mercruiser

# SERVICE MANUAL

Number 27

## MARINE ENGINES

### V-8 Diesel
### D7.3L D-Tronic

Printed in U.S.A.

90-861784 998

# IMPORTANT INFORMATION

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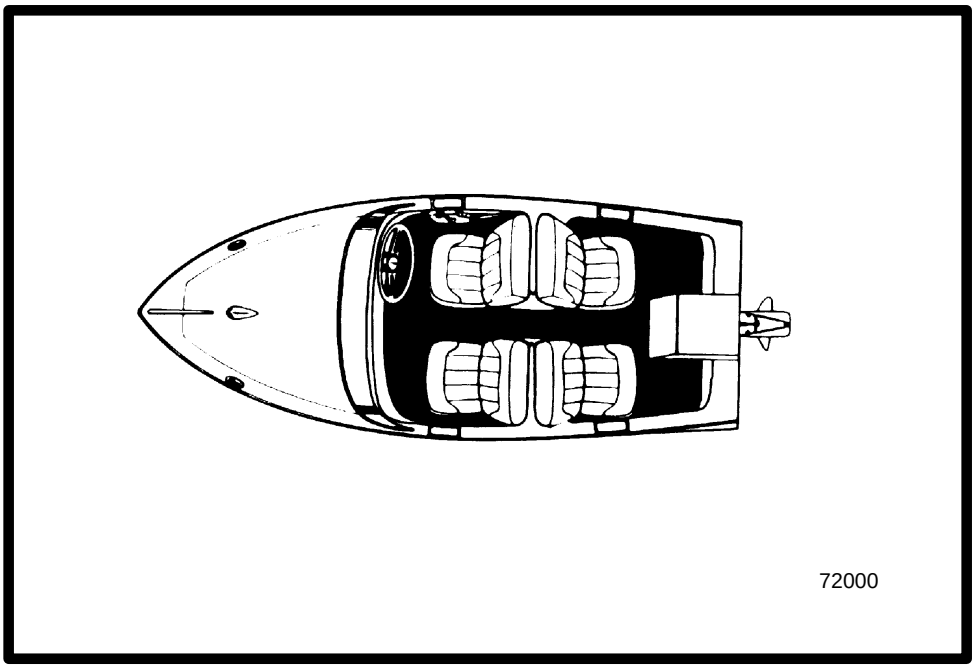

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## GENERAL INFORMATION

# Table of Contents

# Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

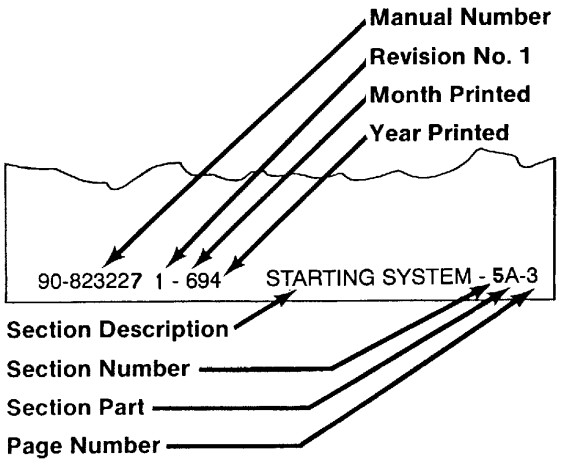
# How to Use This Manual

This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

## Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.

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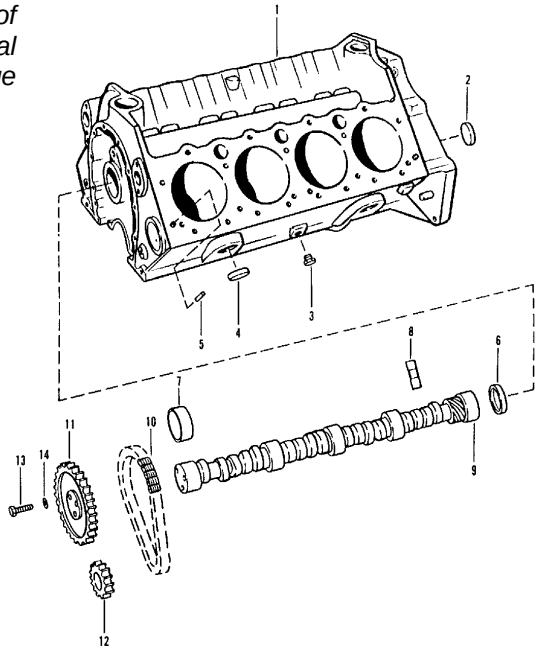
# How to Read Parts Manual

***NOTE:*** *The following is representative of a page from a MerCruiser Parts Manual and is not intended to be an actual page from a specific Parts Manual.*



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M0033-D8

**CYLINDER BLOCK AND CAMSHAFT**

| a PART NO. | b REF. NO. | c DESCRIPTION | d QUAN. |
|---|---|---|---|
| 841-81631 | 1 | CYLINDER BLOCK ASSEMBLY | 1 |
| N.S.S. | 2 | PLUG, expansion (1-1/4″) | 2 |
| 22-87238 | 3 | DRAIN COCK, cylinder block | 2 |
| 19-34270 | 4 | PLUG, expansion - cylinder block (1-5/8″ Diameter) | 8 |
| 17-35465 | 5 | PIN, dowel - block to head (5/16″ Diameter) | 4 |
| 22-72640 | 6 | PLUG, expansion - camshaft bearing hole | 1 |
| 23-85674 | 7 | BEARING UNIT, camshaft (set) | 1 |
| 72638 | 8 | LIFTER, hydraulic valve | 16 |
| 431-5943 | 9 | CAMSHAFT | 1 |
| 35378 | 10 | CHAIN, camshaft timing | 1 |
| 43-35338 | 11 | SPROCKET, camshaft timing | 1 |
| 43-48338 | 12 | SPROCKET, crankshaft timing | 1 |
| 10-34505 | 13 | BOLT, camshaft timing sprockets (3/4″) | 3 |
| 12-39167 | 14 | WASHER, camshaft timing sprocket bolt | 3 |

e 841-8163 Cylinder Block Assembly includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.

A. **Part Number:** For part ordering - Note N.S.S. for Reference Number 2, Plug, expansion - that means Not Sold Separately by Mercury Marine.

B. **Reference Number:** For part shown on exploded parts view.

C. **Description:** This is the most important column because it gives:

1) Description of Part: Ref. No. 1 is a Cylinder Block Assembly, No. 9 is a Camshaft, etc.

2) What parts are included with a certain part: Notice how the Description of Part, for Ref. Nos. 1 and 8 through 14, are at the left side of the column. Description of Part for Ref. Nos. 2 through 7 are indented under “Cylinder Block Assembly”. If Ref. No. 1 (Cylinder Block Assembly) was ordered, all indented parts (Ref. Nos. 2 through 7) would come with the part. Ref. Nos. 8 through 14 would not come with Ref. No. 1 and would have to be ordered separately. If two Cylinder Blocks were listed, both cylinder blocks would come with the indented parts. In some cases, an indented part will have another part indented under it. The second indented part will come with the first indented part.

3) Serial number break: If serial number information is listed, check product serial number to ensure that correct part is ordered.

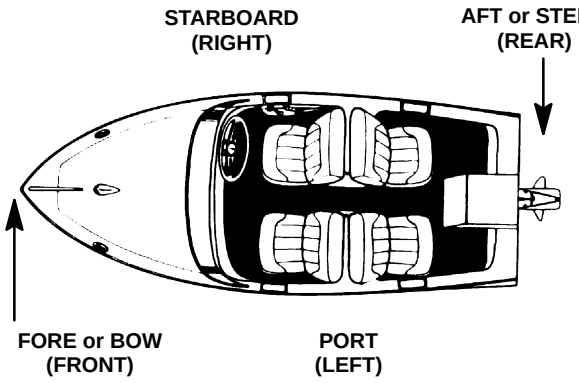
4) Special information: Many times special information will be shown after description, such as: L.H. Rotation, R.H. Rotation, Filter Up, Filter Down, etc. This will help in selecting the correct part.

D. **Quantity:** Quantity that has to be ordered.

E. **Special Information Block:** Additional information, part numbers for gasket sets, etc.

# Directional References

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern looking toward bow.

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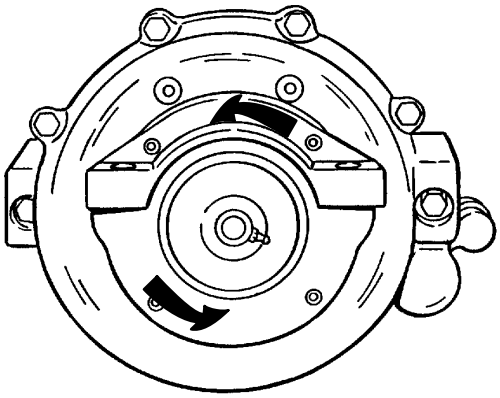
# Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



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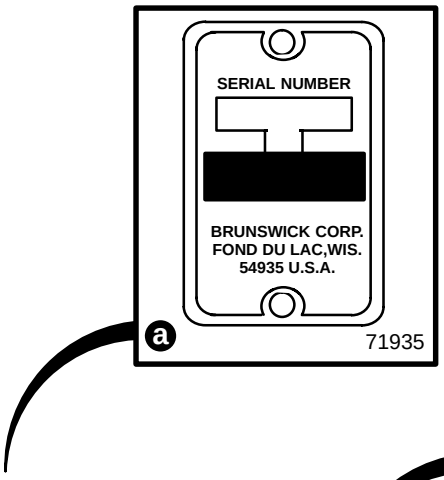
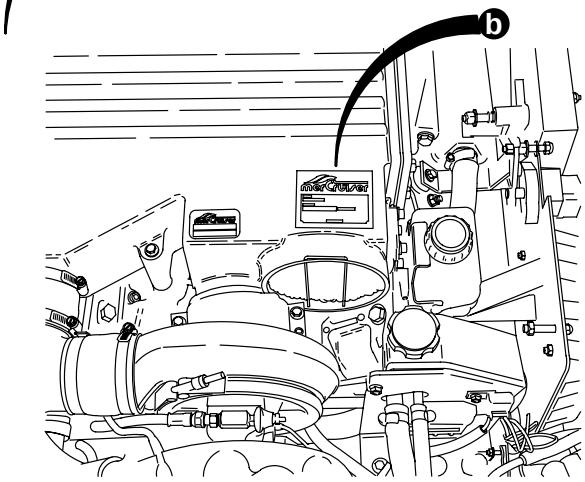
a - Standard Left-Hand Rotation

# Engine Serial Number and Identification Locations

The permanent engine serial number is stamped on the top left side of the engine block. The self-adhesive serial number plate is located on the top side of the aftercooler.

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a - Riveted Serial Number Plate (Top, PortSide of Engine Block)
b - Self-Adhesive Serial Number Plate Applied to Top of Aftercooler

# Propeller Information

Refer to the “Propeller” section in appropriate MerCruiser Stern Drive Service Manual, or order publication P/N 90-86144-92. “Everything you need to know about propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine RPM and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified RPM range at wide-open-throttle (W.O.T.).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 100 to 150 RPM will be achieved for each single pitch change of a propeller.

**⚠CAUTION**

**If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will “labor” and will not produce full power. Operation under this condition will cause excessive fuel consumption and engine overheating. On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.**

# Engine Initial Break-In Procedure

It is especially important that the following procedure be used on new and rebuilt diesel engines. This break-in procedure allows the proper seating of the pistons and rings, which greatly reduces the likelihood of problems.

**IMPORTANT: It is recommended that the boat not be accelerated hard until this procedure has been completed.**

**IMPORTANT: Never operate the starter motor longer than 15 seconds at a time, to avoid overheating the starter motor. If engine does not start, wait 1 minute to allow the starter motor to cool; then, repeat starting procedure.**

**Initial Break-In Procedure is as follows:**

1. Refer to owner’s manual and start engine. Allow engine to idle until engine has reached normal operating temperature.
2. Run engine in gear for 3 minutes at each of the following RPMs: 1200 RPM, 2400 RPM and 3000 RPM.
3. Run engine in gear for 3 minutes at each of the following RPMs: 1500 RPM, 2800 RPM and 3200 RPM.
4. Run engine in gear for 3 minutes at each of the following RPMs: 1800 RPM, 3000 RPM and Maximum Rated Full-Throttle RPM.

# Engine 20-Hour Break-In Period

**IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:**

The first 20 hours of operation is the engine (new or rebuilt) break-in period. During this period, it is extremely important that the engine is operated as outlined in the following.

1. DO NOT operate engine below 1500 RPM for extended periods of time during the first 10 hours. During this period, shift into gear as soon as possible after starting engine and advance throttle so that RPM is above 1500 (provided that conditions permit safe operation at this speed).

2. DO NOT operate at any one constant speed for extended periods of time.
3. DO NOT exceed 75% of full throttle during the first 10 hours except during the Engine Initial Break-In Procedure. During the next 10 hours, occasional operation at full throttle (5 minutes at a time maximum) is permissible.
4. AVOID full throttle accelerations from stopped position.
5. DO NOT operate at full throttle until engine reaches normal operating temperature.
6. OBSERVE INSTRUMENTATION carefully. If an abnormal reading occurs, stop engine immediately and determine cause.
7. FREQUENTLY CHECK crankcase oil level and add oil if necessary. It is normal for oil consumption to be somewhat high during the break-in period.
8. AT END OF THE 20-HOUR BREAK-IN PERIOD, drain oil from crankcase and replace oil and filter. Fill crankcase with correct grade and viscosity oil.

# Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure ONLY AFTER the engine INITIAL BREAK-IN PROCEDURE has been completed.

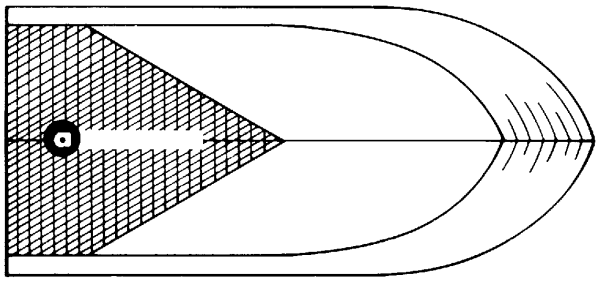
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

**IMPORTANT: Do not run at maximum RPM for more than 2 minutes.**

# Boat and Engine Performance

## Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5 m).

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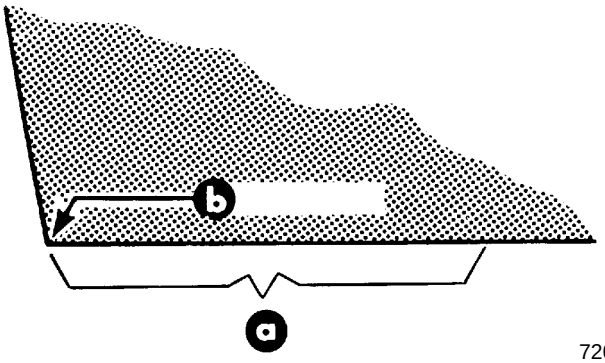
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.

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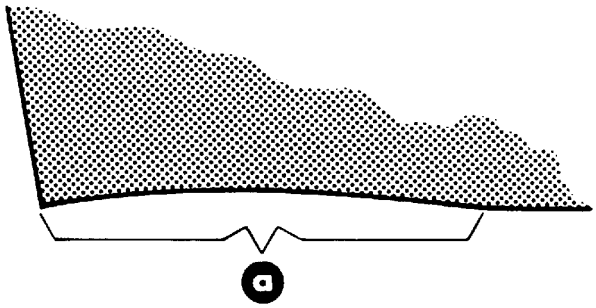
a - Flat
b - Sharp Corner

The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.

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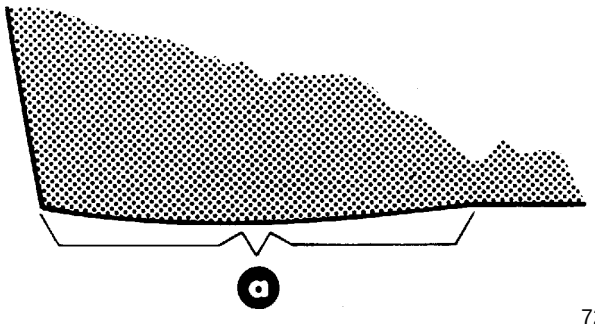
a - Hook

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

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a - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

## Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat’s bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as anti-fouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units (outboard or stern drive) are made primarily of aluminum, be sure to select an anti-fouling paint having a copper-free, organo-tin base. The BIS (Tri Butyl Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion “cell” as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instructions, it also is very effective.

## Weight Distribution

Weight distribution is extremely important; it affects a boat’s running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the “wetted area” of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

## Water in Boat

When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

## How Elevation And Climate Affect Performance

***NOTE:*** *Engines equipped with EDI (D-Tronic engines) reduce the effects of changes in elevation and climate by automatically adjusting fuel flow for weather conditions and elevation. EDI engines however, do not compensate for increased loading or hull conditions.*

Generally, elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This condition can become particularly annoying when an engine is propped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip.

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. In some cases, a gear-ratio change to more reduction is possible and very beneficial.

Summer conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds, as much as 2 or 3 miles per hour in some cases. Nothing will regain this speed for the boater, but the coming of cool, dry weather.

In pointing out the practical consequences of weather effects, an engine -- running on a hot, humid summer day -- may encounter a loss of as much as 14% of the horsepower it would produce on a dry brisk spring or fall day. With the drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended RPM. This will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however, can be somewhat regained by switching to a lower-pitch propeller that allows the engine to again run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine be propped to allow it to operate at or near the top end of the recommended maximum RPM range at wide-open-throttle with a normal boat load.

Not only does this allow the engine to develop full power, but equally important is the fact that the engine also will be operating in an RPM range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

## Recommended Operation/Duty Cycle

It is the operator's responsibility to operate within the following recommended operational capability, or duty cycle, as applicable to engine and installation:

- **Pleasure Duty**

1. Operated at rated power and rated speed for short periods of time.
2. Annual operating time is not to exceed 500 hours.

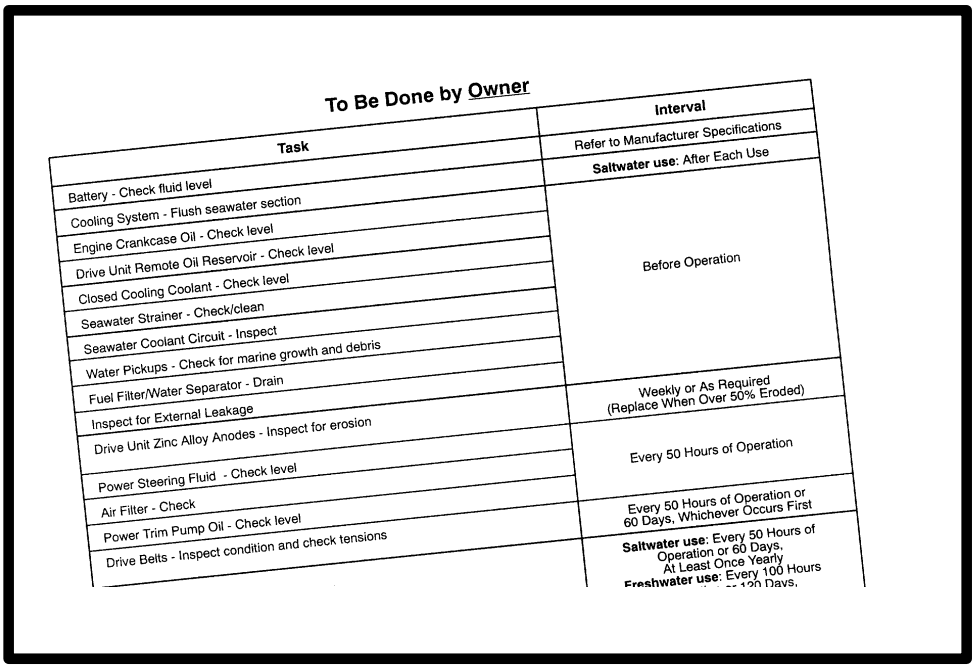
***NOTE:*** *Pleasure duty rating applies to high performance-type boats, or boats with planing hulls where acceleration and top speed are of primary importance. This rating is reserved for privately-owned yachts, or recreational power boats in non-revenue applications.*

**IMPORTANT: Damage caused by improper application or failure to operate within the operational capability, or duty cycle, will not be covered by the MerCruiser Diesel Limited Warranty - U.S.A. and Canada, nor by the MerCruiser Diesel International Warranty.**

# IMPORTANT INFORMATION

1

B



| To Be Done by Owner | |
|---|---|
| **Task** | **Interval** |
| Battery - Check fluid level | Refer to Manufacturer Specifications |
| Cooling System - Flush seawater section | **Saltwater use**: After Each Use |
| Engine Crankcase Oil - Check level | Before Operation |
| Drive Unit Remote Oil Reservoir - Check level | |
| Closed Cooling Coolant - Check level | |
| Seawater Strainer - Check/clean | |
| Seawater Coolant Circuit - Inspect | |
| Water Pickups - Check for marine growth and debris | |
| Fuel Filter/Water Separator - Drain | |
| Inspect for External Leakage | Weekly or As Required (Replace When Over 50% Eroded) |
| Drive Unit Zinc Alloy Anodes - Inspect for erosion | Every 50 Hours of Operation |
| Power Steering Fluid - Check level | |
| Air Filter - Check | |
| Power Trim Pump Oil - Check level | Every 50 Hours of Operation or 60 Days, Whichever Occurs First |
| Drive Belts - Inspect condition and check tensions | **Saltwater use**: Every 50 Hours of Operation or 60 Days, At Least Once Yearly<br>**Freshwater use**: Every 100 Hours |

# MAINTENANCE

# Table of Contents

# Maintenance Schedule

**⚠ WARNING**

**Always disconnect battery cables from battery BEFORE working around electrical system components to prevent injury to yourself or damage to electrical system should a wire be accidentally shorted.**

***NOTE:*** *Refer to appropriate Stern Drive Service Manual for information and procedures on stern drive maintenance items listed.*

**SCHEDULED MAINTENANCE TO BE PERFORMED BY OWNER/OPERATOR**

| REQUIRED SERVICE | INTERVAL |
|---|---|
| Check engine oil level. | Before Operation |
| Check drive unit gear lube monitor. | |
| Check closed coolant level. | |
| Check water pickups for marine growth or debris. | |
| Drain fuel filter. | |
| Check/Clean seawater strainer. | Before Operation/Clean As Required |
| Inspect drive unit alloy anodes for erosion (Replace when over 50% eroded). | Weekly or As Required |
| Flush seawater section of cooling system. | **Saltwater Use**: After Each Use |
| Check power trim pump oil level. | Every 50 Hours of Use |
| Check power steering fluid level. | |
| Clean air filter element. | Every 50 Hours of Operation, or as Conditions Require |
| Inspect condition and check tension of drive belts. | Every 50 Hours of Operation or 60 Days - Whichever Occurs First |
| Lubricate propeller shaft. | **Saltwater Use:** Every 50 Hours of Operation or 60 Days, Whichever Occurs First<br>**Freshwater Use:** Every 100 Hours of Operation or 120 Days, Whichever Occurs First |
| Replace fuel filter. | Every 100 Hours of Operation or Once A Year, Whichever Occurs First |
| Replace air filter element. | Every 200 Hours of Operation, or Once a Year, Whichever Occurs First |
| Check sacrificial anode (in heat exchanger) - Replace when over 50% eroded. | Once a Year |
| Check sacrificial anode (in engine oil cooler) - Replace when over 50% eroded. | |
| Spray power package exterior surfaces with Quicksilver Corrosion Guard. | |
| Clean and paint power package exterior surfaces. | As Necessary |
| Check battery fluid level. | Refer to Battery Manufacturer Specifications |

# Maintenance Schedule (Continued)

**SCHEDULED MAINTENANCE TO BE PERFORMED BY DEALER**

| REQUIRED SERVICE | INTERVAL |
|---|---|
| Change engine oil and filter. | After 20-Hour Break-In Period, Then, for **Pleasure-craft Use[1]:** Every 100 Hours of Use or 120 Days, Whichever Occurs First. |
| Lubricate engine coupling and universal joint shaft splines. | Every 50 Hours of Operation or 60 Days, Whichever Occurs First |
| Check engine alignment and mounting hardware. | Every 100 Hours of Operation |
| Change transmission fluid. | |
| Change Stern Drive Unit oil including gear lube monitor oil. | Every 100 Hours of Operation or 120 Days, Whichever Occurs First |
| Retorque gimbal ring clamping U-bolt to 50 - 55 lb. ft. (67 - 74 N·m). | Every 100 Hours of Operation or Once a Year, Whichever Occurs First |
| Clean, inspect and test the closed cooling system pressure cap. | |
| Replace coolant (using only Quicksilver Premixed Marine Engine Coolant). | Every 200 Hours of Operation or Once a Year, Whichever Occurs First |
| Clean heat exchangers. | |
| Lubricate universal joint cross bearings. | |
| Check and adjust idle RPM. | Once a Year |
| Clean aftercooler core. | Every 500 Hours of Operation |
| Replace drive belts. | |
| Inspect cooling system hoses and clamps. | **Saltwater use:** Every 50 hours of operation or 60 days, Whichever Occurs First<br>**Freshwater use:** Every 100 hours of operation or 120 days, Whichever Occurs First |
| Inspect exhaust system and clamps. | |
| Inspect and lubricate shift/throttle cables and linkage. | |
| Check electrical system for loose or damaged wiring. | |
| Lubricate transom gimbal bearing. | |
| Lubricate and inspect steering system for loose, damaged or missing parts. | |
| Ground Wire Circuit continuity - Check components for loose connections, broken or frayed wires. | |
| Disassemble and inspect seawater pump. | At Least Once yearly |
| Clean fuel tank. | Every 1000 Hours of Operation |

NOTE 1: For an explanation of Pleasure Craft usage refer to SECTION 1A - “Recommended Operation/Duty Cycle”.

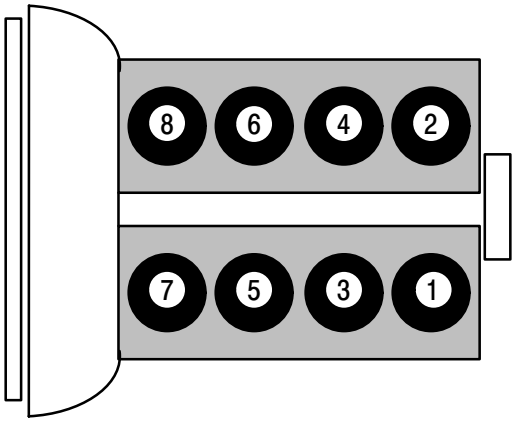
# Specifications

## Engine

| ITEM / MODEL | | SPECIFICATION |
|---|---|---|
| Crankshaft Horsepower (Kilowatts) [1] | | 300 ( 224 ) |
| Propeller Shaft Horsepower (Kilowatts) [1] | | 270 ( 201 ) |
| Engine Type | | V-8 Cylinder Diesel |
| Displacement | | 444 cu. in. ( 7.3 L ) |
| Firing Order | | 1-2-7-3-4-5-6-8 |
| Bore | | 4.11 in. ( 104.39 mm ) |
| Stroke | | 4.18 in. ( 106.20 mm ) |
| Compression Ratio | | 17.5:1 |
| Valve Clearance ( Intake/ Exhaust ) | | Non-Adjustable (Hydraulic) |
| Maximum Pressure Difference Between Cyl. | | 75 PSI ( 517 kPa ) |
| Maximum Governed WOT RPM | | 3950 ± 50 |
| Maximum WOT RPM | | 3800 |
| Idle RPM in Forward Gear | | 625 ± 25 |
| Oil Pressure: | 650 RPM | 10 PSI [ 0.7 bar (69 kPa)] Minimum |
| | 3800 RPM | 40 - 70 PSI [2.8 - 4.8 bar (276 - 482 kPa)] |
| Oil Temperature | | 250° F ( 121° C ) Maximum |
| Thermostat | | 170° F ( 77° C ) |
| Coolant Temperature | | 170° - 210° F ( 77° - 99° C ) |
| Electrical System | | 12-volt Negative ( – ) Ground |
| Alternator Rating | | 949W, 14.6v, 65A |
| Recommended Battery Rating ( Cold Cranking Amperage ) | | 12v, 1500 cca or 300 Ah |
| Starter | Delco, Series 28MT | 12v, 2.4 kW |

[1] Power rated in accordance with NMMA Procedure - ISO 3046 (Technically Identical to ICOMIA 28-83).

## Firing Order




**Firing Order: 1-2-7-3-4-5-6-8**

## Fluid Capacities

**NOTICE**

**All capacities are approximate fluid measures in U.S. Quarts (Litres).**

| ITEM | | SPECIFICATION |
|---|---|---|
| Total Oil-Filling Capacity[1] | | 16.5 ( 15.6 ) |
| Oil Drainage: | from oil pan | 14.5 ( 13.7 ) |
| | from oil filter | 1 ( 1 ) |
| | from oil cooler | 1 ( 1 ) |
| Drive Unit Oil Capacity (With Gear Lube Monitor) [1] | | 3 ( 3 ) |
| Closed Cooling System | | 26 ( 24.5 ) |
| Seawater Cooling System [2] | | 15 ( 14 ) |

[1] Always use dipstick to determine exact quantity of oil or fluid required.

[2] Seawater cooling system capacity information is for cold weather or extended storage use only.

# Fluid Specifications

## Diesel Fuel

**⚠WARNING**

**FIRE HAZARD: Fuel leakage from any part of the fuel system can be a fire hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, primers, fittings, and fuel filters should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.**

**⚠WARNING**

**Under *no circumstances* should gasoline, gasohol and/or alcohol be mixed with diesel fuel for any reason. This mixture of gasoline, gasohol and/or alcohol with diesel fuel is highly flammable and produces a significant risk to the user.**

**IMPORTANT: Use of improper or water-contaminated diesel fuel will damage your engine seriously. Use of improper fuel is considered misuse of engine, and damage caused thereby will not be covered by warranty.**

Grade 2-D diesel fuel is required, meeting ASTM Standards D975 (or fuel rated Diesel DIN 51601), and having a minimum cetane rating of 45.

The cetane number is a measure of the ignition quality of diesel fuel. Increasing the cetane number will not improve overall engine performance, but it may be necessary to raise the cetane rating for low temperature or high altitude use.

***NOTE:*** *If your engine suddenly becomes noisy after a fuel fill, you possibly received substandard fuel with a low cetane rating.*

Sulphur content of the above fuel is rated at 0.50% by weight, maximum (ASTM). Limits may vary in countries outside of the United States.

On intermittent use engines, high sulphur content diesel fuel will greatly increase:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Corrosion and extensive damage, and excessive wear of internal engine parts, particularly bearings.
- Starting and operating difficulties.

### DIESEL FUEL IN COLD WEATHER

Unaltered diesel fuels thicken and “gel” in cold temperatures, unless treated. Virtually all diesel fuels are “climatized” to allow their use in the particular region for that time of the year. If it becomes necessary to further treat diesel fuel, it is the owner/operator’s responsibility to add a commercial “standard brand” “anti-gel” diesel fuel additive, following that product’s directions.

## Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, the engine requires engine oil with a rating of 15W-40 - API - CG4/SJ.

For all temperature operation use 15W-40 oil.

## Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron, Dexron II.

## Coolant for Closed Cooling System

**⚠CAUTION**

**Alcohol or Methanol base antifreeze or plain water are not recommended for use in closed cooling section of cooling system at any time.**

Because diesel engines are high compression engines and related higher engine operating temperatures are created, the closed cooling system and engine, including related cooling passages must remain as clean as possible to provide adequate engine cooling. This can only be assured by using the proper anti-freeze, water, additives and inhibitors. It is recommended that the closed cooled section of the cooling system be filled with a low, or no, silicate formula of ethylene glycol antifreeze in solution with deionized water. A low silicate formula prevents antifreeze separation which causes a silicate gelatin to form. This gelatin will block engine and heat exchanger passages causing engine overheating.

The coolant, if not premixed, should be mixed before being added to the closed cooling system using a proper anti-freeze together with deionized water. Common tap water or softened water contains unwanted minerals which can leave large deposits in the system that restrict the cooling system efficiency. In addition, additives and inhibitors introduced into acceptable coolant solutions will form a protective film on internal passages and provide protection against internal cooling system erosion.

The closed cooling section should be kept filled year-round with an acceptable anti/freeze/coolant solution. Do not drain closed cooled section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooled section is filled with a properly mixed antifreeze/coolant solution, to protect engine and closed cooling system to lowest temperature to which they will be exposed.

**IMPORTANT: The anti-freeze/coolant used in these marine engines must be a low (or no) silicate ethylene glycol, containing special additives, and deionized, purified water. Using other types of engine coolant may cause fouling of the heat exchangers, and overheating of the engine. Do not combine different types of coolants without knowing that they are compatible. Refer to the coolant manufacturer's instructions.**

Some acceptable types of anti-freeze/coolants are listed in the following table. Refer to "Maintenance Schedules" for respective change intervals.

| DESCRIPTION | PART NUMBER |
|---|---|
| Quicksilver Premixed Marine Engine Coolant | 92-813054A2 |
| Extended Life Anti-Freeze/ Coolant | Obtain Locally |
| Fleetguard Complete | |

## Maintaining Crankcase Oil Level

### OVERFILLED ENGINE CRANKCASE

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter" on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down". This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a "false reading," make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

## Checking Engine Oil Level/Filling

**IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.**

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Insert dipstick all the way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the FULL and ADD marks.
6. If oil level is below ADD mark, proceed to Steps 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

## Changing Crankcase Oil and Oil Filter

1. Start engine and run until it reaches normal operating temperature.

**IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.**

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

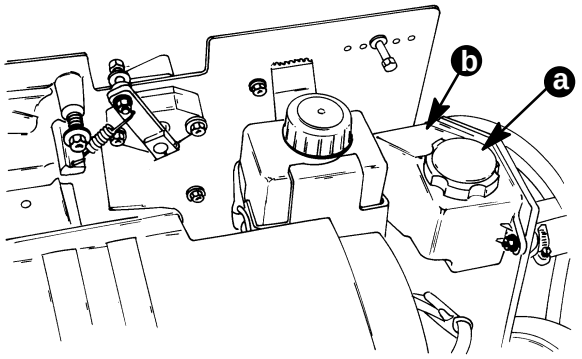
***NOTE:*** *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not over-tighten.
7. Fill crankcase with oil.
8. Start engine and check for leaks.

## Maintaining Power Steering Pump Fluid Level

### WITH ENGINE WARM

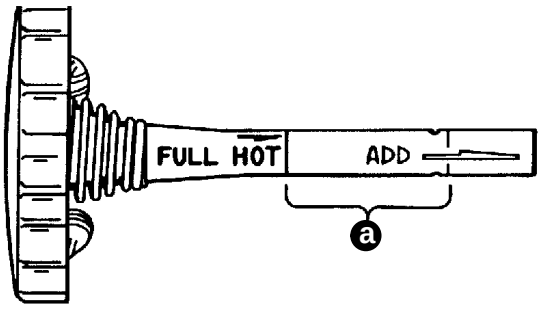
1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering fluid reservoir and note fluid level.




75952

a - Fill Cap/Dipstick
b - Power Steering Reservoir

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



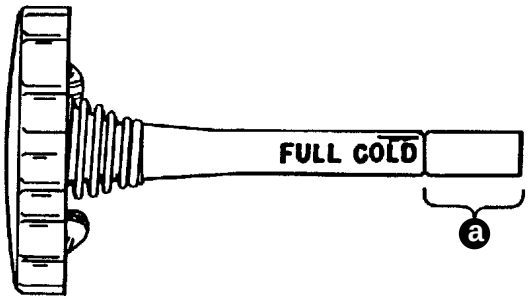

72518

a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

**WITH ENGINE COLD**

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering reservoir and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.




72519

a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find the cause and correct as required.

# Filling and Bleeding Power Steering System

**IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.**

1. With engine stopped, position drive unit so that it is straight back. Remove fill cap/dipstick from power steering pump. Add Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, as required, to bring level up to FULL COLD mark on dipstick.

**IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II in power steering system.**

2. Turn steering wheel back and forth to end of travel in each direction several times, then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

**⚠CAUTION**

**DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.**

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.** Reinstall fill cap securely.

**IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.**

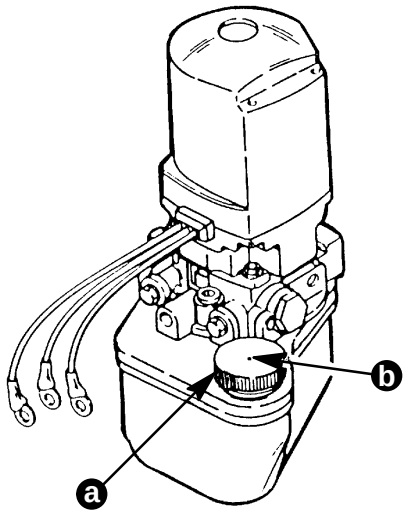
6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

# Maintaining Power Trim Pump Oil Level

1. Place drive unit in full down/in position.

**IMPORTANT: Trim pump reservoir fill cap has a small vent hole in it. Occasionally check to ensure vent is not restricted.**

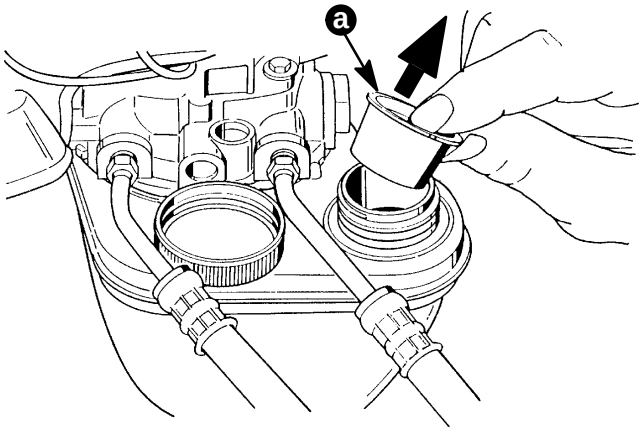
2. Unscrew fill cap.




73182

a - Fill Cap
b - Fill Cap Vent Hole

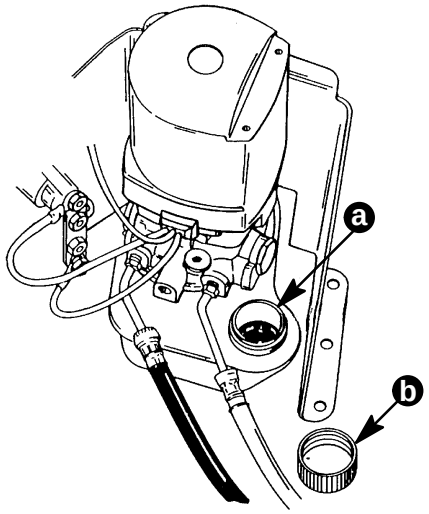
***NOTE:*** *New trim pumps have a shipping "caplug" in the reservoir fill neck. Check to ensure that this caplug is NOT present in filler neck. DISCARD caplug if present.*




73183

a - Caplug

3. Observe oil level. Level must be up to, but not over, bottom of fill neck. Add Quicksilver Power Trim and Steering Fluid if required (or SAE 10W-30 motor oil if Quicksilver Power Trim and Steering Fluid is unavailable) to bring level to bottom of filler neck. Replace fill cap, and tighten when finished with checks.



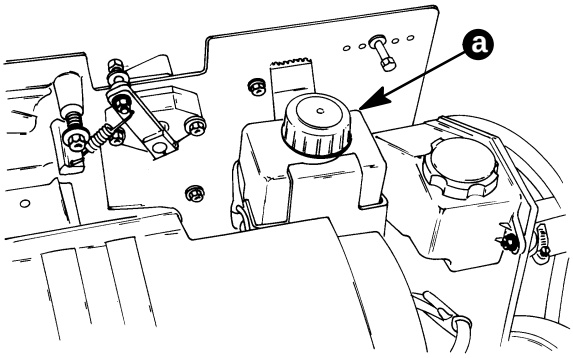

a - Fill Neck
b - Fill Cap

73184

# Maintaining Drive Unit Oil (Gear Lube Monitor)

Check gear lube monitor oil level; keep oil level at or near FILL line. Check for water at bottom of monitor, and/or if oil appears a milky-tan. Both conditions indicate a water leak somewhere in the drive unit.

**IMPORTANT: If more than 2 oz. (57 grams) of Quicksilver High Performance Gear Lube are required to fill drive unit, a seal may be leaking. Damage to unit may occur due to lack of lubrication.**

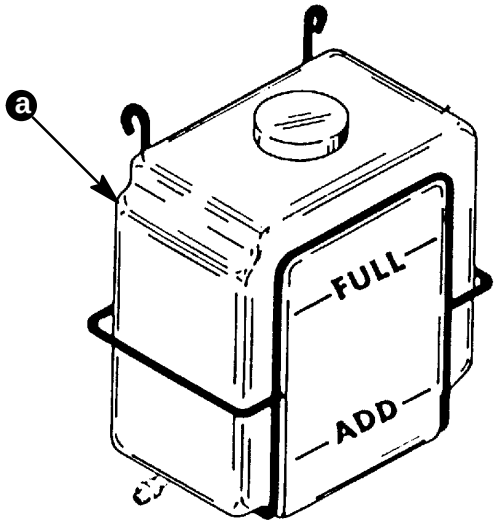



75952

a - Gear Lube Monitor

# Maintaining Closed Cooling System Coolant Level

1. Check coolant level in coolant recovery bottle. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature. Add specified coolant as required.




72520

a - Coolant Recovery Reservoir

***NOTE:*** *Coolant recovery system is considered to be functioning properly when coolant level in heat exchanger/coolant tank remains at bottom edge of its filler neck.*

**⚠WARNING**

**Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.**

2. Periodically, to ensure that coolant recovery system is functioning properly, you should allow engine to cool and then *slowly and carefully* remove coolant tank cap. Coolant level must be to the bottom edge of the tank filler neck. If coolant is low, add coolant as necessary to bring up to proper level. Refer to “Specifications” for proper coolant.

**IMPORTANT: When installing pressure cap, be sure to tighten it until it contacts stop on filler neck.**

# Changing Closed Cooling Fluid

**⚠WARNING**

**Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.**

**IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes.**

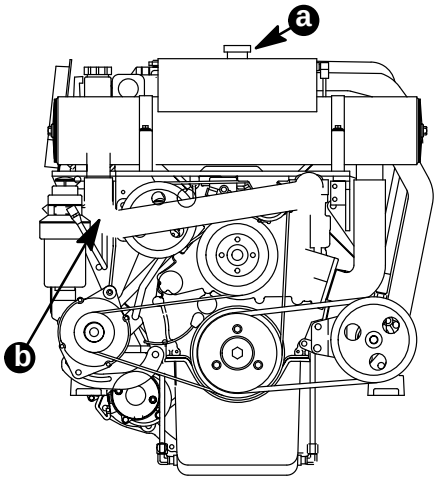
**IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.**

**IMPORTANT: Closed cooled section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooled section is filled with an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.**

**IMPORTANT: Do not use Propylene Glycol Antifreeze in the closed cooled section of the engine.**

***NOTE:*** *Drain coolant into a suitable container. Dispose of old coolant properly.*

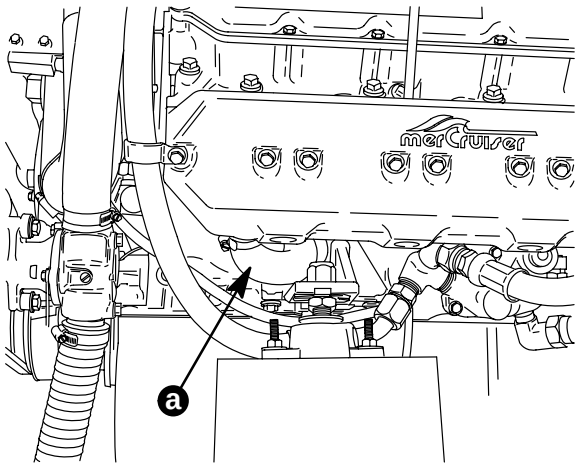
1. After engine cools down, remove pressure cap from coolant tank.
2. Disconnect hose from bottom of the heat exchanger.




76186

a - Pressure Cap
b - Hose

3. Remove the engine block-to-manifold hoses (port and starboard) and drain.

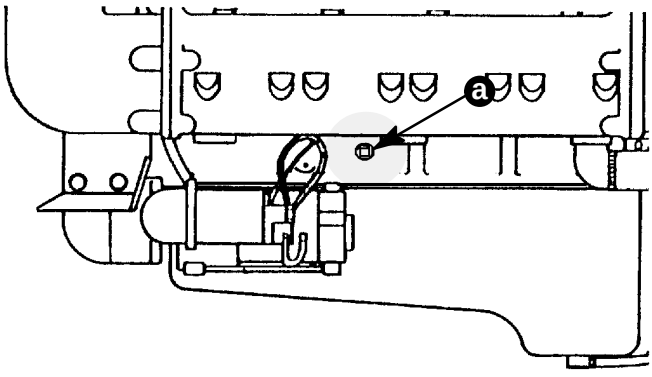



76113

**Port Manifold Shown (Starboard Similar)**

a - Exhaust Manifold
b - Hose

4. Remove port and starboard drain plugs from from the cylinder block and allow coolant to drain.




73255

**Starboard Shown (Port Similar)**

a - Crankcase Drain Plug (Below Manifold - Both Sides of Engine)

5. After coolant has drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten securely.
6. Reinstall exhaust manifold hoses. Tighten clamps securely.
7. Remove coolant recovery bottle from mounting bracket and pour out coolant.
8. Fill system as outlined in “Filling Closed Cooling Section.”

# Filling Closed Cooling Section

1. Remove pressure cap from heat exchanger and fill section with Quicksilver Premixed Marine Engine Coolant through heat exchanger fill neck. Continue filling until coolant level is 1 in. (25 mm) below filler neck.

**⚠ CAUTION**

**Avoid seawater pickup pump impeller damage and subsequent overheating damage to stern drive unit. DO NOT operate engine without water being supplied to seawater pickup pump.**

2. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1 in. (25 mm) below filler neck.
3. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
4. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
5. Install pressure cap on heat exchanger.
6. Remove cap from coolant recovery reservoir and fill to FULL mark with coolant solution. Reinstall cap.
7. With engine still running, check hose connections, fittings and gaskets for leaks. Repeat Step 4.

# Flushing Seawater Cooling System

If engine is operated in salty, polluted or mineral-laden waters, seawater cooled section should be flushed periodically (preferably after each use) with fresh water to reduce corrosion and prevent the accumulation of deposits in the system. Seawater cooled section also should be thoroughly flushed prior to storage.

***NOTE:*** *The closed section of cooling system that contains coolant does not need to be flushed. Coolant is changed at specified intervals. Refer to "Maintenance Chart."*

**⚠WARNING**

**When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.**

**⚠CAUTION**

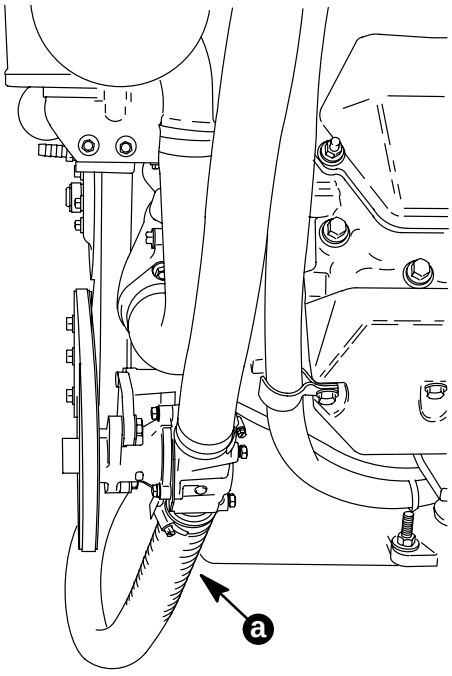
**Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.**

**IMPORTANT: If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.**

**⚠CAUTION**

**Watch temperature gauge at dash to ensure the engine does not overheat.**

1. Close seacock (if so equipped) or remove and plug seawater inlet hose.
2. Loosen hose clamp and remove seawater inlet hose at location shown. Connect tap water hose to inlet fitting.




76107

a - Seawater Inlet Hose

3. Place remote control in NEUTRAL, idle speed position and start engine. Operate engine at idle speed, in NEUTRAL, for about 10 minutes, or until discharge water is clear.
4. Stop engine.

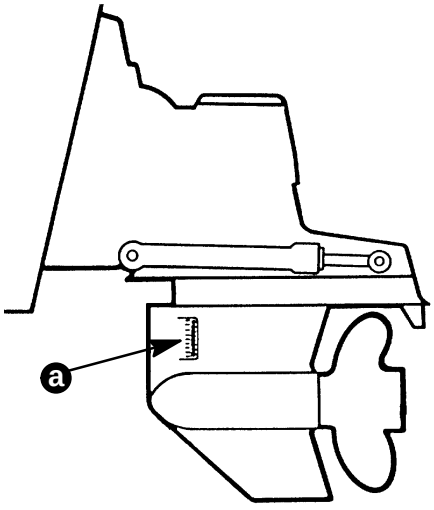
**⚠CAUTION**

**If boat is in the water, seacock (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.**

5. Shut off tap water. Remove flushing connector at seawater pump inlet. Refer to preceding precautionary statement and then follow instructions “a” or “b.”
   a. **If equipped with seacock:** Reconnect water inlet hose and tighten hose clamp securely. Open seacock accordingly.
   b. **If NOT equipped with seacock:** Unplug and reconnect seawater inlet hose accordingly. Tighten hose clamp securely.

## Inspect Water Pickups

Check water inlet area of gear housing to ensure that openings are clean and not obstructed.




73186

a - Water Inlet Holes

## Check/Clean Seawater Strainer

1. Visually inspect seawater strainer through glass top.

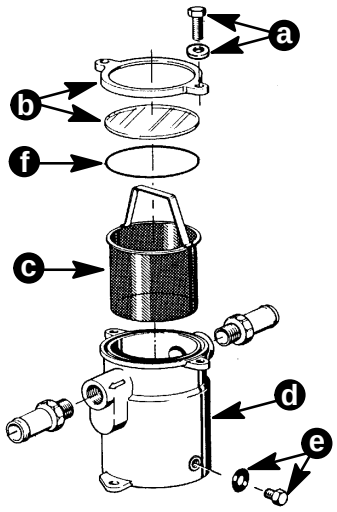
**⚠CAUTION**

**When cleaning seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses.**

**⚠CAUTION**

**Do not overtighten cover screws or cover will warp and leak.**

2. With engine off, close seacock (if so equipped) or remove and plug seawater inlet hose if no seacock exists. Remove two screws, washers, and cover. Remove strainer, drain plug and washer. Clean all debris from strainer housing; flush both strainer and housing with clean water. Check gasket and replace when necessary (if it leaks). Reinstall strainer, drain plug and washer. Reattach cover with screws and washers. After starting engine, check for leaks and/or air in system, which would indicate an external leak.




72673

a - Screws and Washers
b - Cover, with Glass
c - Strainer
d - Housing
e - Drain Plug and Sealing Washer
f - Gasket

## Fuel Filter

**⚠WARNING**

**Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire. This eliminates the engine wiring as a potential source of ignition.**

**⚠CAUTION**

**Absolute cleanliness is required for work on the fuel injection system, since the injection pump and fuel injectors have very close tolerances. Even minute particles of dirt or small amounts of water can impair the function of the fuel injection system.**

**⚠WARNING**

**Be careful when draining, filling or replacing water separating fuel filter; diesel fuel is flammable. Be sure that the ignition key is OFF. DO NOT smoke or allow sources of open flame in the area while changing fuel system components. Wipe up any spilled fuel immediately. DO NOT allow fuel to come into contact with any hot surface which may cause it to ignite.**

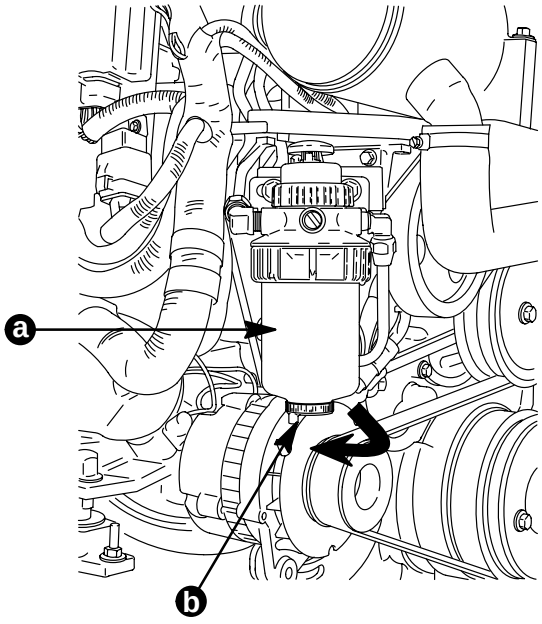
## Draining

**⚠WARNING**

**Dispose of fuel-soaked rags, paper, etc., in an appropriate air tight, fire retardant container. Fuel-soaked items may spontaneously ignite and result in a fire hazard which could cause serious bodily injury or death.**

***NOTE:*** *In warm weather, open the drain cock before starting daily operations. In cold weather, when there is a possibility that the condensed water will freeze, drain the filter shortly after the end of daily operations.*

1. Open the drain cock at bottom of filter by turning the drain counterclockwise (*as viewed from the bottom of the filter*).




76102

a - Fuel Filter
b - Drain Cock

2. Drain until fuel is clear in appearance.
3. Close drain cock by turning clockwise (*as viewed from the bottom of the filter*). Tighten securely.
4. Fill fuel filter as outlined later in this section.

**⚠WARNING**

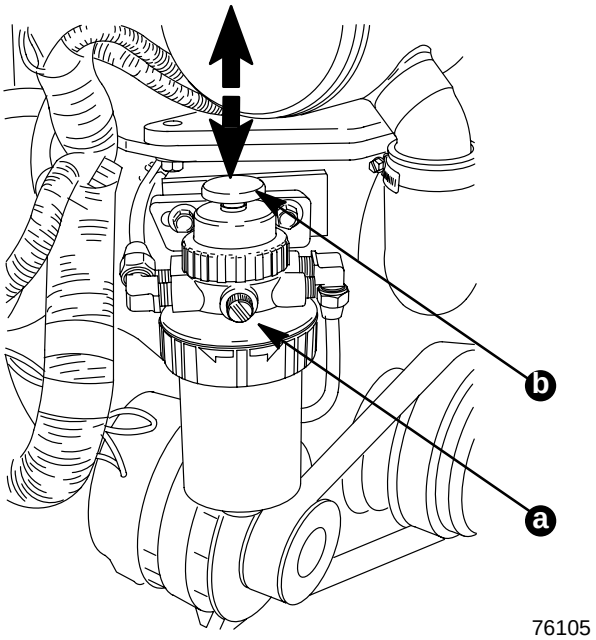
**Make sure no fuel leaks exist before closing engine hatch.**

## Filling

**⚠WARNING**

**Dispose of fuel-soaked rags, paper, etc., in an appropriate air tight, fire retardant container. Fuel-soaked items may spontaneously ignite and result in a fire hazard which could cause serious bodily injury or death.**

1. Loosen bleeder valve on fuel filter header flange.
2. Move plunger on hand pump/primer up and down repeatedly, until an air free stream of fuel flows from bleeder valve. Filter is full when this occurs.




76105

a - Bleeder Valve
b - Hand Pump/Primer

3. Retighten bleeder valve.

**⚠WARNING**

**Make sure no fuel leaks exist before closing engine hatch.**

## Replacing

**⚠WARNING**

**Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire. This eliminates the engine wiring as a potential source of ignition.**

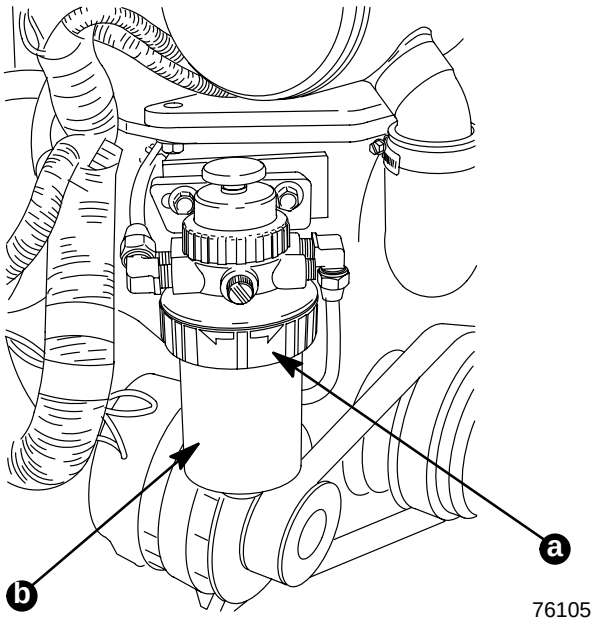
**⚠WARNING**

**Be careful when changing water separating fuel filter; diesel fuel is flammable. Be sure that the ignition key is OFF. DO NOT smoke or allow sources of open flame in the area while changing fuel system components. Wipe up any spilled fuel immediately. DO NOT allow fuel to come into contact with any hot surface which may cause it to ignite.**

**⚠WARNING**

**Dispose of fuel-soaked rags, paper, etc., in an appropriate air tight, fire retardant container. Fuel-soaked items may spontaneously ignite and result in a fire hazard which could cause serious bodily injury or death.**

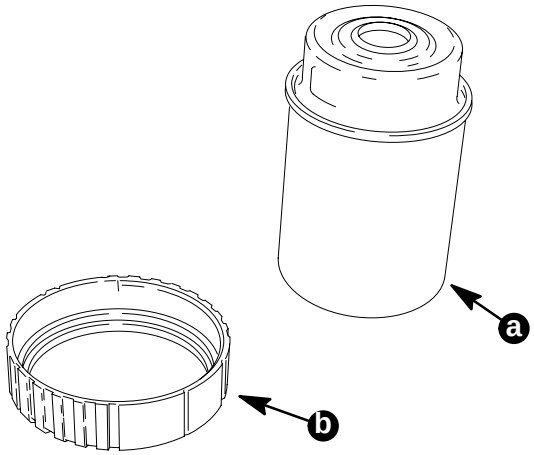
1. Remove filter retaining ring.




76105

a - Retaining Ring
b - Filter

2. Pull down on filter to remove it.
3. Clean filter sealing surface on fuel filter adapter.
4. Install new gasket.
5. Install new filter and secure with retaining ring.




76114

a - Filter
b - Retaining Ring

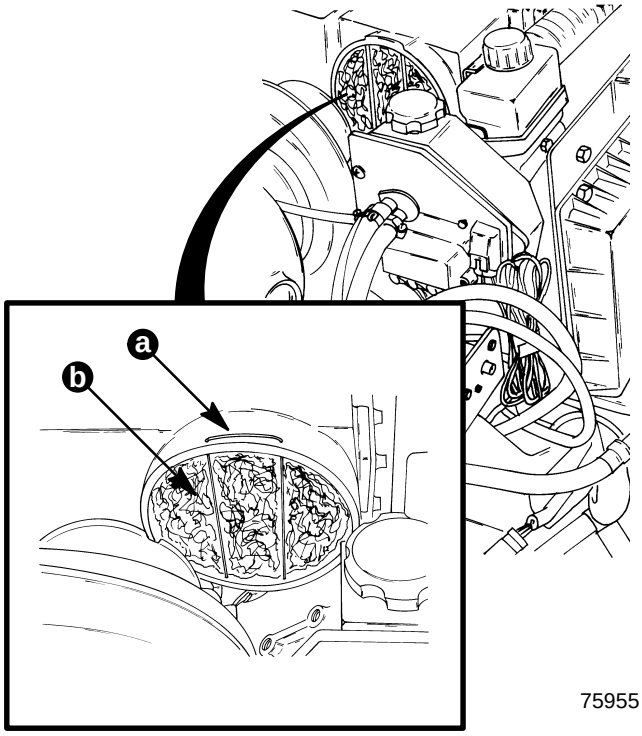
6. Fill fuel filter as outlined previously.
7. Start and run engine. Check filter connections for fuel leaks. If leaks exist, recheck filter installation and correct as needed.

**⚠ WARNING**

**Make sure no fuel leaks exist before closing engine hatch.**

## Clean/Replace Air Filter

1. Remove wire retainer that secures air cleaner element.




75955

a - Wirer Retainer
b - Filter Element

2. Carefully remove air cleaner element from around air intake screen housing mounted on the aftercooler air inlet.

3. Inspect element for tears or holes.

**IMPORTANT: Replace the element if it is deteriorated or torn. (Refer to MAINTENANCE - "Maintenance Schedules" for replacement interval under normal conditions.)**

4. Wash element in warm water and detergent until clean.

**IMPORTANT: No treatment (such as partial oil saturation) is required or recommended on air cleaner element prior to use. Use element clean and dry for proper filtration.**

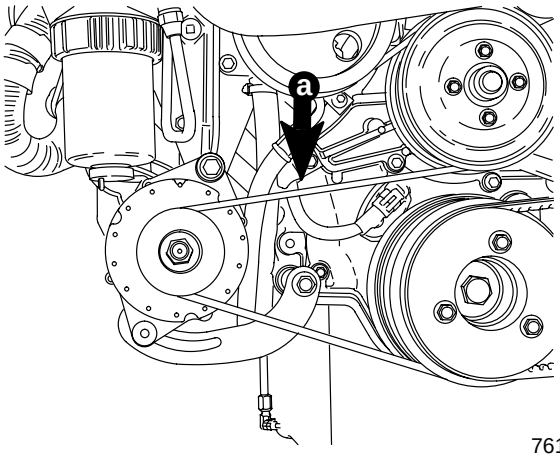
5. Allow element to completely dry before use and install around air intake screen.
6. Inspect installation to ensure engine draws in filtered air only.

## Inspect Drive Belts

**⚠ WARNING**

**Make sure engine is stopped and ignition key is removed.**

1. Visually inspect all drive belts for cracks, glazing, fraying or separation.
2. Check drive belts for proper tension by pressing at center point between pulleys. Belt(s) must not deflect more than 3/16 in. (5 mm).




76117

a - Drive Belt

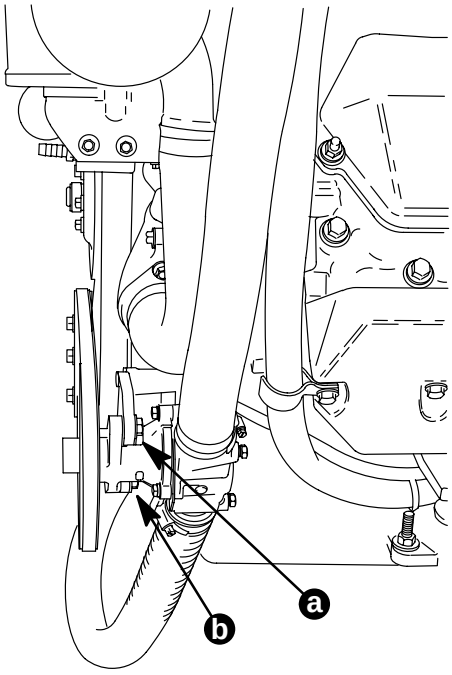
## Replace Drive Belts

Belt and Pulley Replacement Guidelines:

- Do not use belt dressing.
- Always check condition of remaining belts. Replace belt if worn, cracked, grease- or oil-soaked.
- When replacing belt and pulley, pulley alignment must be checked under tensioned condition (brackets securely clamped). A misalignment that can be detected by visual inspection is detrimental to belt performance.
- If belt is disturbed for any reason, it must be tensioned to the correct tension.
- Replace pulleys if worn, or clean if still suitable for service.

### SEAWATER PUMP BELT

1. Loosen mounting bolt on seawater pump.
2. Loosen tensioning bolt on seawater pump.




76107

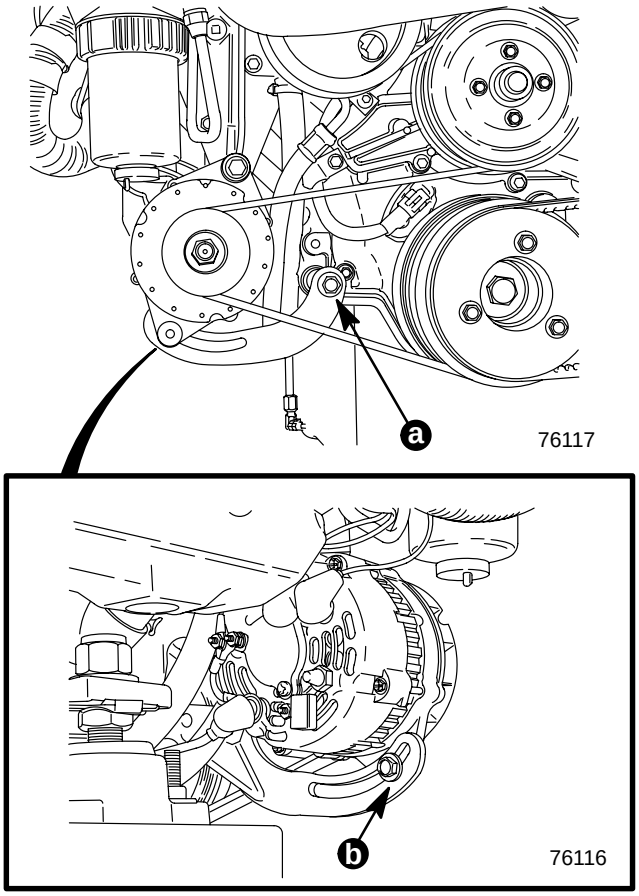
a - Seawater Pump Mounting Bolt
b - Seawater Pump Tensioning Bolt

3. Move or pry seawater pump to loosen belt.
4. Remove seawater pump belt.
5. Install new seawater pump belt.
6. Move or pry seawater pump to adjust belt. Tighten tensioning bolt and mounting bolt on seawater pump securely.

7. Check belt tension. Approximately 3/16 in. (5 mm) deflection should be measured at midpoint between the pulleys on the longest span. Refer to “Inspect Drive Belts” as previously outlined.

### ALTERNATOR BELT

1. Remove seawater pump belt.
2. Loosen alternator mounting hardware.



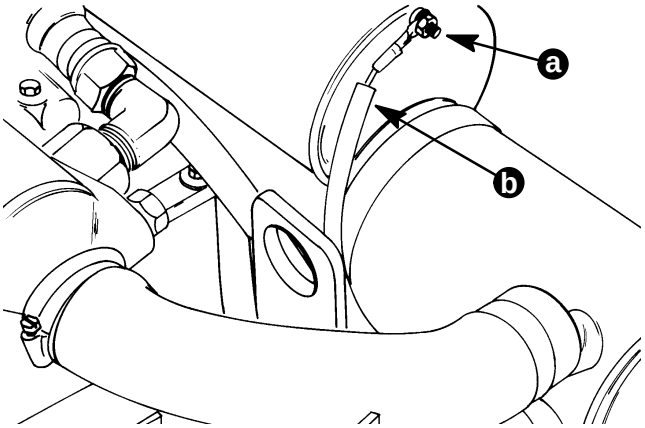

a - Alternator Mounting Hardware
b - Alternator Tensioning Bolt

3. Loosen alternator tensioning bolt.
4. Move or pry alternator to loosen belt.
5. Remove alternator belt.
6. Install new alternator belt.
7. Move or pry alternator to adjust belt. Tighten tensioning bolt and mounting bolt securely.
8. Check belt tension. Approximately 3/16 in. (5 mm) deflection should be measured at midpoint between the pulleys on the longest span. Refer to “Inspect Drive Belts” as previously outlined.
9. Reinstall seawater pump belt.

## Inspect/Replace Cooling System Sacrificial Anodes

### COOLANT TANK / HEAT EXCHANGER GROUND CIRCUIT

On the top starboard side of the heat exchanger a stud is provided with a wire connection made to the ground stud on the alternator. Inspect the BLACK wire for a loose connection, or if it is broken or frayed. Repair as needed.

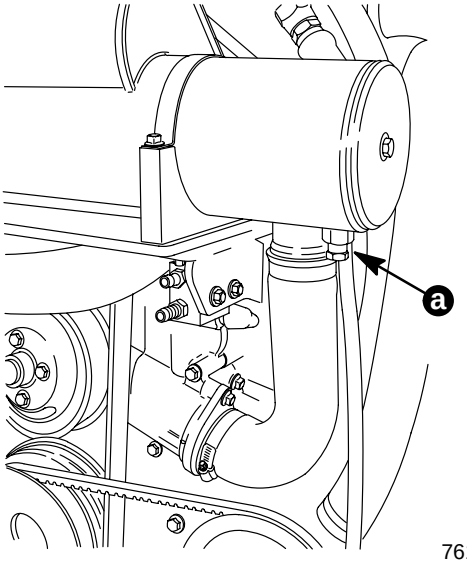



a - Heat Exchanger Ground Circuit Stud
b - BLACK Wire Connection to Alternator Ground Stud

## Coolant Tank / Heat Exchanger Anode

### INSPECTION

The sacrificial anode is located at the bottom port side of the heat exchanger.

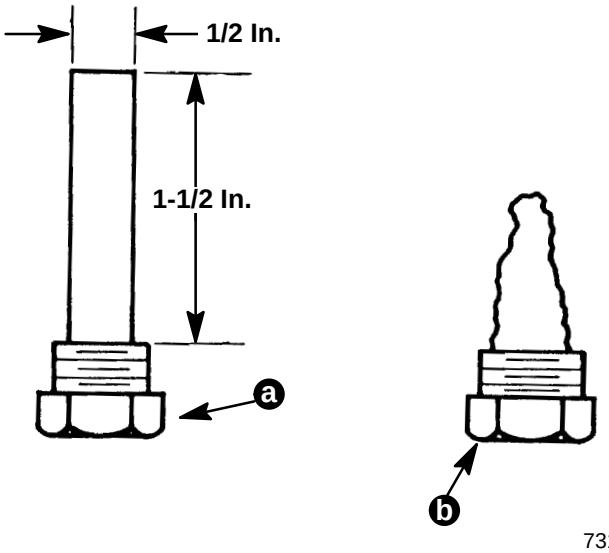



76108

a - Hose - To Circulating Pump

### REPLACEMENT

1. With the engine cold, remove sacrificial anode and inspect for deterioration.
2. Replace anode assembly when deteriorated 50%.



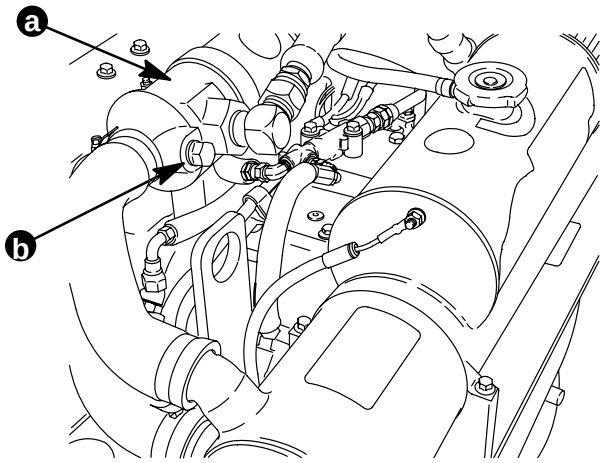

73192

a - New Anode Assembly
b - Example of a Deteriorated Anode

## Oil Cooler Anode

### INSPECTION

The sacrificial anode is located at the top starboard side of the oil cooler.

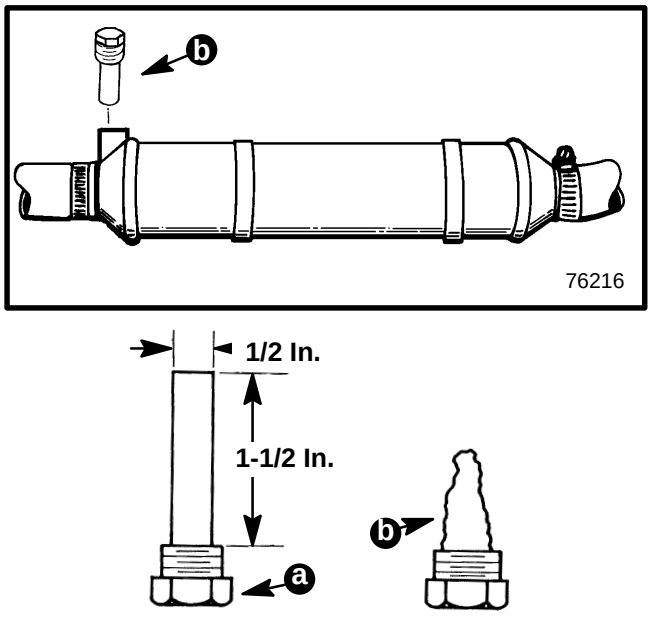



76120

a - Engine Oil Cooler
b - Sacrificial Anode

### REPLACEMENT

1. With the engine cold, remove sacrificial anode and inspect for deterioration (Refer to “Inspection” for location, as previously shown.).
2. Replace anode assembly when deteriorated 50%.




73192

a - New Anode Assembly
b - Example of a Deteriorated Anode

## Corrosion and Corrosion Protection

1. After first cleaning all surfaces, check all metal surfaces and touch up with Quicksilver Paint as necessary.
2. To maintain a corrosion protective coating on all metal surface areas, spray with Quicksilver Corrosion Guard.

**NOTICE**

**For additional information on Drive Unit corrosion protection and external corrosion protection refer to appropriate Stern Drive Service Manual.**

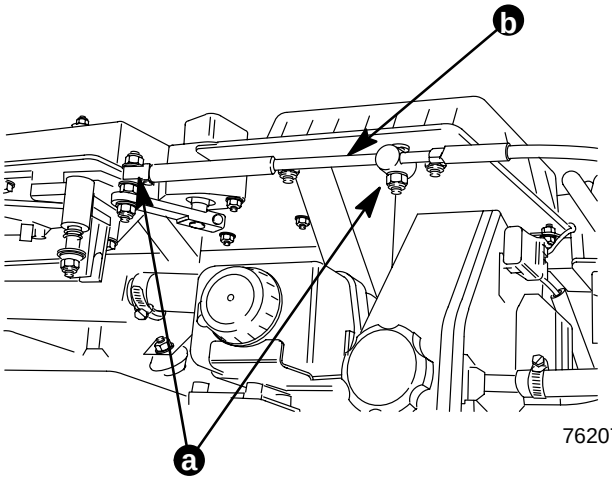
## Check Battery

1. Check battery connections to ensure they are clean and tight.
2. Keep exterior surfaces of battery wiped clean with a water/baking soda solution.
3. Ensure battery is securely fastened in place.
4. Refer to battery manufacturer's recommendations for fluid levels and charging.

## Lubrication

### THROTTLE CABLE

Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.

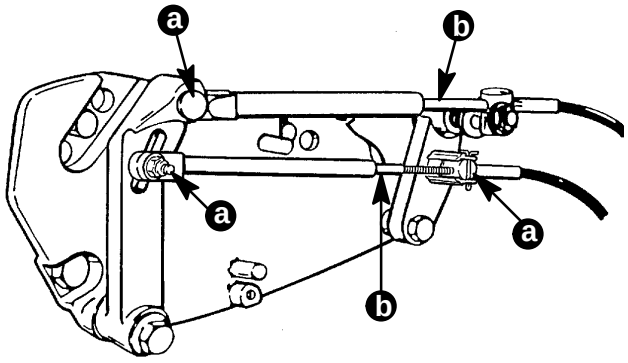



76207

a - Pivot Points
b - Guide Contact Surfaces

### SHIFT CABLE

Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.

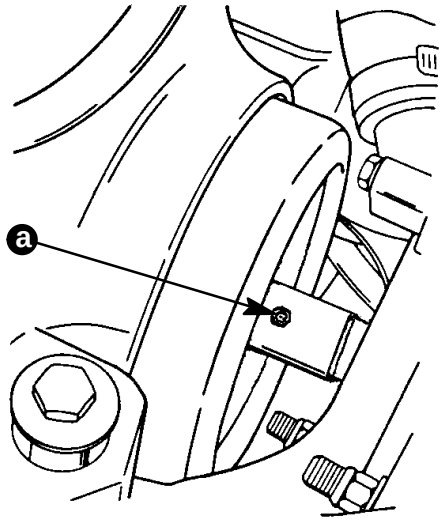



72016

a - Pivot Points
b - Guide Contact Surface

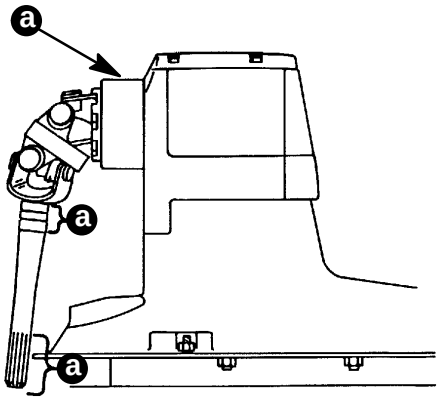
### ENGINE COUPLER/U-JOINT SHAFT SPLINES

***NOTE:*** *Refer to MerCruiser Stern Drive Service Manual for stern drive unit removal and installation.*




73346

a - Quicksilver Engine Coupler Spline Grease




72531

a - Quicksilver Engine Coupler Spline Grease

# Freezing Temperature and Cold Weather Operation

**IMPORTANT: If boat is operated during periods of freezing temperature, precautions must be taken to prevent freezing damage to power package. Refer to the following and to "Cold Weather or Extended Storage" for related information and draining instructions.**

In order to operate the engine in temperatures of 32°F (0°C) or lower, observe the following instructions:

**⚠CAUTION**

**Seawater (raw water) section of cooling system MUST BE COMPLETELY drained for winter storage or immediately after cold weather use, if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.**

1. At the end of each daily operation, COMPLETELY drain seawater section of the cooling system and the seawater strainer to protect against damage by freezing. Refer to Section 6A, and the precautionary statement above.

**⚠CAUTION**

**If boat is in the water, seacock (water inlet valve), if so equipped, must remain closed until engine is to be re-started to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.**

2. At the end of each daily operation, drain water from water separator, if equipped. Fill fuel tank at end of daily operation to prevent condensation.
3. Closed cooling section of engine must be filled with specified coolant or a mixture of antifreeze/water solution sufficient to prevent freezing to the coldest temperature of the user area.
4. Be sure to use proper cold weather lubrication oil, and be sure the crankcase contains a sufficient amount.

5. Make certain that the battery is of sufficient size and is fully charged. Check that all other electrical equipment is in optimum condition.
6. At temperatures of –4°F (–20 C) and below, it is recommended that you use the crankcase mounted coolant heater to improve cold starting.
7. If operating in arctic temperatures of –20°F (–29°C) or lower, consult your dealer for information about special cold weather equipment and precautions.

## Saltwater Operation

Seawater section must be flushed after each use. Refer to “Flushing Seawater Cooling System”.

## Cold Weather or Extended Storage

**PRECAUTIONS**

**⚠CAUTION**

**Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.**

**⚠CAUTION**

**If boat is in the water, seacock (water inlet valve), if so equipped, must remain closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.**

**IMPORTANT: Observe the following information to ensure complete draining of cooling system.**

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.**

**IMPORTANT: To prevent threads in cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.**

***NOTE:*** *If possible, place a container under drains and hoses to prevent water from draining into boat.*

**⚠CAUTION**

**Closed cooling section of engine must be kept filled with specified coolant to protect engine to lowest temperature to which it will be exposed. DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.**

**⚠CAUTION**

**A discharged battery can be damaged by freezing.**

## Layup

**NOTICE**

**Refer to “Cold Weather or Extended Storage,” “Precautions,” in this section, BEFORE proceeding.**

**IMPORTANT: This service should be performed by an authorized MerCruiser dealer.**

**⚠CAUTION**

**The engine must be prepared for long storage periods to prevent internal corrosion and severe damage.**

**⚠WARNING**

**Do not remove coolant cap when engine is hot; coolant may discharge violently causing severe burns.**

1. Slowly and carefully remove coolant tank cap from the heat exchanger. Be certain coolant level is to the bottom of the filler opening. If not, add specified coolant as necessary to achieve proper level.

**IMPORTANT: If boat has already been removed from water, before starting engine a source of water must be supplied to water intake (inlet) openings. Follow all warnings and flushing attachment procedures stated in "Flushing Seawater Cooling System."**

**⚠ CAUTION**

**DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.**

2. Start engine and run until it reaches normal operating temperature. Stop engine.
3. Change crankcase oil and oil filter (refer to "Changing Crankcase Oil and Oil Filter"). Be certain to fill engine with correct amount of recommended oil. Always use dipstick to determine exact amount of oil required.
4. Start engine and run at IDLE for about 15 minutes. Check for any oil leaks and correct as necessary.
5. Drain seawater section of cooling system and prepare for cold weather or extended storage following these procedures:

**IMPORTANT: Drain only the seawater section of the cooling system.**

**IMPORTANT: Closed cooling section must be kept filled year-round with specified coolant.**

**DRAINING INSTRUCTIONS**

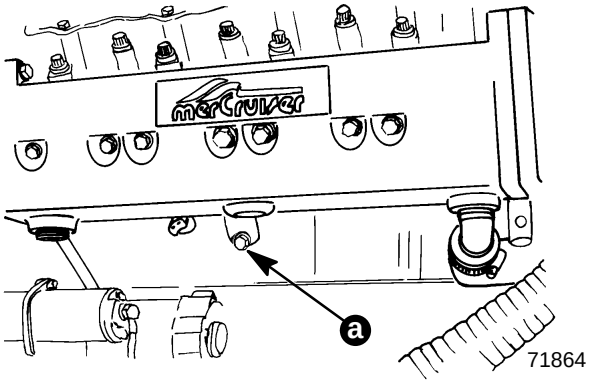
**⚠ CAUTION**

**If boat is to remain in the water, seacock, if so equipped, must be closed until engine is to be restarted to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve must be opened or the water inlet hose reconnected prior to starting the engine.**

**IMPORTANT: Observe the following information to ensure complete draining of seawater cooling system.**

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

1. Close seacock, if so equipped, or disconnect and plug seawater inlet hose, if boat is to remain in the water.
2. Do not remove either of the two drain plugs on the cylinder block [one port and one starboard]. **They are in the closed cooling section.**

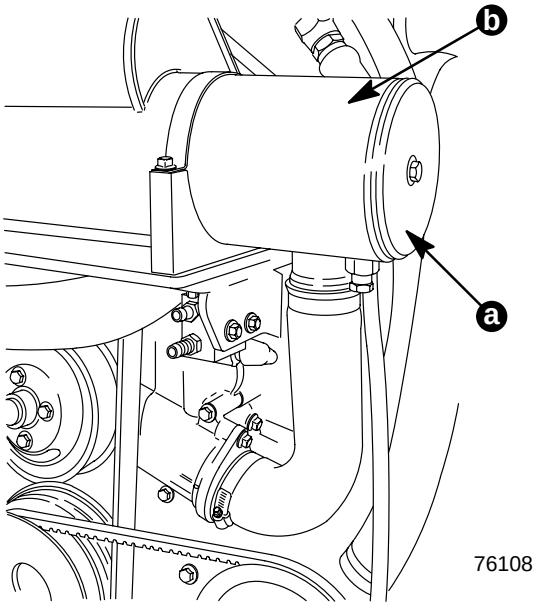



a - Crankcase Drain Plugs (Both Sides of Engine -Do Not Remove)

3. Remove the following:

**IMPORTANT: A wire should be repeatedly inserted into drain holes to ensure that foreign material is not obstructing the drain holes.**

a. Remove the end covers from both the port and starboard sides of heat exchanger. Drain tank completely.



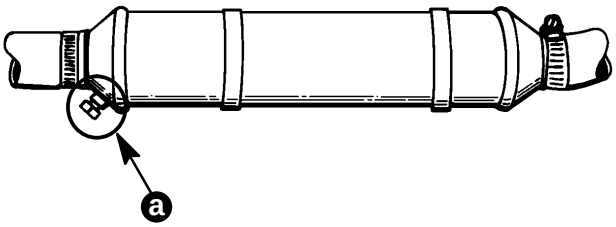

76108

**Port Side Shown (Starboard Similar)**

a - End Cover
b - Coolant Tank / Heat Exchanger

**IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.**

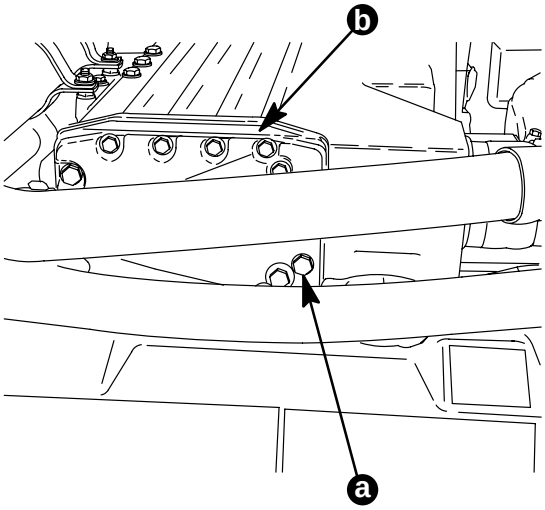
b. The drain plug on the lower side of the engine oil cooler.




71870

a - Engine Oil Cooler Drain Plug

c. The aftercooler drain plugs located on the starboard and port aftercooler side covers.




76122

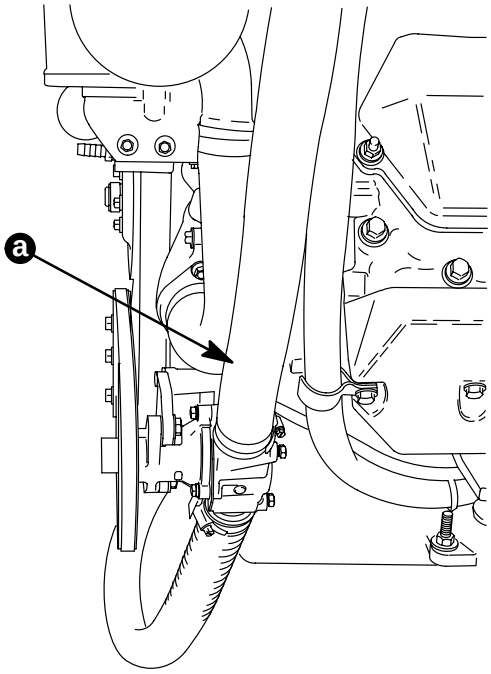
**Port Side Shown (Starboard Similar)**

a - Aftercooler Drain Plugs
b - Aftercooler Side Cover

4. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

***NOTE:*** *It may be necessary to lift or bend hoses to allow water to drain completely.*

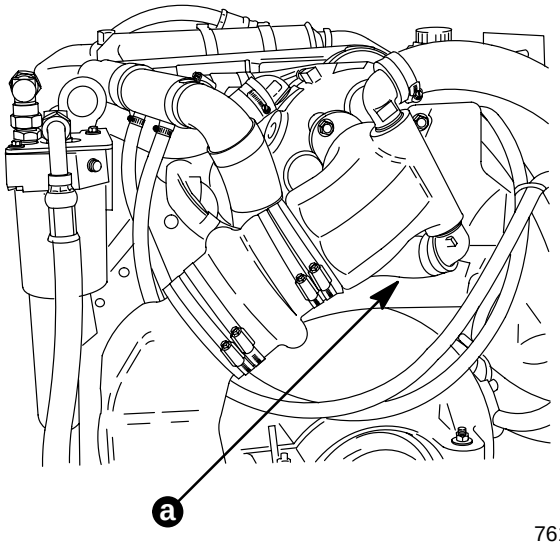
5. Remove seawater pump outlet hose from top of seawater pump and drain.




76107

a - Seawater Pump Outlet Hose

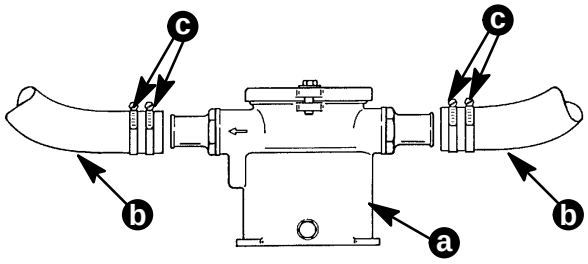
6. Disconnect seawater hose at bottom of exhaust elbow. Lower hose and drain completely.




76106

a - Seawater Hose Connected To Exhaust Elbow

7. Remove hose(s) at seawater strainer and drain hose (s) completely. Empty saewater stainer. Reconnect hose(s) and tighten hose clamp securely.




72691

a - Seawater Strainer
b - Hoses
c - Hose Clamps

8. Make sure that sterndrive unit pitot tube, trim tab cavity vent hole, and trim tab cavity drain passage are unobstructed and open.

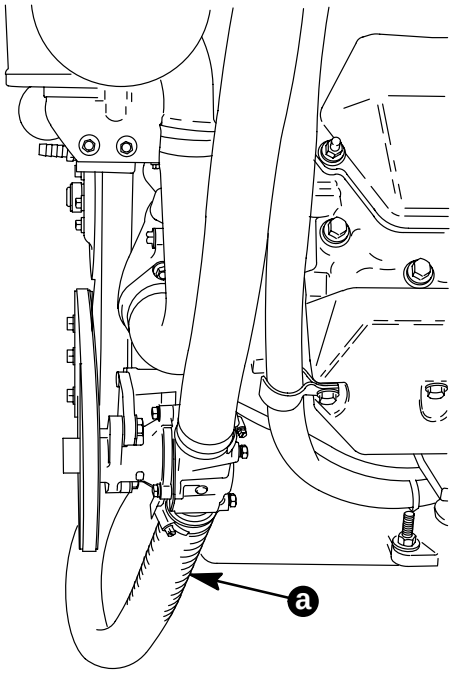
9. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Perfect Seal and reinstall. Tighten securely. Reconnect hoses. Tighten hose clamps securely. Replace end cover gaskets and seals if worn or deteriorated. Install end cover assemblies on the heat exchanger. Torque the end covers to 120-132 lb. in. (14-15 N·m).

10. After seawater section of cooling system has drained completely, coat threads of drain plugs previously removed with Quicksilver Perfect Seal, and reinstall. Tighten securely. Install all hoses previously removed and tighten hose clamps securely.

**IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in seawater section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.**

11. Fill a container with approximately 6 U.S. quarts (5.6 L) of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.

12. Disconnect hose from seawater inlet side of seawater pump. Using an adaptor, temporarily connect an appropriate length piece of hose to seawater pump and place the other end of the hose into container of coolant.

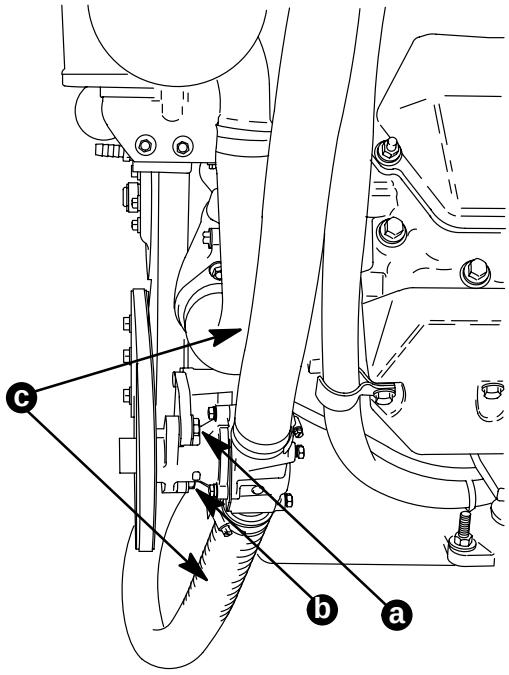



a - Seawater Pump Inlet Hose

**⚠ CAUTION**

**It is good practice to ventilate the engine compartment prior to servicing any engine components to remove any fuel vapors which may cause difficulty breathing or be an irritant.**

13. Start engine and run, AT IDLE SPEED, until antifreeze mixture has been pumped into engine seawater cooling system. Stop engine.
14. Clean engine and coat with Quicksilver Corrosion Guard or equivalent corrosion inhibiting oil.
15. Lubricate all items outlined in “Lubrication”.
16. Remove and store battery in a cool, dry place. Do not store on a concrete surface, or on the ground. Place on a dry, wood board or a thick plastic base (Refer to battery manufacturer’s instructions.)
17. Perform all checks, inspections, lubrication and fluid changes outlined in “Maintenance Schedule” under “At Least Once Yearly”.
18. Remove seawater pump and components as follows:
    a. Disconnect seawater pump hoses.
    b. Remove seawater pump mounting bolt and tensioning bolt. Remove seawater pump.

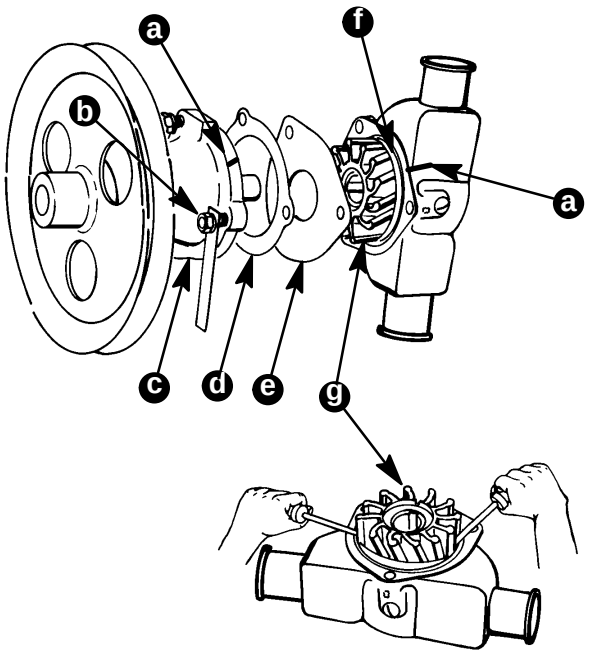



a - Mounting Bolt
b - Tensioning Bolt
c - Seawater Hoses

c. Make matching marks on pump cover and pump housing prior to disassembly (to aid in reassembly later). Remove the three seawater pump cover mounting screws. Remove cover (with pulley and shaft), gasket, and plate.

d. Take notice of O-ring, and location of O-ring in groove on housing.

e. Ease impeller out of pump body with two screwdrivers. Be careful not to damage pump impeller.




a - Matching Marks
b - Cover Screws
c - Cover
d - Gasket
e - Plate
f - O-Ring
g - Impeller

f. Reassemble the components, except for the impeller, for storage.

**IMPORTANT: Place a CAUTION TAG at instrument panel and in engine compartment stating that "Seawater Pump is Out - DO NOT Operate Engine."**

## BATTERY WINTER STORAGE

Follow battery manufacturer's instructions for storage. If not available, use the following instructions:

1. Be certain all electrical components are off, and ignition key is in OFF position.
2. To avoid possible electrical system damage, FIRST remove the NEGATIVE (–) battery cable, and NEXT remove the POSITIVE (+) battery cable. Remove the battery.
3. Remove dirt and grease from top surface of battery.
4. Follow battery manufacturer's recommendations and add distilled water, if needed.
5. Grease cable ends and bolts.
6. Store battery in a cool, dry place. Do not store on a concrete surface, or on the ground. Place on a dry wood board or a thick plastic base.

**⚠CAUTION**

**A discharged battery can be damaged by freezing.**

7. Every 30 to 45 days, check water level and recharge battery according to manufacturer's specifications. Do not fast charge.

If you cannot perform the above service, contact your authorized MerCruiser dealer or local automotive garage.

# Recommissioning

**NOTICE**

**Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.**

1. Reinstall seawater pump components and pump as follows:

***NOTE:*** *Use new gasket and O-ring. Install in correct position.*

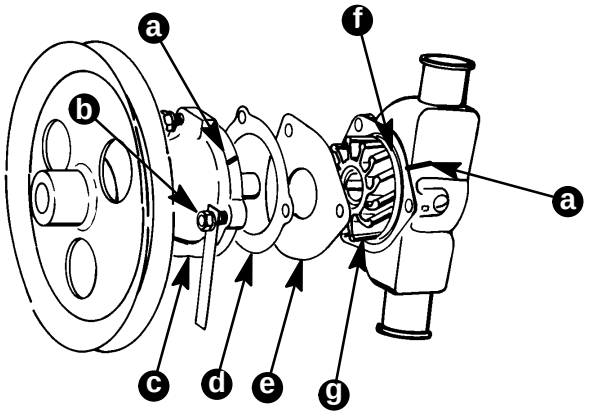
   a. Place impeller in pump housing.

   b. Install new O-ring in groove on housing.

   c. Install pump plate, with new gasket in position.

   d. Engage pump shaft key in impeller keyway and install seawater pump cover. Align matching marks made prior to disassembly.

   e. Install the three seawater pump cover mounting screws. Tighten securely.

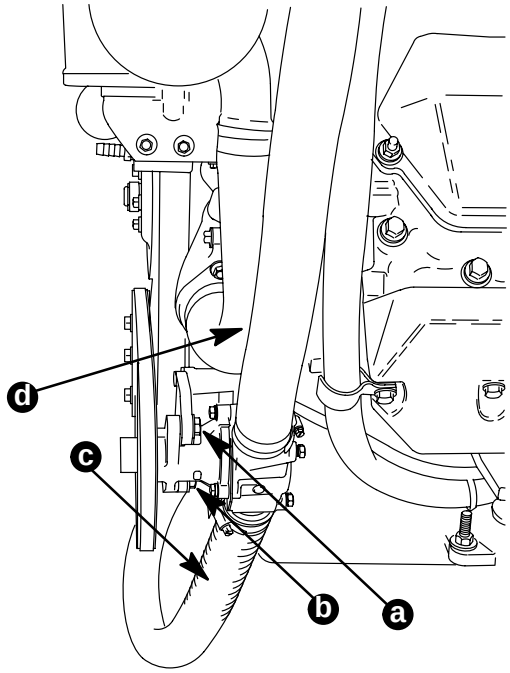



76202

a - Matching Marks
b - Cover Screws
c - Cover
d - Gasket
e - Plate
f - O-Ring
g - Impeller

   f. Install pump on engine using mounting bolt and tensioning bolt with hardware. Tension drive belt. Tighten fasteners securely.

   g. Connect seawater hoses.

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a - Mounting Bolt
b - Tensioning Bolt
c - Seawater Inlet Hose
d - Seawater Outlet Hose

2. Check that all cooling system hoses are in good condition and connected properly, hose clamps are tight, and all petcocks and drain plugs are installed and tight.

3. Inspect all drive belts.

4. Perform all lubrication and maintenance specified for completion "At Least Once Yearly" in "Maintenance Schedule," except items which were performed at time of engine layup.

5. Fill fuel tank(s) with fresh diesel fuel. Old fuel should not be used. Check fuel lines and connections for leaks and general condition.

6. Replace fuel filter as outlined previously in this section.

7. For drive unit, refer to appropriate Stern Drive Service Manual.

**⚠ CAUTION**

**When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.**

8. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.
9. Perform all checks on OPERATION CHART in the STARTING PROCEDURE column in Operation and Maintenance Manual.

**IMPORTANT: Avoid starter motor overheating. DO NOT engage starter for more than 15 seconds; allow at least one minute cool-down time before re-engaging starter for another 15 seconds.**

**⚠ CAUTION**

**DO NOT operate engine without water flowing thru seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or transmission may result.**

10. Start engine and closely observe instrumentation to make sure that all systems are functioning correctly.
11. Carefully inspect engine for fuel, oil, fluid, water and exhaust leaks.
12. Check steering system, shift and throttle control for proper operation.

# IMPORTANT INFORMATION

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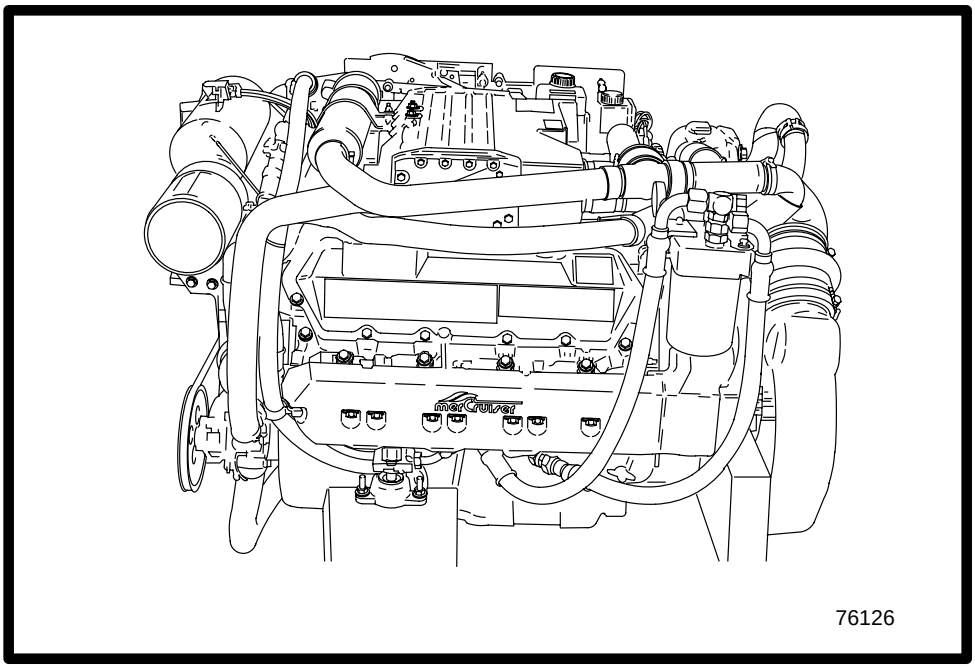


## TROUBLESHOOTING

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# Precautions

**⚠WARNING**

**Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.**

**⚠WARNING**

**Always disconnect battery cables from battery before working around electrical system components to prevent injury to yourself or damage to electrical system.**

**⚠WARNING**

**Be careful when changing fuel system components; diesel fuel is flammable. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel system components. Wipe up any spilled fuel immediately. DO NOT allow fuel to come into contact with any hot surface which may cause it to ignite.**

**⚠WARNING**

**Avoid diesel fuel fire. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedure, given in Section 4 of this manual, for all fuel line connections.**

# Fuel Supply Connections

**⚠WARNING**

**Avoid diesel fuel fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.**

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

**⚠WARNING**

**FIRE HAZARD: Fuel leakage from any part of the fuel system can be a fire hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, primers, fittings, and fuel filters should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.**

**⚠WARNING**

**Dispose of fuel-soaked rags, paper, etc., in an appropriate air tight, fire retardant container. Fuel-soaked items may spontaneously ignite and result in a fire hazard which could cause serious bodily injury or death.**

**⚠WARNING**

**Make sure no fuel leaks exist before closing engine hatch.**

**⚠CAUTION**

**DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out of water, if instructions for running engine with boat out of water, below, are followed.**

**⚠WARNING**

**When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.**

**⚠CAUTION**

**DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.**

**⚠WARNING**

**Be sure that engine compartment is well ventilated and that no diesel fuel vapors are present to prevent the possibility of a FIRE or EXPLOSION.**

**⚠WARNING**

**DO NOT leave helm unattended while performing idle speed adjustment.**

**⚠WARNING**

**Safety glasses should be worn while working on fuel injection system. The fuel injection pump will generate pressures in excess of 2000 PSI (13790 kPa). Use caution when removing injectors, injector lines, or bleeding air from injection system.**

# Poor Boat Performance and/or Poor Maneuverability

| Symptom | Cause |
|---|---|
| 1. Bow too low | 1. A. Improper drive unit trim angle<br>B. Improper weight distribution<br>C. Boat is underpowered<br>D. Permanent or power hook in boat bottom<br>E. False bottom full of water<br>F. Improperly adjusted trim tabs (after planes) |
| 2. Bow too high | 2. A. Improper drive unit trim angle<br>B. Propeller pitch too great<br>C. Dirty boat bottom (marine growth)<br>D. Poor running engine<br>E. Improper weight distribution<br>F. Rocker in boat bottom<br>G. False bottom full of water<br>H. Improperly adjusted trim tabs (after planes) |
| 3. Propeller ventilating | 3. A. Drive unit installed too high on transom<br>B. Dirty or rough boat bottom<br>C. Damaged propeller; pitch too small; diameter too small<br>D. Keel located too close to propeller or too deep in the water<br>E. Water pickup or accessories located too close to propeller<br>F. Hook in boat bottom<br>G. Propeller plugged up with weeds |

# Improper Full Throttle Engine RPM

## RPM Too High

| Cause | Special Information |
|---|---|
| 1. Propeller | 1. Damaged; pitch too low; diameter too small; propeller hub slipping. |
| 2. Boat | 2. A. Water pickup or accessories mounted too close to propeller (ventilation)<br>B. Keel located too close to propeller and/or too deep in the water (ventilation).<br>C. Drive installed too high on transom;<br>D. Wrong gear ratio. |
| 3. Operation | 3. Unit trimmed out too far. |
| 4. Engine coupler slipping | |

## RPM Too Low

| Symptom | Cause |
|---|---|
| 1. Propeller | 1. Damaged; pitch too great; diameter too great |
| 2. Boat | 2. A. Dirty or damaged bottom<br>B. Permanent or power hook in bottom<br>C. False bottom full of water<br>D. Drive installed too low |
| 3. Operation | 3. Unit trimmed in too far |
| 4. Scan Tool | 4. Refer to Section 5 for complete diagnostic procedures. |

# Engine Cranks Over but Will Not Start or Starts Hard

## Important Information

Determine which engine system is causing the problem. To make an engine run, basic components - fuel, glow plugs, compression, and high pressure oil system current are required. If all are present, the engine should run. If any are missing, weak, or arriving at the wrong time, the engine will not run.

## Electrical

| Cause | Special Information |
|---|---|
| 1. Battery, electrical connections, damaged wiring | 1. Discharged or improperly rated battery. Battery cable size improper. |
| 2. Ignition switch | |
| 3. Glow plugs inoperative | |
| 4. CMP Sensor | 4. Defective sensor or sensor wiring. |

## Fuel System

| Cause | Special Information |
|---|---|
| 1. Empty fuel tank | |
| 2. Fuel shutoff valve closed (if equipped) | |
| 3. Low grade, stale fuel or water in fuel | |
| 4. Fuel waxing or frozen water separator (cold weather) | |
| 5. Plugged fuel suction line or filter | |
| 6. Air leaks, suction side fuel line or water separator | 6. Sucks air into fuel system reducing fuel volume |
| 7. Plugged or pinched fuel line (feed or return) | |
| 8. Fuel tank vent plugged | 8. Engine will start initially. After a short time running,engine will stall and will not restart for a period of time. Can verify if it is a vent problem by running engine with filler cap loose. Filler cap will act as a vent. |
| 9. Fuel supply pump | 9. Low pump pressure. |

## Miscellaneous

| Cause | Special Information |
|---|---|
| 1. Low grade or stale fuel | |
| 2. Water in fuel | |
| 3. Incorrect starting procedure | 3. Refer to Owners Manual. |
| 4. Internal mechanical damage (bent rods, etc.) | |
| 5. Low compression | 5. Worn valves, rings, cylinder, or head gasket |
| 6. Valve timing incorrect | 6. Timing gears improperly installed or cam slipped in drive gear |
| 7. Restricted or plugged exhaust | |

# Engine Will Not Crank Over or Starter Inoperative

| Cause | Special Information |
|---|---|
| 1. Remote control lever not in neutral position | |
| 2. Battery charge low; damaged wiring; loose electrical connections | |
| 3. Circuit breaker tripped | |
| 4. Blown fuse | |
| 5. Ignition switch | |
| 6. Slave solenoid | |
| 7. Faulty neutral start safety switch | 7. Open circuit |
| 8. Starter solenoid | |
| 9. Starter motor | |
| 10. Engine mechanical malfunction | |