. Coat only one side of the exhaust gasket with "High Tack" (Manufactured by Permatex Company, Brooklyn, N.Y.) adhesive sealant. Place this coated surface against the exhaust manifold's exhaust port flange (the gasket should stick to the flange without falling off).
2. Place the clamp over the elbow's flange. Place your exhaust elbow against the exhaust manifold's flange so the exhaust manifold's flange rests snug against the exhaust elbow's flange with the gasket centered between the two. Now slip the exhaust clamp over both flanges.
3. **A.** Tighten the clamp just enough so the exhaust elbow can remain attached to the manifold and still be rotated.

   B. The exhaust elbow discharge *must* be directed **downward** so the mixture of sea water and exhaust gases will flow/fall downward into the exhaust muffler which *must* be positioned below the exhaust elbow. There should be no loops or rises in



(Note - Available for 63B Four Only)

the exhaust hose connected between the exhaust elbow and the muffler, as these would trap water and possibly allow water to flow back into the engine during starting or at shut down.

4. Adjust the elbow by rotating it until the desired alignment with the exhaust piping is acquired.

5. Carefully tighten the clamp between 8 to 10 lb-ft, or 24 to 35 lb-in, or 0.27 to 0.41 kg-m.

CAUTION

10 Lb-ft Torque Limit

Approach the **10 lb-ft torque limit** with caution. The clamp's threads will break if more than 10 lb-ft is applied to the clamp.

6. When the engine is started for the first time with the new elbow, check this exhaust manifold/elbow connection for leaks. If a leak exists, correct it immediately.

Exhaust System Failures

When the engine's raw water is fed into an exhaust system so that the full stream of this water strikes a surface, erosion takes place. This erosion may cause premature failures. The proper design of either a water jacketed or water injected "wet" exhaust system to prevent this problem requires that the raw water inlet be positioned so that the entering stream of raw water does **not** directly strike a surface. In addition, the velocity of the entering raw water stream should be as low as possible, which can be achieved by having inlet fittings as big in diameter as possible.

WARNING

Carbon Monoxide Gas Is Deadly!

Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are:.

- **Dizziness**
- **Vomiting**
- **Intense Headache**
- **Muscular Twitching**
- **Weakness and Sleepiness**
- **Throbbing in Temples**

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide poisoning is a daily inspection of the complete exhaust system. Check for leaks around manifolds, gaskets, and welds. Make sure exhaust lines are **not** heating surrounding areas excessively. If excessive heat is present, correct the situation immediately. If you notice a change in the sound or appearance of the exhaust system, shut down the unit immediately and have the system inspected and repaired at once by a qualified mechanic.

Make sure there are no unnecessary objects suspended from any portion of the exhaust lines. Exhaust risers installed off the exhaust manifold **should not exceed 8 lbs** in total weight when rigidly constructed. Excessive weight could cause deflection or distortion of the manifold resulting in damage and/or internal leaks. Inspect insulated portions of the exhaust system to ensure there is no deterioration of the insulation.

CAUTION

Do Not Overcrank!

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with raw water coolant. This may happen because the raw water pump is pumping raw water through the raw water cooling system during cranking. This raw water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the raw water supply through-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of raw water entry is **not** a warrantable issue; the owner/operator should keep this in mind.

Raw Water Intake System

Make sure the intake system (raw water cooling system) is in proper order. Check that the hull inlet, sea cock and strainer are unobstructed. Sea cocks and strainers should be at least one size greater than the inlet thread of the sea water pump. The strainer should be of the type that may be withdrawn for cleaning while the vessel is at sea and should be mounted below the water line to ensure self-priming. Inspect the raw water lines to make sure there are no collapsed sections, which would restrict water flow. Make sure there are no air leaks at any of the connections use double clamps on hose connections below water line.

Cooling System

The engine is fresh water-cooled by an engine-mounted heat exchanger. Raw water is used as the heat exchanger's cooling medium. Raw water is pumped into the exchanger by a raw water pump and is then injected into the exhaust discharge, carrying with it the heat removed from the engine's fresh water cooling system.

Raw water should be supplied to the raw water pump through a flush-type through-hull fitting using a wire-reinforced hose between the through-hull fitting and the raw water pump. This raw water should be directed through a visual-type raw water strainer and then delivered to the pump. Hoses routed from the through-hull fitting to the strainer and to the raw water pump should be wire-reinforced to prevent the hose from collapsing during the generator's operation (suction from the pump may collapse a non-reinforced hose). Raw water strainers should be mounted at or below the water line to make sure the raw water line remains primed after shutdown.

CAUTION

Do Not Use A Scoop-type Through-hull Fitting

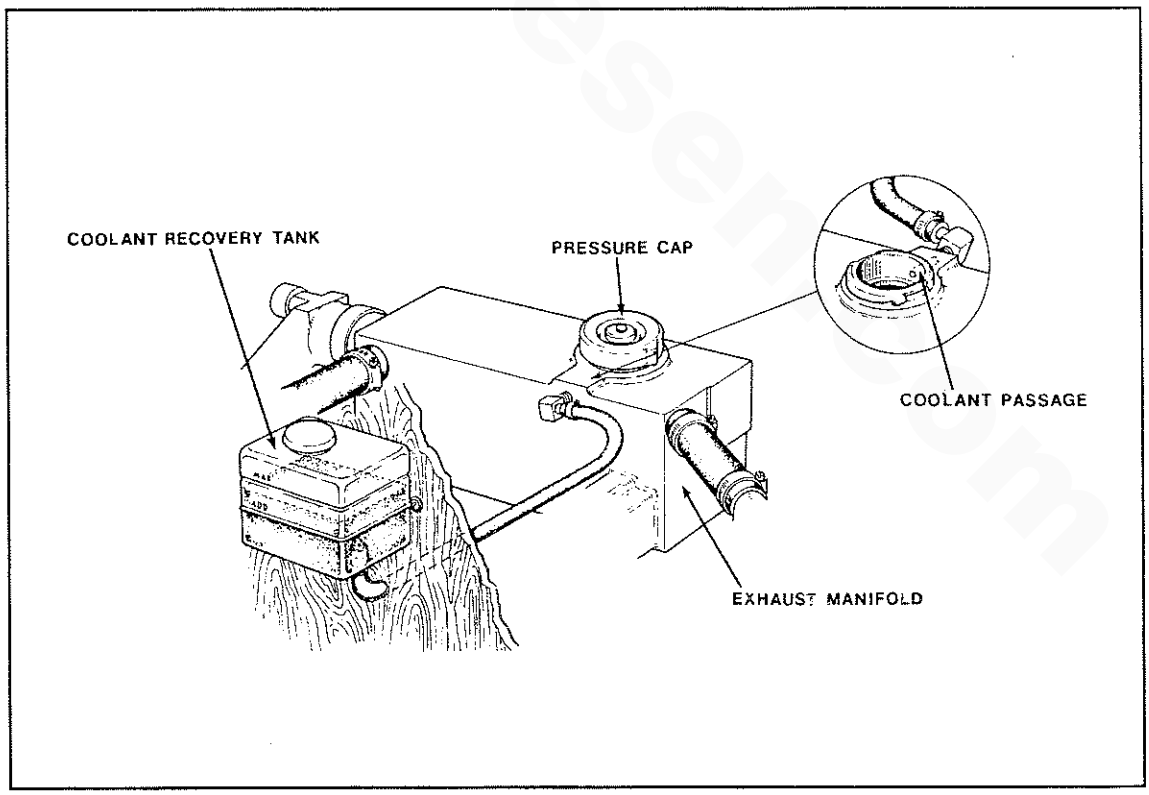
Do not use a scoop-type through-hull fitting as a means of supplying raw water to the generator. Water pressure against this type fitting, while the vessel is under way, can push raw water past the raw water pump's impeller into the generator's exhaust system, filling it and the engine as well. Flush-type, clear, through-hull fittings are recommended and should be located on the hull so as to be below the waterline during all angles of boat operation.

The use of common-type street elbows is **not** recommended for plumbing the raw water circuit. These generally have very restrictive inside diameters. Machined fittings are preferred.

Coolant Recovery Tank, Recommended Installation

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

This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed. A stainless steel mounting bracket is supplied with each kit along with a 30 inch length of clear plastic hose and clamps to connect the hose between the engine's manifold fitting to the hose spud on the base of the recovery tank.



Coolant Recovery Tank Installation

Control Panels

Westerbeke offers two types of control panels as optional equipment for the models in this manual. Read the instructions that apply to the panel you purchased with your engine.

Captains Panel

This manually-operated control panel is equipped with a Key Switch; an RPM gauge; **PREHEAT** and **START** buttons; a instrument test button; three indicator lamps, one for alternator discharge, one for low oil pressure , and one for high engine coolant temperature; and an alarm buzzer for low oil pressure or high water temperature. The RPM gauge is illuminated when the key switch is turned ON and remains illuminated while the engine is in operation. The key switch and the three buttons serve the following functions:

1. Key Switch: The Key Switch provides power only to the instrument panel cluster. The key switch does shutdown the engine when the key is turned OFF.

2. PREHEAT: The **PREHEAT** button energizes the alternator's regulator, the engine's glow plugs, and bypasses the engine's oil pressure alarm switch. In addition, this button energizes the **START** button.

3. START: The **START** button, when pressed, energizes the starter's solenoid which cranks the engine. This button will not operate electrically unless the **PREHEAT** button is pressed and held at the same time.

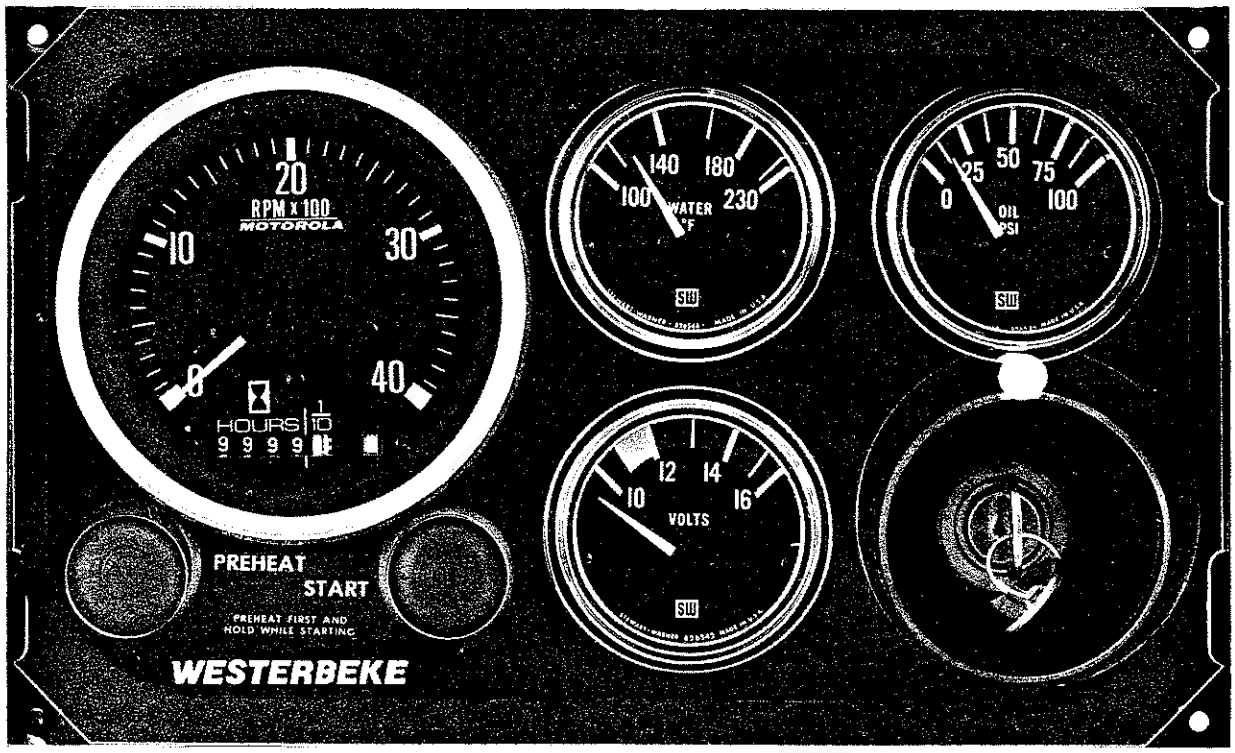
4. Test Button: The Test Button, located above the key switch, tests the alternator, the oil pressure, and the water temperature control circuits. When this button is pressed, the alternator, the oil pressure, and the water temperature indicator lights illuminate in addition to sounding the alarm buzzer.

5. Alarm: The alarm is located above the test button and will sound if the engine's oil pressure falls below 15 psi. In this event, the alarm will emit a *pulsating* signal. The alarm will also sound if the water temperature in the fresh water cooling circuit rises to 205° F. In this event, the alarm will emit *continuous* signal.

> **NOTE:** The alarm will sound when the Key Switch is turned **ON**. This sounding is normal for the engines covered in this manual. Once the engine starts, and the engine's oil pressure reaches 15 psi, the alarm will silence.

Admirals Panel

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



Admirals Panel

1. **Key Switch:** The Key Switch provides power only to the instrument cluster. The key switch does shutdown the engine when the key is turned **OFF**.

2. **PREHEAT:** The **PREHEAT** button energizes the alternator's exciter, the engine's glow plugs, and bypasses the engine's protective oil pressure alarm switch. In addition, this button energizes the **START** button.

3. **START**: The **START** button, when pressed, energizes the starter's solenoid which cranks the engine. This button will not operate electrically unless the **PREHEAT** button is pressed and held at the same time.

4. Alarm: The alarm is located above the test button and will sound if the engine's oil pressure falls below 15 psi. In this event, the alarm will emit a pulsating signal. The alarm will also sound if the water temperature in the fresh water cooling circuit rises to 205° F. In this event, the alarm will emit con*tinuous* signal.

NOTE: The alarm will sound when the Key Switch is turned **ON**. This sounding is normal for the engines covered in this manual. Once the engine starts, and the engine's oil pressure reaches 15 psi, the alarm will silence.

***5.** Water Temperature Gauge: This gauge is graduated in degrees Fahrenheit and is illuminated while the Key Switch is turned **ON**. The engine's normal operating temperature is 170 - 190° F (77 - 88°C).

***6.** Oil Pressure Gauge: This gauge is graduated in pounds per square inch (PSI) and is illuminated while the Key Switch is turned **ON**. The engine's normal operating oil pressure ranges between 30 - 60 PSI.

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

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

Automatic Alarm System

High Water Temperature Alarm

An alarm buzzer has been supplied with the instrument panel. If the engine's fresh water coolant reaches 205° F (96° C), this switch will close sounding the alarm which will emit a *continuous* signal.

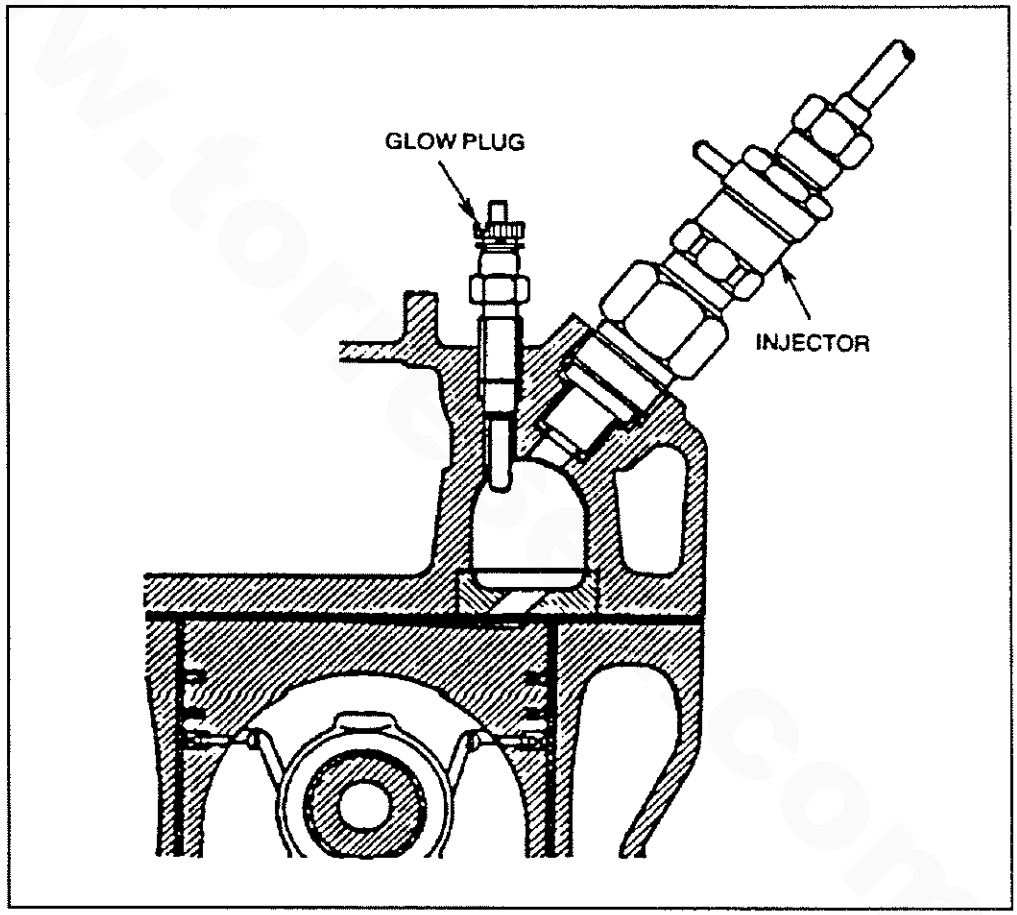
Low Oil Pressure Alarm

A low oil pressure alarm switch is located off the engine's oil gallery. This switch monitors the engine's oil pressure. Should the engine's oil pressure fall to 10 - 15 psi, the switch will close sounding the alarm. In this event, the alarm will emit a *pulsating* signal.

Description of the Starting System

Westerbeke diesel engines use electric starters assisted by glow plugs for both normal and cold weather starting. The figure below shows a cross-sectional view of one cylinder. The glow plug is located in the combustion chamber so that its tip is in the injector nozzle's spray path. When the glow plug is energized by the **PREHEAT** button, the plug glows red at the tip and assists in igniting the fuel. The result is a rapid start with less wear on the starter.

This system is common to Westerbeke Diesels. The start circuitry is designed so that the **PREHEAT** button *must* be depressed for the time specified in the Preheat Table (page 46). Then, while keeping the **PREHEAT** button engaged, the **START** button is depressed to crank the engine.

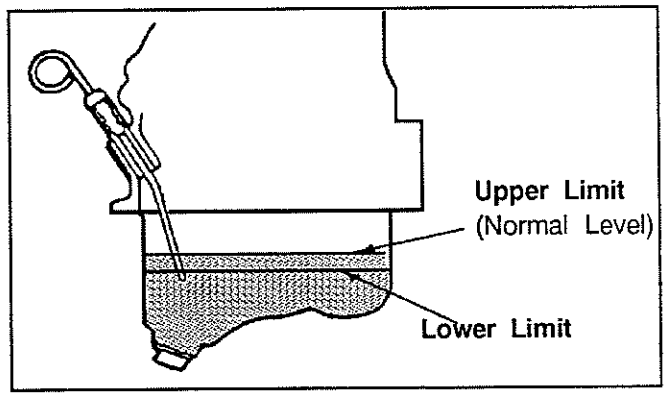


NOTE: The **START** switch will **not** energize unless the **PREHEAT** button is depressed. When depressing the preheat switch, The glow plugs in the cylinder head are activated. Use the preheat intermittently to avoid overheating the glow plugs.

Preparation For Starting

Take the steps described below in starting your engine for the first time or after a prolonged shutdown or layup.

Fill your engine with oil up to or near the upper limit on the dipstick (the installation angle may have an affect on the dipstick reading). Select readily available lubricating oil with an API specification of CC or CD and an SAE number suitable for the temperature in your operating area.



Fill the transmission to the **FULL** mark on the dipstick with the correct lubricant.

For the quantities of oil and transmission fluid needed in your engine, refer to the "**System Specification**" section of this manual.

Fill the fuel tank with a good grade of No. 2 diesel fuel and prime the fuel system up to the engine. When returning fuel is free of air, the engine's fuel system is bled and the engine is ready to start.

Each unit is supplied with a coolant recovery kit (#24977) as standard equipment which *must* be installed and the following applies:

A. Remove the pressure cap from the engine's exhaust manifold, open the air bleed petcock on the heat exchanger and slowly fill the engine's cooling system with a mixture of water and antifreeze suitable for your temperature zone. Close the petcock on the exchanger once coolant flows from it. Operate the engine and observe the coolant level in the manifold. Maintain this level to the base of the filler neck. Once the engine reaches its operating temperature (170 - 190° F), make sure there is no problem with coolant flow through the manifold. Top off the cooling system and install the pressure cap.

B. Make sure the plastic recovery tank is properly mounted near the unit in a location where it can be monitored and filled easily. The recovery tank should be mounted at manifold level or above. For installations that require it, the plastic recovery tank can be mounted below the exhaust manifold's level.

C. Add coolant to the plastic coolant recovery tank once you have topped off the exhaust manifold full right to the filler neck top.

> **NOTE:** This is a closed type cooling system and little or no coolant should be lost from the system. If excessive coolant is lost, artifically pressurize the system and inspect for the cause. With the manifold filled and air expelled, fill the coolant recovery tank half full. Monitor this recovery tank daily and add coolant as needed. Periodically check that the manifold is full when cold.

Make sure the Installation Checks have been made in accordance with those specified in the "**Installations and Installation Checks**" section of this manual.

Starting Procedure

Place the transmission in the **NEUTRAL** position and advance the throttle to a slightly open position.

Atmospheric Temperature	Preheating Time
+ 41° F (+ 5° C) or higher	Approx. 05 sec.
+ 41° F (+ 5° C) to + 23° F (- 5° C)	Approx. 10 sec.
+ 23° F (- 5° C) or lower	Approx 15 sec.
Limit of continuous use	30 seconds before cranking.

Preheat Table

Turn the Key Switch to the **ON** position (2 o'clock).

Depress and hold the **PREHEAT** switch. Preheat according to the table shown above. This activates the fuel pump on the engine and will work to bleed any air from the engnie's fuel system prior to starting.

> **NOTE**: Air found in the fuel system prior to each start would be the result of a leak in the system or improper fuel system plumbing ie. supply to the engine or return.

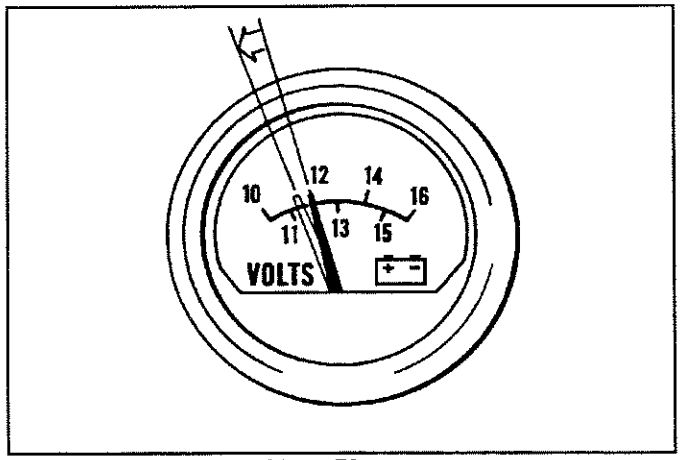
> **NOTE**: Fuel tanks that are positioned below engine fuel system components **must** have the return fuel entered down into the tank via a pickup tube to prevent air entry into the engine fuel system.

While still depressing the **PREHEAT** switch, depress the **START** switch. As soon as the engine runs, release the **START** switch but continue to hold the **PREHEAT** switch depressed for an additional 2 - 3 seconds. This allows the engine to build up enough oil pressure to close the oil pressure shutdown switch and allow the engine to continue to run.

> **NOTE:** Should the engine not start when the **START** switch is depressed for 10 - 12 seconds, release both switches and wait 30 seconds; repeat the previous procedure. **Never** run the starter motor for more than 30 seconds at a time.

Check all the instruments on the panel for proper operation and make sure raw water discharges with the exhaust discharge once the engine starts.

Once the engine starts, allow it to run for a few minutes to warm up and stabilize while the engine's instruments are checked for proper oil pressure and battery charging voltage. **Never** attempt to engage the starter while the engine is running.



Voltage Drop From Glow Plug

NOTE: Some unstable running may occur in a cold engine, but this condition should smooth out as the operating temperature moves into the 170 - 190° F (77 - 88° C) range.

Proper glow plug function is indicated by a voltmeter drop when the **PREHEAT** switch is depressed. This drop will be slight but discernible. If no voltage drop is noted, it may indicate defective glow plugs or a faulty preheat circuit (check for loose connections or faulty preheat solenoid).

CAUTION

Prolonged cranking can damage the engine!

Prolonged cranking intervals without the engine starting can result in filling the engine mounted exhaust system with raw water coolant. This may happen because the raw water pump is pumping raw water through the raw water cooling system during cranking. This raw water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the raw water supply through-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of raw water entry is **not** a warrantable issue; the owner/operator should keep this in mind.

Starting Under Normal Conditions

Follow the procedure below for normal starting of the engine:

1. Check the engine and transmission lubricant levels and fill, if necessary.

2. Make sure there is sufficient fuel on board. Keep fuel tank(s) as full as possible. Check the fuel filters and water separators for the presence of contaminants and/or water. Drain and clean them as needed.

3. Check the coolant level in the plastic recovery tank. Add coolant solution as needed.

> **NOTE:** Excessive loss of coolant from the plastic recovery tank indicates a cooling system leak. Check the entire cooling system and pressurize the system to locate the leak. In cases of excessive coolant loss, the system must be refilled as outlined under the "**Preparation For Starting**" section of this manual.

4. Check for oil and fuel leaks, particularly if signs of such leaks are found on the bottom of the engine or below the engine.

Start the engine in accordance with the "**Starting Procedure**" instructions found on page 46, and allow the engine's operating temperature to reach 140 - 150° F before operating the engine underway.

Starting Under Cold Conditions

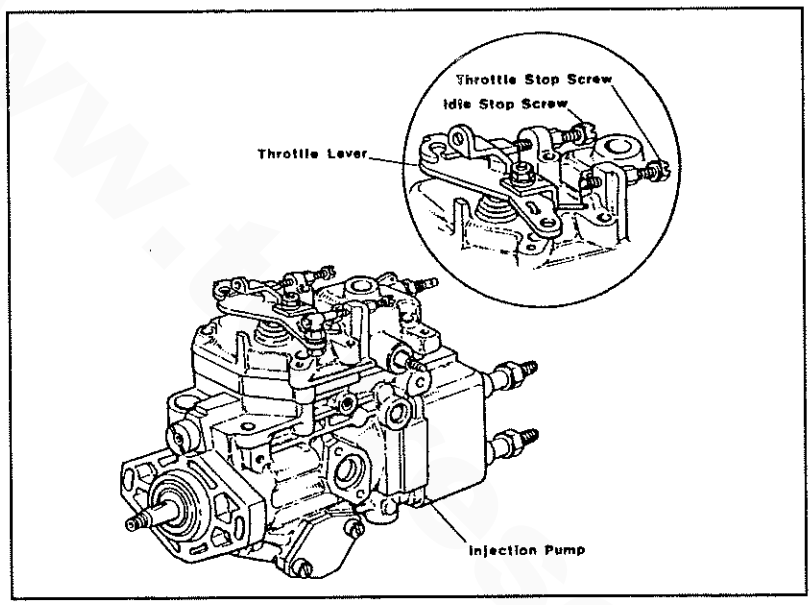
Under extremely cold temperatures, the following conditions can occur. Follow the instructions listed below when operating your engine in cold weather.

Lubricating Oil Turns Viscous - Make certain that the lubricating oil used conforms with the ratings for the prevailing atmospheric temperature.
Voltage Across The Battery Terminals Drops - Make certain that the battery is fully charged to minimize voltage drop across the battery terminals.

The Temperature Of The Intake Air Is Low And The Compression Temperature Does Not Rise Enough - Allow the glow plugs to operate sufficiently to aid in starting during the preheat period whenever the temperature of the intake air is low and when the compression temperature does not rise enough. Refer to the preheat chart found in the "**Starting Procedure**" section, page 46.

Stopping Procedure

To stop the engine bring the throttle to a idle position, place the transmission in neutral. Scan instrument panel gauges. Allow the engine to idle for a few moments to stablize temperatures. Turn the key to the off position. This opens the DC circuit to the instrument panel and engine de-energizing the fuel solenoid on the injection pump stopping fuel flow from it and stopping the engine.



Fuel Injection Pump

NOTE: Only the 63B Four model has a mechanical shut-off arm on the outboard side of the injection pump that can be used to stop the engine by mechanical means. When this mode is used the fuel solenoid on the injection pump is disabled by removing the internal plunger and spring from the solenoid.

With the engine stopped, turn the key switch turned to the **OFF** position (12 o'clock). If the Key Switch is left **ON**, the battery will discharge. An engine alarm buzzer is provided to warn the operator of this condition (Key Switch **ON**). The best method of preventing the battery from discharge is to remove the key from the Key Switch after stopping the engine.

Engine Break-In Procedures

Although your engine has experienced a minimum of one hour of test operations to ensure accurate assembly and proper operation of all systems, break-in time is required. The service life of your engine is dependent upon how the engine is operated and serviced during its initial 50 hours of use.

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

1. Start the engine according to the "**Starting Procedure**" section found on page 46; run the engine at fast idle while checking that all systems (sea water pump, oil pressure, battery charging) are functioning.

2. Allow the engine to warm up (preferably by running at fast idle) until the water temperature gauge moves into the 130-140° F range.

3. While using the vessel, run the engine at varying engine speeds for the first 25 hours.

4. Avoid rapid acceleration, especially with a cold engine.

5. Use caution not to overload the engine. The presence of a gray or black exhaust, and the inability of the engine to reach its full rated speed, are signs of an overload.

6. During the next 25 hours, the engine may be operated at varying engine speeds, with short runs at full rated rpm. Avoid prolonged idling during this break-in period.

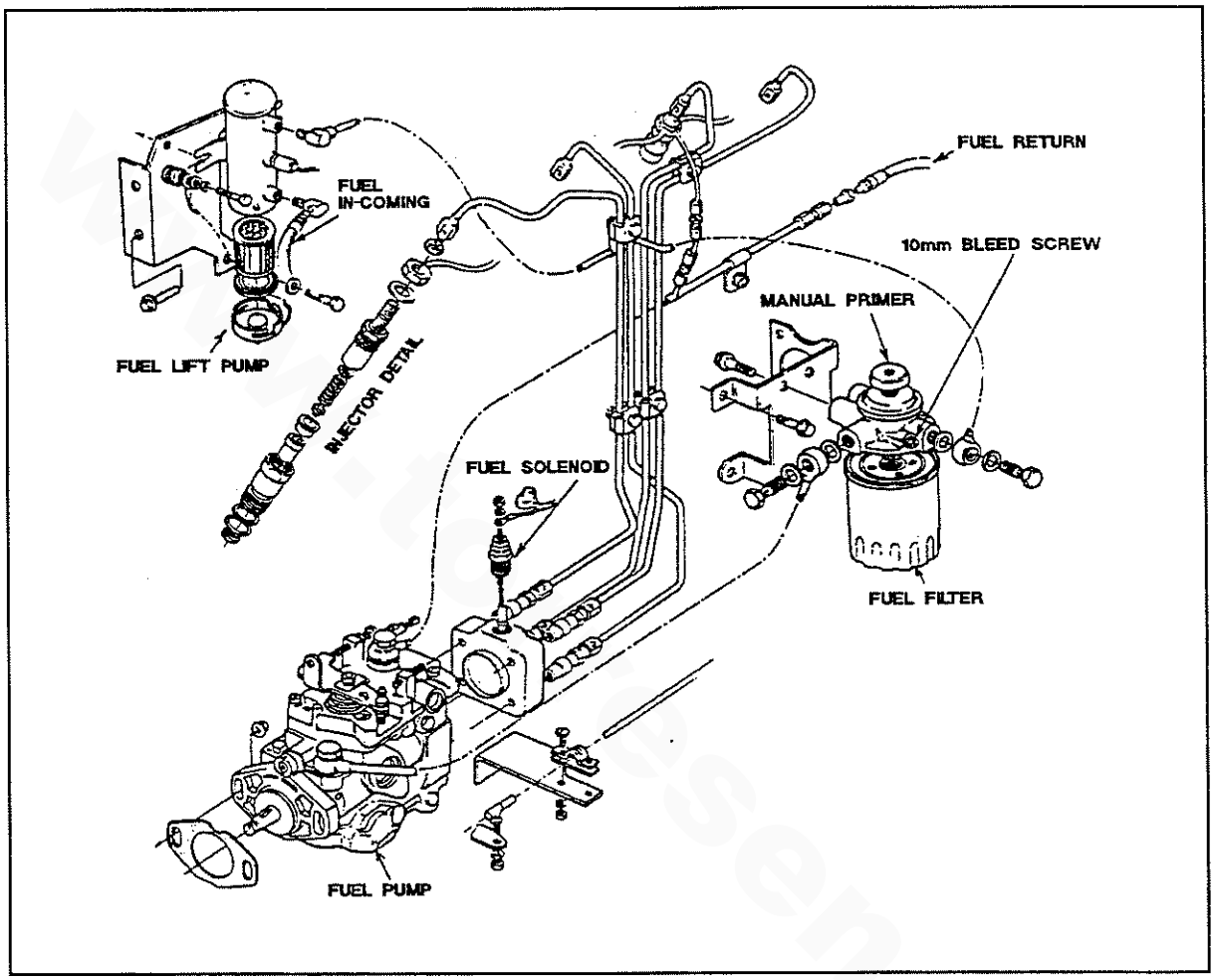
Breaking-in a new engine basically involves seating the piston rings to the cylinder walls. This cannot be accomplished by long periods of running at Idle, nor by early running at full rpm.

Idle running may glaze the cylinder walls, resulting in excessive oil consumption and smoky operation. Excessive speed or heavy overloading, especially with a cold engine, may cause scoring of the cylinder walls, producing similar results.

As indicated above, operate the engine in moderation during the 50-hour break-in period. (Don't baby the engine, but do not abuse it.)

Fuel System

This diagram shows the a typical exploded view of a fuel system for these engines.



Fuel System

Priming the Fuel System (One Bleed Point)

The on engine fuel system is nearly self bleeding. There is one bleed point in the on engine fuel system to open for the removal of air. This bleed screw is located on the housing for the spin on fuel filter mounted on the engine. This bleed point is an 11mm hex/slotted head screw that should be opened 1-2 turns to remove air from the upper housing area of the fuel filter. Energizing the preheat switch for 10-20 seconds or by using the palm of one's hand to slowly depress and release the primer pump on the top of the filter housing will force air in this area out through this bleed point. Once all air is expelled tighten the bleed screw.

> **NOTE**: Do not over tighten this screw. When using the preheat funciton to bleed air from the filter assembly, keep in mind that the preheat elements (glow plugs) are being energized. Take care not to overheat them.

Once the fuel filter assembly is bled of air and the bleed screw tightened again, depress the preheat switch 10-20 seconds or slowly pump the primer on the fuel filter housing to force any air in the system between the filter housing and the injection pump out of the system and back to the fuel tank through the return.

Diesel Fuel

USE # 2 DIESEL FUEL WITH A CETANE RATING OF 45 OR BETTER. NEVER USE KEROSENE OR HEAVY OIL.

In cold weather particularly, water vapor is produced by condensation when air is present in the fuel tank. Keep the fuel tank(s) full and completely free of dirt and water.

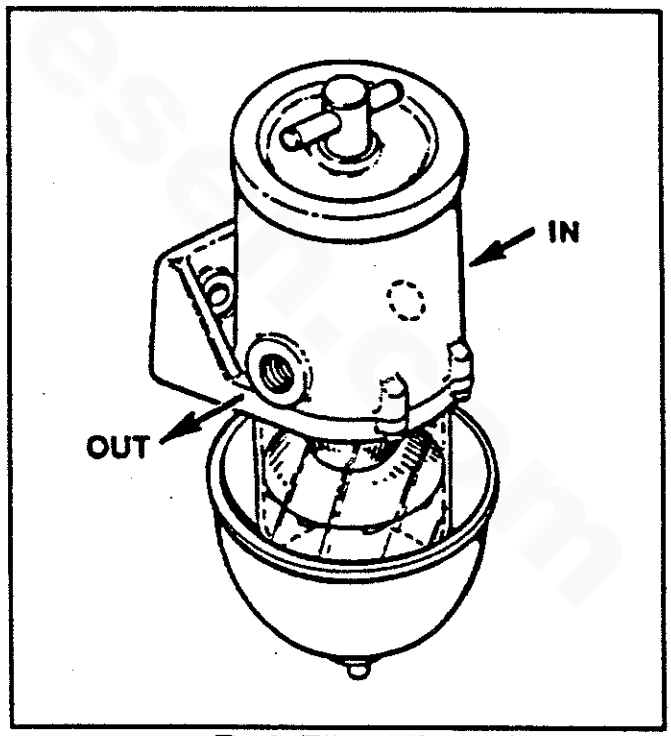
Fuel Filter/Water Separators

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 included with the generator installation package a type of filter/water separator for they are aware of the problems contaminants in the fuel can cause -all of which are **not** warrantable through Westerbeke.

A typical fuel filter/water separator is illustrated in this diagram. This is the Raycor Model 500MA. Keep in mind that if a water separator type filter is not installed between the fuel supply tank and engine-mounted fuel system, any water in the fuel will affect the fuel pump, engine fitler, and injection equipment. The owner/operator is responsible for making certina the fuel reaching the engine's injection equipment is free of impurities. This process is accomplished by installing and maintaining a proper filtration/separation system.

In addition, any gasoline in the fuel system will damage the engine's fuel injection pump assembly and injectors as gasoline does not have the same lubricating qualities as diesel fuel.



Fuel Filter/Water Separator

If a filter/water separator is not installed between the fuel tank and the engine-mounted fuel system, water in the fuel system will inhibit proper starts and particles will pass on to the lift pump's filter, eventually clogging it and pass on into the engine's injection equipment.

Notes on Fuel System

WARNING

Shut off the fuel service valve at the engine when servicing the fuel system. Take care in catching any fuel that may spill from within the pump when the base is removed. **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.

On the previous page is a typical exploded view of a fuel system for these generator engines, which illustrates the self-bleeding and priming system used by Westerbeke.

The Westerbeke self-bleeding fuel system is automatic in operation. While the likelihood of having to service the system at sea is slim, the possibility does exist. Therefore, we recommend that fuel system banjo washers, injector seat washers, a lift pump filter and gasket, and a fuel filter and gasket be carried on board at all times. Purchase needed spares from your local Westerbeke Dealer or Distributor. For example, hardware kit #32050 will supply miscellaneous fuel system sealing washers for the 63B Four engine. Refer to the last page in your models parts list for the kit part number for your specific model.

If a leak should develop at a banjo washer that cannot be corrected by a simple tightening of the fitting, replace the sealing washers.

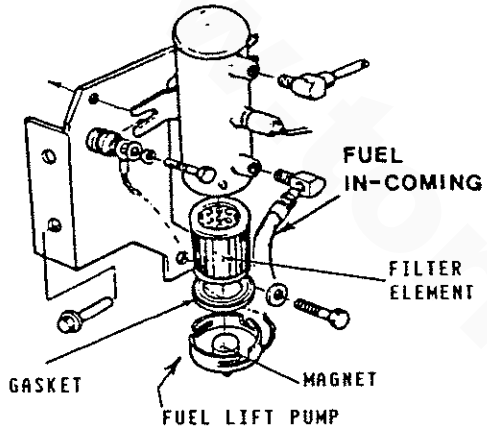
The engine can be started by taking the steps described in the "STARTING PROCEDURE" section of this manual. In cases where excessive amounts of air exist in the fuel system, bleed the high pressure injector lines. Loosen all these lines at the injectors and crank the engine with the starter until fuel spurts from between the nut and the line. Then tighten the nuts.

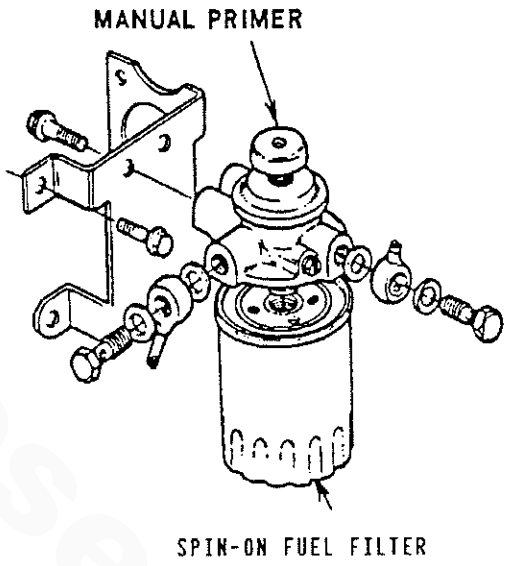
Replacing Filter Elements

After the first 50 hours of operation, unscrew and discard the secondary fuel filter element. Reinstall a new fuel filter. This same maintenance is required of the filter element in the fuel lift pump. As with the secondary fuel filter element located on the engine, the fuel lift pump's filter element needs to be replaced. Make sure that the lift pump's gasket is changed every time the filter is replaced.

> **NOTE: DO NOT** overlook replacing the filter element in the fuel lift pump, as the fuel passes through this filter element before it reaches the secondary filter.

After the first 50-hour filter change, the change period may be increased to 200 hours or once per season.





The base of the fuel lift pump has a 17mm hex nut affixed to it. An open end wrench can be applied to this in twisting the base off the pump housing to gain access to the filter element. (Note - fuel is present in this area.)

The spin-on fuel filter's housing has a 10mm hex/slotted bleed screw and a palm operated manual primer that can be used in assisting the bleeding of air from the engine's fuel system.

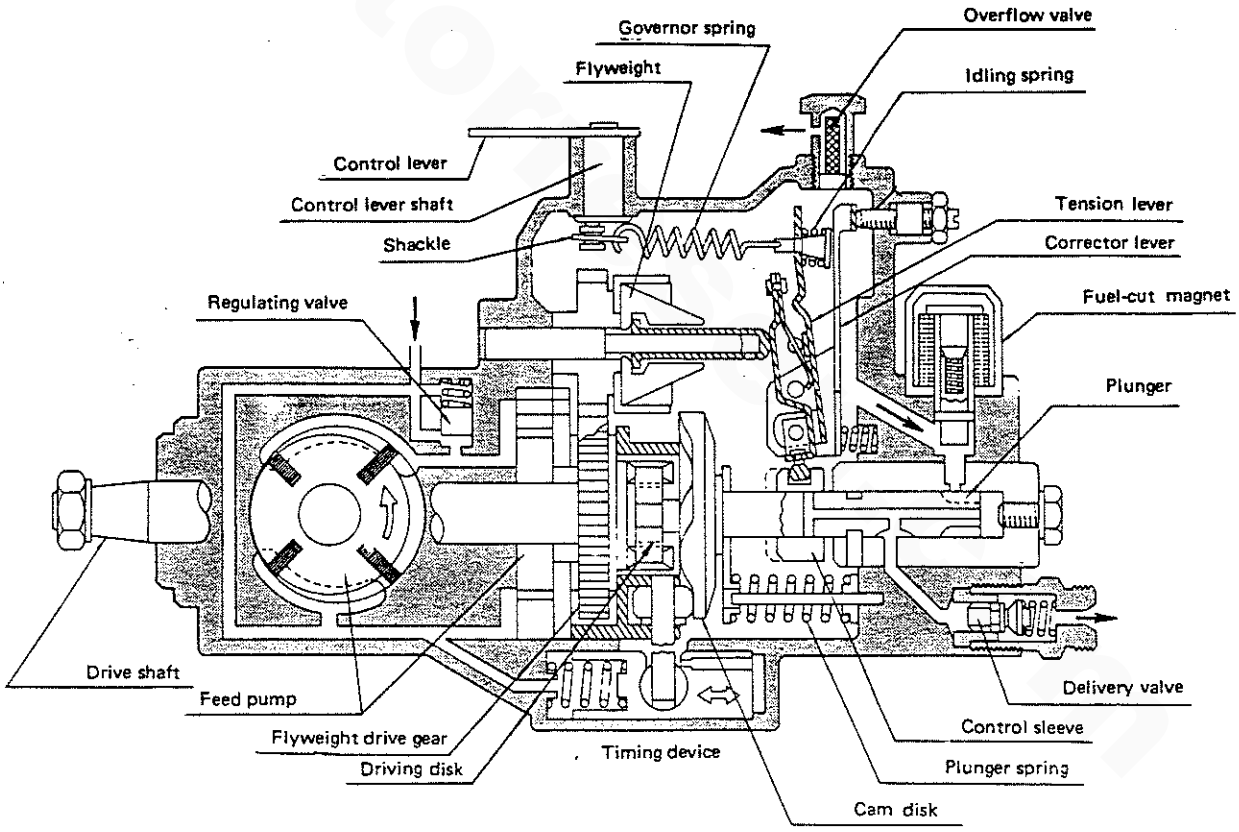
Fuel Injection Pump

The fuel injection pump is one of the most important components of the diesel engine and thus it calls for the utmost care in handling. Futhermore, the fuel injection pump has been thoroughly shop adjusted and should never be readjusted carelessly.

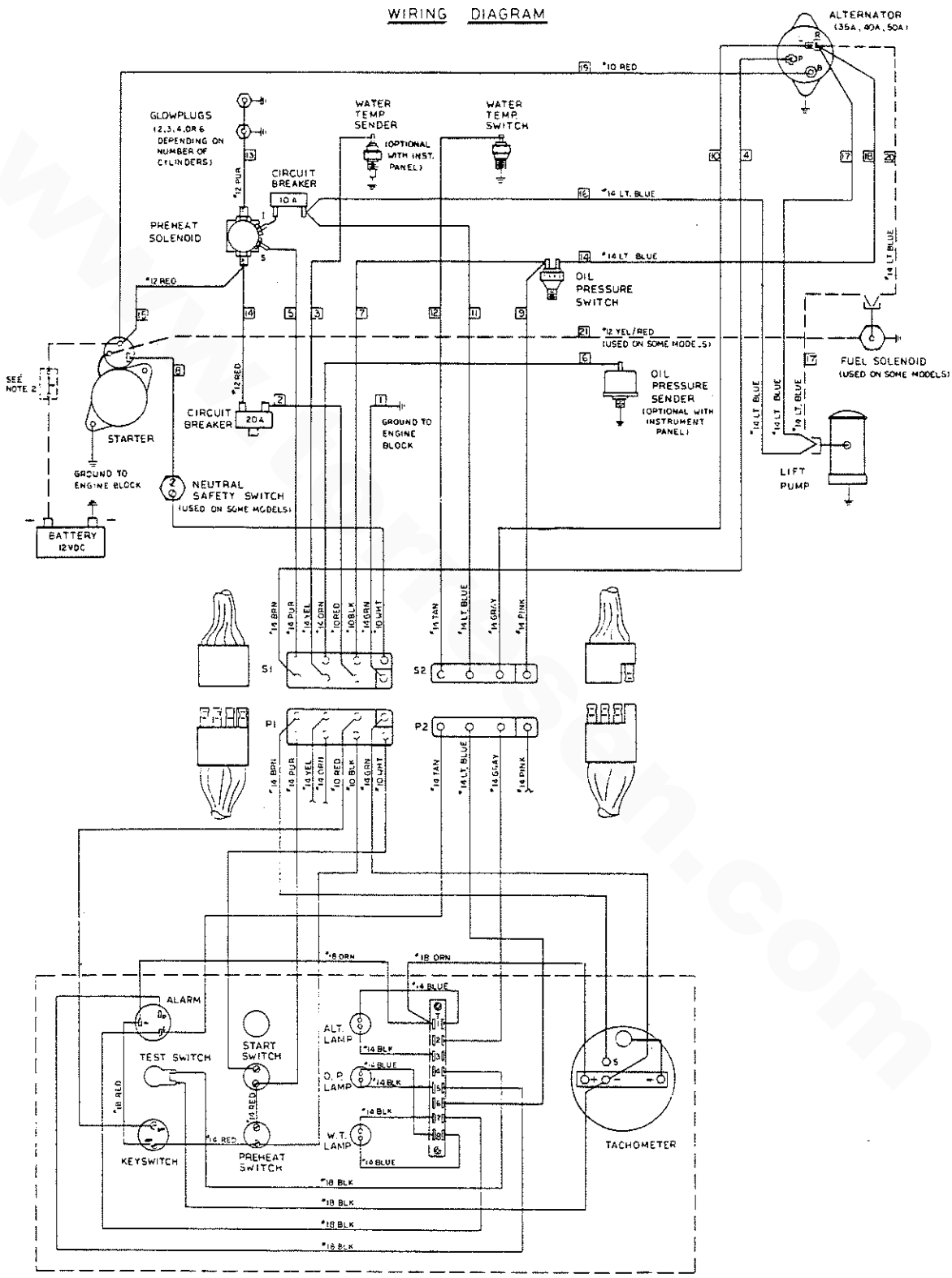
Such adjustment, whenever necessary, should be performed at an authorized service station as a precision pump tester and skills are required to obtain long and satisfactory service from engine's your injection pump:

A. Allways use #2 diesel fuel which is free from impurities.
B. Clean and renew the fuel filters on a regularly scheduled basis.

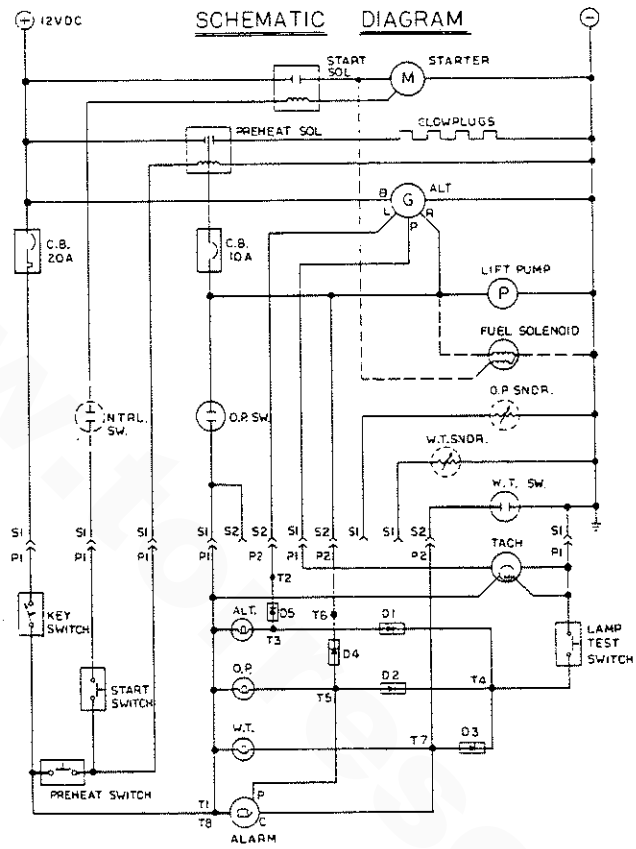
CONSTRUCTION OF "VE" STYLE INJECTION PUMP



Captains Panel DC Control Circuit Wiring Diagram #36467
page 1 of 2



Captains Panel DC Control Circuit Wiring Diagram #36467
page 2 of 2



START: 1. TURN KEY TO ON POSITION. THE ALARM WILL SOUND, OIL PRESSURE AND BATTERY CHARGE INDICATORS WILL LIGHT.

2. PUSH PREHEAT SWITCH FOR 15 TO 60 SECONDS AS REQUIRED, ALARM WILL STOP.

3. WHILE CONTINUING TO PUSH PREHEAT SWITCH, PUSH THE START SWITCH ALSO. WHEN THE ENGINE STARTS RELEASE THE START SWITCH ONLY.

4. WHEN THE OIL PRESSURE INDICATOR LAMP GOES OUT RELEASE THE PREHEAT SWITCH.

STOP: TURN THE KEY TO THE OFF POSITION.

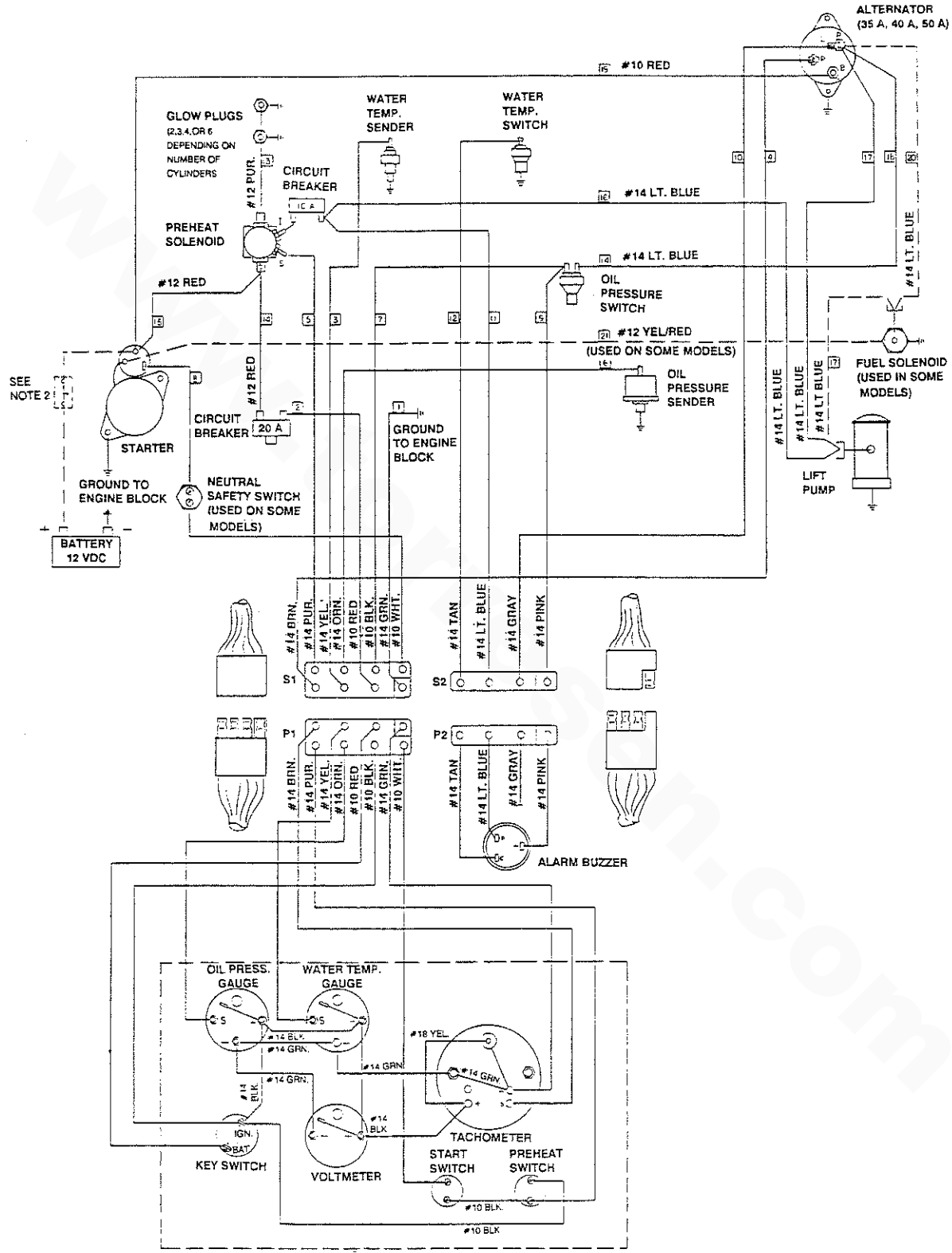
NOTES:

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

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

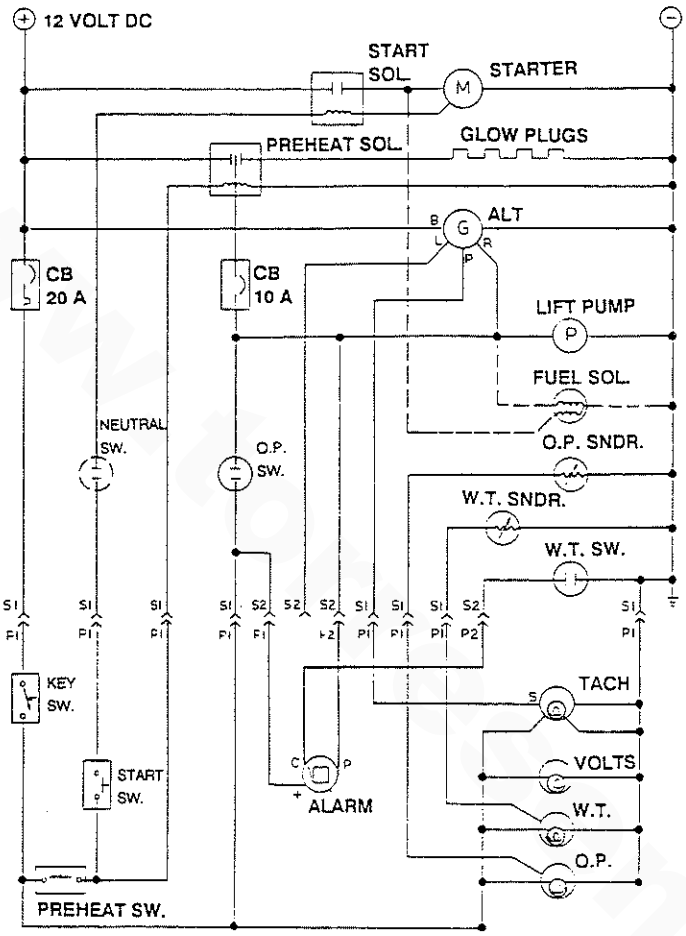
3. PINK WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED.

Admirals Panel DC Control Circuit Wiring Diagram #36844
page 1 of 2



Admirals Panel DC Control Circuit Wiring Diagram #36844

SCHEMATIC DIAGRAM



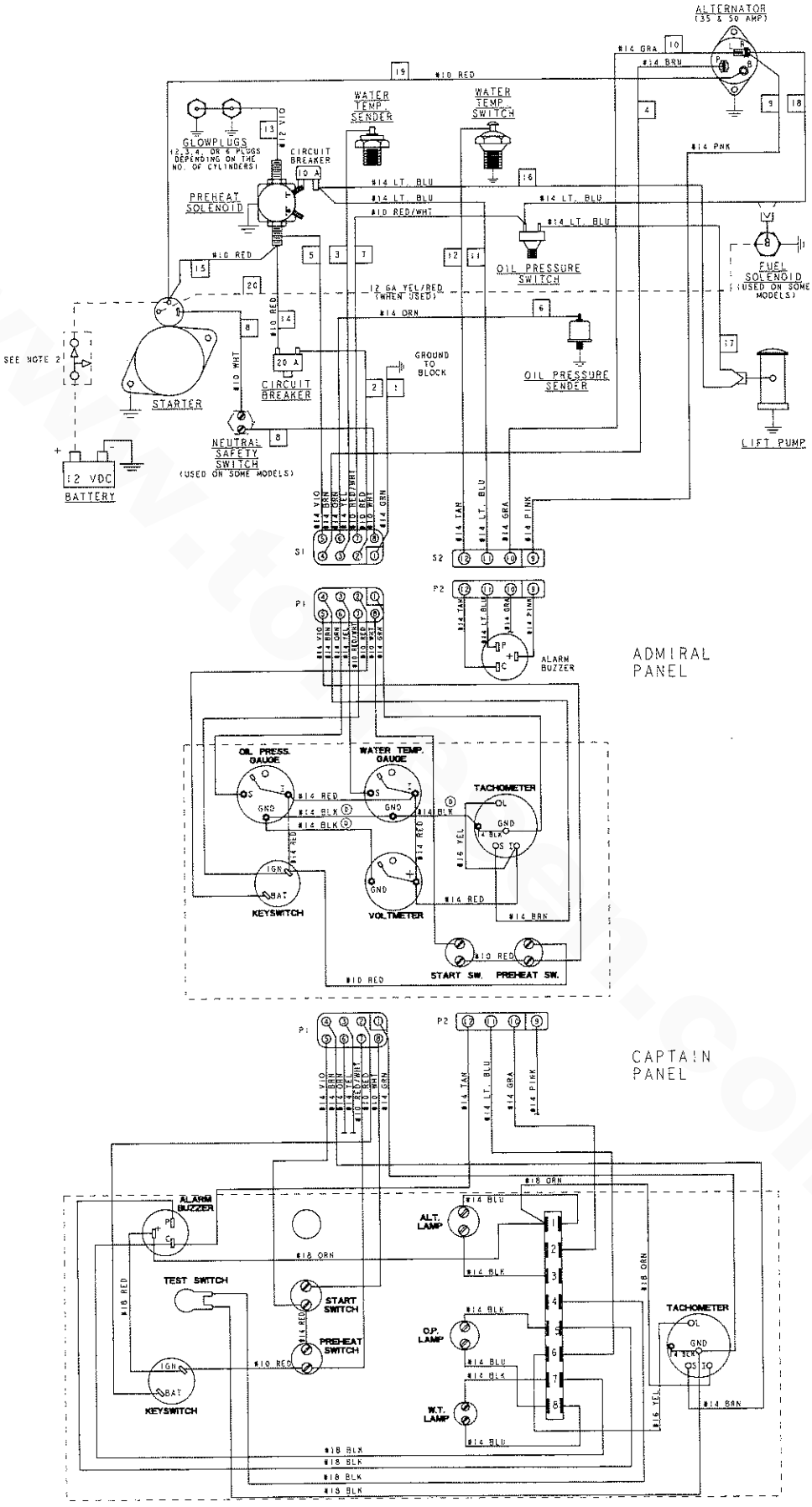
NOTE:

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

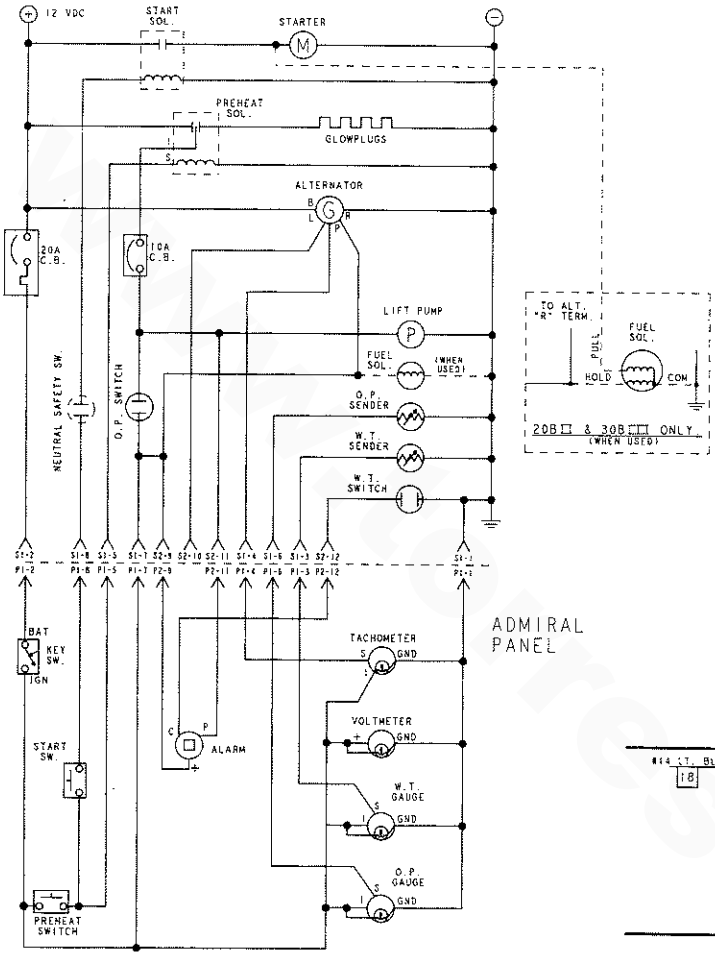
2. AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY,AND WHEN LEAVING THE BOAT. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VOLTS DC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.

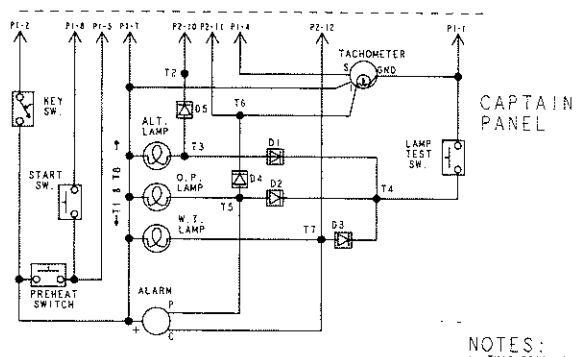
3. THE GRAY WIRE AT PLUG #2 IS UNUSED AND SHOULD BE INSULATED.

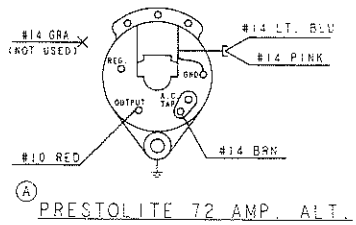
Marine Diesel Propulsion Engines Diagram #39144
page 1 of 2



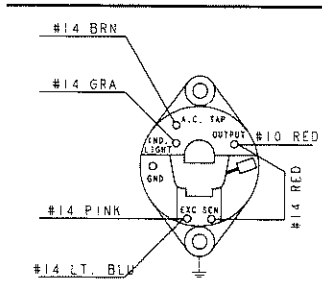
Marine Diesel Propulsion Engines Diagram #39144
page 2 of 2



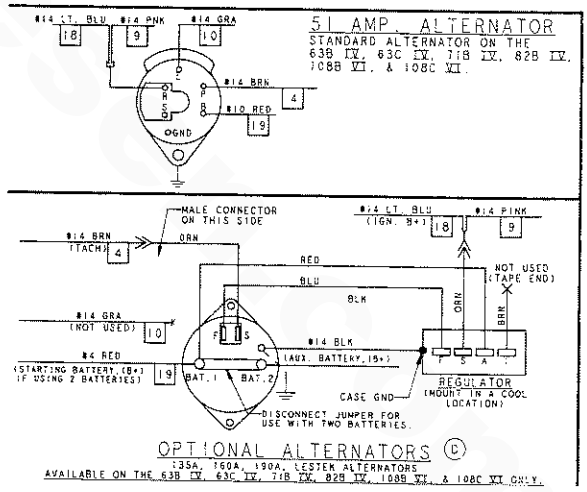




Ⓐ PRESTOLITE 72 AMP. ALT.



Ⓐ UNIVERSAL PROPULSION PRESTOLITE 51 AMP. ALT.



NOTES:

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

COOLING SYSTEM

Description

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

Fresh Water Circuit

NOTE: Refer to paragraphs A and B in this section on the recommended ethylene glycol antifreeze and water mixture to be used as the fresh water coolant, and for information on filling the fresh water system.

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

A. Fresh Water Coolant (Antifreeze) Mixture.

A freshwater and ethylene glycol antifreeze mixture should be used year-round. Water, when it freezes, expands sufficiently to split the heat exchanger and crack the engine block. A water/antifreeze mixture of proper concentration will prevent freezing, reduce boil over and provide corrosion protection. Use soft water with few impurities, such as tap water (potable water) or rainwater. Never use hard or foul water. Use of hard water containing impurities will lead to the collection of scale in the engine and heat exchanger which will reduce the cooling system's efficiency. Antifreeze of poor quality or without proper inhibitors will cause corrosion within the cooling system. Always use antifreeze which is compatible with aluminum cooling system components and is made by a reliable manufacturer. Never mix different brands of antifreeze. Make sure the engine's cooling system is well cleaned before adding antifreeze. Recommended antifreeze for year round use is ZEREX or PRESTONE with rust inhibitors.

In order to control the concentration of the mixture, mix the antifreeze and freshwater thoroughly before adding it to the cooling system.

ANTIFREEZE CONCENTRATION DATA

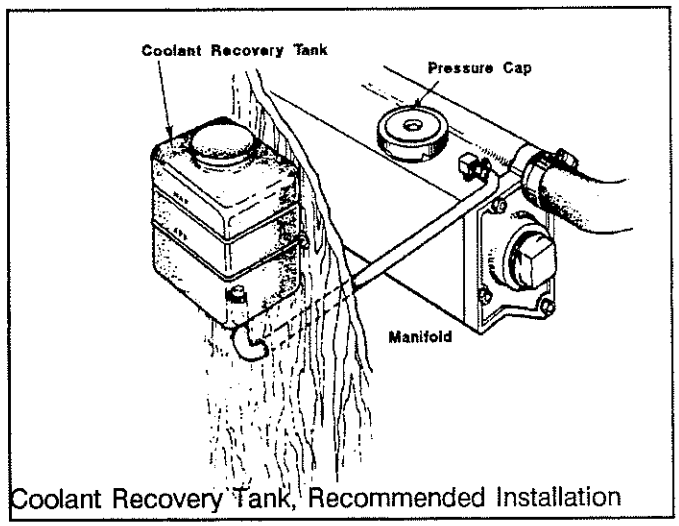
Antifreeze Concentration	%	13	23	30	35	45	50	60
	°F	23	14	5	-4	-22	-40	-58
Freezing Temperature	(°C)	(-5)	(-10)	(-15)	(-20)	(-30)	(-40)	(-50)

A 50/50 ethylene glycol mixture is recommended for year round use even in southern areas. Mixtures below 30% or above 65% are not recommended.

B. Filling the Fresh Water System

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

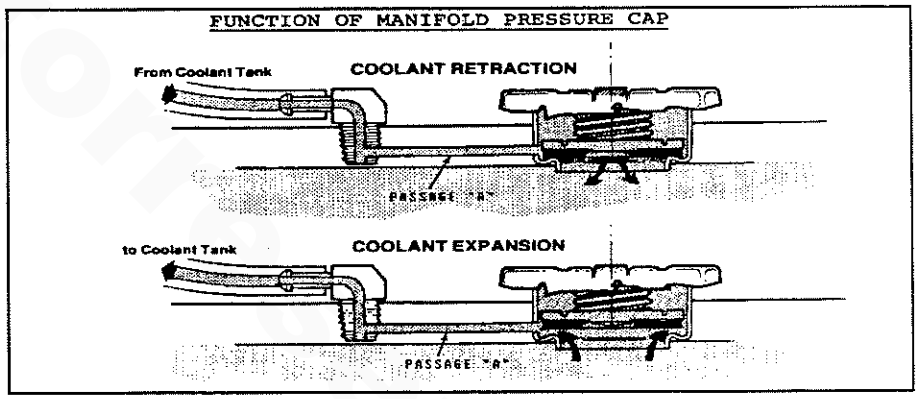
This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed. A stainless steel mounting bracket is supplied with each kit along with a 30-inch length of clear plastic hose and clamps to connect the hose between the engine's manifold fitting and the hose spud on the base of the recovery tank.



Coolant Recovery Tank, Recommended Installation

Coolant from the engine, when heated during engine operation, will expand, lifting the spring-loaded manifold pressure cap, and enter the recovery tank via the hose connecting the recovery tank to the manifold.

When the engine is shut down and cools, a small check valve in the pressure cap is opened by the contraction of the engine coolant, allowing some of the coolant in the recovery tank to be drawn back into the engine's cooling system, free of air and without loss. Periodically check that the passage (**A**) between the 90° fitting on the manifold and the filler neck in the manifold is clear so coolant can flow in either direction.



Fill the fresh water system as follows:

1. Remove the pressure cap from the manifold.
2. Pour a clean, antifreeze mixture into the manifold and allow enough time for the coolant to fill the fresh water cooling system.

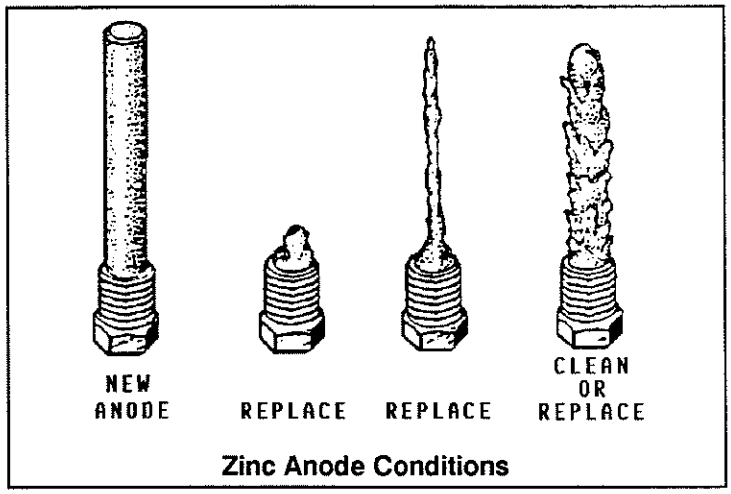
   Note: Open the air bleed petcock on the heat exchanger to help remove air from the exchanger during filling, close when coolant flow is present.
3. Start the engine and allow it to come up to its operating temperature. Monitor the coolant in the manifold and add antifreeze coolant as air is expelled. Once all air is expelled from the system, fill the manifold to the filler neck and install the pressure cap.
4. Remove the plastic cap from the plastic coolant recovery tank and fill the tank with coolant halfway between the **ADD** mark and the **MAX** mark. Replace the plastic cap.
5. Run the engine and observe the coolant's expansion flow into the plastic recovery tank.
6. Check for leaks between the pressure cap/filler neck and then plastic recovery tank. Stop the engine and allow it to cool. Coolant should be drawn back into the cooling system as the engine's temperature comes down. Add coolant mixture to the recovery tank as required. Some coolant will be lost through evaporation.

Thermostat

Generally, thermostats are of two types. One is simply a choking device which opens and closes as the engine's temperature rises and falls. The second type has a bypass mechanism. Usually this is a disc on the bottom of the thermostat which moves downward to close off an internal bypass passage within the head. Since 1980, each type of thermostat has a hole punched through it. The hole is a bypass to prevent the exhaust manifold from overheating during the engine's warm-up. Replacement thermostats must have this design characteristic.

Sea Water Circuit

The sea water flow is created by a positive displacement, neoprene impeller pump. The pump draws sea water directly from the ocean through the sea cock and sea water strainer and passes the water to the heat exchanger's sea water inlet. The sea water passes through the heat exchanger's tubes, absorbing heat from the fresh water circulating around the tubes. The sea water is then discharged from the cooling system overboard through the water-injected wet exhaust system.

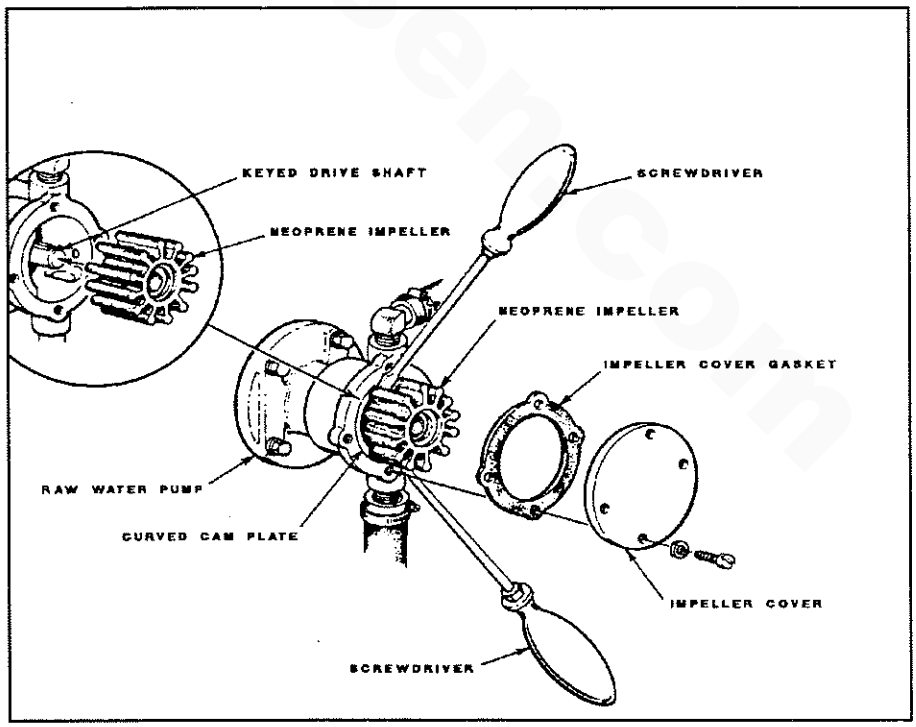


Zinc Anode Conditions

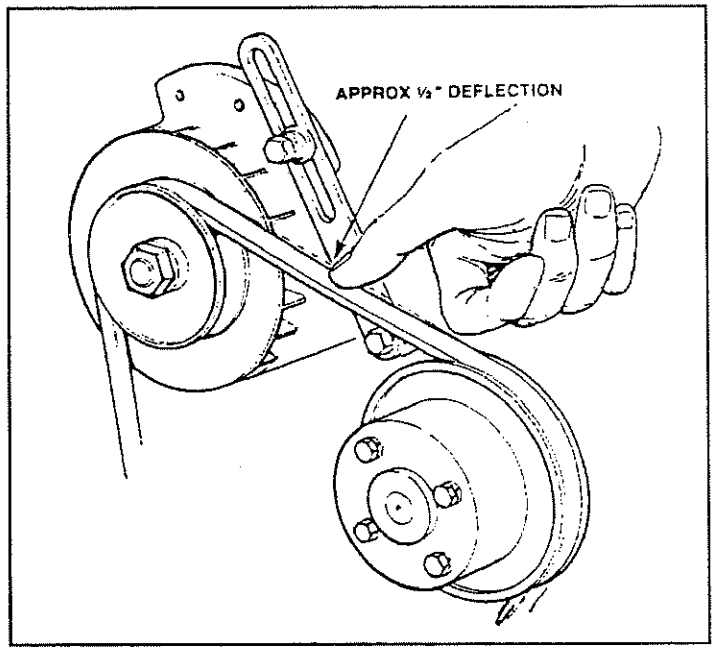
One or two zinc pencil anodes are located in the sea water cooling circuit within the heat exchanger. (Refer to your model's parts list for quantity.) The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the sea water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board. Zinc anode debris should be cleaned from the area inside of the heat exchanger where the zinc is located. If this zinc debris is allowed to accumulate, it will block the tube openings through which the cooling sea water should flow.

Raw Water Pump

The raw water pump is a self-priming, rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. On no account should this pump be run dry. 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 the operators are cautioned to make sure raw water flow is present at start-up.



Alternator and Water Pump Drive Belt Tension



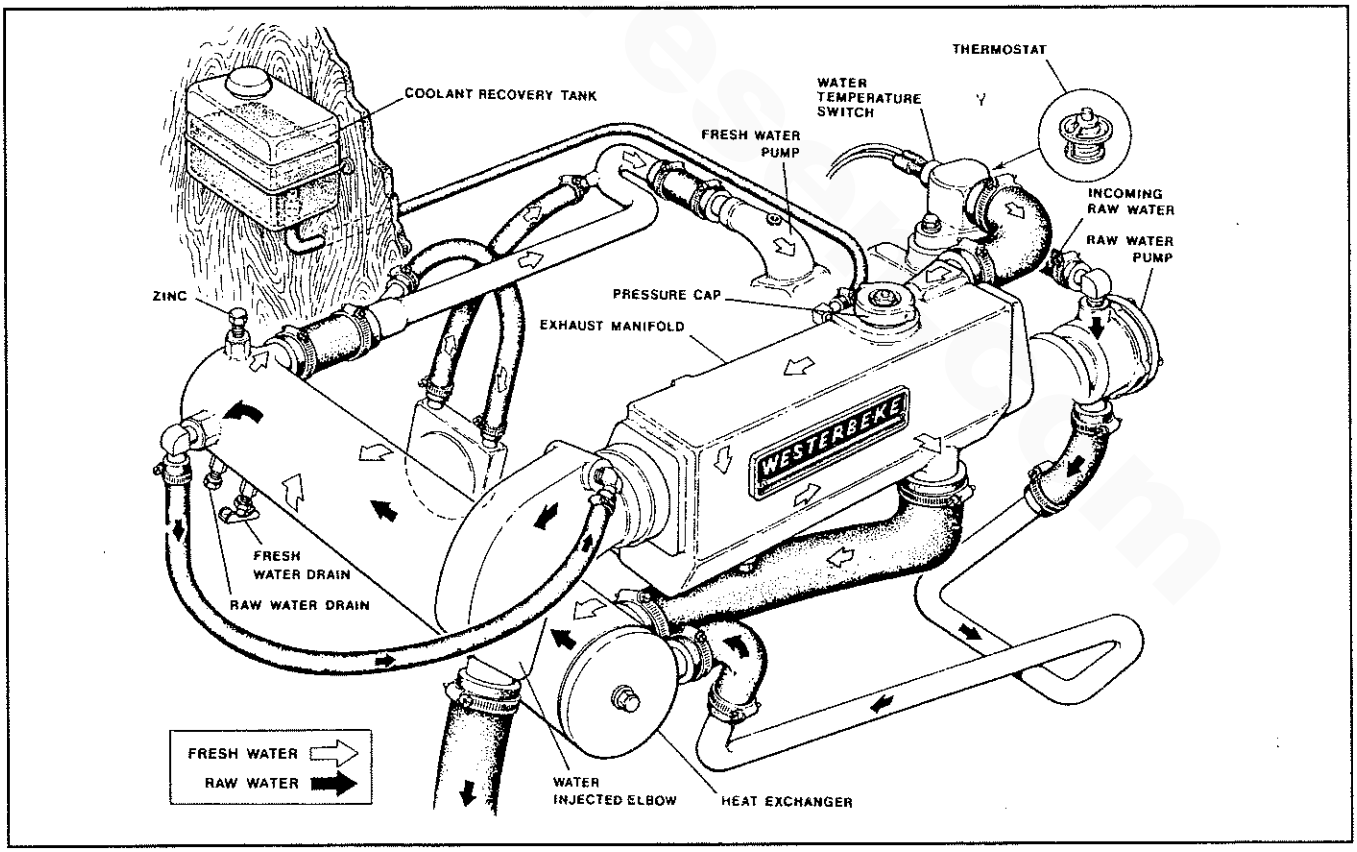
WARNING

Never attempt to adjust the drive belt's tension while the engine is in operation.

CAUTION

Excessive alternator and water pump drive belt tension can cause rapid wear of the belt and reduce the service life of the fresh water pump and alternator shaft bearings. Excessive slack or the presence of oil on the belt can cause belt slipping, resulting in high operating temperature, as well as insufficient alternator output.

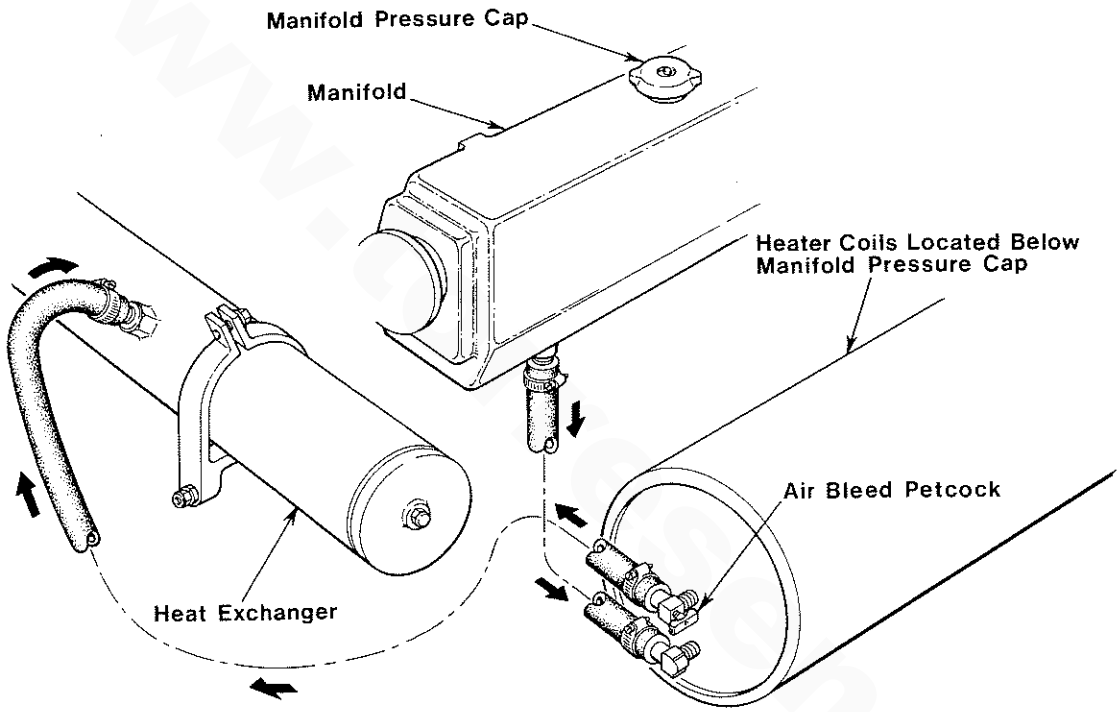
The illustration below shows the basic layout of the cooling system for the models referenced in this manual.



Domestic Hot Water

The models refered to in this manual are equipped with connections for the plumbing of engine freshwater coolant to a domestic hot water heater. One connection (to) is located on the lower side of the exhaust manifold. The other connection (return) is located on the center outer surface of the heat exchanger. Both of these connections have square head 1/2 N.P.T. plugs in them to plumb a domestic hot water heater into the engine's freshwater system. Remove both of these plugs and install the appropriate hose nipple 1/2 N.P.T. x 3/4 I.D. to route hose to and return from the domestic water heater.

Installation: The heater should be mounted conveniently 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.



HEATER BELOW ENGINE

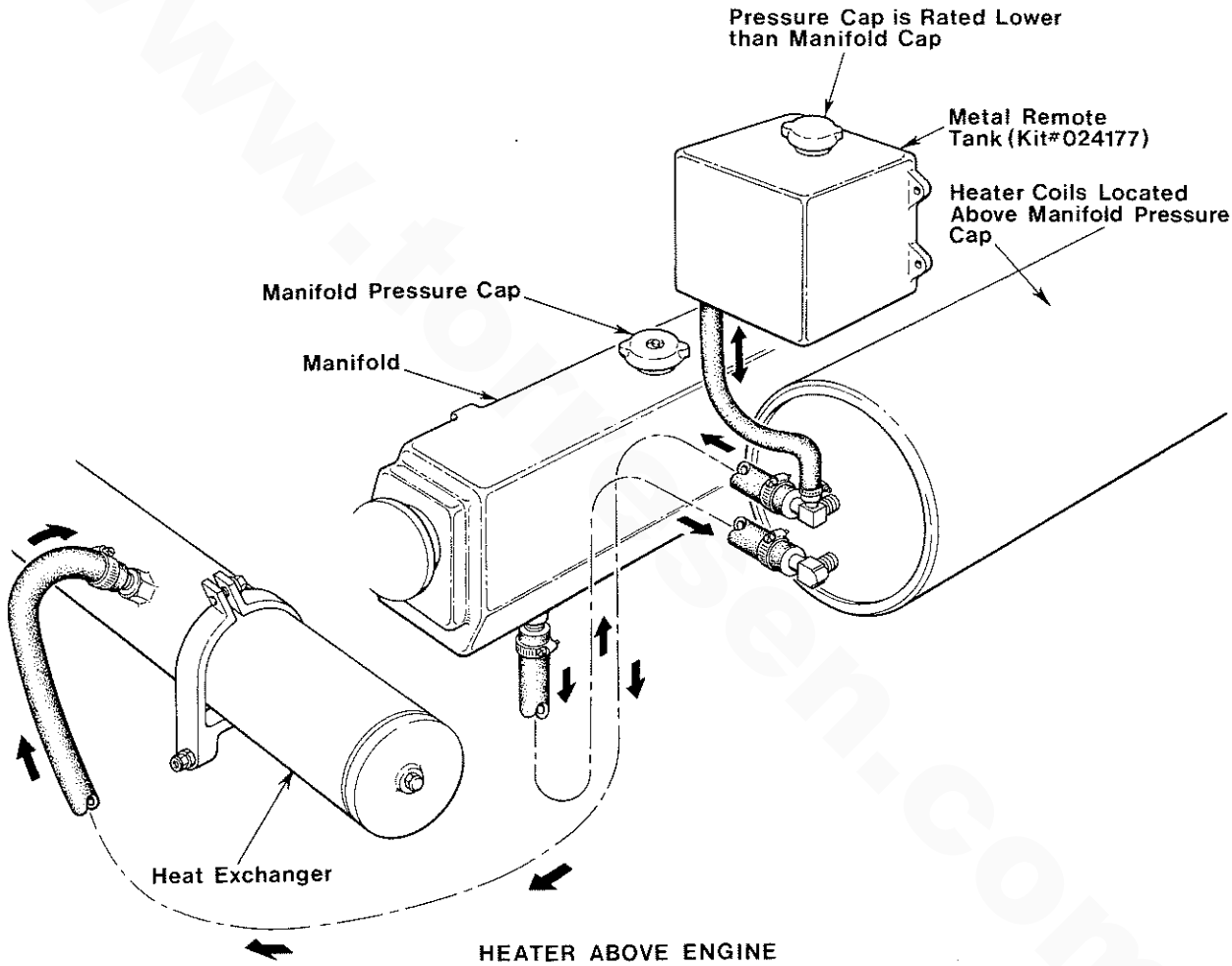
Hoses should rise continuously from their low point at the heater to the engine so that trapped air will rise naturally from the heater to the engine. If trapped air is able rise to the heater, then an air bleed petcock must be installed at the higher fitting on the heater for bleeding air while filling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

> **NOTE:** If any portion of the heating circuit rises above the engine's own pressure cap, then a pressurized (aluminum) remote expansion tank **must** be installed in the circuit to become the highest point. The remote expansion tank's part number is 24177. Tee the remote expansion tank into the heater circuit at the heater connection, choosing the higher of the two for the return. Tee right 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 such as in a sail locker so the fresh water coolant level can easily be checked. The remote expansion tank will now serve as a check and system fill point. The plastic coolant recovery tank is not used when the remote expansion tank kit is installed, since this tank serves the same function.

The pressure cap on the engine's manifold should be installed once the engine's cooling system is filled with coolant. Finish filling the cooling system from the remote tank once the system is filled and is free of air and exhibits good coolant circulation. During engine operation, checking the engine's coolant should be done at the remote tank and not at the engine manifold cap.

The hose connection from the heater to the remote expansion tank should be routed and supported so as to rise continuously from the heater to the tank, enabling any air in the system to rise.

NOTE: An air bleed petcock is located at the top center of the engine's heat exchanger. Open this petcock when filling the freshwater system to allow air in the exchanger to escape. Close tightly once all air is removed.



HEATER ABOVE ENGINE

LUBRICATION SYSTEM

Engine Oil

For engine lubrication, use lubricating oil designated for diesel service. These oils are classified according to the API specifications into service grades CA, CB, CC and CD. The use of CC or higher (CD) grades, made by well-known manufacturers is recommended. The oil selected should be used thereafter.

Engine Oil Viscosity (SAE Number)

Use an oil having a viscosity best suited to the atmospheric temperature. Use of an all-season oil SAE 10W-30 with minimum viscosity change under different temperatures is suggested.

Atmospheric Temperature	Viscosity
60° F (20° C) or higher	SAE 30 or 10W-30
40° F (5° C) - 60° F (20° C)	SAE 20 or 10W-30
40° F(5° C) - or lower	SAE 10W-30

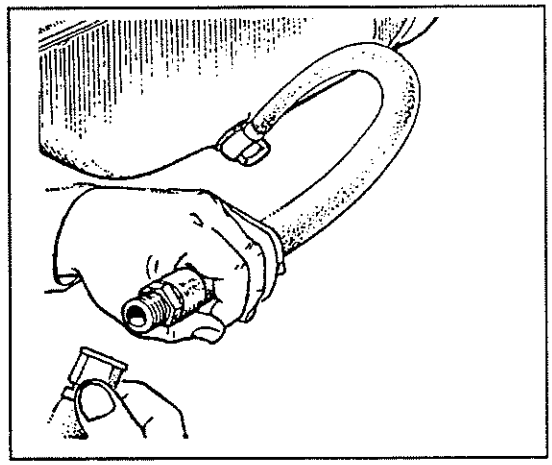
NOTE: Do not use an engine lubricating oil with an SAE number greater than 30 in the engine.

Oil Pressure

The oil pressure during operation of the engine is indicated by the oil pressure gauge on the Admiral Panel.

During normal operation, the oil pressure will range between 30 and 60 psi. At idle speed, the oil pressure will range between 15 and 30 psi. At the time of cranking, the oil pressure will rise proportionately with speed.

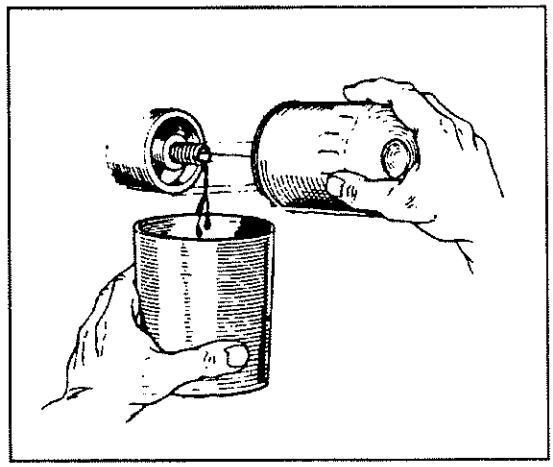
NOTE: A newly started, cold engine can have an oil pressure reading upwards of 60 psi. A warmed engine can have an oil pressure reading as low as 15 psi. These readings may also vary depending upon the speed at which the engine is running.



Engine Oil Change (to include filter)

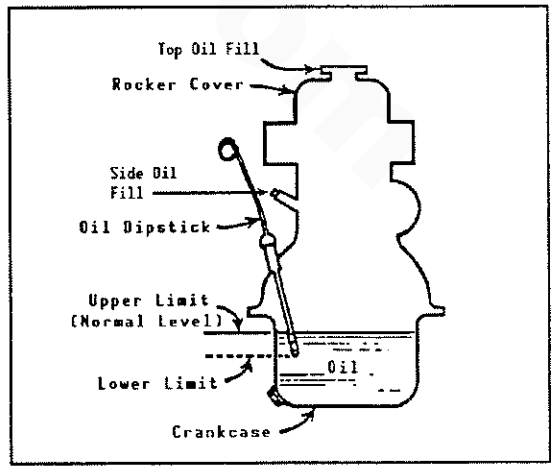
1. Draining the Oil Sump
   Remove the oil drain hose from its attachment bracket and lower it into a container and allow the oil to drain, or attach a pump to the end of the drain hose and pump the old oil out. Make sure the oil drain hose is properly secured in its holder after all of the old oil has 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 should water be present in the oil. Raw water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning through the raw water cooling circuit into the exhaust, filling it up into the engine.



2. Replacement of the Oil Filter
   When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. An automotive filter wrench should be helpful in removing the old oil filter. Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil left in the filter. (Oil or any other fluid on the engine reduces the engine's cooling ability. Please keep your engine clean.) Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket came off with the old oil filter. If this rubber sealing gasket remains sealed against the engine block, gently remove it. The replaceable cartridge-type oil filter requires no cleaning inside, so it may be properly disposed of. When installing the new oil filter element, wipe the filter gasket's sealing surface on the engine block free of oil and apply a thin coat of clean engine oil to the rubber gasket on the oil filter. Screw the filter onto the threaded oil filter stub, and then tighten the filter firmly by hand.

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



3. Filling the Oil Sump
   Add fresh oil through the oil filler cap on the valve cover (refer to the photos at the beginning of this manual for filler cap location on your unit and lube oil dipstick). 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 high mark on the dipstick, should the engine require additional oil.

HBW TRANSMISSION

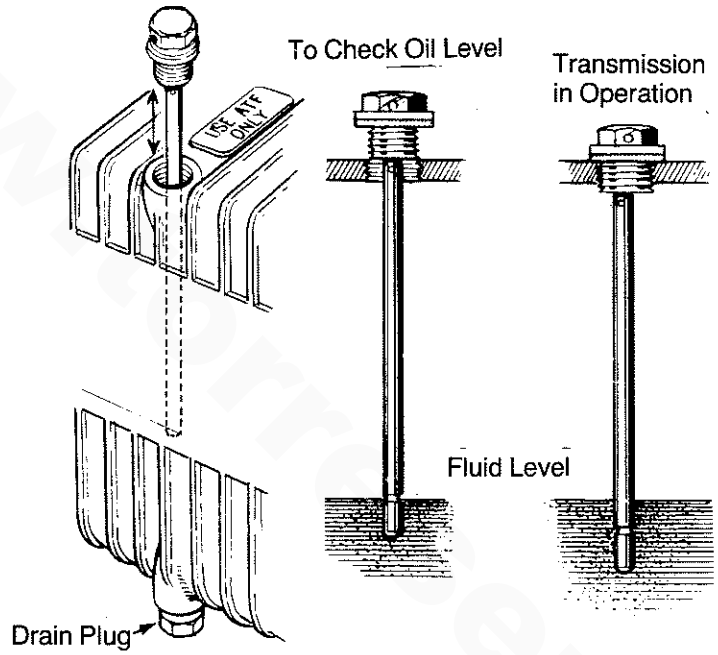
General Information

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

Initial Operation

Fill the gearbox with Automatic Transmission Fluid (DEXRON II) as recommended. The fluid level should be up to the index mark on the dipstick (see illustration)

To check the fluid level, just insert the dipstick, do not screw 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.



Dipstick Oil Level

Operation of Gearbox

The neutral position of the operating lever on the control console must coincide with the neutral position of the actuating lever on the transmission. Shifting is initiated by a cable or rod linkage via the actuating lever and an actuating cam. The completion of the gear changing operation is servo-automatically controlled within the gear.

Gear changing should be smooth, not too slow, and continuous (without interruption). Direct changes from forward to reverse are permissible, since the multiple-disc clutch permits gear changing at high rpm, including sudden reversing at top speeds in the event of danger.

Sailing and Moving in tow

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

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

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

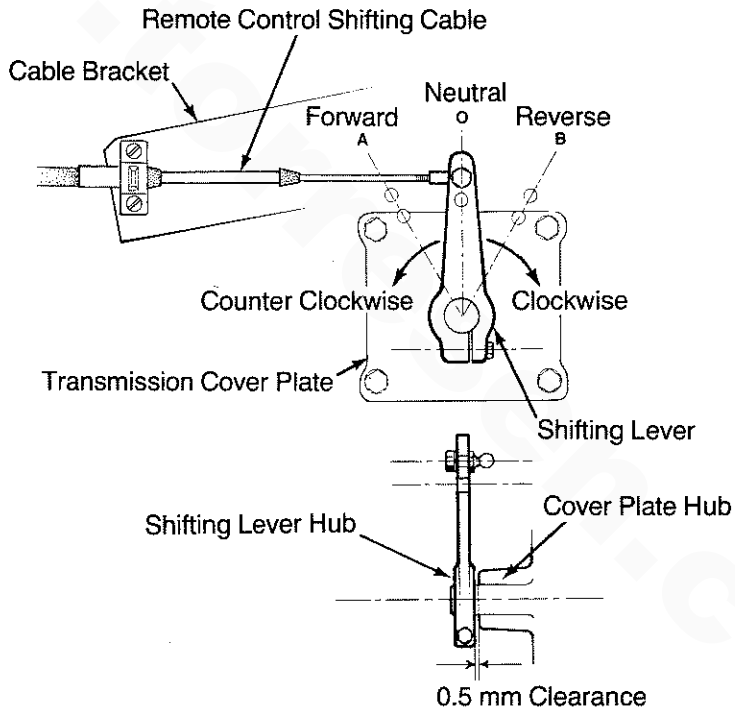
The gearbox is suitable for single lever remote control. Upon loosening the retaining screw, the actuating lever (see illustration) can be moved to any position required for the control elements (cable or rod linkage). Make certain that the lever does not contact the actuating lever cover plate: the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

The control cable or rod should be arranged at right angles to the acutating lever in the neutral position of the lever. The neutral position of the operating lever on the control console should coincide with the neutral position of the lever. The neutral position of the operating lever on the control console should coincide with the neutral position of the actuating lever on the gearbox.

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 preamature wear, excessive heat generation and clutch plate failure. This would be indicated by slow clutch engagement or no engagement at all.



Transmission Shifting Positions

The position of the cover plate underneath the acutating lever is factory-adjusted to ensure equal lever travel from neutral position to A and B.

If this side shift cover is removed or in anyway tampered with, the transmission warranty will be void. Authorized Hurth personnel **only** may adjust or remove this cover.

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

In order to mount a support bracket for control cable connections use the two threaded holes M8 X 12 deep located above the shift cover on top of the gear housing. Reference parts list.

Maintenance

Transmission Fluid

To ensure trouble-free operation of the clutch only use Automatic Transmission Fluid (ATF), (DEXRON II).

Fluid Quantity

HBW 360	1.5 ltr (plus quantity of cooling device)
HBW 360 A	1.4 ltr (plus quantity of cooling device)
HBW 450	2.0 ltr (plus quantity of cooling device)
HBW 630	2.5 ltr (plus quantity of cooling device)

When filling gearbox with fluid, proceed as follows:
- fill with fluid quantity from above chart.
- run engine until pipes and cooling device is filled with fluid.
- refill fluid quantity up to the index mark on the dipstick.

Fluid Change

Change the fluid for the first time after about 25 hours of oepration, then at intervals of at least one year.

Attention: When changing fluid, also drain cooling device, clean it if necessary.

Checking the Bowden Cable or Rod Linkage

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

Connection of Gearbox with Propeller

We recommend a flexible connection between the gearbox and the propeller shaft if the engine is flexibly mounted, in order to compensate for angular deflections. The installation of a special propeller thrust bearing is not required, since the propeller thrust will be taken by the transmission bearing, provided the value specified under 'Technical data' 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 flexible coupling reduces stresses in gearbox bearings caused by hull distrotions, especially in wooden boats or where the distance between gearbox output flange and sterngland is less than about 800 mm.

Lay-up

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

HSW TRANSMISSION

1. Operation

All HSW transmissions have been submitted to a test run before shipment.

In normal operation, the transmission should only be shifted with the engine at idle speed. In emergency cases it is also admissible to shift at higher speeds.

Optimum effectiveness of fluid can only be assured if fluid and filter are changed regularly according to maintenance schedule.

Visual checks for leakage should be made from time to time.

WARNING

Work on the transmission must only be performed with the engine and propeller at standstill.

CAUTION

Before the first start-up, the transmission must be filled with transmission fluid.

For filling procedure, fluid type, quantity and level refer pages 76 - 78.

CAUTION

Using the transmission with an insufficient oil level will damage the gears. An excessive oil level may cause leakage at the shaft seals and transmission breather, and raise the operating temperature considerably.

2. Operation Procedure

CAUTION

Before operating the transmission, check fluid level. In normal operation, the transmission should only be shifted with the engine at idle speed. Shifting at higher engine speed may lead to overstress of the friction linings of the coupling and flywheel damper plate and should be avoided in normal operation.

NOTE: The transmission may be shifted from forward to reverse in case of emergency even up to an engine speed of 3200 rpm. The transmission is shifted by actuating the shifting lever (figure IV-1, item 1) at the control block (figure IV-1, item 2).

Shifting positions:

A = Propeller rotation Right Hand.

N = Neutral position

B = Propeller rotation Left Hand

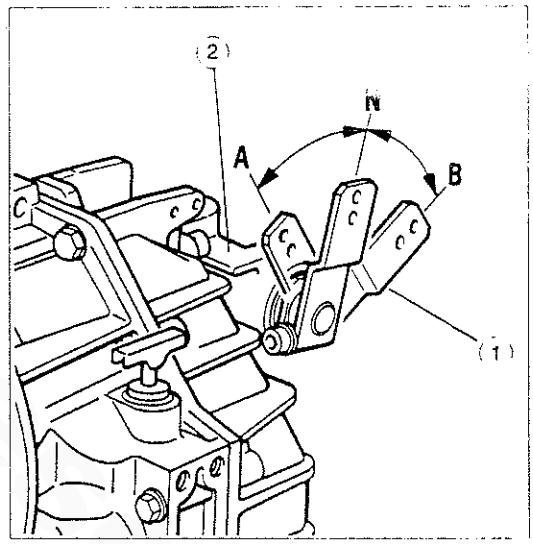


Figure IV-1

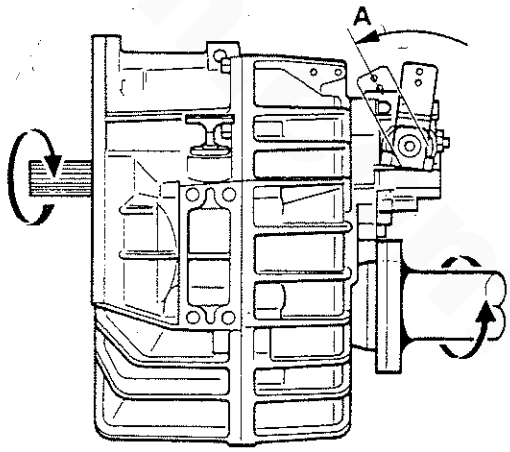
WARNING

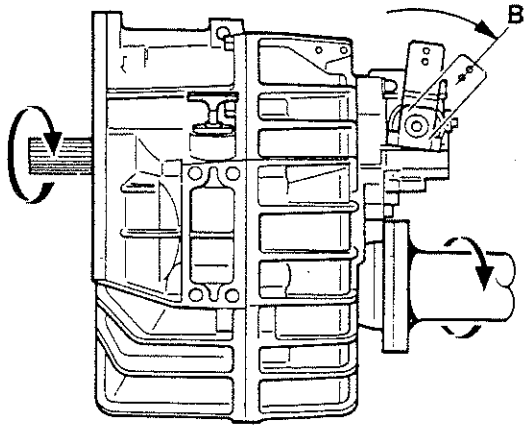
Start engine with transmission in neutral only.

The operating temperature of the transmission should not exceed 176° F (80°C).
A connection for a temperature probe has been provided. At maximum output of the engine, the fluid temperature may reach 220°F (105°C).

CAUTION

If the fluid temperature is too high, stop engine immediately and check transmission fluid level and oil cooler for proper water flow. Do not start the engine again until the malfunction is eliminated.





2.1 Moving in tow or anchoring

When the boat moves in tow or is anchored, the propeller may turn with the water current. This represents no danger for the transmission. In a boat with two engines, the propeller of the unused transmission may idle freely. When the engine is off, the position of the shifting lever is irrelevant.

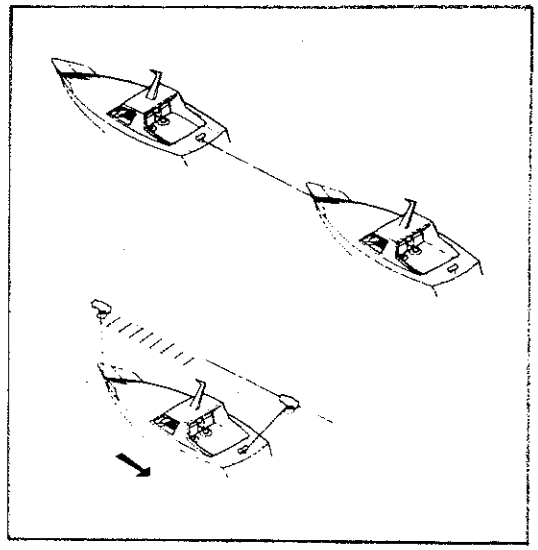


Figure IV-2

WARNING

- **Do not work on the transmission when being towed, or anchoring in a river because the propeller may rotate.**
- **Do not work on the transmission in a twin engine boat, when one unit is under power. The propeller shaft of the inoperative transmission will rotate.**
- **When the engine runs at idle, (such as when charging the battery with the alternator), the shifting lever (figure IV-3, item 1) must be held in the neutral position (N) to prevent the boat from moving.**

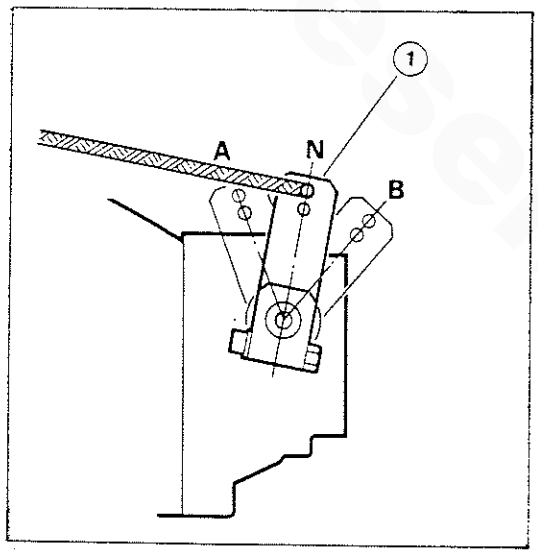


Figure IV-3

WARNING

Do not work on transmission when engine and propeller are running. Always wear gloves when working on a hot transmission.

1. Fluid level check.

Transmission fluid level can be checked in a cold or a hot condition.

Always check fluid level before operating transmission.

1.1 Loosen fluid dipstick (figure VI-1, item 1) by turning the handle counterclockwise.

1.2 Wipe dipstick with a clean and dustfree cloth.

1.3 Insert dipstick to its stop. Remove dipstick and check fluid level again.
NOTE: Quantity of fluid level between minimum and maximum marks is 0.53 US-qts. (0.5 liters).

1.4 Insert the dipstick to its stop and lock it in place by turning the handle clockwise.

CAUTION

Depending on the type and arrangement of the cooler and hoses, a certain amount of fluid will remain in these after stopping the engine and may flow back into the transmission after a long period of non-use. This may cause the fluid level in the transmission to exceed the max. mark. Do not remove this surplus fluid but proceed according to steps 1.5 and 1.6.

1.5 Let engine run at idle speed with shifting lever in neutral position until fluid cooler and all pipelines are filled with fluid.

1.6 Stop the engine and check fluid level again. If necessary, top fluid level up to the dipstick max. mark. The fluid level on the dipstick (figure V-2, item 1) should be between the min. and max. marks. The fluid levels should be checked again after a short period of vessel use.

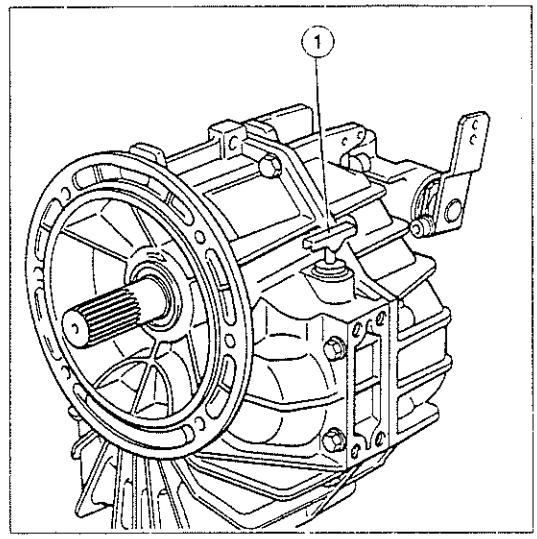


Figure V-1

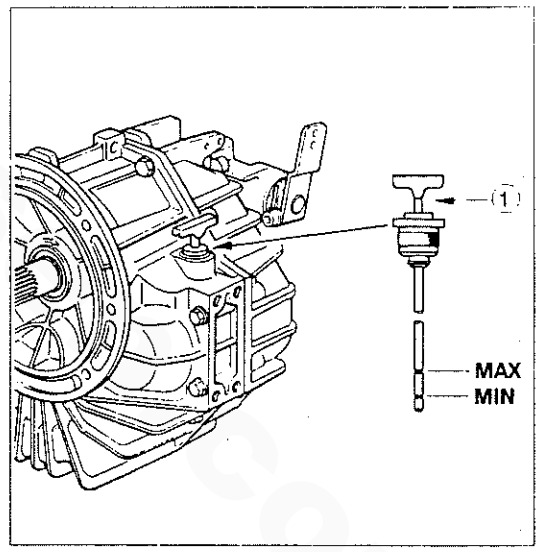


Figure V-2

2. Fluid Change

The first fluid change must be performed after 25 hours of operation. All subsequent fluid changes are to made after every 300 hours of operation or once in a year (according to the time which is reached first).

NOTE: The filter element (figure V-4, item 1) must be renewed whenever the fluid is changed.

Replacement filter elements should be obtained from a local Hurth Transmission service center. The filter part number is embossed on the filter element. Always carry a spare!

2.1 Remove Fluid Filter

2.1.1 Turn the filter cover (figure V-3, item 1) counterclockwise and gently pull out of the housing.

2.1.2 Pull filter element (figure V-4, item 1) off.

2.1.3 Check O-rings (figure V-4, item 2 and 3) for damage, replace if necessary.

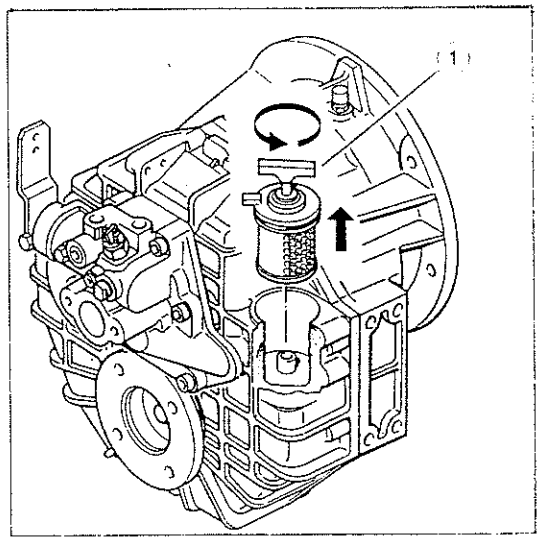


Figure V-3

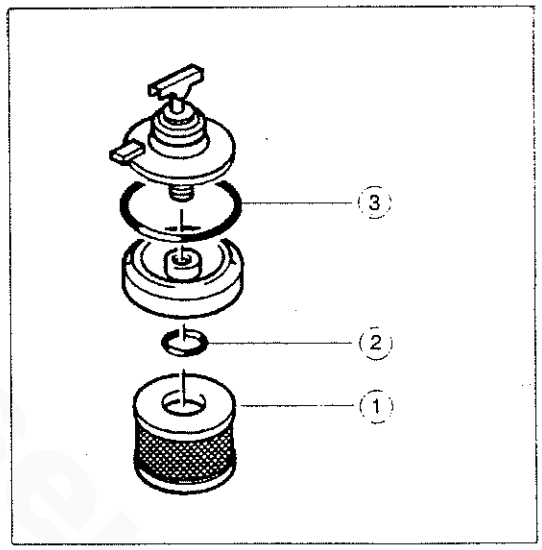


Figure V-4

2.2 Draining Transmission Fluid

2.2.1 Push the hose of a suction pump (figure V-5, item 1) through the suction pipe (figure V-5, item 2) that the filter rests on down to bottom of the housing and such the fluid approx. 3.7 US-qts. (3.5 liters) out.

NOTE: Maximum outside diameter of suction hose is 5/8 inch (16 mm).

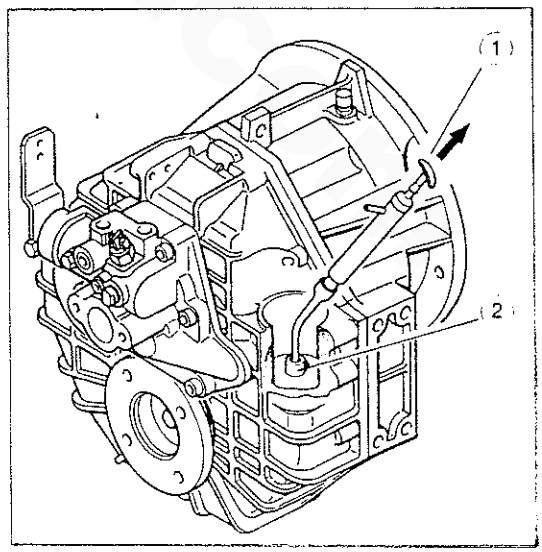


Figure V-5

2.3 Filling the Transmission Fluid

2.3.1 Fill with 3.7 US-qts. (3.5 liters) of Automatic Transmission Fluid (ATF) or Dexron II figure 6, and add the amount required for cooler and hoses.

CAUTION

Only use automatic transmission fluid such as Dexron II-D, or Ford M2C-33G.

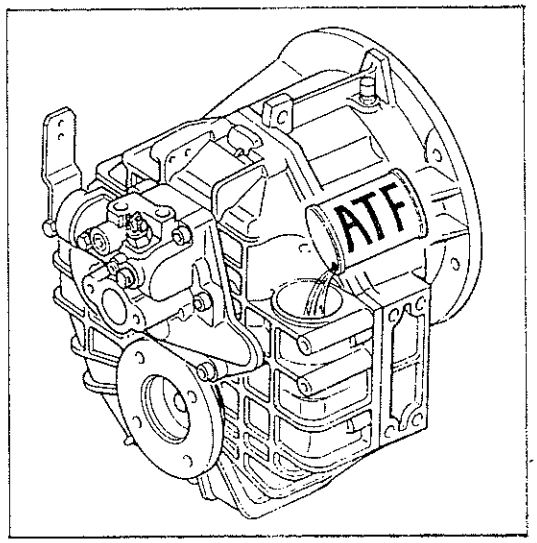


Figure V-6

2.4 Insert fluid filter into housing

2.4.1 Place new filter element onto cover.

2.4.2 Lock filter cover in place by turning clockwise.
Figure V-7
The fluid level should be checked again after a short period of running.

3.0 Trial Run

3.1 Carry out a trial run after the fluid change.

3.2 Set shifting lever to neutral position (N). Start the engine and let it run idle for a short time to fill the cooler and hoses with transmission fluid.

3.3 Stop the engine and check fluid level again. If necessary, add additional fluid to bring the level to the max. mark. Do not over fill!

The fluid level on the dipstick (figure V-2, item 1) should be between the min. and max. marks. The fluid level should be checked again after a short period of operation.

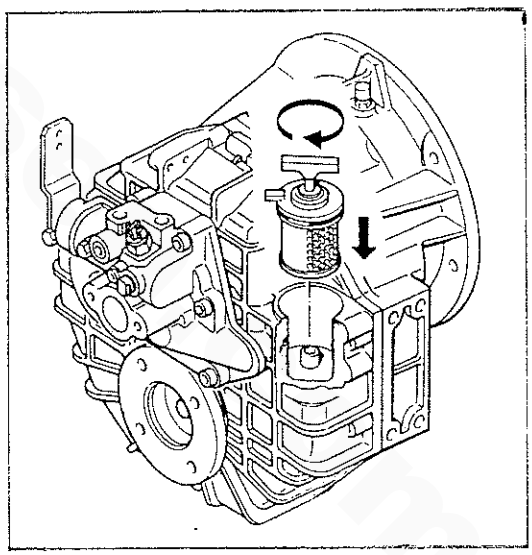


Figure V-7

4.0 Storage

If the transmission is stored for a long period of time 12 months or more, it should be topped up with fluid through the dipstick hole to prevent the unit from the unit from corroding on the inside.

CAUTION

Reduce the fluid to the proper level when putting the unit back into service again.

Borg Warner Transmission

Operation

Perform all pre-operation maintenance on the Velvet Drive transmission. (Page 82)

At the helm place the transmission selector control in Neutral before starting 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.

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

CAUTION

Shifting above 1000 rpm can severely damage boat, transmission and engine.

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

b. **Forward** - Move selector lever to the forward position. You should feel the detent. The shift lever on the transmission is in the forward position. The output shaft and the propeller should move the boat in a forward direction.

WARNING

If boat moves backwards with the selector control in the forward position, shut off engine.

NOTE: This problem can be a result of improper installation by the boat builder or service facility.

CAUTION

Very early gear failure will occur when the transmission is operated in reverse to obtain forward motion.

c. **Reverse** - Move selector lever to the reverse position. You should feel the detent. The shift lever on the transmission is in the reverse position. The output shaft and the propeller should move the boat in a reverse direction. (Astern).

Velvet Drive Transmission Operation

a. Place selector control in the Neutral position. (Neutral Safety Switch Closes)

b. Start engine and set throttle at idle speed and warm up transmission oil for a few minutes.

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

CAUTION

Before checking oil, shut off engine. Hot oil could cause burns.

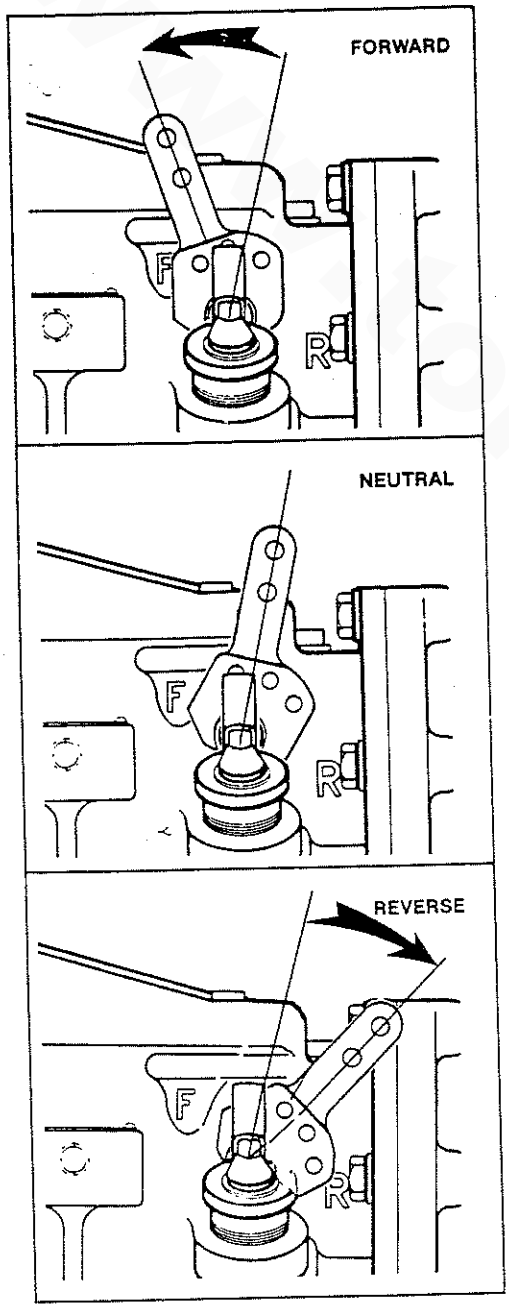
d. Shut off engine and check transmission oil level and add oil, if required, to the full mark on the dipstick.

e. Restart engine.

Shift Lever Position

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

NOTE: When moving the transmission shift lever from Neutral Position to Forward is always towards the engine. Reverse is always away from the engine.



CAUTION

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

The shifting mechanism and transmission shift lever should be free of dirt to ensure proper operation.

Do not remove detent ball!!!

Maintenance

a. Visually check for oil leaks at hydraulic connections, worn hydraulic lines.

b. Check for broken or loose fasteners.

c. Replace all worn hydraulic lines, tighten all connections where an oil leak has occurred, and secure all hydraulic lines. Add oil as needed.

d. Visually check all electrical connections for loose terminals and worn wires.

e. Repair or replace all worn or broken wires to U.S. Coast Guard specifications and tighten all loose connections.

f. Lubricate detent bal so it engages properly.

Transmission Bolts

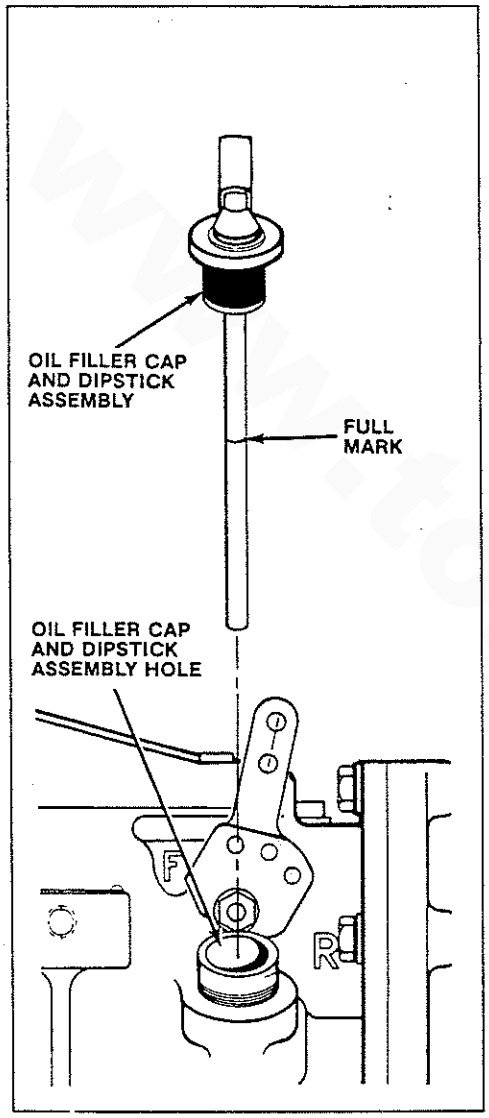
a. Check all exterior transmission bolts for tightness.

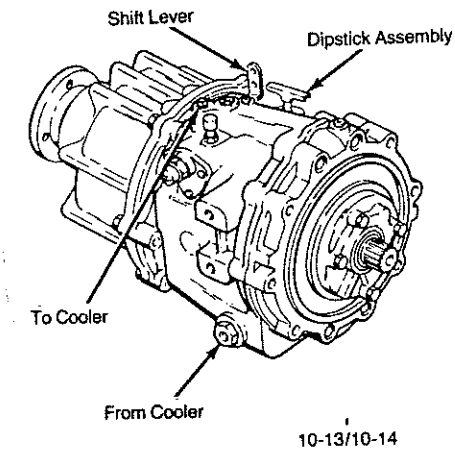
b. Tighten all loose bolts to recommended torque specifications.

c. Tighten all coupling bolts.

Change Transmission Oil

A seasonal transmission oil change is recommended for all pleasure boats. Work boats require tranmsission oil changes every 1,000 hours. Oil must be changed anytime it becomes contaminated, changes color, or becomes rancid smelling.





10-13/10-14

WARNING

Do not use gasoline or any other volatile or highly combustible liquid as a solvent.

Removing Transmission Oil (Oil Filler Cap)

a. Place an appropriate size container near oil cooler return line.

b. Remove oil filler cap and dipstick assembly.

c. Remove oil cooler return line.

d. Allow oil from return line to drain into container.

e. Connect oil cooler return line and torque to 25-35 ft.-lbs. (34-47 N•m).

f. Use a suction pump in the oil filler cap hole to remove remaining oil in the tranmsission.

g. Remove suction pump from transmission.

Fill Tranmsission With Oil

The quantity of oil depends upon the model Velvet Drive angle of installation and oil cooling system capacity.

a. Using a suitable transmission oil (see Recommended Transmission Oil Table below), fill transmission through dipstick hole until oil reaches full mark on dipstick.

b. Replace oil filler cap and dipstick assembly in hole. Press to bottom and turn clockwise until finger tight.

CAUTION

Before running engine replace oil filler cap and dipstick assembly. Hot oil expelled through the dipstick hole during operation of the gear could cause burns.

c. Connect battery and run engine to fill oil cooling system. With engine off promptly recheck oil with dipstick and fill as required.

Recommended Transmission Oil

Oil +	Conditions
Dextron II, Type F	Recommended
Transmission Fluid *	Recommended
SAE #30 *	Preferred **
SAE #40 *	Acceptable ** (High Temperature Only)
Multi-Viscosity Oil	Not Acceptable

* Detroit Diesel Allision Type C3 Specification
** Detroit Diesel Allision Type C3 Specification, Engine Speed Below 3,000 rpm.
+ SAE - AP1 Service Class CD Recommended, Class C Acceptable

Pre-operation

Pre-operation Maintenance is a precaution against a potentially costly major overhaul. The pre-operation maintenance procedure needs to be completed on a daily basis before starting engine.

a. Check transmission oil level on dipstick before operation. Add suitable oil as required.

b. Check for oil leakage in the bell housing, output shaft and other gasket sealed areas.

c. Visually check the general condition of the transmission and wipe clean.

During operation, be aware of any unusual noises or vibrations and investigate to determine the cause.

CAUTION

System related noises or vibrations can occur at low engine speeds which can cause gear rattle resulting in damage to the boat engine and/or transmission. Warner Gear is not responsible for total system related torsional vibration of this type.

Oil temperature maximum is 190°F (105°C) during operation. A transmission warning light (optional) will illuminate if oil temperature is too high. Should this occur, check transmission level or consult your nearest Velvet Drive distributor.

CAUTION

If drainback occurs, oil level must be compensated. To correct this, see your authorized Velve Drive transmission service facility.

Service manuals can be obtained by contacting the nearest Velvet Drive distributor.

Warranty Note: Gear failures the result of shock leads.
Reference Westerbeke
Service Bulletin #142
Dated 12 September 1984

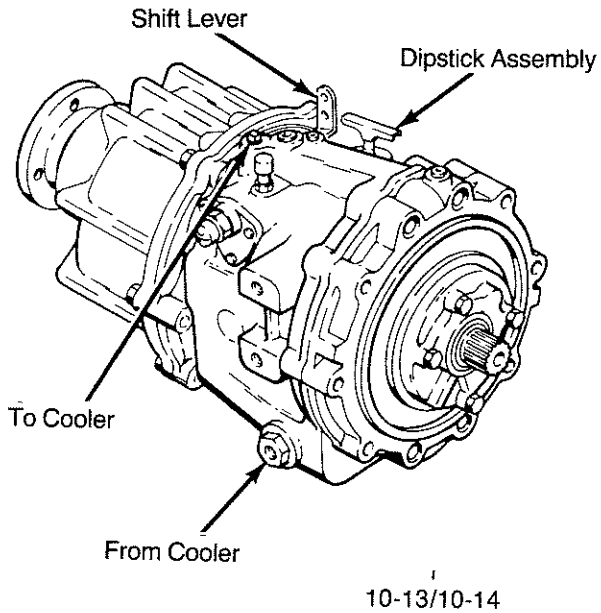
> Borg Warner is aware of the shock loads that can be placed on it's gears the result of mechanical propeller operation with opening or fully reversing of propeller blades while shifting. Therefore torque loads and directional changes should be made at low engine speeds.
>
> Borg Warner reserves the right to make a determination as to cause of failure of its gear involving a warranty claim.
>
> If it is found that the failure was caused by a shock load, the warranty claim will be denied.

Lay-up

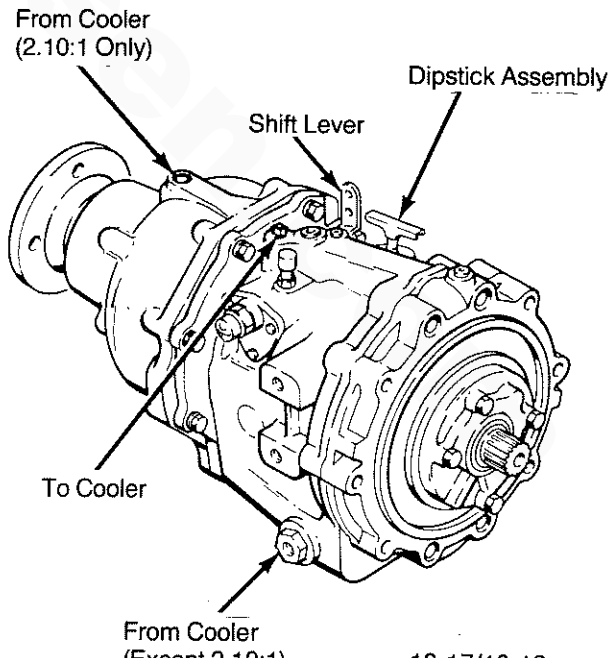
Storage requires special care. Before winter storage one must:

a. Disconnect the battery.
b. Drain water from the transmission oil cooling system.
c. Wipe transmission free of dirt, grime and grease.
d. Touch up unpainted areas of the transmission using suitable paint.
e. Loosen attaching hardware from transmission output flange and propeller shaft coupling flange before removing boat from water and separate flanges.

TRANSMISSION CONNECTION & REFERENCE POINTS



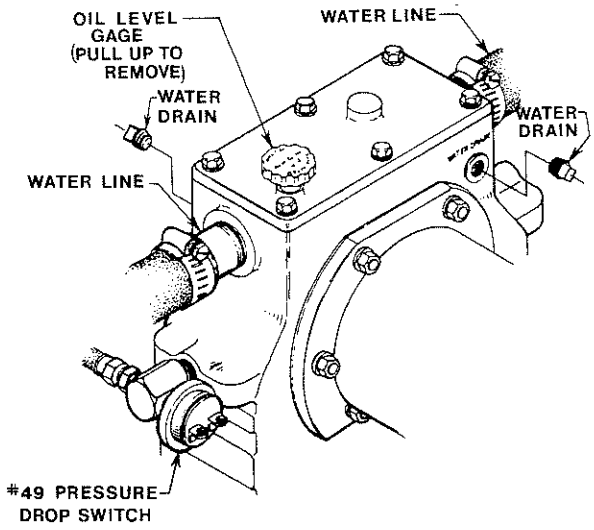
10-13/10-14



10-17/10-18

Operation

A pressure drop warning light is mounted on the instrument panel on V-drives equipped with an oil circulating pump. The warning light will sta on until the boat gets under way and the engine speed increases to sufficient RPM for the pump to maintain pressure. This normally occurs at approximately 1200 RPM, but the actual speed may vary by as much as 400 rpm. Extended cruising at low rpm, such as when trolling, is not harmful to the V-drive, even though the warning light may stay lit. Normal operation is between 6 ro 12 psi. The light will go on when the oil pressure drops below 2 psi. Loss of oil and/or insufficient oil level are the major causes of pressure drop. The oil level should immediately be restored, and while running the boat, the unit should be checked for leaks. If the oil level is normal and the light stays lit when the boat reaches normal cruising speed, the wiring should be checked for loose and/or corroded connections. If the wiring is correct and the light remains lit, the #49 pressure drop switch, which is mounted on the side of the V-drive (see illustration), should be checked for proper operation.



The switch can easily be removed and an accurate oil pressure gauge installed in its place. If the pressure is normal, the switch should be replaced. If the pressure is below normal, the oil lines should be checked for blockage. The pump is standard on the RV-48 and an optional feature on other models (not available on the RV-10).

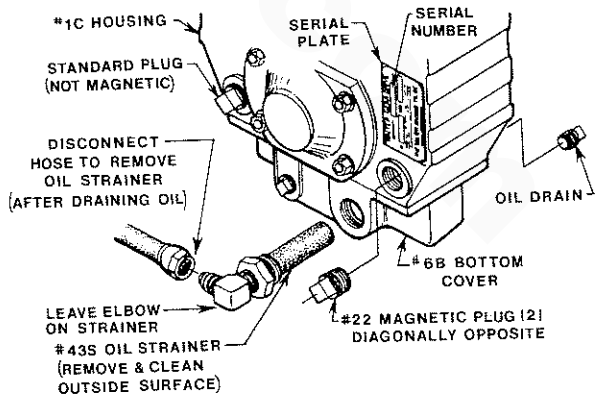
The oil level should be checked several times during the season, especially on V-drives without pumps (see Oil Fill).

A clatter or rattle in the V-drive at low rpm is due to the overriding of the propeller during the compression stroke of the engine. Although annoying, it is not harmful. It may be reduced by adjusting the idle speed up and/or tuning up the engine for smoother operation.

Maintenance

1. Oil Change And Joint Lube

After the first 100 hours or operation and every season and/or 500 hours thereafter, the oil should be changed. Run the boat to warm up the V-drive operating temperature. Turn off the engine. Remove the plugs in the #4B bottom cover that is opposite the #43S oil strainer from the #43S strainer (leave the elbow on the strainer). Unscrew the strainer and clean the outside surface. Reinstall the strainer and reconnect the oil hose. Unscrew the two #22 magnetic plugs that are located on diagonally opposite corners of the #1C main housing.



The plugs can be checked to see if they are magnetic only after removal. Touch the insides face with a

metallic object, such as a screwdriver. Clean them and reinstall. Usually, there are four plugs in the bottom part of the main housing. Only two of these are magnetic. The other two need not be removed. Refill with SAE 30 motor oil to the proper level (see Oil Fill). The Zerk fitting on the external universal joint should be greased with a light alemite lubricant (see Engine Alignment).

2. Water Drain

For protection from freezing during winter lay-up, remove the small pipe plugs (located diagonally opposite) on the front and back of the housing marked "Water Drain". On the RV-10 only, one of the water lines going into the #6 water-cooled bottom cover must be disconnected to drain the water.

3. Flange and Engine Realignment

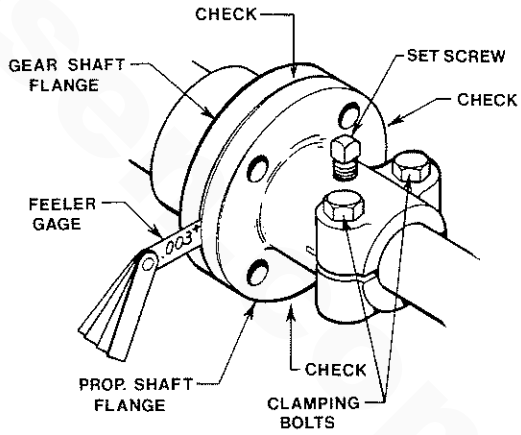
When the boat is launched after being in drydock, the line-up of the V-drive to the propeller shaft flange and the engine to the V-drive should be rechecked and corrected if necessary. Some engine with rubber mounts may sag and must be raised with adjustments or shims for proper alignment (see "Flange Alignment" and "Engine Alignment").

Dealer Preparation

The propeller shaft and engine alignment must be checked and corrected, if necessary, before the boat is delivered. Final alignment should not be attempted until the boat is allowed to "settle" in the water. The oil level must be checked and oil added if required. While the boat is being run, the water connections should be checked for leaks. The oil pressure drop switch and warning light (if the V-drive is equipped with an oil circulating pump) should be checked for proper operation. Do not transport the boat with the propeller shaft coupling connected. Damage to the shaft, shaft log and V-drive can result.

Flange Alignment - Direct Coupled Models

Install the propeller shaft flange on to the propeller shaft and tighten the two clamping bolts on the split hub (none on RV-10D). A self-locking set screw is provided for the propeller shaft flange. Spot drill the propeller shaft and securely tighten the set screw. Many good installations are ruined by improper shaft flange alignment. Accurate alignment will ensure a smooth operating drive train and eliminate many problems that arise due to misalignment. Final alignment should not be attempted until the boat has been allowed to "settle" in the water. After the engine has been installed, adjust the mounts per manufacturer's instructions until the pilot diameters of the gear flange engage freely. Butt the flange faces together. Without rotating either flange, check with a feeler gauge in at least four places as shown in the illustration.

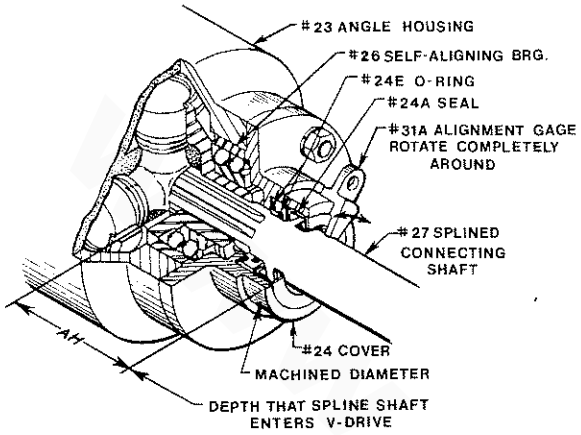


FLANGE ALIGNMENT

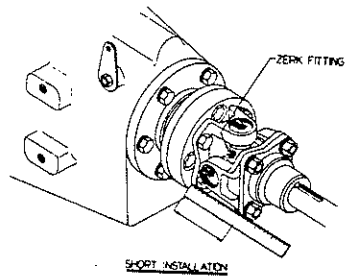
If the maximum feeler gauge that can slip between the flange faces at any point is .003", the unit is properly aligned. If a thicker gauge can be inserted at any point, the engine must be readjusted until proper alignment is obtained. Turn the propeller shaft flange 1/4 of a turn without moving the gear shaft change. Try inserting the .003" feeler gauge as described above. The gap will not change if the propeller shaft is straight. If it increases, the shaft or flange is bent and must be removed and straightened. Rotate the propeller shaft flange in two more 1/4 turn increments and repeat the procedure. The pilot diameters must be rechecked to ensure that they still engage freely. Secure the two flanges together with the heat treated bolts and special high collared lockwashers supplied.

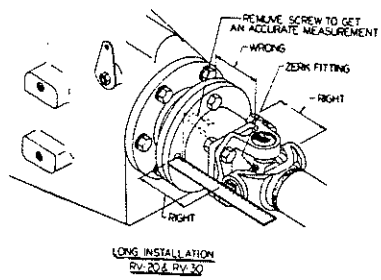
Engine Alignment - Independent Models

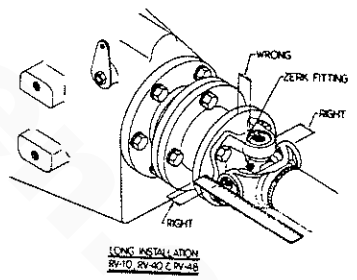
The engine must be adjusted so taht the alignment of the flexible joint is within 3°. An accurate steel rule should be used for this purpose as shown in the illustration. On short installations using a flexible joint assembly, the faces of the flexible joint must be parallel within 1/8".



Measure this in at least four places around the diameter without rotating the assembly. With long installations using the #36 tubular drive shaft (also on al RV-10D's) the distance from the #33A spool adapter to the bores in the universal joint which is welded to the tubular shaft must be measured on both sides of the joint. Rotate the shaft exactly 1/4 of a turn and measure to the same joint. The four distances must be equal within 1/8". (Don not measure to the joint end that is on the spool adapter. This distance will not vary with misalignment since the joint is bolted and cannot move.) Put the #31A alignment gauge on the machined diameter of the #24 cover and slide it completely around. It will indicate how the engine must be moved to center the spline shaft in the oil seal. Re-measure the joints to seal if they are still parallel within 1/8". It is important that both alignments be check thoroughly. It is possible for the spline shaft to be perfectly centered and the flexible joint not be out more than 3°. Premature failure of the #26 self-aligning bearing and seals may occur due to misalignment. The zerk fitting (located on the cross of the universal joint) should be greased with a light alemite lubricant. The above procedure should be repeated after the boat has been placed in operation. It is possible for the engine to slightly shift and settle, especially if it has rubber mounts.



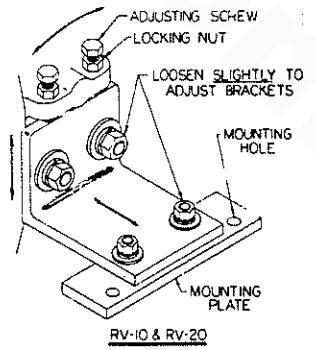




Flange Alignment - Independent Models

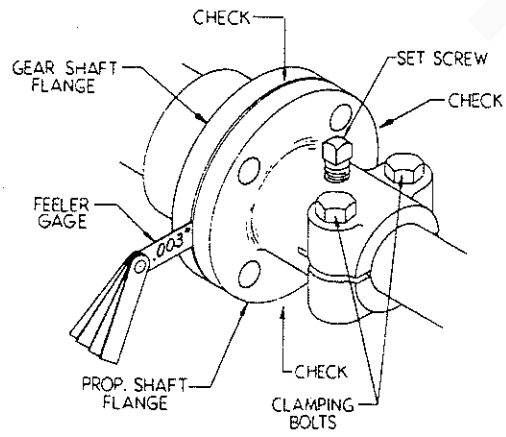
Install the propeller shaft flange on to the propeller shaft and tighten the two clamping bolts on the split hub (none on RV-10). A self-locking set screw is provided for the propeller shaft flange. Spot drill the propeller shaft and securely tighten the set screws.

All V-drives are supplied with 3-way adjustable mounting brackets (2-way on the RV-10 and RV-20) as standard equipment. The brackets must face downward as shown in the illustration to properly absorb propeller thrust. The mounting plates can be removed and reversed to fit wider engine bed centers.

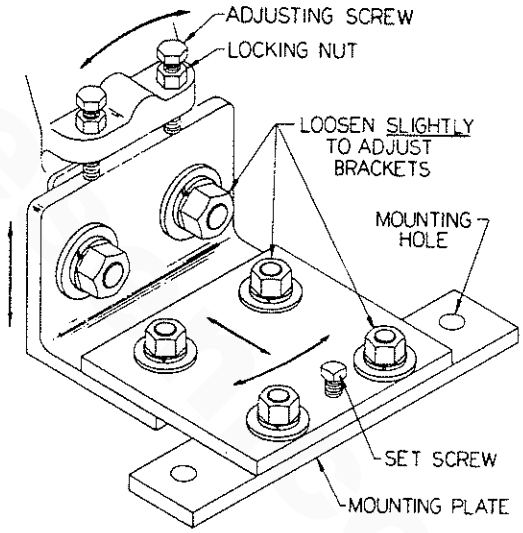


Before installing the V-drive, loosen all the nuts on the mounting brackets and check to see that the studs are in the center of the slots. Retighten the nuts. Place the V-drive on the engine bed, lining it up "by eye" to the propeller shaft flange as closely as possible. Firmly bolt it down through the holes provided in the mounting plates. Loosen the locking nuts on the adjusting screws. Slightly loosen the nuts on the mounting brackets just enough to be able to move the V-drive.

Many good installations are ruined by improper propeller shaft flange alignment. Accurate alignment will ensure a smooth operating drive train and eliminated many problems that arise due to misalignment. Final alignment should not be attempted until the boat has been allowed to "settle" in the water. Adjust the V-drive until the pilot diameters of the gear shaft flange and the propeller shaft flange engage freely. Butt the flange faces together. Without rotating either flange, check with a feeler gauge in at least four places as shown in the illustration. If the maximum feeler gauge that can slip between the flange faces at any point is .003", the unit is properly aligned. If a thicker gauge can be inserted at any point, the V-drive must be readjusted until proper alignment is obtained. Turn the propeller shaft flange 1/4 of a turn without moving the gear shaft flange. Try inserting the .003" feeler gauge as described above. The gap will not change if the propeller shaft is straight. If it increases, the shaft or flange is bent and must be removed and straightened. Rotate the propeller shaft flange in two more 1/4 turn increments and repeat the procedure. The pilot diameters must be rechecked to ensure that they still engage freely. Tighten the nuts on the mounting brackets and the locking nuts on the adjusting screws. Remove the set screws from the brackets (none on RV-10 or RV-20), spot drill and securely tighten. Recheck the flange alignment to make sure the V-drive did not move out of alignment. Secure the two flanges together with the heat treated bolts and special high collared lockwashers supplied.



FLANGE ALIGNMENT



RV-30, RV-40 & RV-48

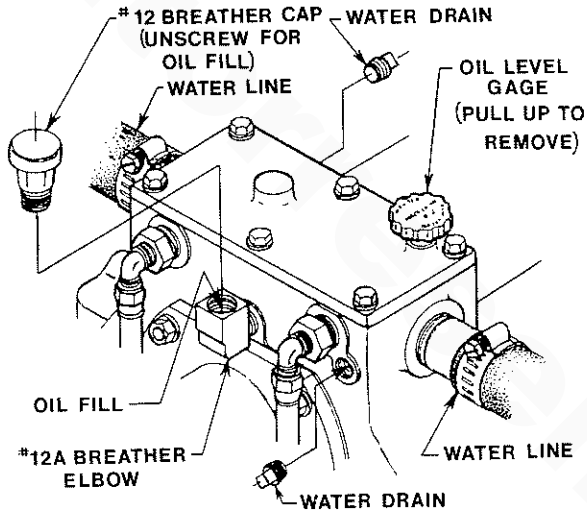
Water and Switch Connections

Hook up the water lines to the two pipe connections on the V-drive (intake and exhaust lines are interchangeable). Generally, one line from the seacock to the V-drive and another from the V-drive to the intake of the engine water circulating pump are utilized. In some cases, scuppers through the hull are connected to and from the V-drive to provide independent water-cooling and are actuated by the movement of the water. With closed cooling systems, the V-drive should be incorporated into the system between the cooler and the suction side of the water pump. Proper operating temperatures are from 140° to 180°F, although safe operating temperatures may be as high as 210°F. On the models equipped with an oil circulating pump, the #49 oil pressure drop switch and the 12 volt #49A warning light should be hooked up per the wiring diagram. The switch may be grounded to any part of the V-drive or engine (either terminal may be used for the ground).

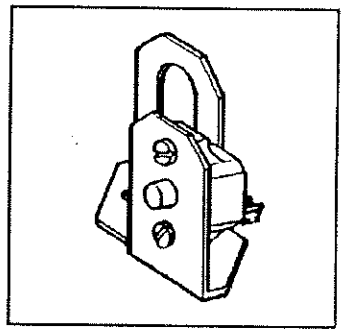
Oil Fill

Pull out the #21 oil level gauge. Unscrew the #12 breather cap and fill the V-drive with SAE #30 motor oil through the #12A breather elbow. On the RV-10 only, the oil may be added by removing the plug in the #6D top cover. See table below for approximate oil capacities. The amount varies with the angle of installation. The oil level should be checked with the oil level gauge fully inserted in the unit. The proper level is between the "H" and "L" marks on the gauge. Add a 2 ounce tube of Molykote (molybdenum disulfide), which is supplied with each V-drive for extra lubrication and break-in. It provides protection against scoring or galling of gears, bearings and other moving parts. Additional Molykot after break-in is not required. Reinstall the breather cap. The oil level should be rechecked after the unit has been run and allowed to sit for about a minute. Add oil if necessary.

	RV-10	RV-20	RV-30	RV-40	RV-48
Oil Capacity (approx.)	1 pint	2 pints	3 pints	4 pints	4 pints



ENGINE TROUBLESHOOTING



Introduction

The tables which follow indicate troubleshooting procedures based upon certain problem indicators, the probable causes of the problems, and the recommendations to overcome these problems.

Note that the engine's control system (electrical system)is protected by a 20-Ampere manual reset circuit breaker. Reference engine photo for location.

Problem	Probable Cause	Verification / Remedy
Key switch ON but no panel or test function.	1. Battery OFF. 2. 20 Amp circuit breaker is tripped. 3. Loose battery cable connection.`	1. Turn Battery ON. 2. Reset the breaker by pushing in the button. 3. Check the + connection to the starter and the - connection to the ground stud on the bell housing.
PREHEAT switch is depressed: no preheat solenoid activation, no electric fuel pump or alternator excitation.	1. Faulty solenoid. 2. Faulty connection or tripped 10 Amp breaker on the terminal on the preheat solenoid.	1. Check for 12 Volts at the S terminal of the solenoid when preheating. 1a. Check the preheat Switch. 2. Check for 12 volts at the 10 Amp breaker. Check for 12 volts at the R terminal on the alternator when the preheat button is pushed.
START switch is depressed: no starter engagement.	1. Connection to solenoid faulty. 2. Faulty START switch. 3. Faulty solenoid. 4. Loose battery connection. 5. Low batteries. Low voltage at the solenoid's S terminal with no activation.	1. Check connection S at the starter solenoid for 12 volts with the switch depressed. 2. Check switch with an ohmmeter. 3. Twelve volts is present at the S terminal of the starter solenoid. 4. Check battery connections at both the + and - ground. 5. Check battery charge state.

Problem	Probable Cause	Verification / Remedy
Engine cranks, but does not start.	1. Shut-off valve at fuel tank.	1. Return shut-off valve to its ON position. Now bleed the fuel system.
	2. Faulty fueling system.	2. Check for fuel to engine.
	3. Air is in the fuel system.	3. Bleed the fuel system. Locate the leak and correct it.
	4. Fuel pump is not operating.	4. Check pump operation.
	5. Fuel filters are clogged.	5. Clean/replace filters.
	6. Blockage in exhaust.	6. Remove exhaust hose from the engine and crank to start.
	7. Injection pump fuel solenoid faulty.	7. Check solenoid for activation.
Failure to stop.	1. Key switch	1. Check switch will not open run circuit.
	2. Alternator.	2. Check EXC terminal from alternator with harness unplugged.
Engine stops.	1. Fuel starvation. Fuel shut-off is turned OFF.	1. Check to see that the shut-off valve at the fuel tank is ON.
	2. Fuel pump is inoperative.	2. Inspect the fuel pump to see if it is pumping. Manually prime the system and check the return flow.
	3. Water is in the fuel.	3. Pump water out of the bottom of the fuel tank(s) and change the fuel filters and bleed the fuel system.
	4. Exhaust system is restricted.	4. Check exhaust system for some type of blockage such as carbon buildup at the exhaust elbow. Check for a fault in the muffler. Check for a collapsed exhaust hose.
Battery runs down.	1. Alternator output is low.	1. Check drive belt tension. Make an output check with a voltmeter at the B+ terminal on the alternator.
	2. Faulty alternator.	2. Voltage leak through the alternator when not operating.
	3. Bad battery connections.	3. Connections are corroded or loose at the battery or/and at the engine.

MAINTENANCE AND ADJUSTMENTS

Introduction

This section contains a scheduled preventive maintenance program and several adjustment procedures the owner/operator can perform without the benefit of sophisticated and expensive tools and instruments.

Preventive Maintenance

Perform the preventive maintenance in accordance with the schedules listed in the following paragraphs. Adherence to these schedules will ensure the equipment is maintained in the best possible condition and that it will perform to expectations. Those items marked by an asterisk (*) are recommended to be performed by an authorized dealer or distributor.

Daily (before each use)

1. Check the oil sump level. Maintain the oil level at or near the upper level mark on dipstick.

2. Check the coolant level in the plastic recovery tank. Maintain this level at or above the level marked ADD.

3. Check transmission's lubricant level, and add additional lubricant as needed.

4. Visually inspect the unit; check for loose belts, chafed or broken wires, loose brackets and fittings, damaged hoses, loose clamps, and other equipment not properly secured.

5. Check the fuel supply. Fill tank(s) with a good grade of No.2 diesel fuel, if required.

6. Check the primary filter/water separator. Drain and service as required. (A primary filter/water separator is optional, but strongly recommended.)

7. Check the engine's gauges or lights for proper oil pressure, operating temperature, and starting battery charging voltage once the engine is operating.

8. Check the alternator's output gauge (if installed) for proper DC voltage.

Monthly

Check the condition of the zinc anode in the heat exchanger's sea water circuit. Clean or replace the anode, as required. Keep the area inside the heat exchanger clean of zinc anode debris.

Servicing After Initial 50 Hours of Operation

1. Change the engine's lubrication oil and oil filter.

2. Replace the secondary fuel filter and the filter element in the base of the fuel pump. Service the primary system filter is installed.

*3. Torque the cylinder head hold-down bolts.

*4. Adjust valve clearances.

5. Adjust the alternator and water pump drive belt tension, if required.

6. Lubricate the throttle and the transmission's control cable check for proper operation and movement.

7. Change the transmission's lubricant.

8. Adjust the engine's idle speed (750 - 1000 rpm).

Servicing After Every 100 Hours of Operation

1. Change the engine's lubrication oil and oil filter.

2. Adjust the alternator and water pump drive belt tension, if required.

3. Lubricate panel keyswitch (use "Lockeze" only).

Servicing After Every 250 Hours of Operation

Replace the fuel filter elements in the on-engine fuel filter and in the optional water/sediment separator.

NOTE: Items marked by an asterisk (*) should be performed by a competent mechanic.

Servicing After Every 500 Hours of Operation

*1. Torque the cylinder head hold-down bolts.

*2. Adjust the valve clearances.

*3. Drain, flush, and refill the fresh water cooling system. For an illustration showing the heat exchanger and block drain locations, see engine photos at beginning of this manual.

*4. Check the condition of the starter motor drive pinion; lubricate pinion.

5. Check the resistance of the glow plugs. Check circuit operation.

6. Check raw water pump for internal wear. Examine the pump's cover, cam, and internal housing. Replace worn parts as needed. Check for leaks at seals or gaskets and repair them as needed.

7. Check the internal condition of the water injected exhaust elbow. Inspect exhaust and water passages. Remove any carbon and/or corrosion build up. Replace elbow if needed.

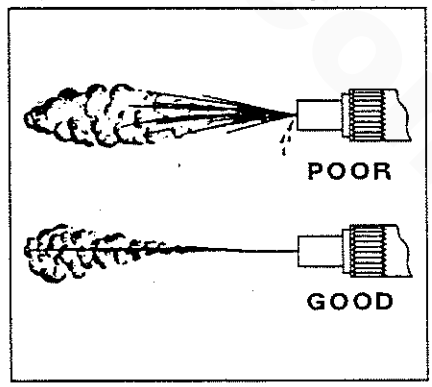
Servicing After Every 800 Hours of Operation

*1. Remove and check fuel injectors.

Injector spray pressure:
1920 psi + 71 psi
(135 kg/cm^2 + 5 kg/cm^2)

NOTE: Poor fuel quality and contaminants will shorten the injector and injector pump service life.

Eliminate undesirable injection conditions including after dripping.



*2. Check the compression pressure. Remove each glow plug and check each cylinder's compression pressure. The engine's speed is at 280 rpm.

*3. Check the battery-charging alternator for proper operation.

*4. Check the tightness of bolts, nuts, and clamps.

Servicing After Every 1000 Hours of Operation

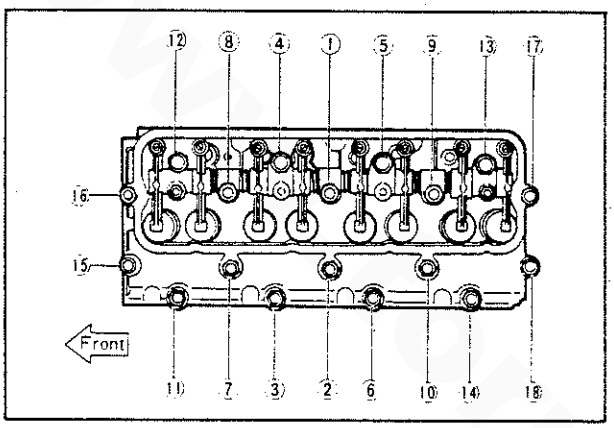
1. Remove, clean, and pressure test the primary heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

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

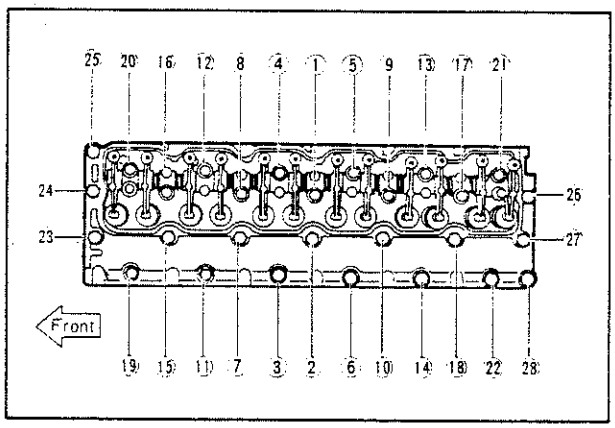
*2. Check the injection pump's timing.

Cylinder Head Bolt Torquing

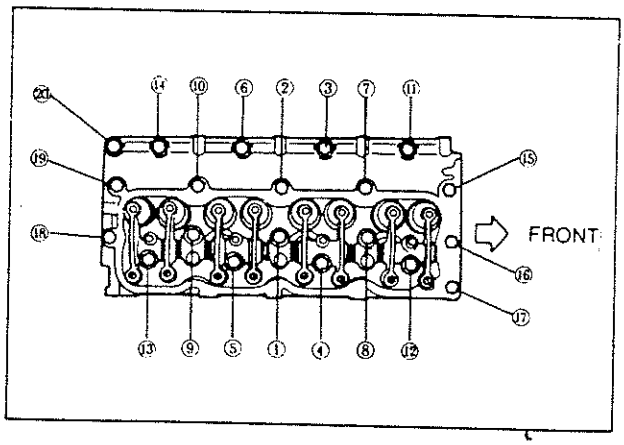
Tighten the cylinder head bolts according to the sequence shown in the illustration for your model. The engine should be at room temperature. Prior to applying torque to each bolt, loosen it one half turn then apply the required torque.



63(B) & (C) FOUR & 82B FOUR



108 (B) & (C) SIX



71B FOUR

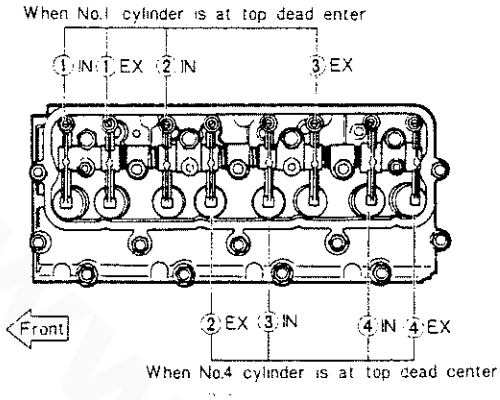
Tightening Torque

63 (B) (C) Four & 108 (B) (C)	80 - 85 ft-lb (11.0 to 11.7 m-kg)
71B Four & 82B Four	85 - 89 ft-lb (11.8 to 12.5 m-kg)

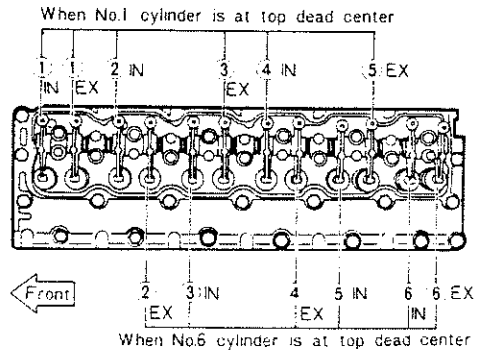
Adjustment of Valve Clearances

CAUTION

Tighten the cylinder head bolts to the specified torque before making valve adjustments.



63(B)(C)FOUR, 71B FOUR & 82B FOUR



108 (B)(C) SIX

Valve Clearance: Intake & Exhaust 0.012 inch (0.30 mm)

Procedure to adjust

1. Position the piston #1 cylinder approximately TDC (Top Dead Center) of its compression stroke. Adjust the valve clearance on the values for the cylinders specified.

4 Cylinder Model

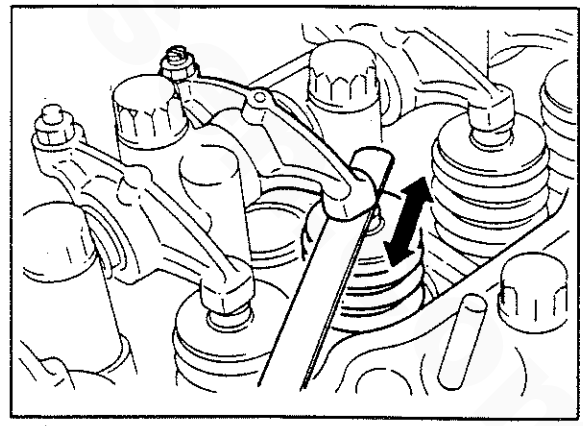
Intake valves - No.1 and No. 2 cylinders

Exhaust valves - No.1 and No. 3 cylinders

6 Cylinder Model

Intake valves - No.1, 2 and 4 cylinders

Exhaust valves - No.1, 3 and 5 cylinders



2. Turn the crankshaft 360 degrees (one complete revolution) and adjust the valve clearances on the valves for the cylinders specified.

4 Cylinder Model

Intake valves - No. 3 and No. 4 cylinders

Exhaust valves - No.2 and No. 4 cylinders

6 Cylinder Model

Intake valves - No.3, 5 and 6 cylinders

Exhaust valves - No. 2, 4 and 6 cylinders

LAY-UP AND RECOMMISSIONING

General

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

The procedures which follow will allow you to perform your own lay-up and recommsissioning, or to use 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 maintanance needs of your engine.

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

Propeller Shaft Coupling

The transmission and propeller half couplings should always be opened up and the bolts removed whenever the boat is hauled out of the water or moved from land to water, and during storage in a cradle. The flexibility of the boat often puts a sever 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 acually 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 periode of time.

Fresh Water Cooling System

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

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

Lubrication System

With the engine warm, drain all the lubricating oil from the oil sump. Remove and replace the oil filter. (Place some paper towels and a plastic bag around the filter to catch the oil during its removal.)

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine model. (Refer to the "SYSTEM SPECIFICATIONS" section of this manual.) Use an oil with an API specification of CC or CD. Run the engine and check for proper oil pressure and make sure there are no leaks.

CAUTION

Do not leave the engine's old lubricating 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

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

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

Raw Water Circuit

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

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

Start the engine 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 Through-Hull Exhaust

Place a clean cloth, lightly soaked in lubricating oil, in the opening of the intake manifold to block the opening. Do no shove the cloth out of sight. (If it is not visible at recommissioning , and an attempt is made to start the engine, you may need the assistance of a servicing dealer.) Make a note to remove the cloth prior to start-up. The through-hull exhaust part can be blocked in the same manner.

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

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

Spares

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

Batteries

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

Recommissioning

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

1. Remove the oil-soaked cloths from the intake manifold and from the through-hull exhaust port.

2. Remove the sea water pump cover and gasket. Discard the gasket. Install the sea water pump impeller removed during lay-up (or a replacement, if required). Install the sea water pump cover with a new cover gasket.

WARNING

Wear rubber gloves, a rubber apron, and eye protection when servicing batteries.

Lead acid batteries emit hydrogen, a highly-exposive 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.

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 the batteries are fully charged.

4. Check the condition of the zinc anode in the sea 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 sea 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.

5. Start the engine in accordance with procedures in the "PREPARATION FOR STARTING" section of this manual.

TABLE OF STANDARD HARDWARE TIGHTENING TORQUES

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

	Pitch	lb-ft	kg-m
Grade 4			
6mm bolt head/nut	1	2.9 - 5.1	0.4 - .07
8mm bolt head/nut	1.25	7.2 - 11.6	1.0 - 1.6
10 mm bolt head/nut	1.25	13.7 - 22.4	1.9 - 3.1
10 mm bolt head/nut	1.5	13.0 - 21.7	1.8 - 3.0
12 mm bolt head/nut	1.25 (ISO)	25.3 - 39.8	3.5 - 5.5
12 mm bolt head/nut	1.5	25.3 - 39.8	3.5 - 5.5
12 mm bolt head/nut	1.75	21.7 - 36.2	3.0 - 5.0
13 mm bolt head/nut	1.5	32.5 - 50.6	4.5 - 7.0
14 mm bolt head/nut	1.5	36.2 - 57.9	5.0 - 8.0
14 mm bolt head/nut	2	34.0 - 55.7	4.7 - 7.7
16 mm bolt head/nut	1.5	54.2 - 79.6	7.5 - 11.0
16 mm bolt head/nut	2	51.4 - 76.7	7.1 - 10.6
Grade 6T			
6mm bolt head/nut	1	4.3 - 6.5	0.6 - 0.9
8mm bolt head/nut	1.25	10.8 - 15.9	1.5 - 2.2
10 mm bolt head/nut	1.25	21.7 - 32.5	3.0 - 4.5
10 mm bolt head/nut	1.5	19.5 - 30.4	2.7 - 4.2
12 mm bolt head/nut	1.25 (ISO)	36.2 - 57.9	5.0 - 8.0
12 mm bolt head/nut	1.5	36.2 - 50.6	5.0 - 7.0
12 mm bolt head/nut	1.75	34.7 - 49.2	4.8 - 6.8
Grade 7T, 8T and 8.8			
6mm bolt head/nut	1	5.8 - 8.7	0.8 - 1.2
8mm bolt head/nut	1.25	14.5 - 21.7	2.0 - 3.0
10 mm bolt head/nut	1.25	28.9 - 39.8	4.0 - 5.5
10 mm bolt head/nut	1.5	26.8 - 37.6	3.7 - 5.2
12 mm bolt head/nut	1.25 (ISO)	54.2 - 75.9	7.5 - 10.5
12 mm bolt head/nut	1.5	50.6 -65.1	7.0 - 9.0
12 mm bolt head/nut	1.75	43.4 -61.5	6.0 - 8.5
13 mm bolt head/nut	1.5	57.9 - 86.8	8.0 - 12.0
14 mm bolt head/nut	1.5	72. 3 - 108.5	10.0 - 15.0
14 mm bolt head/nut	2	68.7 - 101.3	9.5 - 14.0
16 mm bolt head/nut	1.5	108.5 - 166.4	15.0 - 23.0
16 mm bolt head/nut	2	101.3 - 159.1	14.0 - 22.0
Grade 5 cap screw			
1/4 UNC		9 - 11	1.2 - 1.5
1/4 UNF		11 - 13	1.5 - 1.8
5/16 UNC		18 - 20	2.5 - 2.8
5/16 UNF		21 - 23	2.9 - 3.2
3/8 UNC		28 - 33	3.7 - 4.6
3/8 UNF		30 - 35	4.1 - 4.8
7/16 UNC		44 - 49	6.1 - 6.8
7/16 UNF		50 - 55	6.9 - 7.6
1/2 UNC		68 - 73	9.4 - 10.1
1/2 UNF		73 - 80	10.1 - 11.1

TORQUE SPECIFICATIONS

	Lb-ft	Kg-m
Cylinder head bolts		
- 63 (B)(C)Four & 108 (B)(C) Six	80 - 85	11.0 - 11.7
- 71B Four & 82B Four	85 - 90	11.8 - 12.5
Connecting rod caps		
- 63 (B)(C)Four	50 - 54	6.9 - 7.5
- 71B Four & 82B Four	59 - 65	8.2 - 9.0
- 108 (B)(C) Six	55 - 60	7.6 - 8.3
Main Bearing Caps - All Models	80 - 85	11.0 - 11.7
Injection Pump Gear - All Models	29 - 52	4 - 7
Oil Pan Bolts		
- 63 (B)(C)Four	5 - 9	0.7 - 1.2
- 71B Four, 82B Four & 108 (B)(C) Six	12 - 17	1.6 - 2.3
Crankshaft Pulley Nut		
- 63 (B)(C)Four	145 - 181	20 - 25
- 71B Four & 82B Four	253 - 289	35 - 40
- 108 (B)(C) Six	282 - 304	39 - 42
Glow Plugs - All Models	7 - 11	1.0 - 1.5
Intake Manifold - All Models	12 - 17	1.6 - 2.4
Exhaust Manifold		
- 63 (B)(C)Four	12 - 17	1.6 - 2.4
- 71B Four, 82B Four, and 108 (B)(C) Six	20 - 24	2.7 - 3.3
Oil Pressure Switch & Sender - All Models	9 - 13	1.2 - 1.8
Injection H/P Line Nut - All Models	18 - 22	2.5 - 3.0
Fresh Water Pump Mounting Bolts - All Models	9 - 13	1.2 - 1.8
Timing Gear Cover - All Models	12 - 17	1.6 - 2.3
Back Plate - All Models	24 - 35	3.3 - 4.8
Flywheel bolts		
- 63 (B)(C)Four & 108 (B)(C) Six	95 - 137	13.1 - 19.0
- 71B Four & 82B Four	112 -118	15.5 - 16.3
Water Temperature Sender & Switch - All Models	18 - 29	2.5 - 4.0

SPARE PARTS

Since a possibility exists in which the engine may need to be serviced at sea or while in a port other than your home port, certain spare parts should be kept on board to help minimize delays in your voyage. Please refer to your engine's Parts List for part numbers when ordering spare parts. Listed below are those spare parts that should be carried on board at all times.

1. An Impeller kit.
2. A Fuel System hardware kit.
3. A Secondary Fuel Filter.
4. An Alternator/Raw Water Pump Belt.
5. Hose Clamps
6. A Spare Oil Filter with a Spare Quart of Diesel Service Engine Oil along with a Quart of Transmission Oil and a Gallon of Premixed Antrifreeze.
7. Zinc Anodes.
8. Heat Exchanger End Cap Gaskets.
9. Oil Pressure Switch and Sender.

Other parts, whose life expectancy cannot be accurately predetermined, should be carried on board (in addition to those listed above) especially if the vessel is to be taken on long ocean voyages. These parts are listed below.

1. Fuel Injectors or injector nozzles - these can be installed by injection shop.
2. Glow plugs
3. Cooling System Hoses
4. An Alternator
5. A Starter
6. A 20 Amp DC Circuit Breaker
7. A Fuel Lift Pump
8. A Raw Water Pump
9. Battery Terminal Connectors

The spare parts listed directly above are those we *recommend* be carried on board during long ocean voyages. You may wish to ask other boat owners who have similar crafts and who have completed long ocean voyages as to what spare parts they carried on board and what parts were needed at specific times of the voyage. From the list provided directly above and from these inquiries, you can determine what spare parts may be needed. In addition, if you are planning a long ocean voyage, consult your local Westerbeke dealer for a listing of the Westerbeke dealers located on your route.

NOTES

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

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