OPERATOR'S MANUAL

BCD 4.4KW and BCD 6.0KW

MARINE DIESEL

GENERATOR SETS

Publication # 37144

Edition Two

May 1988

WESTERBEKE CORPORATION
MYLES STANDISH INDUSTRIAL PARK
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SAFETY PRECAUTIONS

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

WARNING

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

CAUTION

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

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

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

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

- Prevent Electric Shock

  Shut off electric power before accessing electrical equipment.

  Use insulated mats whenever working on electrical equipment.

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

  Remove wristwatch and jewelry when working on electrical equipment.

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

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

- Exhaust Gases Are Toxic

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

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

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

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

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

- Do Not Alter or Modify the Fuel System

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

  Be certain fuel line fittings are adequately tightened and free of leaks.

  Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

- Use Extreme Care When Servicing Batteries

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

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

- Avoid Moving Parts

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

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

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

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

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

CALIFORNIA
Proposition 65 Warning

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

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 the accuracy, timeliness or completeness thereof, and will in no event be liable for any type of damages or injury incurred in connection with, or arising out of, the furnishing or use of such software.**

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

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

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

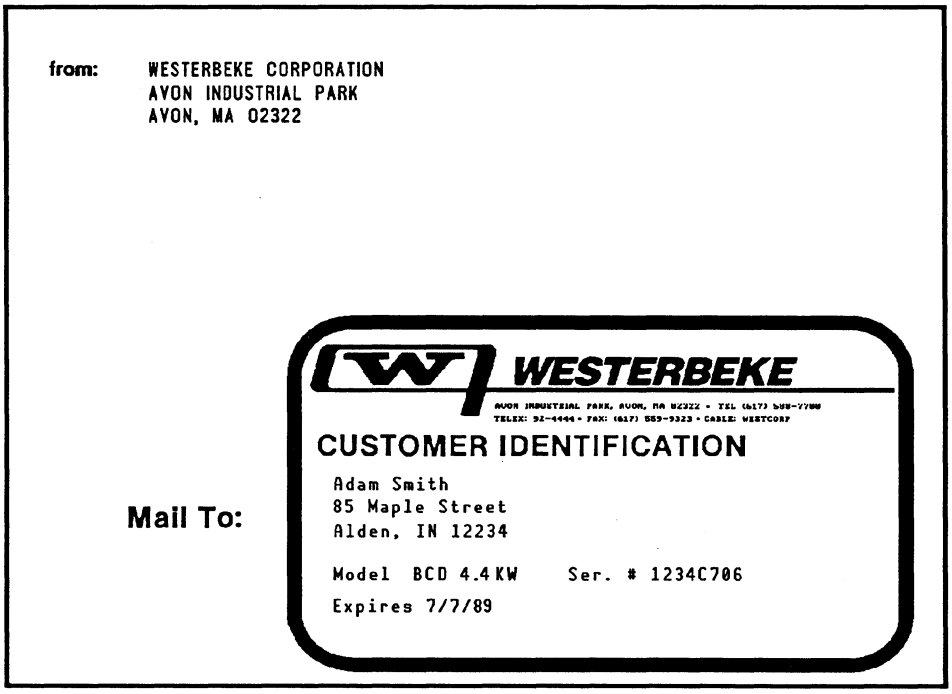
FOREWORD

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.

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



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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; therefore, a troubleshooting table is included.

Understanding the Diesel Engine-Driven Generator

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 fuel lift pump assembly, fuel injection pump and injectors.

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

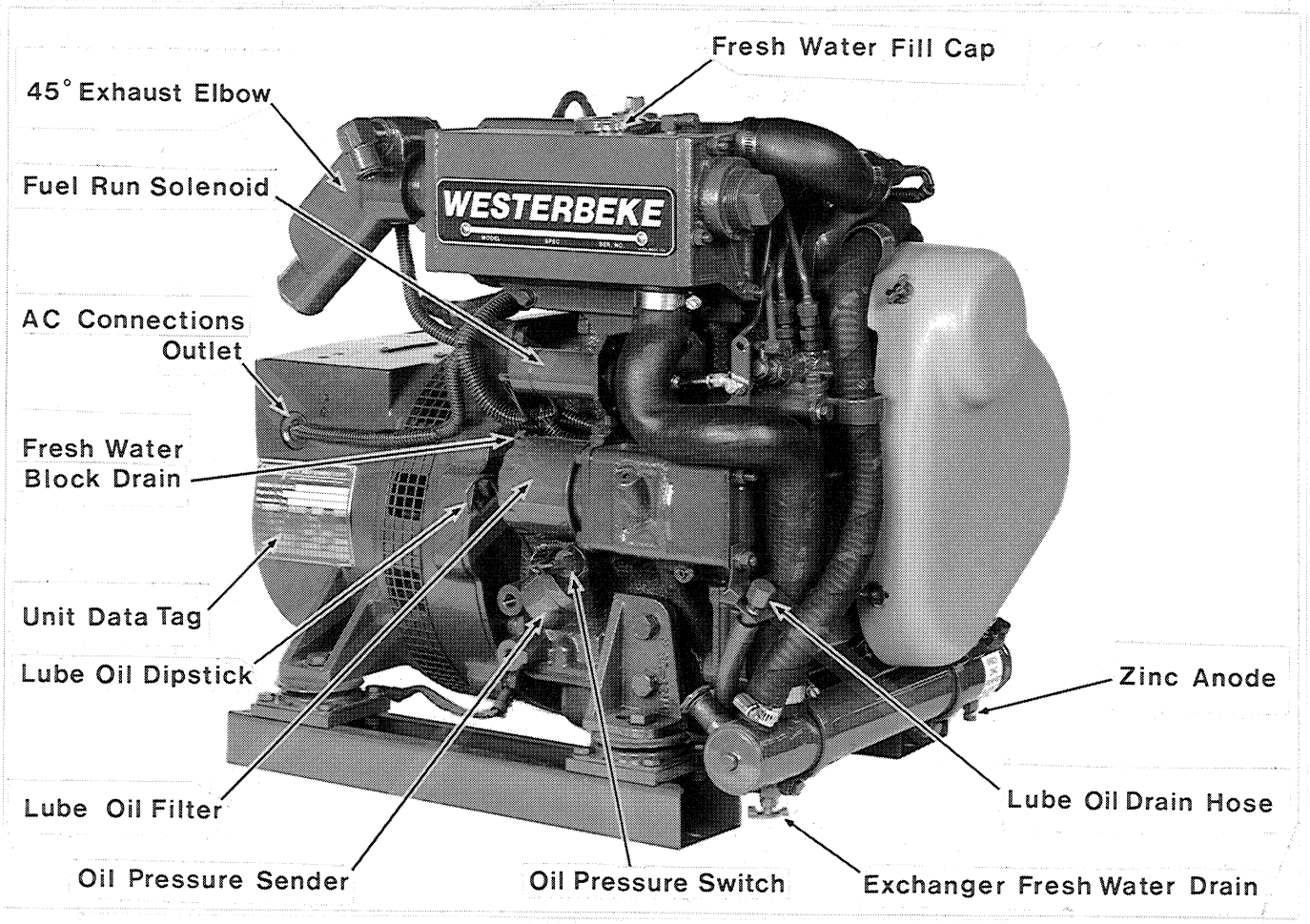
Ordering Parts

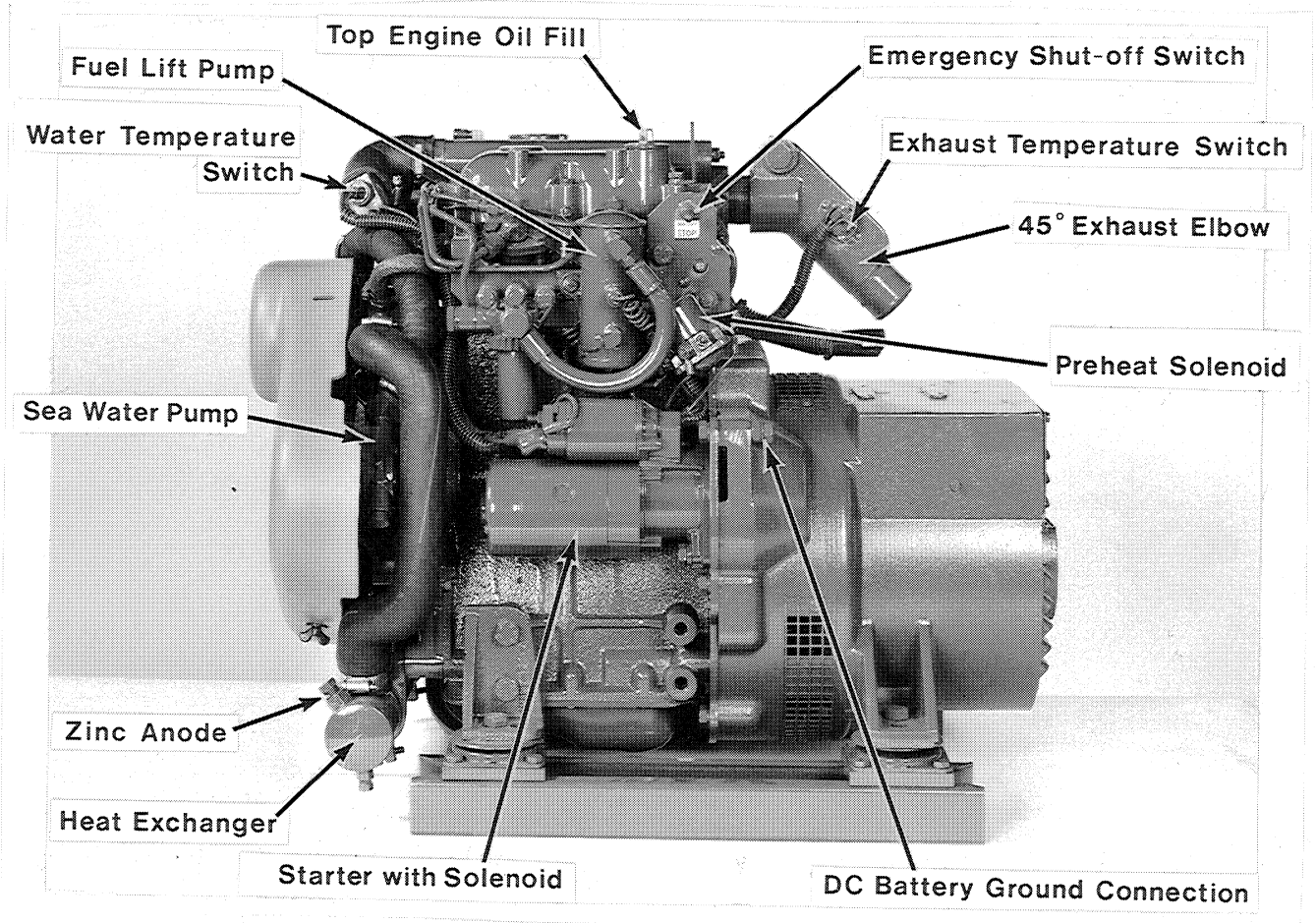
Whenever replacement parts are needed, always provide the generator model number, engine serial number, and generator serial number as they appear on the scarlet and gold name plate located on the generator end. You must provide us with this information so we may properly identify your generator set.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

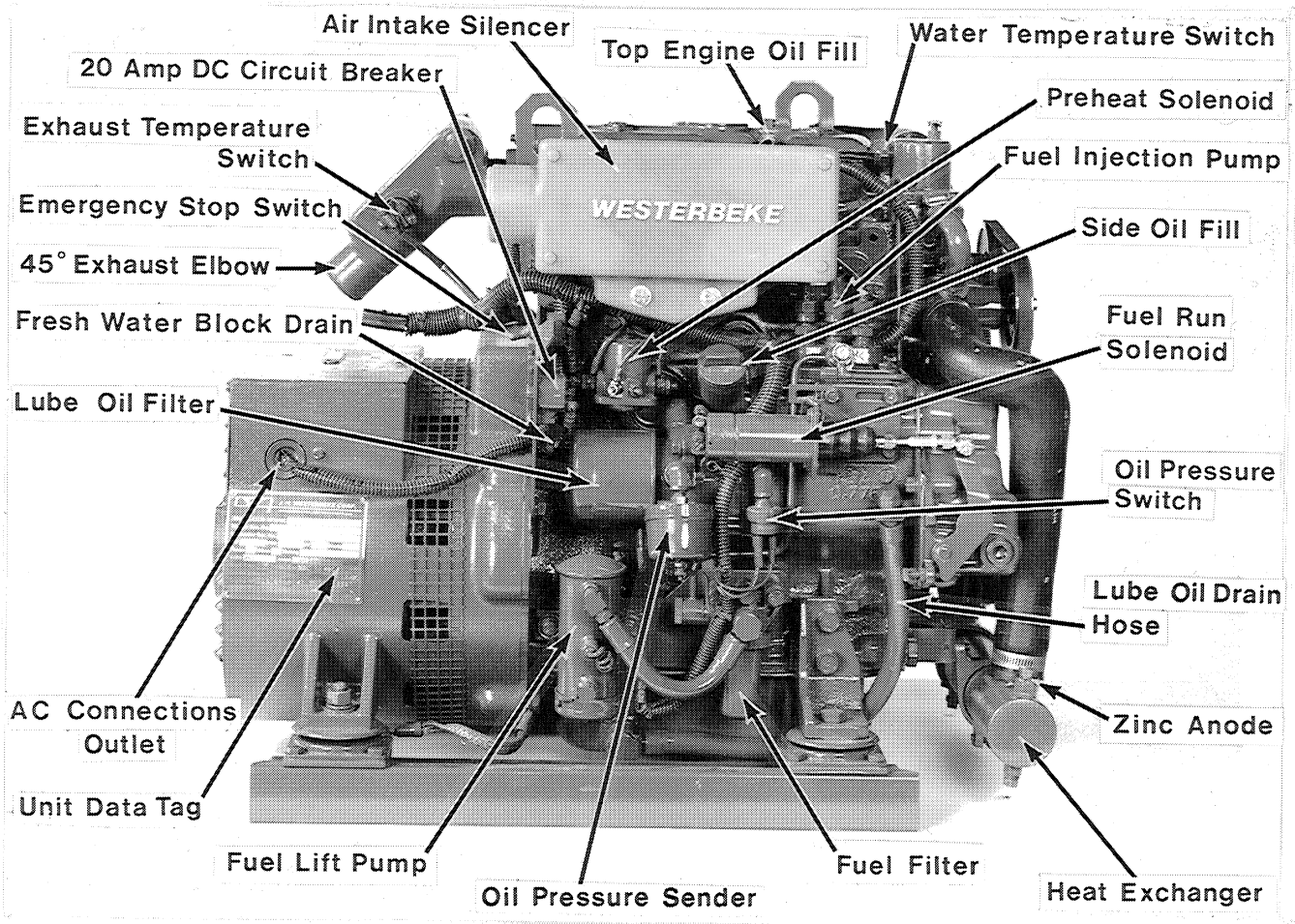
Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/generator end is the rear end.) Left and right sides are determined by the engine; imagine straddling the engine and facing in the same direction as the front of the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

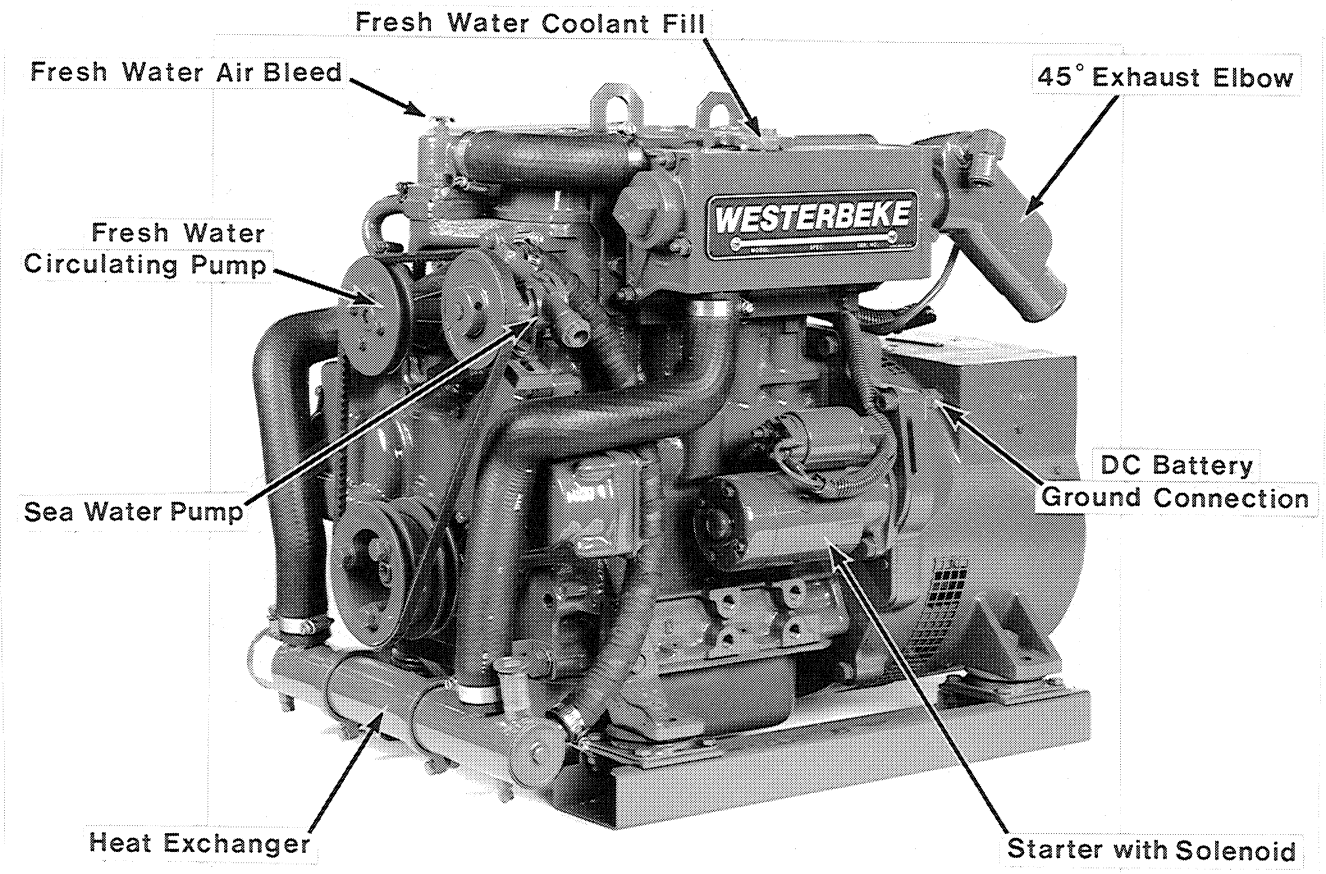
Westerbeke generators sets are thoroughly checked and given a final run under various load conditions before leaving the factory. Test running the generator ensures dependable operation, long service, and a satisfied owner.

Care at the factory during assembly and thorough testing have resulted in a Westerbeke diesel engine-driven generator capable of many thousands of hours of dependable service. However, what the manufacturer cannot control is the treatment the unit receives in the field. That part is up to the owner/operator.


Fresh Water Fill Cap
45° Exhaust Elbow
Fuel Run Solenoid
WESTERBEKE
AC Connections Outlet
Fresh Water Block Drain
Unit Data Tag
Lube Oil Dipstick
Zinc Anode
Lube Oil Filter
Lube Oil Drain Hose
Oil Pressure Sender
Oil Pressure Switch
Exchanger Fresh Water Drain


Top Engine Oil Fill
Fuel Lift Pump
Emergency Shut-off Switch
Water Temperature Switch
Exhaust Temperature Switch
45° Exhaust Elbow
Preheat Solenoid
Sea Water Pump
Zinc Anode
Heat Exchanger
Starter with Solenoid
DC Battery Ground Connection


Air Intake Silencer
Top Engine Oil Fill
Water Temperature Switch
20 Amp DC Circuit Breaker
Preheat Solenoid
Exhaust Temperature Switch
Fuel Injection Pump
Emergency Stop Switch
WESTERBEKE
Side Oil Fill
45° Exhaust Elbow
Fresh Water Block Drain
Fuel Run Solenoid
Lube Oil Filter
Oil Pressure Switch
Lube Oil Drain Hose
AC Connections Outlet
Zinc Anode
Unit Data Tag
Fuel Lift Pump
Oil Pressure Sender
Fuel Filter
Heat Exchanger


Fresh Water Coolant Fill
Fresh Water Air Bleed
45° Exhaust Elbow
Fresh Water
Circulating Pump
WESTERBEKE
DC Battery
Ground Connection
Sea Water Pump
Heat Exchanger
Starter with Solenoid

BCD 4.4KW MARINE DIESEL GENERATOR SET

GENERAL SPECIFICATIONS

Engine Type	Diesel, four-cycle, two-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (8.6 hp at 1800 rpm, maximum).
Combustion Chamber	Swirl type
Bore & Stroke	2.68 x 3.07 inches (68 x 78 mm)
Piston Displacement	37 cubic inches (0.606 liters)
Firing Order	1-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	33 lb-ft (4.91 kg-m)
Compression Ratio	23:1
Compression Pressure	455 psi (32 kg/cm^2) at 280 rpm
Valve Timing	Intake Opens 18° BTDC Intake Closes 46° ABDC Exhaust Opens 46° BBDC Exhaust Closes 18° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.010 inches (0.25 mm) Exhaust 0.010 inches (0.25 mm)
Engine Speed	1800 rpm 60 Hertz 1500 rpm 50 Hertz
Dimensions	Height: 23.25 inches (590.55 mm) Width: 17.00 inches (431.18 mm) Length: 27.25 inches (692.15 mm)
Weight	410 lbs (186 kgs)
Fuel Consumption	0.5 U.S. gph (1.89 lph) at full rated output (approximate)
Inclination	Continuous 15° Temporary 20° (not to exceed 20 min.)

BCD 4.4KW SYSTEM SPECIFICATIONS

FUEL SYSTEM

General	Open flow - totally self-bleeding
Fuel	No. 2 Diesel (cetane # 45 or better)
Injector Pump	In-line plunger type (Bosch M type)
Injectors	Pintle type
Lift Pump	12-Volt DC; lift capacity 6 ft (1.8 m)
Air cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	19.2 cfm (0.544 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt-driven.
Sea Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	3.50 - 3.75 U.S. gpm (13.24 - 14.19 lpm)
System Capacity (fresh water)	6.0 qts (5.68 liters)

LUBRICATION SYSTEM

General	Pressure type by Trochoid pump, gear-driven, with external pressure relief valve
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity (not including filter)	2.5 U.S. qts (2.36 liters)
Operating Oil Pressure (engine hot)	35 - 55 psi (2.5 - 3.8 kg/cm^2)
Oil Grade	API specification of **CF OR CG-4**

BCD 4.4KW SYSTEM SPECIFICATIONS

ELECTRICAL SYSTEM

Starting Battery	12-Volt, 30 A-H, (-) negative ground (recommended) (45 A-H in cold areas)
Battery Capacity	90 - 125 (Ampere-Hours)
Starter	12-Volt, 1.2 KW, reduction type, solenoid-mounted
DC No-Load Current	90 Amp (max.) at 11.5 Volts.
DC Cranking Current (engine cold)	175 - 200 Amps (engine cold)
DC Charging	Integral controller 0 - 10 Amps 13 - 14 Volts DC

AC GENERATOR

General	Brushless, four-pole, revolving field. Self exciting, capacitor saturated field excitation. Pre-lubricated, single-bearing design. Reconnectable 120 Volts or 120/240 Volts, single-phase	
Voltage	120 or 120/240 Volts - 60 Hertz 220 Volts - 50 Hertz. Voltage regulation: ±5% no load to full load. Frequency regulation: ± 3 Hertz (5%) no-load to full-load.	
Rating (Volts AC)		
60 Hertz (1800 rpm)	120 Volts 120/240 Volts	36 Amps 36/18 Amps
50 Hertz (1500 rpm)	220 Volts	15 Amps
AC Circuit Breaker	To be rated at 120% of the generator's rated amperage and voltage output.	
Generator Cooling Air Requirements, (60 Hertz), at 1800 rpm	175 - 200 cfm (4.95 - 5.66 cmm)	

BCD 4.4KW SYSTEM SPECIFICATIONS

NOTE: Increase air supply 15% for 50 Hertz operation (1500 rpm).

Engine Combustion Air Requirements, (60 Hertz), at 1800 rpm	19.2 cfm (0.544 cmm)

TUNE-UP SPECIFICATIONS

Injector Pressure	2275 psi +142 psi - 0 psi (120 kg/cm^2 + 10kg/cm^2 - 0kg/cm^2)
Engine Timing	19° BTDC at 1800 rpm

BCD 6.0KW MARINE DIESEL GENERATOR SET

GENERAL SPECIFICATIONS

Engine Type	Diesel, four-cycle, three-cylinder, fresh water-cooled Vertical, in-line overhead valve mechanism (12 hp at 1800 rpm, maximum).
Combustion Chamber	Swirl type
Bore & Stroke	2.56 x 3.07 inches (65 x 78 mm)
Piston Displacement	47.4 cubic inches (0.776 liters)
Firing Order	1-3-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	42 lb-ft (6.2 kg-m)
Compression Ratio	9.2:1
Compression Pressure	455 psi (32 kg/cm^2) at 280 rpm
Valve Timing	Intake Opens 19° BTDC Intake Closes 51° ABDC Exhaust Opens 51° BBDC Exhaust Closes 19° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0071 inches (0.18 mm) Exhaust 0.0017 inches (0.18 mm)
Engine Speed	1800 rpm 60 Hertz 1500 rpm 50 Hertz
Dimensions	Height: 23.38 inches (593.85 mm) Width: 18.69 inches (474.73 mm) Length: 26.75 inches (679.45 mm)
Weight	440 lbs (199.6 kgs)
Fuel Consumption	0.7 U.S. gph (2.65 lph) at full rated output (approximate)
Inclination	Continuous 15° Temporary 20° (not to exceed 20 min.)

BCD 6.0KW SYSTEM SPECIFICATIONS

FUEL SYSTEM

General	Open flow - totally self-bleeding
Fuel	No. 2 Diesel (cetane # 45 or better)
Injector Pump	In-line plunger type (Bosch M type)
Injectors	Pintle type
Lift Pump	12-Volt DC; lift capacity 6 ft (1.8 m)
Air cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	24.6 cfm (0.697 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt-driven.
Sea Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	3.50 - 3.75 U.S. gpm (13.24 - 14.19 lpm)
System Capacity (fresh water)	5.0 qts (4.73 liters)

LUBRICATION SYSTEM

General	Pressure type by Trochoid pump, gear-driven, with external pressure relief valve
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity (including filter)	3.3 U.S. qts (3.2 liters)
Operating Oil Pressure (engine hot)	35 - 55 psi (2.5 - 3.8 kg/cm^2)
Oil Grade	API specification of **CF OR CG-4**

BCD 6.0KW SYSTEM SPECIFICATIONS

ELECTRICAL SYSTEM

Starting Battery	12-Volt, 26 A-H, (-) negative ground (recommended) (35 A-H in cold areas)
Battery Capacity	90 - 125 (Ampere-Hours)
Starter	12-Volt, 1.2KW, reduction type, solenoid-mounted
DC No-Load Current	90 Amp (max.) at 11.5 Volts.
DC Cranking Current (engine cold)	175 - 200 Amps (engine cold)
DC Charger	Integral controller 0 - 10 Amps 13 - 14 Volts DC

AC GENERATOR

General	Brushless, four-pole, revolving field. Self exciting, capacitor saturated field excitation. Pre-lubricated, single-bearing design. Reconnectable 120 Volts or 120/240 Volts, single-phase	
Voltage	120 or 120/240 Volts - 60 Hertz 220 Volts - 50 Hertz. Voltage regulation: ±5% no load to full load. Frequency regulation: ± 3 Hertz (5%) no-load to full-load.	
Rating (Volts AC)		
60 Hertz (1800 rpm)	120 Volts 120/240 Volts	50 Amps 50/25 Amps
50 Hertz (1500 rpm)	220 Volts	20.4 Amps
AC Circuit Breaker	To be rated at 120% of the generator's rated amperage and voltage output.	
Generator Cooling Air Requirements, (60 Hertz), at 1800 rpm	175 - 200 cfm (4.95 - 5.66 cmm)	

NOTE: Increase air supply 15% for 50 Hertz operation (1500 rpm).

Engine Combustion Air Requirements, (60 Hertz), at 1800 rpm	24.6 cfm (0.697 cmm)

TUNE-UP SPECIFICATIONS

Injector Pressure	2275 psi +142 psi - 0 psi (120 kg/cm^2 + 10kg/cm^2 - 0kg/cm^2)
Engine Timing	19° BTDC at 1800 rpm

INSTALLATION CHECKS

General

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

Factors in the installation that must be considered are ventilation, to aid in cooling the generator end; to provide air for engine combustion and to remove heat produced by the engine while operating; the exhaust system, to properly discharge raw cooling water (sea water), to quiet the exhaust, and to expel exhaust gas; the cooling water supply; and the electrical connections.

CAUTION

For safety reasons, the generator's engine is **NOT** filled with lubricating oil for shipment. Before leaving the factory, however, each generator set is 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 generator is properly stored.

Inspection of Equipment

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

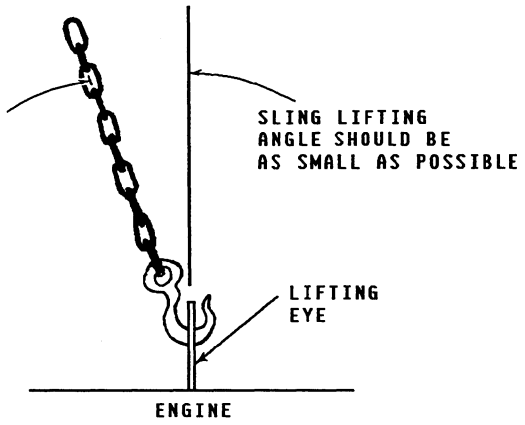
Before accepting shipment of the generator set from the transportation company, the crate should be opened and the contents inspected for concealed damage. If either visible or concealed damage is noted, you should require the delivery agent sign "Received in damaged condition" on the proper delivery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

Rigging and Lifting

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

CAUTION

Slings must not be so short as to place significant stress on the generator's lifting eyes. Strain placed on the generator's lifting eyes by the lifting sling should be reduced as much as possible by using longer lifting slings when possible.

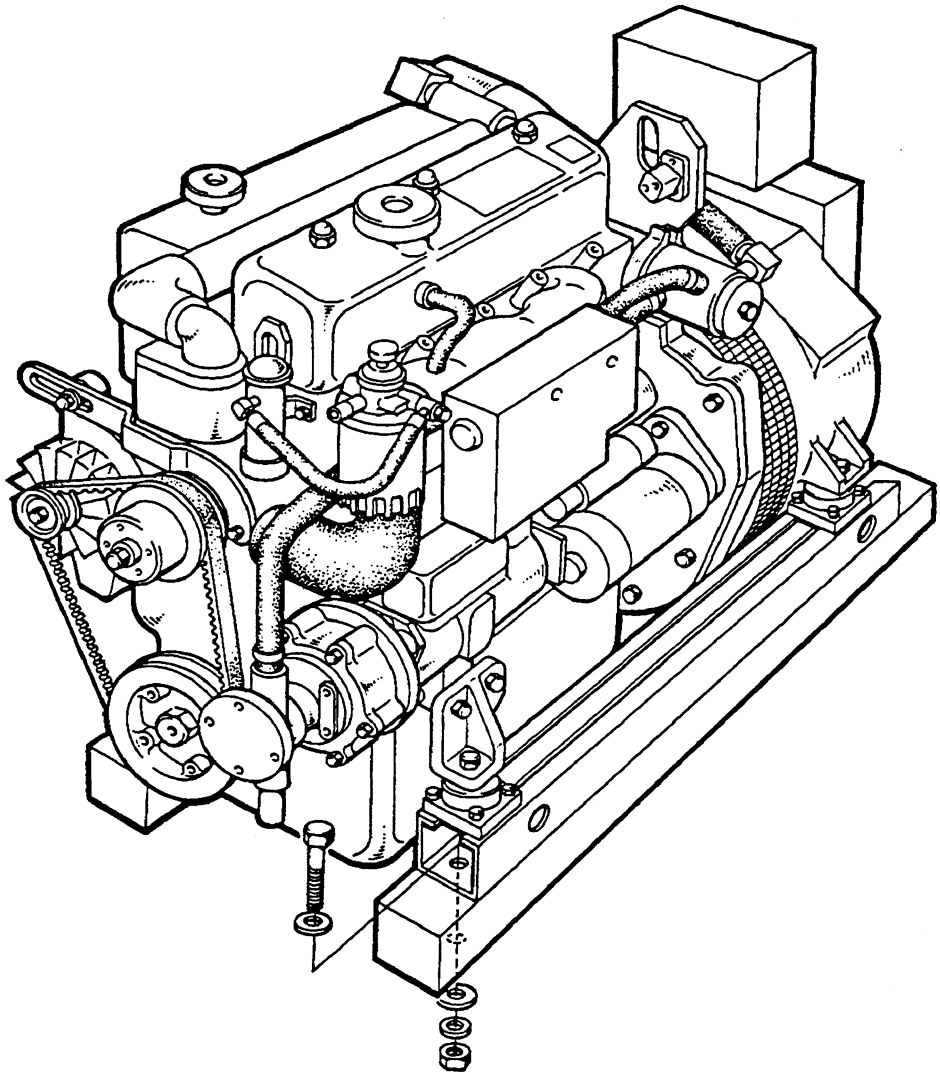


The general rule in moving generators is to see that all equipment used is amply strong and firmly fixed in place. Move the engine a little at a time and see that it is firmly supported. Eliminate the possibility of accidents by avoiding haste. Do not lift the generator by its crankshaft pulley. In certain situations it may be necessary to lift the engine in positions other than the horizontal position. Certain situations exist by which the engine must be lowered endwise through a small hatchway which cannot be made larger. Under these conditions, If the opening of the hatchway is extremely small, it is possible to reduce, to some extent, the outside dimensions of the generator by removing external components such as the cooling system's piping, the heat exchanger, certain filters, the mounting rails and other obstructive equipment. This accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damage to any exposed parts. In addition, be careful not to allow dirt from entering any opening created by the removal of equipment. Removed parts should be returned to their respective position once the generator is in its installation area. Replace gaskets as needed for the parts that were removed.

In case it becomes necessary to hoist the generator front-end upwards or generator-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.

Generator Mounting - Location

The complete generator unit is mounted on lightweight rails by means of four flexible isolator mounts that help prevent the transfer of vibration from the generator to the rails. Each generator mounting rail has several 1/2-inch bolt holes so bolts can be employed to properly secure the generator to its mounting platform. These holes are on 15 inch mounting centers.



The location should be dry, above low-lying vapor areas, and in an area where bilge water and water from above cannot splash on the generator. It should be properly ventilated and accessible for minor servicing and repairs. Access for major repairs should be given consideration as well. The location should be properly ventilated to provide fresh cooling air for the generator end, for engine combustion needs, and to remove heat produced by the engine while operating. The generator set needs fresh cool air in whatever location in the vessel it is installed. Hot generator discharge air *must* be removed from the generator area. The platform on which the generator and its mounting rails are located should be strong enough to support the generator during all angles of vessel operation.

Exhaust System

WARNING

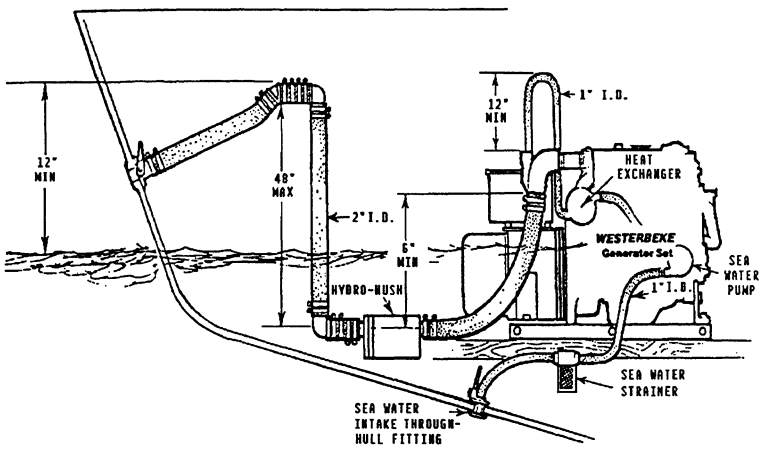
Although diesel fuel is not as dangerous as gasoline, precautions should be taken to guard against CARBON MONOXIDE GAS. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are listed below.

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

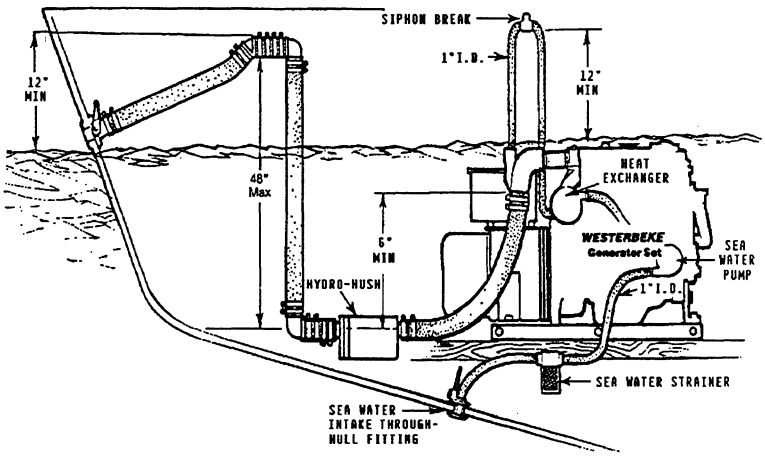
All exhaust systems should be such that the entry of sea water into the engine's exhaust manifold and cylinders is prevented while the engine is not running, or while the vessel is under sail or power in which case the vessel may experience heeling or backing down from following seas or any other conditions. Special attention must be taken to make certain the exhaust system is secure, tight and free of leaks. The sea water supply through-hull sea cock fittings *must* be of the flush-hull type. High-speed scoop type fittings must not be used, as they tend to encourage siphoning.

When a water lift type exhaust system is used, the exhaust muffler should be mounted as close to the engine as practical. The exhaust discharge should always drop downward into the exhaust muffler. Loops in the exhaust hose between the water-injected exhaust elbow and the water lift muffler should be avoided, as these will trap and hold water.

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



GENERATOR ABOVE WATER LINE



GENERATOR BELOW WATER LINE

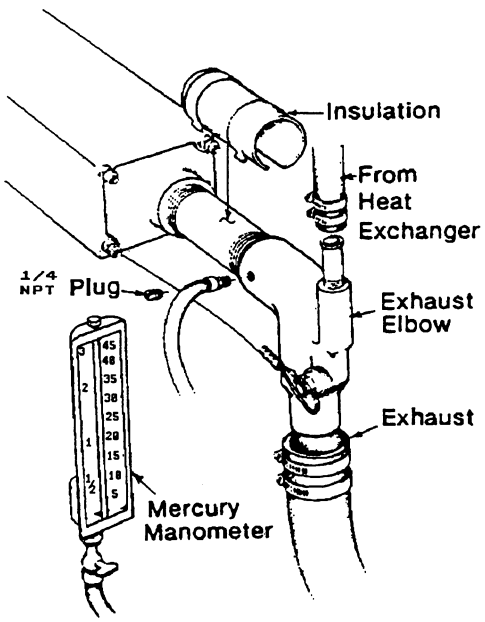
Exhaust Back-Pressure

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 a generator is put into service. (Refer to the illustration.) Excessive back-pressure will affect the engine's performance and the generator's power output.

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

Measure the engine's back-pressure at the exhaust elbow while the generator is under a full load.

Refer to the pressure specifications listed below.

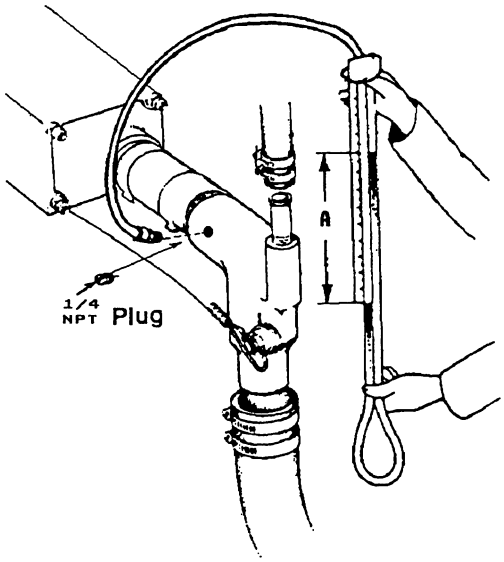


A water column can be made by taking a clear plastic tube and taping one end of the tube along a yardstick and fitting the other end of the tube with a 1/4 inch NPT (National Pipe Tap) pipe fitting.

Measure the engine's back-pressure at the exhaust elbow while the generator is under a full load.

Dimension **A** cannot exceed 39 inches of water.

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

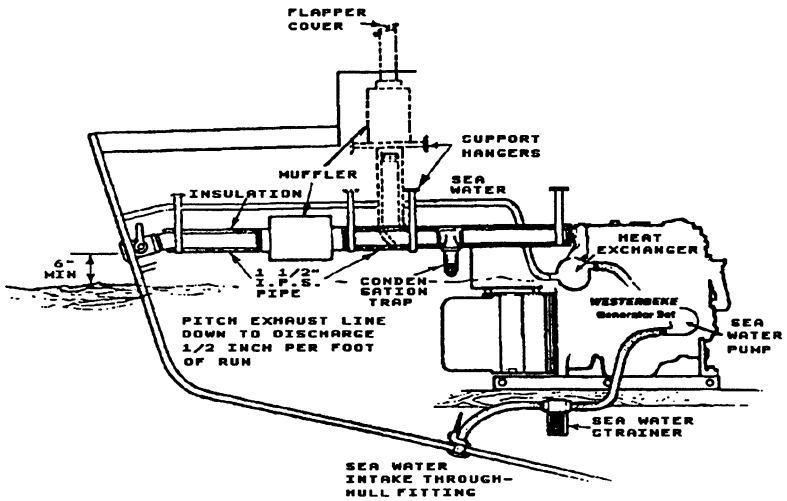


Specifications:

2 inches of mercury
27 inches of water in a water column
15.6 ounces PSI
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 generator'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.

Dry stack-type exhaust systems (shown to the right) must be attached to the generator engine's exhaust manifold by means of a flexible connector pipe. This system must be properly supported and insulated to prevent water from entering into the engine's cylinders. Provisions must be made for discharging the engine's cooling sea water.



DRY STACK EXHAUST

Exhaust System Failures

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

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

Make sure there are no unnecessary objects suspended from any portion of the exhaust lines. Excessive weight could cause deflection or distortion of the lines, resulting in damage or leaks. Inspect insulated portions of the exhaust system to make sure there is no deterioration of the insulation.

NOTE: A maximum of 8 lbs can be attached to the exhaust manifold without support.

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.

Exhaust Elbow Installation

The Westerbeke Corporation offers a 45°and 90°exhaust elbow as well as an exhaust riser you can install on your propulsion engine. Refer to the instructions below when installing the exhaust elbow purchased for your generator.

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 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.

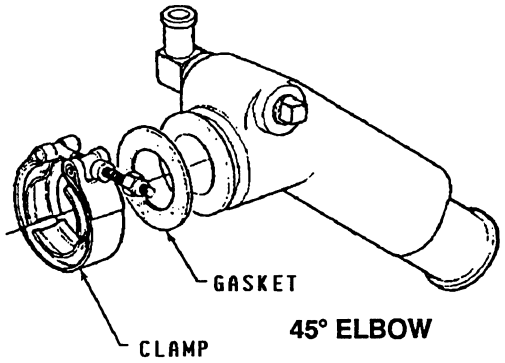
5. Carefully tighten the clamp between 2 to 3 lb-ft, or 24 to 35 lb-in, or 0.27 to 0.41 kg-m.

CAUTION

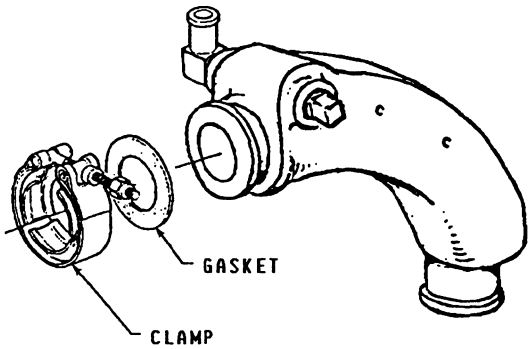
Approach the 3 lb-ft torque limit with caution. The clamp's threads will break if more than 3 lb-ft is applied to the clamp.

If a leak exists, correct it immediately.

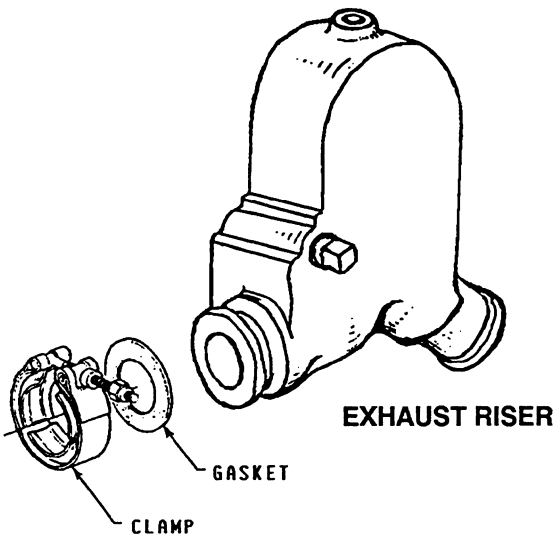
* Manufactured by Permatex Company, Brooklyn, N.Y.



45° ELBOW



90° ELBOW



EXHAUST RISER

Fuel System

The fuel system should be installed in such a manner as to allow the engine-mounted fuel lift pump to 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 mechanical fuel lift pump and the injection pump; this filter has a replaceable filter element.

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

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

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

Fuel tanks that are located below the engine's fuel system level must have its fuel return at the tank extending down into the tank in the same manner as the pickup tube, otherwise fuel siphoning out of the engine's fuel system through the return will take place.

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

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

Oil Drain Hose

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

Connecting Pressure Sensing Devices to Oil Galleries

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

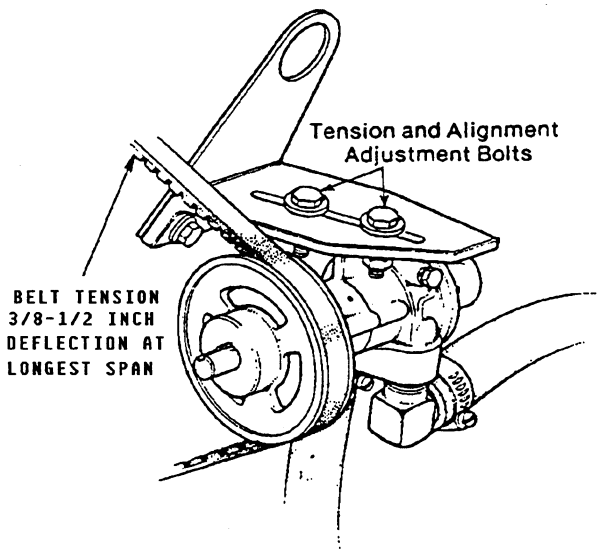
When additional sensing devices such as switches or sensors need to be installed that function on engine oil pressure, these devices must be bulkhead-mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the gallery must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

Sea Water Intake System

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

Cooling System

The generator's engine is fresh water-cooled by an engine-mounted heat exchanger. Sea water is used as the heat exchange'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 generator'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 generator. Water pressure against this type fitting, while the vessel is under way, can push sea water past the sea water pump's impeller into the generator's exhaust system, filling it and the engine as well. Flush-type, clear, through-hull fittings are recommended and should be located on the hull so as to be below the waterline during all angles of boat operation.

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

Electrical System

The electrical system should be checked to make sure 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 make sure all engine harness connections are tight and that they are made to the appropriate terminals.

DC Electrical Connections

A common ground for the negative (-) DC terminal connection is found at the bellhousing of the generator, next to the starter, in the form of a threaded grounding stud. The battery ground should be connected at this stud.

Connect the battery's positive (+) connection to the starter solenoid tagged for this connection.

CAUTION

To avoid an overcharging condition, and a possible equipment failure, **DO NOT** disconnect the DC battery source while the engine is running.

Automatic Shutdown

High Exhaust Temperature Shutdown Switch (normally closed)

An exhaust temperature switch is located on the exhaust elbow. Should the switch's sensor indicate an excessive exhaust temperature, the switch will open and shut the generator OFF (an inadequate supply of sea water coolant causes high exhaust temperatures). This switch opens at 260 - 270° F (127 - 132° C) and resets at approximately 225° F (107° C).

High Water Temperature Shutdown Switch (normally closed)

A high water temperature switch is located on the thermostat housing. Should the fresh water coolant's operating temperature reach approximately 205° F (96° C), the switch will open and shut the generator OFF. This switch resets at 195° F (107° C).

Low Oil Pressure Shutdown Switch (normally open)

A low oil pressure shutdown switch is located off the engine's oil gallery. The switch's sensor monitors the engine's oil pressure. Should the engine's oil pressure fall to 10 - 15 psi, the switch will open and turn the generator OFF.

Generator (AC Output)

Make sure that the AC output connections within the generator's distribution box are tight and in accordance with the specific AC Load Connections diagram found later in this manual. (See the "BC GENERATOR" section of this manual, page 54.)

WARNING

Do not smoke or allow an open flame near batteries. Lead acid batteries emit hydrogen, a highly-explosive gas.

Batteries

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 (the engine block).

WARNING

When servicing the battery or checking the 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 the electrolyte caps.

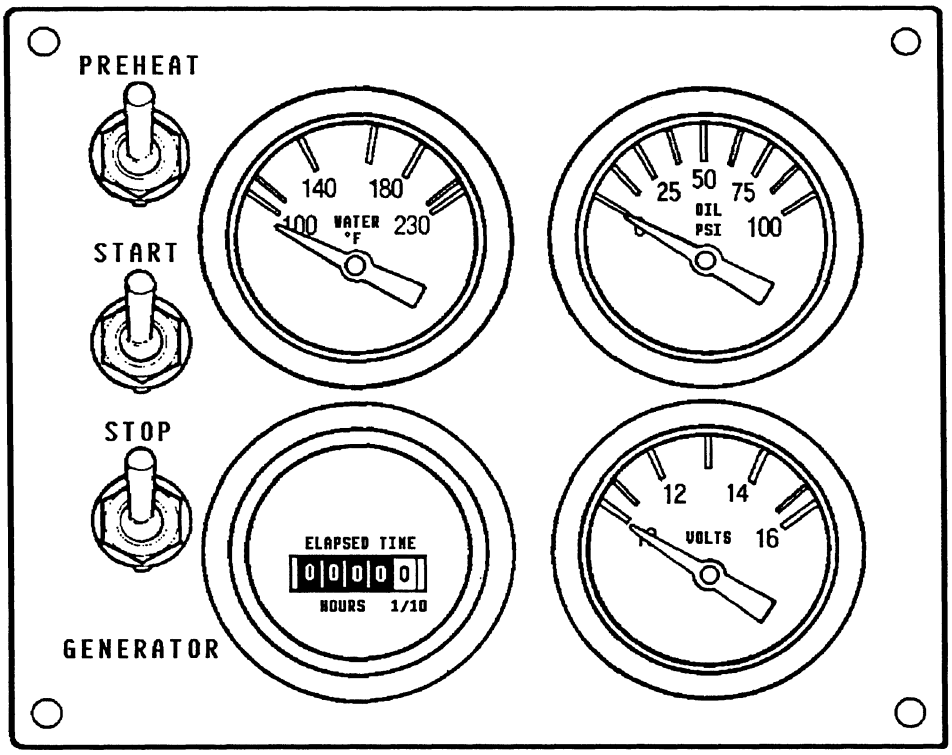
Check the battery's electrolyte level and specific gravity to ensure maximum engine starting efficiency. Make sure the battery's terminals are clean and tight.

Ventilation

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

Keep in mind that hot air rises, so heated air should be removed from the upper area of the generator compartment and cool fresh air should be directed to the lower areas of the compartment. Ventilation should be accomplished with the aid of blowers especially when the vessel is not underway. Refer to the "SYSTEM SPECIFICATIONS" section of this manual for the airflow requirements of the generator sets, page 11 for the BCD 4.4KW, and page 15 for the BCD 6.0KW.

DESCRIPTION OF INSTRUMENT PANEL



General

The manually-operated series of Westerbeke generators is equipped with toggle switches and, optionally, remote panels. The Standard Instrument Panel (shown above) includes two gauges which indicate water temperature in degrees Fahrenheit (WATER °F) and oil pressure in pounds per square inch (OIL PSI). This panel is also equipped with two meters which indicate DC control circuit voltage (VOLTS) and the generator's running time (ELAPSED TIME) in HOURS and in 1/10 hours. The water temperature and oil pressure gauges and the DC volt meter are illuminated; the ELAPSED TIME meter is not illuminated.

1. PREHEAT: The PREHEAT switch energizes the engine's glow plugs, activates the electric fuel pump, bypasses the engine's oil pressure switch, and activates the fuel run solenoid. In addition, this switch energizes the START switch.

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

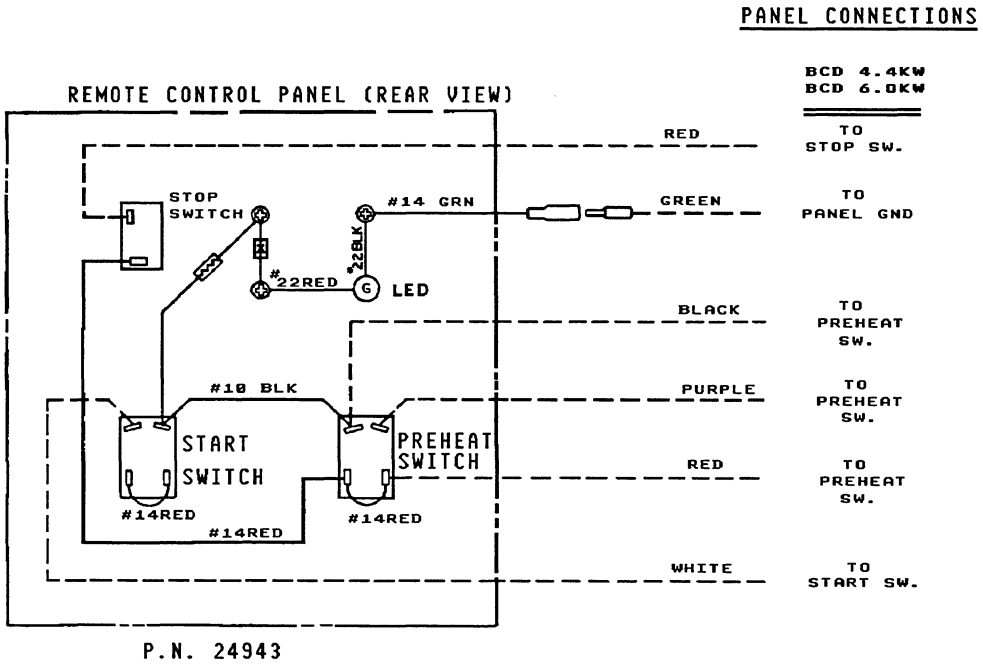
3. STOP: Through the STOP switch power is provided to the fuel solenoid. Opening this switch deactivates the fuel solenoid and shuts OFF fuel to the engine, thereby stopping the engine.

   NOTE: When the engine is manually shut down, the water temperature gauge and oil pressure gauge will continue to register the last temperature reading and oil pressure reading indicated by the gauge before electrical power was turned OFF. The temperature gauge and oil pressure gauge will return to zero once electrical power is restored to these gauges.

Remote Operation

For starting and stopping the generator at a remote location, the same three switches are used. The PREHEAT and START switches are connected in parallel with the local panel's switches and serve the same functions as in the local panel. The STOP switch is connected in series with the local panel's STOP switch and serves the same function as in the local panel. The generator may be stopped from local or remote positions

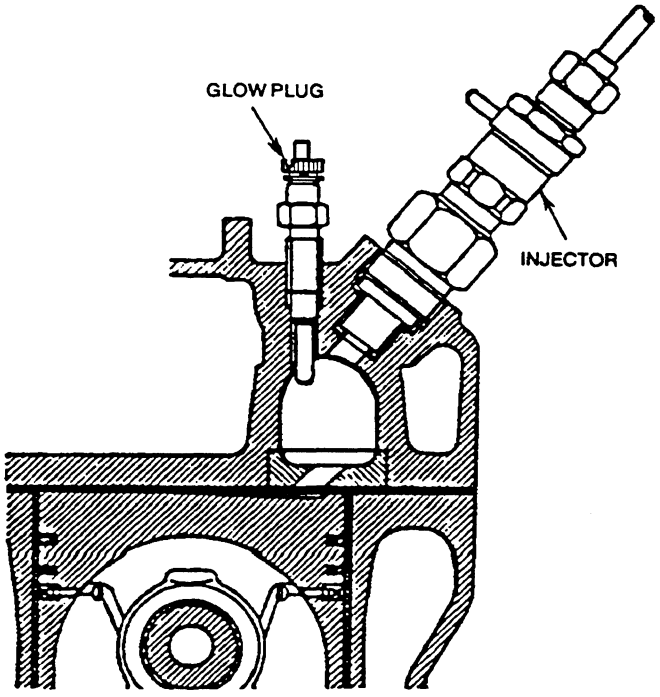
Refer to the remote panel wiring diagram when installing a remote instrument panel.



Description of Starting System

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

This system is common to Westerbeke Diesels. The start circuitry is designed so that the PREHEAT button must be depressed for the time specified in the "Preheat" chart shown on page 33. Then, while keeping the PREHEAT button engaged, the START button is depressed to crank the engine.



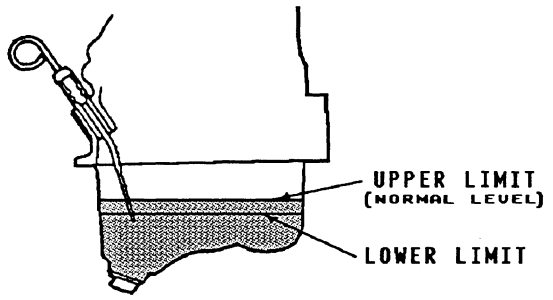
Combustion Chamber

NOTE: The START switch will not energize unless the PREHEAT button is depressed. When depressing the preheat switch, we are activating the glow plugs in the cylinder head, so use the preheat intermittently so as not to overheat the glow plugs.

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 set 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 (see page 51). For the quantity of oil needed in your engine, refer to the "SYSTEM SPECIFICATION" section of this manual, page 11 for the BCD 4.4KW, and page 15 for the BCD 6.0KW.



Fill the fuel tank with a good grade of No. 2 diesel fuel and prime the fuel system up to the engine (see page 37). When returning fuel is free of air, the engine's fuel system is bled and the engine is ready to start.

Each unit is supplied with a coolant recovery kit (#24977) as standard equipment, 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, page 46.) Operate the engine and observe the coolant level in the manifold. Maintain this level to the base of the filler neck. Once the engine reaches its operating temperature (170 - 190° F), make sure there is no problem with coolant flow through the manifold. Top off the cooling system and install the pressure cap.

B. Make sure the plastic recovery tank is properly mounted near the unit (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 these 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 after the engine's 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.

Make sure the Installation Checks have been made in accordance with those specified in the "INSTALLATION CHECKS" section of this manual (refer to page 18).

STARTING PROCEDURE

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

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

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

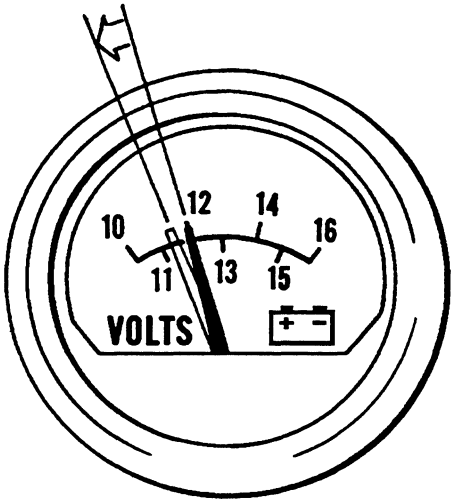
3. Check all the instruments on the panel for proper operation. Make sure sea water discharges with the exhaust discharge.

Atmospheric Temperature	Preheating Time
+ 41° F (+ 5° C) or higher	Approx. 10 sec.
+ 41° F (+ 5° C) to + 23° F (- 5° C)	Approx. 20 sec.
+ 23° F (- 5° C) or lower	Approx. 30 sec.
Limit of continuous use	30 seconds before cranking

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

NOTE: Some unstable running may occur in a cold engine, but this condition should smooth out as the operating temperature of 130 - 150° F (55 - 66° C) is reached.

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



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 cylinder's 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.

STOPPING PROCEDURES

1. Remove the AC electrical load from the generator and allow the generator to run for 3 to 5 minutes so the engine can stabilize its operating temperatures.

2. Depress the STOP switch and hold it until the generator comes to a complete stop. Now release this switch.

Engine Break-In Procedures

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

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

1. Start the engine according to the "STARTING PROCEDURE" section found on page 33; run the engine while checking that all systems (sea water pump, oil pressure, battery charging) are functioning.

2. Start the generator and allow the engine to warm up until the water temperature gauge moves into the 130-140° F range.

3. Use caution not to overload the generator. The presence of a gray or black exhaust with loss of engine rpm (Hertz) are signs of a possible overload.

4. Run the generator at 1/2 of its rated capacity for the first 10 hours then increase the load to 3/4 of its rated capacity. For the remainder of the break-in period, the generator may be run at different load intervals.

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

As indicated above, operate the generator with a moderate load during the 50-hour break-in period. (On one hand don't baby the engine, but on the other hand, however, don't abuse it.)

Starting Under Normal Conditions

Follow the procedure below for normal starting of the generator:

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

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

   NOTE: Excessive loss of coolant from the plastic recovery tank indicates a cooling system leak. Check the entire cooling system and pressurize the system to locate the leak. In cases of excessive coolant loss, the system must be refilled as outlined under the "PREPARATION FOR STARTING" section of this manual, page 32.

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

Start the generator in accordance with the "STARTING PROCEDURE" instructions found on page 33, and allow the engine's operating temperature to reach 140 - 150° F before placing load on it.

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, page 51 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, page 33.

FUEL SYSTEM

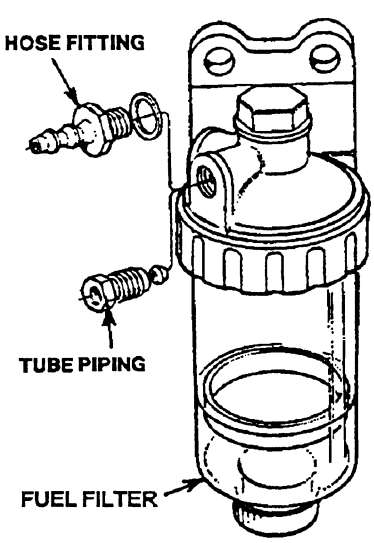
Diesel Fuel

Use No. 2 diesel fuel with a cetane rating of 45 or higher. Never use kerosene or home heating oil since these fuels do not have the same lubricating properties as No. 2 diesel fuel.

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 Filters

A primary fuel filter of the water entrapment type must be installed between the fuel tank and the engine. A primary fuel filter, shown here, is available from your local Westerbeke representative or your boatbuilder. This filter, adapted for boatbuilder use, comes complete with fittings for either hose or metal tubing. Mount it in an accessible place, inspect it often and drain off water accumulation frequently.



INSTALLATION INSTRUCTIONS

1. BOLT SEDIMENT/WATER TRAP SECURELY TO AN ACCESSIBLE STRUCTURE SO POSITIONED THAT A RECEPTICLE TO CATCH DRAINAGE CAN BE PLACED UNDER IT.
2. IF FUEL IS TO BE PIPED WITH COPPER, OR BUNDY TUBING, USE NUTS AND FERRULES PROVIDED. BE SURE THE TUBING PROJECTS 1/4 INCH THROUGH THE FERRULE BEFORE TIGHTENING THE NUT.
3. IF FUEL IS TO BE PIPED WITH HOSE, USE THE TWO BRASS BARBED FITTINGS AND WASHERS SUPPLIED. BE CERTAIN THAT THE HOSE SELECTED HAS DIAGONAL BRAID INSERTED (TO CLING ON THE BARB), THAT IT IS NEOPRENE LINED, AND THAT IT IS USCG APPROVED.
4. IF WATER IS PRESENT IN THE FUEL, IT WILL COLLECT SLOWLY IN THE BOTTOM OF THE SEDIMENTER. WHEN THE RED FLOAT RING REACHES THE DRAIN LINE ON THE PLASTIC BOWL, LOOSEN THE BOTTOM DRAIN PLUG UNTIL ALL WATER RUNS OUT.
5. TIGHTEN DRAIN PLUG SECURELY SO NO AIR CAN ENTER THE SYSTEM.
6. ENERGIZE THE FUEL PUMP TO REFILL THE BOWL.

If a water trap type filter is not installed between the fuel tank and the engine-mounted fuel system, any water in the fuel system will tend to lay in the bottom of the electric lift pump. Internal metal parts of the lift pump will rust. Particles will pass on to filters and eventually to the injection pump and injectors with damaging results and the possibility of expensive repairs. Remember, water damage to the fuel system is not covered under the Westerbeke warranty. The owner/operator is responsible in making sure that fuel reaching the engine's injection equipment is free of impurities. This process is accomplished by installing a proper filtration/separation system and maintaining this 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.

Although most boatbuilders supply a water trap/filter, some do not. Westerbeke offers a sedimentary/water trap/filter as an optional extra at moderate cost. The filter is supplied with fittings for either hose or metal tubing fuel lines.

Priming the Fuel System

The Westerbeke self-bleeding fuel system is semiautomatic in operation. The self-bleeding feature of the fuel system allows for easy servicing of the fuel filters. Simply remove the and replace the filter elements (take care in catching any fuel that may drain out of the fuel filtering assemblies) as described in the "Replacing the Fuel Filter Elements" section below. Energize the PREHEAT switch and allow the electric fuel pump to operate for 20 to 30 seconds to prime and bleed air from the system. (No fittings should be opened.) Then proceed to start the engine as you normally would. If the engine does not start, stop and wait a few moments, and then repeat the bleed procedure as indicated above. When the PREHEAT switch is depressed, the preheat elements (the glow plugs) are energized, so take care not to over heat them.

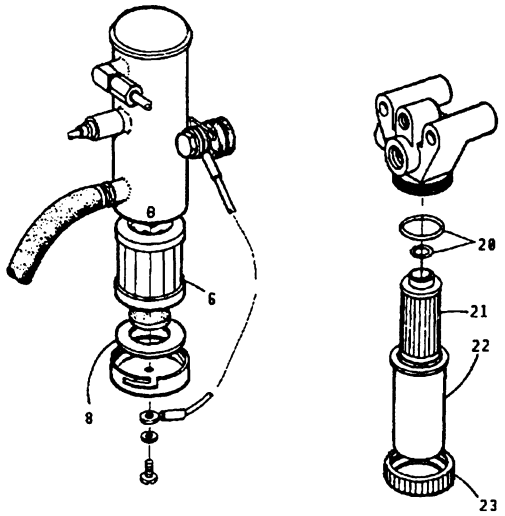
CAUTION

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.

Replacing the Fuel Filter Elements

While it is unlikely that the operator will be forced to service the system at sea, the possibility does exist. Therefore, it is recommended that banjo washers, injector seat washers, electric lift pump filter and gasket, fuel filter and gasket be carried on board at all times. Select the parts for your engine from the Parts List and purchase spares from your local Westerbeke Dealer or Distributor. For example, hardware kit #33093 includes replacement elements with gaskets (items #6, 8, 20, 21). 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 the new filter.

After the first 50 hours of operation, loosen retainer ring # 23 and discard filter element # 21. Clean bowl # 22 and install a new filter using a new # 20 gasket. *Be careful to catch any fuel that may spill from within these fuel filter assemblies.* This same service is required of the # 6 filter element in the electric fuel lift pump. Similarly, install a new # 6 filter element along with a new # 8 gasket. The base of the electric fuel pump is removed with the aid of an open end wrench. Twist the base off the pump's locking tabs and reinstall the base by twisting it back on the locking tabs. Place the wrench on the hex nut cast into the base.

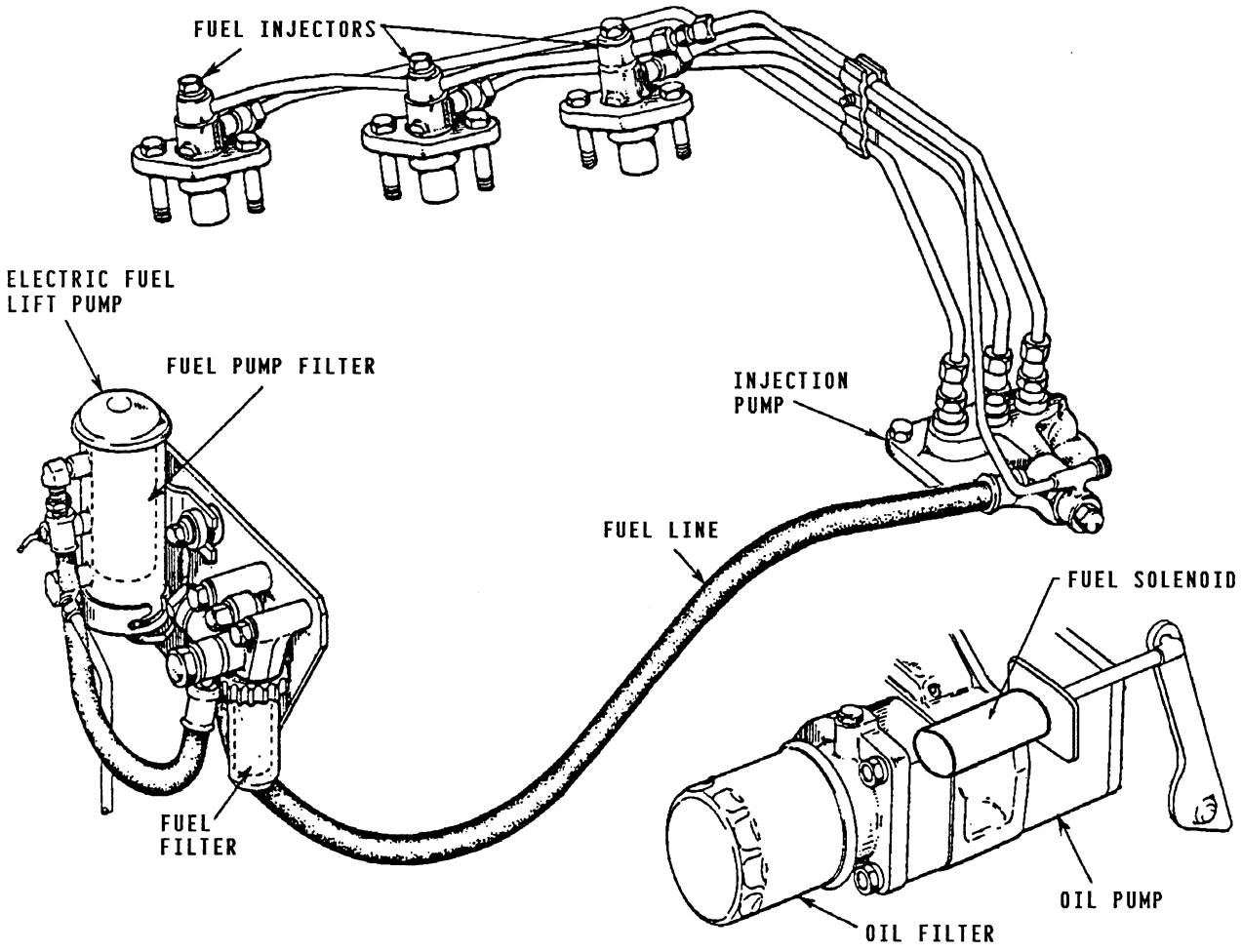


After the first 50-hour change, the change period may be increased to 200 hours or once per season.

Fuel Injection Pump

The illustration below shows the BCD 6.0KW's fuel system. The BCD 4.4KW fuel system's differs in that it has one less fuel injector and injector pump plunger. The fuel injection pump, located to the right, is one of the most important components of the diesel engine and, therefore, calls for the utmost caution in handling. Furthermore, the fuel injection pump has been thoroughly bench-tested and should not be tampered with.

Speed (Hertz) 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.



Fuel Injection 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.

DC ELECTRICAL SYSTEM

Engine 12-Volt DC Control Circuit

The Westerbeke BCD 4.4KW and BCD 6.0KW generators have a 12-Volt DC electrical control circuit, as shown on the wiring diagrams which follow on pages 42 and 45. 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.

Shut off the engine battery switch, however, 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 90 - 125 Ampere-hours (minimum).

Testing the Battery Charging Circuit

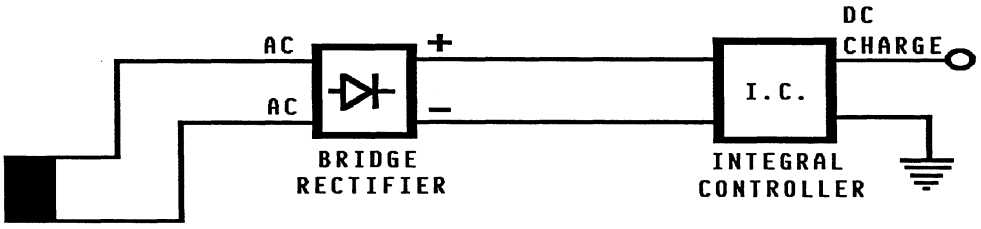
NOTE: This circuit is totally separate from the AC output of the generator. The AC output of the generator effects this circuit's output but not the reverse.

1. *Bridge Rectifier*

Normal AC voltage running to the rectifier (while the engine is operating at 1800 rpm) is measured across the two AC connections on the bridge rectifier. (See the illustration below.)

AC voltage running to the bridge rectifier (approximate):

No-load off the generator	16.0 Volts AC
Full-load off the generator	17.5 Volts AC



Normal DC voltage running out of the rectifier (in Volts DC) is measured across the two DC connections of the bridge rectifier; that is, + and - .

DC voltage running from the bridge rectifier (approximate):

No-load off the generator	17.0 Volts DC
Full-load off the generator	18.5 Volts DC

2. *AC Stator Winding: 0.14 Ohms*

Lift the two AC leads off the bridge rectifier and measure with an ohmmeter the resistance between these two leads should measure 0.14 Ohm. No continuity should exist between these two leads and the ground.

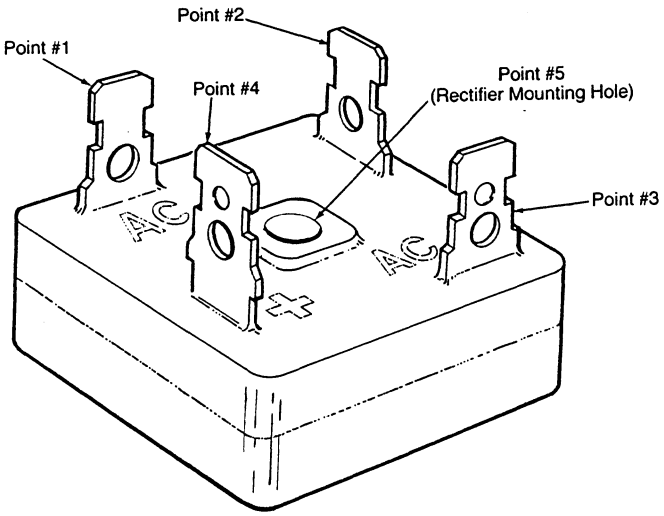
3. *Testing the Bridge Rectifier*

A. Set your Ohmmeter's scale on RX1 (+DC) and set the needle to zero.

B. Connect the (+) positive lead from the Ohmmeter to point #4. Taking the Ohmmeter's negative (-) lead, momentarily touch points #1, #2, #3, and #5. The Ohmmeter should register no deflection for any of the points touched.

C. Remove the positive (+) lead from point #4 and connect the negative (-) lead; momentarily touch points #1, #2, and #3. The Ohmmeter's needle should deflect when each point is touched.

D. Leaving the negative (-) lead on point #4, touch point #5 with the positive lead. No deflection should take place.



E. Place the positive (+) lead on point #1 and the negative (-) lead on point #3. The Ohmmeter again should not register any deflection (no deflection indicated infinite resistance). Reverse these connections and the Ohmmeter should again register no deflection. IF THE RECTIFIER FAILS ANY OF THE PREVIOUS TESTS (A - E), REPLACE THE RECTIFIER BECAUSE IT IS DEFECTIVE.

4. *Integral Controller* (I.C.)

The integral controller (I.C.) is an encapsulated, solid-state unit that supplies a DC charging voltage to the generator's starting battery while the generator is operating.

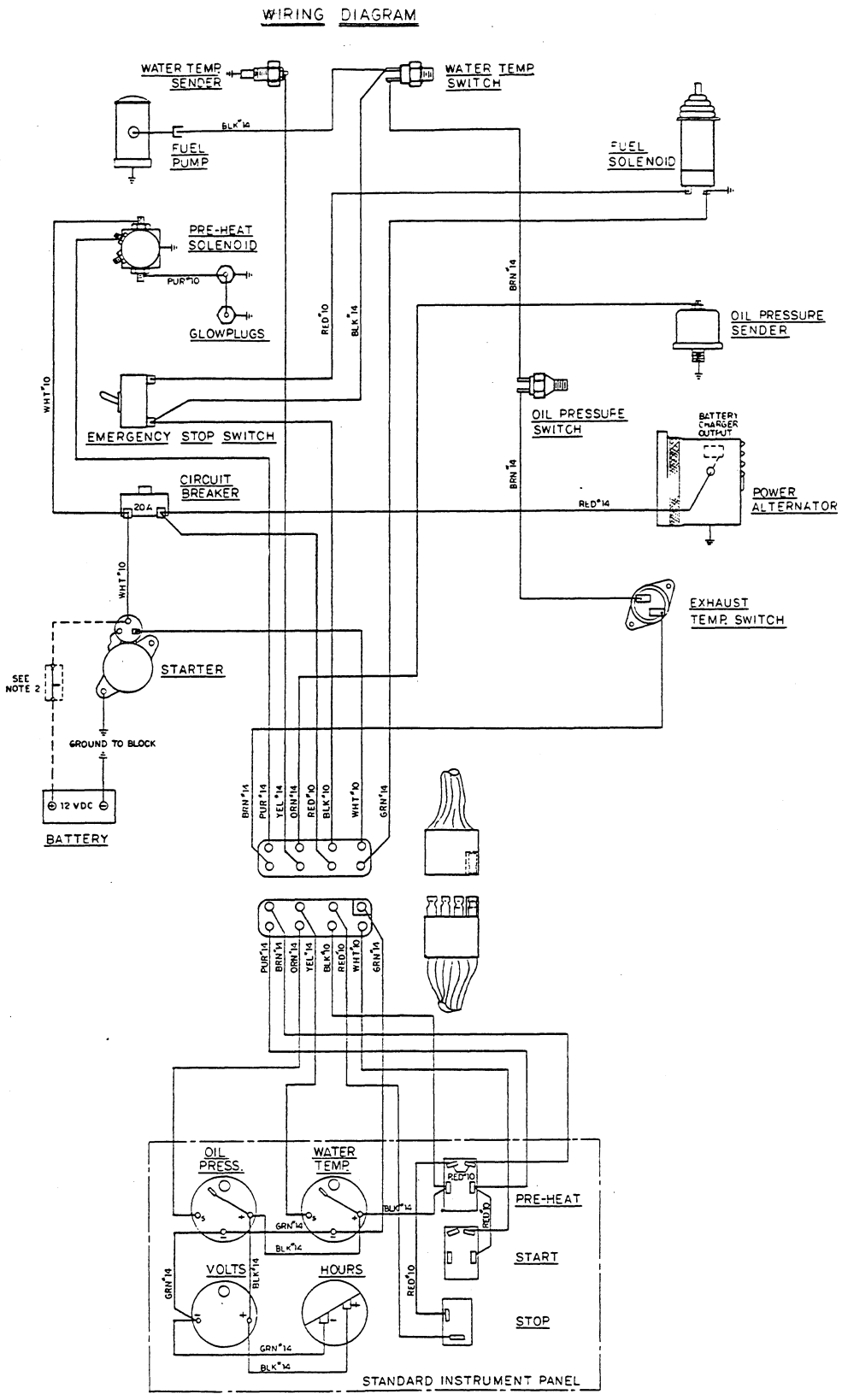
Charging Voltage:	13.0 - 14.0 Volts DC
Charging Amperage:	0 - 10 Amps DC

A separate group of stator windings supplies AC voltage to a bridge rectifier which converts the AC current into DC current to supply the I.C. unit. The I.C. unit senses the needs of the starting battery and supplies a DC charge when one is needed. If you suspect that the I.C. unit is faulty (that is, if the battery's charge is low), check the charging circuit's operating and components as described in steps 1-4. Check all connections for cleanliness and tightness including the ground before replacing the I.C. unit.

NOTE: When the generator is first started, the I.C. unit will produce a low charging rate. This charging rate will rise as the generator is operated for awhile.

BCD 4.4KW DC Control Circuit Wiring Diagram #35951

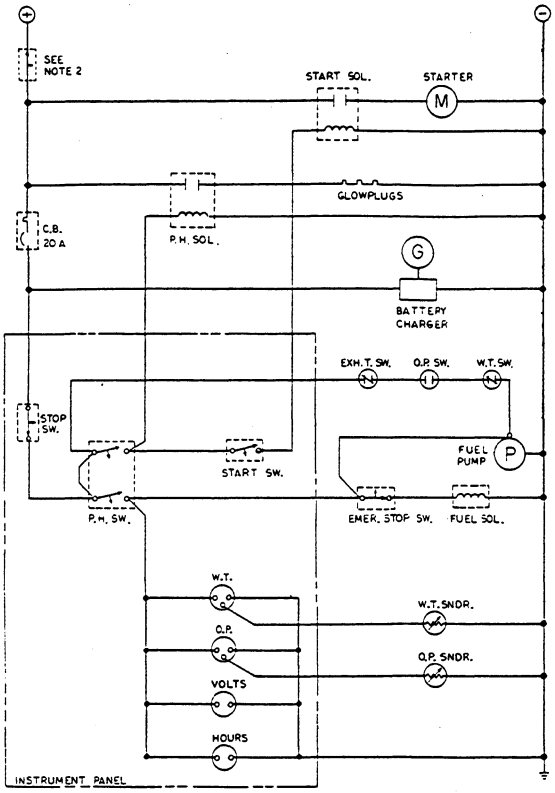
page 1 of 2



BCD 4.4KW DC Control Circuit Wiring Diagram #35951

page 2 of 2

SCHEMATIC DIAGRAM



STARTING AND STOPPING INSTRUCTIONS

START: 1. ALWAYS PUSH PRE-HEAT SWITCH FIRST. HOLD FOR 15 TO 60 SECONDS AS REQUIRED.

2. WHILE CONTINUING TO PUSH PRE-HEAT SWITCH, PUSH START SWITCH.

3. WHEN GENERATOR STARTS, RELEASE START SWITCH ONLY.

4. WHEN OIL PRESSURE REACHES APPROXIMATELY 20 PSI RELEASE PRE-HEAT SWITCH (THE PRE-HEAT SWITCH OVERIDES THE LOW OIL PRESSURE SHUTDOWN CIRCUIT).

STOP: PUSH AND HOLD THE STOP SWITCH UNTIL THE GENERATOR STOPS COMPLETELY.

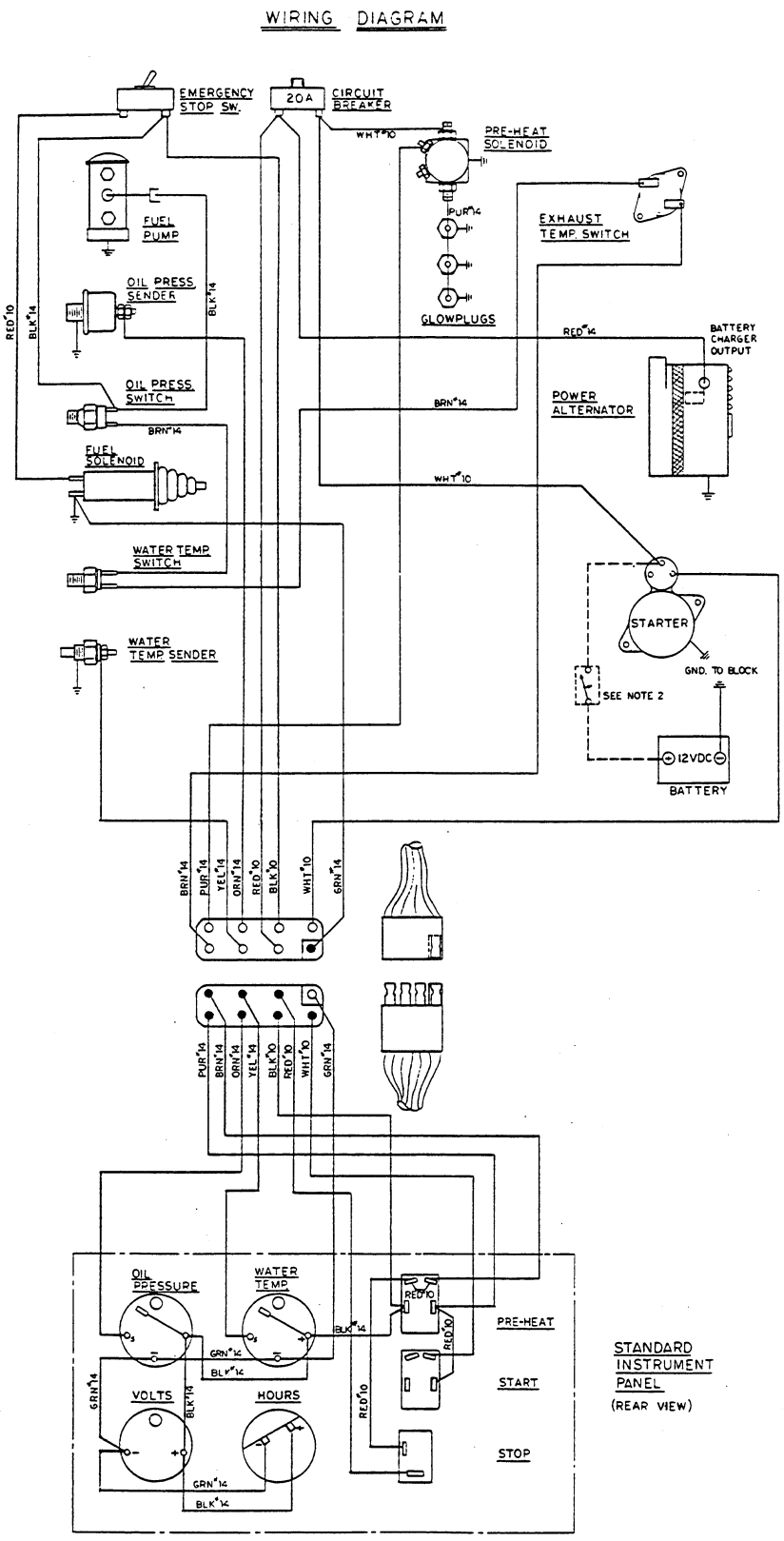
NOTES

1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE SOUCE OF CURRENT AS POSSIBLE. EXCESSIVE CURRENT DRAW ANYWHERE IN THE INSTRUMENT PANEL OR ENGINE WIRING WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT MOST GENERATORS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISCONNECTS THE FUEL SUPPLY. THEREFORE THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL AND ENGINE WIRING ARE INSTALLED TO PREVENT CONTACT BETWEEN ELETRICAL DEVICES AND SALT WATER.

2. AN ON-OFF SWITCH SHOULD BE INSTALLED IN THIS CIRCUIT TO DISCONNECT THE STARTER FROM THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. TWELVE VOLT DIESEL ENGINE STARTERS TYPICALLY DRAW 200 TO 300 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12VDC WILL WILL NORMALLY SERVE THESE FUNCTIONS, BUT A SWITCH MUST NEVER BE USED TO MAKE THE STARTER CIRCUIT.

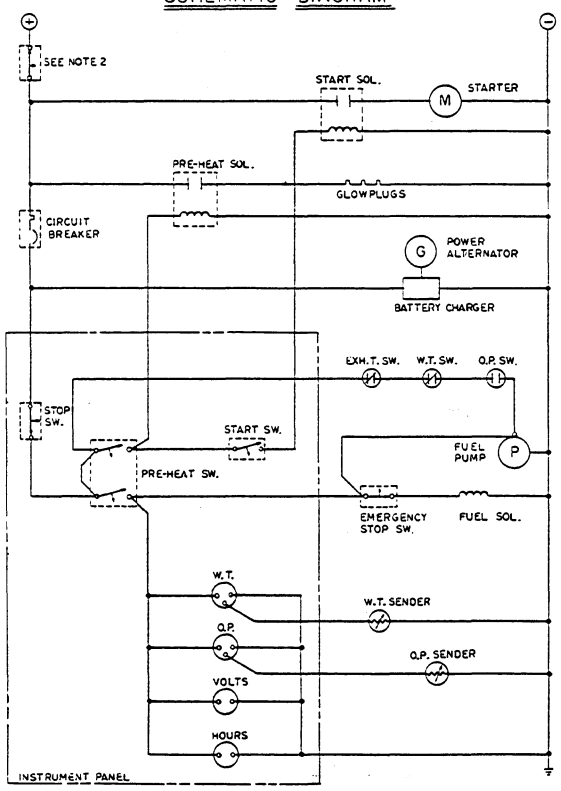
3. MOST STARTER SOLENOIDS DRAW 15 AMPS, THEREFORE THE VOLTAGE DROP IN THIS CONDUCTOR MUST BE NO GREATER THAN 10% (IN THE PATH FROM THE STANDARD START SWITCH TO ANY REMOTE SWITCHES AND BACK TO THE STANDARD START SWITCH). IF THIS REQUIRES IMPRACTICALLY LARGE CONDUCTORS THEN A RELAY MAY BE ADDED TO CONTROL THE STARTER SOLENOID ITSELF.

BCD 6.0KW DC Control Circuit Wiring Diagram #35773



BCD 6.0KW DC Control Circuit Wiring Diagram #35773

SCHEMATIC DIAGRAM



STARTING AND STOPPING INSTRUCTIONS

START: 1. ALWAYS PUSH PRE-HEAT SWITCH FIRST. HOLD FOR 15 TO 60 SECONDS AS REQUIRED.

2. WHILE CONTINUING TO PUSH PRE-HEAT SWITCH, PUSH START SWITCH.

3. WHEN GENERATOR STARTS, RELEASE START SWITCH ONLY.

4. WHEN OIL PRESSURE REACHES APPROXIMATELY 20 PSI RELEASE PRE-HEAT SWITCH (THE PRE-HEAT SWITCH OVERIDES THE LOW OIL PRESSURE SHUT DOWN CIRCUIT)

STOP: PUSH AND HOLD THE STOP SWITCH UNTIL THE GENERATOR STOPS COMPLETELY.

NOTES:

1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE SOURCE OF CURRENT AS POSSIBLE. EXCESSIVE CURRENT DRAW ANYWHERE IN THE INSTRUMENT PANEL WIRING OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT MOST GENERATORS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISSCONNECTS THE FUEL SUPPLY. THEREFORE THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL WIRING AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.

2. AN ON OFF SWITCH SHOULD BE INSTALLED IN THIS CIRCUIT TO DISCONNET THE STARTER FROM THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. TWELVE VOLT DIESEL ENGINE STARTERS TYPICALLY DRAW 200 TO 300 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12VDC WILL NORMALLY SERVE THESE FUNCTIONS BUT A SWITCH MUST NEVER BE USED TO MAKE THE STARTER CIRCUIT.

3. BATTERY CHARGER CAUSES A 9mA DRAIN WHEN GENERATOR IS NOT OPERATING. WHEN LEAVING BOAT FOR AN EXTENDED PERIOD DISCONNECT THE BATTERY.

COOLING SYSTEM

Description

Westerbeke marine diesel generators 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 passages to stay clean and free from harmful deposits. The two independent circuits and their components are discussed in the following paragraphs.

Fresh Water Circuit

> NOTE: Refer to paragraphs **A** and **B** in this section for 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 in the cooling system. 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 (see page 47 for an antifreeze/water mixture chart).

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 that the cooling system of the engine 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 Temperature	° F	23	14	5	- 4	- 22	- 40	- 58
	(° C)	(- 5)	(-10)	(-15)	(- 20)	(- 30)	(- 40)	(- 50)

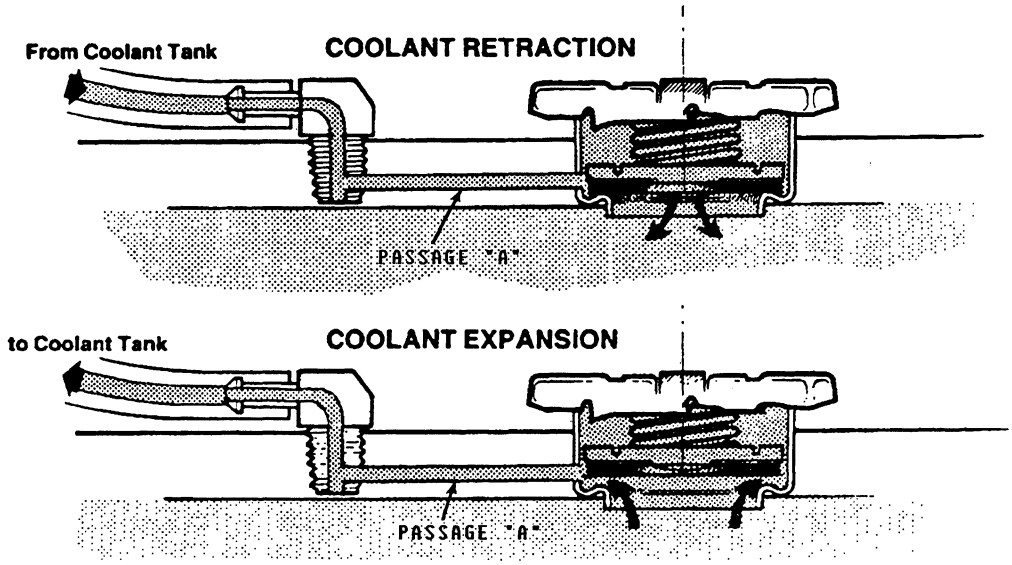
NOTE: An antifreeze concentration should be selected on the basis of a temperature which is about 10° F (5° C) lower than the actual atmospheric temperature expected.

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.

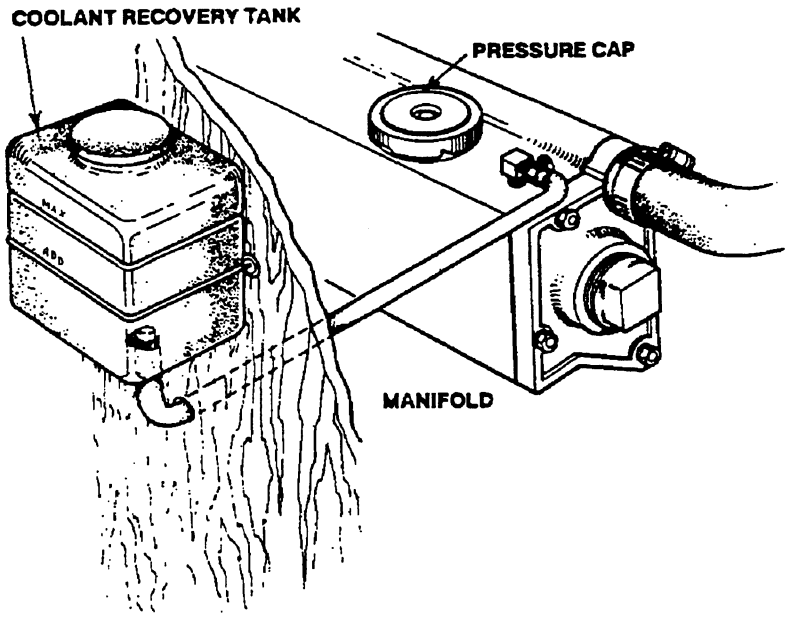
This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed (see the figure below). A stainless steel mounting bracket is supplied with each kit along with a 30-inch length of clear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

3. Start the engine and allow it to come up to its operating temperature. Monitor the coolant in the manifold and add antifreeze coolant as air is expelled. Once all air is expelled from the system, fill the manifold to the filler neck and install the pressure cap.

4. Remove the plastic cap from the plastic coolant recovery tank and fill the tank with coolant halfway between the **ADD** mark and the **MAX** mark. Replace the plastic cap.

5. Run the engine and observe the coolant's expansion flow into the plastic recovery tank.

6. Check for leaks between the pressure cap/filler neck and then plastic recovery tank. Stop the engine and allow it to cool. Coolant should be drawn back into the cooling system as the engine's temperature comes down.

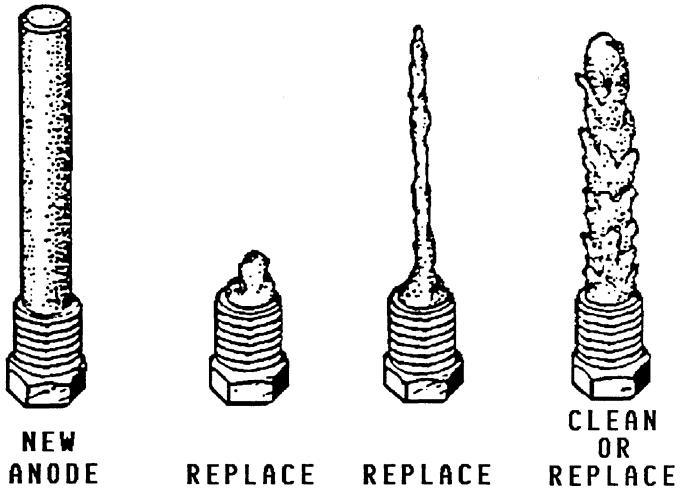
7. Add coolant to the recovery tank, as required, to top off the fresh water coolant system.

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 belt-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, from which heat from the fresh water system is absorbed, and then the sea water is discharged from the cooling system overboard through the water-injected wet exhaust system. Be sure to clean zinc debris from the area inside of the heat exchanger where the zinc anode is positioned.



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 replaced as required. Spare anodes should be carried on board.

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 failures occur when lubricant (sea water) is not present. Such failures are not warrantable and the operator's are cautioned to make sure sea water flow is present at start-up.

Water Pump Drive Belt Tension

WARNING

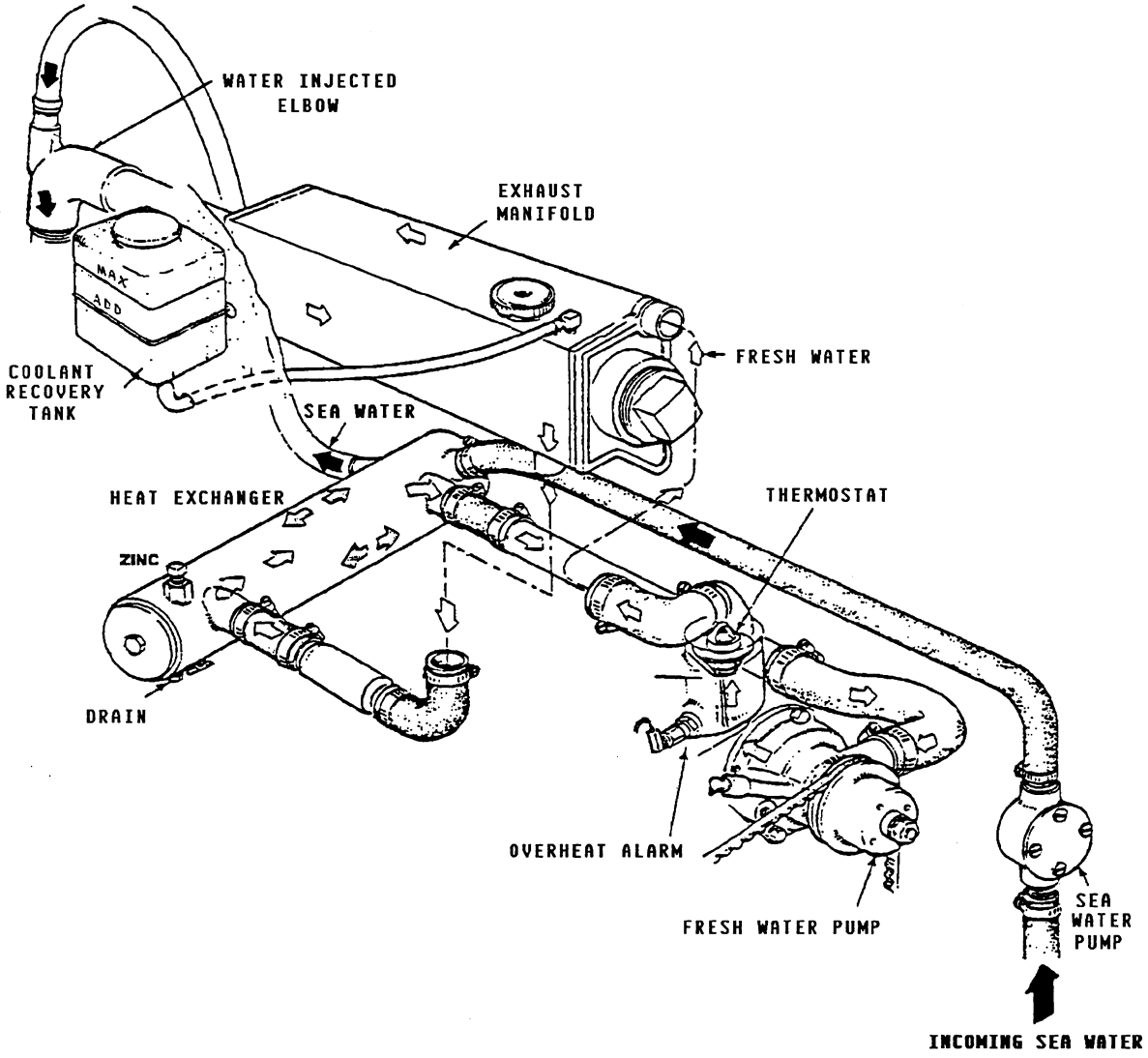
Never attempt to adjust the drive belt's tension while the engine is in operation.

CAUTION

Excessive water pump drive belt tension can cause rapid wear of the belt and reduce the service life of the fresh water pump's bearings. Excessive slack or the presence of oil on the belt can cause belt slipping, resulting in high operating temperatures.

The 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 (10 mm, 12 mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt. A spare drive belt should be carried on board.

Illustrated below is a typical Westerbeke engine's cooling system. Both fresh water and sea water flow through their independent cooling circuits. Refer to your generator's Parts List for part numbers and part descriptions if you need to order cooling system parts for your engine.



Typical Cooling System

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 CC, CD CF AND CG-4. THE USE OF THE HIGHEST GRADE AVAILABLE IS RECOMMENDED. THE OIL YOU SELECT SHOULD BE USED ON A REGULAR BASIS WHEN POSSIBLE.

Engine Oil Viscosity (SAE Number)

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

Atmospheric Temperature	Viscosity
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

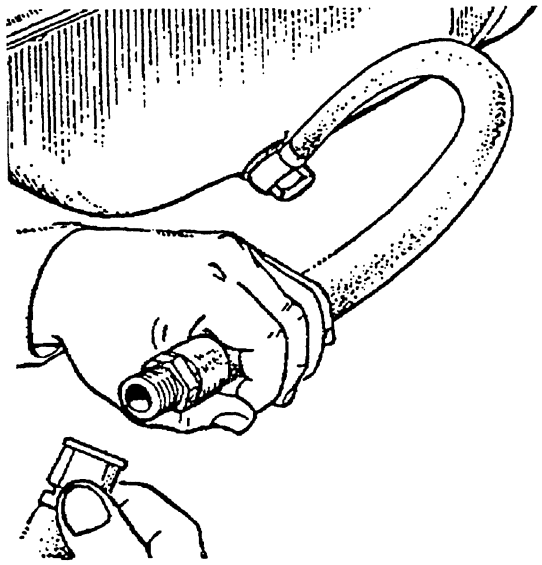
The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel

During normal operation, the oil pressure will range between 35 and 55

NOTE: A newly started, cold engine can have an oil pressure reading upwards of 60 psi. A warmed engine can have an oil pressure reading as low as 35 psi. These readings will vary depending upon the temperature of the engine and the load placed on the generator.

Engine Oil Change (to include filter)

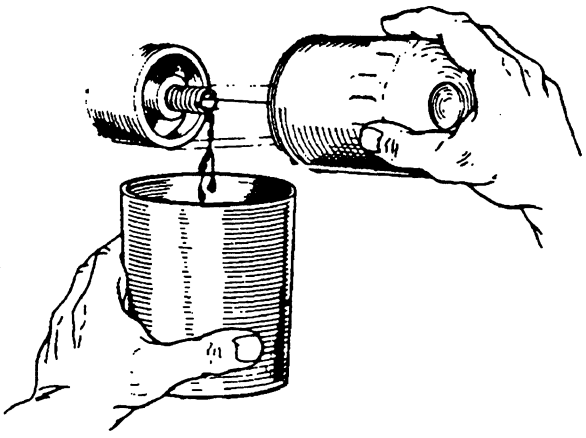
1. Draining the Oil Sump



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

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic should water be present in the oil. 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 (refer to the installation illustrations on page 21 and 22).

2. Replacement of the Oil Filter



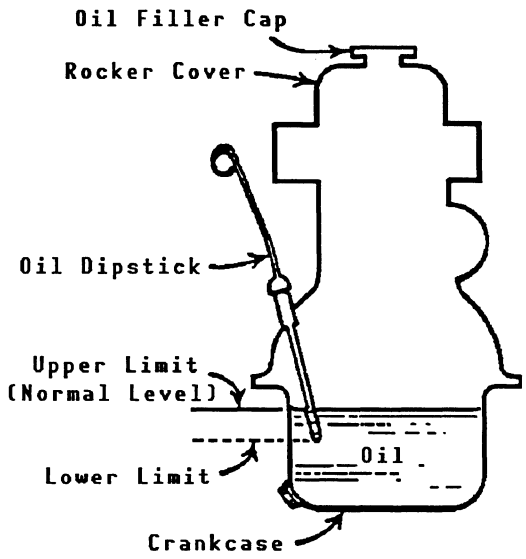
When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. A small style automotive filter wrench should be helpful in removing the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

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

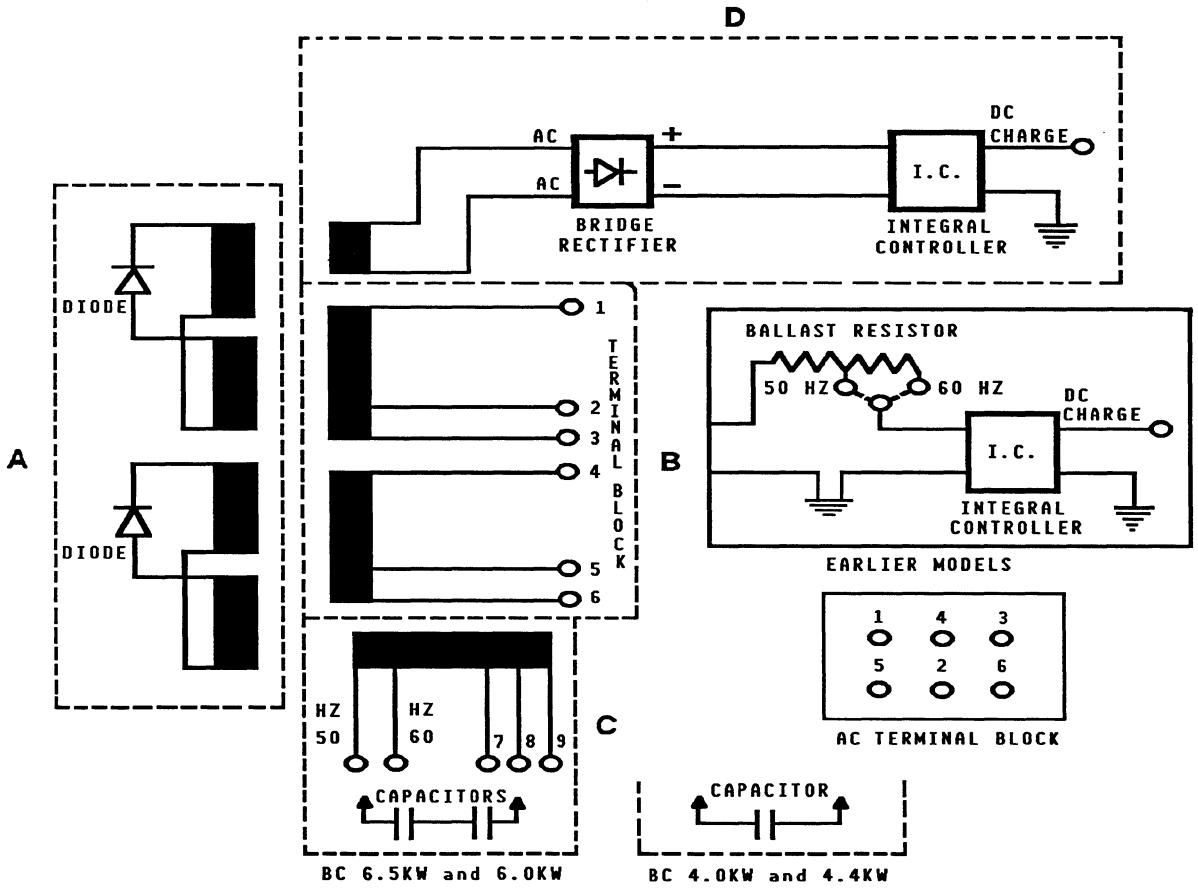
3. Filling the Oil Sump

Add fresh oil through the oil filler cap on the valve cover (refer to the photographs on pages 6 and 7 for the BCD 4.4KW, and pages 8 and 9 for the BCD 6.0KW for the location of the oil filler cap and lube oil dipstick). After refilling the oil, run the generator for a few moments while checking the engine's oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and then stop the generator. Then check the quantity of oil with the lube oil dipstick. Fill to, but not over, the high mark on the dipstick, should the engine require additional oil.



BC GENERATOR

The BC generator is a brushless, self-excited generator which requires only the driving force of the engine to produce an AC output. The stator houses two sets of windings: the main stator windings and the exciter windings. When the generator is started, residual magnetism in the four rotating poles induces a current in the stator exciter windings. This flow of current then induces a greater current flow through the four rotating poles which then generates an even larger current in the exciter windings. This mutual build up of current in the four rotating poles and in the exciter windings quickly reaches the saturation point of the capacitor(s) and a regulated energy field is then maintained in the stator. At the same time, this regulated field produces a steady voltage in the stator windings which then can be drawn off the generator's AC terminals to operate AC equipment.



Generator Internal Wiring Schematic with
DC Battery Charging Circuit

A. Rotating Field/Auxiliary Windings with Diodes

B. Integral Controller with Ballast Resistor (Earlier Models)

C. Exciter Windings and Capacitor(s)

D. Bridge Rectifier and Intergral Controller

Generator Frequency

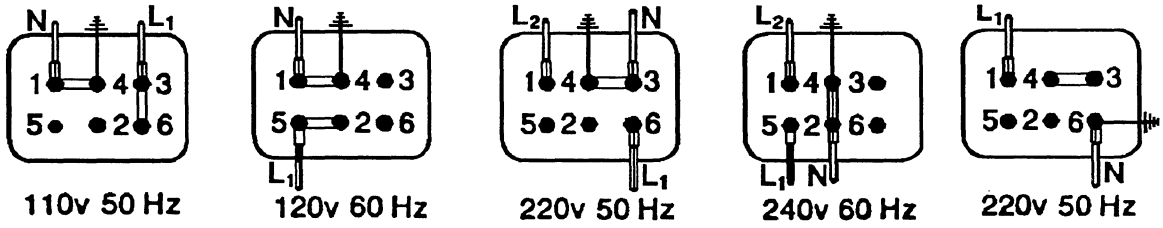
Frequency is a direct result of engine/generator speed: 1800 RPM - 60 Hertz, 1500 RPM - 50 Hertz To change the generator's frequency, refer to the "MAINTENANCE AND ADJUSTMENTS" section of this manual, page 72.

No-Load Voltage Adjustment: BCD 4.4KW

1. Remove the louvered metal plate covering the terminal connections and the capacitor (see page 56).

2. Start the generator and allow it to run for approximately five minutes so the engine can warm up. Make sure the generator is operating without any equipment drawing AC current from the generator (that is, shut OFF all electrical appliances). Make sure the engine's speed (Hertz) is correct. Adjust the governor/fuel solenoid linkage as needed to obtain the correct engine speed before proceeding. (See page 73.)

3. Referring to the AC load connections diagram below, check the generator's no-load current by measuring the voltage across the neutral lead and the hot lead with a volt meter. Make sure you record this reading. The generator's no-load voltage is 115 - 124 volts at 60.5 - 61.5 Hertz. If the voltage output is higher or lower than specified, proceed.



4. Shut off the generator. Make sure the correct Hertz lead (60 Hertz #6, or 50 Hertz #5) is plugged into the capacitor. Refer to the illustration on the top of the next page.

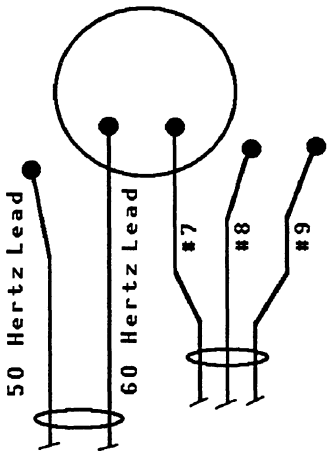
WARNING

DO NOT attempt to make a no-load voltage adjustment while the generator is operating. The capacitor can hold a 450 - 500 volt charge. Touching any wiring can result in a severe electrical shock. In addition, attempting to make a no-load voltage adjustment while the generator is operating can cause fingers to be caught in the generator's rotor.

5. Refer to the illustration on the next page before making any adjustments. Note that there are three plugs grouped for the right capacitor terminal, #7, #8, and #9. If the generator's no-load voltage is low, then disconnect the lower numbered plug and connect the plug with the next higher number. If the generator's no-load voltage is high, then disconnect the higher numbered plug and connect the plug with the next lower number. Note that the plug presently connected to this terminal may be any one of the three plugs available.

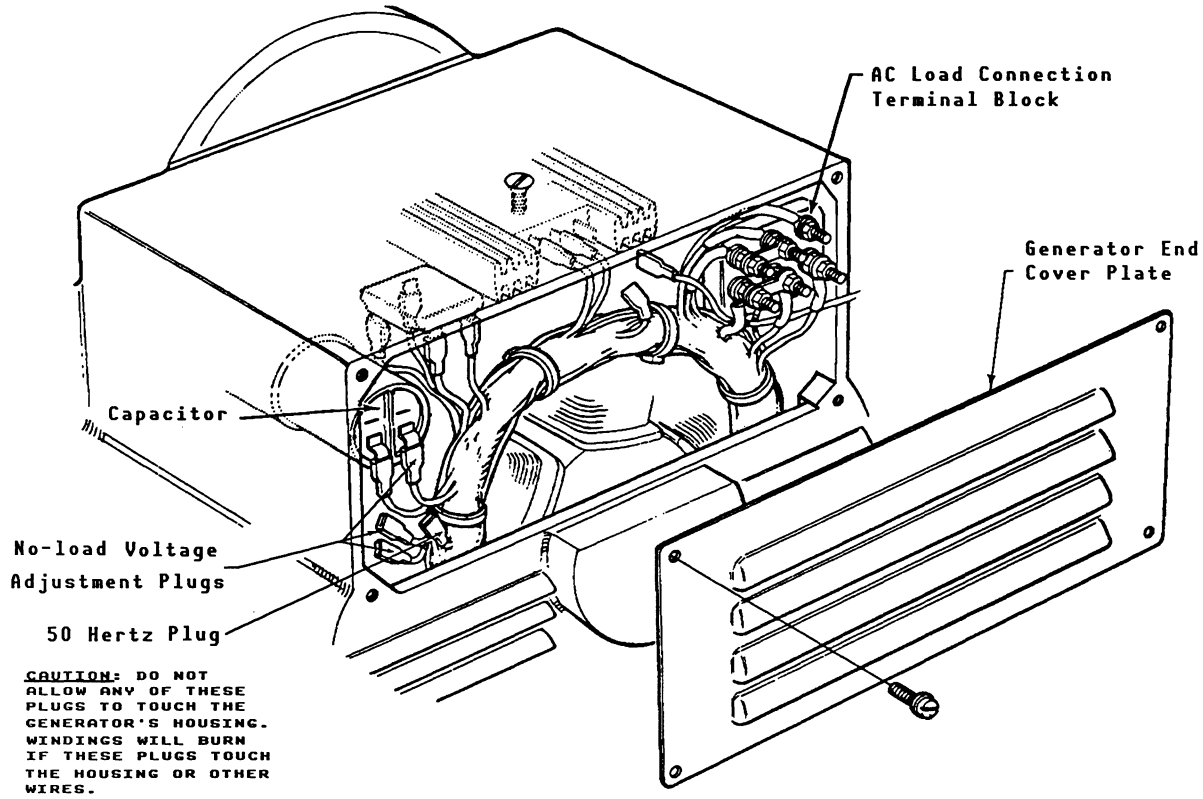
6. If the generator's no-load voltage cannot be adjusted because the voltage needs to be increased and the highest numbered plug is already connected to the right terminal, or the voltage needs to be lowered and the lowest numbered plug is connected, then follow the steps at the bottom of the next page. Ask your local Westerbeke dealer for a BC GENERAL TROUBLESHOOTING GUIDE before performing the steps listed at the bottom of the next page.

NOTE: Make sure the insulating covers on the unused leads are in place and are not in contact with each other or are in contact with the generator's housing.



THE #7 PLUG IS SHOWN CONNECTED TO THE CAPACITOR ONLY FOR DEMONSTRATION PURPOSES.

BCD 4.4KW GENERATOR



A. Check the resistance of the exciter windings

BCD 4.4KW : 1.9 Ohm

B. Check the capacitor.

BCD 4.4KW: 31.0 uF ± 5°

C. Check the engine's speed.

60 Hertz: 60.5 - 61.5
50 Hertz: 50.5 - 51.5

Adjust the engine's speed by use of the governor/fuel solenoid linkage adjustment, page 73, to obtain the correct Hertz.

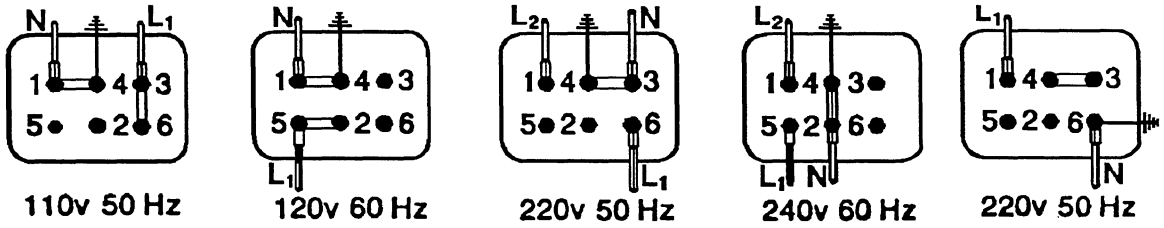
NOTE: Refer to the "NOTE" at the bottom of page 59.

No-Load Voltage Adjustment: BCD 6.0KW

1. Remove the louvered metal plate covering the terminal connections and the capacitor (see page 56).

2. Start the generator and allow it to run for approximately five minutes so the engine can warm up. Make sure the generator is operating without any equipment drawing AC current from the generator (that is, shut OFF all electrical appliances). Make sure the engine's speed (Hertz) is correct. Adjust the governor/fuel solenoid linkage as needed to obtain the correct engine speed before proceeding. (See page 73.)

3. Referring to the AC load connections diagram below, check the generator's no-load current by measuring the voltage across the neutral lead and the hot lead with a volt meter. Make sure you record this reading. The generator's no-load voltage is 115 - 124 volts at 60.5 - 61.5 Hertz. If the voltage output is higher or lower than specified, proceed.



4. Shut off the generator. Make sure the correct Hertz lead (60 Hertz #6, or 50 Hertz #5) is plugged into the capacitor. Refer to the illustration on the top of the next page.

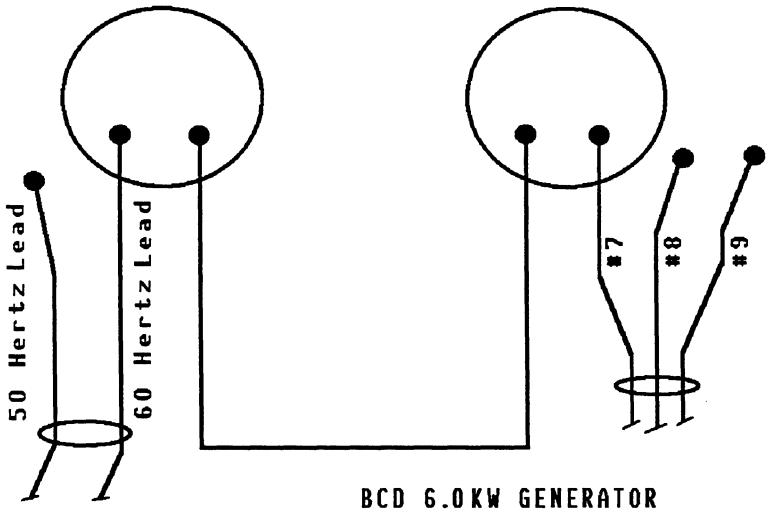
WARNING

DO NOT attempt to make a no-load voltage adjustment while the generator is operating. The capacitor can hold a 450 - 500 volt charge. Touching any wiring can result in a severe electrical shock. In addition, attempting to make a no-load voltage adjustment while the generator is operating can cause fingers to be caught in the generator's rotor.

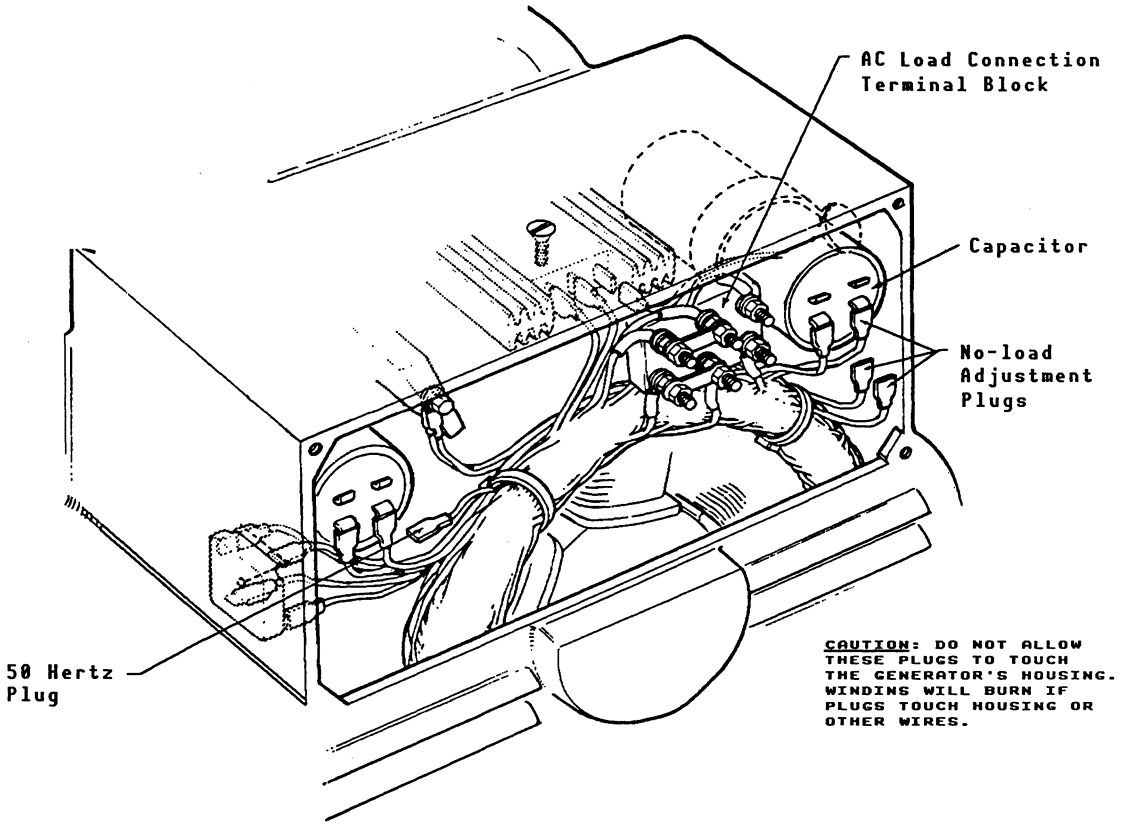
5. Refer to the illustration on the next page before making any adjustments. Note that there are three plugs grouped for the right capacitor terminal, #7, #8, and #9. If the generator's no-load voltage is low, then disconnect the lower numbered plug and connect the plug with the next higher number. If the generator's no-load voltage is high, then disconnect the higher numbered plug and connect the plug with the next lower number. Note that the plug presently connected to this terminal may be any one of the three plugs available.

6. If the generator's no-load voltage cannot be adjusted because the voltage needs to be increased and the highest numbered plug is already connected to the right terminal, or the voltage needs to be lowered and the lowest numbered plug is connected, then follow the steps at the bottom of the next page. Ask your local Westerbeke dealer for a BC GENERAL TROUBLESHOOTING GUIDE before performing the steps listed at the bottom of the next page.

NOTE: Make sure the insulating covers on the unused leads are in place and are not in contact with each other or are in contact with the generator's housing.



BCD 6.0KW GENERATOR



A. Check the resistance of the exciter windings

BCD 6.0KW : 2.2 Ohm

B. Check the capacitor.

BCD 6.0KW: 31.0 uF ± 5°

C. Check the engine's speed.

60 Hertz: 60.5 - 61.5
50 Hertz: 50.5 - 51.5

Adjust the engine's speed by use of the governor/fuel solenoid linkage adjustment, page 73, to obtain the correct Hertz.

NOTE: Refer to the "NOTE" at the bottom of page 59.

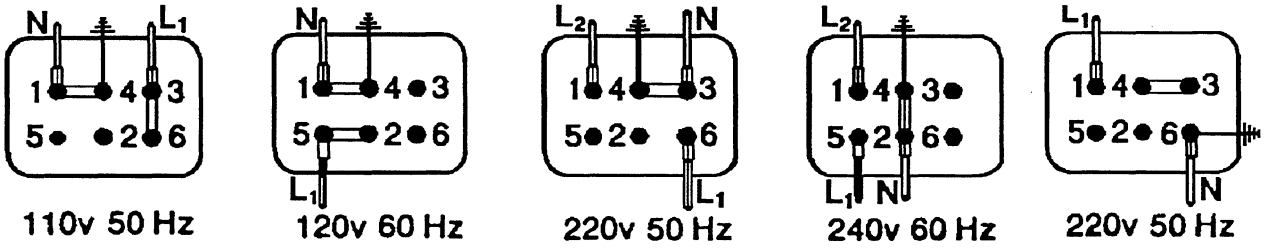
Load Connections

The generator's data plate gives the voltage, current and frequency rating of the generator. An AC wiring decal is affixed to the inside of the louvered cover on the generator end. A diagram of the various AC voltage connections is provided on the decal.

The generator is a single-phase, reconnectable 120 Volts AC two-wire or 120/240 Volts AC three-wire, at 60 Hertz; or 110 Volts AC two-wire, 110/220 Volts AC three-wire, or 220 Volts AC two-wire, at 50 Hertz. Refer to the "SYSTEM SPECIFICATIONS" section of this manual for generator ratings, page 11 for the BCD 4.4KW, and page 15 for the BCD 6.0KW.

> NOTE: The frame ground wire must be moved when changing from 110 Volts, 50 Hertz to /220 Volts, 50 Hertz.

A circuit breaker should be installed between the generator and the AC load. This circuit breaker should be rated at 120% of the generator's AC output and be able to react quickly to overloads, subject to motor starting considerations.



For making connections to the AC terminal block, use terminal ends for #10 studs which will accept multi-strand wire sized for the number of conductors in the bundle, the rating of the conductor's insulation, and amperage that will be drawn through the conductor(s). (Refer to the generator's data plate for the generator's amperage and voltage ratings.)

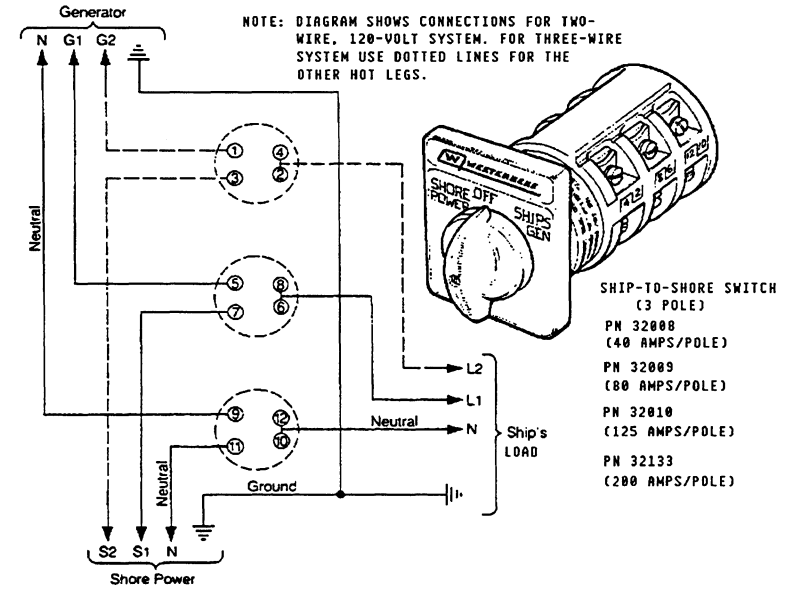
> NOTE: When changing Hertz produced by the generator, an engine speed adjustment at the governor/fuel solenoid linkage must be made. The AC output connections on the above illustrated terminal blocks must be selected for the voltage and Hertz to be produced. A plug at the capacitor must be changed for 50(#5) or 60(#6) Hertz use. Early models with 3 wire connections to the integral controller require a 50(#5) or 60(#6) Hertz connection change at the bridge rectifier in the DC charging circuit. Refer to the "Generator's Internal Wiring Schematic" on page 54.

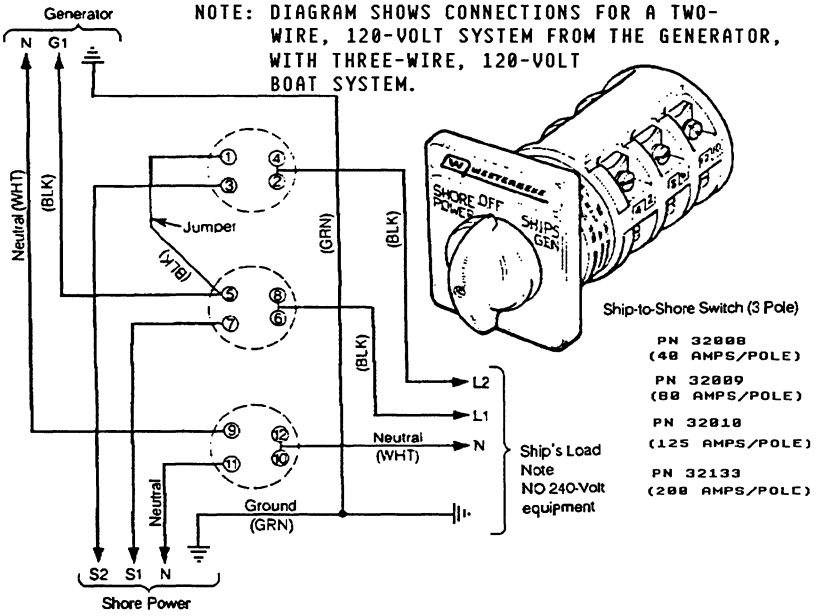
Shore Power Connections

If the installer connects shore power to the vessel's AC circuit, this must be done by means of the SHORE POWER/OFF/SHIPS GEN., center position-off transfer switch shown below. Use of this switch prevents simultaneous connection of shore power to generator output.

CAUTION

Damage to the generator can result if utility shore power and generator output are connected at the same time. This type of generator damage is not covered under the warranty; it is the installer's responsibility to make sure all AC connections are correct.





Shore Power Switch Connection Diagrams

Use of Electric Motors

The power required to start an electric motor is considerably more than is required to keep it running after it is started. Some motors require much more current to start than others. Split-phase (AC) motors require more current to start, under similar circumstances, than other types. They are commonly used on easy-starting loads, such as washing machines, or where loads are applied after the motor is started, such as small power tools. Because they require 5 to 7 times as much current to start as to run, their use should be avoided, whenever possible, if the electric motor is to be driven by a small generator. Capacitor and repulsion-induction motors require from 2 to 4 times as much current to start as to run. The current required to start any motor varies with the load connected to it. An electric motor connected to an air compressor, for example, will require more current than a motor to which no load is connected.

In general, the current required to start 115-Volt motors connected to medium starting loads will be approximately as follows:

MOTOR SIZE (HP)	AMPS FOR RUNNING (Amperes)	AMPS FOR STARTING (Amperes)
1/6	3.2	6.4 to 22.4*
1/4	4.6	9.2 to 32.2*
1/3	5.2	10.4 to 72.8*
1/2	7.2	14.4 to 29.2
3/4	10.2	20.4 to 40.8
1	13	26 to 52

* Note that in the above table the maximum "Amps for Starting" is more for some small motors than for larger ones. The reason for this is that the hardest starting types (split-phase) are not made in larger sizes.

Because the heavy surge of current needed for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

Required Operating Speed

Although individual units may vary slightly, the normal voltage and frequency of typical 60-(50-)Hertz engine-driven generators described in this manual are shown on the chart on the next page.

Run the generator at first with no load applied, then at half the generator's capacity, and finally loaded to its full capacity as indicated on the generator's data plate.

See the rpm/Hertz/frequency chart on the next page.

Load Applied	4-Pole Speed (rpm)	Frequency (Hertz)	Generator 120V (110) Plants	Voltage 240V (220) Plants
None	1830 (1530)	62 (52)	122 (112)	240 (224)
Half	1800 (1500)	60 (50)	120 (110)	240 (220)
Full	1755 (1455)	59 (49)	110 (100)	220 (200)

The output voltage should be checked periodically to ensure proper operation of the generating plant and the appliances it supplies.

If an AC voltmeter or ampmeter is not installed to monitor voltage and load, check it with a portable meter and amp-probe.

Preventive Maintenance (Generator)

Maintenance on the generator is minimal.

1. Keep the generator **clean, dry** and **well-ventilated.**

2. Make sure all connections are clean and tight and that cables carrying AC voltage are properly supported and protected against chafing.

3. The rear armature bearing is lubricated and sealed; therefore, no maintenance is required. If the bearing becomes rough or noisy, replace it.

Generator Troubleshooting

A complete and illustrated text on troubleshooting the BC series of generators is furnished in the Technical Manual which is available through your local dealer.

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
Preheat is depressed: no preheat.	1. Connection or switch.	1. Check for 12 volts at the PREHEAT switch and at the **S** terminal on the preheat solenoid.
	2. Preheat solenoid.	2. No activation with 12 volts at the **S** terminal. Tap solenoid with a mallet to determine if it is stuck internally. Solenoid should produce a click when activated and when deactivated.
	3. Glow plugs are faulty.	3. Twelve volts are present at the glow plugs. Remove each plug and check the resistance of the plugs by applying 12 volts artificially.
Preheat is depressed: fuel pump does not operate.	1. Faulty connections or bad pump.	1. Check for 12 volts at the fuel pump connections. If 12 volts are present, the pump is possibly faulty. Tap pump with a mallet. Pump's plunger may be stuck. Remove the filter and check for contamination which will affect the pump.
Preheat is depressed: no fuel solenoid activation.	1. Faulty connections or solenoid.	1. Check for 12 volts at (+) positive terminal at the back of the fuel solenoid when the PREHEAT button is depressed. Twelve volts with no activation indicates a faulty solenoid.
	2. Voltage problem.	2. Less than 10 volts found at the positive (+) terminal on the solenoid will not properly activate the solenoid and will cause a failure. Check for low batteries or voltage loss in small electrical wiring or corroded connections.

Problem	Probable Cause	Verification/Remedy
START switch is depressed: no starter engagement. Engine does not crank.	1. Connection to starter 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.
	6. Sea water in cylinders.	6. Remove exhaust hose at exhaust elbow and drain water.
Engine cranks, but does not start.	1. Shut-off valve at fuel tank.	1. Return shut-off valve to its ON position. Now bleed the fuel system.
	2. Faulty fueling system.	2. Check for fuel to engine.
	3. Air is in the fuel system.	3. Bleed the fuel system. Locate the leak and correct it.
	4. Fuel pump is not operating.	4. Check pump operation. Check for 12-Volts at pump.
	5. Fuel filters are clogged.	5. Clean/replace filters.
Failure to stop.	1. Solenoid linkage is disconnected.	1. Stop engine by manually shutting 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 for 12 volt and to see if it is pumping.
	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. Bad DC windings is low.	1. Perform DC Voltage. check.
	2. Bad battery connections.	2. Connections are corroded or loose at the battery or/and at the engine.
Black exhaust smoke.	1. Generator is overloaded.	1. Check generator data plate for rating and monitor the load that is producing the black exhaust smoke.
	2. Poor fuel quality or incorrect fuel.	2. Check fuel filters. Make sure you are using #2 diesel fuel.
	3. Faulty injector(s).	3. Remove and test injectors.
	4. Lack of air.	4. Check air intake for restrictions. Make sure adequate combustion air is present.

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. 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.
4. Check the fuel supply. Fill tank(s) with a good grade of No. 2 diesel fuel, if required.
5. Check the primary filter/water separator. Drain and service as required. (A primary filter/water separator is optional, but strongly recommended.)
6. Check the generator's gauges or lights for proper oil pressure, operating temperature, and starting battery charging voltage once the engine is operating.
7. Check the generator's output meters (when installed) for proper AC voltage and output frequency.

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 electric fuel lift pump and in the engine-mounted secondary fuel filter. Change the fuel filter element and clean the optional filter/water sedimentor, if a separator has been installed, and if the model type permits cleaning.

*3. Torque the cylinder head bolts.

*4. Adjust valve clearances.

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

6. Lubricate the ball joint linkage between the run solenoid and the throttle arm. Make sure the fuel solenoid operates properly when 10 - 12 volts are present at the solenoid during preheat.

7. Adjust the engine's no-load speed, if required (hertz). Please note that this adjustment is not a warrantable adjustment during or after the generator's break-in.

Servicing After Every 100 Hours of Operation

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

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

3. Lubricate the ball joint linkage between the run solenoid and the throttle arm.

Servicing After Every 250 Hours of Operation

1. Replace the fuel filter elements in the electric fuel lift pump and in the engine-mounted secondary fuel filter.

2. Lubricate the ball joint linkage between the run solenoid and the throttle arm.

Servicing After Every 500 Hours of Operation

*1. Torque the cylinder head bolts.

*2. Adjust the valve clearances.

3. Drain, flush, and refill the fresh water cooling system. The illustration on pages 6 to 9 show the heat exchanger and the zinc anode location. The drain plug for the fresh water system is next to the zinc anode.

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

5. Check the resistance of the glow plugs. (.4 to .6 ohms)

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

6. Check the condition of the sea water pump. Examine the pump for leaks and internal wear. Check the impeller cover, the cam plate, and the internal housing for wear. Check the impeller and replace it if it is worn or cracked. Replace worn components as needed. Operating condition (such as sea water) affect the service life of the sea water pump's components. Therefore, the life of the sea water pump or the lives of the pump's various components which come in contact with sea water cannot be accurately predicted.

7. CHECK THE INTERNAL CONDITION OF THE WATER INJECTED EXHAUST ELBOW. INSPECT THE EXHAUST AND WATER PASSAGES. REMOVE ANY CARBON AND/OR CORROSION BUILD UP. REPLACE THE ELBOW IF CORROSION IS EXTENSIVE.

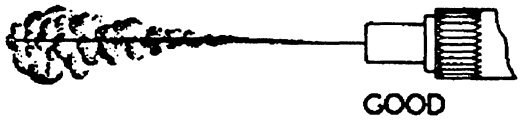
Servicing After Every 800 Hours of Operation

*1. Remove and check fuel injectors.

Injector spray pressure:

2275 psi + 140 psi
(160 kg/cm^2 + 10 kg/cm^2)

Eliminate undesirable injection conditions including after dripping.



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

Standard	Minimum	
455 psi (32 kg/cm^2)	369.7 psi (26 kg/cm^2)	(Maximum difference between cylinders: 35.5 psi (2.5 kg/cm^2)

*3. Check the DC Charging Circuit for proper operation.

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

Servicing After Every 1000 Hours of Operation

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

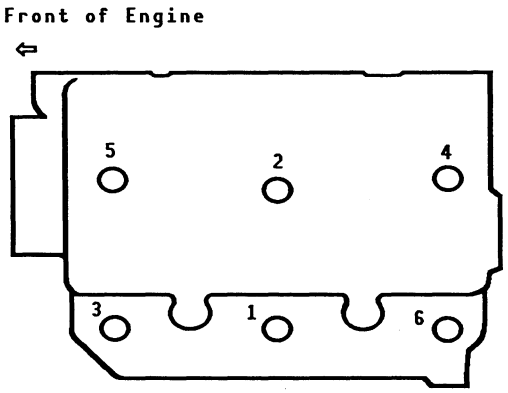
NOTE: Operating in silty and/or tropical waters may require that a heat exchanger cleaning be performed more often than every 1000 hours.

*2. Check the injection pump's timing.

Torquing Cylinder Head Bolts: BCD 4.4KW

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

Bolts # 1, 2, 3, 4, 5 and 6 are tightened between 50.6 to 57.8 lb-ft (7 to 8 kg-m).

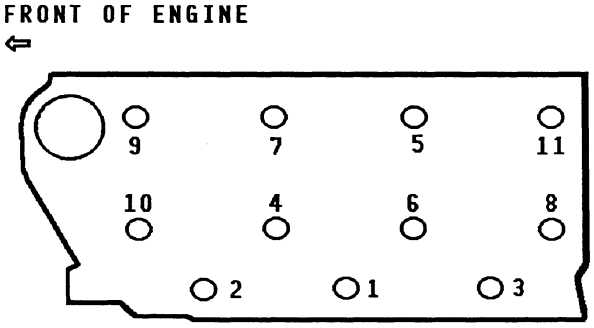


Torquing Cylinder Head Bolts: BCD 6.0KW

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

Bolts # 4,5,6,7,8,9,10 and 11 are tightened between 79.5 to 86.8 lb-ft (11 to 12 kg-m).

Bolts # 1,2 and 3 are tightened between 50.6 to 57.8 lb-ft (7 to 8 kg-m).



Valve Clearance Adjustment: BCD 4.4KW

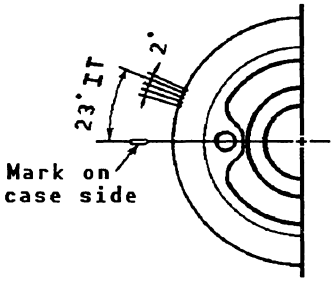
CAUTION

Adjust the valve clearance when the engine is cold. Valves are adjusted by cylinder in the firing order of the engine.

Tighten the cylinder head bolts to the specified torque before adjusting the valves. (See page 69.)

1. Pull off the air breather pipe from the rocker cover, and take off the rocker cover bolts and the rocker cover.

2. Adjust the valve clearances at TDC (Top Dead Center) for each cylinder when they are on their compression stroke (see below). Remember the engine's firing order is 1-2. You may find that turning the engine's crankshaft is more easily accomplished when the engine's glow plugs are removed before the crankshaft is rotated.

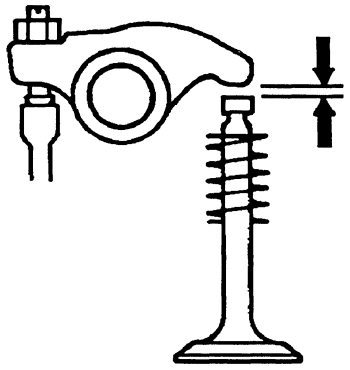


A. Align the timing mark on the gear case with the timing mark on the crankshaft pulley indicated for cylinder No. 1 (the one next to the three injection timing marks). In this position, the No. 1 cylinder is at its top Timing Mark while dead center on its compression stroke. Check both intake and exhaust valve clearances for this cylinder. If the valves have no specified clearance, adjust by means of the adjusting screws. Remember to align the timing marks properly; if not, the valve may be pushed up by the piston, depending on the position of the cam lobe. Be sure to check the valves for this cylinder - they both should be closed.

B. Next is the No. 2 cylinder: Turn the crankshaft clockwise 360° to position the TDC mark on the crankshaft pulley approximately at the position shown in the illustration above. Now adjust the intake and exhaust valves for cylinder No. 2. Be sure to check the valves for this cylinder - they both should be closed.

ADJUST VALVES TO 0.010 INCHES
(0.25 MM)

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

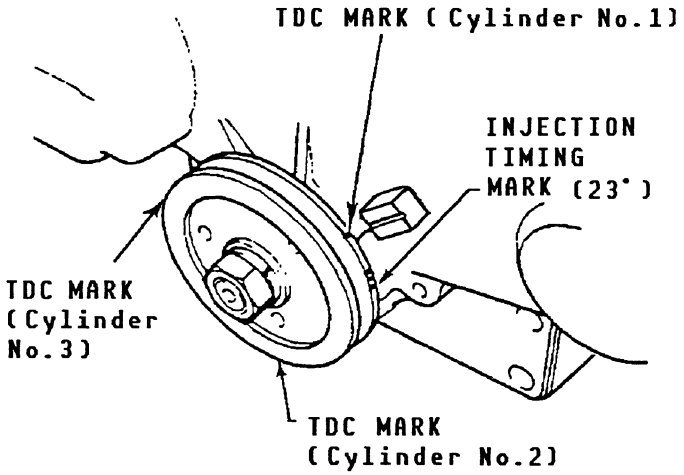


Valve Clearance Adjustment: BCD 6.0KW

CAUTION

Adjust the valve clearance when the engine is cold. Valves are adjusted by cylinder in the firing order of the engine.

Tighten the cylinder head bolts to the specified torque before adjusting the valves. (See page 69.)



1. Pull off the air breather pipe from the rocker cover, and take off the rocker cover bolts and the rocker cover.

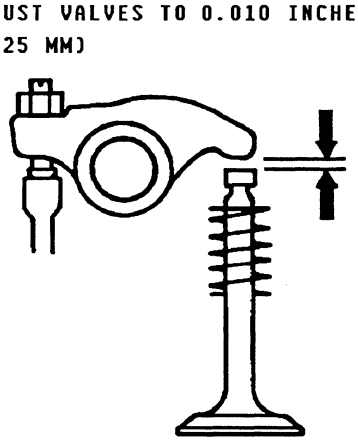
2. Adjust the valve clearances at TDC (Top Dead Center) for each cylinder when they are on their compression stroke (see below). Remember the engine's firing order is 1-3-2. You may find that turning the engine's crankshaft is more easily accomplished when the engine's glow plugs are removed before the crankshaft is rotated.

   A. Align the timing mark on the gear case with the timing mark on the crankshaft pulley indicated for cylinder No. 1 (the one next to the three injection timing marks). In this position, the No. 1 cylinder is at its top Timing Mark while dead center on its compression stroke. Check both intake and exhaust valve clearances for this cylinder. If the valves have no specified clearance, adjust by means of the adjusting screws. Remember to align the timing marks properly; if not, the valve may be pushed up by the piston, depending on the position of the cam lobe. Be sure to check the valves for this cylinder - they both should be closed.

   B. Next the No. 3 cylinder: Turn the crankshaft clockwise 240° so the TDC mark for the No. 3 cylinder, on the front crankshaft pulley, is approximately at the position shown in the illustration above. Now adjust the intake and exhaust valves for cylinder No. 3. Be sure to check the valves for this cylinder - they both should be closed.

   C. Last is the No. 2 cylinder: Turn the crankshaft clockwise another 240° to position the TDC mark on the crankshaft pulley approximately at the position shown in the illustration shown above. Now adjust the intake and exhaust valves for cylinder No. 2. Be sure to check the valves for this cylinder - they both should be closed.

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



Injection Pump Timing Adjustment (Spill Timing)

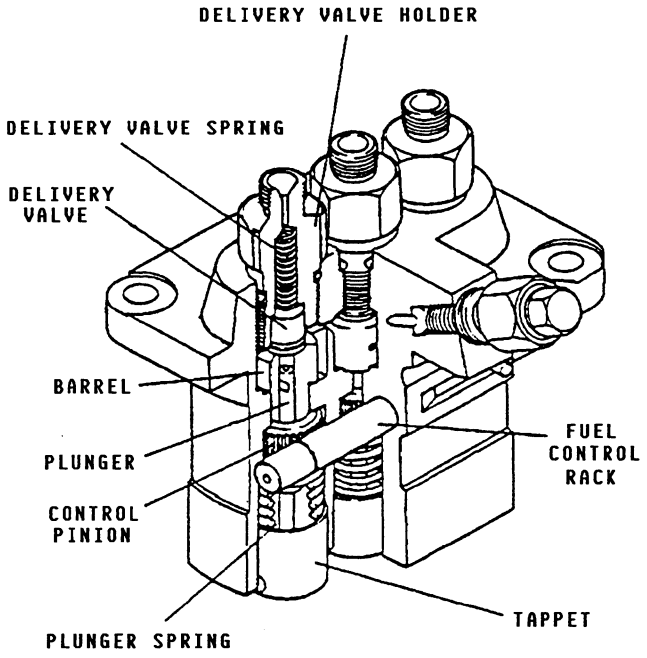
If your engine's fuel injection timing is not properly adjusted, the engine will not operate properly and will be difficult to start. Have the injection pump delivery rate checked by a well-established fuel injection shop. Adjust the injection timing as follows:

> NOTE: The fuel shut-off lever must be in the **RUN** position while making the adjustment or no fuel will flow from the fuel injection pump.

Refer to the illustration below when servicing the fuel injection pump. First remove the high-pressure fuel line from between the No. 1 injector and the No. 1 fuel delivery valve holder. Remove the No. 1 fuel delivery valve holder and remove the delivery valve spring beneath the holder. Reinstall only the delivery valve holder and reattach the high pressure fuel line to the delivery holder. Attach it so that the end that would connect to the fuel injector is pointing away from the engine. Fuel will flow from this line during the timing check.

Rotate the engine's crankshaft in its normal direction of rotation to position piston No. 1 at the beginning of its compression stroke

Move the throttle lever to its full open position and operate the electric lift pump. Slowly rotate the crankshaft clockwise (as viewed from the front), catching the fuel from the No. 1 fuel line, until the instant the fuel completely stops flowing (no drips). At this instant, the 19° BTDC timing mark on the crankshaft pulley should be directly aligned with the timing indicator on the front of the gear case (refer to the illustrations on pages 70 and 71).



If the specified injection timing (19° BTDC) cannot be attained, adjust the timing by increasing or decreasing the thickness of shim material under the injection pump's mounting flange to change the injection timing point. Changing the shim thickness by 0.004 inch (0.01mm) changes the injection timing by approximately one degree. To advance the timing, decrease the shim thickness, as required. To retard the timing, increase the shim thickness, as required. Refer to your generator's Parts List for shim part numbers.

Adjustments (Generator)

Once the diesel generator set has been placed in operation, there may be adjustments required for engine speed (Hertz) during the engine's break-in period (first 50 hours) or after this period. A no-load voltage adjustment may also be required in conjunction with the engine's speed adjustment.

CAUTION

When starting the generator, all AC loads, especially large motors, should be switched OFF until the engine has come up to speed and, in cold climates, starts to warm up. This precaution will prevent damage caused by unanticipated operation of AC machinery and will prevent a cold engine from stalling.

Generator Frequency Adjustment (Hertz)

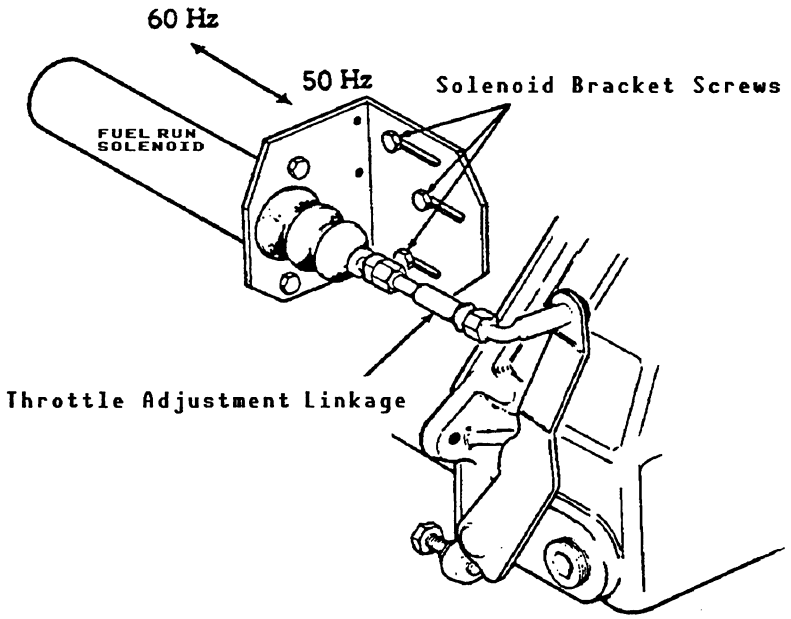
Frequency is a direct result of engine/generator speed, as indicated by the following:

When the generator is run at 1800 rpm, the AC voltage output frequency is 60 Hertz. When the generator is run at 1500 rpm, the AC voltage output frequency is 50 Hertz.

Therefore, to change the generator's frequency, the engine's speed must be changed. To accomplish the frequency change, perform the following:

1. Connect the AC output leads to the AC terminal block in accordance with the AC Voltage Connections diagram specified for your generator set, and change the Hertz connection to the capacitor. These connections are illustrated in the "BC GENERATOR" section of this manual, page 54.

2. Adjust the engine's speed to obtain the frequency corresponding to the voltage selected by extending or shortening the Throttle Adjustment Linkage. Make sure the solenoid's plunger is completely bottomed in the solenoid. (See figure below.)



CAUTION

Failure of the solenoid plunger to bottom in the solenoid will result in a failed solenoid.

To avoid failure of the solenoid, make sure the solenoid plunger bottoms in the solenoid. Check the solenoid's operation at the initial start-up. Periodically lubricated linkage joints between the solenoid plunger and the throttle arm will eliminate binding.

NOTE: The solenoid plunger *must* move smoothly and rapidly into the solenoid when the solenoid is electrically energized, drawing the engine's throttle arm into the Set Speed/Run position.

To arrive at the appropriate frequency, either monitor the speed of the engine/generator with a tachometer, or monitor the frequency with a frequency meter, the latter method being the more precise of the two.

Make sure 10 - 12 volts DC is present at the solenoid's positive (+) harness connection during PREHEAT and START. Loss of voltage will affect the solenoid's operation and cause a solenoid failure.

LAY-UP AND RECOMMISSIONING

General

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

The procedures which follow will allow you to perform your own lay-up and 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.

Fresh Water Cooling System

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

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

Lubrication System

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

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine. (Refer to the"SYSTEM SPECIFICATIONS" section of this manual, page 11 for the BCD 4.4KW, and page 15 for the BCD 6.0KW.) Use an oil with an API specification of CC or CD. Run the generator and check for proper oil pressure and make sure there are no leaks.

CAUTION

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

Fuel System

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

Change the fuel filter elements on the engine and bleed the fuel system, as needed. Start the engine and allow it to run for 5 - 10 minutes to make sure no air is left in the fuel system. Check for any leaks that may have been created in the fuel system during this servicing, correcting them as needed.

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, and also clean any zinc debris from inside the heat exchanger where the zinc anode is located. 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 the same manner.

Generator End

Remove the louvered cover on the end of the generator. Check all wire connections on the AC terminal block and those running to the capacitor(s) and the bridge rectifier making sure they are secure. Should these connections appear corroded, they should be removed, cleaned, and reconnected. Make sure all AC leads are properly cleaned and reconnected. Make sure all AC leads are properly supported and not chafing as they exit the generator housing.

Starter Motor

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

Cylinder Lubrication

It is not necessary to remove the 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 recommended that this procedure be performed. The light oil in the cylinders will prevent the pistons rings from sticking to the cylinder walls. Make sure you have replacements for the injector and return line sealing washers.

Spares

Lay-up time provides a good opportunity to inspect your Westerbeke engine to see if external items such as drive belts or coolant hoses need replacement. Check your basic spares kit and order items not on hand, or replace those items used during the lay-up, such as filters and zinc anodes. Refer to the "SPARE PARTS" section of this manual, page 81.

Batteries

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

Recommissioning

The recommissioning of your Westerbeke engine after a seasonal lay-up generally follows the same procedures as those presented in the "PREPARATIONS FOR STARTING" section, page 32, regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counteracted before starting the engine.

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

2. Remove the sea water pump cover and gasket and discard the old 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 make sure 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 engine is put into operation, the system will self-flush in a short period of time with no adverse affects.

5. Start the engine in accordance with procedures in the "PREPARATIONS FOR STARTING" section of this manual, page 32.

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 4T			
6mm bolt head/nut	1	2.9 - 5.1	0.4 - 0.7
8mm bolt head/nut	1.25	7.2 - 11.6	1.0 - 1.6
10mm bolt head/nut	1.25	13.7 - 22.4	1.9 - 3.1
10mm bolt head/nut	1.5	13.0 - 21.7	1.8 - 3.0
12mm bolt head/nut	1.25 (ISO)	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.5	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.75	21.7 - 36.2	3.0 - 5.0
13mm bolt head/nut	1.5	32.5 - 50.6	4.5 - 7.0
14mm bolt head/nut	1.5	36.2 - 57.9	5.0 - 8.0
14mm bolt head/nut	2	34.0 - 55.7	4.7 - 7.7
16mm bolt head/nut	1.5	54.2 - 79.6	7.5 -11.0
16mm bolt head/nut	2	51.4 - 76.7	7.1 -10.6
Grade 6T			
6mm bolt head/nut	1	4.3 - 6.5	0.6 - 0.9
8mm bolt head/nut	1.25	10.8 - 15.9	1.5 - 2.2
l0mm bolt head/nut	1.25	21.7 - 32.5	3.0 - 4.5
10mm bolt head/nut	1.5	19.5 - 30.4	2.7 - 4.2
12mm bolt head/nut	1.25 (ISO)	36.2 - 57.9	5.0 - 8.0
12mm bolt head/nut	1.5	36.2 - 50.6	5.0 - 7.0
12mm bolt head/nut	1.75	34.7 - 49.2	4.8 - 6.8
Grade 7T, 8T and 8.8			
6mm bolt head/nut	1	5.8 - 8.7	0.8 - 1.2
8mm bolt head/nut	1.25	14.5 - 21.7	2.0 - 3.0
10mm bolt head/nut	1.25	28.9 - 39.8	4.0 - 5.5
10mm bolt head/nut	1.5	26.8 - 37.6	3.7 - 5.2
12mm bolt head/nut	1.25 (ISO)	54.2 - 75.9	7.5 -10.5
12mm bolt head/nut	1.5	50.6 - 65.1	7.0 - 9.0
12mm bolt head/nut	1.75	43.4 - 61.5	6.0 - 8.5
13mm bolt head/nut	1.5	57.9 - 86.8	8.0 -12.0
14mm bolt head/nut	1.5	72.3 -108.5	10.0 -15.0
14mm bolt head/nut	2	68.7 -101.3	9.5 - 14.0
16mm bolt head/nut	1.5	108.5 - 166.4	15.0 - 23.0
16mm bolt head/nut	2	101.3 - 159.1	14.0 - 22.0
Grade 5 capscrew			
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	(M14)	50.7 - 57.9	7.0 - 8.0
	(M17)	79.6 - 86.8	11.0 - 12.0

(See the " **Torquing Cylinder Head Bolts**" section of this manual on page 69.)

Crankshaft pulley nut		
BCD 4.4KW	108.5 - 144.6	15.0 - 20.0
BCD 6.0KW	108.5 - 180.8	20.0 - 25.0
Oil pan drain plug (All Models)	36.2 - 43.4	5.0 - 6.0
Oil filter (All Models)	8.0 - 9.4 (or tighten firmly by hand)	1.1 - 1.3
Delivery valve holder (injection pump) (All Models)	28.9 - 36.2	4.0 - 5.0
Nozzle mounting bolt (All Models)	10.8 - 14.5	1.5 - 2.0
Nozzle holder and retaining nut (All Models)	43.4 - 57.9	6.0 - 8.0
Glow plug (All Models)	10.8 - 14.5	1.5 - 2.0

* NOTE: M8 indicates Metric, 8 mm thread diameter

SPARE PARTS

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

1. An Impeller Kit
2. A Fuel System hardware Kit
3. An Electric Fuel Lift Pump Filter and a 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 Premixed Antifreeze.
7. A few Zinc Anodes and Heat Exchanger End Plate Gaskets
8. An Oil Pressure Switch

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

1. Fuel Injectors
2. Glow Plugs
3. Cooling System Hoses
4. A Starter
5. A 20 Amp DC Circuit Breaker
6. An Electric Fuel Lift Pump
7. A Sea Water Pump
8. Battery Terminal Connectors
9. A Fuel Run Solenoid

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

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