



MARINE DIESEL ENGINES

M2-12A(C) M3-20A(C) M4-30A(C)

M25XPA(C) M35A(C)

OPERATORS MANUAL

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 Member National Marine Manufacturers Association

**CALIFORNIA
PROPOSITION 65 WARNING**

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

⚠ WARNING

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

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

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



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

WESTERBEKE also recommends installing CARBON MONOXIDE DETECTORS near the engine room. They are inexpensive and easily obtainable at your local hardware store.

SAFETY INSTRUCTIONS

INTRODUCTION

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

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

PREVENT ELECTRIC SHOCK

⚠ WARNING: Do not touch AC electrical connections while engine is running. Lethal voltage is present at these connections!

- Do not operate this machinery without electrical enclosures and covers in place.
- Shut off electrical power before accessing electrical equipment.
- Use insulated mats whenever working on electrical equipment.
- Make sure your clothing and skin are dry, not damp (particularly shoes) when handling electrical equipment.
- Remove wristwatch and all jewelry when working on electrical equipment.

PREVENT BURNS — HOT ENGINE

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

- Monitor engine antifreeze coolant level at the plastic coolant recovery tank and periodically at the filler cap location on the water jacketed exhaust manifold, but only when the engine is COLD.

⚠ WARNING: Steam can cause injury or death!

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

PREVENT BURNS — FIRE

⚠ WARNING: Fire can cause injury or death!

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

PREVENT BURNS — EXPLOSION

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

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

SAFETY INSTRUCTIONS

ACCIDENTAL STARTING

 **WARNING:** *Accidental starting can cause injury or death!*

- Turn OFF the DC breaker on the control panel or turn the unit's battery selector switch to OFF before servicing the engine.
- Make certain all personnel are clear of the engine before starting.
- Make certain all covers, guards, and hatches are re-installed before starting the engine.

BATTERY EXPLOSION

 **WARNING:** *Battery explosion can cause injury or death!*

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

BATTERY ACID

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

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

TOXIC EXHAUST GASES

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

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

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

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

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

AVOID MOVING PARTS

 **WARNING:** *Rotating parts can cause injury or death!*

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

SAFETY INSTRUCTIONS

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

HAZARDOUS NOISE

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

- Never operate an engine without its muffler installed.
- Do not run an engine with the air intake (silencer) removed.

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

OPERATORS MANUAL

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

GASOLINE ENGINE AND GENERATOR INSTALLATIONS

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

Sections of the ABYC standards of particular interest are:

- H-32 Ventilation for boats using diesel fuel
- H-33 Diesel Fuel Systems
- P-1 Installation of Exhaust Systems for Propulsion and Auxilliary Engines
- P-4 Marine Inboard Engines and Transmissions
- E-11 AC & DC Electrical Systems on Boats
- TA Batteries and Battery Chargers

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

ABYC, NFPA AND USCG PUBLICATIONS FOR INSTALLING MARINE ENGINES AND GENERATORS

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

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

Order From:

ABYC
613 Third Dstreet, Suite 10
Annapolis, MD 21403
(410) 990-4460
www.abycinc.org

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

Order From:

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

USCG (United States Coast Guard)
"CFR 33 AND CFR46"
Code of Federal Regulations

Order From:

U.S. Government Printing Office
Washington, D.C. 20404

INSTALLATION

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

CODES AND REGULATIONS

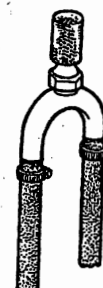
Strict federal regulations, ABYC guidelines, and safety codes must be complied with when installing engines and generators in a marine environment.

SIPHON-BREAK

For installations where the exhaust manifold/water injected exhaust elbow is close to or will be below the vessel's waterline, provisions must be made to install a siphon-break in the raw water supply hose to the exhaust elbow. This hose must be looped a minimum of 20" above the vessel's waterline. *Failure to use a siphon-break when the exhaust manifold injection port is at or below the load waterline will result in raw water damage to the engine and possible flooding of the boat.*

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

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



AVAILABLE FROM
YOUR WESTERBEKE
DEALER

SIPHON-BREAK WITH STAINLESS
LOOP

EXHAUST SYSTEM

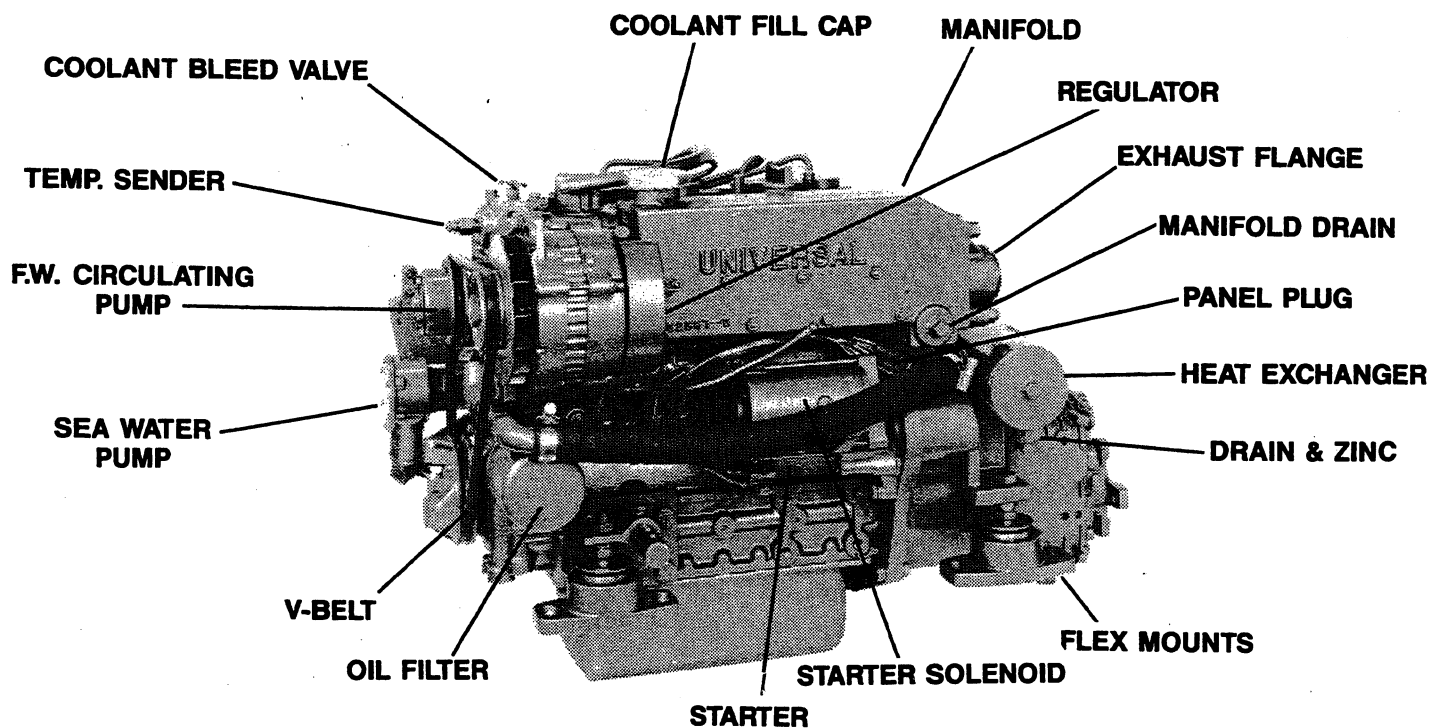
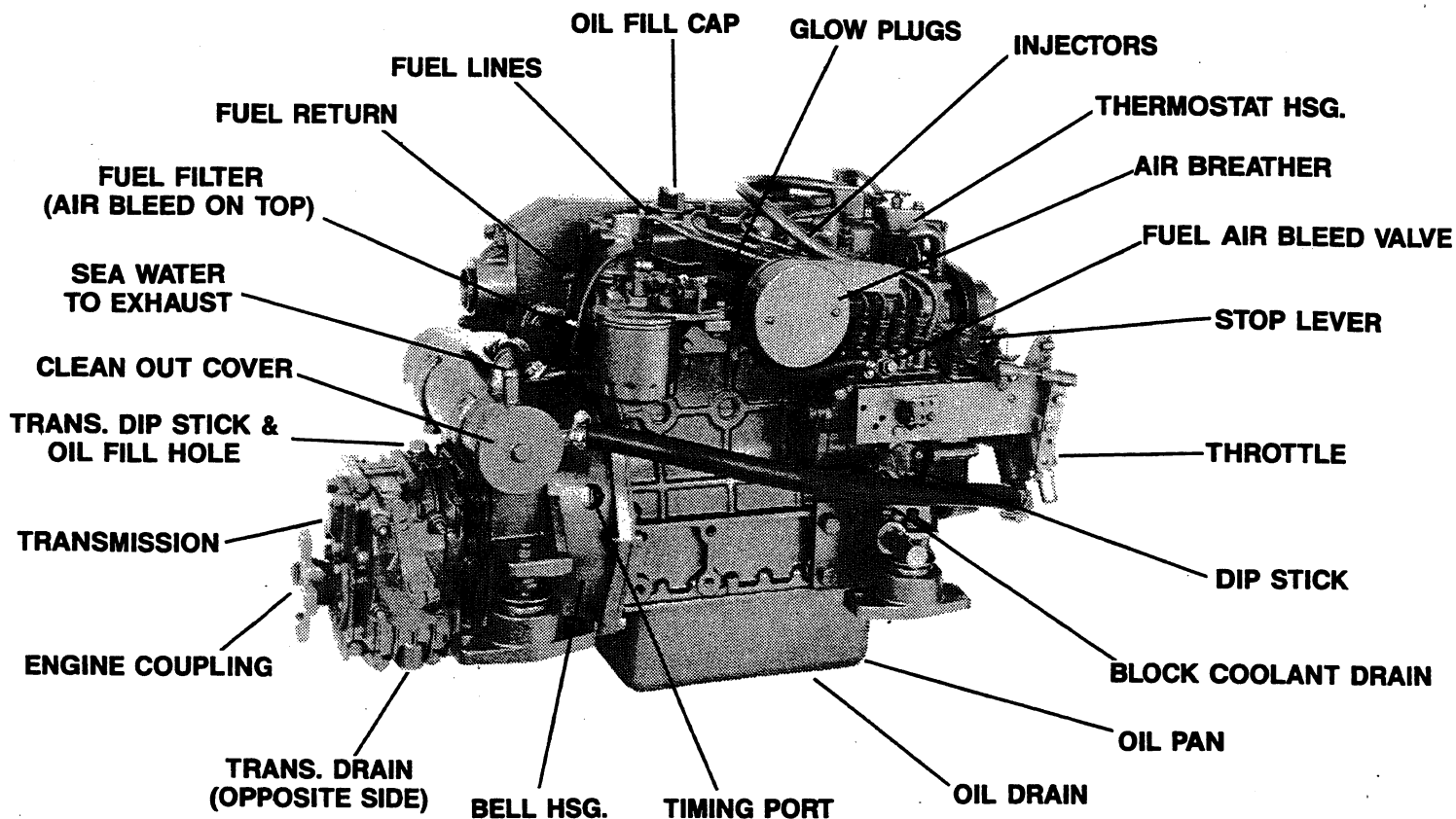
The exhaust system's hose **MUST** be certified for marine use. Corrugated Marine Exhaust Hose is recommended. The use of this type of hose allows for extreme bends and turns without the need of additional fitting and clamps to accomplish these bends and turns. In this regard, a single length of corrugated exhaust hose can be used. The system **MUST** be designed to prevent the entry of water into the exhaust system under any sea conditions and at any angle of vessels heel.

A detailed Marine Installation Manual covering gasoline and diesel, engines and generators, is supplied with each unit. A pdf is available to download from our website at www.westerbeke.com.

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PARTS IDENTIFICATION



INTRODUCTION

These new high performance UNIVERSAL marine diesel engines are a product of UNIVERSAL/WESTERBEKE'S design technology and their combined years of experience manufacturing quality marine engines. We take great pride in the superior durability and dependable performance of our marine engines. Thank you for selecting UNIVERSAL.


In order to get the full use and benefit from your engine, it is important that you operate and maintain it correctly. This manual is designed to help you do this. Please read this manual carefully and observe all the safety precautions throughout. An extensive network of UNIVERSAL WESTERBEKE distributors, dealers and service centers are available worldwide. Should your engine require servicing, contact your nearest dealer for assistance.

This is your operators manual. A Parts Catalog is also provided and a Technical Manual is available from your UNIVERSAL dealer. Also, if you are planning to install this equipment, contact your UNIVERSAL dealer for UNIVERSAL'S installation manual.

WARRANTY PROCEDURES

Your UNIVERSAL Warranty is included in a separate folder. If you have not received a customer identification card registering your warranty 60 days after submitting the warranty registration form, please contact the factory in writing with model information, including the unit's serial number and commission date.

TYPICAL CUSTOMER IDENTIFICATION CARD

	
Customer Identification	
UNIVERSAL OWNER	

Model _____	Ser. # _____
Expires _____	

MANUFACTURING DATE CODE

The serial number for your Universal Marine Diesel Engine contains a manufacturing date code at its end. Date codes from 1990 up to 2008 were alpha numeric. The first character representing the decade D=1990s, E= 2000s. The three numbers following represent the year in that decade and the month. Example: D311 represents 1993, the month November (11 month). Universal A model Diesel engines were manufactured from 1993-1997.

PRODUCT SOFTWARE

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


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NOTES, CAUTIONS AND WARNINGS

As this manual takes you through the operating procedures, maintenance schedules, and troubleshooting of your marine engine, critical information will be highlighted by NOTES, CAUTIONS, and WARNINGS. An explanation follows:

NOTE: *An operating procedure essential to note.*

 **CAUTION:** *Procedures, which if not strictly observed, can result in the damage or destruction of your engine.*

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

INTRODUCTION

SERIAL NUMBER LOCATION

An identification nameplate that displays the engine model number and engine serial number is mounted on the side of the engine's manifold. Take the time to enter this information on the blank decal provided below. This will provide a quick reference when seeking technical information and/or ordering parts.



UNDERSTANDING THE DIESEL ENGINE

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

To a great extent, a diesel engine requires the same preventive maintenance as a gasoline engine. Most important are proper ventilation and proper maintenance of the fuel, lubricating and cooling systems. Replacement of fuel and lubricating filter elements at the time periods specified and frequent checking for contamination (water, sediment, etc.) in the fuel system are essential. Also important is the consistent use of a brand of high detergent diesel lubrication oil designed specifically for diesel engines.

The diesel engine does differ from the gasoline engine, however, in its method of handling and firing of fuel. The carburetor and ignition systems are done away with and in their place is a single component (the fuel injection pump) which performs the function of both.

ORDERING PARTS

Whenever replacement parts are needed, always provide the engine model number and engine serial number as they appear on the silver and black identification nameplate located on the manifold. You must provide us with this information so we can identify your engine. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts Catalog). Also insist upon UNIVERSAL/WESTERBEKE packaged parts because will fit or generic parts are frequently not made to the same specifications as original equipment.

SPARES AND ACCESSORIES.

Certain spares will be needed to support and maintain your UNIVERSAL marine engine. Your UNIVERSAL/WESTERBEKE dealer will assist you in preparing an on board inventory of spare parts. See the *UNIVERSAL SPARE PARTS* page in this manual for a suggested list.

PROTECTING YOUR INVESTMENT

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

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

- ☐ Proper engine installation and alignment.
- ☐ An efficient well-designed exhaust system that includes an anti-siphon break to prevent water from entering the engine.
- ☐ Changing the engine oil and oil filters every 100 operating hours.
- ☐ Proper maintenance of all engine components according to the maintenance schedule in this manual.
- ☐ Use clean, filtered diesel fuel.
- ☐ Winterize your engine according to the *LAY-UP AND RECOMMISSIONING* section in this manual.

ADMIRAL CONTROL PANEL

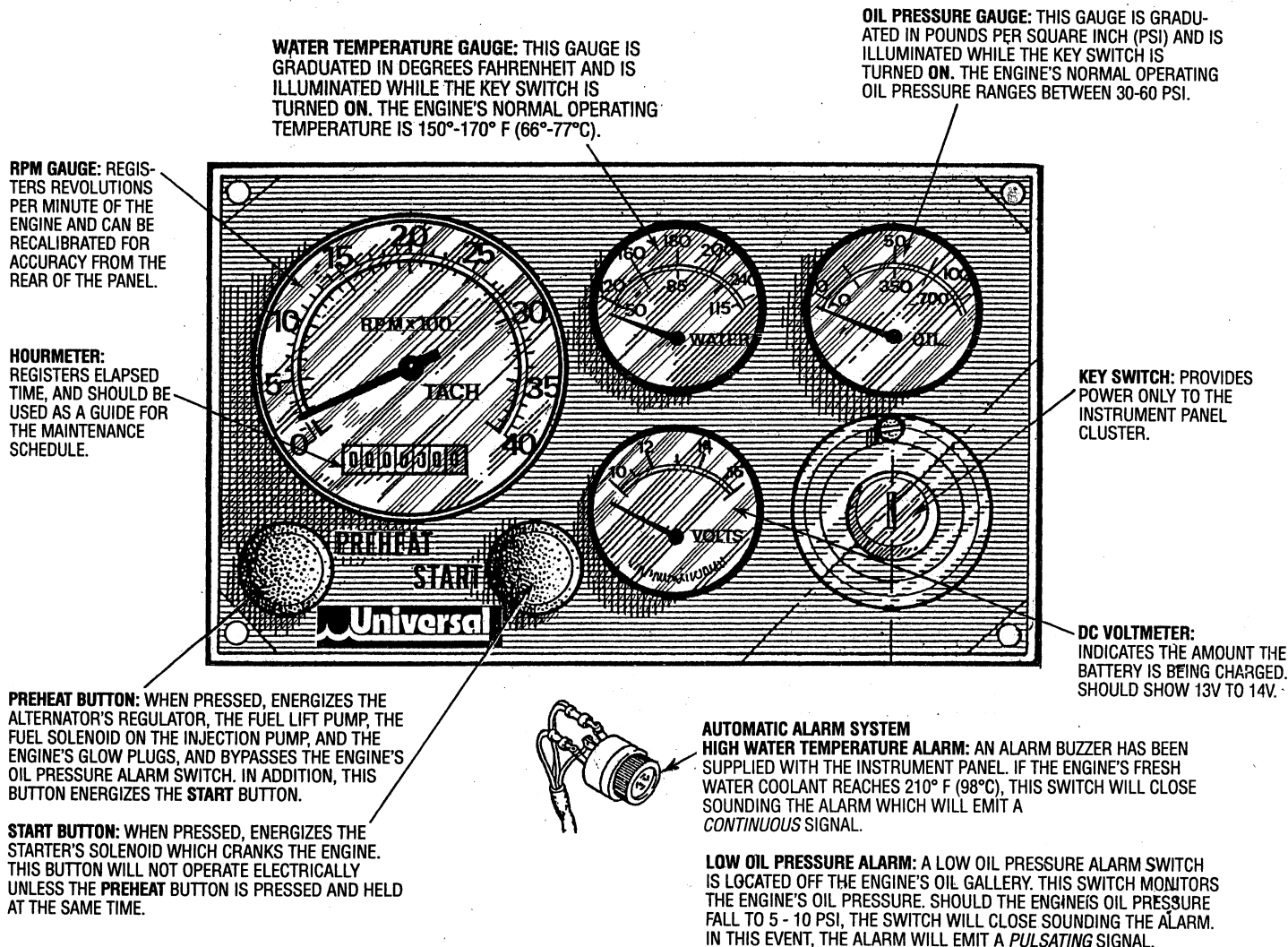
UNIVERSAL offers two optional panels. Refer to the instruction page that applies to the panel you purchased.

ADMIRAL PANEL

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

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

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



CAPTAIN CONTROL PANEL

CAPTAIN PANEL

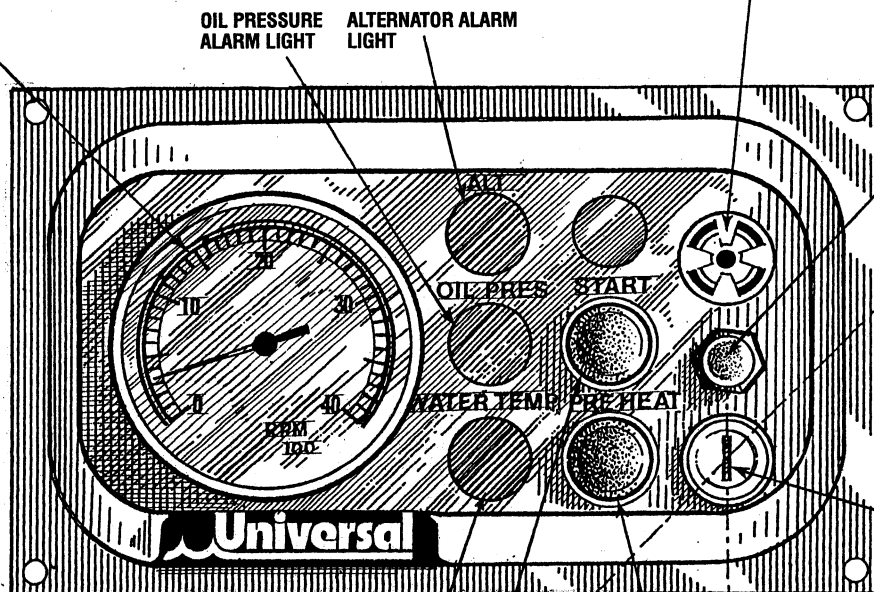
This manually-operated control panel is equipped with a Key Switch, an RPM gauge, PREHEAT and START buttons, an INSTRUMENT TEST button and three indicator lamps, one for ALTERNATOR DISCHARGE, one for low OIL PRESSURE,

and one for high ENGINE COOLANT TEMPERATURE. It also includes an alarm buzzer for low OIL PRESSURE or high WATER TEMPERATURE. The RPM gauge is illuminated when the Key Switch is turned **on** and remains illuminated while the engine is in operation.

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

ALARM: THE ALARM WILL SOUND IF THE ENGINE'S OIL PRESSURE FALLS BELOW 15 PSI. IN THIS EVENT, THE ALARM WILL EMIT A *PULSATING* SIGNAL. THE ALARM WILL ALSO SOUND IF THE WATER TEMPERATURE IN THE FRESHWATER COOLING CIRCUIT RISES TO 210°F. IN THIS EVENT, THE ALARM WILL EMIT A SIGNAL.

NOTE: THE ALARM WILL SOUND WHEN THE KEY SWITCH IS TURNED **ON**. THIS SOUNDING IS NORMAL. ONCE THE ENGINE STARTS AND THE ENGINE'S OIL PRESSURE REACHES 15 PSI, THE ALARM WILL SILENCE.



TEST BUTTON: WHEN PRESSED, TESTS THE ALTERNATOR, THE OIL PRESSURE, AND THE WATER TEMPERATURE CONTROL CIRCUITS. WHEN PRESSED, THE ALTERNATOR, THE OIL PRESSURE, AND THE WATER TEMPERATURE INDICATOR LIGHTS ILLUMINATE IN ADDITION TO SOUNDING THE ALARM BUZZER.

KEY SWITCH:
PROVIDES POWER TO THE INSTRUMENT PANEL CLUSTER AND THE DC ALTERNATOR REGULATOR TERMINAL.

WATER TEMPERATURE ALARM LIGHT

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

PREHEAT BUTTON: WHEN PRESSED, ENERGIZES THE FUEL LIFT PUMP AND THE ENGINE'S GLOW PLUGS, AND BYPASSES THE ENGINE'S OIL PRESSURE ALARM SWITCH. IN ADDITION, THIS BUTTON ENERGIZES THE START BUTTON.

DIESEL FUEL, ENGINE OIL AND ENGINE COOLANT

DIESEL FUEL

Use a diesel fuel that meets the requirements of No. 2-D SAE J 313 and has a Cetane rating of #45 or higher grade of diesel fuel according to ASTM D975

Care Of The Fuel Supply

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

Purchase a well-known brand of fuel. The use of additives to combat BACTERIAL growth in the fuel tank is recommended such as Bio-Bor and an additive such as Diesel Kleen + Centane Boost to help restore lubricity back into the diesel fuel when an Ultra Low Sulfur diesel is being used.

Install and regularly service a good, visual-type fuel filter/water separator between the fuel tank and the engine. The Raycor 500 MA or 230 RMAM are good examples of such filters. A 10 micron filter element is recommended.

ENGINE OIL

Use a heavy duty diesel oil with an API classification of CF, CG-4, CH-4 or CI-4. Change the engine oil and filter after an initial 50 hours of break-in operation. Then follow the oil and filter change intervals as specified in the **MAINTENANCE SCHEDULE** in this manual. Westerbeke Corporation does not approve or disapprove the use of synthetic oils. If synthetic oils are used, engine break-in must be performed using conventional oil. Oil change intervals must be as listed in the **MAINTENANCE SCHEDULE** section of this manual and not be extended if synthetic oils are used.

NOTE: *The information above supersedes all previous statements regarding synthetic oil.*

SAE OIL VISCOSITY GRADE

For all temperature ranges: SAE 15W-40 or SAE 10W-40.



ENGINE COOLANT

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

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

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

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

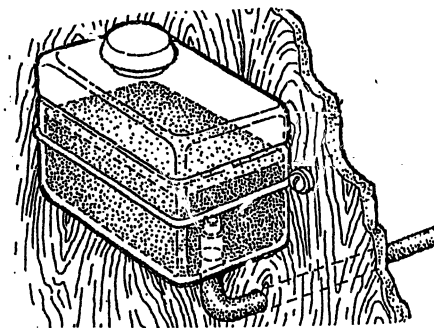
PURCHASING ANTIFREEZE

Select a brand of antifreeze specified for diesel engines. Antifreeze specified for diesel engines contains a special additive to protect against cavitation erosion of the engine's cylinder walls.

Prestone and Zerex are two nationally known brands that offer antifreeze specifically for use in diesel engines. Select the pre-mixed variety so that the correct mixture will always be added to the cooling system when needed. Change the antifreeze mixture according to the **MAINTENANCE SCHEDULE** in this manual.

COOLANT RECOVERY TANK

A coolant recovery tank kit is supplied with each **UNIVERSAL** 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 kit is provided and must be installed before running the engine.



NOTE: *This tank, with its short run of plastic hose, is best located at or above the level of the engine's manifold, but it can be located below the level of the engine's manifold if the particular installation makes this necessary.*

PREPARATIONS FOR INITIAL START-UP

PRESTART INSPECTION

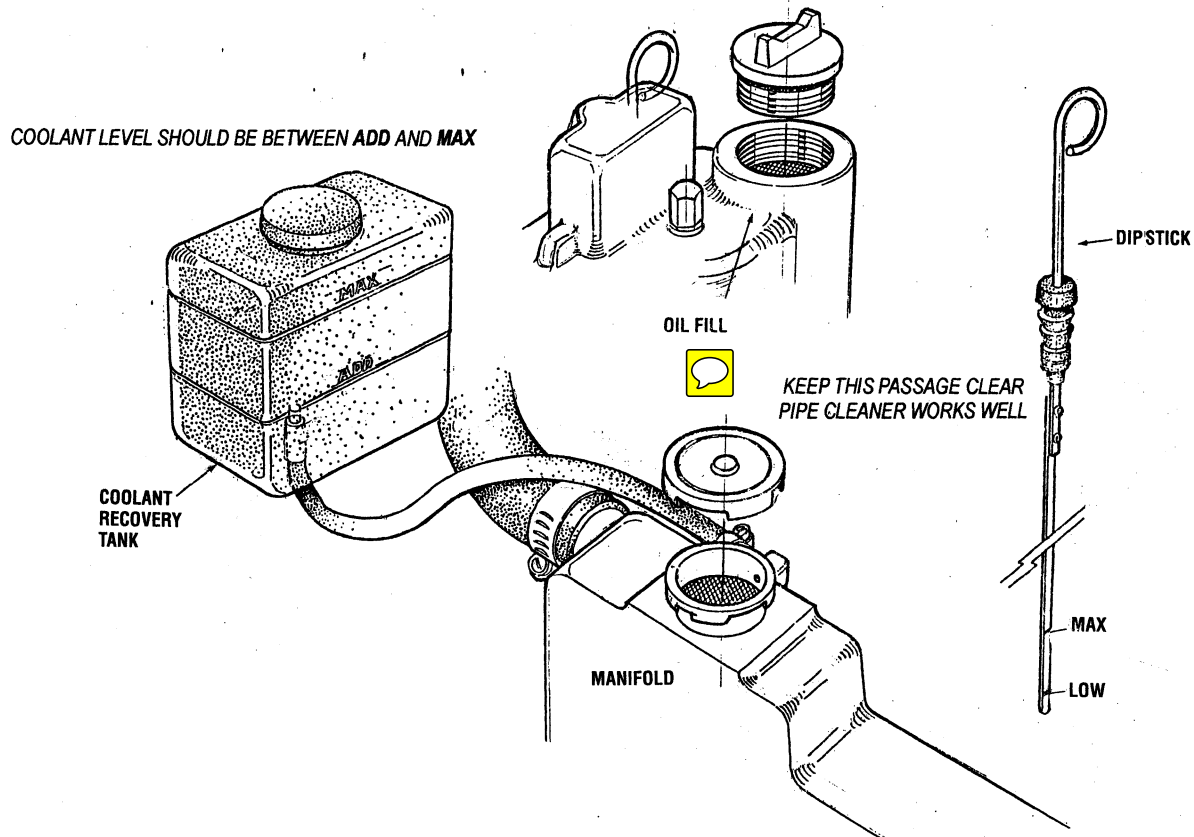
Before starting your engine for the first time or after a prolonged layoff — check the following items.

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

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

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

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



STARTING/STOPPING PROCEDURE

STARTING PROCEDURE

Place the transmission in neutral and advance the throttle control to slightly open.

CAUTION: Make certain the transmission is in neutral. Starting in gear could result in serious damage to your transmission, your boat, and vessels nearby.

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

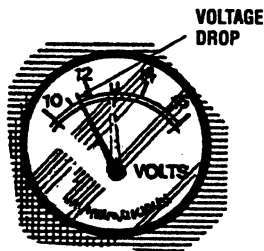
PREHEAT: Depress the PREHEAT switch. The voltmeter and panel lights, gauges and meters will be activated. The PREHEAT switch should be depressed in accordance with the following chart:

Temperature/Preheat

Atmospheric Temperature	Preheating Time
41°F(5°C) or higher	Approx. 10 seconds
41°F(5°C) to 23°F (-5°C)	Approx. 15 seconds
23°F(-5°C) or lower	Approx. 20 seconds
Limit of continuous use	30 seconds before cranking

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

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



Should the engine not start when the START switch is depressed for 10 to 20 seconds, release both switches and wait 30 seconds; repeat the procedure above and preheat longer. *Never run the starter for more than 30 seconds.*

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

Once the engine starts, check the instruments for proper oil pressure and battery charging voltage.

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

NOTE: Some unstable running may occur in a cold engine. Depressing the PREHEAT switch for 10-15 second intervals will help stabilize the engine rpm until the operating temperature of the engine reaches 150-170°F. (60-77°C) and a propeller load is applied to the engine when the engine is running and the PREHEAT switch is depressed. A charging load on the DC alternator will be discernible.

STARTING UNDER COLD CONDITIONS

Make certain the lubricating oil conforms with the ratings for the prevailing temperature. Check the table on the engine oil section of this manual.

The battery should be fully charged to minimize voltage drop. Use a sufficient amount of preheat to aid in starting. See the Temperature/Preheat chart elsewhere in this section.

STOPPING PROCEDURE

To stop the engine, bring the throttle to an idle position and place the transmission in neutral. Allow the engine to idle for a few moments to stabilize temperatures. Pull the STOP lever to shut down the engine. Then turn OFF the key to close down the electric fuel pump and accessories.

Make certain this key switch is in the OFF position (12 o'clock). If the key switch is left ON, the battery will discharge. An engine alarm buzzer is provided to warn the operator of this condition (Key Switch ON). The best method of preventing the battery from discharging is to remove the key from the Key Switch after stopping the engine. (The extra key should be stowed in a safe place.)

BREAK-IN PROCEDURE

THE FIRST 50 HOURS

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

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

1. Start the engine according to the Starting Procedure section in this manual; run the engine at fast idle while checking that all systems (raw water pump, oil pressure, battery charging) are functioning.
2. Allow the engine to warm up (preferably by running at fast idle) until the water temperature gauge moves into the 130°-140°F range.
3. While using the vessel, run the engine at varying engine rpms for the first 25 hours.
4. Avoid rapid acceleration, especially with a cold engine.
5. Use caution not to overload the engine. The presence of a gray or black exhaust, and the inability of the engine to reach its full rated rpm, are signs of an overload.
6. During the next 25 hours, the engine may be operated at varying engine rpms, with short runs at full rated rpm. Avoid prolonged idling during this break-in period.

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

RECOMMENDED RPM RANGES			
MODEL	IDLE RPM	CRUISE RPM	MAXIMUM RPM
M2-12A	1000 - 1200	2500 - 3000	3500 - 3600
M3-20A	1000 - 1200	2500 - 3000	3500 - 3600
M25XPA	1000 - 1200	2100 - 2600	3100 - 3200
M35A	800 - 1000	2100 - 2600	3100 - 3200
M4-30A	800 - 1000	2000 - 2500	2900 - 3000

NOTE: Attempting to reduce idle speed below the minimum shown may produce unstable engine operation and stalling.

NOTE: The propeller should be either 2 or 3 blade. It should allow the engine to reach its maximum rated rpm at full open throttle underway in forward gear to ensure the availability of rated horsepower when needed.

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

THE DAILY ROUTINE

CHECK LIST

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

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

NOTE: Excessive loss of coolant indicates a cooling system leak. Check the entire system. If necessary, use a cooling system pressure tester to pressurize the cooling system to locate the area of leakage. In cases of excessive coolant loss, refill the system as outlined in the ENGINE COOLING CIRCUIT section in this manual.

START YOUR ENGINE

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

1. Put transmission in neutral, throttle advanced.
2. Turn KEY to the ON position (2 o'clock)
3. Depress PREHEAT (10 to 15 seconds).
4. While pressing PREHEAT, push START.
When engine starts - release START.
5. Hold PREHEAT until oil pressure reaches 15 psi and/or alarm shuts off.

NOTE: Should engine fail to start, wait 30 seconds, repeat the above procedure, and PREHEAT longer.

6. Allow a few minutes for the engine to warm at a comfortable rpm (approx. 1200 rpm), then reduce the rpm, shift into gear, and get underway.

CAUTION: When shifting the transmission, always reduce the engine rpm to idle, then shift the transmission firmly from one direction to another. A slight pause in neutral will allow the propeller to slow. Shifting at high rpm will damage the transmission/damper plate.

MAINTENANCE SCHEDULE

WARNING: Never attempt to perform any service while the engine is running. Wear the proper safety equipment such as goggles and gloves, and use the correct tools for each job. When servicing/replacing DC components, ensure the key switch in the instrument panel is in the OFF position or turn OFF the DC starting battery.

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

INSPECTION AND PREPARATION FOR INITIAL START-UP (Also refer to the PREPARATIONS for START-UP in the manual).



Coolant Level	Check at recovery tank, if empty, check at manifold. Add coolant if needed.
Engine Oil Level	Oil level should indicate between MAX and LOW on dipstick. Do not overfill!
Fuel Filter/Water Separator (owner installed)	The fuel in the filter should be clean and the valves open. Replace filter every 250 operating hours or once a year.
Fuel Supply	Fuel tank must have the proper amount of clean diesel fuel and the fuel valve must be open.
*Visual Inspection of Engine	Check for fuel, oil and water and exhaust leaks. Check that the water injected exhaust elbow securing v-clamp is tight. No exhaust leaks around the elbow. Inspect wiring and electrical connections. Look for loose bolts/hardware and correct as needed.
Transmission Fluid Level	Fluid level should be at the top mark on the dipstick.
Drive Belts	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed.

AFTER THE FIRST 50 HOURS OF OPERATION

*Inlet Fuel Filter	Initial change, then every 250 hours or once a year.
*Fuel Filter	Initial change, then every 250 hours or once a year.
Engine Oil and Filter	Initial engine oil and filter change at 50 hours, then change both every 250 hours.
*Exhaust System	Initial check at 50 hours, then every 250 hours or once a year. Carefully inspect for leaks. Check that the exhaust hoses are properly attached and that the securing clamps are tight. Check the integrity/mounting security of the water injected exhaust elbow.
Engine Idle Speed	Adjust as needed.
Transmission Fluid	Initial change, then at 300 hours or once a season.
Heat Exchanger	Open end caps and clean out debris. Change zinc anode if necessary. Determine zinc service interval for your area.

EVERY 50 OPERATING HOURS OR MONTHLY

*Drive Belts (Fresh Water/Raw Water Pumps as applicable)	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt for slipping, cracking and wear. Adjust tension or replace as needed. Replace cover.
Starting Batteries	Check electrolyte levels Make sure cables and connections are in good order. Clean off corrosion if needed. Apply petroleum jelly to terminals for corrosion protection.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.

EVERY 100 OPERATING HOURS OR YEARLY

Air Intake Filter	Remove and clean filter, replace if contaminated.
Heat Exchanger	Inspect and clean zinc anode. Note the condition, then determine your own schedule. If zinc anode needs replacing, you should remove the end cap and clean out the debris. Replace zinc if necessary.
Panel Key Switch	Lubricate with "lockze".
*Drive Belts (Fresh Water/Raw Water Pumps as applicable)	Inspect for proper tension (3/8" to 1/2" deflection) and adjust if needed. Check belt for slipping, cracking and wear. Adjust tension or replace as needed. Replace cover.
Starting Batteries	Check electrolyte levels Make sure cables and connections are in good order. Clean off corrosion if needed. Apply petroleum jelly to terminals for corrosion protection.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
Raw Water Pump	Inspect impeller, check drive shaft security. Inspect there is no shaft water or oil seal leaks.
Throttle and Transmission Cables	Check security of cables to brackets. Lubricate cables.

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

MAINTENANCE SCHEDULE

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

EVERY 250 OPERATING HOURS OR YEARLY

Transmission	Change fluid at 300 operating hours. Lubricate control cable and check attachment.
Engine Oil	Change the engine oil and oil filter (always together)
Fuel Filter and O-Rings	Remove and replace fuel filter and all sealing O-rings.
Inlet Fuel Filter	Remove and replace inlet fuel filter.
Air Intake Filter	Remove and clean, replace if contaminated.
DC Alternator	Check mounting bracket, tighten electrical connections.
Electric Fuel Pump	Inspect for leaks, ensure fuel and electrical connections are clean and tight.
*Vibration Isolators/Engine Mounts	Check vibration isolators, brackets and mounting hardware. Replace as needed.
Heat Exchanger	Inspect zinc anode replace if necessary.
*Exhaust Elbow/Exhaust System	Check the structural integrity of the water injected exhaust elbow casting. Check the integrity of the exhaust system attached to the elbow. All hose connections should be secure. No chaffing. No exhaust leaks. Hoses and muffler are in good serviceable condition. NOTE: An exhaust leak will cause exposure to diesel exhaust!

EVERY 500 OPERATING HOURS OR FIVE YEARS

*Fuel Injectors	Check and adjust injection opening pressure and spray conditions.
Coolant System	Drain, flush and re-fill the cooling system with appropriate antifreeze mix. Replace the thermostat and cooling pressure cap.
*Valve Clearances	Adjust valves. (Incorrect valve clearance will result in poor engine performance)
*Starter Motor	Check solenoid and motor for corrosion. Remove and lubricate. Clean and lubricate the starter motor pinion drive.
Raw Water Pump	Remove from engine, remove cover and inspect cam and wear plate. Replace any components showing wear. If needed, replace the impeller and gasket. Lubricate when re-assembling.
*Preheat Circuit	Check operation of the pre-heat. Remove and clean the glow plugs. Re-install with anti-seize compounds on threads.
*Engine/Shaft Alignment	Check security of the shaft coupling and check shaft alignment.

EVERY 1000 OPERATING HOURS OR OR EVERY FIVE YEARS

*Heat Exchanger	Remove the heat exchanger for professional cleaning and pressure testing. Change the antifreeze and flush the system.
*Adjusting the Valve Clearances	Adjust the valves.
*Positive Crankcase Ventilation Valve	Disassemble and clean.
*Fuel Injectors	Pressure test injectors/re-build at 1500 hours.
*Transmission Oil Cooler	Remove, inspect casting, clean and replace as needed.
*Transmission Damper Plate	Inspect the damper plate, replace if necessary (damper plate chatter at idle speed is an indication of damper spring wear).

WARNING: Never attempt to perform any service while the unit is operating. Wear the proper safety equipment such as goggles and gloves, and use the correct tools for each type of maintenance performed. Shut OFF the control panel's DC breaker when servicing any of the engines DC electrical components.

NOTE: Keep the engine surface clean. Dirt and oil will inhibit the engine's ability to remain cool.

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



ENGINE COOLING CIRCUIT

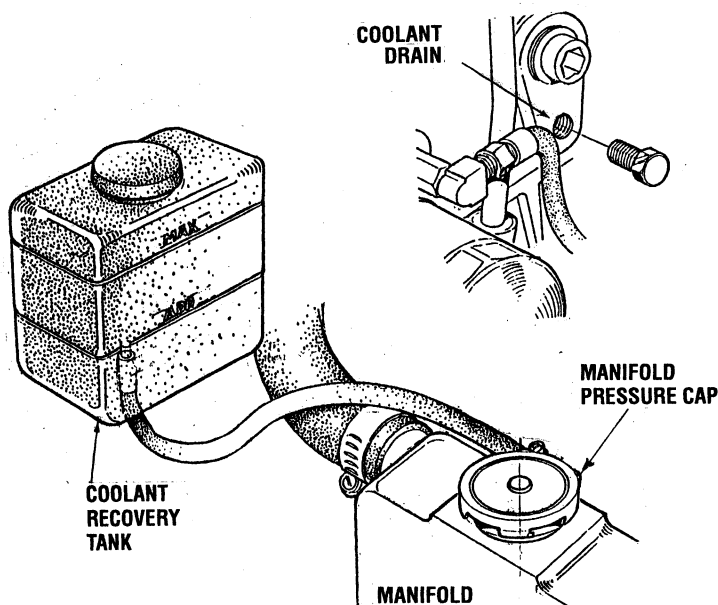
DESCRIPTION

The engine is fresh water cooled (engine coolant) by an engine-mounted heat exchanger. Raw water is pumped through the heat exchanger by a gear-driven, positive displacement impeller pump. After the raw water cools the engine coolant in the heat exchanger, it mixes with the engine's exhaust gases, cools the exhaust gases, and discharges overboard.

The engine's coolant is circulated by a belt-driven centrifugal-type metal impeller pump mounted on the front of the engine. The engine's coolant temperature is thermostatically controlled.

The engine's coolant must be changed according to the maintenance schedule in this manual. If the coolant is allowed to become contaminated, it can lead to overheating problems.

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



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

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

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

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

To Refill With Coolant

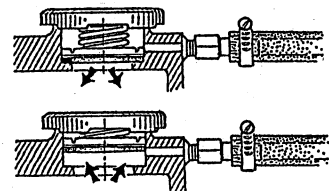
With the engine running in idle, slowly pour clean premixed coolant into the manifold.

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

Monitor the coolant in the manifold and add as needed. Fill the manifold to the filler neck and install the pressure cap. The petcock on the thermostat should also be opened when refilling to allow trapped air to escape.

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

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

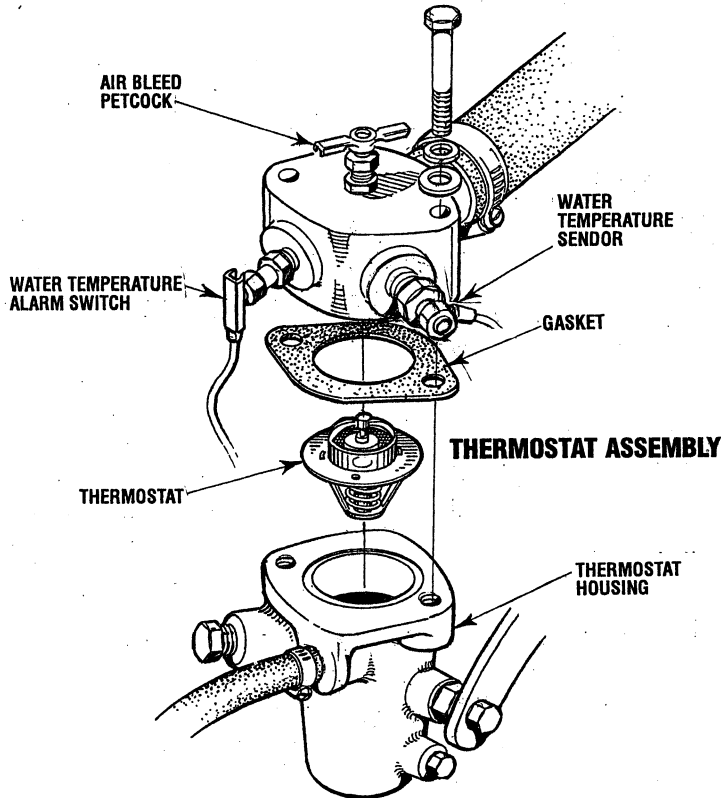


NOTE: Periodically check the condition of the pressure cap. Ensure that the upper and lower rubber seals are in good condition and check that the vacuum valve opens and closes tightly. Carry a spare cap.

ENGINE COOLING CIRCUIT

THERMOSTAT

A thermostat, located near the manifold at the front of the engine, controls the coolant temperature as it continuously flows through the closed cooling circuit. When the engine is first started the closed thermostat prevents coolant from flowing (some coolant is by-passed through a hole in the thermostat to prevent the exhaust manifold from overheating). As the engine warms up the thermostat gradually opens. The thermostat is accessible and can be checked, cleaned, or replaced easily. Carry a spare thermostat and gasket.

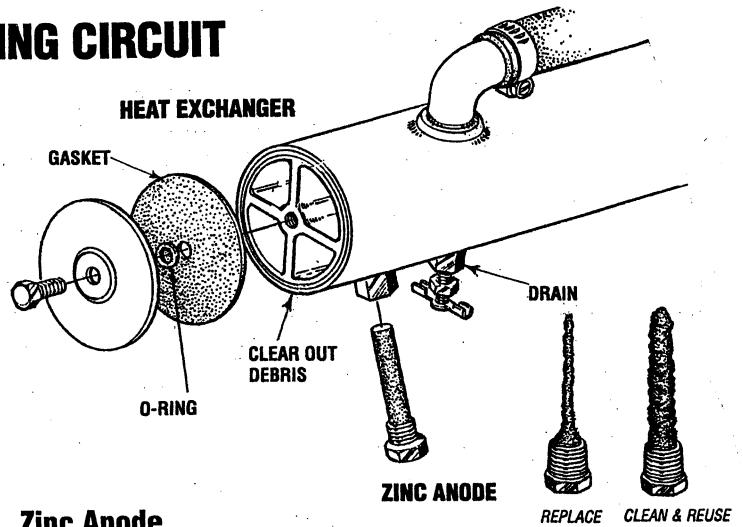


To Replace the Thermostat

Remove the two cap screws and disassemble as illustrated. When assembling the new thermostat and gasket put a thin coat of sealant on both sides of the gasket before pressing in place. Run the engine and check for normal temperatures and that there are no leaks at the thermostat housing.

Heat Exchanger

The heat exchanger is a copper tube which encloses a number of small copper tubes. Raw water is pumped through the small copper tubes and the freshwater coolant from the engine is circulated around the copper tubes. The raw water removes heat from the freshwater coolant. To keep the heat exchanger operating efficiently, it should be removed from the engine every 1000 hours to be thoroughly cleaned and pressure tested.



Zinc Anode

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

RAW WATER INTAKE STRAINER

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

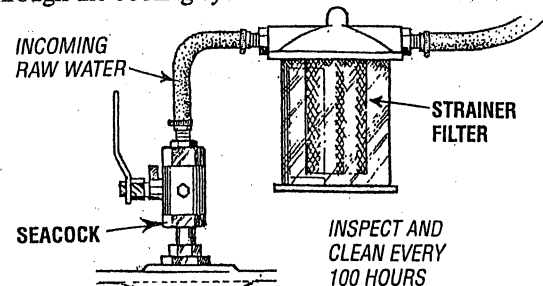
A clean raw water intake strainer is a vital component of the engine's cooling system. Include a visual inspection of this strainer when making your periodic engine check. The water in the glass should be clear.

Perform the following maintenance after every 100 hours of operation:

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

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

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



TYPICAL RAW WATER INTAKE STRAINER
(OWNER INSTALLED)

ENGINE COOLING CIRCUIT

RAW WATER COOLING CIRCUIT

The raw water flow is created by a positive displacement impeller pump. This pump draws water directly from the ocean, lake, or river from a through-hull opening through a hose to the water strainer. The raw water passes from the strainer through the pump to a heat exchanger (through the heat exchanger tubes) where it cools the engine's circulating fresh water coolant. The raw water is then discharged into the water injected exhaust elbow, mixing with, and cooling the exhaust gasses. This mixture of exhaust gas and raw water is driven through the stern tube and overboard.

Raw Water Pump

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

Changing the Raw Water Impeller

1. Close the raw water intake.
2. Remove the inlet and outlet port hoses from the pump, noting the port location and positioning.
3. Remove the pump assembly and its gasket from the engine.
4. Remove the three hex head screws that hold the housing to the cover.
5. Remove the impeller cover exposing the impeller.
6. Pull the impeller off the shaft. Observe that the key on the shaft is not lost.

7. Check the cam and inner wear plate for wear. Replace as needed.

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

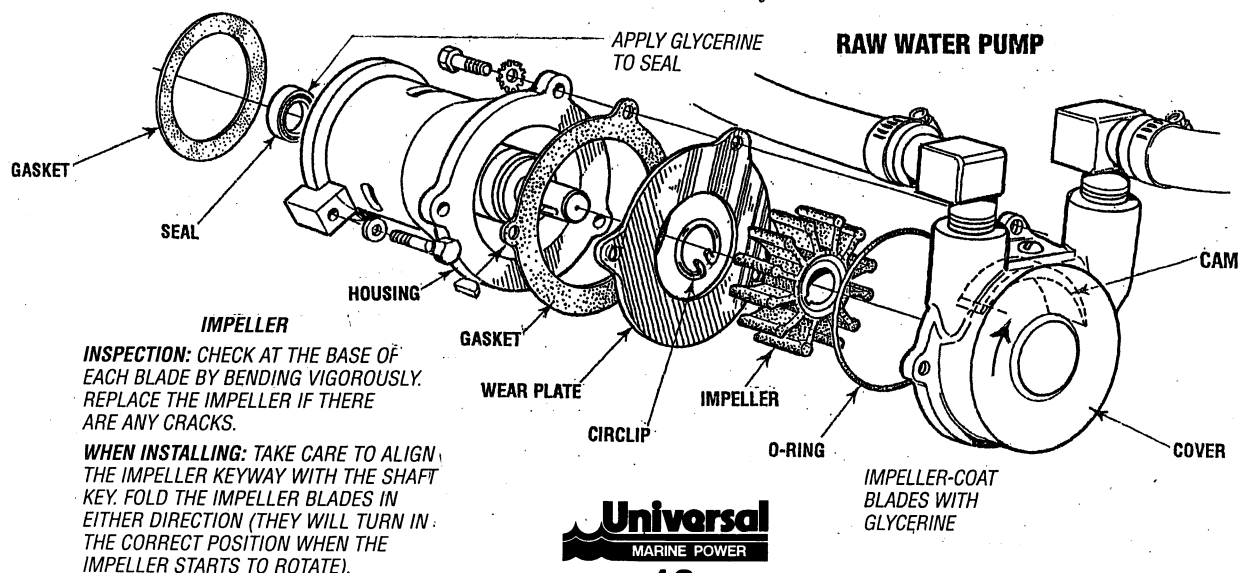
8. Slide the new impeller onto the shaft taking care to engage the impellers slot with the key on the shaft.
9. Apply a film of petroleum jelly or silicone to the inner surface of the impeller housing.

NOTE: Just coat the surface, do not over apply.

10. Install the sealing O-ring in the impeller cover. Position the gasket and wear plate and install the impeller housing and secure in position with the 3 retaining bolts and washers.
11. Mount the pump to the engine taking care that the end seal and gasket are in place. Do not tighten the pump mounting screws, just finger tight.
12. Reassemble the hose connections and open the raw water intake.
13. Crank the engine a few revolutions to allow the pump to center on its drive slot.
14. Stop cranking and secure the pump to the gear case.
15. Start and run the engine, check for leaks and check for a normal operating temperature.

NOTE: Should a failure occur with the pumps internal parts (seals and bearings) it may be more cost efficient to purchase a new pump. The price of individual parts would almost match the price of a new pump.

NOTE: Keep the slotted weep holes in the pump housing clear and open. Water found coming from these openings indicates a shaft seal leak and must be attended to without delay.



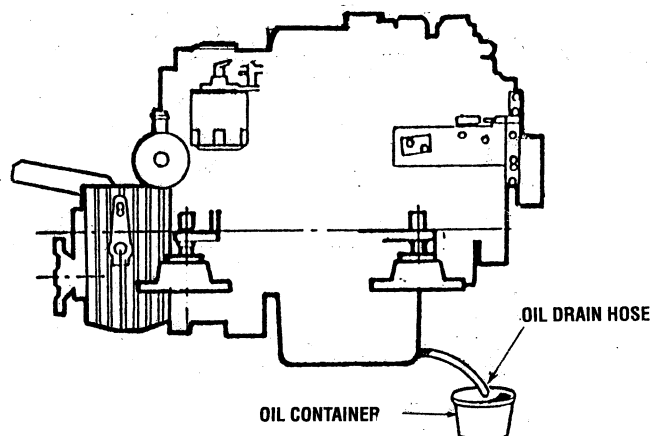
ENGINE OIL CHANGE

DRAIN THE SUMP

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

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

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic if water is present in the oil. Raw water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning of raw water through the raw water cooling circuit into the exhaust, filling the engine. This problem is often caused by the poor location or the lack of an anti-siphon valve. See UNIVERSAL'S Installation Manual.

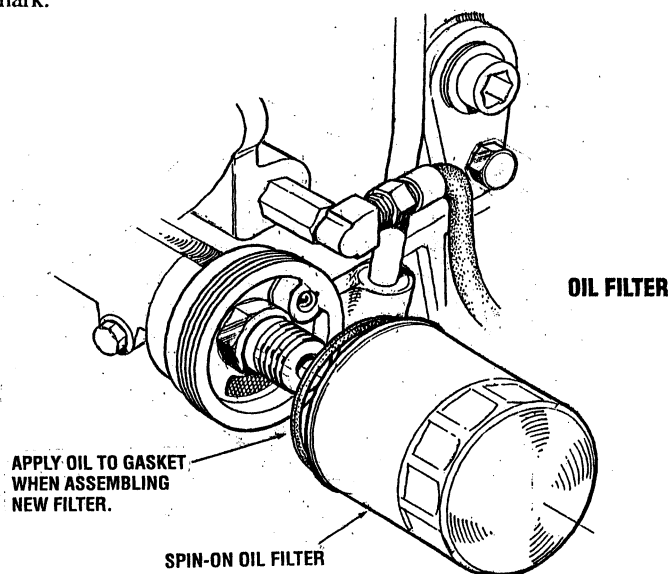


⚠ WARNING: Used engine oil contains harmful contaminants. Avoid prolonged skin contact. Clean skin and nails thoroughly using soap and water. Launder or discard clothing or rags containing used oil. Discard used oil properly.

Replacing the Oil Filter

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

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine model. (Refer to the SPECIFICATIONS section of this manual for amount, SAE Viscosity Grade and API Service Category). Run the engine and check for proper oil pressure and make sure there are not leaks. Stop the engine, check oil level and add oil as needed to bring level to dipstick full mark.



NOTE: Use genuine UNIVERSAL oil filters - generic filters are not recommended.

REMOTE OIL FILTER

PART NO. 040078

INSTALLATION

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

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

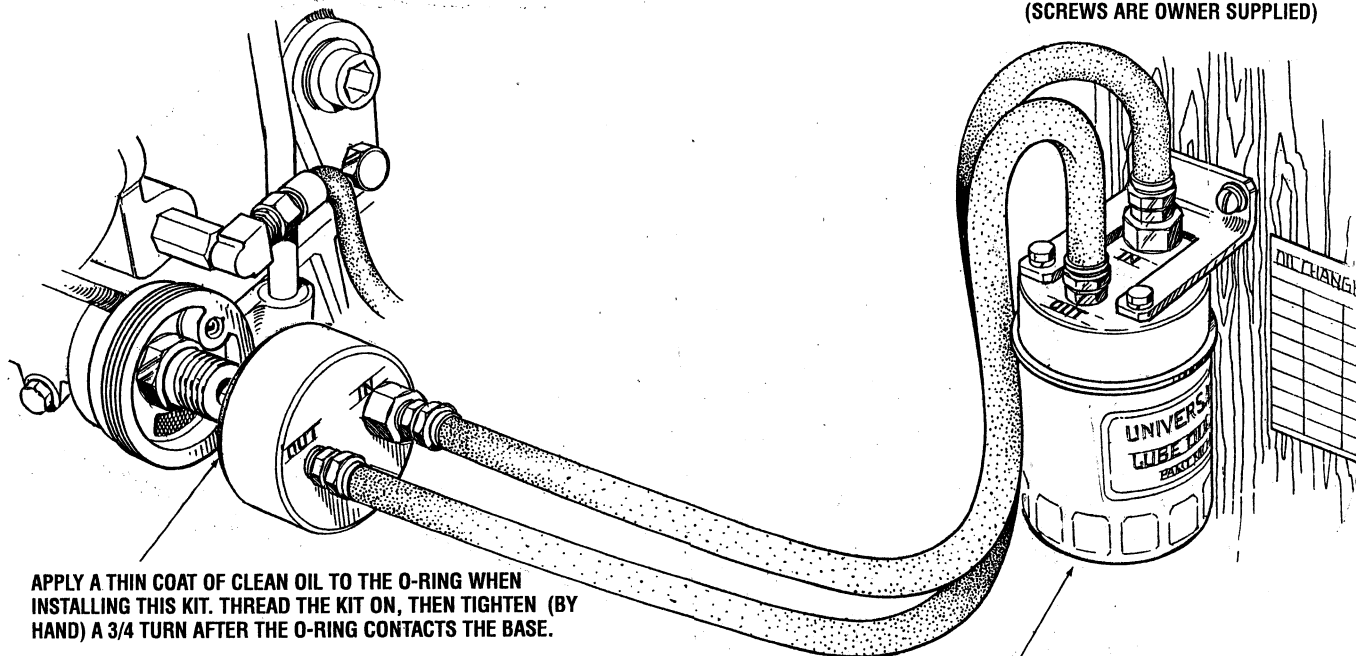
To install, simply remove the engine oil filter and thread on UNIVERSAL's remote oil filter kit as shown.

Always install this kit with the oil filter facing down as illustrated.

Contact your UNIVERSAL/WESTERBEKE dealer for more information.

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

FASTEN SECURELY TO A BULKHEAD
(SCREWS ARE OWNER SUPPLIED)



APPLY A THIN COAT OF CLEAN OIL TO THE O-RING WHEN INSTALLING THIS KIT. THREAD THE KIT ON, THEN TIGHTEN (BY HAND) A 3/4 TURN AFTER THE O-RING CONTACTS THE BASE.

APPLY A THIN COAT OF CLEAN OIL TO THE FILTER GASKET WHEN INSTALLING. ONCE THE FILTER CONTACTS THE BASE, TIGHTEN IT A 3/4 TURN.

FUEL SYSTEM

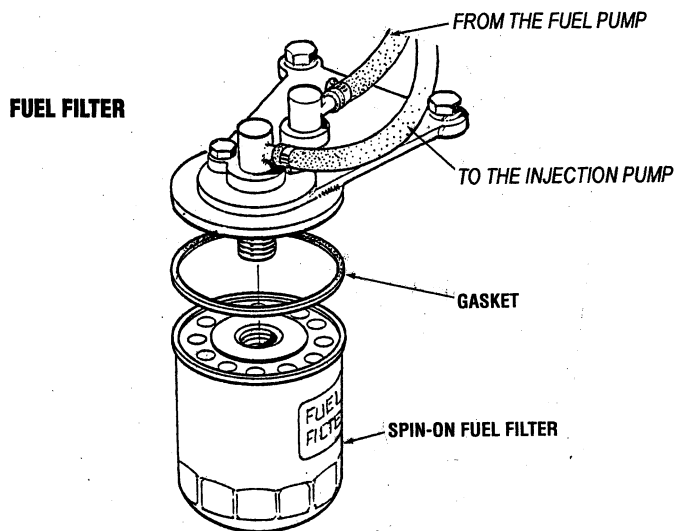
⚠ WARNING: Shut off the fuel valve at the tank when servicing the fuel system. Take care in catching any fuel that may spill. DO NOT allow any smoking, open flames or other sources of fire near the fuel system when servicing. Ensure proper ventilation exists when servicing the fuel system.

FUEL FILTERS

The fuel injection pump and the fuel injectors are precisely manufactured and they must receive clean diesel fuel, free from water and dirt. To ensure this flow of clean fuel, the fuel must pass through at least two fuel filters, a fuel/water separator and the engine's spin-on fuel filter. Visually inspect, clean, and change these filters according to the maintenance schedule in this manual.

1. Shut fuel supply off.
2. Loosen the fuel filter, turning counterclockwise with a filter wrench.
3. Using a rag, wipe clean the sealing face on the housing bracket so the new filter can be seated properly.
4. Lightly oil the sealing O-ring on the new filter. To reinstall, turn the filter assembly clockwise carefully until the O-ring contacts the sealing surface of the housing bracket. Turn 2/3 further with the filter wrench.
5. Turn on the fuel and start the engine. The normal preheat function should quickly prime the system and the engine should start.

NOTE: The cartridge contains fuel. Take care not to spill it, during disassembly. Perform the PRIMING THE FUEL SYSTEM after replacing the spin-on filter.

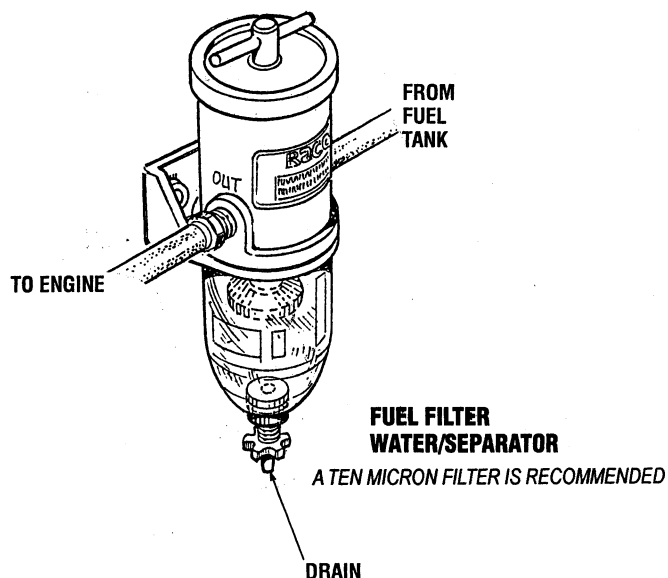


FUEL WATER SEPARATOR

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

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

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



FUEL SYSTEM

FUEL ADDITIVES

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

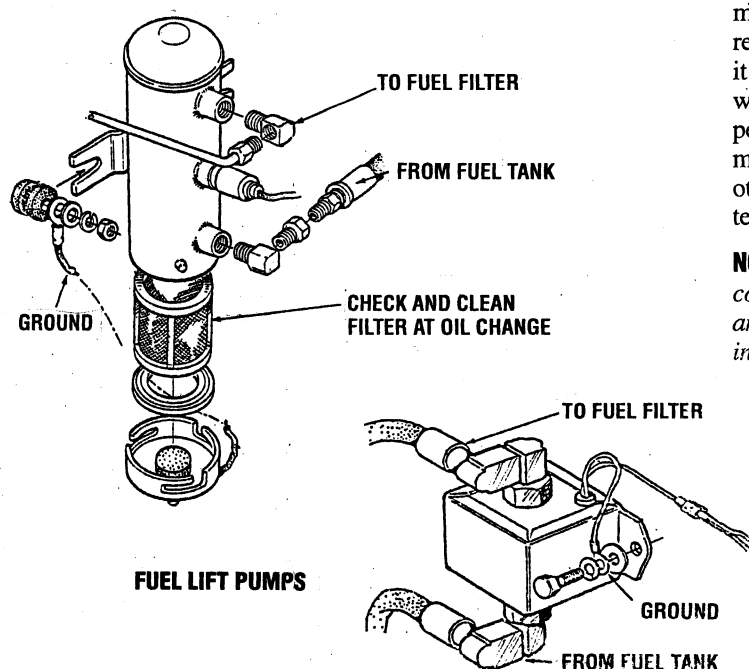
SPARES

While the likelihood of having to service the fuel system at sea is slim, the possibility does exist. Therefore, we recommend that banjo washers, injector seat washers, and a fuel filter be carried on board at all times. Purchase needed spares from your local UNIVERSAL dealer or distributor. If a leak should develop at a banjo washer that cannot be corrected by a simple tightening of the fitting, replace the sealing washer.

PRIMING (BLEEDING) THE FUEL SYSTEM

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

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

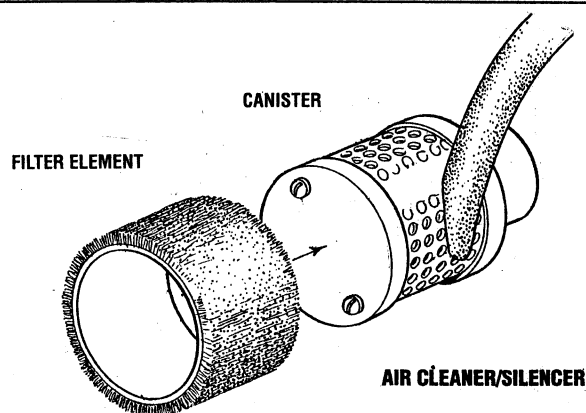


If it becomes necessary to bleed air from the system, use the following procedure:

Loosen all the nuts attaching the high pressure injector lines to each injector. Open throttle full and crank engine with the starter. Once fuel spurts from the loosened lines, stop and tighten the attaching nuts and start the engine as normal.

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

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



Air Cleaner/Silencer

Some UNIVERSAL engines use a replaceable air filter element wrapped around a metal canister. This element can be removed and brushed off or cleaned with an air hose. When it becomes too contaminated it can be replaced. The canister with its interior element should also be removed and cleaned periodically. Simply wash the assembled unit in a non-flammable cleaning solvent. Use this same cleaning procedure for other UNIVERSAL air cleaners that use a similar type canister.

NOTE: To operate efficiently a diesel engine must intake a continuous volume of clear air. Hard starting, an erratic idle, and black exhaust smoke are all symptoms of a restricted air intake.

DC ELECTRICAL SYSTEM

DESCRIPTION

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

Alternator Troubleshooting

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

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

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

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

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

Checking for Proper Voltage

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

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

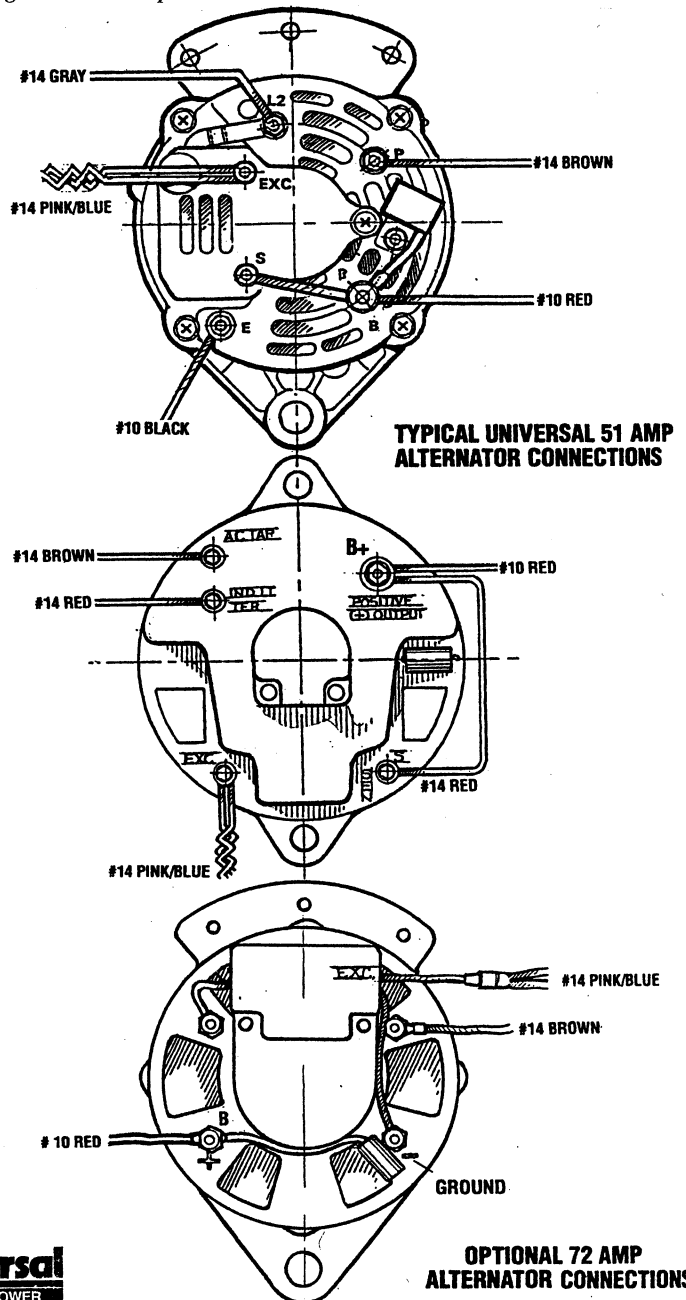
⚠ CAUTION: To avoid damage to the battery charging circuit, never shut off the engine battery switch when the engine is running!

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

5. Start the engine.

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

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



DC ELECTRICAL SYSTEM

ENGINE 12 VOLT DC CONTROL CIRCUIT

The engine has a 12 volt DC electrical control circuit that is shown on the wiring diagrams that follow. Refer to these diagrams when troubleshooting or when servicing the DC electrical system on the engine.

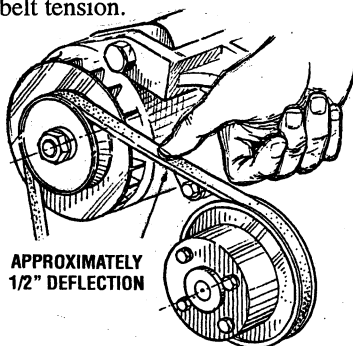
DRIVE BELT ADJUSTMENT

⚠ CAUTION: Drive belts must be properly tensioned. Loose drive belts will not provide proper alternator charging and will eventually damage the alternator. Drive belts that are too tight will pull the alternator out of alignment and/or cause the alternator to wear out prematurely.

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

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

BELT TENSION



BATTERY CARE

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

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

⚠ WARNING: Sulfuric acid in lead batteries can cause severe burns on skin and damage clothing. Wear protective gear.

⚠ CAUTION: When quick charging the battery with an external charger, be sure to disconnect the battery cables from the battery so the quick charge doesn't damage the alternator diodes.

GLOW PLUGS

The glow plug is a small heater installed in each pre-combustion chamber. They run off the engine starting battery and become red hot when activated.

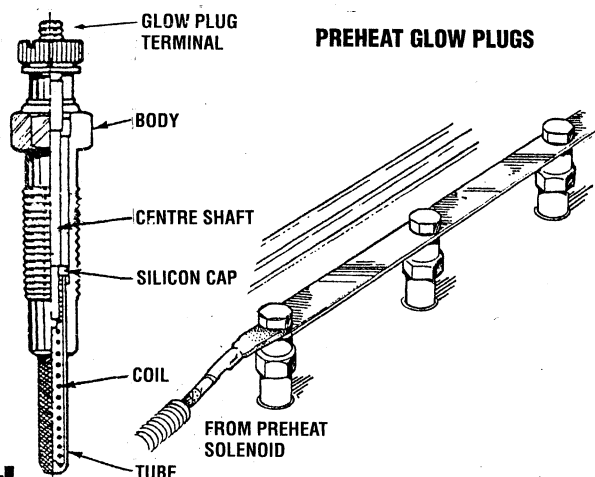
The glow plugs are wired through the preheat solenoid. When preheat is pressed at the control panel this solenoid should "click" on and the glow plug terminal should begin to get hot.

Glow plugs can be checked by unscrewing and holding them against a good ground (engine block) and turning them on. The tip should glow red hot. You can also use an ammeter to test the power drain (8 to 9 amps per plug); or an ohmmeter to test resistance (1.1 to 1.2 ohms).

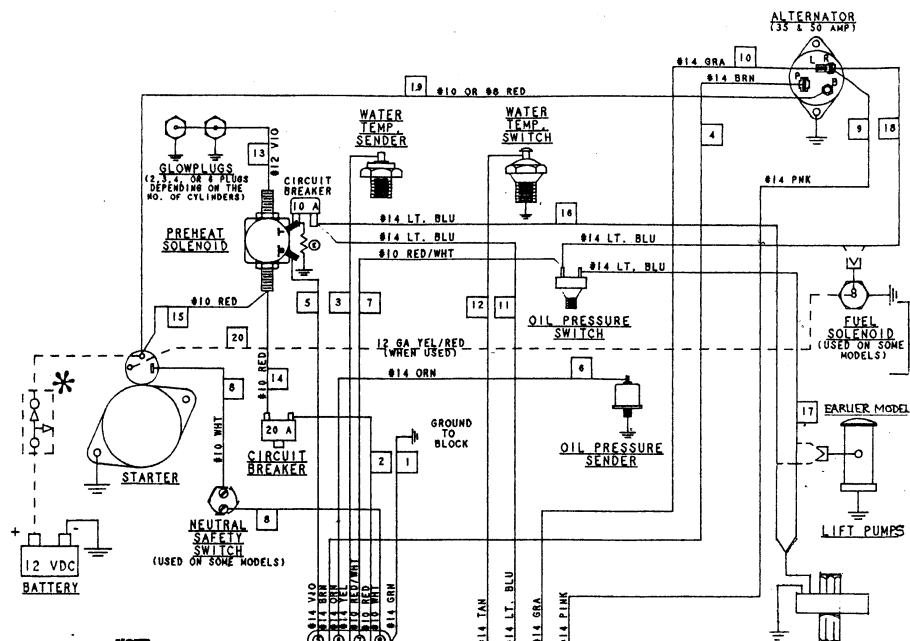
⚠ WARNING: These glow plugs will become very hot to the touch. Be careful not to burn your fingers when testing plugs.

Re-install the plugs in the engine and test them again. The plugs should get very hot (at the terminal end) with 20 to 25 seconds. If the plugs don't heat up quickly, check for a short circuit.

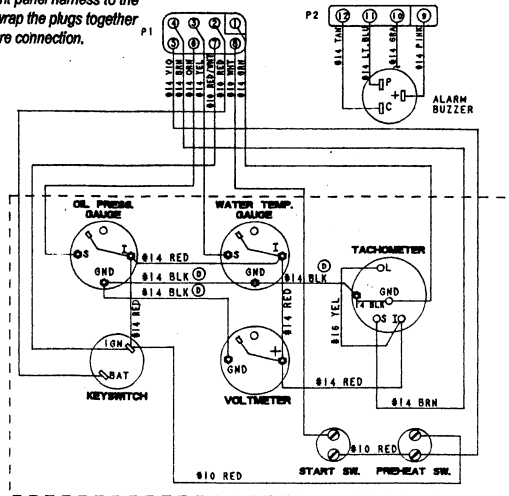
⚠ CAUTION: Do not keep glow plug on for more than 30 seconds.



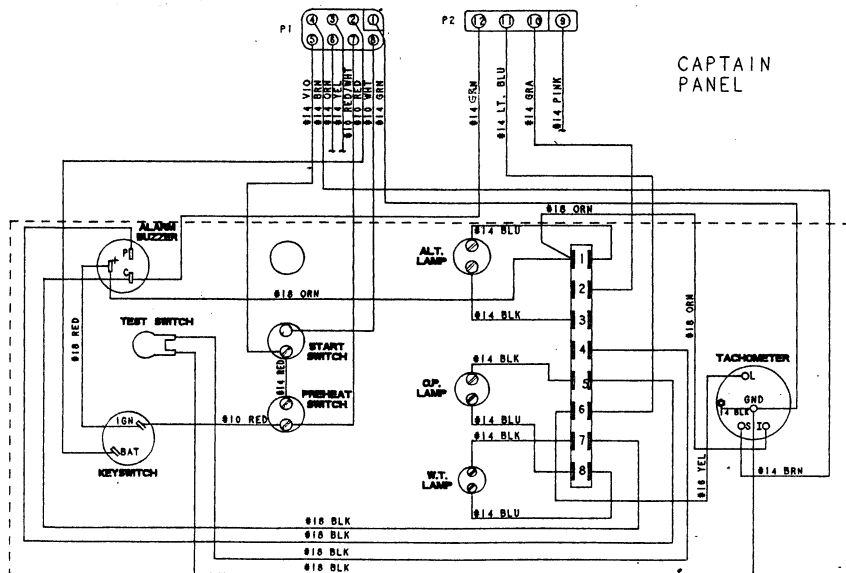
DC ELECTRICAL SYSTEM WIRING DIAGRAM #39144



NOTE:
Use di-electric grease on the wiring connections when mating the instrument panel harness to the engine harness. Then ty-wrap the plugs together to ensure a tight and secure connection.



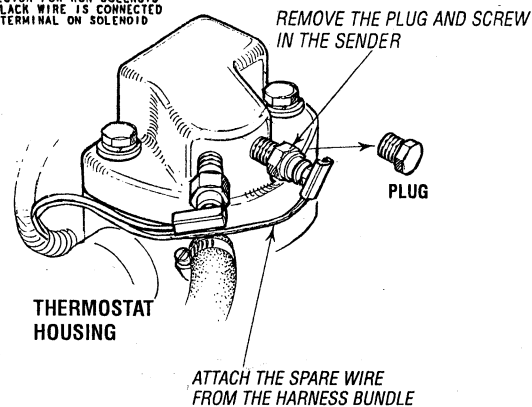
ADMIRAL PANEL



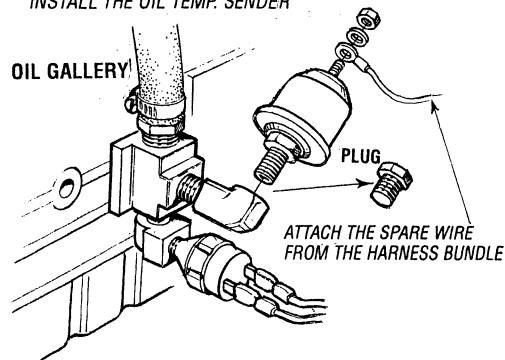
CAPTAIN PANEL

These diagrams illustrate the 12 volt negative ground electrical circuit. The two optional instrument panels, the CAPTAIN PANEL and the ADMIRAL PANEL are diagramed below.

When an ADMIRAL PANEL is installed, two additional instrument senders are assembled to the engine to provide data for the panel gauges (refer to the illustrations below).

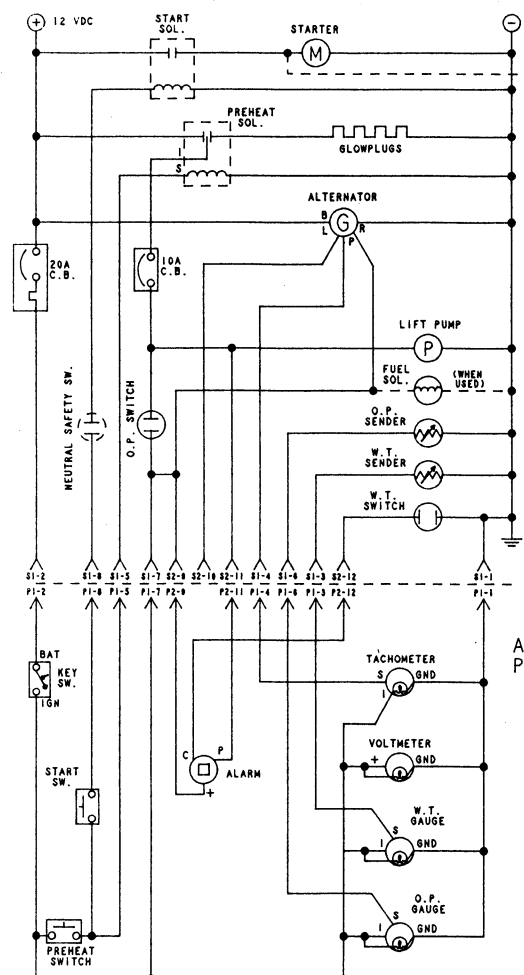


REMOVE THE PLUG AND INSTALL THE OIL TEMP. SENDER

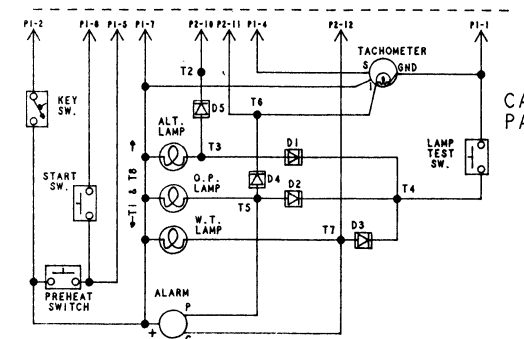


*An on-off switch should be installed between the battery and the starter to disconnect the battery in an emergency and when leaving the boat. A switch with a continuous rating of 175 amps at 12 volts will serve the function. This switch should not be used to make or break this circuit.

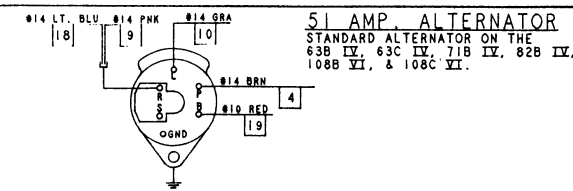
DC ELECTRICAL SYSTEM WIRING SCHEMATIC #39144



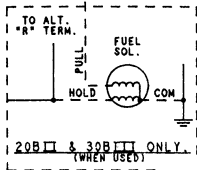
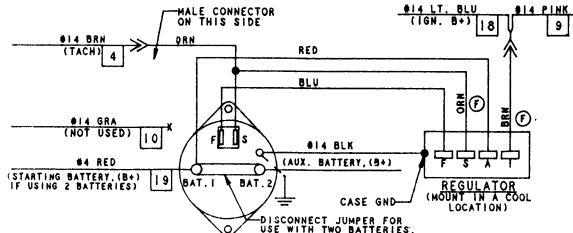
ADMIRAL PANEL



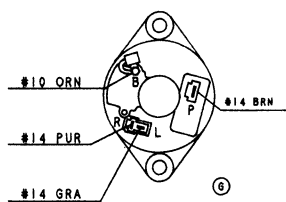
CAPTAIN PANEL



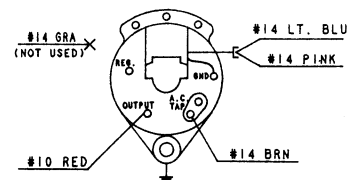
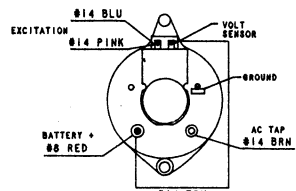
51 AMP. ALTERNATOR
STANDARD ALTERNATOR ON THE
63B IV, 63C IV, 71B IV, 82B IV,
108B VI, & 108C VI.



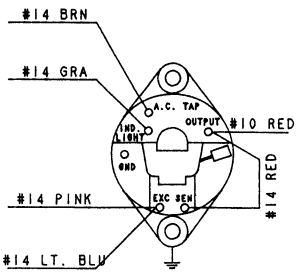
MITSUBISHI 50 AMP. ALT.



PRESTOLITE LEECE-NEVILLE 90 AMP. ALT.



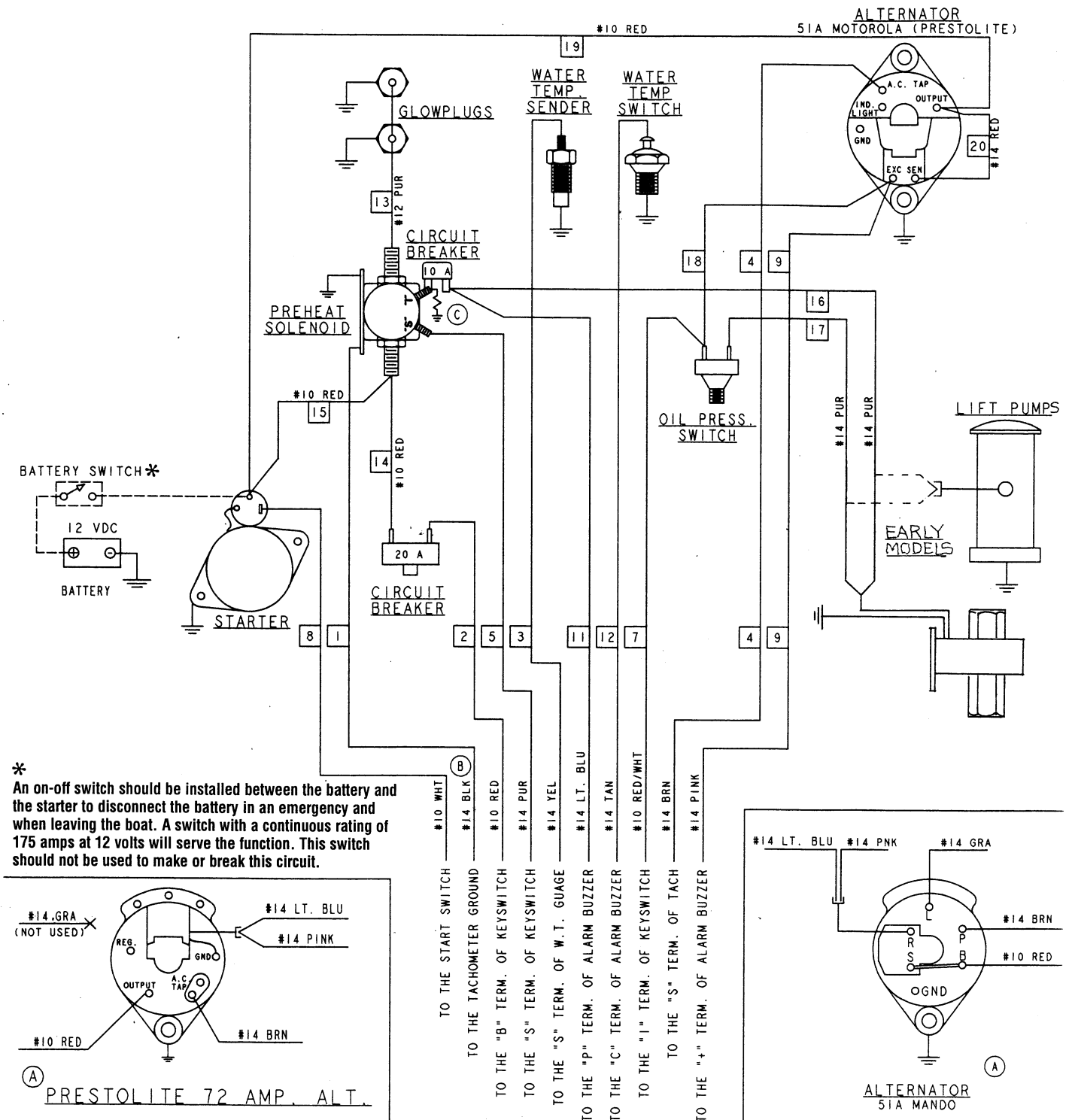
PRESTOLITE 72 AMP. ALT.



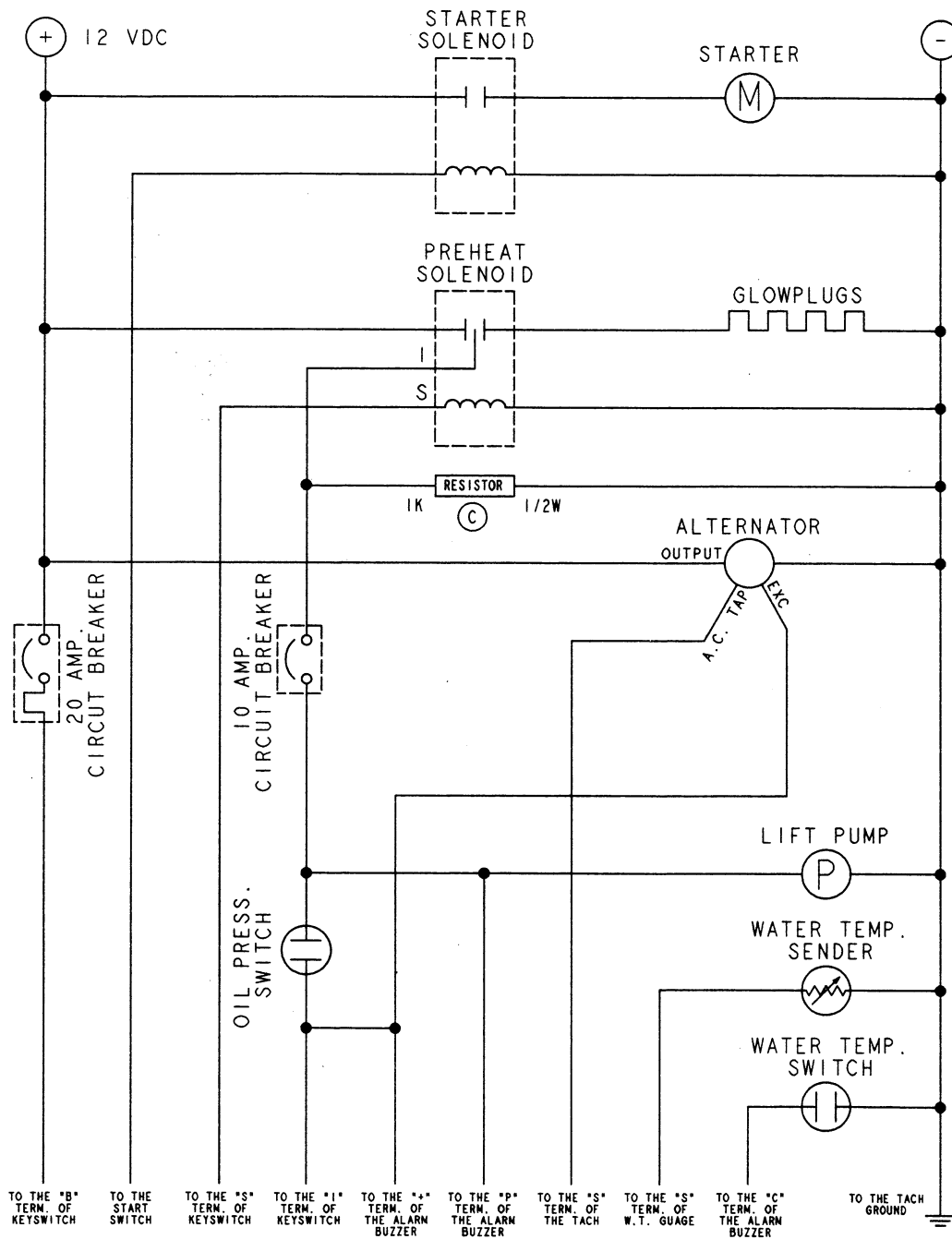
UNIVERSAL PROPULSION
PRESTOLITE 51 AMP. ALT.



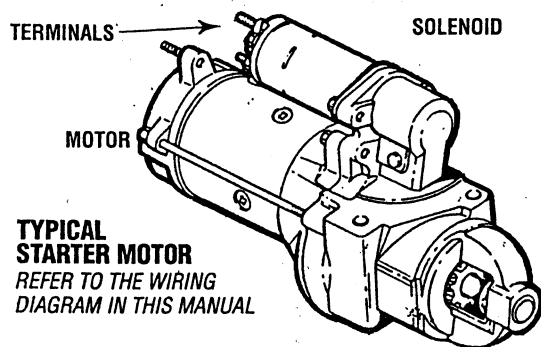
WIRING DIAGRAM CATALINA YACHTS #200360



WIRING SCHEMATIC CATALINA YACHTS #200360



STARTER MOTOR



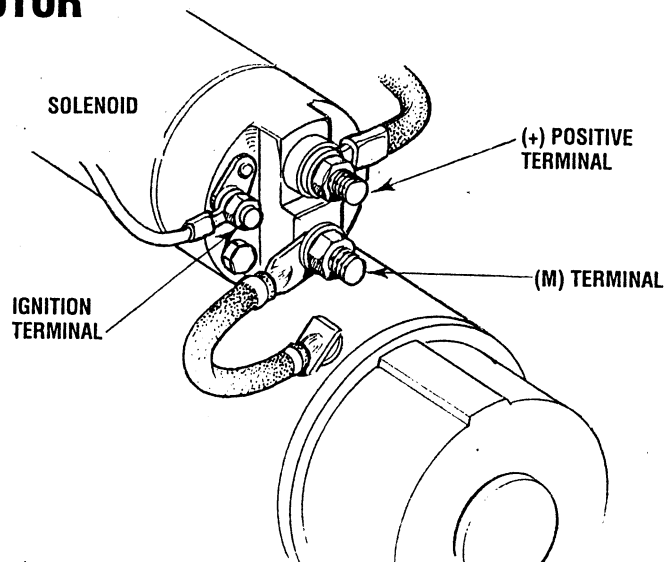
TROUBLESHOOTING TESTING WITH A SCREWDRIVER

Prior to testing, make certain the ship's batteries are at full charge and that the starting system wiring connections (terminals) are clean and tight. Pay particular attention to the ground wire connections on the engine block.

To check the wiring, try cranking the starter for a few seconds, never more than 10 seconds at a time, then run your hand along the wires and terminals looking for warm spots that indicate resistance. Repair or replace any trouble spots.

Using a multimeter, test the voltage between the positive terminal stud on the start solenoid and the engine block (ground).

If you read 12 volts, the starter is faulty.

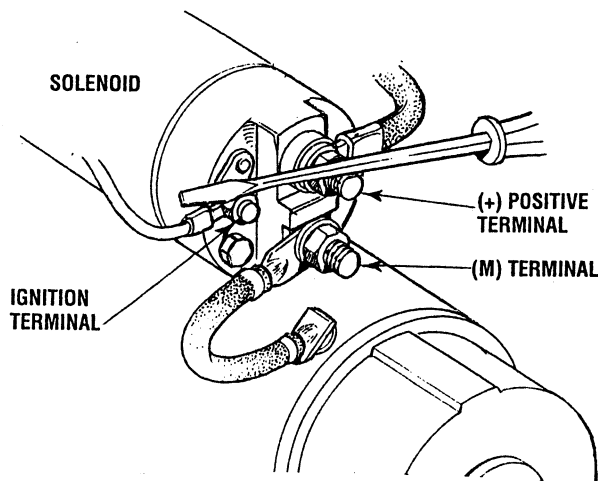


To test the ignition circuit, locate the ignition(s) terminal (it is one of the small terminal studs and is wired to the ignition circuit). Use a screwdriver, don't touch the blade, to jump from that ignition terminal to the positive battery connection terminal on the solenoid.

If the starter cranks, the fault lies with the ignition circuit.

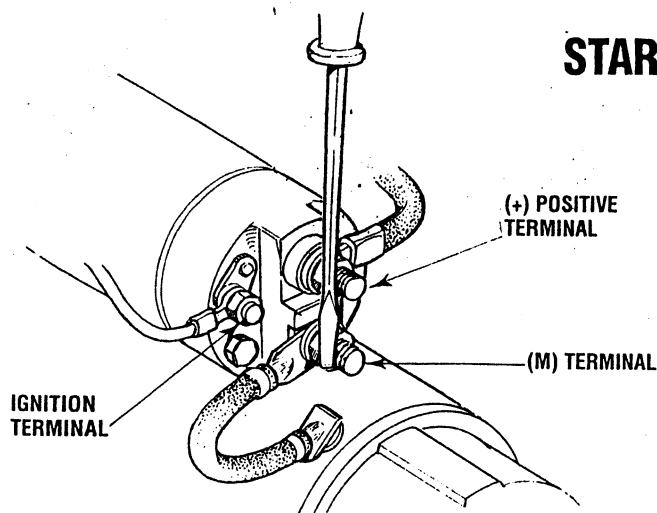
If the solenoid clicks but nothing else happens, the starter motor is probably faulty.

⚠ WARNING: *There will be arcing and sparks will fly when jumping terminals. Be certain the engine space is free of potentially explosive fumes, especially gasoline.*



If nothing at all happens the solenoid isn't getting current. Check the battery isolation switch and inspect the wiring connections. It is also possible that the solenoid is defective.

STARTER MOTOR



Test again by jumping the two large terminal studs. Hold the screwdriver blade firmly between the studs. Do not allow the screwdriver blade to touch the solenoid or starter casing, this would cause a short.

⚠ WARNING: *There will be arcing as the full starting current should be flowing thru the blade of the screwdriver.*

If the starter spins, the solenoid is faulty.

If the starter fails to spin, the motor is probably faulty.

If no arcing occurred, there is no voltage reaching the solenoid.

NOTE: *Starter motors are either inertia type or pre-engaged. In the pre-engaged model, the solenoid also moves an arm that engages the starter motor to the flywheel of the engine. Using a screwdriver to bypass the solenoid on such a starter will run the motor without engaging the flywheel. Turn the battery switch on to provide the power to the solenoid. Hopefully it will create enough magnetic field for the arm to move even though the contacts inside the solenoid are bad.*

SERVICE

If replacing the starter motor, make certain the new motor is certified for marine use. Automotive starters do not meet USCG standards. If in doubt, contact your UNIVERSAL dealer.

TO REMOVE FOR SERVICE

1. Turn off the DC battery switch.
2. If necessary, remove any components to gain full access to the starter motor.
3. Label and disconnect the wiring from the starter. (Do not allow wires to touch, tape over the terminals).
4. Remove the starter mounting bolts.
5. Remove the starter from the engine. In some cases the starter will have to be turned to a different angle to clear obstructions,

TROUBLESHOOTING WATER TEMPERATURE AND OIL PRESSURE GAUGES

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

Assuming that there is 12 volts as required, leave the instrument panel energized (key switch on) and perform the following steps:

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

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

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

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

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

STARTER MOTOR

DESCRIPTION

The starter can be roughly divided into the following sections:

- A motor section which generates a drive power.
- An overrunning clutch section which transmits an armature torque, preventing motor overrun after starting.
- A switch section (solenoid) which is operated when actuating the overrunning clutch through a lever and which supplies load current to the motor.

The starter is a new type, small, light-weight and is called a high-speed internal-reduction starter. The pinion shaft is separate from the motor shaft; the pinion slides only on the pinion shaft. A reduction gear is installed between the motor shaft and a pinion shaft. The pinion sliding part is not exposed outside the starter so that the pinion may slide smoothly without becoming fouled with dust and grease. The motor shaft is supported at both ends on ball bearings. The lever mechanism, switch and overrunning clutch inner circuit are identical to conventional ones.

ADJUSTMENT AND REPAIR

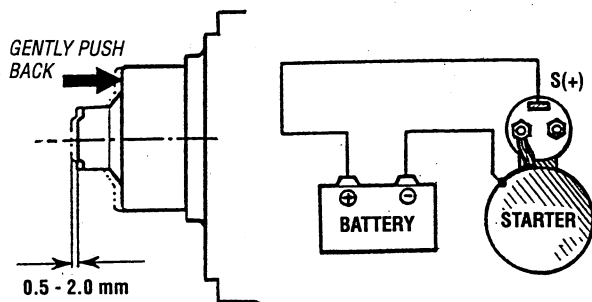
If any abnormality is found by the following tests, the starter should be disassembled and repaired.

Pinion Gap Inspection

1. Connect a battery (12V) between the starter terminal S and the starter body, and the pinion drive should rotate out and stop.

CAUTION: Never apply battery voltage for over 10 seconds continuously.

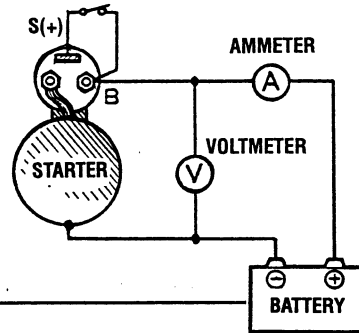
2. Lightly push the pinion back and measure the return stroke (called pinion gap).
3. If the pinion gap is not within the standard range, (0.5 to 2.0 mm), adjust it by increasing or decreasing the number of shims on the solenoid. The gap is decreased as the number of shims increases.



PINION GAP

No-Load Test

1. Connect the ammeter, voltmeter, and battery to the starter as illustrated.
2. When the switch is closed, the pinion must protrude and the starter must run smoothly (at 3000 rpm or more). If the current or starter speed is out of specification, disassemble the starter and repair it.

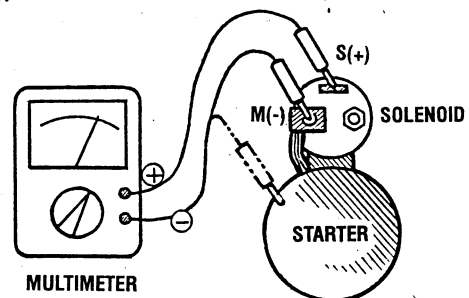


CAUTION: Use thick wires as much as possible and tighten every terminal securely. This is a solenoid shift-type starter which makes a rotating sound louder than that of a direct-drive type starter. When detecting starter rotation at the pinion tip, be careful not to come in contact with the pinion gear when it protrudes.

SOLENOID

Perform the following tests. If any test result is not satisfactory, replace the solenoid assembly.

1. Inspect the solenoid for continuity between terminals (+) and (-) and between terminals S and the body and M and the body. There should be no continuity found between terminals S and M. Continuity will be found between terminals S and the body and terminal M and the body.

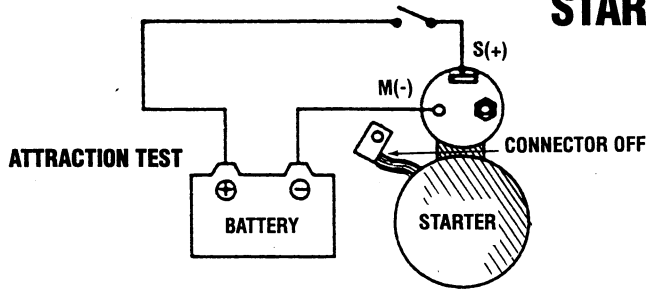


NOTE: Disconnect the wire from terminal M.

2. Connect a battery to the solenoid's terminal S for (+) and M for (-). Have a switch in the + lead and close it. The pinion drive should extend fully out.

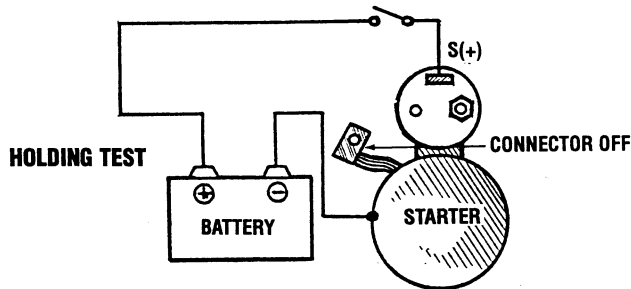
CAUTION: Do not apply battery current for more than 10 seconds when testing the solenoid.

STARTER MOTOR



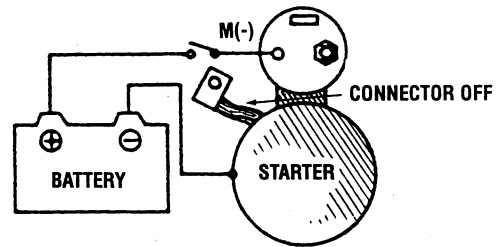
ATTRACTION TEST

3. *Holding test.* With a battery connected to the solenoid terminal S (+) and to the starter body, manually pull out the pinion fully. The pinion must remain at that position even when released from holding with your hand.



HOLDING TEST

4. *Return test:* With a battery connected to the solenoid terminal M (-) and to the starter body, manually pull out the pinion fully. The pinion must return to its original position when released from holding by hand.

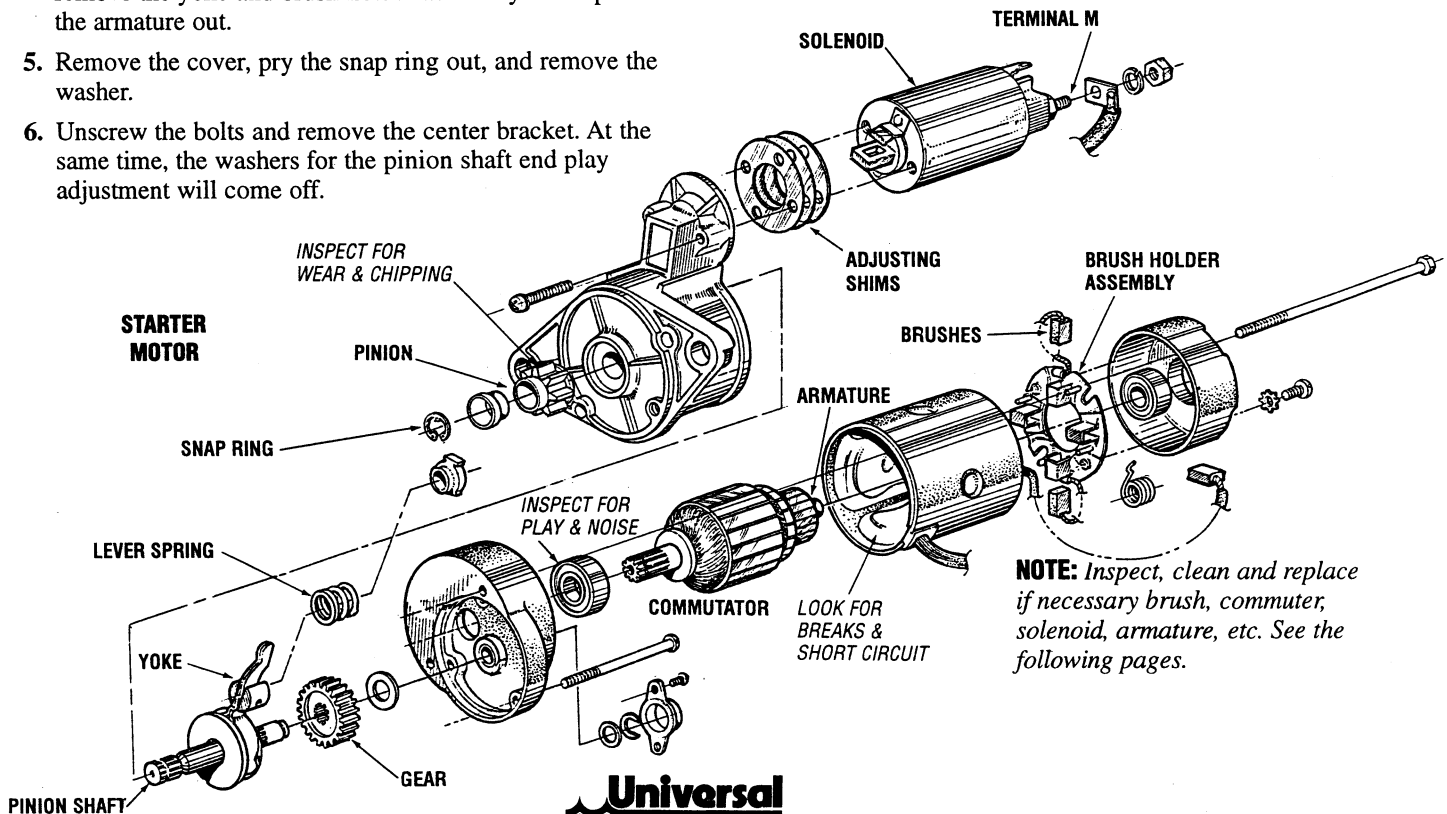


RETURN TEST

STARTER DISASSEMBLY

1. Disconnect the wire from the solenoid terminal M (-).
2. Loosen the two screws fastening the solenoid. Remove the solenoid assembly.
3. Remove the two long through bolts and two screws fastening the brush holder. Remove the rear bracket.
4. With the brushes pulled away from the armature, remove the yoke and brush holder assembly. Then pull the armature out.
5. Remove the cover, pry the snap ring out, and remove the washer.
6. Unscrew the bolts and remove the center bracket. At the same time, the washers for the pinion shaft end play adjustment will come off.

7. Pull out the reduction gear lever and lever spring from the front bracket.
8. On the pinion side, pry the snap ring out, and pull out the pinion and pinion shaft.
9. At each end of the armature, remove the ball bearing with a bearing puller. It is impossible to replace the ball bearing press-fitted in the front bracket. If that bearing has worn off, replace the front bracket assembly.



WATER HEATER CONNECTIONS

WATER HEATER INSTALLATIONS

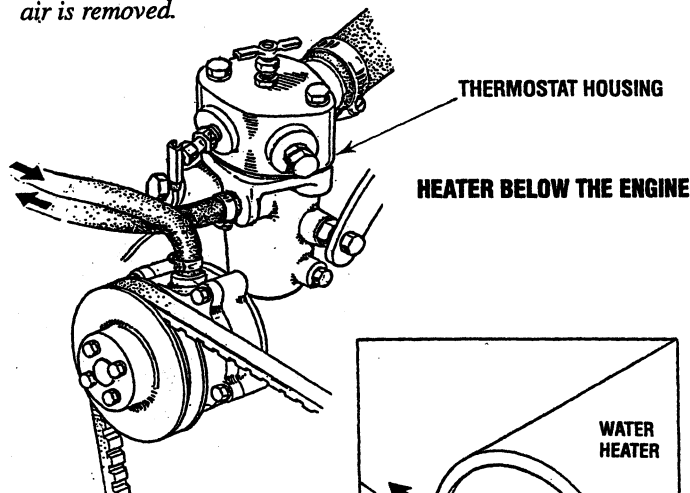
This engine is equipped with connections for the plumbing of engine coolant to heat an on-board water heater. The water heater should be mounted in a convenient location either in a high or low position in relation to the engine, so that the connecting hoses from the heater to the engine can run in a reasonably direct line without any loops which might trap air.

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

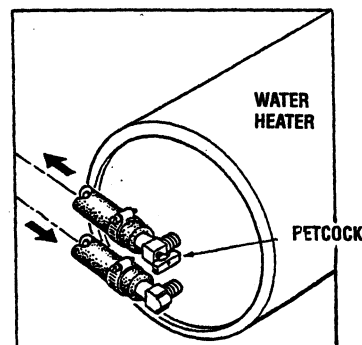
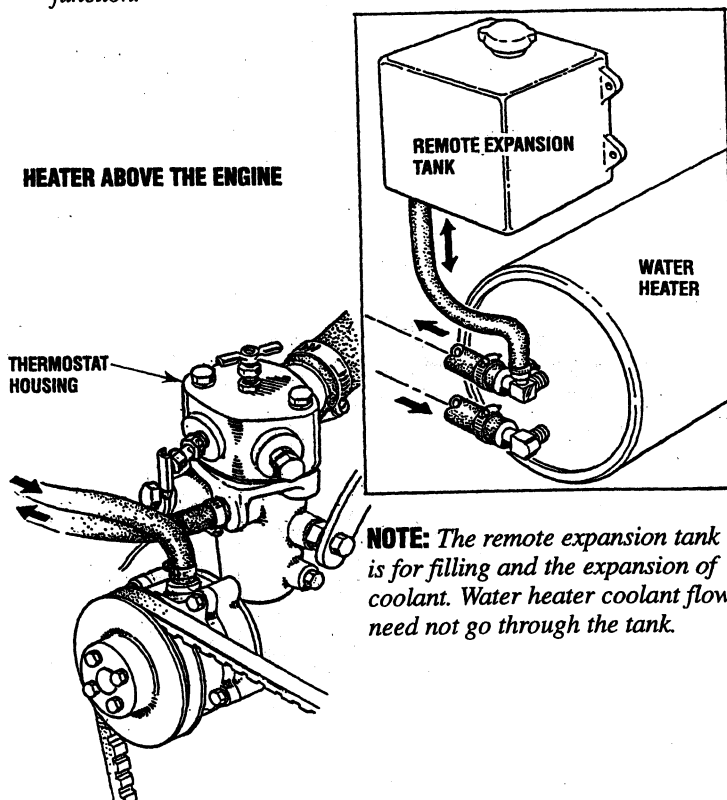
NOTE: If any portion of the heating circuit rises above the engine's closed cooling system pressure cap, then a pressurized (aluminum) remote expansion tank (Kit #024177) must be installed in the circuit to become the highest point. Tee the remote expansion tank into the heater circuit, choosing the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

The pressure cap on the engine's manifold should be installed after the engine's cooling system is filled with coolant. Finish filling the cooling system from the remote tank after the system is filled and is free of air and exhibits good coolant circulation. During engine operation, checking the engine's coolant should be done at the remote tank and not at the engine manifold cap. The hose connection from the heater to the remote expansion tank should be routed and supported so it rises continuously from the heater to the tank, enabling any air in the system to rise up to the tank and out of the system.

NOTE: Air bleed petcocks are located on the engine's heat exchanger and on the thermostat housing. Open these petcocks when filling the engine's fresh water system to allow air in the coolant circuit to escape. Close tightly after all the air is removed.



HEATER ABOVE THE ENGINE



HOSE CONNECTIONS

The hose adapters (nipples) coming off the engine (thermostat housing and water pump housing) are sized for 3/8" I.D. hose. An adapter is available (#302391) that will increase the size to 5/8" I.D. hose.

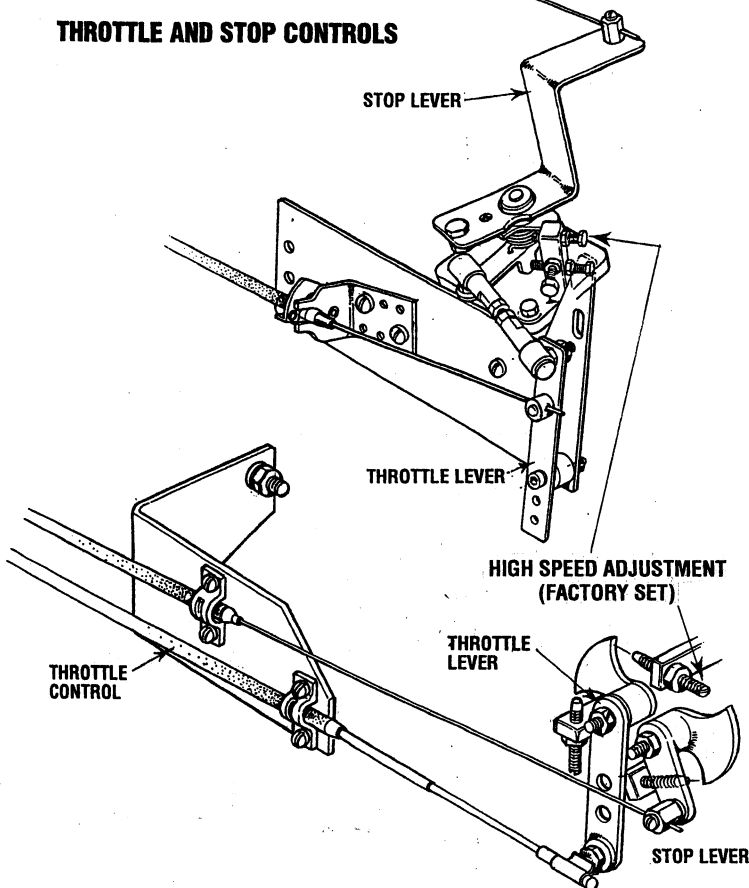


ADAPTER PN 302391

ENGINE ADJUSTMENTS

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

THROTTLE AND STOP CONTROLS



CONTROL CABLES

The throttle and engine stop levers are located on the out-board side of the engine just below the fuel injection pump. Brackets are provided for owner-installed push-pull cables that run to the steering station.

The throttle high speed adjustment has been factory set and is wire locked. The throttle idle screw is adjustable.

These levers and brackets should be periodically lubricated and checked for loose fastenings.

VALVE CLEARANCE ADJUSTMENT

NOTE: *Valve adjustment should not be necessary under normal operating conditions. These adjustments, when required, should be performed by an authorized mechanic.*

Remove the valve rocker cover to expose the engine's valve train. Remove the glow plugs from each of the cylinders to enable the engine to be easily rotated by hand to position each cylinder for valve adjustment.

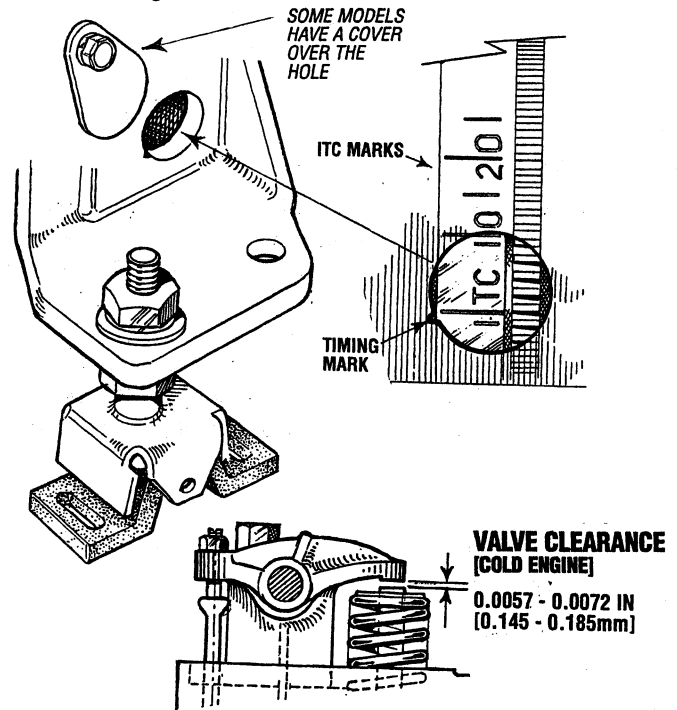
Valves are adjusted with the piston in the cylinder being adjusted at TDC (Top Dead Center) of its compression stroke. Each cylinder is adjusted following the engine's firing order.

Adjust the valves beginning with Cylinder #1. Rotate the crankshaft slowly and observe the operation of the valves for Cylinder #1. Watch for the intake valve to open indicating the piston is on its intake stroke (the piston is moving down in the cylinder). Continue to rotate the crankshaft slowly and look for the intake valve to close. The piston is now starting its compression stroke (the piston is moving up in the cylinder towards TDC).

Firing Orders

3 Cylinder Models	1 - 2 - 3
4 Cylinder Models	1 - 3 - 4 - 2

Watch the timing hole in the bell housing for timing numbers to appear. Position the ITC Mark in alignment with the notch in the timing hole. The piston in Cylinder #1 is now at TDC. Adjust the valves in Cylinder #1. Proceed to the next cylinder in the firing order.



Three cylinder models

Rotate the crankshaft 240° in the normal direction of rotation and adjust the #3 Cylinder's valves. Rotate the crankshaft another 240° and adjust the #2 Cylinder's valves.

Four cylinder models

Rotate the crankshaft 180° in the normal direction of rotation and adjust the #3 Cylinder's valves. Rotate the crankshaft another 180° and adjust the #4 Cylinder's valves. Rotate the crankshaft another 180° and adjust the #2 Cylinder's valves.

ENGINE ADJUSTMENTS

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

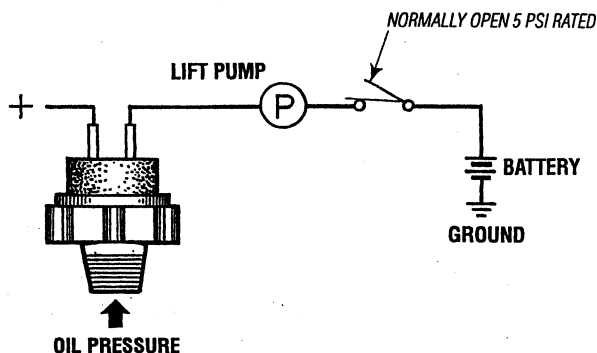
OIL PRESSURE

The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 40 and 60 psi (2.8 and 4.2 kg/cm²).

NOTE: *A newly started, cold engine can have an oil pressure reading up to 60 psi (4.2 kg/cm²). A warmed engine can have an oil pressure reading as low as 35 psi (2.5 kg/cm²). These readings will vary depending upon the temperature of the engine and the rpms.*

Low Oil Pressure

The specified safe minimum oil pressure is 5 - 10 psi. A gradual loss of oil pressure usually indicates a worn bearings. For additional information on low oil pressure readings, see the **ENGINE TROUBLESHOOTING** chart.

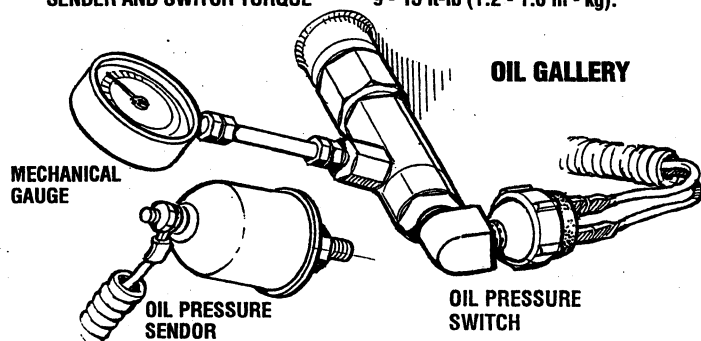


Testing Oil Pressure

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

OIL PRESSURE 7 psi [49 KPa] at idle speed.

SENDER AND SWITCH TORQUE 9 - 13 ft-lb (1.2 - 1.8 m - kg).

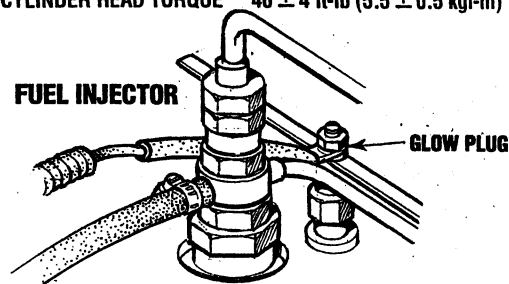


FUEL INJECTORS

In case of severe vibrations and detonation noise, have the injectors checked and overhauled by an authorized fuel injection service center. Poor fuel quality, contaminants and loss of positive fuel pressure to the injection pump can result in injector faults. Since fuel injectors must be serviced in a clean room environment, it is best to carry at least one extra injector as a spare should a problem occur.

Before removing the old injector, clean the area around the base of the injector to help prevent any rust or debris from falling down into the injector hole. If the injector will not lift out easily and is held in by carbon build-up or the like, work the injector side-to-side with the aid of the socket wrench to free it, and then lift it out.

The injector seats in the cylinder head on a copper sealing washer. This washer should be removed with the injector, replace with a new washer when the new injector is installed.
INJECTOR TO CYLINDER HEAD TORQUE 40 ± 4 ft-lb (5.5 ± 0.5 kgf-m)



TACHOMETER

TACHOMETER/HOUR METER

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

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

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

Hour meter Inoperative

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

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

Tachometer Inoperative

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

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

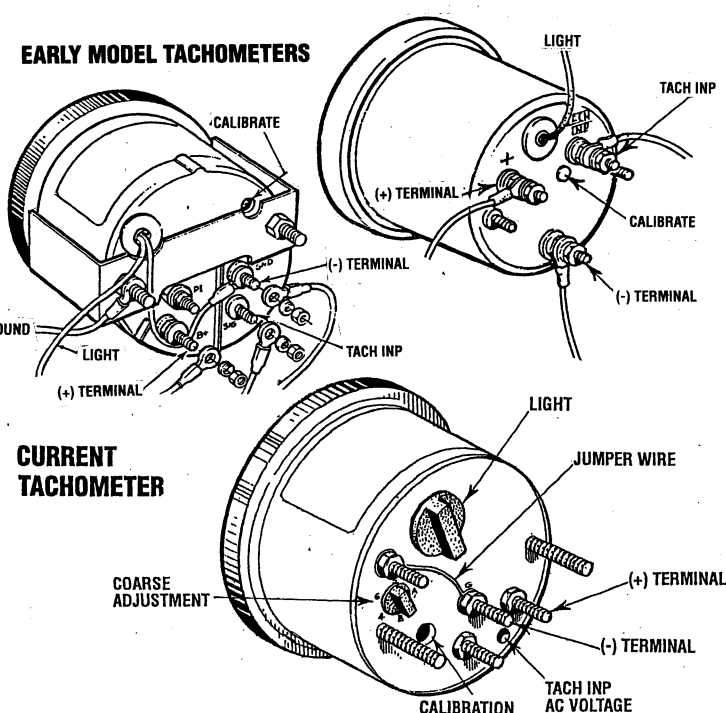
Tachometer Sticking

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

Tachometer Inaccurate

- a. Using a hand held strobe tachometer reading front crank shaft pulley speed. Adjust the engine speed to 1/2 rated engine rpm..
- b. Using the coars adjustment, select A, B, 4, 6, or 8 that puts the panel tachometer rpm reading the closest to the strobes tachometers rpm reading.
- c. Using a 5/64 (2mm) allen wrench, adjust the calibration pod on the panel tachometer to read the same as the strobe tachometers rpm.

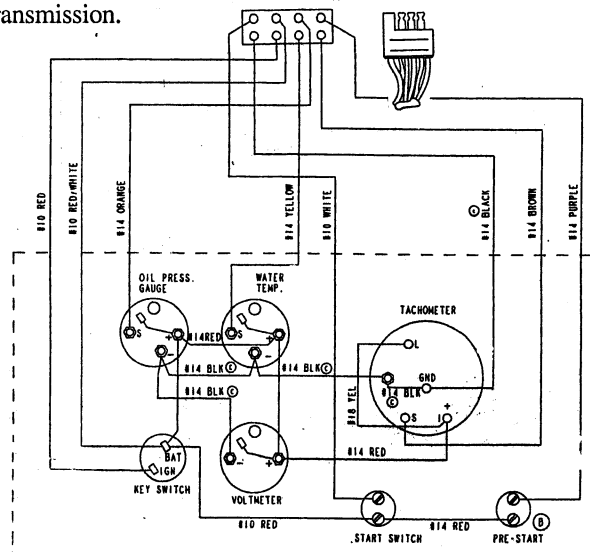
NOTE: Current model tachometers use a coarse adjustment dial to set the tachometer to the crankshaft pulley rpms. The calibrating screw is then used for fine tuning.



TACHOMETER CALIBRATION & IDLE SPEED ADJUSTMENT (New Installation)

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

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



ENGINE TROUBLESHOOTING

The following trouble shooting chart describes certain problems, the probable causes of the problems, and the recommendations to overcome the problems.

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

Problem	Probable Cause	Verification/Remedy
Key switch on, PREHEAT switch depressed: no panel indications; fuel solenoid or electrical fuel pump	<ol style="list-style-type: none"> 1. Battery Switch not on. 2. 20-Amp circuit breaker tripped. 3. 10-Amp breaker tripped. 4. Loose battery connections. 5. Preheat solenoid not operating. 	<ol style="list-style-type: none"> 1. Check switch and/or battery connections. 2. Reset breaker; if breaker trips again, check preheat solenoid circuit and check circuit for shorts to ground. 3. Check voltage at and after breaker. 4. Check (+) connection to starter solenoid and (-) connection to engine ground stud. Check battery cable connections. 5. Check solenoid.
Key switch on, PREHEAT switch depressed: START switch depressed; no starter engagement.	<ol style="list-style-type: none"> 1. Connection to solenoid faulty. 2. Faulty START switch. 3. Faulty solenoid. 4. Loose battery connections. 5. Low batteries. 	<ol style="list-style-type: none"> 1. Check connection at solenoid. 2. Check switch with ohmmeter. 3. Check that 12 volts are present at starter solenoid activation connection. 4. Check (+) connection to starter solenoid and (-) connection to engine ground stud. Check battery cable connections. 5. Check battery charge state.
Engine cranks, but does not start.	<ol style="list-style-type: none"> 1. Faulty fueling system. 2. Preheat solenoid faulty. 3. Low compression. 	<ol style="list-style-type: none"> 1. Check that fuel valves are open. 2. Check solenoid. 3. Compression test the engine.
Engine can't be stopped.	<ol style="list-style-type: none"> 1. Faulty shut-off lever at engine. 2. Push-pull shut off cable from steering station to engine disconnected. 	<ol style="list-style-type: none"> 1. Reconnect shut off lever 2. Reconnect push-pull cable.
Engine stops.	<ol style="list-style-type: none"> 1. Fuel lift pump failure. 2. Switches and/or wiring loose or disconnected. 3. Fuel starvation. 4. 20 Amp circuit breaker tripping. 5. Exhaust system is restricted. 6. Water in fuel. 	<ol style="list-style-type: none"> 1. Fuel lift pump should make a distinct ticking sound. Replace pump with spare. 2. Inspect wiring for short circuits and loose connections. Inspect switches for proper operation. 3. Check fuel supply, fuel valves, fuel lift pump. 4. Check for high DC amperage draw during operation. Ensure breaker is not overly sensitive to heat which would cause tripping. 5. Check for blockage, collapsed hose, carbon buildup at exhaust elbow. 6. Pump water from fuel tank(s); change filters and bleed fuel system.
Battery not charging	<ol style="list-style-type: none"> 1. Alternator drive. 	<ol style="list-style-type: none"> 1. Check drive belt tension. Alternator should turn freely. Check for loose connections. Check output with voltmeter. Ensure 12 volts are present at the Exc terminal.

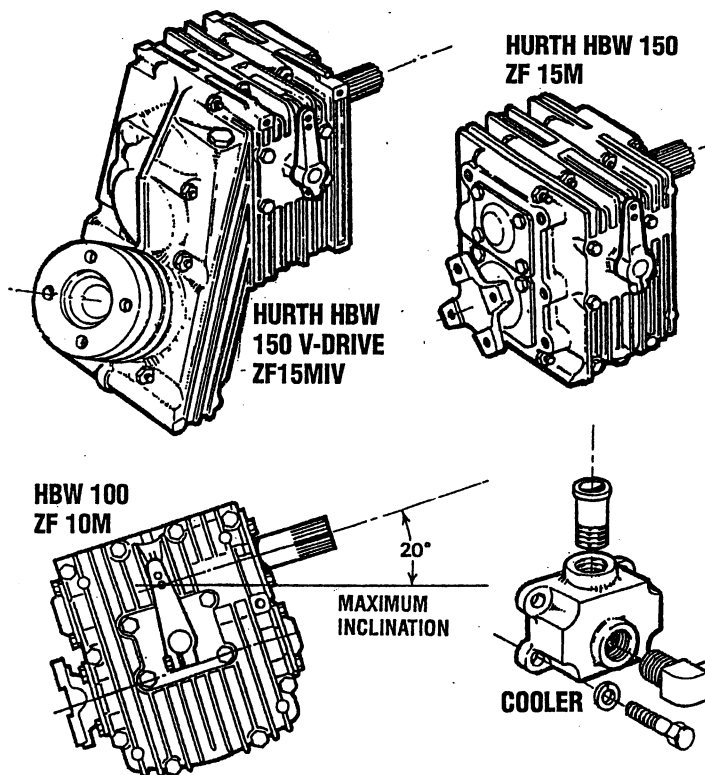
ENGINE TROUBLESHOOTING

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

HURTH HBW/ZF TRANSMISSIONS

DESCRIPTION

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



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

SHAFT COUPLINGS

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

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

"Drivesaver" is a product of Globe Marine Rockland, MA.

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

SHIFT LEVER

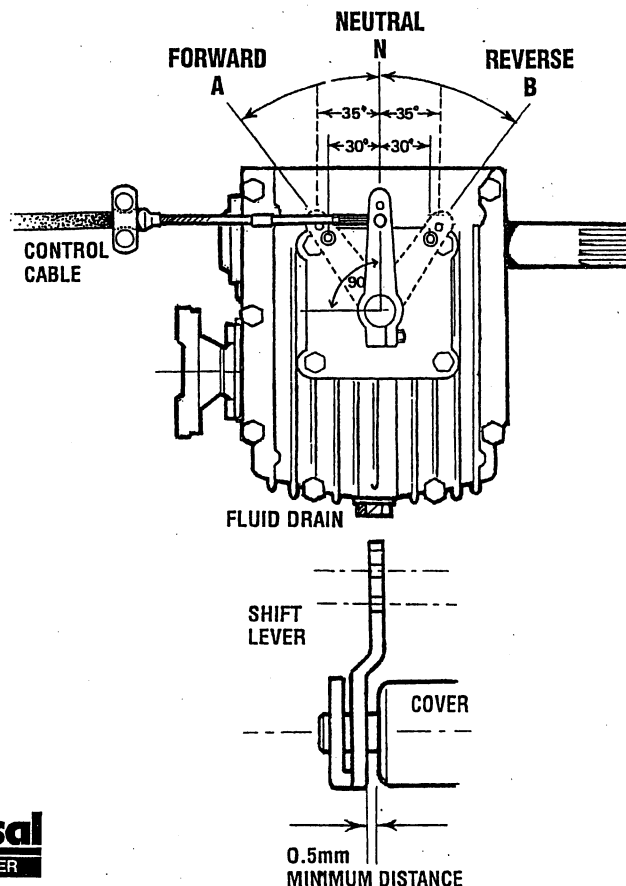
The transmission is suitable for single lever remote control. Upon loosening the retaining screw, the actuating lever can be moved to any position required for the control elements (cable or rod linkage). Make certain that the shift lever does not contact the actuating lever cover plate: the minimum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

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

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

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

NOTE Check for proper lever travel at least each season.

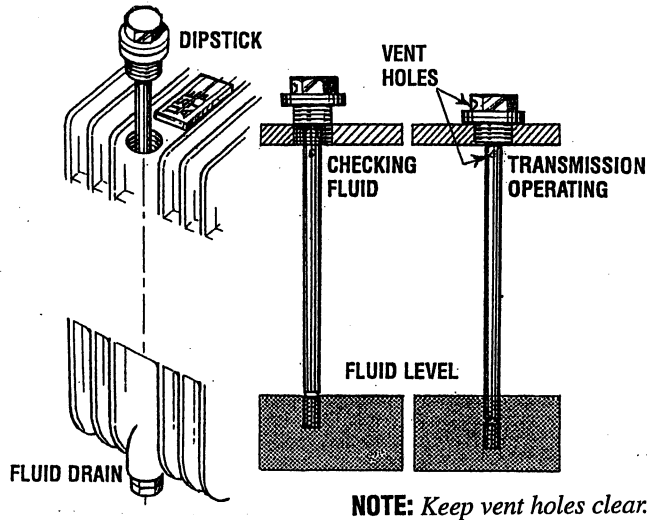


HURTH HBW/ZF TRANSMISSIONS

INITIAL OPERATION

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

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



FLUID CHANGE

Change the fluid for the first time after about 50 hours of operation, then every 250 operating hours or at least once a year or when you change engine oil.

Removing the fluid

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

Drain plug torque 20 - 25 ft/lbs

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

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

LOCKING THE PROPELLER

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

WHEN UNDER SAIL OR BEING TOWED

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

DAILY OPERATION

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

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

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

HBW/ZF TRANSMISSIONS SPECIFICATIONS

General	(Hurth/ZF Standard Transmission) Case-hardened helical gears, with a servo-operated multiple disc clutch.	
Gear ratio (optional)	HBW 50/ZF 5M	(2.05 : 1)
	HBW 100/ZF 10M	(1.79 : 1)
	HBW 150V/ZF 15MIV	(2.13 : 1)
	HBW 150A/ZF 15MA	(1.88 : 1)
Lubricating Fluid	ATF - or Dexron - II or III	
Transmission Sump Capacity	HBW 50/ZF 5M	0.63pts (0.3L)
	HBW 100/ZF 10M	0.74pts (0.35L)
	HBW 150V/ZF 15MIV	2.1pts (1.0L)
	HBW 150A/ZF 15MA	1.0pts (0.47L)
Propeller Rotation	Transmissions turn Right Hand propellers	

HURTH HBW/ZF TRANSMISSIONS

OPERATING TEMPERATURE

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

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

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

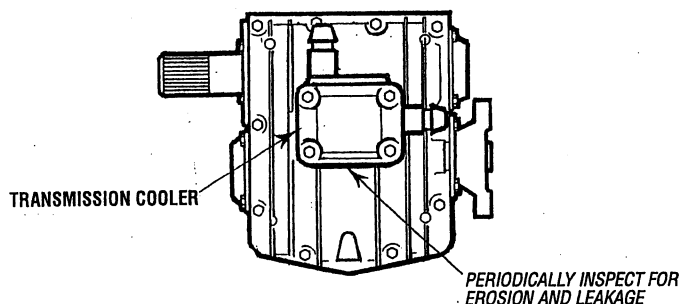
TRANSMISSION COOLER

Some **UNIVERSAL** model's transmissions are equipped with an externally attached convection type transmission cooler.

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

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

WESTERBEKE recommends having a spare cooler aboard.



MAINTENANCE

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

Periodically inspect the transmission and the cooler for leaks and corrosion. Lubricate the cable connections.

Lay-up/Winterize

Storage requires special care. Follow these procedures:

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

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

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

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

For additional information contact:

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

HURTH HBW/ZF TRANSMISSION TROUBLESHOOTING

CONTROL CABLES

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

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

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

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

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

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

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

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

HURTH HBW/ZF TRANSMISSION TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
High fluid temperature.	<ol style="list-style-type: none"> 1. Fluid level high during operation. 2. Fluid level low. 3. Plugged or restricted fluid cooler. 4. No water in cooling system. 5. Filter clogged (if applicable). 	<ol style="list-style-type: none"> 1. Pump out fluid to the maximum and mark on dipstick. 2. Add fluid. 3. Replace cooler and flush water system. 4. Check cooling system and repair. 5. Replace element.
Fluid on transmission housing.	<ol style="list-style-type: none"> 1. Loose screws. 2. Loose screw connections. 3. Loose dipstick. 4. Loose fluid filter. 5. Fluid level high during operation. 	<ol style="list-style-type: none"> 1. Tighten to specification. 2. Tighten, replace. 3. Tighten, replace. 4. Tighten, replace. 5. Pump out fluid to the maximum and mark on dipstick.
Fluid and water mixed; shifts hard.	<ol style="list-style-type: none"> 1. Damage to fluid cooler. 2. Selector control linkage. 	<ol style="list-style-type: none"> 1. Replace cooler and flush transmission and hoses. 2. Refer this manual.
Slow engagement.	<ol style="list-style-type: none"> 1. Selector control. 2. Low fluid level. 3. Linkage. 	<ol style="list-style-type: none"> 1. Refer this manual. 2. Add fluid. 3. Adjust (refer this manual).
No movement of the boat.	<ol style="list-style-type: none"> 1. Selector control. 2. Improper selector position. 3. Low fluid level. 4. Propeller missing. 5. Propeller shaft broken. 6. Transmission malfunction. 7. Engine malfunction. 	<ol style="list-style-type: none"> 1. Consult service station. 2. Adjust (see this manual). 3. Add fluid. 4. Replace. 5. Contact marine repair. 6. Contact manufacturer. 7. Contact marine repair.

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

UNIVERSAL MARINE ENGINES SPECIFICATIONS

Four cycle, fresh-water cooled, vertical in-line marine diesel engines.

M35A(C)

M4-30A

HORSEPOWER	30 @3200 rpm	25 @3600 rpm	
CYLINDERS	4	4	
BORE AND STROKE	2.95 x 2.76 in (76 x 70 mm)	2.60 x 2.45 in (64 x 70 mm)	
COMBUSTION CHAMBER	Spherical type; three vortex combustion system		
DISPLACEMENT (cubic inches)	75.5 C.I.	51.9 C.I.	
COMPRESSION RATIO	21:1	23:1	
FIRING ORDER	1-3-4-2	1-3-4-2	
VALVE CLEARANCE	.005 to .007"/0.14 to 0.18 mm		
ENGINE OIL	SAE 10W-40, 15W-40 (API CF, CF-4, CG-4, CH-4 or better)		
ENGINE OIL CAPACITY	4.5 Qts/4.2L	4.0 Qts/3.8L	
TRANSMISSION	HBW-100	HBW-50	
TRANSMISSION FLUID	Dexron II or Dexron III		
ENGINE DRY WEIGHT (w/trans)	335 lbs/152kg	270 lbs/122kg	
FUEL	No. 2 Diesel Oil cetane rating of 45 or higher		
COOLANT CAPACITY	5 Qts/4.7L	3.5 Qts/3.3L	
ENGINE COOLING	Freshwater-cooled block, thermostatically controlled with raw water exchanger and centrifugal fresh water pump.		
ROTATION	Clockwise when viewed from the front.		
FUEL NOZZLE TYPE	Bosch "throttle" type		
FUEL INJECTION PUMP	Bosch Per-MD Type, mini-pump		
STARTING MOTOR	12 volt 1.2 kw activated shift w/Solenoid		
STARTING AID	Voltage: 10.5 - 12.0 VDC/Current: 8.7 - 9.0 Amps/Resistance: 1.0 - 1.2 Ohms		
ALTERNATOR – STANDARD	51 amp 12 volt with internal regulator. Reg. set volts 14.4v-maximum		

UNIVERSAL MARINE ENGINES SPECIFICATIONS

Four cycle, fresh-water cooled, vertical in-line marine diesel engines.

	M2-12A	M3-20A	M25XPA(C)
HORSEPOWER	11 @3600 rpm	18 @3600 rpm	23 @3200rpm
CYLINDERS	2	3	3
BORE AND STROKE	2.60 x 2.45 in (64 x 70 mm)	2.60 x 2.45 in (64 x 70 mm)	2.95 x 2.76 in (76 x 70 mm)
COMBUSTION CHAMBER	spherical type; three vortex combustion system		
DISPLACEMENT (cubic inches)	26.0 C.I.	38.9 C.I.	57 C.I.
COMPRESSION RATIO	23:1	23:1	21:1
FIRING ORDER	1-2	1-2-3	1-2-3
ENGINE OIL	SAE 10W-40, 15W-40 (API CF, CF-4, CG-4, CH-4 or better)		
VALVE CLEARANCE	.0057 to .007"/0.14 to 0.18 mm		
ENGINE OIL CAPACITY	2.1 Qts/2L	3.2 Qts/3L	4.3 Qts/4L
TRANSMISSION	HBW-50	HBW-50	HBW-50
TRANSMISSION FLUID	Dexron II or Dexron III		
ENGINE DRY WEIGHT (w/trans)	175 lbs/79kg	235 lbs/106kg	285 lbs/129kg
FUEL	No. 2 Diesel Oil cetane rating of 45 or higher		
COOLANT CAPACITY	2.3 Qts/2.1L	3 Qts/2.8L	5 Qts/4.7L
ENGINE COOLING	Fresh water-cooled block, thermostatically controlled with raw water exchanger and centrifugal fresh water pump.		
ROTATION	Clockwise when viewed from the front.		
FUEL NOZZLE TYPE	Bosch "throttle" type		
FUEL INJECTION PUMP	Bosch Per-MD Type, mini-pump		
STARTING MOTOR	12 volt 1.2 kw activated shift w/Solenoid		
STARTING AID	Voltage: 10.5 - 12.0 VDC/Current: 8.7 - 9.0 Amps/Resistance: 1.0 - 1.2 Ohms		
ALTERNATOR – STANDARD	51 amp 12 volt with internal regulator. Reg. set volts 14.4v-maximum		

NOTE: THE (C) IN SOME MODEL DESIGNATIONS REFERS TO CATALINA YACHT SPECIFICATIONS. THIS IS MAINLY THE DC HARNESS ON THE ENGINE BEING CONFIGURED TO MATE TO THE CATALINA INSTRUMENT PANEL.

LAY-UP AND RECOMMISSIONING

LAY-UP

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

The following procedures will allow you to perform your own lay-up and recommissioning, or you may use them as a check list for others. These procedures should afford your engine protection during a lay-up and also help familiarize you with the maintenance needs of your engine.

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

PROPELLER SHAFT COUPLING

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

FRESH WATER COOLING SYSTEM

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

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

LUBRICATION SYSTEM

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

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine model. (Refer to the SPECIFICATIONS section of this manual.)

Run the engine and check for proper oil pressure and make sure there are not leaks. Stop the engine, check oil level and add oil as needed to bring level to dipstick full mark.

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

FUEL SYSTEM

Top off your fuel tanks with No. 2-D (SAE J313) that has a cetane rating of #45 or higher grade of diesel according to ASTM D975. Fuel additives should be added at this time to control bacterial growth and a fuel conditioner such as Diesel Kleen + Cetane Boost (DO NOT use any alcohol based additives). Change the element in your primary fuel filter/water separator, if the system contains one, and clean the separator sediment bowl.

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

RAW WATER CIRCUIT

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

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

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

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

NOTE: If the engine storage is going to be a lengthy one, 12 months and beyond, it is wise to rotate the engine by hand two complete turns every additional 4 months to allow the injection pump components to move. This will help prevent their sticking during extended storage periods.

LAY-UP AND RECOMMISSIONING

STARTER MOTOR

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

CYLINDER LUBRICATION

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

TRANSMISSION

Check or change fluid in the transmission as required. Keep full to prevent corrosion. Wipe off grime and grease and touch up unpainted areas. Protect coupling and output flange with anticorrosion coating.

SPARES

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

BATTERIES

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

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

RECOMMISSIONING

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

1. Remove the oil-soaked cloths from the intake manifold.
2. Remove the raw water pump cover and gasket. Discard the gasket. Install the raw water pump impeller removed during lay-up (or a replacement, if required). Install the raw water pump cover with a new cover gasket.
3. Reconnect the shaft coupling and check for proper alignment.
4. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to make sure the batteries are fully charged.
5. Check the condition of the zinc anode in the raw water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/freshwater solution from the raw water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse affects.
6. Start the engine in accordance with procedures in the PREPARATIONS FOR INITIAL START-UP section of this manual.

STANDARD AND METRIC CONVERSION DATA

LENGTH-DISTANCE

Inches (in) x 25.4 = Millimeters (mm) x .0394 = Inches
Feet (ft) x .305 = Meters (m) x 3.281 = Feet
Miles x 1.609 = Kilometers (km) x .0621 = Miles

DISTANCE EQUIVALENTS

1 Degree of Latitude = 60 Nm = 111.120 km
1 Minute of Latitude = 1 Nm = 1.852 km

VOLUME

Cubic Inches (in³) x 16.387 = Cubic Centimeters x .061 = in³
Imperial Pints (IMP pt) x .568 = Liters (L) x 1.76 = IMP pt
Imperial Quarts (IMP qt) x 1.137 = Liters (L) x .88 = IMP qt
Imperial Gallons (IMP gal) x 4.546 = Liters (L) x .22 = IMP gal
Imperial Quarts (IMP qt) x 1.201 = US Quarts (US qt) x .833 = IMP qt
Imperial Gallons (IMP gal) x 1.201 = US Gallons (US gal) x .833 = IMP gal
Fluid Ounces x 29.573 = Milliliters x .034 = Ounces
US Pints (US pt) x .473 = Liters (L) x 2.113 = Pints
US Quarts (US qt) x .946 = Liters (L) x 1.057 = Quarts
US Gallons (US gal) x 3.785 = Liters (L) x .264 = Gallons

MASS-WEIGHT

Ounces (oz) x 28.35 = Grams (g) x .035 = Ounces
Pounds (lb) x .454 = Kilograms (kg) x 2.205 = Pounds

PRESSURE

Pounds Per Sq In (psi) x 6.895 = Kilopascals (kPa) x .145 = psi
Inches of Mercury (Hg) x .4912 = psi x 2.036 = Hg
Inches of Mercury (Hg) x 3.377 = Kilopascals (kPa) x .2961 = Hg
Inches of Water (H₂O) x .07355 = Inches of Mercury x 13.783 = H₂O
Inches of Water (H₂O) x .03613 = psi x 27.684 = H₂O
Inches of Water (H₂O) x .248 = Kilopascals (kPa) x 4.026 = H₂O

TORQUE

Pounds-Force Inches (in-lb) x .113 = Newton Meters (Nm) x 8.85 = in-lb
Pounds-Force Feet (ft-lb) x 1.356 = Newton Meters (Nm) x .738 = ft-lb

VELOCITY

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

POWER

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

FUEL CONSUMPTION

Miles Per Hour IMP (MPG) x .354 = Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L) x 2.352 = IMP MPG
Miles Per Gallons US (MPG) x .425 = Kilometers Per Liter (Km/L)
Kilometers Per Liter (Km/L) x 2.352 = US MPG

TEMPERATURE

Degree Fahrenheit (°F) = (°C X 1.8) + 32
Degree Celsius (°C) = (°F - 32) x .56

LIQUID WEIGHTS

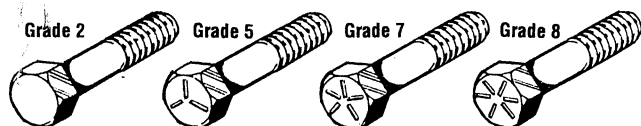
Diesel Oil = 1 US gallon = 7.13 lbs
Fresh Water = 1 US gallon = 8.33 lbs
Gasoline = 1 US gallon = 6.1 lbs
Salt Water = 1 US gallon = 8.56 lbs

STANDARD HARDWARE

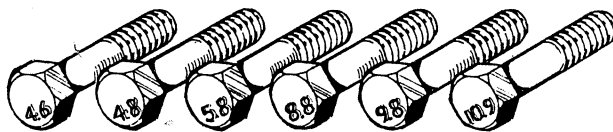
BOLT HEAD MARKINGS

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

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



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



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

STANDARD BOLT & NUT TORQUE SPECIFICATIONS

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

METRIC BOLT & NUT TORQUE SPECIFICATIONS

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

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

SEALANTS & LUBRICANTS

GASKETS/SEALANTS

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

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

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

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

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

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

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

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

BOLTS & FASTENERS/ASSEMBLIES

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

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

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

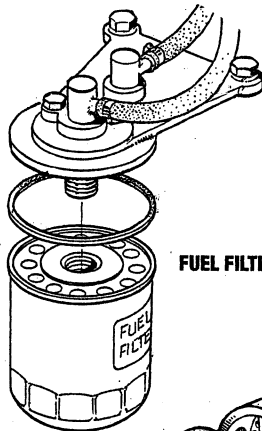
LITHIUM based grease is waterproof, ideal for water pump bearings and stuffing boxes.

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

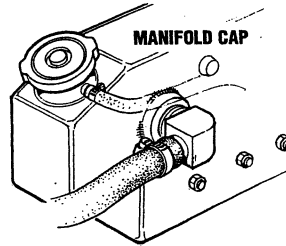
SUGGESTED SPARE PARTS

UNIVERSAL MARINE ENGINES

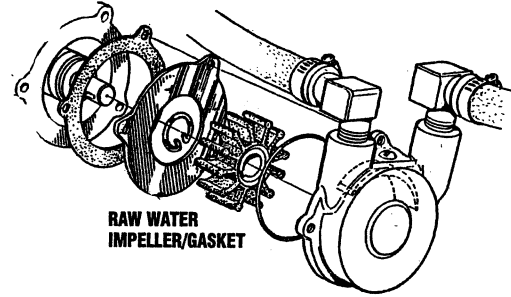
CONTACT YOUR UNIVERSAL DEALER FOR SUGGESTIONS AND ADDITIONAL INFORMATION



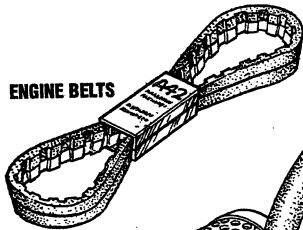
FUEL FILTER



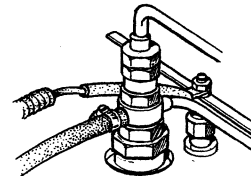
MANIFOLD CAP



RAW WATER
IMPELLER/GASKET



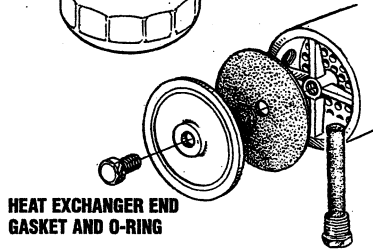
ENGINE BELTS



FUEL INJECTOR

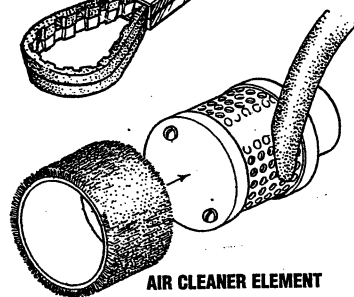


HARDWARE KIT

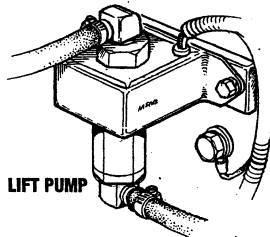


HEAT EXCHANGER END
GASKET AND O-RING

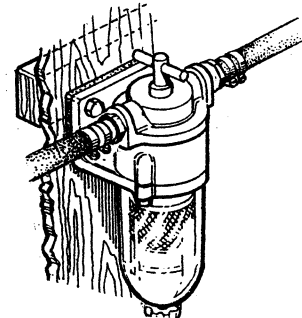
ZINC ANODES



AIR CLEANER ELEMENT

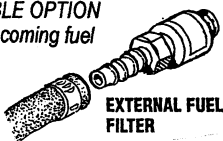


LIFT PUMP

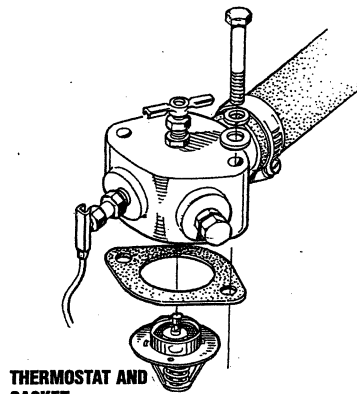


FUEL
FILTERS

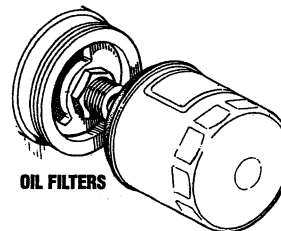
AVAILABLE OPTION
to filter incoming fuel



EXTERNAL FUEL
FILTER



THERMOSTAT AND
GASKET



OIL FILTERS

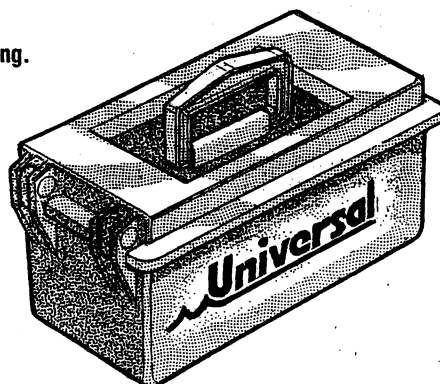
UNIVERSAL RECOMMENDS
CARRYING ENOUGH SPARE
ENGINE OIL (YOUR BRAND
FOR AN OIL CHANGE,
AND A GALLON OF PRE-
MIXED COOLANT.

UNIVERSAL SPARE PARTS KITS

UNIVERSAL also offers two Spare Parts Kits, each packaged in a rugged hinged toolbox. Kit "A" includes the basic spares. Kit "B" is for more extensive off-shore cruising.

KIT A

Impeller Kit
Heat Exchanger Gasket
Fuel Filter
Fuel Filter with Gasket
Oil Filter
Belt
Zinc Anodes



KIT B

Impeller Kit
Oil Filter
Water Pump Repair Kit
Zinc Anodes
Heat Exchanger Gasket
Thermostat Kit
Complete Gasket Kit
Injector
Fuel Filter
Fuel Filter with Gasket
Belt
Glow Plug

