# OPERATOR'S MANUAL

# &

# INSTALLATION GUIDE

## WESTERBEKE

## 12C-TWO

## MARINE DIESEL ENGINE

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WESTERBEKE

WESTERBEKE CORPORATION • MYLES STANDISH INDUSTRIAL PARK
150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319 U.S.A.
TEL: (508)823-7677 • FAX: (508)884-9688 • WEBSITE: WWW.WESTERBEKE.COM

## SAFETY PRECAUTIONS

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

### *WARNING*

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

### *CAUTION*

This 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.

- 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.

- 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 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 it 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.

IMPORTANT

PRODUCT SOFTWARE DISCLAIMER

Product software of all kinds, 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 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 into 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.

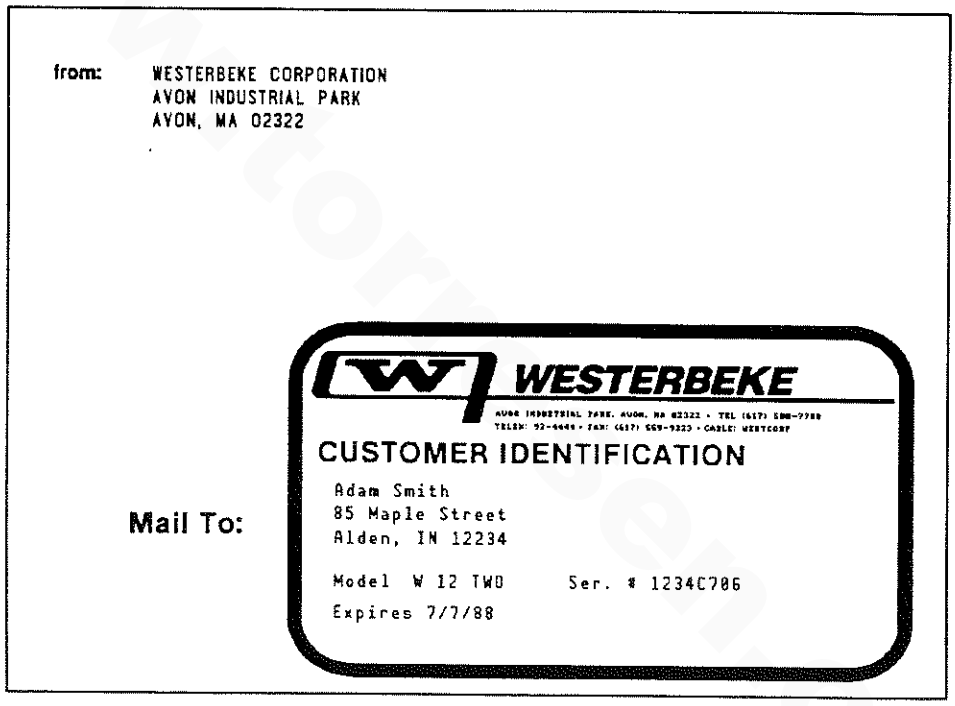
In summation, product software provided with Westerbeke products, whether from Westerbeke or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense but is imperative that appropriate representatives of Westerbeke or the supplier in question be consulted to determine the accuracy and currentness of the product software being consulted by the customer.

## 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 safety precautions included throughout. Operating procedures, periodic preventive maintenance procedures, installation checks, system descriptions and minor adjustment procedures are included herein 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.

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.




### Inspection of Equipment

The engine is shipped from the factory mounted securely 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 that 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.

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# GENERAL

## 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; consequently, 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 preventive 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 lift pump assembly, fuel injection pump, and in the injectors.

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

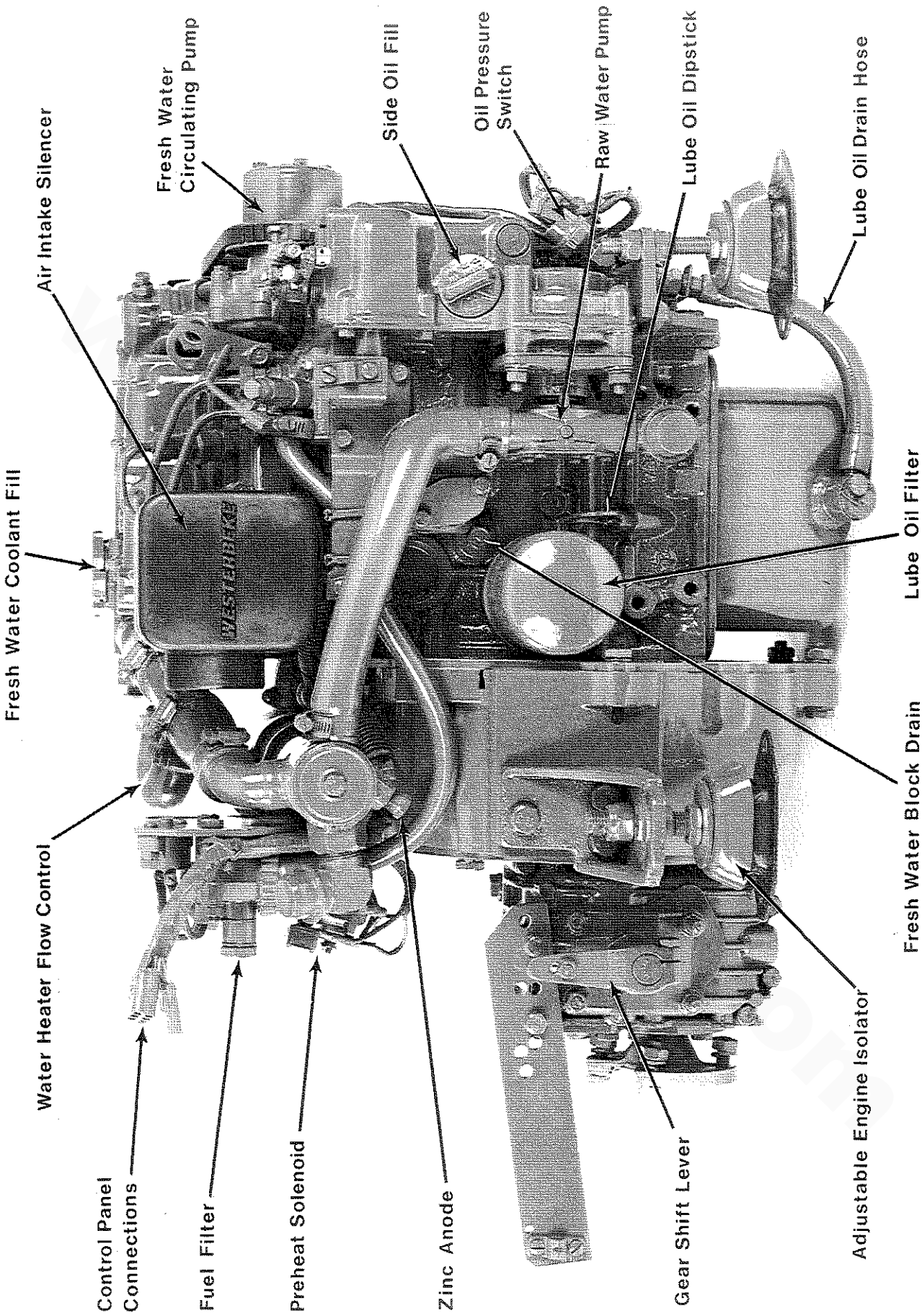
## ORDERING PARTS

Whenever replacement parts are needed, always provide the engine model number, engine serial number, and transmission serial number as they appear on the silver and black name plate located on the exhaust manifold. You must provide us with this information so we may properly identify your engine. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). 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.

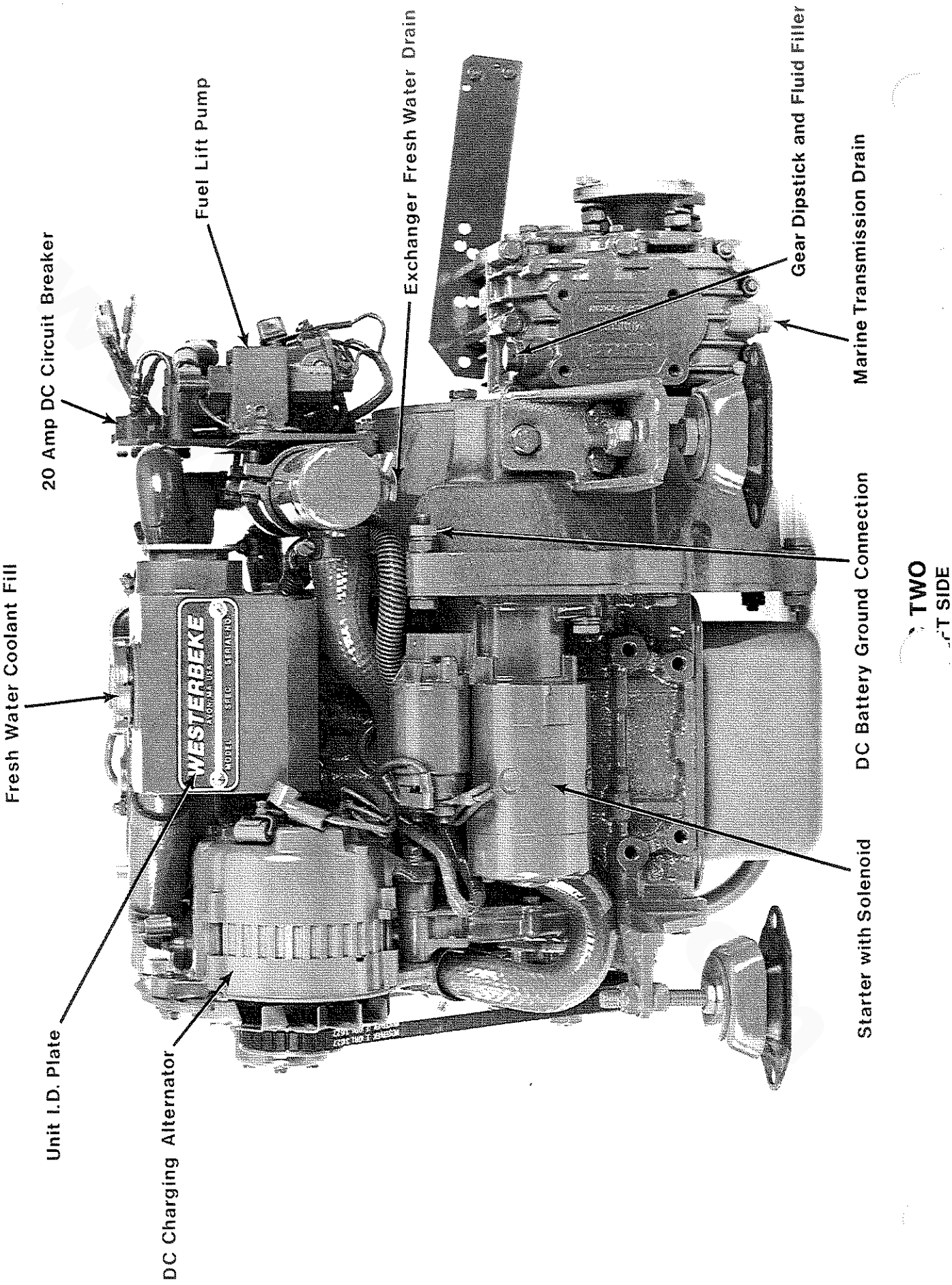
Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/transmission end is the rear end.) Left and right sides are determined by the engine; imagine straddling the engine and facing in the same direction as the front of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

Westerbeke engine sets are thoroughly checked and given a final run under various load conditions before leaving the factory. This is done to ensure dependable operation, long service, and a satisfied owner.

Care at the factory during assembly and thorough testing have resulted in Westerbeke units being capable of many thousands of hours of dependable service. However, the manufacturer cannot control the type of treatment a unit receives in the field. This part is up to the owner/operator.




**12 C TWO**
**RIGHT SIDE**




TWO
T SIDE

# 12C MARINE PROPULSION ENGINE
# GENERAL SPECIFICATIONS

| | |
|---|---|
| Engine Type | Diesel, four-cycle, two-cylinder, fresh water cooled Vertical, in-line |
| Horsepower | 12 hp at 3000 R.P.M. |
| Governor | Mechanical, centrifugal weight type |
| Combustion Chamber | Swirl chamber type |
| Bore & Stroke | 2.99 x 2.76 inches (76 x 70 mm) |
| Piston Displacement | 38.75 cubic inches (0.635 liters) |
| Firing Order | 1 - 2 |
| Direction of Rotation | Clockwise, when viewed from the front |
| Maximum Torque (at 2200 rpm) | 30 lb.-ft (4.15 kg-m) |
| Compression Ratio | 23:1 |
| Compression Pressure | 398 psi (28 kg/cm$^2$) at 280 rpm |
| Valve Seat Angle | Intake 45°<br>Exhaust 45° |
| Valve Clearance (engine cold) | Intake 0.010 inches (0.25 mm)<br>Exhaust 0.010 inches (0.25 mm) |
| Dimensions: | Height: 19.75 inches (501.65 mm)<br>Width: 17.22 inches (437.3 mm)<br>Length: 25 inches (635 mm) |
| Weight | 225 LBS ( 102.13 kgs) |
| Fuel Consumption: | 0.7 gph (2.65 lph) at 2500 rpm (approx.) |
| Inclination | Continuous 14°<br>Temporary 25° (not to exceed 30 min) |
| Idle Speed | 1000-1200 rpm |
| Cruise RPM | 2000-2500 RPM |
| Maximum RPM | 2900 - 3000 RPM |

## 12 C TWO SYSTEM SPECIFICATIONS

*FUEL SYSTEM:*

| | |
|---|---|
| General | Open flow, totally self-bleeding |
| Fuel | No. 2 diesel oil (cetane rating of 45 or higher) |
| Fuel Injection Pump | Nippondenso (Bosch NC type) |
| Fuel Injection Timing | 19 ° TDC |
| Nozzle | Throttle Type |
| Injection Pressure | 1991 psi (140 kg/cm$^2$) |
| Lift Pump | Electric 12 volt |
| Fuel Filter (on engine) | Canister type, with replaceable element |
| Air cleaner | Metal screen type - cleanable |
| Air-Flow (engine combustion) | 34 cfm (0.96 cmm) |

*COOLING SYSTEM:*

| | |
|---|---|
| General | Fresh water-cooled block, thermostatically controlled with heat exchanger. |
| Operating Temperature | 170 - 190° (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 3000 RPM (measured before discharging into exhaust elbow) | 8.0 gpm (30 lpm) |
| System Capacity (fresh water) | 2.9 qts ( 2.7 liters) |

*LUBRICATION SYSTEM*

| | |
|---|---|
| General | Pressure fed system, gear type, enclosed in gear case, direct drive by crankshaft, forced lubrication. |
| Oil Filter | Full flow, paper element, spin-on type. |

## SYSTEM SPECIFICATIONS CONTINUED...

| | |
|---|---|
| Sump Capacity (including filter) | 3.0 US quarts (2.9 liters) |
| Operating Oil Pressure (engine hot) | 15 - 45 psi (1.0 - 3.1 kg/cm$^2$) |
| Oil Grade | API specification of CC or CD<br>SAE 30, SAE 20, 10W-30 |

*ELECTRICAL SYSTEM*

| | |
|---|---|
| Starting Battery | 12-Volt, (-) negative ground. |
| Battery Capacity | 300-400 cold cranking amps |
| Starting Aid | Glow plugs, sheathed type |
| Starter Motor | 12 Volt, 1.2KW, solenoid actuated shift |
| DC No-Load Current | 100 Amps at 11.5 Volts (3000 rpm, min.) |
| Cold Cranking Current | 125 Amps at 10 volts (805 rpm, min.) |
| Alternator | 12 Volt DC, 50 Amps |
| Regulator | Internal regulator, built into alternator |

*TRANSMISSION (HBW 35)*

| | |
|---|---|
| Standard Gear Ratio | 2.05:1 |
| Direction of Rotation | Right Handed - standard transmission |
| Lubrication Fluid | Automatic Transmission Fluid (ATF)<br>Type A or Dexron II |
| Sump Capacity | 0.32 U. S. quarts (0.3 liters) approx. |

## SYSTEM SPECIFICATIONS CONTINUED...

### *PROPELLER RECOMMENDATION*

| | |
|---|---|
| Standard Transmission<br>HBW 35 - 2R 2.05 : 1 | 14 D x 9 P-RH Two blade<br>14 D x 7 P-RH Three blade |
| The propeller selected must allow the engine to reach its rated rpm at full throttle underway in forward gear (3000 rpm +000 - 100) | |
| Propeller Shaft Diameter | 3/4 inch diameter (minimum) |

### *ENGINE AIR REQUIREMENTS*

| | |
|---|---|
| Combustion Air | Engine Combustion Air 34.0 CFM (0.96 cmm) |
| Cooling Air | Engine Block Cooling 100.0 CFM (2.8 cmm) |

### *FRONT CRANKSHAFT LOADING*

| | |
|---|---|
| Maximum Side Load | 5 - 5.5 hp |
| Maximum Distance at crankshaft shives (measured from engine block) | 4.7 inches |
| Maximum Allowable Thrust Load | 9.5 hp |

# INSTALLATION CHECKS

## GENERAL

Since the crafts in which Westerbeke engines are installed vary in design, installation procedures will vary accordingly. The intent of this section is not to advise boatyards or installers on procedures already well developed and well understood. However, it is important that the owner/operator 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 engine in the vessel are of prime importance.

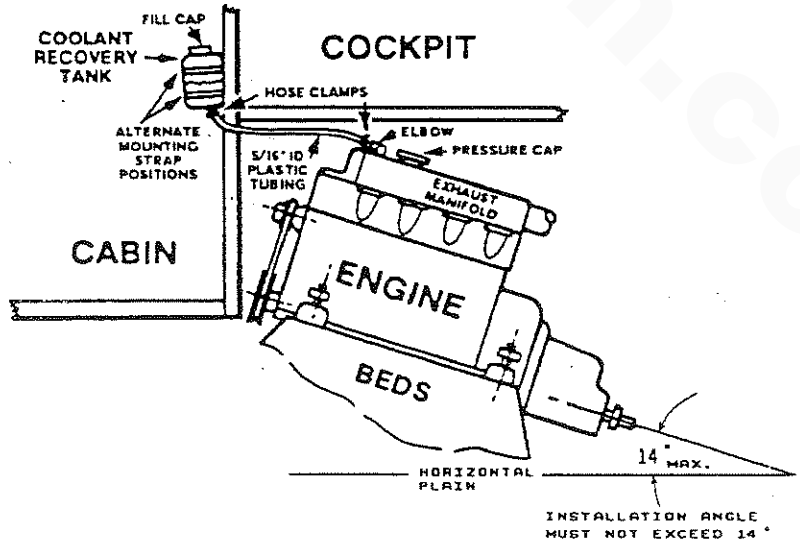
Factors in the installation that must be considered are ventilation, of prime importance, to aid in the cooling of the transmission, to provide air for engine combustion and to remove hot air produced by the engine during operation. The exhaust system, to properly discharge raw cooling water (sea water) to quiet the exhaust while expelling exhaust gases. The cooling water supply, proper fuel supply and DC electrical connections.

### *CAUTION*

For safety reasons, the engine and transmission are NOT filled with lubricating oil for shipment. Before leaving the factory, however, each engine and transmission are thoroughly tested with oil in its engine. 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 is properly stored.

## LOCATION

The location should be *dry* and in a location where the engine cannot be splashed by bilge water or water from above. It should be properly ventilated and accessible for minor servicing and repairs. Access for major repairs should be given consideration as well. The location must be properly ventilated to provide fresh air for engine combustion. Access must be given for the lubrication oil sump dipstick, the fresh water and oil fills, and the transmission's dipstick and oil fill. Please note that the engine's installation angle cannot exceed 14 degrees from the horizontal plain.



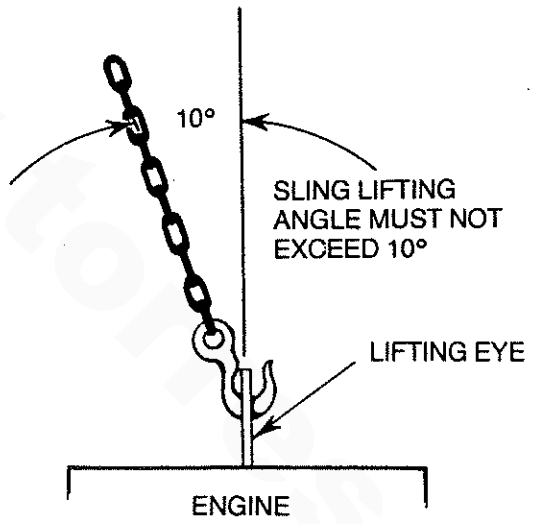

Please note that the engine's installation angle cannot exceed 14° from the horizontal plain.

## 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 this sling. 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 lifting eyes by the lifting sling must not be in excess of 10° from the vertical plain.




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 those conditions, if the opening of the hatchway is extremely restrictive, it is possible to reduce, to some extent, the outside dimensions of the engine by removing external component such as the alternator, the cooling system's piping, the heat exchanger, certain filters, the mounting isolators 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 contaminants to enter any opening created by the removal of equipment. Removed parts should be returned to their respective position as soon as the engine has cleared the obstruction opening and is ready to be positioned on its mounting platform.

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 isolator 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.

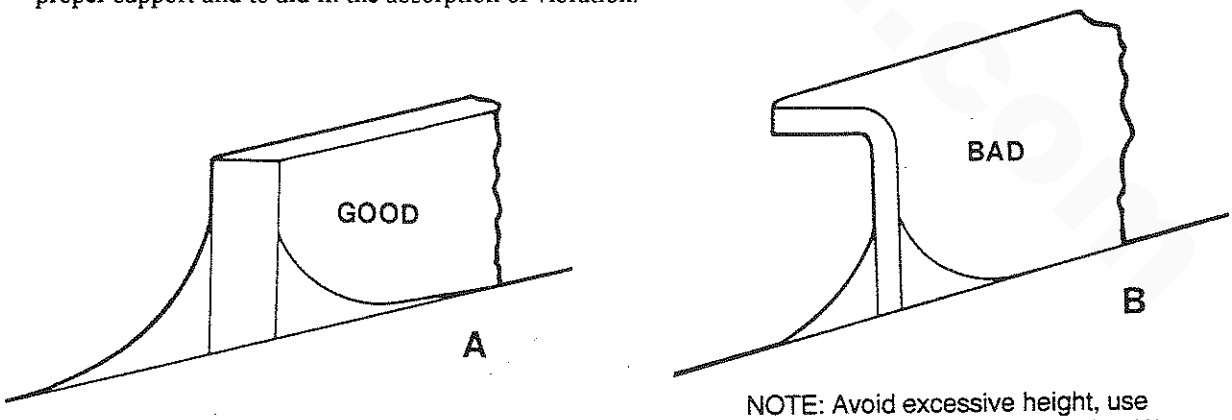
In fiberglass hulls, we recommend that similar wooden stringers as in wooden hulls be formed and fitted, then glassed securely to the hull. This allows the hanger bolts to be installed firmly in the wood, thereby reducing noise and transmitted vibration.

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.

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 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 vibration.




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

## 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.

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 filled in order to fit properly. It is important that the key be properly fitted to both the shaft and 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

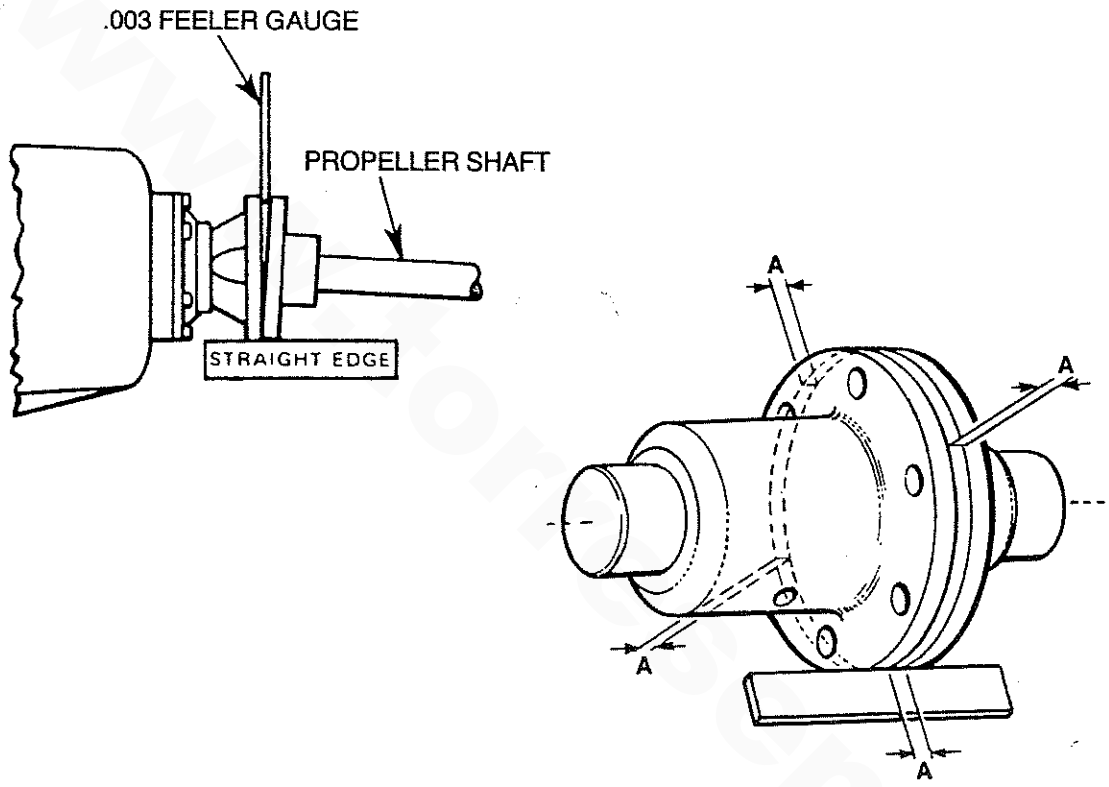
The engine must be exactly aligned with the propeller shaft in the proper fashion. No matter what material is used to build a boat, the material will be found to be flexible to some extent; hence, the boat's hull will change its shape to a greater extent than is usually realized when the boat is launched 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.

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). (see diagram)




Try to position the engine as low down on the isolators threaded stud as possible. This will help reduce engine movement under load. Shim under the isolator base if necessary to accomplish this.

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 degrees 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 degree increments, checking dimension (**A**) while in each 90 degree position until the half-coupling has been rotated full circle. (see diagram)

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.

## EXHAUST SYSTEM

*WARNING*

Although diesel engine exhaust fumes are not as toxic as exhaust fumes from gasoline engines, carbon monoxide gas is present in diesel exhaust fumes. 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 listed below.

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

All exhaust systems should be such that the entry of sea water into the engine's exhaust manifold and cylinders is prevented while the engine is running, or while the vessel is under sail or power in which case the vessel may experience healing or backing down from following seas or any other conditions. Special attention must be made to ensure that the exhaust system is secure and tight and free of leaks.

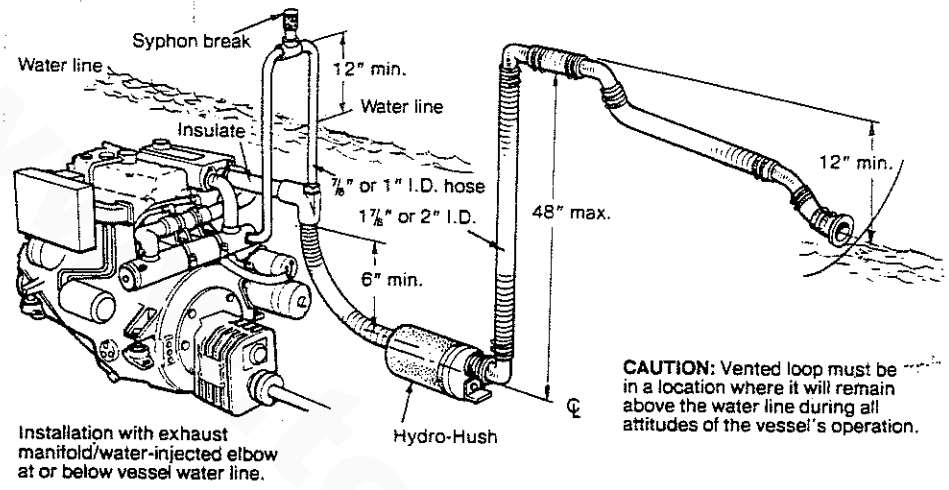
THE SEA WATER SUPPLY THROUGH-HULL FITTING MUST BE THE FLUSH TYPE. HIGH SPEED SCOOP TYPE FITTINGS MUST NOT BE USED. THEY CAN FORCE SEA WATER THROUGH THE SEA WATER COOLING CIRCUIT AND FILL THE ENGINE WITH WATER WHEN THE ENGINE IS NOT RUNNING AND THE VESSEL IS UNDERWAY.

The exhaust system provides an outlet line to vent engine exhaust gases out of and away from the vessel. The system also discharges sea 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 sea water supply to the exhaust *must* be configured to prevent the siphoning of sea water into the exhaust through the sea water cooling circuit and to prevent the entry of sea water into the exhaust through the circuit's through-hull discharge port. If not prevented, sea water entering through the system can fill the exhaust system muffler and enter the engine's cylinders. This will prevent proper starting and possibly cause damage to internal engine components.

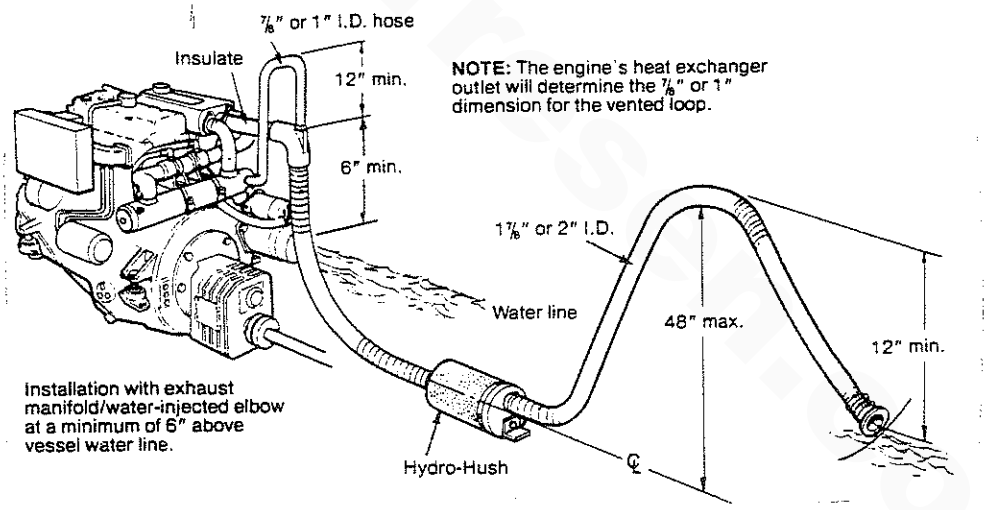
## SIPHON BREAK

Installers are reminded that installations that place a unit's exhaust manifold/water injected exhaust elbow within 12 inches or less of being at the vessel's water line or place it below the vessel's water line must install a siphon break device in the raw water supply line to the water injected exhaust elbow. This device must be located well above the vessel's water line. Twelve (12) inches minimum, eighteen (18) inches preferred. The device must be located so as to always remain at this height above the waterline during all conditions of vessel operation. With this in mind, the siphon break may well need to be located even higher than 18 inches because of the vessel's changes in water line location with the change of vessel attitude on the water while under power or sail. Should the vessel attitude during operation cause the device to be close to or below the vessel's water line, the device will have no effect on stopping the siphoning of raw water through the raw water cooling system into the exhaust; thus, filling the exhaust and entering the engine's exhaust manifold and engine cylinders. The illustration shows a siphon break installed.

The sea water supply hose to the exhaust system's water injected elbow should be routed (looped) at least 12 inches above the vessel water line. An anti-siphon break should be installed, when needed, at the top of this loop. The top of the loop should be placed high enough above the vessel's water line so as to remain above the water line when the vessel is underway, no matter what the angle of heel or roll may be.




Installation with exhaust manifold/water-injected elbow at or below vessel water line.

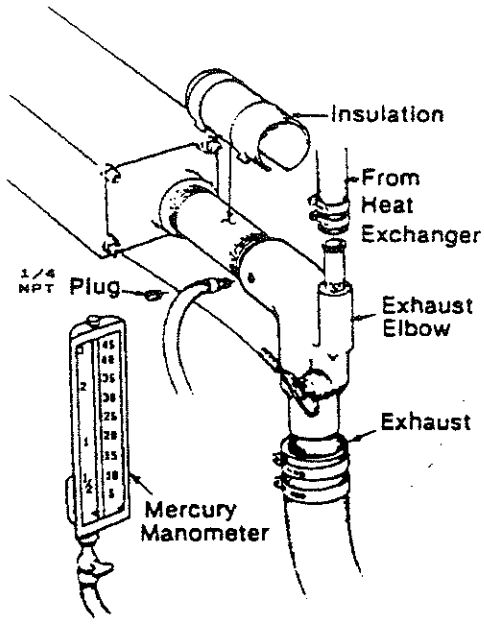



Installation with exhaust manifold/water-injected elbow at a minimum of 6" above vessel water line.

The sea 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 can force sea water through. 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 sea water entry if the through-hull discharge fitting becomes submerged when the vessel heels or rolls while under way, or is subjected to following sea conditions. Refer to the figures shown above for recommended exhaust system installations. The exhaust through-hull discharge fitting must not be restrictive so as to 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 an engine is put into service. (Refer to the illustration) Excessive back-pressure will affect the engine's performance and the power output.

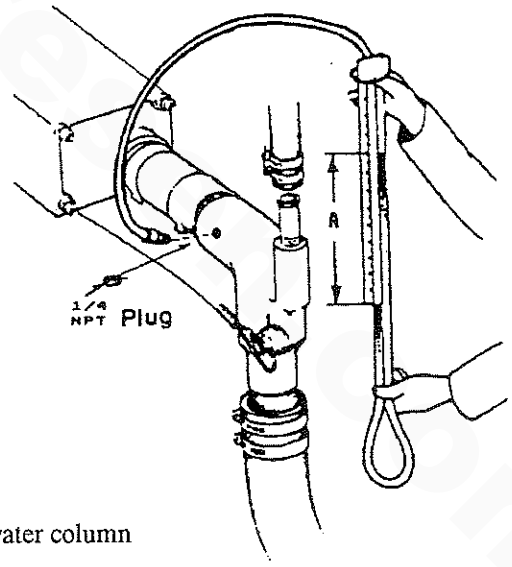



To measure the engine's back-pressure, use either a mercury manometer, a water column, or another pressure measuring gauge. If the enigne set does not have a tapped hole in its exhaust elbow, one must be drilled and tapped for a 1/4 inch NPT fitting.

Measure back-pressure at the exhaust elbow when engine is running at 3000 rpm. Back-pressure, as measured by manometer, a pressure gauge, or water column, should not be over the specifications listed below.

**NOTE:** Other gauges may be available to test for exhaust back-pressure. Contact your local Westerbeke dealer.

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) fitting.




Measure the engine's back-pressure at the exhaust elbow while the engine is running at 3000 rpm.

Dimension A cannot exceed 27 inches of water

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
1.11 kg/cm$^2$
15.6ounces per square inch
1.0 psi

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.

## EXHAUST SYSTEM FAILURES

The best protection against exhaust gas leakage 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, inspect the exhaust system and correct the cause.

### *CAUTION*

Exhaust risers installed off the exhaust manifold must not exceed 8 lbs. in total weight when rigidly connected. Excessive weight and vibration can result in a manifold failure and/or the fracturing of the riser from the manifold at its attachment. **If a rigidly connected exhaust riser is used, it must be properly supported to the engine, not the hull.** Dry portions of the exhaust connected to the manifold, which lay before the water injected exhaust system, *MUST* be properly insulated to retain the exhaust heat within the exhaust pipe.

### *WARNING*

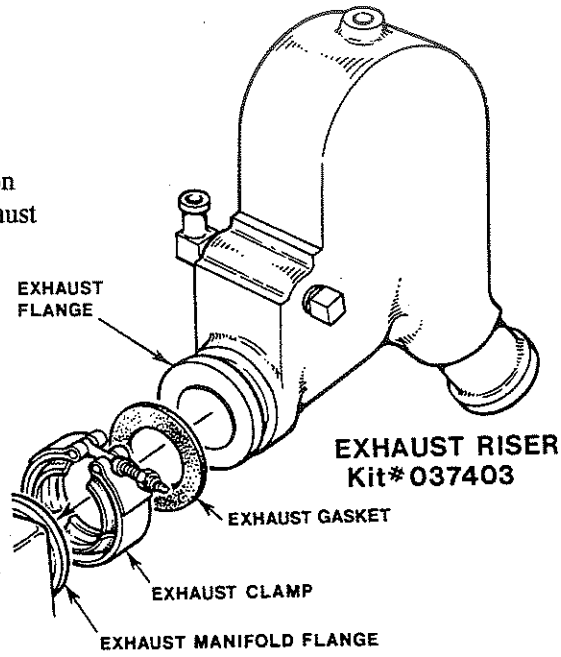
Although diesel engine exhaust gases are not as toxic as exhaust fumes from gasoline engines, carbon monoxide is present in diesel exhaust fumes in less concentration. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are as follows:

- 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.

## Exhaust Elbow Installation

Westerbeke Corporation offers a 45° and 90° 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.

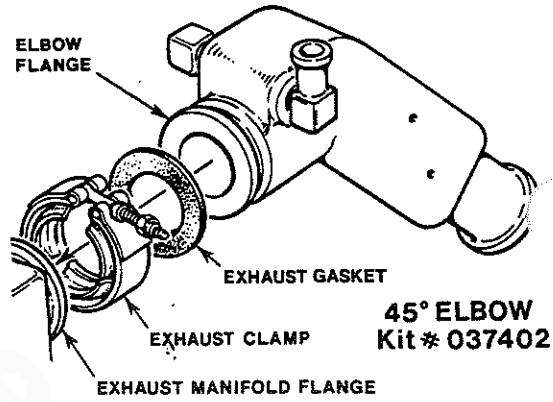



1. Coat only one side of the exhaust gasket with "High Tack" adhesive sealant. Place this coated surface against the exhaust manifold's exhaust port flange (the gasket should stick to the flange without falling off.)

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 that 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 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.

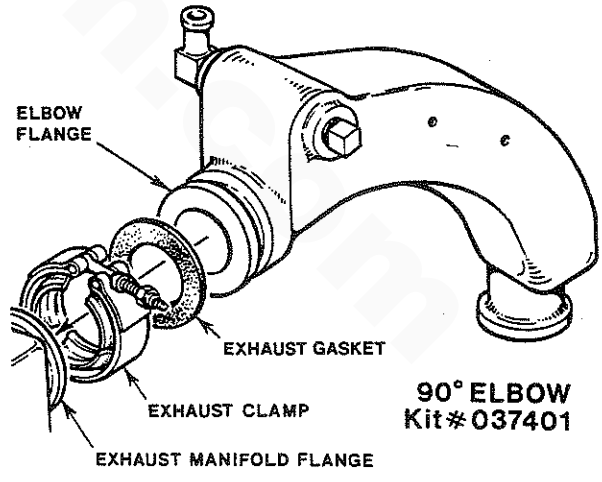



4. Adjust the elbow by rotating it until the desired alignment with the exhaust piping is acquired.

5. Carefully tighten the clamp between 8 to 10 lb-ft, or 0.1 to 1.3 kg-m.

**CAUTION**

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.

## OIL DRAIN HOSE

An oil sump drain hose is installed on the engine with the discharge and 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 and can be extended, or have a pump added, for easier removal of the old oil, if desired.

## COOLING SYSTEM

Westerbeke engines are fresh water cooled by an engine mounted heat exchanger. Sea water is used as the heat exchanger's cooling medium. Sea water is pumped into the exchanger by a sea water pump and is then injected into the exhaust discharge, carrying with it the heat removed from the engine's fresh water cooling system.

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

*CAUTION*

**DO NOT** use a scoop type through-hull fitting as a means of supplying sea water to the engine. Water pressure against this type fitting while the vessel is under way and the engine is not running can push sea water past the sea water pump's impeller into the engine's exhaust system, filling the engine with water. 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 sea water circuit. These generally have very restrictive inside diameters. Machined fittings with true inside diameters (I.D.s) are preferred.

## AUTOMATIC ALARM SYSTEM

High Water Temperature Alarm

Alarm buzzers are supplied with Westerbeke instrument panels. If the engine's fresh water coolant reaches 205°F (96° C), a switch will close sounding the alarm which will emit a *continuous* signal. Refer to the "DESCRIPTION OF INSTRUMENT PANELS" section of this manual for the location of the alarm in your engine's panel.

Low Oil Pressure Alarm

A low oil pressure alarm switch is located at 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. Refer to the "DESCRIPTION OF INSTRUMENT PANELS" section of this manual for the location of the alarm in your engine panel.

## INTAKE SYSTEM

Make sure the intake system (sea water cooling system) is in proper order. Check that the through-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 sea water lines to ensure there are no collapsed sections, which would restrict water flow. Make sure there are no air leaks at any of the connections. Avoid loops and sharp angles when routing water hoses. Short, straight runs are preferred.

## FUEL SYSTEM

The fuel system should be installed in such a manner as to allow the engine mounted fuel lift 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 lift pump. Only one fuel filter is installed on the engine, between the fuel lift pump and the injection pump; this filter is a spin-on full flow type.

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.

> **NOTE: DO NOT** use spring loaded check valves in the fuel supply line in lieu of mechanical shut-off valves.

The fuel return at the tank should extend down into the tank in the same manner as a pickup tube. This practice is particularly important in installations where fuel tanks are installed below the engine's fuel system and will help prevent air from entering the fuel system when the engine is shut down. Ensure that the fuel tank filler is properly sealed to prevent water entry should it become awash.

The fuel tank's vent should be located so that its discharge route cannot allow water to enter through to the fuel tank(s). Moisture must not be allowed to accumulate in the vent's line.

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

## ELECTRICAL SYSTEM

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

WARNING

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

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 .

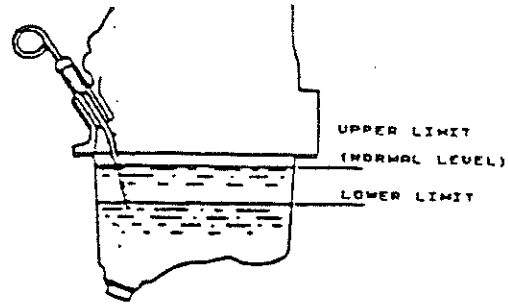
## VENTILATION

The ventilation requirements of the engine include the following: combustion air is required for the engine's cylinders and ventilating air is required to clear the bilges below the engine, as well as the compartment in which the engine is located, of heated air produced during engine operation and of potentially toxic and flammable diesel fumes. Refer to the "SYSTEM SPECIFICATIONS" section of this manual for your engine's airflow requirements.

## PREPARATION FOR STARTING

This section of the manual provides the operator with preparation, initial starting, break-in, starting (cold or warm), and stopping procedures. Follow the procedures as presented, for the conditions indicated, and your Westerbeke engine will give you reliable performance and long service life.

Fill your engine with oil up to or near the upper limit on the dipstick (the installation angle may have an effect 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. For the quantity of oil needed in your engine, refer to the "SYSTEM SPECIFICATIONS" section of this manual.




Fill the transmission to the **FULL** mark on the dipstick with the correct lubricant. (Refer to the "SYSTEM SPECIFICATIONS" section of this manual.

Each unit is supplied with a coolant recovery kit (#24977) as standard equipment, to which the following applies:

A. Remove the pressure cap from the engine's exhaust manifold and slowly fill the engine's cooling system with a mixture of water and antifreeze suitable for your temperature zone. (See the "COOLING SYSTEM" section of this manual.) 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 coolant flow to the domestic water heaters when installed. Top off the cooling system and install the pressure cap.

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

C. Add coolant to the plastic tank after the engine has been started and operating temperature has been reached, to make sure all air is expelled from the manifold and the engine's cooling system. With the manifold filled and the pressure cap installed, fill the plastic recovery tank half full. Monitor daily and add coolant as needed.

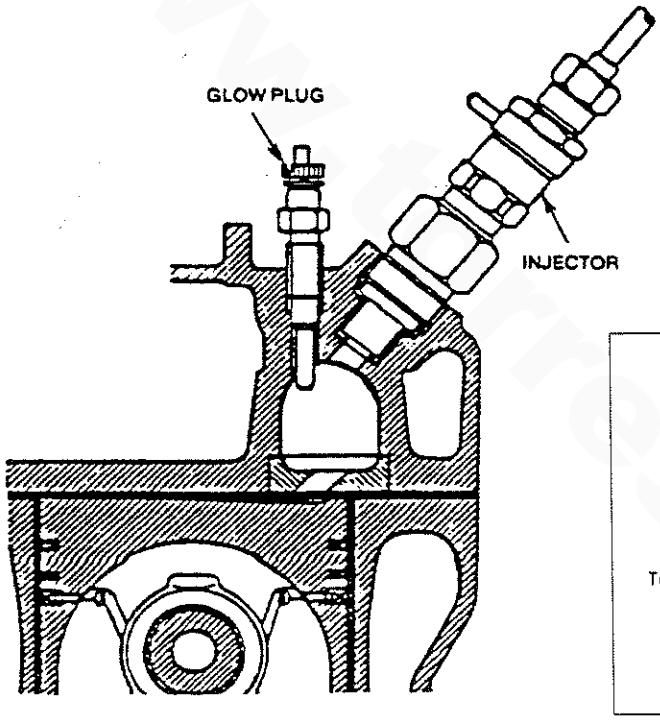
Fill the fuel tank with a good grade of No. 2 diesel fuel and manually prime the fuel system up to and including the engine. When returning fuel is free of air, the engine's fuel system is bled and the engine is ready to start.

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

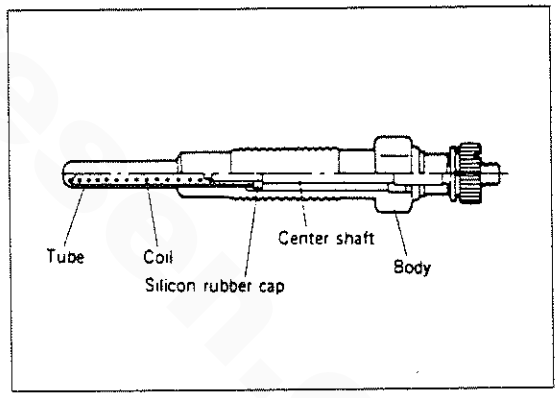
## DESCRIPTION OF STARTING SYSTEM

All 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" chart. Then, while keeping the PREHEAT button engaged, the START button is depressed to crank the engine.




Combustion Chamber




**Sectional View of Glow Plug**

**NOTE:** The START button will not energize unless the PREHEAT button is depressed. When depressing the preheat switch, you are activating the glow plugs in the cylinder head, so use the preheat intermittently so as no to overheat the glow plugs.

# ENGINE CONTROL PANELS

Westerbeke offers two types of control panels as optional equipment.
Read the following instructions that apply to the panel you purchased with your engine.


CAPTAIN PANEL

## GENERAL

This manually-operated control panel is equipped with a Key Switch; an RPM gauge; PREHEAT and START buttons; an instrument test button; three indicator lamps, one for alternator discharge, one for low oil pressure, and one for high engine coolant temperature; and an alarm buzzer for low oil pressure or high water temperature. The RPM gauge is illuminated when the key switch is turned ON and remains illuminated while the engine is in operation. 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. Be aware that the key switch does not shutdown the engine when the key is turned OFF. Refer to the "STOPPING PROCEDURE" section of this manual.

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 buzzer.

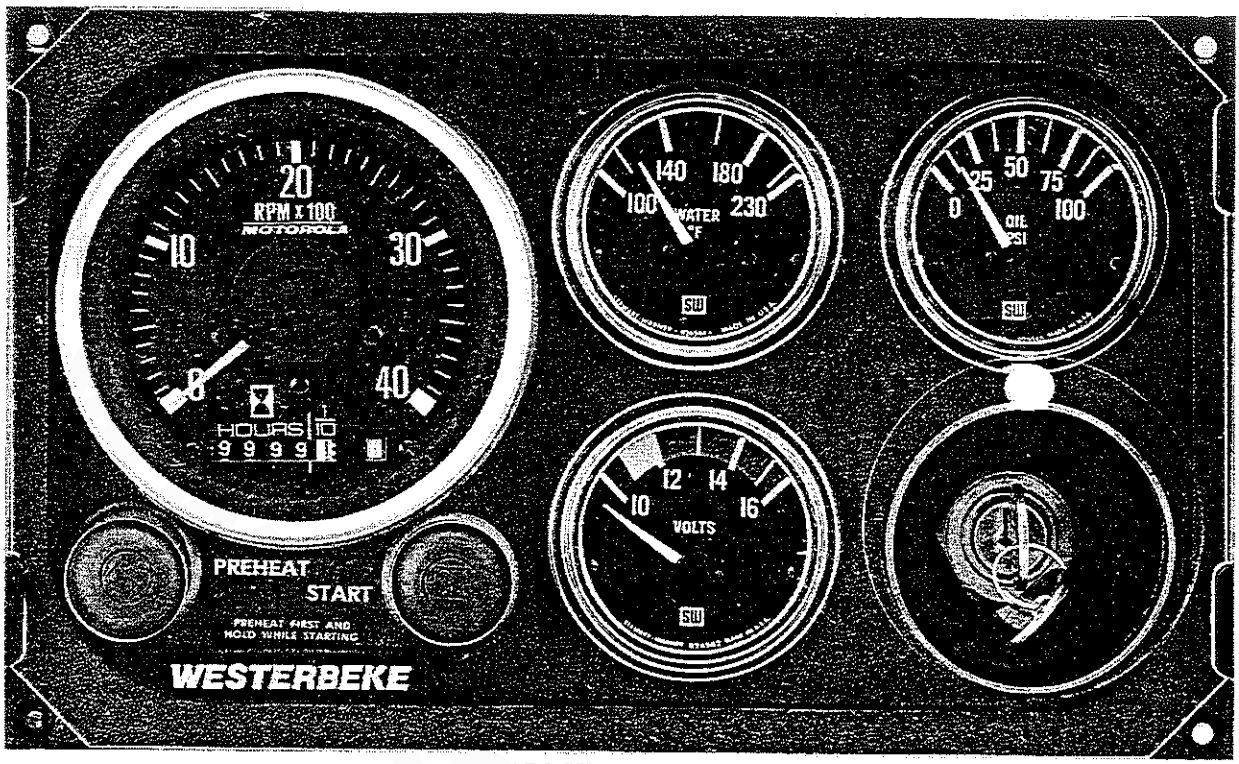
5. Alarm: The alarm is located above the test button and will sound if the engine's oil pressure falls below 15 psi. In this event, the alarm will emit a *pulsating* signal. The alarm will also sound if the water temperature in the fresh water cooling circuit rises to 205° F. In this event, the alarm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

**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.**

*6. 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).

*7. 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 manually shut down, and the engine's Key Switch is 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.




**ADMIRAL PANEL**

**General**

This manually-controlled 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.

1. Key Switch: The Key Switch provides power only to the instrument cluster. Be aware that the keys switch does not shutdown the engine when the key is turned OFF. Refer to the "STOPPING PROCEDURE" section of this manual.

2. PREHEAT: The PREHEAT button energizes the alternator's exciter, the engine's glow plugs, and bypasses the engine's protective oil pressure 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 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 210° F. In this event, the alarm will emit continuous signals.

**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.**

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 that 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.

*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 manually shut down, and the engine's Key Switch is 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.

## STARTING PROCEDURE

Place the transmission in the NEUTRAL position and advance the throttle to its full open position for a cold engine and partially open for a warm engine.

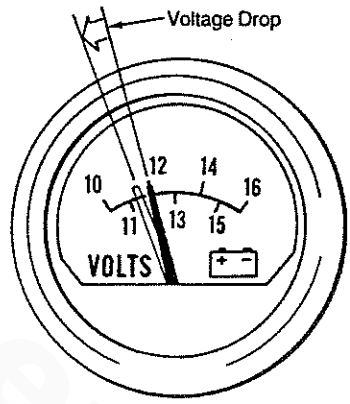
Turn the Key Switch to the ON position (2 o'clock).

Depress and hold the PREHEAT switch. Preheat according to the following chart:

| 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 |

Proper glow plug function is indicated by a voltmeter drop (voltmeter is on the Admiral Panel only) 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).

While holding the PREHEAT button depressed, depress the START button. The starter motor will run, thereby cranking the engine. As soon as the engine runs, release the START button and PREHEAT button. Check your instrumentation for proper engine operation. Make sure sea water discharges along with the exhaust discharge.




**DC Control Circuit Voltage Gauge (Available only on Admirals Panel)**

Should the engine not start when the START switch is depressed for 10 to 12 seconds, release both switches and wait 30 seconds; repeat the procedure above. Never run the starter for more than 30 seconds at a time.

*CAUTION*

**Prolonged cranking intervals without the engine starting can result in filling the engine mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea 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 sea water supply through-hull, drain the exhaust muffler, and correct the cause of the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is NOT a warrantable issue, the owner/operator should keep this in mind.**

Once the engine starts, run it at idle for a few minutes to warm up the engine and check instruments for proper oil pressure and battery charging voltage. Never attempt to engage the starter while the engine is running.

NOTE: Some unstable running may occur in a cold engine, but this condition should smooth out as the operating temperature of 170 - 190° F is reached.

## STOPPING PROCEDURE

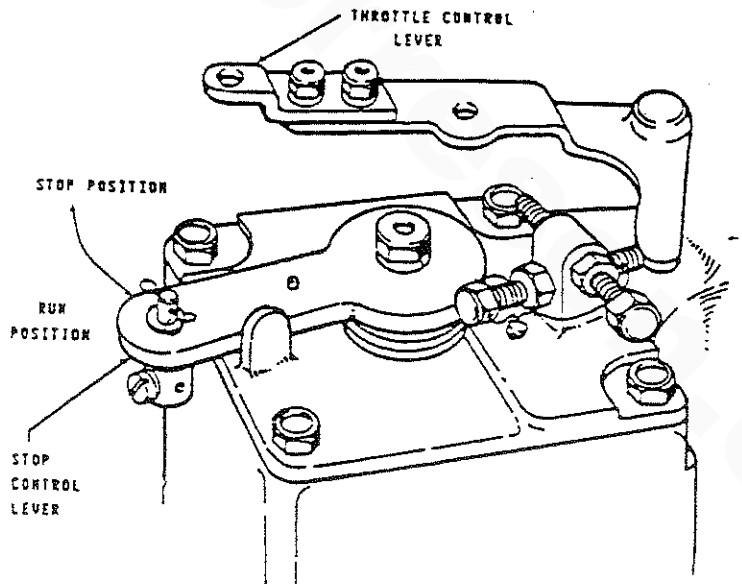
A manual pull type stop control (tee handle or knob) is provided by the installer in a location close to the engine's controls. Know the location of this control before attempting to start the engine. To stop the engine, pull out this tee handle or knob fully and hold it out until the engine comes to a complete stop. Push back on this control to return it to the engine run position otherwise the engine will not restart.

With the engine stopped, turn the key switch 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.

**CAUTION**

**DO NOT** attempt to shutdown the engine by turning the Key Switch OFF. The Key Switch only provides power to the instrument panel: the engine will continue running even if the Key Switch is turned OFF. Shut down the engine by pulling the stop control out fully.

(An optional key shut off package is available, that allows the operator to shut off the engine by turning the Key Switch OFF which turns OFF an electrically run Fuel Run Solenoid. This electrical shut off option is installed at the factory upon the specific request/order of the owner.



## 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. 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 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.)

## 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 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 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. Refer to the "LUBRICATION SYSTEM" section of this manual for an atmospheric/oil viscosity specification table.

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.

# FUEL SYSTEM

**Diesel Fuel**

**Use #2 diesel fuel with a cetane rating of 45 or better. Never use kerosene or heavy oil.**

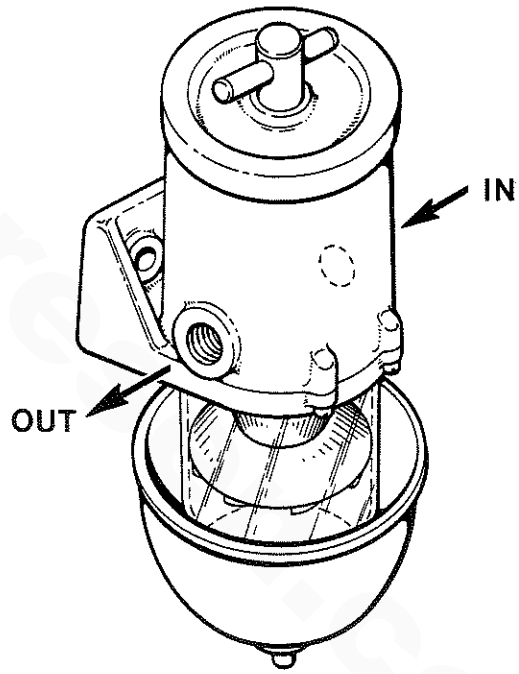
In cold weather particularly, water vapor is produced by condensation when air is present in the fuel tank. Keep fuel tank(s) full and completely free of dirt and water.

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




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.

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.

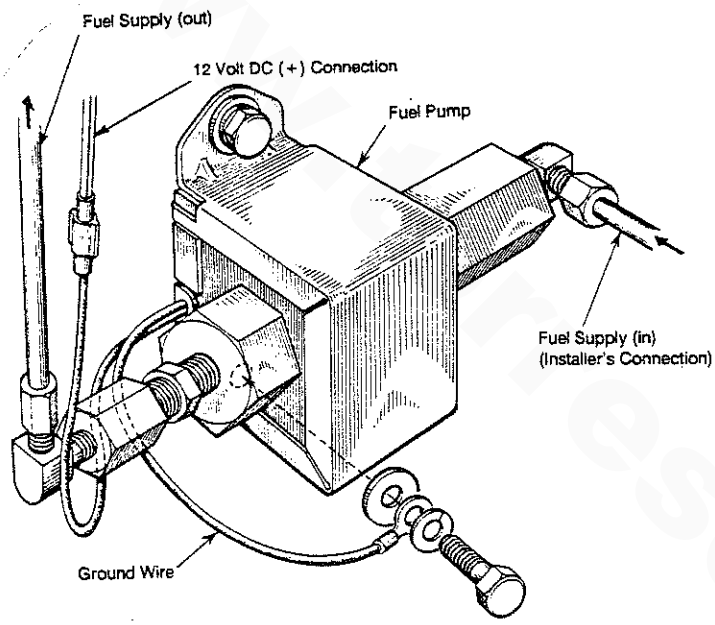
**Notes on Fuel System**

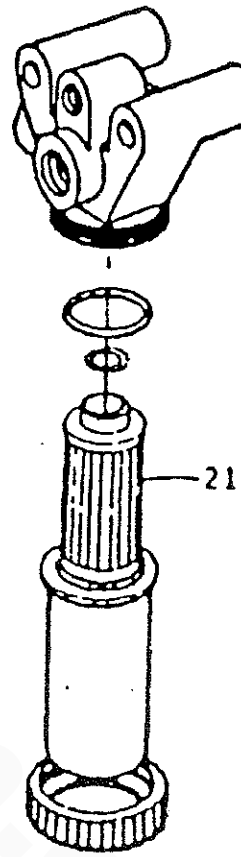
*WARNING*

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 fuel filter assembly when the filter cup 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.

## Priming the Fuel System

The models covered by this manual have a single replaceable fuel filter in the engine mounted fuel system. This filter is located between the engine mounted electric fuel pump and the inlet to the fuel injection pump. The exploded view below shows this filter element as item #21. Servicing this filter element is explained a few pages further in this manual. When the filter element in this canister has been changed, the air in the system is bled out by simply turning on the panel key switch which energizes the fuel pump. The pump delivers fuel to the system which pushes the air out. Allow the fuel pump to operate for approximately one minute to accomplish this.



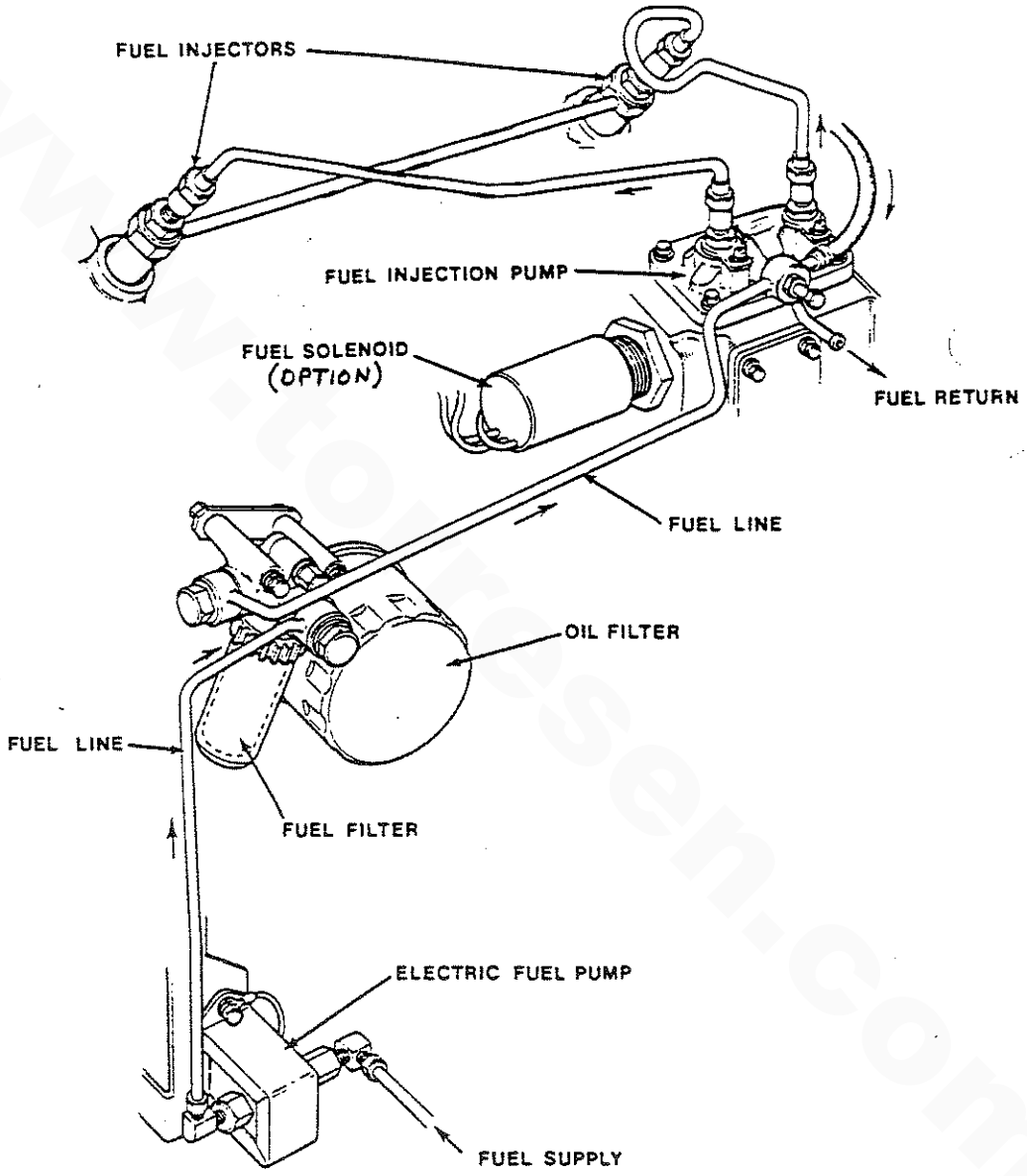




**CAUTION**

**Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea 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 sea 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 sea water entry is not a warrantable issue; the owner/operator should keep this in mind.**

## Notes on the Fuel System

The illustration that follows is an exploded view of the 12C TWO's fuel system.




To obtain long and satisfactory service from the injection pump, always use fuel which is free from impurities and maintain a good filtration and water separation system between the fuel tank and engine. Service this system regularly: the injection pump it saves will be your own.

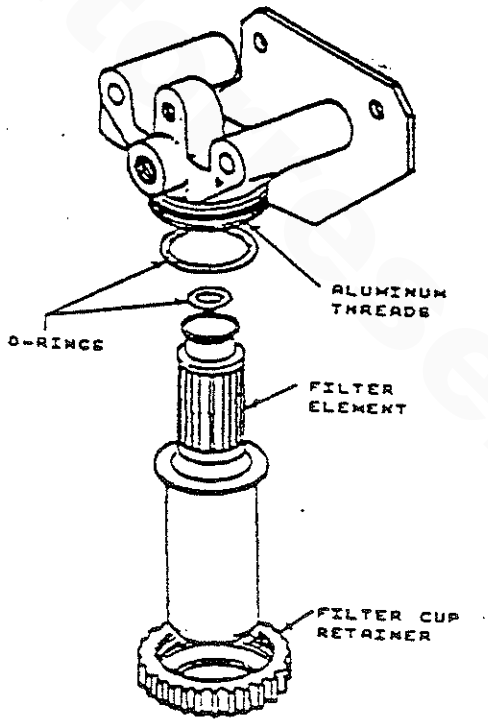
The Westerbeke fuel system is self-bleeding. While it is unlikely that the operator will be forced to service the system at sea, the possibility does exist. Therefore, we recommend that a replacement fuel filter be carried on board at all times. Each fuel filter comes with two O-ring gaskets. Select the part number for this fuel filter from your Parts List and purchase spares from your local Westerbeke Dealer or Distributor.

If a leak should develop at a fuel banjo or sealing washer location that cannot be remedied by a slight tightening of the filter cup retainer, replace the filter along with the O-rings supplied with a new filter.

**Replacing the Fuel Filter Element**

After the first 50 hours of operation, loosen the filter cup retainer and remove the filter cup. *Be careful in catching any fuel that may spill from within the filter cup.* Discard the old filter element and the old O-rings. Clean the filter cup and install the new filter along with the new O-rings. Carefully replace the filter cup and retainer. Take care not to cross thread the retainer when threading on to the filter bracket.

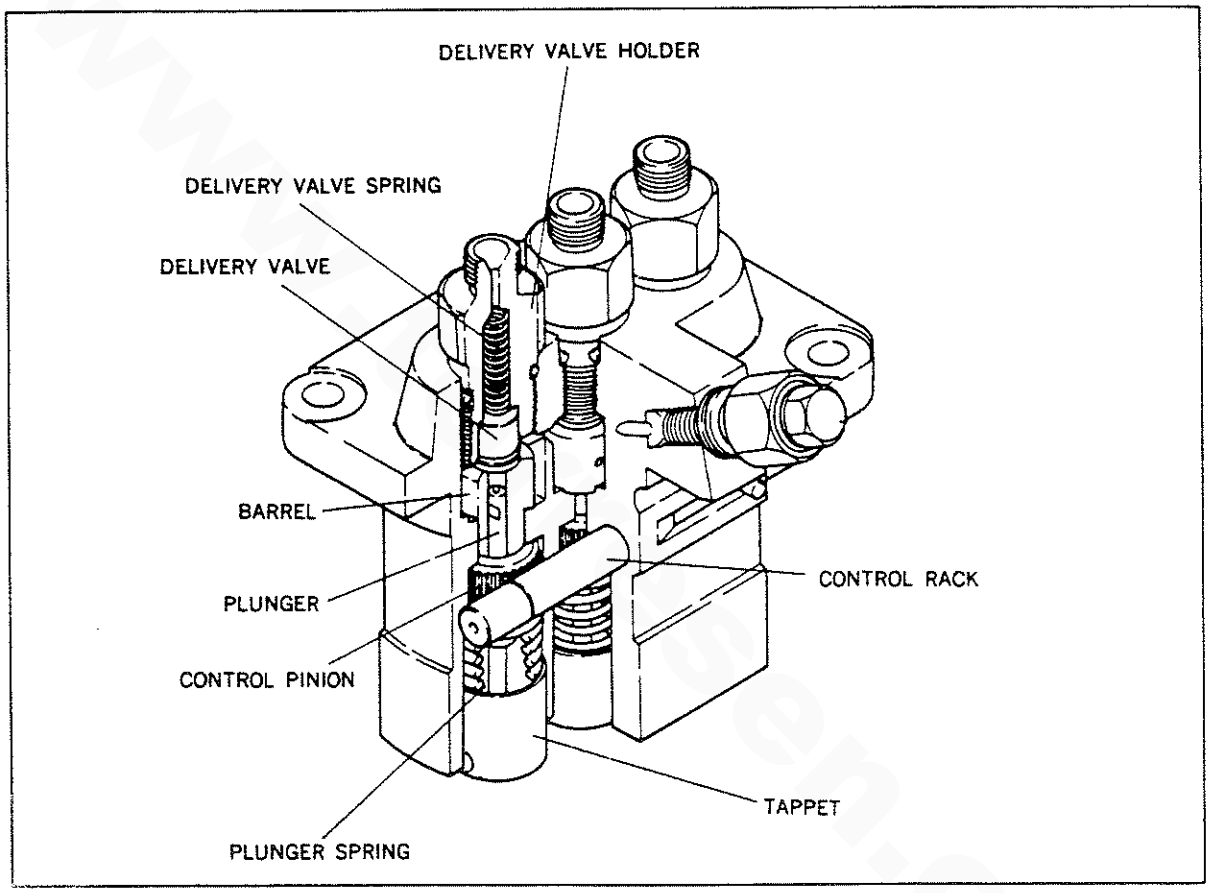
**NOTE: DO NOT** over-tighten the filter cup retainer; excessive tightening can strip the soft aluminum threads on the fuel filter assembly.




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

**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 caution in handling. Furthermore, the fuel injection pump has been thoroughly shop-adjusted and should never be tampered with.




Sectional View of Pump

Idle speed and timing adjustment are the only adjustments the servicing dealer can perform on the injection pump. Other types of adjustments or repairs must be performed by a qualified injection service shop.

# ELECTRICAL SYSTEM

## Engine 12-Volt DC Control Circuit

The Westerbeke 12C-TWO propulsion engine has a 12-Volt DC electrical control circuit, as shown on the wiring diagrams which follow. Refer to these diagrams when troubleshooting or servicing electrical components on the engine.

**CAUTION**

To avoid damage to the battery charging circuit, never shut off the engine battery switch while the engine is running. However, shut off the engine battery switch to avoid electrical shorts when working on the engine electrical circuit.

## Battery Specification

The minimum recommended capacity of the battery used in the engine's 12-Volt DC control circuit is 300 - 400 C.C.A.

**CAUTION**

When quick-charging the battery with an external charger, be sure to disconnect the battery cables from the battery. Leaving the charging circuit connected while quick-charging will damage the alternator's diodes.

## Alternator

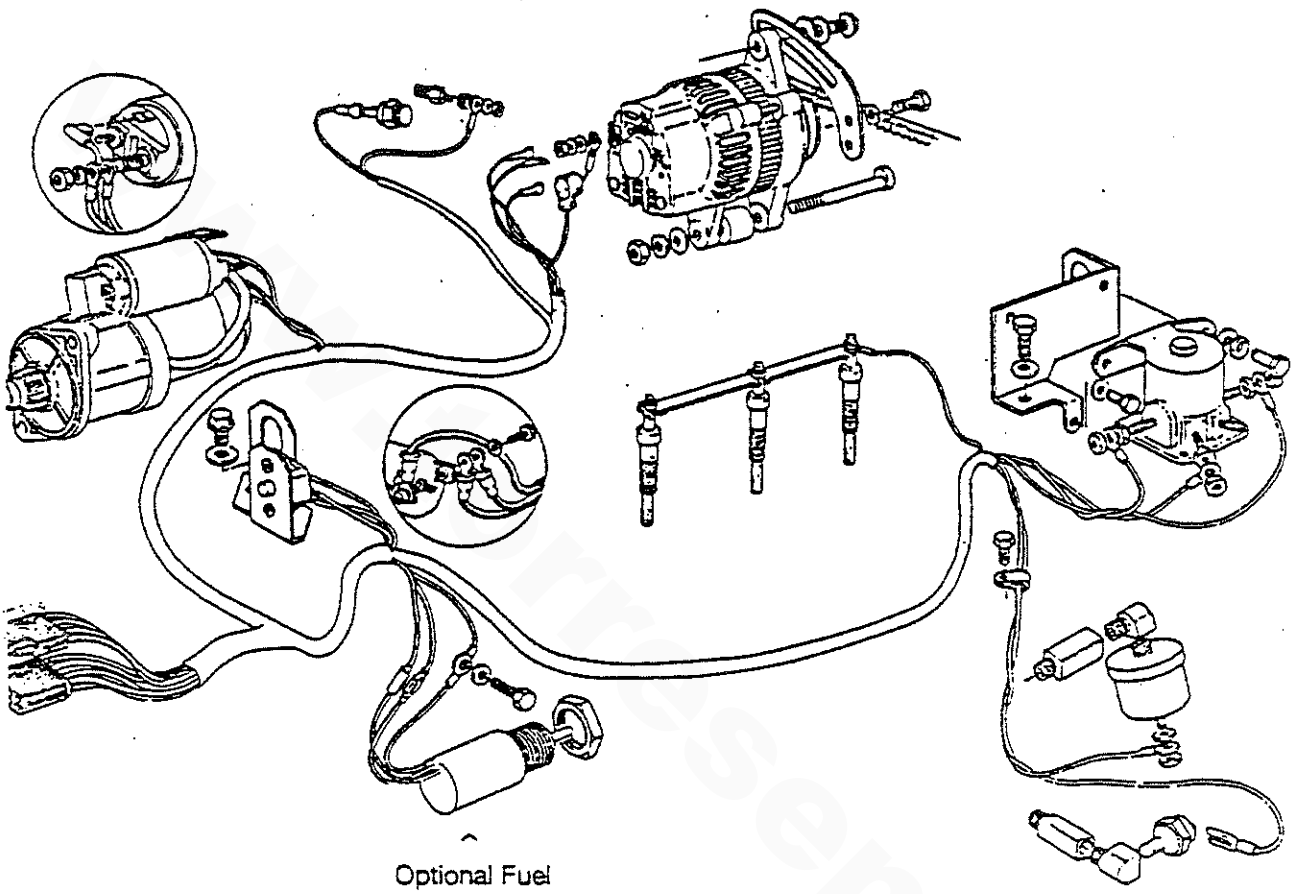
**CAUTION**

When testing the alternator circuit (charging circuit), do not use a high-voltage tester such as a megger; damaged diodes could result.

During high-speed operation of the engine, do no disconnect the positive terminal of the battery from the B terminal of the alternator, nor disconnect the negative terminal of the battery from the ground.

When cleaning the engine with a steam cleaner, be careful to keep steam away from the alternator.

Illustrated below is a wiring harness for a three-cylinder engine electrical system. The wiring harness for the 12C-TWO's electrical system differs only in that it has one less glow plug terminal.



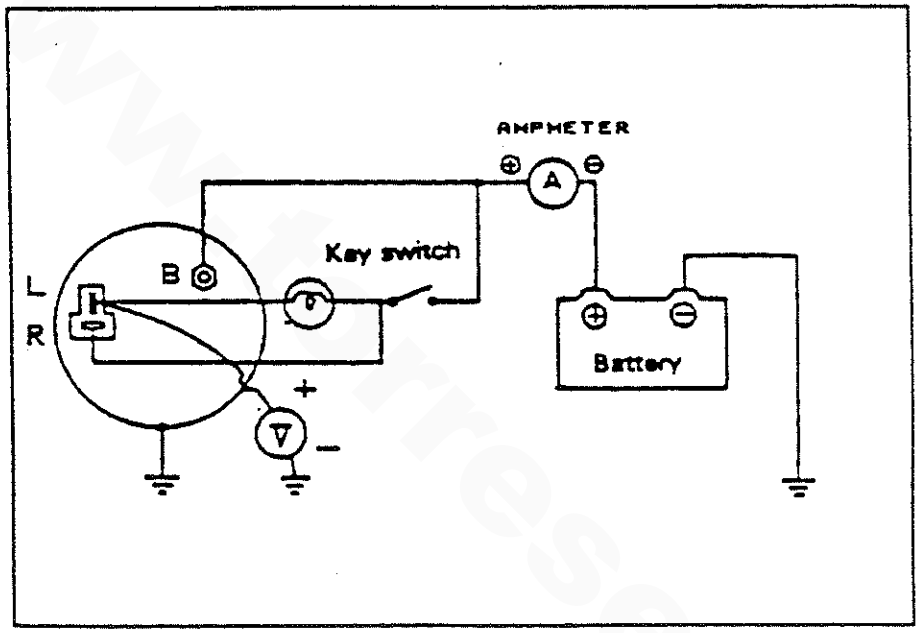
Optional Fuel
Run Solenoid

The charging system consists of an alternator with an internal voltage regulator, an engine-mounted circuit breaker, a battery and connecting wires.

Because of the use of IC's (integrated circuits), the electronic voltage regulator is very compact and is built into the rear bracket of the alternator.

**Charging Voltage Test**

If you suspect that the alternator is not producing enough voltage to charge the engine's battery, perform the following voltage test.




Interconnections for Charging Voltage Test

1. Using a voltmeter, connect the voltmeter's red wire clip to the B output terminal on the alternator. Refer to the schematic shown above.

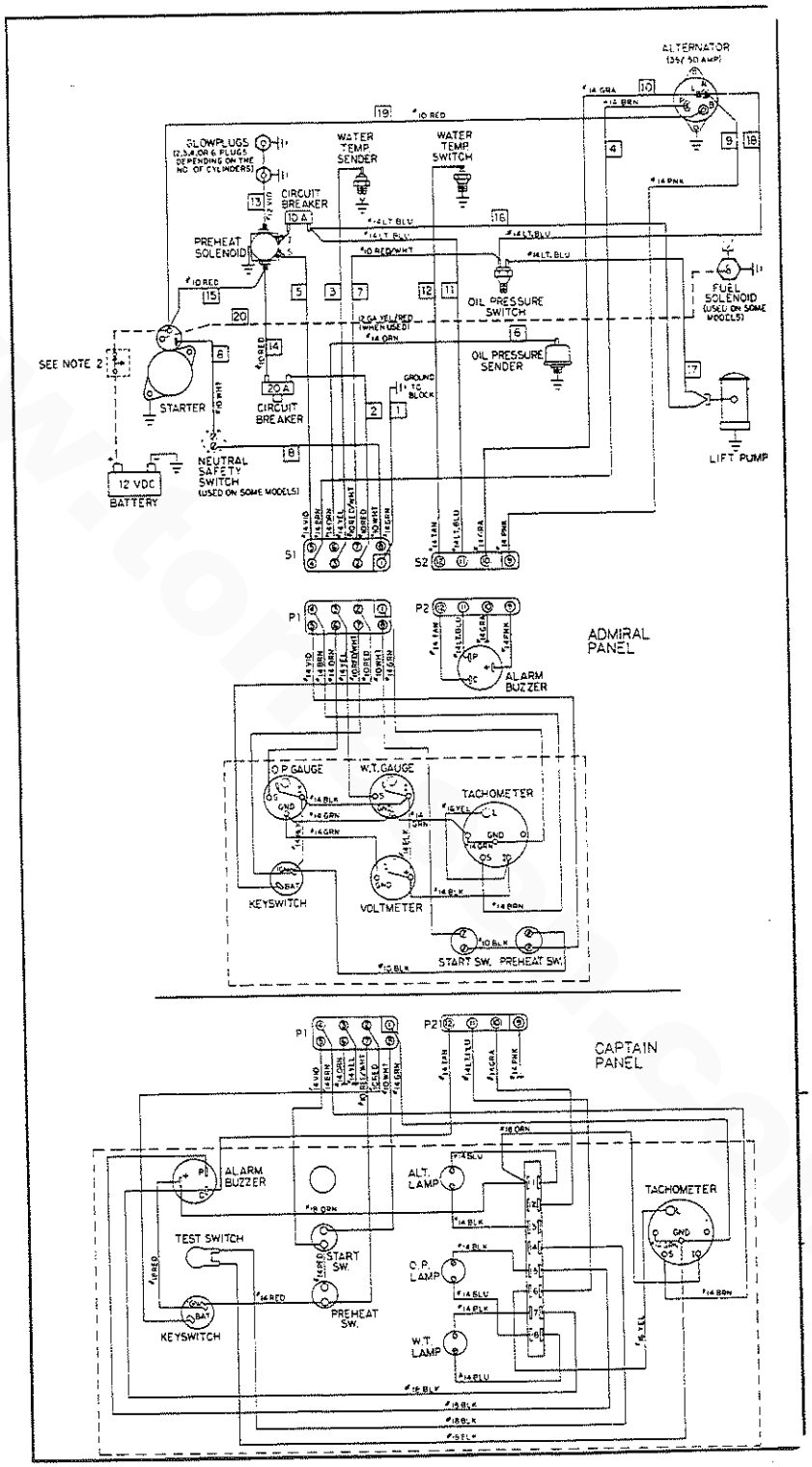
2. Connect the other wire clip to a ground on the engine.

3. Start the engine and increase the engine's speed to 2000 rpm. Now record the reading given by the voltmeter.

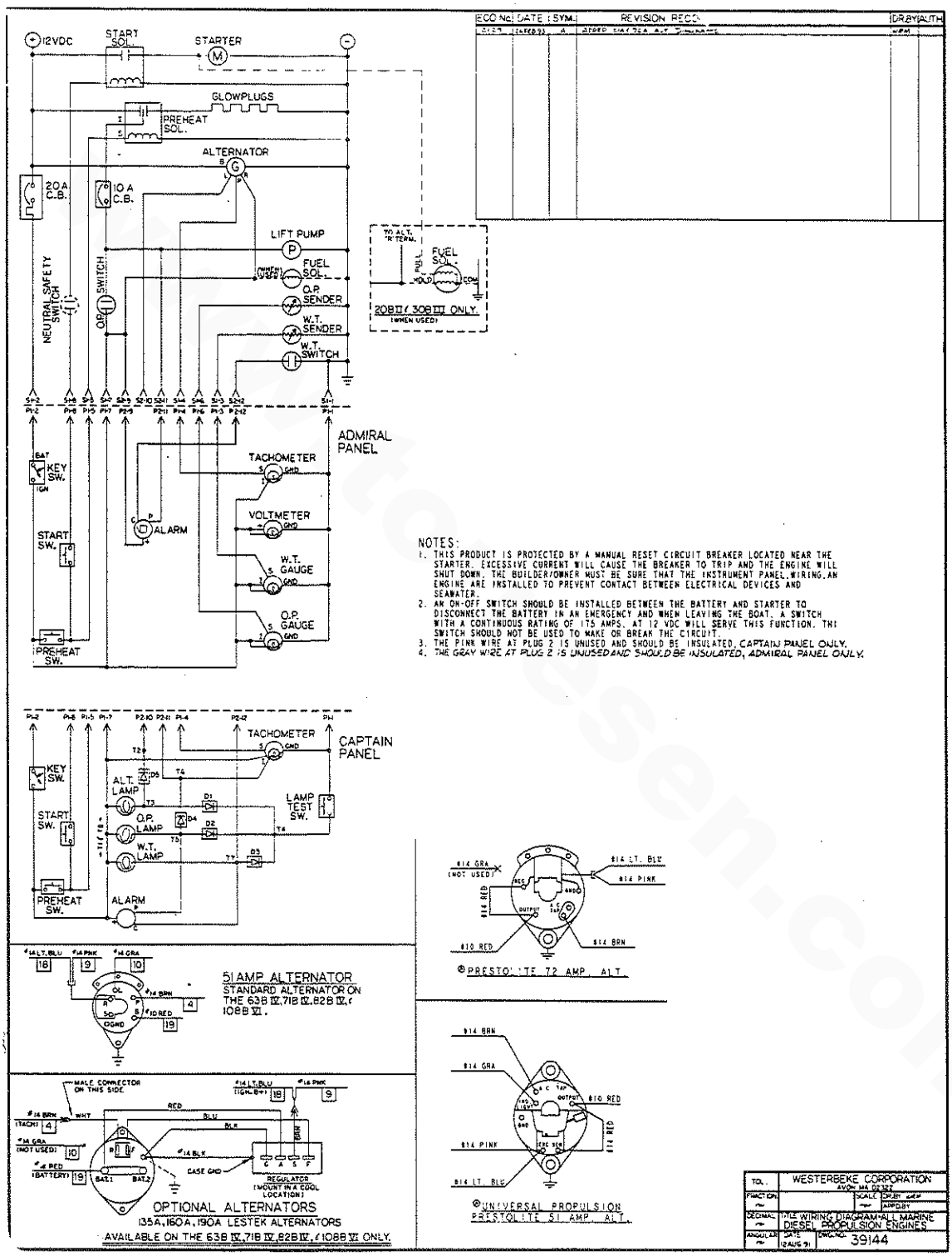
The voltage reading for a properly operating alternator should be between 13.5 to 14.5 volts. If your alternator is over or under charging, have it replaced or rebuilt by a reliable service shop.

**NOTE:** Before removing the alternator for repair, make sure 12-volts excitation is present at the R terminal should the above test show only battery voltage at the B output terminal.

## DC Control Circuit Wiring Diagram #39144
## page 1 of 2



# DC Control Circuit Diagram #39144
## page 2 of 2



# 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 is 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 passage 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 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 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.

Use soft water with few impurities, such as tap water (potable water) or rainwater. Never use hard or foul water. Use of hard water or 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 rust 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 |
|---|---|---|---|---|---|---|---|---|
| Freezing°F Temperature | 23 (°C) | 14 (-5) | 5 (-10) | -4 (-15) | -22 (-20) | -40 (-30) | -58 (-40) | (-50) |

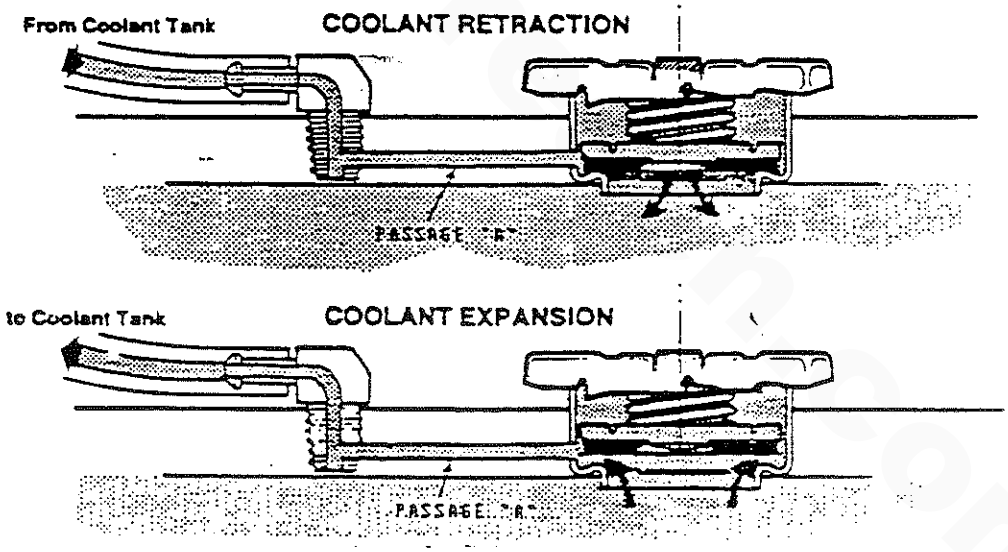
NOTE: An antifreeze concentration should be selected on the basis of a temperature which is about 10° F (5°C) lower than the actual atmospheric temperature expected.

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 the loss of coolant and without introducing air into the cooling system.

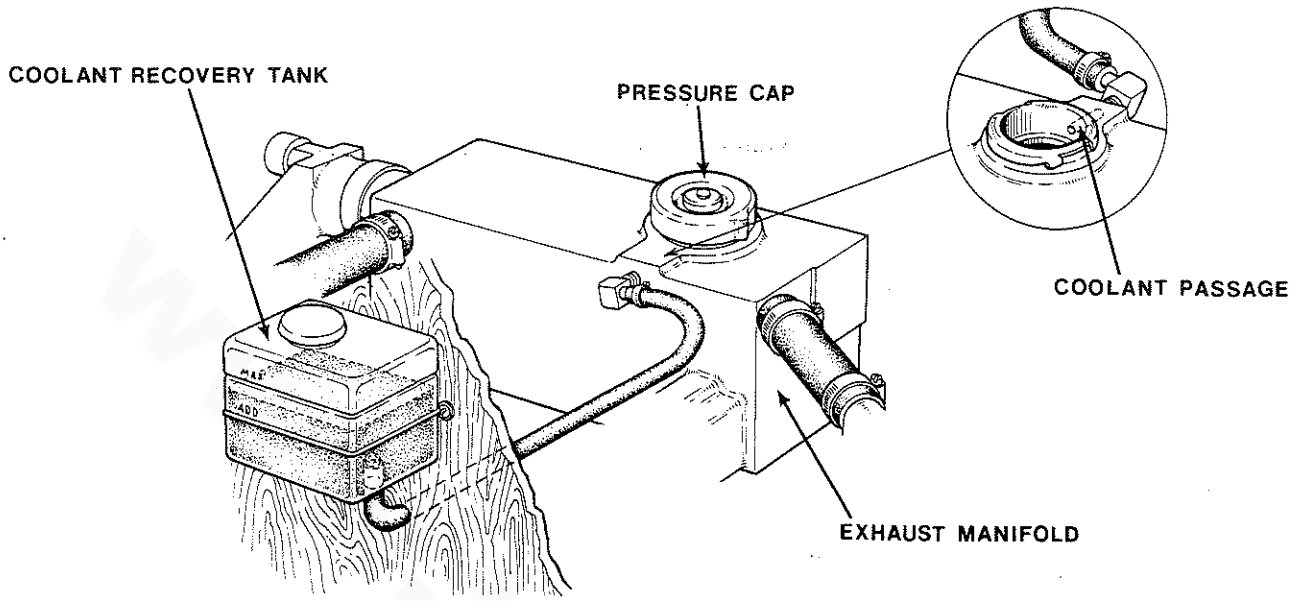
This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed (see the figure below). A stainless steel mounting bracket is supplied with each kit along with a 30-inch length of clear 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.

## FUNCTION OF MANIFOLD PRESSURE CAP




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.




Coolant Recovery Tank, Recommended Installation

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.

2. 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.

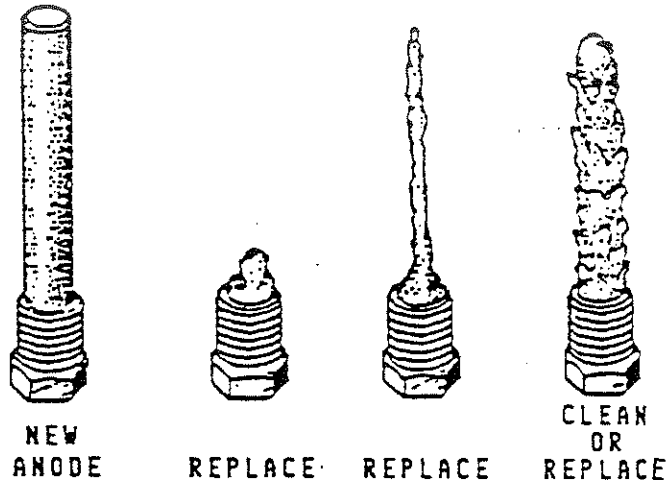
7. Add coolant to the recovery tank, as required, to top off the fresh water coolant system.

**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 gear-driven, 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

A zinc anode, or pencil, is located in the sea water cooling circuit within the heat exchanger. 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 replace 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.

### Sea Water Pump

The sea water pump is a self-priming, gear-driven 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). Sea water pump impeller failures occur when lubricant (sea water) is not present during engine operation. Such failures are not warrantable, and the operators are cautioned to make sure sea water flow is present at start-up.

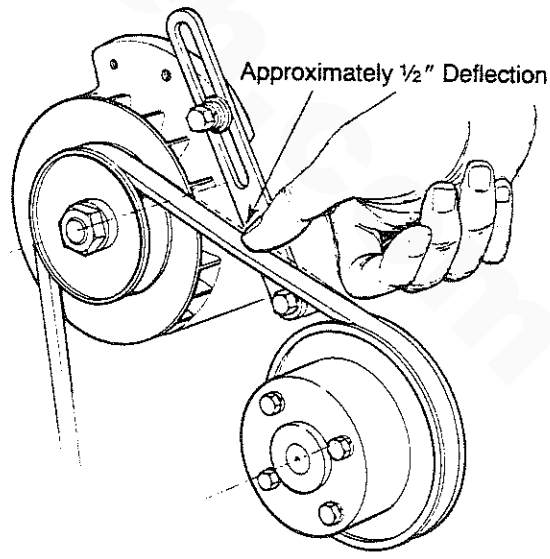
### Alternator and Water Pump Drive Belt Tension

**WARNING**

Never attempt to adjust the drive belt's tension while the engine operating.

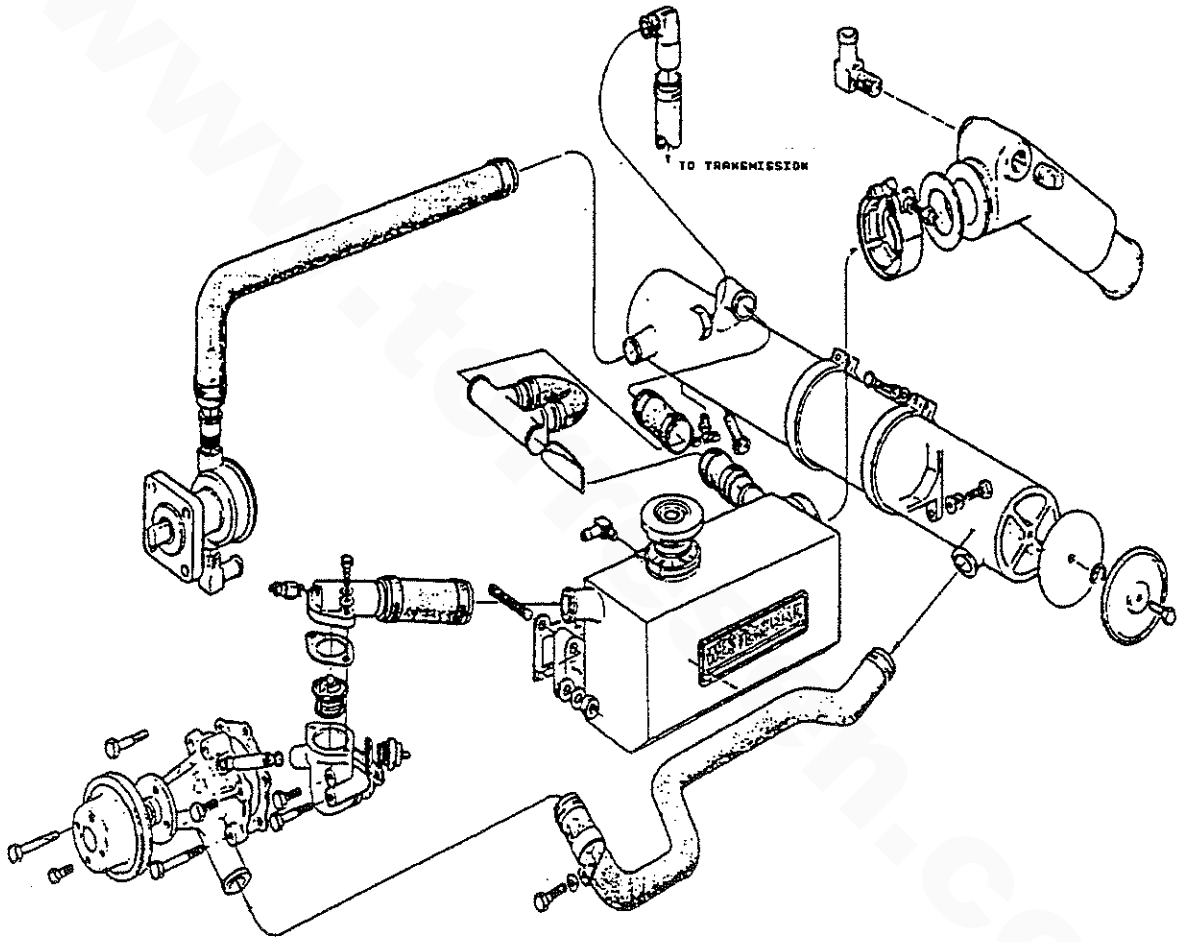
**CAUTION**

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 alternator and circulating water pump drive belt is properly adjusted if the belt can be deflected no less than 3/8 inch and no more than 1/2 inch (10mm , 12 mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt. (See illustration on the previous page.) A spare drive belt should be carried on board. Refer to the "SPARE PARTS" section of this manual.

**Cooling System Components, Exploded View**

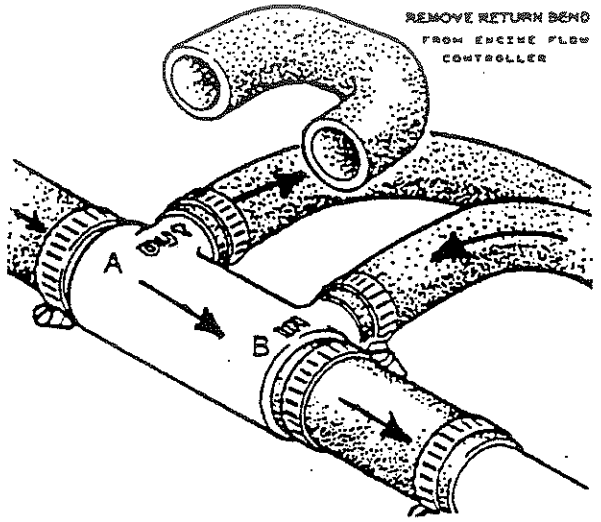



The illustration shows the cooling system components for the 12C Two engine. Refer to the Parts List for ezch component's name and part number.

### Domestic Hot Water

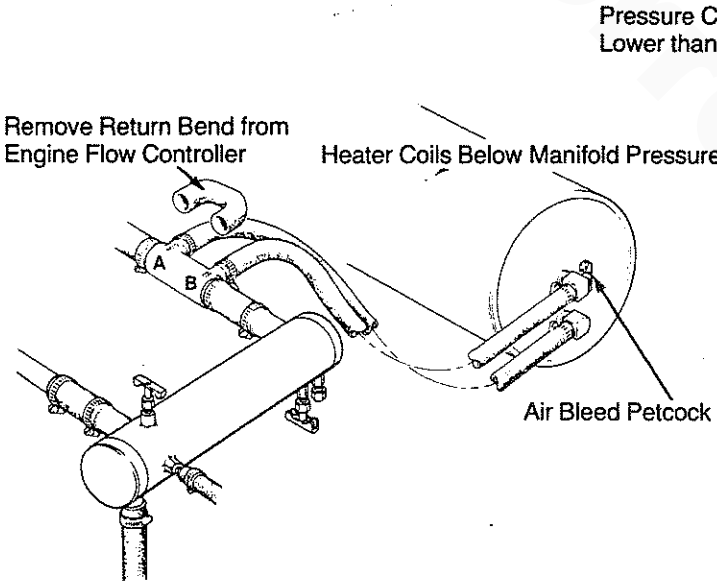
The 12C-Two engine is equipped with a domestic hot water connection. If the owner/operator wishes to connect a hot water heater, remove the bypass hose and connect a heater as described in the instructions presented below.

**General:** With the bypass hose (Part #30962) removed, there remain two connecting points A and B for hoses to run to and from the water heater. These connections assure a flow of hot water through the heater at all times but do not restrict the engine's cooling water.

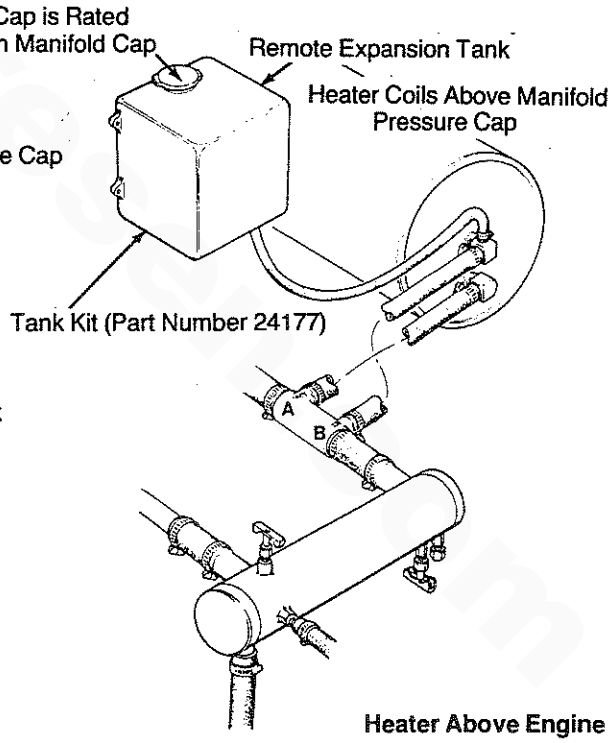



Flow Controller

**Installation:** The water 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. Connection point A on the Flow Control housing should connect to the lower of the two connections on the water heater while the upper connection on the heater returns to connection B, nearest to the heat exchanger.




Heater Below Engine




Heater Above Engine

The illustrations shown above are Flow Control designs that have been adapted to operate with the single pass manifolds installed on the 12C-Two 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 to rise to the heater, then an air bleed petcock must be installed at the higher fitting on the heater for bleeding air while filling the system. 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 flow control. (Refer to the illustration on the previous page.) 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 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.

Refer to the illustrations on the previous page.

# 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 an all-season SAE 10W-30 oil with a minimum viscosity change under different temperatures. Refer to the chart below:

| Atmospheric Temperature | Viscosity |
|---|---|
| 68° F (20° C) or higher | SAE 30 or 10W-30 |
| 41° F (5° C) - 68° F (20° C) | SAE 20 or 10W-30 |
| 41° 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**

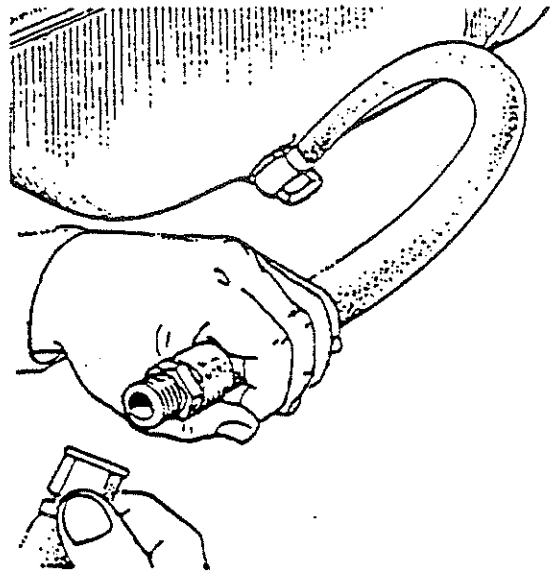
The oil pressure during operation of the engine is indicated by the oil pressure gauge on the Admiral Panel.

During normal operation, the oil pressure will range between 30 and 55 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 55 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 oil filter)**

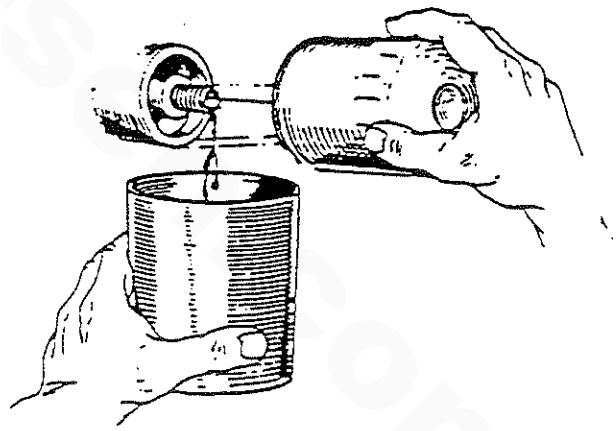
1. Draining the Oil Sump



Start the engine and allow the engine temperature to reach the 130° - 140° range (minimum). Oil is easier to remove from the sump when it is warm. Remove the oil drain hose from its attachment bracket and lower it into a container and allow the oil to drain, or attach a pump to the end of the drain hose and pump the old oil out. Make sure the oil drain hose is properly secured in its holder after all of the old oil has been drained.

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic should water be present in the oil. Sea 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 sea water cooling circuit into the exhaust, filling it up into the engine.

**2. Replacement of the Oil Filter**



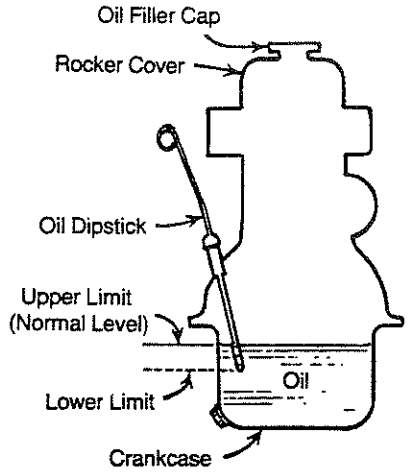
When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. A small style automotive filter wrench should be helpful in removing the 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 onto the rubber gasket on the oil filter. Screw the filter onto the threaded oil filter stub, and then tighten the filter firmly by hand.

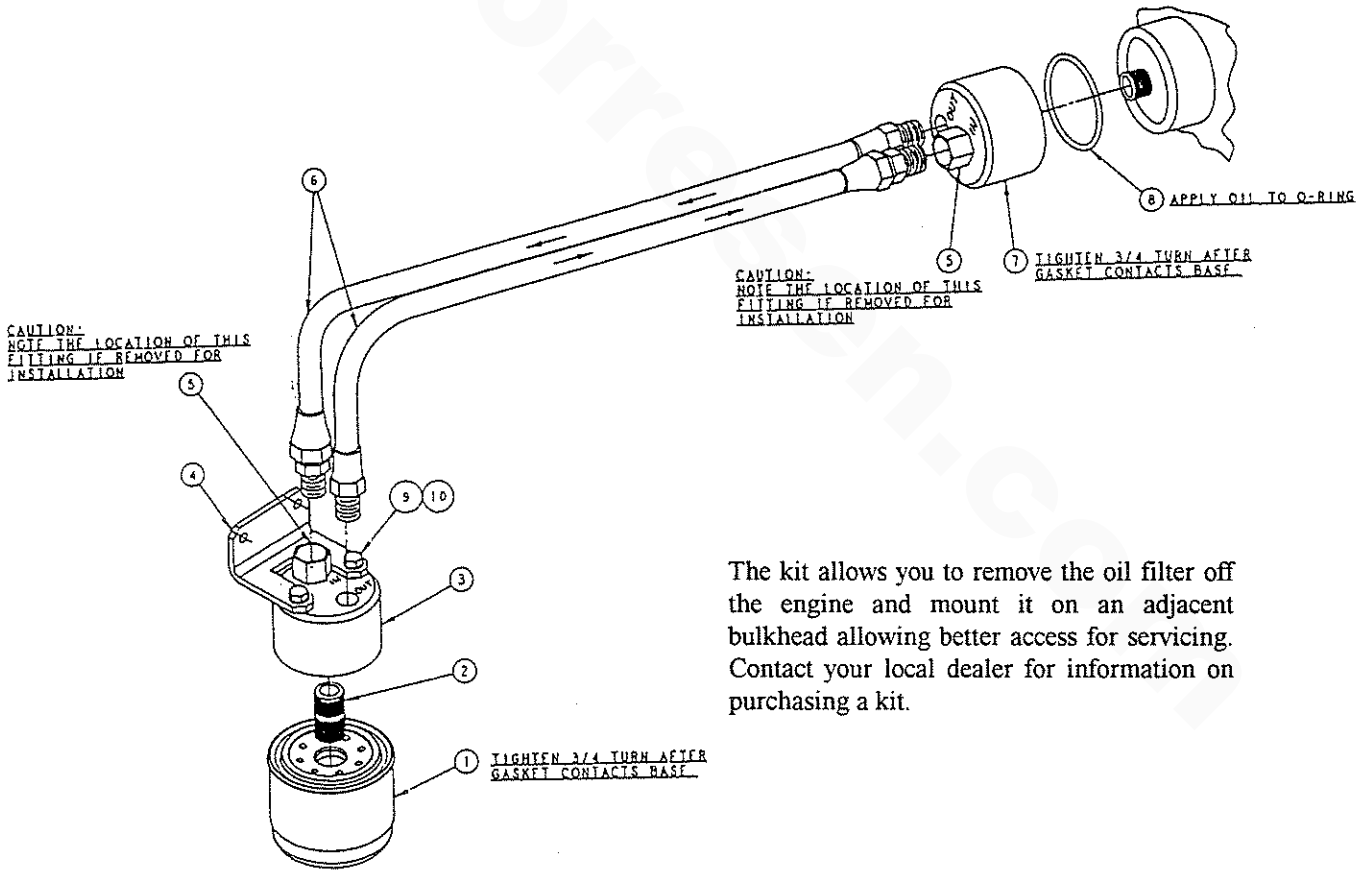
NOTE: Generic filters are not recommended, as the material standards or diameters of important items on generic parts might be entirely different from genuine parts. Immediately after an oil filter change and oil fill, run the engine for a few minutes to make sure the oil pressure is normal and that 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. After refilling the oil, run the engine for a few moments while checking the engine's oil pressure. Ensure 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 dipstick. Fill to, but not over, the high mark on the dipstick, should the engine require additional oil.




**Remote Oil Filter Kit #040078**

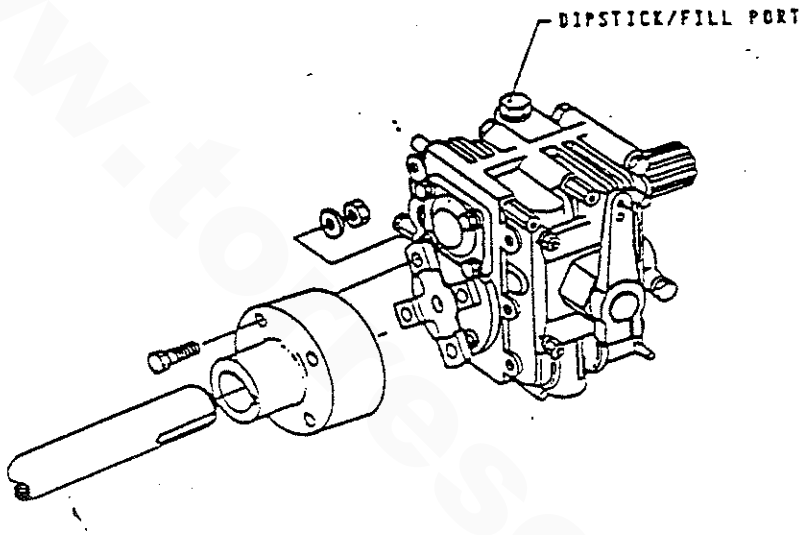



The kit allows you to remove the oil filter off the engine and mount it on an adjacent bulkhead allowing better access for servicing. Contact your local dealer for information on purchasing a kit.

# THE HBW 35 TRANSMISSION

## General

The HBW 35 transmission is equipped with a positively-driven, mechanically-operated helical gearing system. The servo-operated multiple-disc clutch requires only a minimum effort to change drives. This feature makes the transmission suitable for a single-lever remote control with a rod linkage, such as a Morse or Bowden cable. For safety reasons, the transmission is **NOT** filled with transmission fluid before shipment. Before leaving the factory, however, each transmission is thoroughly tested with fluid in the transmission. This testing, among other things, provides all internal parts with a coating of transmission fluid. This fluid acts as a preservative, providing reliable protection against corrosion for at least one year if the transmission is properly stored.




## Lubrication

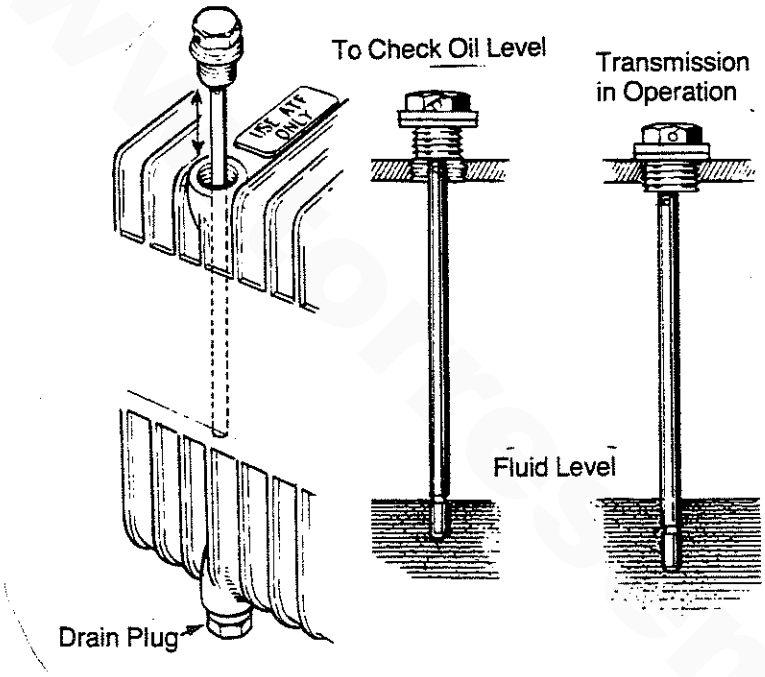
The HBW 35 transmission is an immersion-lubricated type. Fill the transmission up to or near the top of the machined notch cut on the dipstick with approximately .32 U.S. quarts (0.3 liters) of automatic transmission fluid (ATF).

Change the transmission fluid after the first 50 hours of engine operation and thereafter every 250 hours (or once per year, minimum). The HBW 35 transmission has a drain plug for draining the old transmission fluid. To ensure that most of the old fluid is drained from the transmission, run the engine in NEUTRAL for approximately 10 to 15 minutes so the transmission fluid may warm and flow better from the transmission. This transmission fluid may also be removed by inserting a small tube through the dipstick opening (where the transmission fluid is added) and attaching a pump onto the tube so the old fluid may be sucked out.

The operating oil temperature must not exceed 266° F (130°C). If this temperature is to be exceeded during normal operation, an optional transmission oil cooler should be installed. Consult your local Westerbeke Dealer for details on this cooler.

**NOTE:** To check the transmission fluid level, remove the dipstick and wipe off all transmission fluid on the dipstick, and place the dipstick back in the hole where it was removed, making sure that the base of the dipstick's threaded portion rests on the transmission housing. Now remove the dipstick and see where the fluid measures on the dipstick. If the transmission's fluid level lies below the notch, add enough transmission fluid to raise the level back up to the notch. Do not overfill the transmission.

DO NOT screw the dipstick into this hole to check the transmission fluid level. Screw the dipstick into this hole only after an accurate reading of the fluid's level has been taken. Make sure that the dipstick is screwed in before and while the engine is operating. Ensure that the sealing washer is present.




**Dipstick Oil Level**

The transmission drain plug is located directly below the dipstick and is the same size hex head as the dipstick. This drain plug also has a sealing washer.

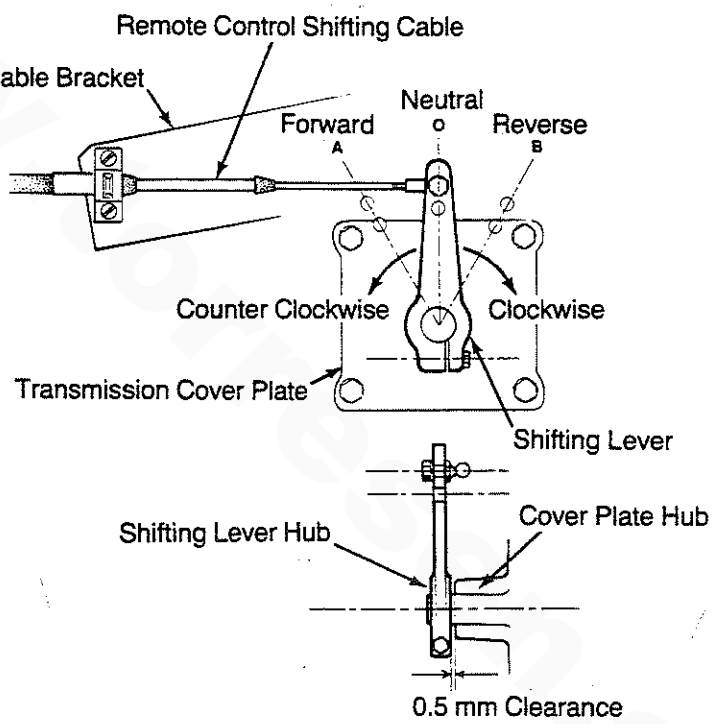
**Alignment**

Misalignment between the transmission's coupling and the propeller shaft's coupling can create serious problems. Ensure that the alignment procedures outlined in the "Propeller Coupling," the "Propeller," and the "Alignment of the Engine" sections of this manual are followed.

**Controls**

The only controls required to operate the transmission is a single lever remote control cable. The cable should be attached to the gear box lever using the cable bracket supplied with the unit. Both the gear box lever and the remote control lever must be in the NEUTRAL position when the cable is attached to the gear box lever. This allows the remote cable an equal throw distance to shift the gear box into FORWARD or into REVERSE from the NEUTRAL position without running out of cable. Allow approximately 1.18 inches (1 3/16) of cable throw from the NEUTRAL position on the transmission's gear box lever to each of the two drive positions.

NOTE: If the throw distance (or travel) of the remote cable is too short, the gear box lever cannot fully engage the transmission into FORWARD or REVERSE. In this situation, the transmission's clutch plates will wear prematurely and the transmission will eventually fail.




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

**Shifting**

To shift the transmission from NEUTRAL to FORWARD, exert a heavy push to the remote control lever. A gentle throw may not carry enough force to actually shift the transmission's internal gears. A gentle throw is signaled by the transmission not engaging into the desired drive. Make sure the remote control lever is lubricated at least once each operating session. Shift the transmission while the engine is running at 1200 rpm or below. The clutch pack within the transmission makes an audible "clunk" when engaging into gear.
Moving the shift lever toward the output shaft (coupling end) of the transmission puts the transmission in FORWARD. Moving the shift lever toward the engine puts the transmission in REVERSE.

**CAUTION**

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

**Sailing Operation**

The HBW 35 transmission can be left in its NEUTRAL position while sailing. Leaving the transmission in NEUTRAL while sailing alleviates unnecessary drag on the vessel because the propeller shaft while under sail, this can be done by placing the transmission into REVERSE to look the propeller shaft.

**Service**

If any seal on the transmission shows signs of leaking, have the transmission looked at by an authorized Westerbeke Dealer or a Hurth Service Center. This problem, especially concerning the rear seal, is often contributed to an improper alignment of the transmission's coupling and the propeller shaft's coupling. Refer to the "Alignment of the Engine" section of this manual.

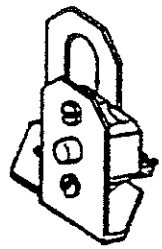
To locate the Hurth Service Center closest to you, call (708) 231-1680 (C.H. Corporation) and inquire. Repairs or disassembly of the HBW 35 transmission should only be undertaken by authorized Hurth Service Centers.

# 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 located on the rear lifting bracket.



| Problem | Probable Cause | Verification/Remedy |
|---|---|---|
| Key switch ON but no panel or test function. | 1. Battery OFF. | 1. Turn battery OFF. |
| | 2. 20 Amp circuit breaker is tripped. | 2. Reset the breaker by pushing in the button. |
| | 3. Loose battery cable connection. | 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, connections or switch. | 1. Check the preheat switch. |
| | 2. Faulty connection or tripped 10 Amp breaker on the I terminal on the preheat solenoid. | 2. Connection for 12 volts at S terminal of the solenoid is faulty. |
| Amp alternator | | 3. Check for 12 volts at the 10 breaker. Check for 12 volts at the R terminal on the when the preheat button is pushed. |

| Problem | Probable Cause | Verification/Remedy |
|---|---|---|
| START switch is depressed: no starter engagement. | 1. Connect to solenoid faulty. | 1. Check connection S at the starter solenoid for 12 volts. with the switch depressed. |
| | 2. Faulty START switch. | 2. Check switch with an ohmmeter. |
| | 3. Faulty solenoid. | 3. Twelve volts is present at the S terminal of the starter solenoid. |
| | 4. Loose battery connection. | 4. Check battery connections at both the + and - ground. |
| | 5. Low batteries. | 5. Check battery charge state. Low voltage at the solenoid's S terminal with no activation. |
| 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 to engine. | 2. Check for fuel. |
| | 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. |
| Failure to stop. | 1. Mechanical Run linkage disconnected. | 1. Stop engine by manually moving the RUN linkage to STOP. That failing, shut OFF fuel and air. |

| Problem | Probable Cause | Verification/Remedy |
|---|---|---|
| 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 ouput is low. | 1. Check the 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 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 the 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 fuel filter element in the on-engine filter and in the optional water/sediment separator, if a separator has been 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, the RUN linkage cable, and the transmission's remote control cable.

7. Change the transmission's transmission lubricant.

8. Adjust the engine's idle speed (1000-1200 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.

**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.

**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.

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

5. Check the resistance of the glow plugs. (0.16 ohm)
NOTE: Items marked by an asterisk (*) should be performed by a competent mechanic.

6. Check the condition of the sea water pump. Examine the pump's impeller and other pump components for wear. Replace worn components as needed. Check for leaks and repair as needed; DO NOT NEGLECT!

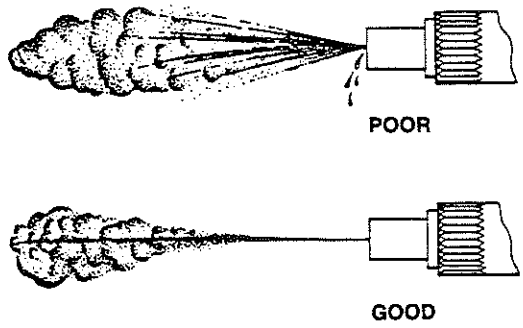
7. Check internal and external condition of water injected elbow. Remove any carbon or corrosion build-up. Replace the elbow should its condition be questionable.

**Servicing After Every 800 Hours of Operation**

*1. Remove and check fuel injectors.

Injector spray pressure:

1991 psi + 140 psi
(140 kg/cm$^2$ + 10 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 cranking speed is at 280 rpm.

| Standard | Minimum |
|---|---|
| 389 psi (28 kg/cm$^2$) | 312 psi (22 kg/cm$^2$) |

(Maximum difference between cylinders: 35.5 psi (2.5 kg/cm$^2$)

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

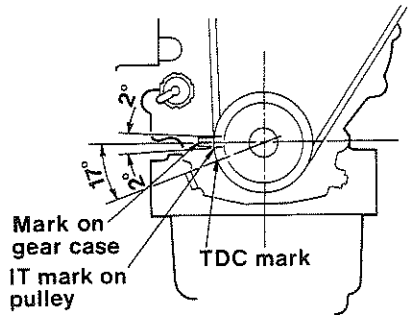
*4. Check the tightness of bolts, nuts, and clamps.

**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 salty 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.



# 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 by themselves.

The procedures which follow will allow you to perform your own lay-up and recommissioning, 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 maintenance needs of your engine. If you have any questions regarding lay-up procedures, call your local servicing dealer, he will be more than willing to provide assistance.

## Propeller Shaft Coupling

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

## Fresh Water Cooling System

A 50-50 solution of antifreeze and fresh water is recommended for use in the 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 ensure that 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 which has an API specification of CC or CD. Run the engine and check for proper oil pressure and ensure that there are no leaks.

*CAUTION*

Do not leave the engine's old lubricating oil in the sump during 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 condition the fuel. Care should be taken to ensure 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, clean the separator sediment bowl.

Change the fuel filter element on the engine and bleed the fuel system, as needed. Start the engine and allow it to run 5 - 10 minutes to ensure that 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.

**Sea Water Circuit**

Close the through-hull sea cock. Remove the sea 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 sea 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 sea water system. Once the bucket is empty, stop the engine. This antifreeze mixture should protect the sea water circuit from freezing during the winter lay-up, as well as providing corrosion protection.

Remove the impeller from your sea 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 not shove the cloth out of sight. (If it is not visible at recommissioning, and an attempt is made to start the engine, you may need 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 he same manner.

**Starter Motor**

Lubrication and cleaning of the starter drive pinion is advisable, if access to the starter permits its easy removal. Ensure that 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 fuel injectors from the cylinder head to squirt light lubricating oil into the cylinders for the few months of normal lay-up. However, if you anticipate a longer lay-up period (12 months or more), we recommend that this procedure be performed. The light oil in the cylinders will prevent the pistons rings from sticking to the cylinder walls. Ensure that you have replacements for the injector and return line sealing washers. Remove the glow plugs and use this opening to squirt oil into each cylinder. Turn the engine over manually two revolutions before reinstalling the glow plugs.

### Spares

Lay-up time provides a good opportunity to inspect the equipment 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, ensure that 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 unit after a seasonal lay-up generally follows the same procedures as those presented in the "PREPARATIONS FOR STARTING" section, regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counter-acted 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-explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

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 ensure that 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 unit is put into operation, the system will self-flush in a short period of time with no adverse affects.

5. Start the unit in accordance with procedures in the "PREPARATIONS 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. | 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 bolt, main *(wet), M10 (14) | 54.23 - 61.46 | 7.5 - 8.5 |
| Cylinder head bolt, sub * (wet), M8 (12) | 14.46 - 21.69 | 2.0 - 3.0 |
| Connecting rod cap nut, M8 (14) | 23.14 - 25.31 | 3.2 - 3.5 |
| Flywheel bolt, M10 (17) | 61.46 - 68.69 | 8.5 - 9.5 |
| Crankshaft pulley nut, M16 (24) | 72.31 - 86.77 | 10.0 - 12.0 |
| Main Bearing cap bolt, M10 (17) | 36.15 - 39.77 | 5.0 - 5.5 |
| Rocker shaft hold-down bolt, M8 (12) | 10.85 - 15.91 | 1.5 - 2.2 |
| Rocker cover nut, M6 (10) | 3.62 - 5.06 | 0.5 - 0.7 |
| Nozzle holder (fitting to engine), M20 (21) | 36.15 - 43.38 | 5.0 - 6.0 |
| Nozzle union color fixing nut, M12 (17) | 18.08 - 21.69 | 2.5 - 3.0 |
| Nozzle retaining nut, M16 (21) | 25.31 - 28.92 | 3.5 - 4.0 |
| Fuel injection pipe nut, M12 (17) | 18.08 - 25.31 | 2.5 - 3.5 |
| Delivery valve holder, M16 (17) | 25.31 - 28.20 | 3.5 - 3.9 |
| Injection pump hollow return bolt, M10 (14) | 7.23 - 10.85 | 1.0 - 1.5 |
| Solenoid locknut, M30 (36) | 28.92 - 36.15 | 4.0 - 5.0 |
| Water temperature sender, 7/16 | 14.46 - 21.69 | 2.0 - 3.0 |
| Oil filter, M20 (17) | 7.95 - 9.40 | 1.1 - 1.3 |
| Oil relief plug, M18 (19) | 32.5 - 36.15 | 4.5 - 5.0 |
| Oil drain hose plug, M18 (19) | 36.15 - 43.38 | 5.0 - 6.0 |
| Glow plug, M10 (12) | 10.85 - 14.46 | 1.5 - 2.0 |
| Glow plug lead wire fitting nut, M4 (7) | 0.723 - 1.08 | 0.1 - 0.15 |

**NOTE:** Hardware listed on this page is metric, with values given as in the following example :Flywheel bolt M10 (17). M10 indicates Metric, 10 mm thread diameter; (17) indicates 17 mm across the flats of the bolt head.

* Wet indicates that the bolts (if removed) are to have a thin oil film wiped on them before they are retorqued. If the bolts have not been removed and need only to be retorqued, then no oil is needed

## SPARE PARTS LIST

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 Spin-on Secondary Fuel Filter.
4. An Alternator/Sea Water Pump Belt
5. Hose Clamps
6. A Spare Oil Filter with a Spare Quart of Diesel Service Engine Oil along with a Gallon of Pre-mixed Antifreeze.
7. A Spare Oil Pressure Switch and Water Temperature Switch.

Other parts, whose life expectancy cannot be accurately pre-determined, 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.
2. Glow Plugs
3. Cooling System Hoses
4. An Alternator
5. A Starter
6. A 20 AMP DC Circuit Breaker
7. An Electric Fuel Lift Pump
8. A Sea 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 should be carried on board. In addition, if you are planning a long ocean voyage, consult your local Westerbeke distributor for a listing of the Westerbeke dealers located along your route.

# YOUR NOTES





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

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