Workshop Manual
Electrical, Carburetor & Ignition

3.0GS-A/B/C, 3.0GL-A/B/C
4.3GL-A/B/C/D
5.0GL-A/B/C/D/E
5.7GL-A/B/C/D/E
Model Identification

All stern drive system components must be matched for either single or dual engine installations. Failure to properly match engine, transom bracket and stern-drive will result in poor boat performance, and risk damage to engine and drive because of incorrect drive gear ratio.

Model identification is located on the engine, and MUST correspond with the transom shield and stern-drive numbers as listed in the Product Matrix sheet available separately.

Engine Model Number

All Engine Models

Gi, GXi, OSI and OSXi Models

Emission Control Labels

GL Models
Emission Control Labels
Gi, GXi, OSi and OSXi Models

Transom Shield Model Number Location

Sterndrive Model Number Location

SX and DP-S

XDP-B
# General Information

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Introduction

This service manual is divided into sections concerning various systems and assemblies. Refer to the Table Of Contents to locate the section covering the system or assembly requiring service. Each section title page has an additional listing that will describe the section's contents in more detail. Be sure to read Safety Information on page i at the beginning of this manual, and pay special attention to all safety warnings as they appear throughout the text. Since models are subject to change at any time, some photos may not depict actual product.

Good Service Practice

Service required for stern drives is generally one of three kinds:

- **Normal care and maintenance** - which includes putting a new stern drive into operation, storing engines, lubrication, and care under special operating conditions such as salt water and cold weather.

- **Operating malfunctions** - due to improper engine or drive mounting, propeller condition or size, boat condition, or the malfunction of some part of the engine. This includes engine servicing procedures to keep the engine in prime operating condition.

- **Complete disassembly and overhaul** - such as major service or rebuilding a unit.

It is important to determine before disassembly just what the trouble is and how to correct it quickly, with minimum expense to the owner.

When repairing an assembly, the most reliable way to ensure a good job is to do a complete overhaul on that assembly, rather than just to replace the bad part. Wear not readily apparent on other parts could cause malfunction soon after the repair job. Repair kits and seal kits contain all the parts needed to ensure a complete repair, to eliminate guesswork, and to save time.

Repair time can also be minimized by the use of special tools. Volvo Penta special tools are designed to perform service procedures unique to the product that cannot be completed using tools from other sources. They also speed repair work to help achieve service flat rate times. In some cases, the use of substitute tools can damage the part.

**Note! Do not operate engine out of water even momentarily. If operated in test tank, use proper test wheel. Failure to do so can damage water pump, overheat engine, or allow excessive engine RPM.**

Preparation for Service

Proper preparation is extremely helpful for efficient service work. A clean work area at the start of each job will minimize tools and parts becoming misplaced. Clean an engine that is excessively dirty before work starts. Cleaning will occasionally uncover trouble sources. Obtain tools, instruments and parts needed for the job before work is started. Interrupting a job to locate special tools or repair kits is a needless delay.

**WARNING!**

*Use proper lifting and handling equipment. Working on stern drives without proper equipment can cause damage and personal injury.*

Always use clean fresh fuel when testing engines. Troubles can often be traced to the use of old or dirty fuel.
Service Policy
It is a policy of Volvo Penta to provide dealers with service knowledge so they can give professional service demanded by today’s consumer. The Volvo Penta Training Centers, frequent mailing of Service Bulletins, Letters and Promotions, Special Tools and this Service Manual represent our continuing efforts to assist dealers in giving consumers the best and most prompt service possible. If a service question does not appear to be answered in this manual, you are invited to write to the Volvo Penta Service Department for additional help. Always be sure to give complete information, including engine model number and serial number.

When a brand-name product or specific tool is called for, another item may be used. However, the substitute must have equivalent characteristics, including type, strength, and material. You must determine if incorrect substitution could result in product malfunction and personal injury to anyone. To avoid hazards, equivalent products which are used must meet all current U.S. Coast Guard Safety Regulations and ABYC standards.

Replacement Parts

CAUTION!
When replacement parts are required, always use genuine Volvo Penta parts, or parts with equivalent characteristics, including type, strength, and material. Failure to do so may result in product malfunction and possible injury to the operator and/or passengers.

Parts Catalogs
Parts Catalogs contain exploded views showing the correct assembly of all parts, as well as a complete listing of the parts for replacement. These catalogs are helpful as a reference during disassembly and reassembly, and are available from Volvo Penta Parts.

Special Service Tools
Volvo Penta has specially designed tools to simplify some of the disassembly and assembly operations. These tools are illustrated in this Service Manual, in many cases in actual use. All Volvo Penta special tools can be ordered from Volvo Penta Parts. Individual purchasers of Service Manuals must order Special Tools through an authorized dealer.

Product References, Illustrations & Specifications
Volvo Penta reserves the right to make changes at any time, without notice, in specifications and models and also to discontinue models. The right is also reserved to change any specifications or parts at any time without incurring any obligation to equip same on models manufactured prior to date of such change. All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

All photographs and illustrations used in this manual may not depict actual models or equipment, but are intended as representative views for reference only. The continuing accuracy of this manual cannot be guaranteed.

Tuning The Engine
The purpose of an engine tune-up is to restore power and performance that has been lost through wear, corrosion or deterioration of one or more parts or components. In the normal operation of an engine, these changes can take place gradually at a number of points, so that it is seldom advisable to attempt an improvement in performance by correction of one or two items only. Time will be saved and more lasting results will be obtained by following a definite and thorough procedure of analysis and correction of all items affecting power and performance. Refer to the Engine Service Manual for all tune-up specifications.
Gasoline Requirements

⚠️ DANGER!

Gasoline is extremely flammable and highly explosive under certain conditions. Always stop engine and do not smoke or allow open flames or sparks near the boat when refuelling gas tanks. When filling the gas tank, ground the tank to the source of gasoline by holding the hose nozzle firmly against the side of the deck filler plate, or ground it in some other manner. This action prevents static electricity buildup which could cause sparks and ignite fuel vapors.

USE ONLY UNLEADED FUEL. Use lead-free gasoline with the following minimum or higher octane specification:

Inside the U.S.: \((R+M)/2\) (AKI) = 87
Outside the U.S.: (RON) = 90

If fuels with 89 AKI pump posted (93 RON) octane number or higher are used an increase in power can be expected with EFI models.

Premium fuels contain injector cleaners and other additives that protect the fuel system and provide optimum performance.

⚠️ Caution!

Engine damage resulting from the use of gasoline with octane 86 AKI (89 RON) and lower is considered misuse of the engine and will void the engine warranty. Volvo Penta suggests the use of 89 AKI or higher fuels. These fuels have additives that are beneficial to maximum engine performance and long life of service components.

To prevent gum formation and corrosion in the fuel system, use a Marine Fuel Stabilizer in the gasoline.

Gasoline Containing Alcohol

Many gasoline types being sold today contain alcohol. Two commonly used alcohol additives are Ethanol (ethyl alcohol) and Methanol (methyl alcohol).

See the Owner’s Manual for your boat to determine if the boat’s fuel system is compatible with alcohol blended fuels. If it is compatible, your engine may be operated using gasoline blended with no more than 10% Ethanol (ethyl alcohol) meeting the minimum octane specification. Do not use any gasoline which contains METHANOL (methyl alcohol).

⚠️ WARNING!

Serious damage to the boat or engine fuel systems will result from the continued use of fuel containing METHANOL (methyl alcohol).

If you use gasoline containing alcohol, be aware of the following:

- The engine will operate leaner with alcohol blended fuel. This may cause engine problems such as vapor lock, low speed stall, or hard starting.
- Alcohol blended fuels attract and hold moisture. Moisture inside fuel tanks can cause corrosion of the tank material. Inspect fuel tanks at least annually. Replace fuel tanks if inspection indicates leakage or corrosion.
- Inspect non-metallic parts of fuel system frequently and replace if excessive stiffness, deterioration or fuel leakage is found.

⚠️ WARNING!

Fuel leakage can contribute to a fire and/or explosion.
Battery and Cables

Special Tools Required: Battery Hydrometer

The primary function of the battery is to provide power to operate the starter motor. The battery also supplies power to operate the lights and other electrical equipment which may be used when the engine is not running. On battery ignition systems, the battery must supply the ignition current during the starting period and during the time that the alternator is not producing a sufficient charge to meet operating requirements.

Battery Requirements
3.0 GS/GL, & 4.3 GL MODELS ONLY

- Use a 12 volt battery having a minimum rating of 360 Cold Cranking Amps at 0° F (-18° C), and a 115 minute reserve capacity rating at 80° F (27° C).

ALL OTHER MODELS

- Use a 12 volt battery having a minimum rating of 650 Cold Cranking Amps at 0° F (-18° C), and a 165 minute reserve capacity rating at 80° F (27° C).

Battery Maintenance

There are two things which must be done periodically in order to obtain long life from a battery.

1. The electrolyte must be kept above the plates and separators at all times. The liquid level should be brought up to the level specified by the battery manufacturer. Acid should never be added except when it is definitely known that some has been lost by spilling, and then only by an experienced battery man.

   CAUTION!

   Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

2. Be sure that the battery is kept nearly at full charge at all times. The state of charge should be checked at frequent intervals by making specific gravity readings with a battery hydrometer. It is suggested that gravity readings and replacement of evaporated water be made every two weeks. Should the gravity fall more than 0.040 specific gravity below a fully charged gravity reading, remove the battery and have it charged.

   Note! Full charge specific gravity is 1.260 at 80° F (27° C).
WARNING!
Do not use a jumper cable and a booster battery to start engine. Remove battery from boat and recharge. Fumes vented during charging battery can lead to an explosion.

Good Battery Servicing Includes the Following Nine Points:
1. Protect boat against acid damage.
2. Clean battery.
3. Inspect cables.
4. Clean terminals.
5. Inspect hold-downs.
6. Inspect casing for leaks.
7. Carry out hydrometer test.
8. Remove battery from boat for tests. Recharge battery if less than 3/4 charged. Make load test.
9. Add water.

If battery is not in a good state of charge or if it uses an excessive amount of water, check the charging system.

Clean the battery and terminals with a solution of baking soda and water. This will neutralize the acid on the battery. After washing with this solution, flush top of battery with clear water. Care must be taken when washing the battery so that the baking soda and water solution does not enter the battery cells.

Cable Requirements
The battery should be mounted as close to the engine as practical to cut down on battery cable lengths. Follow the recommendations below.
- 0-10 Feet 0 Gauge
- 10-15 Feet 2/0 Gauge
- 15-20 Feet 4/0 Gauge

Note! These specifications do not apply to aluminum battery cables. Volvo Penta does not recommend the use of aluminum battery cables.

WARNING!
To prevent possible explosion or fire, do not substitute automotive parts for the following marine components: starter, alternator, distributor (and related ignition parts), spark plug leads, solenoids, carburetor (and related parts), fuel pump or fuel filter canister. These components have been specifically designed not to emit fuel vapors or to cause ignition of fuel vapors in the bilge.
Relays

Special Service Tools Required: Ohmmeter or Test Light

The purpose of the relay assembly is to use a low amperage electrical circuit to control a high amperage circuit. In the case of a relay used in a starting circuit, the low amperage circuit from the key switch will control the high amperage circuit from the battery to the starter motor.

Inspection Procedure
The relays used in stern drive electrical circuits have proven to be trouble free under normal operating conditions. No periodic service is required. To prevent corrosion, all terminals of the relay and socket should be covered with Terminal Grease or equivalent.

Relay Ohmmeter Tests

Note! Throughout this section two symbols are used to interpret electrical troubleshooting results.

A: This symbol indicates continuity or very low resistance.

B: This symbol indicates no continuity or very high resistance (∞).

Note! To avoid damaging components or troubleshooting equipment, disconnect the battery cables from the battery and remove the relays before proceeding.

1. Use a continuity light or ohmmeter calibrated on appropriate scale to test continuity.

2. Connect meter leads to relay terminals 87a and 30 (1).
   - The meter must show continuity.

3. Connect meter leads to relay terminals 87 and 30 (2).
   - The meter must show no continuity.

4. Calibrate an ohmmeter on appropriate scale and connect the leads to relay terminals 85 and 86 (3).
   - The meter must show 70 - 100 ohms.
General Information

5. Connect meter leads to relay terminals 87 and 30. Connect a 12 volt source to relay terminals 85 and 86 (4).
   • The meter must show continuity.

6. Connect meter leads to relay terminals 87a and 30. Connect a 12 volt source to relay terminals 85 and 86 (5).
   • The meter must show no continuity.

7. Replace relay if your test results vary.

Circuit Protection

CAUTION!

Do not attempt to connect or disconnect any part of the electrical circuit while the engine is running.

When installing additional electrical accessories always use individual fused circuits. Power takeoff should be made at a terminal strip powered by auxiliary accessory wire and protected by a 30 amp (maximum) fuse.

Circuit Protectors and Locations

10 Amp Fuse: Protects trim switch. Located on trim/tilt pump.

SFE 20 Amp Fuse: Protects ignition switch. Located under dash.

7.5 Amp Fuse: Protects fuel pump.
   • 2Located at starboard front of engine on fuel pump bracket.
   • 3Located inside fuse box.

12.5 Amp Fuse: Protects ignition/injector relay and ECM.
   • 4Located at front of starboard high-rise exhaust elbow.
   • 5Located inside fuse box.

20 Amp Fuse: Protects fuel pumps.
   • 4Located at port front of engine.
   • 5Located in Fuse Box.

50 Amp Circuit Breaker: Protects trim/tilt motor.
   • 2Located at starboard front of engine.
   • 5Located adjacent to the main harness connector on the engine.

40 Amp Fuse: Protects main harness. Located at front of starboard high-rise exhaust elbow.

2X20 Amp Fuses: Protects main harness. Located in fuse box
Oil and Water Sending Units

Special Tools Required: Ohmmeter

Inspection Procedure
Check wiring and connections between senders and gauges. Check to see that senders are operating properly. Inspect orifice in oil pressure sender for blockage.

Test Procedure - Gauge Sending Units

Oil Pressure Sender: To check oil gauge senders, start engine and run up from slow to fast. Observe gauge. If reading is unsatisfactory, check sender with an ohmmeter:

- 0 PSI 227-257 ohms
- 40 PSI 92-114 ohms
- 80 PSI 21.5-49.5 ohms

Replace sender with a new one if it fails the ohmmeter checks. Re-test; if reading is still unsatisfactory, problem may be in gauge, engine lubrication system or excessive bearing wear. Refer to appropriate Engine Mechanical Workshop manual for the paragraph on Oil Pump Service.

To check gauge, disconnect wire at sender, turn ignition switch on, and momentarily ground sender wire. Gauge needle will peg at high side of scale if gauge is operating properly.

Water Temperature Sender: To check water temperature senders, remove sender from engine. Connect sender to a digital ohmmeter. Immerse sender in a container of oil with a cooking thermometer. Heat oil over a flameless source. Observe meter and thermometer. Meter should indicate:

- 448 ohms ± 10% at 100° F (38° C)
- 128 ohms ± 7.5% at 160° F (71° C)
- 46.6 ohms ± 5% at 220° F (105° C)

Test Procedures - Audible Warning Switches

Oil Pressure Switch: The oil pressure audible warning switch is calibrated to make or break contact at 4 ± 2 PSI (27.6 ± 13.8 kPa). Use an ohmmeter to make the following continuity checks. Replace the switch if it fails either of these tests.

1. With the engine off and the switch wire disconnected, there should be a full continuity (zero) reading between the switch terminal and engine block.
2. With the engine running and switch wire disconnected, there should be no continuity (infinity) reading between the switch terminal and engine block.

Water Temperature Switch: The water temperature audible warning switch is calibrated to make or break contact at 267° ± 10° F (130° ± 5° C). Attach an ohmmeter to the switch and make the following check. Replace the switch if it fails this test.

1. Immerse switch in a container of oil. Heat oil over a flameless source and check temperature with a cooking thermometer.
2. Below the make/break temperature, the ohmmeter should show a no continuity (infinity) reading. Above the make/break temperature, the ohmmeter should show a full continuity (zero) reading.

Test Procedure - Audible Warning Horn (if equipped)

Note! Under normal conditions, horn will sound when ignition is turned on. Horn will continue to sound until engine is started and oil pressure exceeds 4 ± 2 PSI (27.6 ± 13.8 kPa).

The dash mounted audible warning horn can be tested as follows. Replace the horn if it fails this test.

1. Turn ignition switch to the ON position. Do not start engine.
2. If horn does not sound, disconnect the lead at the water temperature audible warning switch, and momentarily touch lead terminal to engine block. If audible warning horn does not sound, horn is defective, or wiring of switch-horn-ignition switch circuit has lost continuity.
3. Disconnect the lead at the oil pressure audible warning switch, and momentarily touch lead terminal to engine block. If audible warning horn does not sound, horn is defective, or wiring of switch-horn-ignition switch circuit has lost continuity.
Spark Plugs and Leads

Removal and Inspection

1. To disconnect wires, twist and pull only on boot because pulling on wire may cause separation of the core of the wire. Remove spark plugs using a 5/8 in. spark plug socket or a 5/8 in. box wrench. Use care to avoid cracking the spark plug insulators.

2. Carefully inspect the insulators and electrodes of all spark plugs. Replace any spark plug which has a cracked or broken insulator or which has loose electrodes. If the insulator is worn away around the center electrode, or the electrodes are burned or worn, the spark plug is worn out and should be discarded. Spark plugs which are in good condition, except for carbon or oxide deposits, should be thoroughly cleaned and gapped.

3. The spark plug wires are a special resistance type. The core is carbon impregnated linen. This type wire is superior to copper core wire in its resistance to cross-fire; however, it is more easily damaged than copper core. For this reason, care must be taken so that the spark plug wires are removed by pulling on the spark plug boots rather than on the wire insulation. If the wire is stretched, the core may be broken with no evidence of damage on the outer insulation. If the core is broken, it will cause misfiring. In the case of wire damage, it is necessary to replace the complete wire assembly since a satisfactory repair cannot be made.

4. Use an ohmmeter to test ignition leads for excessive high resistance or an open circuit. Proper resistance is 3,000-7,000 ohms per foot.

Note! Clean ignition wires with a cloth moistened in kerosene, and wipe dry. Bend wires to check for brittle, cracked or loose insulation. Defective insulation will permit misfiring, cross-firing, or spark to ground, therefore defective wires must be replaced.

5. If the wires are in good condition, clean any terminals that are corroded and replace any that are broken or distorted. Replace any wires with broken or deteriorated cable nipples or spark plug boots.

Spark Plug Cleaning

Spark plugs which have carbon or oxide deposits should be cleaned in a blast type spark plug cleaner. Scraping with a pointed tool will not properly remove the deposits and may damage the insulator. If spark plugs have a wet or oily deposit, dip them in a degreasing solvent and dry thoroughly with compressed air. Oily plugs will cause the cleaning compound to pack in the shell.

Carefully follow the instructions of the manufacturer of the cleaner being used. Clean each plug until the interior of shell and entire insulator is cleaned. Avoid excessive blasting.

1. Examine interior of plug in good light. Remove any cleaning compound with compressed air. If traces of carbon or oxide remain in plug, finish the cleaning with a light blasting operation. Clean firing surfaces of center and side electrodes with several strokes of a fine cut file.

2. When spark plugs have been thoroughly cleaned, carefully inspect them for cracks or other defects which may not have been visible before cleaning.

Adjust Spark Plug Gap

Use a round wire feeler gauge to check the gap between the spark plug electrodes. Flat feeler gauges will not give a correct measurement if the electrodes are worn. Adjust gap by bending the side electrode only. Bending the center electrode will crack the insulator. Setting the spark plug gap to any other specification in an attempt to improve idle or affect engine performance is not recommended.
Installation of Spark Plugs and Wires

- All 3.0 Models (A)
- All V6 Models (B)
- All V8 except 8.1 Models (C)

For proper engine performance it is very important that the correct spark plugs be used. When installing spark plugs, make sure that the threads in the cylinder head and all surfaces on plugs and in cylinder heads are clean. Tighten spark plugs the specified amount. All engines use tapered seat plugs without gaskets.

⚠️ **CAUTION!** Do not operate engine if spark plug boots or high tension leads are torn or cracked. This condition can allow external sparks which could ignite any fuel vapors in the engine compartment.

Spark plug wires must be arranged between the distributor cap and spark plugs in the order of firing sequence. If spark plug wires are not correctly installed, misfiring or cross-firing will result.
Ignition Switch

**Special Tools Required:** Continuity Light or Meter

**Inspection Procedure**
Check for loose connections, loose or corroded terminals. Check for correct wiring.

**Test Procedure**
1. Disconnect battery leads at battery and leads at switch.
   - Connect continuity light or ohmmeter leads between switch battery B terminal and ignition A terminal. Turn switch to ON position. Light or meter should indicate continuity.
   - Connect continuity light or ohmmeter leads between switch battery B terminal and starter S terminal. Turn switch to START position. Light or meter should indicate continuity.

In the OFF position, there should be no continuity between the battery B terminal and either the ignition A or start S terminal. The M terminals and C terminal are not used in stern drive applications.

**Service and Repair Procedure**
Clean terminals, correct wiring (see appropriate wiring diagram at end of this section) or replace unit. Tighten connections and coat with Liquid Electrical Tape or equivalent.

Tachometer

**Special Tools Required:** None

**Inspection Procedure**
1. Check for loose or corroded terminals and connectors.
2. Check tachometer for tight connections, and trace leads for proper routing. Determine if tachometer is programmed correctly for each engine:
   - **A:** Four-cylinder engine - arrow goes to Number 2
   - **B:** Six-cylinder engine - arrow goes to Number 3
   - **C:** Eight-cylinder engine - arrow goes to Number 4
Amphenol Connector Service

Terminal Removal

Note! Use the recommended lubricant for terminal removal. Substitutes may cause high resistance connections or short circuits between terminals, or adversely affect the connector material.

1. To remove a terminal from the plug or receptacle, lubricate it by applying isopropyl alcohol to both ends of the cavity.

2. Select the proper removal tool for the terminal: Socket Remover, Volvo Penta P/N 3854350-0.

3. Place the plug or receptacle against the edge of a flat surface and allow clearance for the terminal to be removed.

4. Insert the removal tool A into the terminal and push the terminal from the connector B.

5. Pin C and socket D terminals may be replaced if damaged. Crimp new terminals onto the wire at point E.

6. Use Crimping Pliers when attaching Amphenol terminals.
Terminal Installation

1. Connect the plug and receptacle before installing the terminals. Apply isopropyl alcohol to the plug and receptacle. Align arrows and carefully insert the plug into the receptacle.

2. Apply isopropyl alcohol to the terminal cavity.

**Note! Use only Insert Tool, P/N 3854349-2, to install terminals. To avoid injury, securely hold insert tool against shoulder of terminal while inserting terminals.**

3. Position the insert tool against the shoulder of the terminal A.

4. Rest the connector against a solid surface. With insert tool firmly against its shoulder, insert leading tip of terminal into its cavity B. Push terminal in until the step of the insert tool reaches connector body, seating the terminal.

5. Check your work. Separate the connector and look at the terminal you just installed. If it is properly seated, apply isopropyl alcohol to both connector halves and reconnect them. If the terminal did not seat, remove it and repeat the procedure.

6. Secure the connector with wire retainer C.

Packard Connector Service

**Terminal Removal**
To remove a terminal, its holding tab must first be compressed enough to clear the body of the connector when sliding out.

Insert a thin wire, such as a paper clip D, about 1/4 in. (6 mm) into the slot next to the terminal to be removed. As the wire seats, it will compress the tab.

Gently pull the wire and slide its terminal out of the connector body.

**Terminal Installation**
The tab on the terminal must extend out enough to lock the terminal in place inside the connector body. If the tab isn’t extended, use a thin tool E and bend it outward slightly.

Insert the terminal into the connector body until the tab locks into place.
# Troubleshooting - System Isolation

The following is to help you isolate a malfunction of one or possibly several systems. After determining which systems are related to the malfunction, refer to the individual system troubleshooting charts to isolate the specific cause.

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<th>Components</th>
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| **Cranking System** | Engine should crank at specified RPM. If not, check for:  
1. Discharged or dead battery  
2. Loose or corroded connections  
3. See *Cranking System Problems* on page 34 |
| **Ignition System** | Must have good spark at spark plugs. If not, check the:  
1. Distributor cap and rotor  
2. Coil and spark plug leads  
3. Ignition timing  
4. Automatic spark advance  
5. See *Ignition System Problems* on page 63 or 79  
6. **EFI Models**: refer to *EFI Diagnostic Manual* |
| **Fuel System** | **EFI Models**: refer to *EFI Diagnostic Manual*  
**Non-EFI Models**: Carburetor accelerator pump should squirt fuel into venturi when throttle is advanced. If not, check the:  
1. Fuel tank, valves, and lines  
2. Fuel pumps and filter  
3. Carburetor and filter  
4. See *Boat Fuel System Troubleshooting* on page 89  
5. See *Carburetor Troubleshooting* on page 103  
6. See *Engine Fuel System Troubleshooting* on page 117 |
| **Engine Runs Improperly** | Check the following:  
1. Compression  
2. Ignition system  
3. Fuel system  
4. Lubrication system  
5. Cooling system  
6. Sterndrive and propeller  
7. Sterndrive gear ratio and installation  
8. PCV Valve  
9. See *Engine Troubleshooting Guides* on page 16 |
Engine Troubleshooting Guides

EFI Engines: Refer to GM EFI Diagnostic Manual.

These guides were written to help you trace the symptoms of the trouble to the source, without having to read through and prove every possibility. Much of the information here will be familiar to well informed mechanics.

Also, many factors will seem insignificant but when you think of it, usually the toughest problem to troubleshoot is caused by the smallest error. The greatest aid to solving a service problem is information. Start gathering information from the boat operator and write it on his job card or work ticket. Find out pertinent facts, such as:

- When did this trouble start?
- How was the boat loaded?
- Did the trouble occur suddenly, or start gradually?

Analyze this information and try to match it to similar situations you have experienced in the past. Keep in mind the fundamental rules:

1. **COMPRESSION** - Mixture inducted into cylinder and compressed.
2. **SPARK** - Proper intensity at the proper time.
3. **FUEL** - Proper mixture of air and fuel.

There are very old rules, but necessary for the engine to run. Use these charts and the service information they refer to. Do not try to remember tolerances, settings, measurements, etc., as they are written in the service manual. Leave your mind free to analyze the problem.

Following is a list of the troubleshooting guides which may be found on the pages indicated.

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<td>5. Engine Runs Rough</td>
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<td>6. Engine Noises and Vibrations</td>
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<td>7. Engine Overheats</td>
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<td>8. Engine Dies Out</td>
<td>21</td>
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<tr>
<td>11. Low Battery Voltage After Short Storage</td>
<td>23</td>
</tr>
</tbody>
</table>
Engine Will Not Crank

Starter Circuit - Check:
- Battery condition: weak, dead, sulfated, bad cells
- Battery cables for loose or corroded connections
- Shorted or open ignition switch
- Starter motor and solenoid for shorts, grounds or open circuits
- Starter assist solenoid/relay
- Circuit breakers
- Wiring from battery to ignition switch
- See Cranking System Operation on page 27

Engine Cranks, But Will Not Start

Ignition Circuit - Check:
- Primary circuit wiring from ignition switch to ignition coil/ignition module
- Secondary circuit wiring from coil to spark plug
- Spark plugs for proper gap, fouling, burned electrodes, cracked or dirty insulator
- See respective Ignition System section
- Low Battery Voltage

Fuel System - Check:
- Quantity and condition of fuel in boat tank
- Operation and flow capacity of boat anti-siphon valve
- Fuel tank vent is unrestricted
- Fuel tank pick-up screen is clean
- Correct diameter/unrestricted boat fuel lines
- Fuel shutoff and multiple tank valves are open and operating properly
- Fuel pump vent hose for signs of fuel or oil that would indicate a fuel pump failure
- Fuel pump/relay/circuit breaker operation
- External fuel filter canister and carburetor filter
- Carburetor accelerator pump for fuel discharge
- See Fuel Systems - Carbureted Models on page 83

Cylinder Compression - Check:
- See Engine Service Manual
Hard Starting - Cold Engine
Ask these questions first:

Has Engine Always Done This? Check:
- Carburetor choke operation and adjustment
- Fuel lines for obstructions
- For debris inside fuel tank
- See *Fuel Systems - Carbureted Models* on page 83.

Was Engine Used For A Long Time? Check:
- For clean external canister and carburetor fuel filters
- Empty carburetor float bowl due to evaporation
- Water in fuel due to condensation
- Fuel quality deterioration
- See *Fuel Systems - Carbureted Models* on page 83.

Is This A New Condition? Check:
- Carburetor choke operation and adjustment
- Carburetor accelerator pump
- Fuel system for leaks, dirt, or obstructions
- Engine timing and ignition system
- See *General Information* on page 1 See *Ignition System Troubleshooting* on page 54 or 76. See *Fuel Systems - Carbureted Models* on page 83.
- See Engine Service Manual

Hard Starting - Hot Engine
Ask these questions first:

Has Engine Always Done This? Check:
- Carburetor choke operation and adjustment
- See *Fuel Systems - Carbureted Models* on page 83.

Is This A New Condition? Check:
- Brand, type or octane of fuel
- Spark plugs
- Water in fuel
- Condition of battery and cables
- Starter motor for overheat damage
Hard Starting - Hot Engine (Cont.)

Did Engine Refuse To Start After Being Run? Check:

- Ignition system primary circuit
- Ignition coil/ignition module
- Engine timing
- Carburetor choke operation and adjustment
- See General Information on page 1
- See Ignition System Troubleshooting on page 54 or 76.
- See Engine Fuel System Troubleshooting on page 117.
- See Engine Service Manual

Engine Runs Rough

If At Slow Speed - Check:

- Idle speed and idle mixture
- Engine timing and spark plugs
- Fuel pump pressure
- Water or contaminants in fuel
- Carburetor or manifold vacuum leak
- Internal carburetor fuel leak
- See General Information on page 1
- See Ignition System Troubleshooting on page 54 or 76.
- See Engine Fuel System Troubleshooting on page 117.
- See Engine Service Manual

If At High Speed - Check:

- Air leak on suction side of fuel system
- Too low octane fuel
- Ignition system secondary circuit
- Engine timing
- Wrong model or size carburetor, improper main jets or power valve, defective secondary fuel circuit, secondary vacuum diaphragm failure
- External canister and carburetor fuel filters
- Fuel pump pressure
- Engine compression
- Water or contaminants in fuel, water in cylinders
- See General Information on page 1
- See Ignition System Troubleshooting on page 54 or 76.
- See Engine Fuel System Troubleshooting on page 117.
- See Engine Service Manual
- Engine operating in S.L.O.W.
Engine Noises and Vibrations

Valves - Hydraulic Lifters

- Rapping only when starting (oil too heavy for prevailing weather, varnish on lifter, oil needs to be changed)
- Intermittent rapping (leakage at lifter check ball)
- Idle noise (excessive leak down rate, faulty check ball seat)
- Generally noisy (excessive oil in crankcase, stuck lifter plunger)
- Loud noise at operating temperature (scored lifter plunger, fast leak down rate, oil viscosity too light for prevailing weather or operating temperatures)

- See Engine Service Manual

Ignition System (Ping or Knock)

- Improper tuning
- Incorrect spark plug wire routing
- Poor quality or contaminated fuel

- See General Information on page 1 See Ignition System Troubleshooting on page 54 or 76. See Engine Fuel System Troubleshooting on page 117.

- See Engine Service Manual

Cooling System

- Supply pump
- Loose belts, pulleys

- See Cooling System section of Engine Service Manual

Mountings

- Loose, broken or worn engine mounts
- Loose lag screws holding mounts to stringer

Crankshaft Balancer or Flywheel

- Loose bolt(s)

Alternator

- Loose pulley, worn bearings
- Loose mounting bolts

Sterndrive

- Failed U-joints or gimbal bearing
- Damaged internal drive components
- Worn, bent or broken propeller hub or blades
- Loose, worn or damaged engine coupler
Engine Overheats

Check

- Actual engine temperature by verifying with an accurate thermometer
- Gauge operation and wiring circuit
- Sending unit operation and wiring circuit
- Supply pump, circulating pump and belt
- Water intake screens for blockage
- Thermostat
- Water supply hoses
- Engine timing
- Water leaks on pressure side of supply pump
- Air leaks on suction side of supply pump
- Engine compression

Engine Dies Out

Loss Of, Or Out Of, Fuel - Check:

- Fuel gauge operation and wiring
- Fuel level in tank
- Water or debris in fuel
- Fuel pickup tube and screen blockage
- Fuel tank vent blockage
- Plugged external canister or carburetor fuel filters
- Air leak on suction side of fuel system
- Fuel leak on pressure side of fuel system
- Inoperative, restricted or incorrectly sized anti-siphon valve
- Boat fuel lines too small in diameter
- Fuel pump pressure and suction
- Carburetor cleanliness and operation
- See Engine Fuel System Troubleshooting on page 117.
Engine Dies Out (Cont.)

Loss Of Ignition - Check:

- Primary and secondary ignition circuits
- Ignition switch
- Circuit breakers
- Wiring between engine and dash
- Main engine harness wiring
- See General Information on page 1 See Ignition System Troubleshooting on page 54 or 76.

Engine Stops Or Dies Out Due To Seizure - Check:

- Sterndrive for internal damage
- Oil pressure gauge and crankcase oil level
- Temperature gauge and cooling system operation
- Internal engine components as required

Engine Won’t Reach Operating RPM

Check

- Fuel type or octane
- Propeller pitch or diameter, damaged blades, slipping hub
- Crankcase oil volume
- Marine growth on hull and drive
- Wrong sterndrive gear ratio
- Operating at high altitude
- Restricted carburetor air intake
- Restricted exhaust outlets in engine, transom bracket or drive
- Poor cylinder compression
- Carburetor size and type correct for engine
- Fuel pump pressure and vacuum
- Boat overloaded, or load improperly placed
- Engine overheating
- Engine timing and ignition system operation
- Remote control cables and linkage for proper attachment and travel
- Engine operating in S.L.O.W.
Defective Engine Lubricating System

Engine Components - Check:
- Clogged or incorrect oil filter
- Worn oil pump gears, cover or shaft
- Worn or collapsed oil pump relief valve spring, or foreign material caught on valve seat
- Oil pump relief valve plunger loose in cover
- Damaged filter bypass grommet
- Clogged oil pickup screen, broken tube or housing
- Plugged crankshaft or block oil galleys
- Dirty or defective hydraulic lifters, clogged push rod passages
- Poor quality, incorrect viscosity or quantity of oil
- Incorrect hose routing on remote filter systems
- Water in crankcase oil from condensation, defective head gasket, oil cooler, or cracked manifold/block water passages

Oil Pressure Warning System - Check:
- Oil gauge/warning horn operation and wiring
- Engine temperature
- Oil pressure gauge and warning horn sender operation and wiring

Low Battery Voltage After Short Storage

Engine/Boat Components - Check:
- All electrical accessories including ignition circuit off
- Disconnect main battery negative cable from battery
- Connect ammeter or voltmeter in series between negative battery cable and negative battery post:
  1. Meter reading of “0” indicates no draw, test battery and charging system
  2. Meter movement no matter how slight indicates draw from battery
- Disconnect main engine harness 10-Pin Connector:
  1. Meter drops back to “0”, problem caused by boat system, continue to isolate each boat electrical accessory until problem is found
  2. Meter does not drop back to “0”, problem caused by engine electrical system, continue to isolate each engine electrical accessory until problem is found
- Repair or replace components as necessary
### Metric Conversion Chart

#### LINEAR

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches to millimeters</td>
<td>25.4</td>
</tr>
<tr>
<td>feet to meters</td>
<td>0.3048</td>
</tr>
<tr>
<td>yards to meters</td>
<td>0.9144</td>
</tr>
<tr>
<td>miles to kilometers</td>
<td>1.6093</td>
</tr>
<tr>
<td>inches to centimeters</td>
<td>2.54</td>
</tr>
</tbody>
</table>

#### AREA

<table>
<thead>
<tr>
<th>Unit2</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches2 to millimeters2</td>
<td>645.16</td>
</tr>
<tr>
<td>inches2 to centimeters2</td>
<td>6.452</td>
</tr>
<tr>
<td>feet2 to meters2</td>
<td>0.0929</td>
</tr>
<tr>
<td>yards2 to meters2</td>
<td>0.8361</td>
</tr>
<tr>
<td>acres to hectares (104 m2)</td>
<td>0.4047</td>
</tr>
<tr>
<td>miles2 to kilometers2</td>
<td>2.590</td>
</tr>
</tbody>
</table>

#### VOLUME

<table>
<thead>
<tr>
<th>Unit3</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches3 to millimeters3</td>
<td>16387</td>
</tr>
<tr>
<td>inches3 to centimeters3</td>
<td>16.387</td>
</tr>
<tr>
<td>inches3 to liters</td>
<td>0.01639</td>
</tr>
<tr>
<td>quarts to liters</td>
<td>0.94635</td>
</tr>
<tr>
<td>gallons to liters</td>
<td>3.7854</td>
</tr>
<tr>
<td>feet3 to liters</td>
<td>28.317</td>
</tr>
<tr>
<td>feet3 to meters3</td>
<td>0.02832</td>
</tr>
<tr>
<td>fluid oz to milliliters</td>
<td>29.57</td>
</tr>
<tr>
<td>yards3 to meters3</td>
<td>0.7646</td>
</tr>
</tbody>
</table>

#### MASS

<table>
<thead>
<tr>
<th>Unit (av)</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ounces (av) to grams</td>
<td>28.35</td>
</tr>
<tr>
<td>pounds (av) to kilograms</td>
<td>0.4536</td>
</tr>
<tr>
<td>tons (2000 lb) to kilograms</td>
<td>907.18</td>
</tr>
<tr>
<td>tons (2000 lb) to metric tons</td>
<td>0.90718</td>
</tr>
</tbody>
</table>

#### FORCE - f (av)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ounces to newtons</td>
<td>0.278</td>
</tr>
<tr>
<td>pounds to newtons</td>
<td>4.448</td>
</tr>
<tr>
<td>kilograms to newtons</td>
<td>9.807</td>
</tr>
</tbody>
</table>

#### ACCELERATION

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>feet/sec2 to meters/sec2</td>
<td>0.3048</td>
</tr>
<tr>
<td>inches/sec2 to meters/sec2</td>
<td>0.0254</td>
</tr>
</tbody>
</table>

#### ENERGY OR WORK

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>foot-pounds to joules</td>
<td>1.3558</td>
</tr>
<tr>
<td>calories to joules</td>
<td>4.187</td>
</tr>
<tr>
<td>Btu to joules</td>
<td>1055</td>
</tr>
<tr>
<td>watt-hours to joules</td>
<td>3500</td>
</tr>
<tr>
<td>kilowatt - hrs to megajoules</td>
<td>3600</td>
</tr>
</tbody>
</table>

#### FUEL ECONOMY AND FUEL CONSUMPTION

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles/gal to kilometers/liter</td>
<td>0.42514</td>
</tr>
</tbody>
</table>

**Note:**

\[
235.2/(\text{mi/gal}) = \text{liters/100 km}
\]

\[
235.2/\text{(liters/100 km)} = \text{mi/gal}
\]

#### PRESSURE OR STRESS

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches HG (60°F) to kilopascals</td>
<td>3.377</td>
</tr>
<tr>
<td>pounds/sq in to kilopascals</td>
<td>6.895</td>
</tr>
<tr>
<td>inches H2O (60°F) to kilopascals</td>
<td>0.2488</td>
</tr>
<tr>
<td>bars to kilopascals</td>
<td>100</td>
</tr>
<tr>
<td>pounds/sq ft to pascals</td>
<td>47.88</td>
</tr>
</tbody>
</table>

#### LIGHT

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>footcandles to lumens/meter2</td>
<td>10.76</td>
</tr>
</tbody>
</table>

#### TEMPERATURE

\[
^\circ\text{Celsius} = 0.556 \times (^\circ\text{F} - 32)
\]

\[
^\circ\text{Fahrenheit} = (1.8 \times ^\circ\text{C}) + 32
\]

#### TORQUE

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>pound-inches to newton-meters</td>
<td>0.11299</td>
</tr>
<tr>
<td>pound-feet to newton-meters</td>
<td>1.3558</td>
</tr>
</tbody>
</table>

#### VELOCITY

<table>
<thead>
<tr>
<th>Unit</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>miles/hour to kilometers/hour</td>
<td>1.6093</td>
</tr>
<tr>
<td>feet/sec to meters/sec</td>
<td>0.3048</td>
</tr>
<tr>
<td>kilometers/hr to meters/sec</td>
<td>0.27778</td>
</tr>
<tr>
<td>miles/hour to meters/sec</td>
<td>0.4470</td>
</tr>
</tbody>
</table>

**Units:**

- **LINEAR:** inches, feet, yards, miles, inches, feet, yards, acres, miles
- **AREA:** inches2, feet2, yards2, acres, miles2
- **VOLUME:** inches3, inches, fluid oz, yards3
- **MASS:** ounces (av), pounds (av), tons (2000 lb), ounces, pounds, tons
- **FORCE:** ounces, pounds, kilograms
- **ACCELERATION:** feet/sec2, inches/sec2
- **ENERGY OR WORK:** foot-pounds, calories, Btu, watt-hours, kilowatt - hrs
- **FUEL ECONOMY AND FUEL CONSUMPTION:** miles/gal
- **PRESSURE OR STRESS:** inches HG (60°F), pounds/sq in, inches H2O (60°F), bars, pounds/sq ft
- **LIGHT:** footcandles
- **TEMPERATURE:** °Celsius, °Fahrenheit
- **TORQUE:** pound-inches, pound-feet
- **VELOCITY:** miles/hour, feet/sec, kilometers/hr, miles/hour
- **ACCELERATION:** feet/sec2, inches/sec2

**Conversion Factors:**

- **LINEAR:** X 25.4, X 0.3048, X 0.9144, X 1.6093, X 2.54
- **AREA:** X 645.16, X 6.452, X 0.0929, X 0.8361, X 0.4047, X 2.590
- **VOLUME:** X 16387, X 16.387, X 0.01639, X 0.94635, X 3.7854, X 28.317, X 0.02832, X 29.57, X 0.7646
- **MASS:** X 28.35, X 0.4536, X 907.18, X 0.90718
- **FORCE:** X 0.278, X 4.448, X 9.807
- **ACCELERATION:** X 0.3048, X 0.0254
- **ENERGY OR WORK:** X 1.3558, X 4.187, X 1055, X 3500, X 3600
- **FUEL ECONOMY AND FUEL CONSUMPTION:** X 0.42514
- **PRESSURE OR STRESS:** X 3.377, X 6.895, X 0.2488, X 100, X 47.88
- **LIGHT:** X 10.76
- **TEMPERATURE:** X 0.556, X 1.8
- **TORQUE:** X 0.11299, X 1.3558
- **VELOCITY:** X 1.6093, X 0.3048, X 0.27778, X 0.4470

**Notation:**

- **av** (av): avoirdupois
- **m** (m): metric
## Periodic Maintenance Chart

Items marked Safety Warning are safety related service points to prevent mechanical failures, fire and explosion. Make sure the safety related service is performed at these points and at the intervals specified.

### Electrical

<table>
<thead>
<tr>
<th>Service Point</th>
<th>Every 25 Hours or as Specified</th>
<th>Every 50 Hours or as Specified</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td>Check electrolyte level monthly</td>
<td>Tighten connections</td>
<td>Recharge battery if specific gravity reads below 1.220 temperature corrected.</td>
</tr>
<tr>
<td>Electrical System</td>
<td></td>
<td>Check connections and insulation.</td>
<td>Tighten loose connections, and replace deteriorated wiring.</td>
</tr>
<tr>
<td>High Tension Leads and/or Distributor Cap</td>
<td></td>
<td>Check for corrosion, deterioration or arcing. Boots must fit snugly on terminals.</td>
<td>If damaged, replace with specified Volvo Penta parts. Maintain original routing and support.</td>
</tr>
<tr>
<td>Ignition Coil</td>
<td></td>
<td>Check for arcing or cracks in plastic portion of coil.</td>
<td>Replace with specified Volvo Penta parts.</td>
</tr>
<tr>
<td>Spark Plugs</td>
<td></td>
<td>Annually check ceramic for cracks. Replace, or clean and gap.</td>
<td>If damaged, replace with specified Volvo Penta parts. Maintain original routing and support</td>
</tr>
</tbody>
</table>

### Fuel

<table>
<thead>
<tr>
<th>Service Point</th>
<th>Every 25 Hours or as Specified</th>
<th>Every 50 Hours or as Specified</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carburetor</td>
<td></td>
<td>Annually or as needed.</td>
<td>Adjust idle mixture and idle RPM. Clean linkage.</td>
</tr>
<tr>
<td>Flame Arrestor Mounting</td>
<td></td>
<td>Clean and check annually.</td>
<td>Tighten nut. Replace if damaged.</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td></td>
<td>Annually</td>
<td>Replace fuel filter.</td>
</tr>
<tr>
<td>Mechanical Fuel Pump</td>
<td>Check transparent vent tube for presence of fuel or oil.</td>
<td></td>
<td>Replace leaking fuel pump. Check for leaks after starting engine.</td>
</tr>
<tr>
<td>Fuel System</td>
<td>Check for leakage daily.</td>
<td></td>
<td>Tighten connections. Replace with specified Volvo Penta components.</td>
</tr>
<tr>
<td>Fuel Tank</td>
<td></td>
<td>Check for water in fuel tank.</td>
<td>Keep tank filled with recommended fuel.</td>
</tr>
<tr>
<td>Non-Metallic Fuel Hoses</td>
<td>Check for excessive stiffness, deterioration and/or leakage every 50 hours or monthly, whichever comes first.</td>
<td></td>
<td>Replace as necessary with A.B.Y.C. approved components</td>
</tr>
</tbody>
</table>
# General Torque Specifications

The following specifications are for nut and screw sizes not having specific torque recommendations.

<table>
<thead>
<tr>
<th>U.S. Screw Sizes</th>
<th>Ft. lb.</th>
<th>Nm</th>
<th>Metric Thread Sizes</th>
<th>Ft. lb.</th>
<th>Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 6</td>
<td>NA</td>
<td>1,1-1,6</td>
<td>M-6</td>
<td>6-9</td>
<td>8-12</td>
</tr>
<tr>
<td>No. 8</td>
<td>NA</td>
<td>2,2-2,8</td>
<td>M-8</td>
<td>14-21</td>
<td>19-28</td>
</tr>
<tr>
<td>No. 10</td>
<td>2-3,5</td>
<td>2,7-4,7</td>
<td>M-10</td>
<td>28-40</td>
<td>38-54</td>
</tr>
<tr>
<td>No. 12</td>
<td>3-4</td>
<td>4,1-5,4</td>
<td>M-12</td>
<td>50-71</td>
<td>68-96</td>
</tr>
<tr>
<td>1/4-20</td>
<td>5-7</td>
<td>6,8-9,5</td>
<td>M-14</td>
<td>80-114</td>
<td>108-15</td>
</tr>
<tr>
<td>5/16-18</td>
<td>12-14</td>
<td>16-19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8-16</td>
<td>20-25</td>
<td>27-34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/16-14</td>
<td>32-40</td>
<td>43-54</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Cranking System

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Cranking System Operation ................................................................. 27
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Cranking System Operation
The cranking system consists of a 12 volt starter motor, solenoid(s), ignition switch, neutral start switch, 50 amp circuit breaker, two 20 amp (40 amp) fuses wired in parallel, and wiring to complete the circuit with the battery.

⚠️ CAUTION! Any remote control box used with the stern drives covered in this manual must have a neutral start switch which prevents operation of the starter if the control handle is not in the neutral position. All Volvo Penta remote controls meet this requirement.

Stern drive starters employ a solenoid and lever to close the battery circuit and engage the starter pinion with the flywheel ring gear. When the key switch is turned to START position, an assist solenoid energizes the starter solenoid which closes the battery circuit and through leverage engages the starter pinion with the flywheel ring gear. When the key switch is released, the solenoids are de-energized, springs open the battery circuit, and the over-running clutch disengages the starter pinion.

Starter Motor Test Procedures
Special Tools Required: Battery Hydrometer, Voltmeter, Ammeter, Tachometer, Jumper Wire

⚠️ CAUTION! Do not substitute an automotive type starter. The Volvo Penta starter motor meets U.S. Coast Guard regulations for external ignition proof operation and marine use. The Volvo Penta starter is specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive type starters can result in fire and explosion.

Inspection Procedure
No periodic lubrication of the starter motor or solenoid is required. Starter motor action is indicative, to some extent, of the starter motor condition. A starter motor which responds readily and cranks the engine at normal speed when the control circuit is closed is usually in good condition.

Check the starter motor and solenoid switch attaching bolts to make sure these units are solidly mounted; both the starter and solenoid use their mounting for a ground path. Inspect and manually check all wiring connections in the starter motor circuit. Make sure these connections in the starter motor and control circuits are clean and tight. It is advisable to test the cranking circuit to ensure that excessive resistance does not exist. For additional information, see Test Procedure With Starter Installed on page 28.
Test Procedure With Starter Installed

The voltage across the starting motor and switch, while cranking the engine, gives a good indication of any excessive resistance.

⚠️ Caution! All remote controls used with Volvo Penta stern drives must have a neutral start switch to prevent operation of the starter if the shift lever is not in the neutral position. Engine must be at normal operating temperature when test is made.

1. Inspect the battery and cables to make sure that battery has ample capacity for cranking and ignition. Battery must be fully charged.

2. To crank the engine without firing:

⚠️ WARNING! Ensure ignition switch is off when disconnecting primary wires. Failure to do so may result in sparking that can ignite fuel vapors in engine compartment or bilge, and may result in fire or explosion.

- Turn off ignition switch, and disconnect both 2-wire connectors at ignition coil.
- Turn off ignition switch, disconnect purple leads from ignition coil.
- Turn off ignition switch, disconnect engine crankshaft sensor connector.

3. Connect the voltmeter POSITIVE (+) lead to the motor terminal A on the solenoid switch; connect the voltmeter NEGATIVE (-) lead to ground on starter B.

4. Turn the ignition switch on, crank engine and take voltmeter reading as quickly as possible. If starter motor turns engine at normal cranking speed with voltmeter reading nine or more volts, the motor and switch are satisfactory. If the cranking speed is below normal and the voltmeter reading is lower than 9 volts, check for defective battery, corroded battery terminals, or corroded solenoid.

⚠️ Caution! Do not operate starter motor for more than 10 seconds at a time without pausing to allow motor to cool for at least two minutes; otherwise, overheating and damage to the motor may result.

---

1. 3.0GS-A/B/C, 3.0GL-A/B/C, 4.3GXi-A, 5.0GXi-A, 5.7Gi-A, 5.7GXi-B
2. 5.0GL-A, 5.7GL-A
3. 4.3GXi-B/C/D/E, 5.0GXi-B/C/D/E, 5.7Gi-B/C/D/E, 5.7GXi-C/D/E/F
Solenoid Contacts Test

If the starter motor turns the engine at a low rate of speed and the voltmeter reads less than 9 volts, test the solenoid switch contacts as follows:

1. With the voltmeter switch turned to any scale above 12 volts, connect the voltmeter **NEGATIVE** (-) lead to the motor terminal A of the solenoid switch and connect the **POSITIVE** (+) lead to the battery terminal B of the solenoid switch.

2. Turn the ignition switch on and crank the engine. Immediately turn voltmeter switch to low scale and take reading as quickly as possible, then turn switch back to higher scale and stop the motor.

The voltmeter will read 1/10 volt or less if solenoid switch contacts are satisfactory. If voltmeter reads more than 1/10 volt, solenoid switch should be replaced.
Starter Motor Bench Test

To obtain full performance data on a starter motor, or to determine the cause of abnormal operation, the motor should be removed from the engine and submitted to a no-load test with equipment designed for such tests. In a no-load test the starter motor is connected in series with a 12 volt battery A and an ammeter B capable of reading several hundred amperes. A variable resistor C is connected between the ammeter and the solenoid battery terminal. Attach a voltmeter D between the solenoid BAT terminal and motor ground E. Activate the motor by attaching a jumper wire F between the solenoid's BAT and S (starter) terminals. A tachometer or RPM indicator is used to indicate armature RPM. Starter motor specifications will be found at the end of this section.

Compare the results of the test with the chart below. This will indicate what should be looked for when the motor is overhauled.

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Probable Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Current draw and no-load speed within specifications.</td>
<td>Normal condition for starting motor.</td>
</tr>
<tr>
<td>2 Low free speed and high current draw.</td>
<td>Too much friction - namely tight, dirty or worn bearings, bent armature shaft, or loose pole shoe screws allowing armature to drag. Shorted armature. Check after disassembly on growler. Grounded armature or fields. Check further after disassembly.</td>
</tr>
<tr>
<td>3 Fails to operate with high current draw.</td>
<td>Direct ground in terminal or fields. &quot;Frozen&quot; bearings. Should be noticed by turning armature by hand.</td>
</tr>
<tr>
<td>4 Fails to operate with no current draw.</td>
<td>Open field circuit. Check after disassembly by inspecting internal connections and tracing circuit with a test lamp. Open armature coils. Inspect for badly burned bars after disassembly. Broken brush spring, worn brushes or high insulation between commutator bars thus preventing good brush to commutator contact.</td>
</tr>
<tr>
<td>5 Low no-load speed and low current draw.</td>
<td>High internal resistance due to poor connections, defective leads or dirty commutator. (Also, causes listed under 4, above.)</td>
</tr>
<tr>
<td>6 High free speed and high current draw.</td>
<td>Shorted field coils. If shorted field coils are suspected, replace with new coils and check for improved performance.</td>
</tr>
</tbody>
</table>
Starter Motor Replacement

Removal

⚠️ CAUTION!
Do not substitute an automotive type starter. The Volvo Penta starter motor meets U.S. Coast Guard regulations for external ignition proof operation and marine use. The Volvo Penta starter is specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive type starters can result in fire and explosion.

1. Disconnect the battery ground cable at battery.
2. Disconnect all wires at solenoid terminals to prevent sparks in engine compartment.

Installation

1. To reinstall, position the starter assembly on the engine and start finger start the mounting bolts.
2. Snug hardware while holding the starter squarely against its mounting surface. Tighten the screws to 30-36 ft. lb. (41-49 Nm). Install ring gear guard and tighten screws to 5-7 ft. lb. (7-9 Nm).
3. If servicing a 3.0 liter engine starter, install the rear support bracket. Tighten the bracket to engine bolt to 16 ft. lb. (22 Nm). Tighten the bracket to starter nut to 13 in. lb. (1.5 Nm).
4. Connect wires to solenoid and apply Liquid Electrical Tape or equivalent to terminals to prevent corrosion.
5. Connect battery ground cable at battery. Attach bell housing drain hose, if equipped, to solenoid with a tie strap.
Cranking System

Cranking Circuit

Models: 3.0 GS and GL, 4.3 GL, 5.0 GL, 5.7 GL

1. Black
2. Red
3. Yellow/Red
4. Starter Relay
5. Red/Purple
6. 10 Amp Fuse
7. 40 Amp Fuse (Accessories)
Cranking System

Models: 4.3 GXi, 5.0 GXi, 5.7 Gi, 5.7GXi, 8.1 GXi

1. Black
2. Red
3. Starter Relay
4. Red/Purple
5. Yellow/Red
6. 10 Amp Fuse
7. 40 Amp Fuse (Accessories)
Cranking System Problems

**Starter turns engine slowly. Check:**
- battery water level and specific gravity
- for loose and corroded connections
- engine and drive unit for binding
- starter armature, brushes, field coils, or bearings

**Starter turns intermittently. Check:**
- starter motor - complete tear-down
- connection at ignition switch
- starter solenoid

**Starter doesn’t turn - solenoid clicks. Check:**
- battery and connections
- starter solenoid
- engine, transom bracket and sterndrive for seizure, or debris
- starter armature, brushes, or field coils

**Starter doesn’t turn - solenoid doesn’t click. Check:**
- remote control in start position, shift into neutral
- battery and connections
- starter solenoid
- key switch and wiring circuit 20 amp fuse
- 50 amp circuit breaker

**Starter remains engaged and runs with engine. Check:**
- shorted ignition switch
- starter motor - complete tear-down
- defective electric fuel pump “Orange” lead diode - 4.3 GL, GS, 5.0 GL and 5.7 GS models only

**Starter Motor Specifications**

⚠️ **CAUTION!** Do not substitute automotive parts. Volvo Penta marine components meet U.S. Coast Guard regulations for external ignition proof operation and marine use. Volvo Penta marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.

**Motor Free Speed At 11.5 Volts (between 3-5 seconds)**
- **Current** - 64-95 amps
- **Speed** - 2825-3275 RPM
Charging System

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  4.3 GXi-C/D/E, 4.3OSi-C/D/E, 5.0 GXi-C/D/E, 5.0OSi-C/D/E, 5.7Gi-C/D/E, 5.7OSi-B/C/D, 5.7GXi-
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    D/E/F, 8.1Gi-C/D/E/F, 8.1GXi-B/C/D/E ................................... 53
Alternator Replacement

All GL Models except 3.0

See the Engine Components Workshop Manual for alternator removal on Gi and GXi models.

Removal

To ensure proper operation and to protect the alternator and regulator, the following steps should be observed during removal and installation.

**CAUTION!** Do not substitute automotive parts. Volvo Penta marine components meet U.S. Coast Guard regulations for external ignition proof operation and marine use. Volvo Penta marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.

1. Disconnect the battery ground cable at battery.

2. Remove tie strap securing alternator wiring harness. Remove alternator adjusting bolt A from brace. Loosen pivot bolt and nut B.

3. Push alternator towards engine and remove alternator belt.

4. Disconnect all leads C, D, E, and F from the alternator.

5. Remove alternator pivot bolt and nut B. Remove the alternator.

Installation

1. Position alternator in bracket and loosely install the pivot bolt and nut B.

2. Attach connector with the green and purple lead to the “L” terminal on the alternator at F. Connect black ground lead to the alternator case at C. Tighten nuts securely and coat both terminals with **Liquid Electrical Tape** or equivalent.

3. Connect heavy gauge orange lead to the “B+” terminal E. Tighten nuts securely. **Slide rubber boot up lead and cover terminal.**

4. Connect purple/white lead to “P” terminal at D.
5. Pivot alternator toward the engine and place the belt onto the pulley. Attach the alternator brace to the alternator with screw A. Follow the procedure for “Alternator Belt Tension” in this section. Correctly tension the belt and tighten all mounting bolts B to 26-30 ft. lbs (35-41 Nm).

6. Secure the wiring harness to the alternator with a tie strap.

7. Connect battery cables.

**Alternator Belt Tension**

**All GL Models except 3.0**

1. Crankshaft Pulley
2. Circulating Pump Pulley
3. Alternator Pulley
4. Belt Tension Check Point

With engine stopped, check belt tension half way between the circulating pump and alternator pulleys using one of the following methods:

- Use belt tension gauge to set tension to 75 ± 10 lb. (33,6 ± 44,5 N).
- Use light thumb pressure and check for 1/4 in. (6.4 mm) belt deflection.

If belt is too tight, excessive belt and bearing wear can occur. If it’s too loose, slippage can occur, resulting in belt wear; and poor circulating pump, alternator, or power steering operation. Tension of a new belt should be checked after 10 hours of service and every 50 hours thereafter.

1. Loosen alternator mounting bolts and nuts, and pivot alternator away from engine to increase belt tension.

2. While maintaining pressure on alternator, retighten top bolt, bottom bolt and nut. Recheck belt tension.

**Note!** The belts used for the alternator, circulating pump, and power steering pump are heavy-duty. Do NOT replace with automotive belts.

**Note!** When adjusting alternator belt, do not overtighten as the alternator may be damaged.
Troubleshooting the Alternator

Belt Tension
Check the alternator belt for correct tension.

Alternator Output Test
Before beginning charging system checks, test the alternator output to verify that a charging problem exists.

1. Disconnect orange lead from “B” terminal 4 on back of alternator and connect an ammeter 6 in series 5.

2. Attach a voltmeter 1 to the “B” terminal 4 and battery ground 2.

3. Connect a carbon pile or Stevens LB-85 Load Bank across the battery.

4. Turn ignition switch 3 to start and run the engine. The amperage and voltage output readings should be as follows when the carbon pile is adjusted to obtain maximum output:
   - 650 RPM - 30 amps min.
   - 1000 RPM - 60 amps min.
   - 2000+ RPM - 75 amps min.

Regulated Voltage Range: 13.5 - 15.5 volts
The output test results will fall into one of these categories; overcharging, undercharging or no charge at all.

If battery overcharge is indicated by excessive water use, ammeter or voltmeter showing consistent charge, or alternator output exceeding 15.0 volts (no load) with engine idling, check orange “B+” lead voltage. Low volts, or no volts, will cause overcharging. If orange “B+” lead voltage is okay, voltage regulator is shorted and must be replaced.

If battery undercharge (or no charge) is indicated, perform the following tests in the order shown.
Alternator Wire Harness Tests

For the battery to receive sufficient charging current, and the alternator to supply the correct amount, three wires must carry battery voltage; the orange output B+ lead and the purple excite “L” lead.

Check No. 1: Testing Battery Charging Circuit

1. Slide the protective rubber boot off the B terminal.

2. Connect the voltmeter positive lead to the orange lead 4, and negative lead to an engine ground 2. With the key switch off, the voltmeter should show a reading nearly equal to battery voltage.

Test Results:

A: Circuit Okay: Reading is within a few tenths of battery voltage. Go on to Check No. 2.

B: Excessive Resistance: One or more volts less than battery voltage (example: 10.2 volts versus 11.8 volts).

C: Open Circuit: Reading of zero volts.

If circuit is open or resistance is excessive, disconnect orange lead at alternator. With an ohmmeter, check alternator output circuit between alternator and battery. Correct any problems, then conduct alternator output test again. If output reading is still not as specified, go on to following test.

Check No. 2: Testing Ignition Circuit

1. Connect a voltmeter to the “L” lead 5 at back of alternator and an engine ground 2.

2. With battery connected and key switch 3 “ON”, engine not running, the voltmeter reading should be within a few tenths of battery voltage.

Test Results:

A: Circuit Okay: Reading is within a few tenths of battery voltage. Go on to Check No. 3.

B: Excessive Resistance: One or more volts less than battery voltage (example: 10.2 volts versus 11.8 volts).

C: Open Circuit: Reading of zero volts.

D: Grounded Circuit: A reading of zero accompanied by a blown fuse or circuit breaker each time key switch is turned on.
Results were conditions B or C: disconnect the purple lead from back of alternator, then use an ohmmeter to check wire continuity back to key switch. Correct any problems, then conduct alternator output test again.

Results were condition D: disconnect the purple lead from back of alternator and repeat voltage check, Steps 1 and 2 above. If fuse or circuit breaker no longer blows, circuit is grounding through alternator; replace alternator. Fuse or circuit breaker continues to blow, check wiring back to key switch to find cause. Correct any problems, then conduct alternator output test again.

If the tests show the engine wiring, battery or accessories are not at fault, make additional running tests on the alternator, Check No. 3.

Check No. 3: Testing Excite/Sense Circuit

1. With key switch 3 “ON”, but engine not running, check for 1.0-2.0 volts at the “L” terminal 4.

2. If “L” terminal voltage is not as specified, the voltage regulator is defective, replace alternator.
**Alternator Troubleshooting Chart**

Troubleshooting the charging system may involve any one or more of the components in the system; the alternator (including voltage regulator), the battery, key switch, and wiring connecting these components into a circuit. The following troubleshooting chart categorizes trouble and remedies.

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Place of Trouble</th>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Under-Charging</td>
<td>Fan Belt</td>
<td>Fan belt slipping (v-belts only)</td>
<td>Readjust the tension of belt</td>
</tr>
</tbody>
</table>
| | Alternator | 1 Stator coil grounded or disconnected  
2 Rotor coil disconnected  
3 Brush and slip ring insufficient contact  
4 Diode intermittently operated | 1 Replace Alternator  
2 Replace Alternator  
3 Replace Alternator  
4 Replace Alternator |
| | Battery | 1 Not enough or bad electrolyte  
2 Sulfated plate (short circuit)  
3 Insufficient contact due to corroded terminal | 1 Supply, remeasuring specific gravity  
2 Change battery  
3 Clean and tighten |
| | Wiring | Disconnection or insufficient contact between key-switch and regulator "L" terminal | Repair |
| Ammeter Needle Unstable | Fan Belt | Loose fan belt (v-belts only) | Readjust belt tension |
| | Key Switch | Key switch insufficient contact | Change key switch |
| | Wiring | Connection point loose, almost disconnected wires | Tighten, repair |
| Abnormal Noise from Alternator | Alternator | 1 Inferior bearings  
2 Diode puncture  
3 Stator coil grounded or layer shorted | 1 Replace Alternator  
2 Replace Alternator  
3 Replace Alternator |
| Charging Circuit Fuse Melted | Wiring | "B+" terminal shorted | Repair |
| | Alternator | Positive side and negative side diode shorted | Replace Alternator |
| | Regulator | Over charge | Replace Alternator |
| | Battery | Battery misconnected | Connect properly |
Charging Circuit

3.0GS-A/B/C, 4.3GL-A, 5.0GL-A/B, 5.7GL-A/B

1. Black
2. Red
3. Purple/White
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Carburettor Choke Coil
8. Orange
9. 40 Amp Fuse (Accessories)
3.0GL-A/B, 4.3GL-B/C, 5.0GL-C/D, 5.7GL-C/D
1. Black
2. Red
3. Purple/White
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Carburettor Choke Coil
8. Orange
9. 40 Amp Fuse (Accessories)
3.0GL-C, 4.3GL-D, 5.0GL-E, 5.7GL-E

1. Black
2. Red
3. Purple/White
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Carburettor Choke Coil
8. Orange
9. 20 Amp Fuse X 2 (Accessories)
Charging System

4.3 GXi-A, 4.3OSi-B, 5.0 GXi-A, 5.0OSi-B, 5.7Gi-A, 5.7OSi-A, 5.7GXi-B, 5.7OSXi-B, 8.1Gi-B, 8.1GXi-A

1. Black
2. Red
3. Orange
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Orange
8. 40 Amp Fuse (Accessories)
4.3 GXi-B, 4.3OSi-B, 5.0 GXi-A, 5.0OSi-B, 5.7Gi-A, 5.7OSi-A, 5.7GXi-B, 5.7OSXi-B, 8.1Gi-B, 8.1GXi-A

1. Black
2. Red
3. Orange
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Orange
8. 20 Amp Fuse X 2 (Accessories)
4.3 GXi-C/D/E, 4.3OSi-C/D/E, 5.0 GXi-C/D/E, 5.0OSi-C/D/E, 5.7Gi-C/D/E, 5.7OSi-B/C/D, 5.7GXi-D/E/F, 5.7OSXi-B/C/D, 8.1Gi-C/D/E/F, 8.1GXi-B/C/D/E

1. Black
2. Red
3. Orange
4. Red/Purple
5. 10 Amp Fuse
6. Purple
7. Orange
8. 20 Amp Fuse (Accessories)
Charging System Problems

Battery
Check:
- Proper Cold Cranking Amps rating
- All wiring and connections
- Specific gravity
- Water, add and recharge
- Make load test

Overcharge
Check:
- Regulator
- Loose connections
- Battery

Undercharge
Check:
- Belt tension
- Regulator
- Tarnished slip rings
- Internal alternator components

No charge
Check:
- Alternator ground
- Belt tension and condition
- Fuse(s)
- All wiring and connections
- Regulator
- Tarnished slip rings
- Internal alternator components

Ignition Misfire. Check:
- Alternator ground

Inoperable Electric Fuel Pump
Check:
- 4.3GL, 5.0GL and 5.7GL models only - voltage at “L” terminal

Inoperable Electric Choke
Check:
- All carbureted models - voltage at “P” terminal
Alternator Internal Circuit

1. Regulator
2. Rotor (field)
3. Stator
4. Rectifier
5. Diode Trio
6. Capacitor

3.0GS-A/B/C, 4.3GL-A, 5.0GL-A/B, 5.7GL-A/B
4.3 GXi-A, 4.3OSi-B, 5.0 GXi-A, 5.0OSi-B, 5.7Gi-A, 5.7OSi-A,
5.7GXi-B, 5.7OSXi-B, 8.1Gi-B, 8.1GXi-A

3.0GL-A/B/C, 4.3GL-B/C/D 5.0GL-C/D/E
5.7GL-C/D/E
1. Regulator
2. Rotor (field)
3. Stator
4. Rectifier
5. Diode Trio
6. Capacitor

4.3 GXi-C/D/E, 4.3OSi-C/D/E
5.0 GXi-C/D/E, 5.0OSi-C/D/E
5.7Gi-C/D/E, 5.7OSi-B/C/D
5.7GXi-D/E/F, 5.7OSXi-B/C/D
8.1Gi-C/D/E/F, 8.1GXi-B/C/D/E
Specifications

3.0GS-A/B/C, 4.3GL-A, 4.3GXi-A/B, 5.0GL-A/B, 5.0GXi-A/B, 5.7GL-A/B, 5.7Gi-A/B, 5.7GXi-A/B/C, 8.1Gi-B, 8.1GXi-A

Alternator - 65 Amp
Minimum Engine RPM for Alternator Output ................................................................. 400 RPM
Regulated voltage range ....................................................................................... 14.0 - 14.7
Amperage output ......................................................................................................... 65
Regulator .................................................................................................................. Internal, solid state
Belt tension (GS and GL models only exc. 3.0) .......................................................... 1/4-1/2 in. give with finger pressure
Output tests: .............................................................................................................. Load battery to obtain maximum alternator output
   At 650 engine RPM .............................................................................................. 20 amps approximately
   At 1500 engine RPM ........................................................................................... .53 amps min.
   At 2000+ engine RPM ......................................................................................... .56 amps min.
“L” terminal voltage (engine running) ................................................................. 13.0 - 14.0 volts
“P” terminal voltage (engine running) ............................................................... 6.5 - 7.5 volts
Capacitor capacity .................................................................................................. 0.5 ± 0.1 microfarads

3.0GL-A/B/C, 4.3GL-B/C/D, 4.3GXi-C/D/E, 5.0GL-C/D/E, 5.0GXi-C/D/E, 5.7GL-C/D/E, 5.7Gi-C/D/E, 5.7GXi-D/E/F, 8.1Gi-C/D/E/F, 8.1GXi-B/C/D/E

Alternator - 75 Amp
Minimum alternator RPM for Alternator Output
   Fuel Injected Engines .................................................. 446 engine RPM
   Carburetted Engines .................................................. 612 engine RPM
Regulated voltage range .......................................................................................... 14.75 ± 0.2V
Amperage output ...................................................................................................... 75A
Regulator .................................................................................................................. Internal, solid state
Belt tension (GL models only exc. 3.0) ................................................................. 1/4-1/2 in. give with finger pressure
Output tests: .............................................................................................................. Load battery to obtain maximum alternator output
Fuel Injected Engines
   At 600 engine RPM .............................................................................................. 30 - 45 amps
   At 1000 engine RPM ........................................................................................... 60 - 70 amps
   At 2000+ engine RPM ......................................................................................... 75 - 80 amps
Carburetted Engines
   At 650 engine RPM .............................................................................................. 30 - 45 amps
   At 1200 engine RPM ........................................................................................... 60 - 70 amps
   At 2600+ engine RPM ......................................................................................... 75 - 80 amps
“L” terminal voltage (engine running) ................................................................. 13.0 - 14.0 volts
“P” terminal voltage (engine running) ............................................................... 6.5 - 7.5 volts
Capacitor capacity .................................................................................................. 1.5 ± 0.1 microfarads
Drive Pulley Ratio
   Fuel Injected Engines .................................................. 3.36:1
   Carburetted Engines .................................................. 2.45:1
Ignition System: Delco EST

Contents

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Models: 3.0 GL/GS, 4.3 GL, 5.0GL-B/C/D/E, 5.7GL-B/C/D/E

Description
The Delco EST (Electronic Spark Timing) system is used on non-EFI engines. The system consists of a distributor with an electronic ignition control module and pickup coil, a cap, rotor and remote coil. It does not contain breaker points, a condenser or centrifugal advance.

Ignition System Troubleshooting
The following tests are used to check various components of the Delco system. These tests should be conducted as necessary to solve a particular problem, and should not be part of a normal tune-up procedure. The following equipment will be needed:

- Ohmmeter
- Voltmeter
- Terminal Adaptors
- Timing Light
- Timing Test Lead
- Tachometer

Volvo Penta P/N 885163-6

NOTE! All running tests must be conducted in water with the correct test propeller to properly load engine. Do not perform tests with a flushing adaptor.

12 Volt Positive (B+) Test

Ignition Coil:
1. Disconnect the purple and gray wire connector at coil.

2. Connect voltmeter positive (+) lead to purple wire terminal A in connector and the negative (–) lead to engine ground B. Turn on ignition switch, meter should read a minimum of 8 volts.

Distributor:
1. Attach purple and gray wire connector to coil. Disconnect pink and brown wire connector at distributor.
2. Connect voltmeter positive (+) lead to pink wire terminal C in connector and the negative (–) lead to engine ground. Turn on ignition switch, meter should read a minimum of 8 volts.
Ignition System - Delco EST

**Ignition Coil Test**

The ignition coil can be checked for open circuits and shorts with an ohmmeter. If the ignition coil fails any one of the following checks, replace it. **Remove both wire connectors from coil before performing tests.**

1. To check for short to ground, connect ohmmeter to the frame A and purple wire terminal B. With the ohmmeter set on the high scale, reading should be infinite (∞). A reading of other than infinity (∞) indicates a short to ground.

2. To check for an open or shorted primary circuit, connect ohmmeter to purple wire terminal B and gray wire terminal C. With the ohmmeter set on the low scale, reading should be .35-.45 ohms. A reading of more than .45 ohms indicates a possible open circuit. A reading of less than .35 ohms indicates a shorted circuit.

3. To check for an open or shorted secondary circuit, connect ohmmeter to purple wire terminal B and high tension terminal D. With the ohmmeter set on the high scale, reading should be 7500-9000 ohms. A reading higher than 9000 ohms indicates a possible open circuit. A reading lower than 7500 ohms indicates a shorted circuit.

**Pickup Coil Test**

The pickup coil can be checked for an open circuit and shorts with an ohmmeter. If the pickup coil fails either one of the following checks, replace it.

1. Remove the flame arrestor cover (4.3 GL and GS Models Only). Remove screws securing distributor cap. Remove cap and rotor.

2. Release locking tab E and unplug pickup coil connector.

3. To check for a short to ground, connect ohmmeter to the body of distributor and either terminal F or G. With the ohmmeter set on the high scale, reading should be infinite (∞). A reading of less than infinity (∞) indicates a shorted circuit.

4. To check for an open or shorted coil, connect ohmmeter to terminals F and G. With the ohmmeter set on the high scale, a good coil should have a constant value between 700 and 900 ohms. A reading higher than 900 ohms indicates a possible open circuit. A reading lower than 700 ohms indicated a shorted circuit.
Ignition Module Test

The distributor's ignition module has only two failure modes, “No spark” and “No spark advance”. After all other checks have been made and these conditions still exist, replace ignition module.

Distributor Removal


1. Disconnect high tension leads from distributor cap.

2. Lift locking tabs A and unplug connector from the distributor. Crank engine so number 1 cylinder is in firing position. Make a mark B on distributor base and engine, so the distributor can be replaced in its original position during installation.

3. Remove two attaching screws and distributor cap. Note rotor tip position, and place a reference mark at this point on distributor housing so rotor/distributor housing can be realigned during installation.

NOTE! If engine is cranked while distributor is out, complete ignition timing procedure must be followed. See Timing Out of Synch on page 59 and See Setting Initial Timing on page 60.

4. Remove distributor clamp and lift distributor from engine. Discard gasket.

NOTE! Use special tool 888863 to remove and install tamper proof screw on 3.0GL-B, 4.3GL-C, 5.0GL-D, 5.7GL-D and later engines.
Distributor Service

CAUTION!

Do not substitute automotive parts. Volvo Penta marine components meet U.S. Coast Guard regulations for external ignition proof operation and marine use. Volvo Penta marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.

Disassembly

Remove distributor from engine (if necessary) following previous procedure.

Ignition Pickup Coil:
1. Pull off rotor.
2. Place a mark on the gear A and the drive tang B so that the gear can be re-installed in its original location. Drive pin C from gear and remove shaft assembly.
3. Detach leads from module. Pry off retainer D, and remove pickup coil E.

Ignition Module:
Detach leads and remove the mounting screws F. Remove module. Module may be stuck to housing and require prying off.

Reassembly

Ignition Module:
1. Clean old heat sink compound or silicone grease from mounting surfaces G of module and distributor.
2. Apply Heat Sink Compound or silicone grease to mounting surface of module.

NOTE! Heat sink compound or silicone grease is necessary for proper heat dissipation.
3. Position module on mounting area of distributor and install the two mounting screws F. Tighten securely.
**Ignition Pickup Coil:**
1. Align tab A and hole B and attach pickup coil to pole piece as shown. Reattach pickup coil leads to module.
2. Install retainer with locking tabs securely positioned in shaft groove.

**Shaft, Gear and Rotor:**
1. Install shaft into housing and assemble gear on shaft. Align gear C with tang mark D and secure with roll pin.
2. Align rotor with notch in shaft and press on securely.

**Distributor Installation**

See *EFI Diagnostic Workshop Manual 7742218* for Fuel Injected Engines

**Engine Not Disturbed**

**NOTE!** Use this procedure if the rotor/housing/block relationship was marked and the crankshaft has not been rotated. If ignition/valve timing relationship has been disrupted or if engine has been cranked with distributor out, install distributor following *Timing Out of Synch* procedure.

1. Position rotor about one-eighth turn counterclockwise from the rotor reference mark previously placed on the distributor housing.
2. Place a new distributor gasket on engine block. Align reference mark on distributor housing with mark on engine. Push distributor down into block until the housing is in a normal installed position.

**NOTE!** It may be necessary to move rotor slightly to engage distributor with camshaft gear and oil pump driveshaft, but rotor/housing/block reference marks should properly align when distributor is down in place.

3. Reinstall hold-down clamp and screw. Tighten screw enough so you can just turn the distributor. Attach the connector(s) to the distributor.
4. **Install distributor cap. Tighten screws securely to maintain external ignition proof characteristics.** Lubricate sockets in the distributor cap with *EP/Wheel Bearing Grease* or equivalent and install spark plug wires if they were removed.
5. Time ignition as required. For additional information, see *Setting Initial Timing* on page 60.
Timing Out of Synch

NOTE! Use this procedure if the rotor/housing/block relationship was not marked, or if the crankshaft has been rotated and the ignition timing is completely off.

1. Move number 1 piston to firing position (both valves for number 1 cylinder are completely closed) and align harmonic balancer timing mark with timing grid. Number 1 cylinder is now in position to fire.

2. Install distributor into engine. After distributor seats, rotor must be in position to fire number 1 cylinder as shown.

   If distributor does not seat in engine block, press down lightly on distributor housing while turning rotor. After distributor engages oil pump shaft, install distributor clamp and bolt, leaving bolt just loose enough to permit movement of distributor with heavy hand pressure.

3. Place cap on distributor housing. Rotate housing left or right until rotor lines up with terminal for number 1 spark plug wire.

4. Check all high tension wiring, and connect spark plugs wires to cap in proper sequence if they have been removed.

5. Attach connector(s) to distributor. Continue on to Setting Initial Timing procedure.
WARNING! To prevent a possible explosion, operate the blower as recommended by the boat manufacturer before starting engine. If the boat is not equipped with bilge blower, open engine cover or hatch prior to starting and leave open until after engine is running.

Setting Initial Timing

The timing mark is stamped on the rim of the harmonic balancer. The timing grid is a scale attached to the timing chain cover. The timing grid displays Top Dead Center (marked “0”) and degrees of advance (before) or retard (after). Each division on the scale represents 2 degrees.

Preparation

1. Connect a 12-volt timing light to number 1 spark plug lead, and use the timing light following the manufacturer’s instructions.

   Be careful not to puncture the wire or boot as this would cause a high voltage leak. Make sure that spark plug wires are pushed all the way down into the distributor cap terminals and onto the spark plugs. Nipples must be firmly pushed over the terminals, and boots over the spark plugs. Failure to do so can result in ignition of fuel vapors in engine compartment or bilge, and may result in fire or explosion.

2. Start engine and leave running until thoroughly warmed up.

   WARNING! Have someone at controls. Keep hands, hair and clothing away from rotating parts while making adjustments when engine is running.

3. Adjust idle speed to specified in-gear RPM, then shift into NEUTRAL. Shut off engine.
Setting Timing

The timing procedure for Delco EST system requires shunting (shutting off) the electronic spark advance. Follow the steps that apply to your specific model.

1. Install Timing Test Lead, Volvo Penta P/N 885163-6 A, into distributor and connect bare lead to a 12-volt engine B+ source. Start engine.

2. Direct beam of timing light onto timing grid. Loosen distributor clamp, then turn distributor slowly by hand until timing mark is set at the appropriate timing figure. See Ignition Timing Advance on page 64. Recheck timing mark; reset if necessary. Tighten clamp bolt.


Ignition Coil Replacement

1. Remove ignition coil to distributor cap high tension lead, two pin connector (purple and gray wires), and two pin connector (pink and brown wires) from the ignition coil.

2. Remove two screws E securing coil to engine block and remove ignition coil.

3. Place coil in a vise. Wear eye protection. Remove two rivet heads. Drive the rivets out of the coil. Save the bracket pieces.

4. Assemble the two bracket pieces and the coil using two screws and nuts provided in the replacement ignition coil kit. Tighten screws securely.

5. Mount the coil assembly to the engine block. Secure with two bolts E. Tighten to 20-25 ft. lb. (27-34 Nm).
6. Attach two pin connector (pink and brown wires) C to the coil as shown. Attach two pin connector (purple and gray wires) B to the coil as shown.

7. Apply EP/Wheel Bearing Grease or equivalent to the high tension lead terminal F and attach it to the ignition coil.
Ignition System Problems

Engine runs sluggish, overheats
Check:
- Timing
- For proper fuel
- Compression and for carbon buildup

Engine pings
Check:
- Timing
- For proper fuel
- Compression and for carbon buildup
- Spark plugs for proper heat range

Engine starts hard
Check:
- For spark
- Spark plugs
- Compression
- Battery
- Distributor cap

Engine misfires
Check:
- Spark plugs and leads
- Rotor and distributor cap
- Coil
- Engine firing order and plug wire routing
- Engine timing
- Engine operating in S.L.O.W.

Engine cranks but doesn’t start
Check:
- For spark
- Coil primary and secondary circuit wiring
- Tachometer and wiring
- Primary circuit wiring to ignition coil
- Primary circuit wiring to distributor
- Ignition pickup coil
- Ignition module
## Specifications

### Ignition Timing Advance

<table>
<thead>
<tr>
<th>Engine RPM</th>
<th>3.0 All Models</th>
<th>4.3GL Models</th>
<th>5.0GL-B/C/D/E Models</th>
<th>5.7GL-B/C/D/E Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>-2°</td>
<td>1°</td>
<td>10°</td>
<td>12°</td>
</tr>
<tr>
<td>600 RPM</td>
<td>8°</td>
<td>18°</td>
<td>21°</td>
<td>19°</td>
</tr>
<tr>
<td>1000 RPM</td>
<td>13°</td>
<td>21°</td>
<td>22°</td>
<td>22°</td>
</tr>
<tr>
<td>1500 RPM</td>
<td>15°</td>
<td>23°</td>
<td>25°</td>
<td>25°</td>
</tr>
<tr>
<td>2000 RPM</td>
<td>17°</td>
<td>24°</td>
<td>25°</td>
<td>25°</td>
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<tr>
<td>2500 RPM</td>
<td>18°</td>
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<tr>
<td>3000 RPM</td>
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<tr>
<td>4000 RPM</td>
<td>20°</td>
<td>25°</td>
<td>28°</td>
<td>30°</td>
</tr>
<tr>
<td>4600 RPM</td>
<td>21°</td>
<td>25°</td>
<td>28°</td>
<td>28°</td>
</tr>
</tbody>
</table>

1. 3.0GL-B/C, 4.3GL-C/D, 5.0GL-D/E, 5.7GL-D/E and later models require special tool P/N 888863 to adjust ignition timing

### Ignition Components

#### Ignition Coil - HEI
- **Primary Resistance**, in Ohms @ 75° F: 0.35-0.45
- **Secondary Resistance**, in Ohms @ 75° F: 7500-9000

#### Pickup Coil
- **Resistance**, in Ohms @ 75° F: 700-900
**Ignition Circuit**

**Models:** 3.0 GS-A/B/C, 3.0GL-A/B, 4.3 GLA/B/C, 5.0GL-B/C/D, 5.7GL-B/C/D

1. Black
2. Red
3. 40 Amp Fuse
4. Red/Purple
5. 20 Amp Fuse
6. Purple
7. Gray
8. High Tension Lead
9. Spark Plug Lead
10. Spark Plug
11. Tachometer
12. Pink
13. Brown
14. Inductor
Models: 3.0 GL-C, 4.3GL-D, 5.0GL-E, 5.7GL-E

1. Black
2. Red
3. 20 Amp Fuse X 2
4. Red/Purple
5. 20 Amp Fuse
6. Purple
7. Gray
8. High Tension Lead
9. Spark Plug Lead
10. Spark Plug
11. Tachometer
12. Pink
13. Brown
14. Inductor
Ignition System: Prestolite Integral BID

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Ignition System Operation

To clarify operating principles as well as to simplify the process of tracing troubles, it should be understood that the ignition system contains two separate circuits.

The primary circuit carries the low voltage current supplied by the battery or alternator. In addition to these sources of electrical energy, the primary circuit contains the ignition switch A, primary winding B of the ignition coil, electronic control module and sensor C located in the distributor, and all low tension wiring.

The secondary circuit carries the high voltage surges produced by the ignition coil which results in high voltage spark between the electrodes of the spark plug in the engine cylinders. This circuit contains the secondary winding D of the coil, coil to distributor high tension lead, distributor rotor and cap E, high tension ignition leads and spark plugs.

The electronic ignition system is “integrated”, in that the electronics are housed inside the distributor. Only two connections are made to the ignition coil. The electronic control module contained in the distributor is connected to the battery via the ignition coil positive terminal, and grounded through the distributor base.

A sensor F and trigger wheel G replace the points and condenser in the distributor, and control the precise timing needed to fire the spark plugs. The electronic module H controls timing and ignition coil saturation by accurately making and breaking the ignition coil primary circuit.

This ignition system is known as a “tuned” system. It uses an oscillator as its sensor. Acting as a “metal detector”, it senses the trigger wheel teeth turning with the distributor shaft. The presence of metal (each tooth) causes a change to occur in the oscillator which in turn commands the control unit transistor switch to turn off.

This “off” condition causes the primary current to stop flowing. The magnetic field, which built up during the “on” time, will collapse across the secondary coil winding causing a high voltage to fire the spark plug.
The sensor **F** is a coil of very fine wire molded into a plastic housing. This plastic housing is mounted on the base plate and connected directly to the circuit board. The sensor is serviced as an assembly with the electronic control module.

The electronic control module **1** is a completely self-contained solid state device which is encapsulated with potting compound to provide a vibration and moisture-proof barrier. It is irreparable and, if necessary, must be replaced as a complete assembly.

The distributor **2** is of a conventional design using a centrifugal advance mechanism to control timing.

The ignition coil **3** used with this system has a low resistance primary winding. A low resistance primary winding achieves high output for starting. A resistor wire is not used as primary current is regulated in the electronics.

As mentioned before, this system operates as a metal detecting system. The detected metal is each tooth **4** of the trigger wheel when it is in close proximity to the sensor coil **5**. The system is not speed sensitive, that is, it is not necessary to “generate” an electric current by turning the distributor shaft, and will operate at any speed above zero RPM.
When a tooth of the trigger wheel is near the sensor, metal is detected A, the oscillator is at a low level B, the transistor is off C, and no primary current flows. This condition can be compared to "points open" D.

When the trigger wheel is away from the sensor, metal is not detected E, the oscillator is at a high level F, the transistor is on G, and current flows in the primary winding. This condition can be compared to "points closed" H.

The high voltage surge produced in the secondary winding of the ignition coil travels through the cable to the center of the distributor cap, through the rotor to the adjacent distributor cap segment from which it is conducted to the proper spark plug by the high tension ignition wires. The high voltage surge jumps the gap between the insulated center electrode and the grounded side electrode of the spark plug, producing the spark required to ignite the fuel-air charge in the selected combustion chamber of the engine.

The sequence of action described above is repeated as each tooth of the trigger wheel moves past the sensor coil, and causes the transistor to be turned on and off.

The timing of the spark with respect to the piston position in the cylinder must vary in accordance with operating conditions if best engine performance is to be obtained. The spark advance for obtaining satisfactory idling should be as low as possible. At high speed, the spark must occur earlier in the compression stroke in order to give the fuel-air mixture ample time to ignite, burn and deliver its power to the piston as it starts down on the power stroke.

Control of spark timing to satisfy these constantly changing operating requirements is obtained in two ways, as follows:

Initial manual setting of distributor is made so that a tooth of the trigger wheel passes the sensor coil at a specified position of the piston, as indicated by the timing mark on the crankshaft pulley.

Centrifugal advance is governed by engine speed. The centrifugal advance mechanism consists of an advance cam, a pair of advance weights 1, two springs 2 and a weight base plate.
At idle speeds the springs hold the advance weights so that there is no spark advance, and the spark occurs in accordance with the initial manual setting of the distributor.

As speed increases, centrifugal force causes the advance weights to throw outward and push against the advance cam. This rotates the weight plate causing the teeth of the trigger wheel to pass by the sensor coil earlier in the compression stroke, so that the timing is advanced.

### Ignition Coil

**Special Tools Required: Ignition Tester**

Most ignition coils that are replaced are classified as weak. Many coils rejected as weak actually test up to specifications and give normal performance.

A coil that actually is weak will first affect engine performance when the ignition reserve is at a minimum. This may be in starting, low speed acceleration or top speed. Eventually, the engine will fail to start.

High resistance connections in either the primary or secondary circuit wiring will react the same as a weak coil. Wide spark plug gaps, which require higher voltage than the coil can produce, will put the coil under suspicion. High compression and lean carburetion increase the voltage requirements, and lead to many needless coil changes. Leakage of high tension current through moisture on an unprotected coil terminal may produce carbon tracks which weaken the coil output voltage. For this reason, the nipple on the coil high tension terminal must be properly installed and in good condition.

When an ignition coil is suspected of being defective it should be tested on a reliable coil tester according to instructions supplied with the instrument, before being replaced.
Distributor Removal

1. Disconnect the distributor primary wires at the ignition coil. Disconnect high tension leads from distributor cap. Remove distributor cap.

2. Crank engine so number 1 cylinder is in firing position. Note rotor tip position, and place a reference mark at this point on distributor housing so rotor/distributor housing can be realigned during installation.

3. Place a mark on the distributor base and engine, so that the distributor can be replaced in its original position during installation.

Note! If engine is cranked while distributor is out, complete ignition timing procedure must be followed. See Distributor Installation on page 74 and Initial Timing on page 75.

4. Remove distributor clamp and lift distributor from engine. Discard gasket.

Distributor Service

WARNING! Do not substitute automotive parts. Volvo Penta marine components meet U.S. Coast Guard regulations for external ignition proof operation and marine use. Volvo Penta marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.

Disassembly and Inspection

Note! Major components can be serviced without removing the distributor from the engine.

1. Remove the cap from the distributor. Some engines may require several high tension leads be removed to allow the cap to be moved out of the way. Mark the leads and terminals they were removed from so they can be replaced in the correct firing order.

2. Wipe out distributor cap with clean cloth and inspect it for chips, cracks and carbonized paths which would allow high tension leakage. Such defects require replacement of the cap. Clean loose corrosion from surfaces of terminal segments inside the cap. Do not use emery cloth or sandpaper. If segments are deeply grooved, cap should be replaced. Pull cables from terminal sockets and inspect sockets for corrosion. Clean sockets using a stiff wire brush to loosen corrosion. Lubricate sockets with EP/Wheel Bearing Grease or equivalent before reassembly of high tension leads. Check carbon contact for excessive wear.

3. Remove the rotor and inspect it. If rotor is cracked or rotor tip is badly burned, rotor must be replaced.

4. Loosen the sensor screw. Remove two screws and lock washers, then lift out the sensor/ignition module assembly. Remove the purple and black wires from the ignition coil if this assembly is to be replaced.
5. Inspect trigger wheel for signs of contact with sensor. Check distributor shaft for excessive wear between the shaft and bushings in housing.

6. Inspect for excessive wear between centrifugal weights and advance cam or pivot pins. Turn advance plate until weights are fully extended, then release and allow weights to return. Repeat several times. Springs should return weights to stop without sticking, and there should be no excess free play.

7. **Warning!** Distributor housing: Spark suppression screens must be tightly in place.

**Reassembly**

1. Apply Heat Sink Compound or silicone grease to the bottom edge of the sensor/ignition module.

2. Install sensor/ignition module assembly into the distributor housing and secure with two screws and lock washers.

3. Rotate the engine until one of the trigger wheel teeth lines up with the mark on the sensor.

4. Adjust the sensor air gap by sliding the sensor in or out until an 0.008 in. (0.203 mm) measurement can be taken between the sensor and the trigger wheel tooth. Tighten the sensor mounting screw securely.

5. Install the rotor making sure to align the notch in the distributor shaft with the rotor. Push the rotor down until it seats.

6. Attach the purple distributor lead to the positive (+) terminal of the ignition coil. Attach the black distributor lead to the negative (-) terminal of the ignition coil. Coat the terminals with Liquid Electrical Tape or equivalent.

7. **Reinstall the distributor cap. Tighten screws securely to maintain external ignition proof characteristics.** Replace any high tension leads that were removed. Pay close attention to high tension lead routing and firing order.

8. Check ignition timing as required. See Finish Timing procedure.
Distributor Installation

If the distributor has not been removed and the engine will run, continue on to the Initial Timing procedure.

**Engine Not Disturbed**

**Note!** Use this procedure if the rotor/housing/block relationship was marked, and the crankshaft has not been rotated. If ignition/valve timing relationship has been disrupted or engine has been cranked with distributor out, install distributor following Timing Out of Synch procedure.

1. Position rotor about one-eighth turn clockwise from the rotor reference mark previously placed on the distributor housing.

2. Place a new distributor gasket on engine block. Align reference mark on distributor housing with mark on engine. Push distributor down into block until the housing is in a normal installed position.

**Note!** It may be necessary to move rotor slightly to mesh distributor gear with camshaft gear, but rotor/housing/block reference marks should properly align when distributor is down in place.

3. Reinstall hold-down clamp and screw. Tighten screw enough so you can just turn the distributor. Connect purple primary wire to coil positive terminal and black primary wire to coil negative terminal. Coat terminals with **Liquid Electrical Tape** or equivalent.

4. Install distributor cap. Tighten screws securely to maintain external ignition proof characteristics. Lubricate sockets in the distributor cap with **EP/Wheel Bearing Grease** or equivalent and install spark plug wires if they were removed.

5. Time ignition as required. For additional information, see Initial Timing on page 75.

**Timing Out of Synch**

**Note!** Use this procedure if the rotor/housing/block relationship was not marked, or if the crankshaft has been rotated and the ignition timing is completely off.

1. Move number 1 piston to firing position (both valves for number 1 cylinder are completely closed) and align harmonic balancer timing mark with timing grid. Number 1 cylinder is now in position to fire.

2. Install distributor in engine. After distributor seats, rotor must be in position to fire number 1 cylinder.

   If distributor does not seat in engine block, press down lightly on distributor housing while turning rotor. After distributor engages oil pump shaft, install distributor clamp and bolt, leaving bolt just loose enough to permit movement of distributor with heavy hand pressure.

3. Place cap on distributor housing. Rotate housing left or right until rotor lines up with terminal for number 1 spark plug wire.

4. Check all high tension wiring, and connect spark plugs wires to cap in proper sequence if they have been removed.

5. Connect black primary wire to coil negative (–) terminal. Connect purple primary wire to coil positive (+) terminal. Continue on to Initial Timing procedure.

**Note!** To prevent a possible explosion, operate the blower as recommended by the boat manufacturer before starting engine. If the boat is not equipped with bilge blower, open engine cover or hatch prior to starting and leave open until after engine is running.
Initial Timing

The timing grid is stamped on the rim of the harmonic balancer A. The timing mark is cast into the timing chain cover B. It shows Top Dead Center (marked “O”) and degrees of advance (before) or retard (after). Each division on the scale represents 2 degrees.

1. Connect a 12-volt timing light to number 1 spark plug lead, and use the timing light following the manufacturer’s instructions.

**Note!** Be careful not to puncture the wire or boot as this would cause a high voltage leak. Make sure that spark plug wires are pushed all the way down into the distributor cap terminals and onto the spark plugs. Nipples must be firmly pushed over the terminals, and boots over the spark plugs. Failure to do so can result in ignition of fuel vapors in engine compartment or bilge, and may result in fire or explosion.

2. Start engine and leave running until thoroughly warmed up and choke valve is wide open.

**Note!** Have someone at controls. Keep hands, hair and clothing away from rotating parts while making adjustments when engine is running.

3. Adjust idle speed to specified in-gear RPM, then shift into NEUTRAL.

4. Direct beam of timing light onto timing grid. Loosen distributor clamp, then turn distributor slowly by hand until timing mark is aligned with the correct degree on the timing grid. See Tune-up Specifications in the General Information section of the Engine Service Manual.

5. Recheck timing mark; reset if necessary. Tighten clamp bolt. Recheck idle speed and mixture adjustments.
Ignition System Troubleshooting

Due to design and operating characteristics of this ignition system, a high voltage discharge in the coil secondary circuit may occur when the ignition switch is turned “ON” and “OFF”. The engine does not need to be cranked for this to occur. Always ground the coil high tension lead any time it is disconnected from the distributor. Failure to do so may result in fire and explosion if gas vapors are present.

**Note!** Ignition systems sometimes develop more than one problem. Be sure to complete the entire troubleshooting procedure before returning the boat to service.

1. Check simple things first. Inspect the following and correct any problems before proceeding:
   - Check the coil tower for carbon tracking. Check primary wires for tight connections and proper polarity. Make sure the tower is clean and dry. Check coil nipple for proper sealing and insulating qualities. If flash over occurs here, the engine will not start.
   - Check the distributor cap for carbon tracking and dirt inside and outside. Moisture and dirt make a good path for flash over. It is very important that the cap be clean. Once a track has started, the cap must be replaced. Check the rotor for the same condition.
   - Check all high tension leads for proper resistance; 3,000-7,000 ohms per foot of lead length. Also check for poor insulation, burning, cracking and deterioration of the lead, and torn or cracked plug and distributor cap boots.
   - Check spark plugs for fouling, proper gap and cracked insulators. Wipe insulators clean before installing boots.

2. Check for spark from the ignition coil to the distributor, and from the distributor to the spark plug using a kilovolt meter. Follow the meter manufacturer’s instructions when performing the tests. Do not allow open sparks to occur. Open sparks can ignite fuel and air vapors that may be present in the bilge area and cause a fire or explosion.

3. If no spark occurred, remove the distributor cap and rotor, and align a trigger wheel tooth with the center of the sensor. Check sensor air gap, which should be .008 in (0.203 mm). Note that the sensor will operate from a very small gap to a large gap. If the gap is incorrect, reset to .008 in. (0.203 mm) and repeat the spark test. Be sure the distributor shaft turns and is not broken or bent.
Primary Circuit Voltage Tests

Note! Position the trigger wheel so that the sensor is between two teeth. Turn on the key switch. Primary current should flow.

1. Connect a voltmeter across the battery terminals A and B. The meter should read between 12 and 13 volts. Recharge the battery if the voltage is low.

2. Connect the voltmeter between the negative battery terminal A or engine ground and the coil positive terminal C. The reading should be within one volt of the battery voltage in the previous stop. Perform a voltage drop test if the voltage is more than one volt low.

3. Connect the voltmeter between the negative battery terminal A or engine ground and the coil negative terminal D. The reading should be between 4 and 8 volts.

If voltage is 4 to 8 volts, ground the high tension tower of the coil. Place a screwdriver in front of the sensor face. This will discharge the coil. The voltage should now read 12 to 13 volts. If not, either the coil or the sensor/circuit board assembly is faulty. Test the coil and replace if defective. Repeat the screwdriver test. If no spark, replace the sensor/circuit board assembly and reset the sensor air gap.

If voltage is lower than 4 volts, remove the wire from the negative terminal D of the coil. Reconnect the voltmeter to the negative terminal.

- 12-13 volts - sensor/circuit board assembly is shorted. Replace assembly
- 0-4 volts - possible open coil primary circuit. Replace coil.

If voltage is higher than 8 volts, check for an open distributor ground circuit or shorted coil primary circuit.

- Distributor ground bad - repair.
- Distributor ground is good - replace sensor/circuit board assembly.
- Shorted coil primary circuit - replace coil.
Voltage Drop Test

**Note!** Position the trigger wheel so that the sensor is between two teeth. Turn on the key switch. Primary current should flow.

1. Connect the positive voltmeter lead to the positive battery post B, and the negative voltmeter lead to the coil positive terminal C. The meter should read less than one volt. Check for poor connections at all attachment points. A fluctuation indicates a poor connection and repairs must be made before proceeding. Poor connections cause heat and get worse, until there is no current flow.

2. Connect the positive voltmeter lead to the sensor/circuit board assembly case D, and the negative voltmeter lead to the negative battery post A. The voltmeter reading should be less than one volt. If the reading is higher than one volt, tighten the system ground connections and inspect the battery ground cable. Check that the sensor/circuit board assembly mounting screws are secure. Repeat the test. Replace the battery ground cable if necessary.

3. Check the distributor advance mechanism along with basic ignition timing. Be sure to operate the engine at the correct idle speed to be sure of an accurate basic timing adjustment.
Ignition System Problems

Engine runs sluggish, overheats. Check:

- timing and automatic spark advance
- for proper fuel
- compression and for carbon buildup

Engine pings. Check:

- timing and automatic spark advance
- for proper fuel
- spark plugs for proper heat range
- compression and for carbon buildup

Engine starts hard. Check:

- for spark
- spark plugs
- compression
- bypass circuit
- battery
- distributor cap

Engine misfires. Check:

- spark plugs and leads
- rotor and distributor cap
- coil
- for loose connections at coil and ignition switch
- engine firing order and plug wire routing
- engine timing
- engine operating in S.L.O.W.

Engine fires when cranked, stops when key is released. Check:

- wiring circuit
- ignition switch and connections

Engine cranks but doesn’t start. Check:

- for spark
- coil and wiring
- bypass to coil positive (+) terminal
- engine timing and plug wire routing
- tach and wiring
Ignition Circuit

Models: 5.0GL-A, 5.7GL-A

1. Battery
2. Black
3. Red
4. 40 Amp Fuse
5. Red/Purple
6. Main Cable Connector
7. 20 Amp Fuse
8. Ignition Switch
9. Purple
10. Ignition Coil
11. Distributor
12. Tachometer
13. Gray
14. High Tension Lead
15. Spark Plug Lead
16. Spark Plug
## Specifications

### Total Ignition Spark Advance

#### 5.0GL-A

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<tr>
<th>Engine RPM</th>
<th>86 AKI Fuel</th>
<th>89 AKI Fuel</th>
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#### 5.7GL-A

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<td>4600</td>
<td>28°</td>
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### Ignition Coil

- Operating Amperage @ 75° F .......... 1.0 Maximum
- Primary Resistance, in Ohms @ 75° F ........ 1.26 - 1.54
- Secondary Resistance, in Ohms @ 75° F ......... 9400 - 11000
- Coil must sustain 25-30 kv for 30 seconds

### Distributor

- Sensor Air Gap ......................... 0.008 in. (0.203 mm)

¹. This is the initial or “base” timing settings to be used when setting engine timing.
Fuel Systems - Carbureted Models

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**Carburetor Operation**

The carburetor is a metering device for mixing fuel and air. A small chamber (fuel bowl) holds the fuel. A float valve admits fuel from the fuel tank to replace fuel as it is consumed by the engine. Metering jets in the carburetor fuel chamber control the volume of fuel entering the carburetor fuel passages.

The intake stroke of the pistons in the engine cylinders creates a suction that draws air through the carburetor throat. A restriction in the carburetor throat, called a venturi A, has the effect of reducing air pressure B at this point by increasing air velocity.

The differential in throat and chamber air pressures C causes the fuel to be pushed out of the metering jets through fuel passages and into the air stream. Here it mixes with the air to form a combustible mixture for burning in the engine cylinders.

In order to mix air and fuel in the right proportions for all engine speeds, the carburetor design includes idle, off-idle, accelerator, main, power, choke, and where applicable, secondary fuel systems.

To regulate engine speeds, a throttle valve controls the volume of air/fuel mixture drawn into the engine. To compensate for the extra amount of fuel required to start a cold engine, a choke valve is placed above the main venturi on top of the air horn.

When the choke valve is closed, a very rich fuel mixture is drawn into the engine. As the engine starts and warms up, the choke is opened to restore the normal air/fuel ratio required.

The carburetor throat is frequently called the “barrel.” Carburetors with four barrels (BBL.) have individual metering jets, throttle and choke plates for each barrel. For more specific information about carburetor operation, refer to literature available from the carburetor manufacturer.
Mechanical Fuel Pump and Vent Hose

3.0 GS Models

Special tools required: Vacuum and Fuel Pressure Gauge.

Note! Under normal operation, the transparent vent hose should not contain fuel or oil. Any evidence of fuel in this hose is an indication of a ruptured fuel pump diaphragm. Oil in the line indicates a seal failure in the pump allowing crankcase oil to leak into the pump. If fuel or oil is visible, replace the fuel pump immediately.

If fuel pump is suspected of not delivering proper amount of fuel to the carburetor, it should be inspected and tested as follows:

⚠️ WARNING! When performing procedure below, be careful of gasoline vapor build-up in engine compartment. Gasoline is very explosive. Before starting engine, always make sure compartment is free of fuel vapors to prevent possible fire and explosion.

Pressure Testing

1. Make certain that there is gasoline in fuel tank.
2. Make sure fuel filter cartridge and carburetor fuel filter are new and free from obstructions.
3. Install pressure gauge to outlet side of pump. Use vacuum gauge according to instructions of the gauge manufacturer. Be sure to follow all notes and safety warnings.
4. Start engine and let it run at idle speed. If pressure gauge readings are as specified, see Boat Fuel System Troubleshooting for additional problem areas. If pressure is too low or too high, replace fuel pump.

Note! A boat fuel system that is restricted, or has an air leak on suction side of fuel pump, can cause an erroneous fuel pump diagnosis.

Vacuum Testing

1. Disconnect boat fuel line at inlet side of fuel filter canister. Cap end of line to prevent fuel leakage.
2. Disable ignition system to prevent engine starting when it's cranked. Remove all wires from positive (+) terminal of ignition coil, and tape them to prevent accidental grounding.
3. Install and use vacuum/pressure gauge according to instructions of the gauge manufacturer. Be sure to follow all notes and safety warnings.
4. Crank engine and read gauge. Replace fuel pump if gauge does not register specified amount of vacuum.

Fuel Pump Specifications

3.0GS & GL

Pressure ................................................................. 5 3/4 to 7 PSI (39.6 to 48.3 kPa)\(^1\)

Vacuum at Cranking Speed .................................................. 9 to 10 in. of Mercury (30 to 34 kPa)

4.3GL, 5.0GL, 5.7GL

Pressure ................................................................. 4.9 - 8.5 PSI (33.7 to 58.6 kPa)\(^2\)

---

1. At pump outlet, at idle speed
2. At idle speed
Fuel System

Fuel Pump Replacement: 3.0 Models

Removal

**WARNING!** To prevent fire and explosion, disconnect the battery before performing the following replacement procedures.

1. Place a container under the fuel pump to catch fuel that may drain from pump and lines when lines are removed. Unscrew fuel filter line A at fuel pump, and remove line from elbow. **Be sure fuel shutoff is closed or fuel system is plugged to prevent leakage of fuel. Be careful not to spill fuel.**

2. Disconnect carburetor fuel line B at fuel pump.

3. Cut tie strap and pull vent hose C off pump.

4. Remove two fuel pump retaining screws and lock washers. Remove fuel pump and gasket from engine; discard gasket. Note orientation of pump elbows, then unscrew and save for use on new pump.

5. Thoroughly clean fuel pump mounting surface on cylinder block.

Installation

1. Apply **Volvo Penta sealing compound P/N 1141570** or equivalent to old pump elbows. Install elbows, tighten to 48-60 in. lb. (5.4-6.7 Nm), then tighten to original position. **NOTE:** Elbows may be angled or different sizes; make sure elbows are installed in correct holes.

**Note!** **DO NOT** use Teflon tape on elbow threads. Pieces can break loose and clog fuel system components.

2. Apply Volvo Penta Gasket Sealing Compound to both sides of a new fuel pump gasket. Place gasket on block and install pump. Install mounting screws and lock washers, and tighten screws to 20-25 ft. lb. (27-34 Nm).


4. Connect carburetor fuel line B to fuel pump. Tighten line nut to 15-18 ft. lb. (20-24 Nm).

5. Connect fuel filter line C to fuel pump. Tighten line nut to 15-18 ft. lb. (20-24 Nm).

**WARNING!** After completing replacement procedures, make sure engine compartment is free of fuel vapors, then start engine and check entire fuel system for leaks.
**Fuel Filter Replacement**

**WARNING!** To prevent fire and explosion, disconnect the battery before performing the following replacement procedures. After completing replacement procedures, make sure engine compartment is free of fuel vapors, then start engine and check entire fuel system for possible leaks.

### 3.0 Models

**Removal**

*Note!* Place a shop cloth around the filter canister to catch any fuel.

Loosen the yoke screw D and move the yoke to the side far enough to allow removal of the filter canister E and element F. Remove and discard the element and gasket G.

**Installation**

1. Install a new gasket G inside the bottom of the pump housing H. Center the spring I inside of the filter canister E. Place the filter element F on top of the spring. Slide the canister and filter into place on the pump and secure with yoke J. **Tighten the yoke screw D securely.**

2. After completing replacement procedures, make sure engine compartment is free of fuel vapors, then start engine and check entire fuel system for leaks.

### 4.3, 5.0, and 5.7 GL Models

**Filter Canister**

1. Unscrew fuel filter A to remove and discard. Check to make sure the original gasket is not stuck on the filter housing. If so, remove and discard the gasket.

2. Lubricate new fuel filter gasket B with clean oil.

3. Install new fuel filter onto fuel filter bracket. **Tighten approximately one-half turn after gasket makes contact with bracket.**

4. **Start engine and check for leakage.**
Carburetor Fuel Filter

Note! Some models do not have replaceable fuel filters. Instead, the inlet nut contains a screen that should be cleaned periodically.

1. Disconnect the fuel line at the carburetor.
2. Remove fuel inlet nut A and gasket B. Take out filter element gasket C, filter element D, and spring E (if so equipped).
3. Clean inlet filter screen F (non-replaceable) or replace filter element.
4. To reassemble, install spring, new filter element and gasket, and filter nut and gasket. **Tighten inlet nut securely.**
5. Connect fuel line and tighten to 11-13 ft. lb. (14.9-17.6 Nm). **Start engine and check for leaks.**

Tanks, Lines, Valves, and Fittings

Note! Check for water and dirt in system. Examine complete fuel system for leaks and loose connections. Check operation of all fuel shutoff valves. Make sure fuel lines are securely fastened to craft to eliminate possible damage from vibration. Check for leaks in tank pickup assembly or a plugged pickup screen.

If fuel system appears to block proper flow of fuel, disconnect lines at different points and blow compressed air through suspect sections.

**Note!** Do not blow air through sections connected to these components - fuel pump, carburetor, tank. Check tank for open air vent and clean sediment screen.

Replace all connections which leak and cannot be tightened.
Boat Fuel System Troubleshooting

Fuel systems must be checked for restrictions as part of normal troubleshooting procedure.

Fuel systems can use anti-siphon valves, elbows, lines, filters, etc., that may present restrictions greater than can be tolerated by the engine fuel pump. Too great a restriction could reduce fuel flow to the engine resulting in poor performance and stopping at higher speed. An air leak on the suction side of the fuel pump can also cause erratic operation.

1. Disconnect fuel supply line from tank and fuel filter inlet. Blow air through it to make sure it’s clear.

2. Check fuel anti-siphon valve.

The marine industry recommends permanently installed fuel systems meet safety standards A.B.Y.C. H-24 and I.C.O.M.I.A. No. 17. These require such systems to have some form of anti-siphon protection. An anti-siphon valve prevents fuel spillage in case of a break or leak in the distribution system below the level of fuel in the tank.

Anti-siphon protection may also be afforded by keeping all parts of fuel distribution system above level of tank top when boat is in its normal, unloaded, static floating position. If it’s not possible to keep all lines above tank, then an anti-siphon valve is required and each tank pickup tube must be so equipped.

Anti-siphon valves must have a flow restriction pressure drop of no more than 35 in. (88.9 cm) of water at a fuel flow rate of 20 gallons (80 litres) per hour.

Note! All models covered in this manual must use a valve designed for use with 3/8 in. hose. Do not use a smaller valve.
If there is any question that an anti-siphon valve is suitable, then the following test should be made using a transparent hose:

- Remove anti-siphon valve A from tank and install test fittings and test hose.
- Fill test hose B with water to a vertical height of 20 in. (50.8 cm) C. Water must not run from valve. An occasional drop is acceptable. A continuous drip is not acceptable.
- Add more water. Water must run from valve before water height is 25 in. (63.5 cm).
- An anti-siphon valve passing this test will provide anti-siphon protection for a maximum of 28 1/2 in. (72.4 cm) fuel head and also open fully with pump suction. An anti-siphon valve that does not meet these requirements must be replaced with one which does. This test does not check ability of anti-siphon valve to meet flow requirements.

3. Check fuel tank pickup filter screen D:

Recommendations: Use stainless steel, No. 304 wire cloth, 30 mesh, with wire size 0.01 0-0.012 in. (0.254-0.304 mm) diameter. A cylindrical screen E equal to pickup tube outside diameter and 1 in. (25.4 mm) long will provide a screen with required flow area. The screen should be horizontal and set slightly above bottom so that maximum amount of fuel can be used. Make sure screen is not partially restricted by solder and is not bent or kinked.

4. Check fuel tank pickup tube F:

Pickup tube must have an I.D. measuring 3/8 in. (9.5 mm) for all models.

Dual engines require two separate pickup tubes, one for each engine.
Carburetor Service and Adjustments - 2V Models

Carburetor Replacement

Note! The following carburetor removal and installation procedures are similar for all models. The illustrations accompanying the text may not represent the appearance of actual components on a specific engine.

WARNING! All carburetors covered in this manual are designed for marine use. Do not substitute automotive carburetors because they can emit fuel vapor into engine compartment, and create a fire and explosion hazard.

Removal
1. Remove locknut, flame arrestor cover, vent hose brackets, and flame arrestor. Unscrew flame arrestor stud A if carburetor is to be replaced.
2. Cut tie strap and remove fuel pump vent hose B, if equipped.
3. Remove cotter pin and washer, then pull throttle cable off carburetor arm.
4. Disconnect purple/white stripe electrical lead C at choke thermostat housing.
5. Disconnect fuel line from carburetor taking care not to spill fuel.
6. Remove four carburetor mounting nuts E and one flat washer. Note which stud flat washer and choke ground wire were attached to. Lift carburetor off manifold, and discard mounting gasket. Note throttle lever bracket D position, then remove it for transferal to new carburetor.
Installation

Note! Refer to and check carburetor model number. If wrong model carburetor is used, both high and low speed operation are affected.

1. Attach throttle lever bracket from old carburetor. Be sure it’s in its original position. Place new base gasket on mounting studs and install carburetor.

2. Attach flat washer and choke ground wire to original mounting stud A. Install carburetor mounting nuts and tighten to 10-14 ft. lb. (13-19 Nm).

3. Connect fuel line to carburetor and tighten to 11-13 ft. lb. (14.9-17.6 Nm).

4. Connect purple/white stripe lead to choke housing.

5. Attach throttle cable and secure it with a flat washer and cotter pin. Spread pin ends to prevent disengagement. Readjust throttle cable preload as required.

6. Attach vent hose to carburetor fitting if equipped, and secure with tie strap.

7. Screw flame arrestor stud into carburetor (if removed), and tighten to 65-80 in. lb. (7.3-9.0 N.m).

8. Install flame arrestor B and vent hose brackets. Tighten flame arrestor nut to 30-40 in. lb. (3.4-4.5 Nm). Install flame arrestor cover and tighten nut to 30-35 in. lb. (3.4-4.0 Nm).

9. Run engine. Check for fuel leaks, and take corrective action if necessary.
Carburetor Disassembly

Disassembly of Fuel Bowl and Metering Block

Before beginning disassembly, mount carburetor on a holding fixture or a set of 5/16 in. bolts.

1. Remove primary fuel bowl and metering block D. Discard gaskets.

2. Remove idle adjusting needles\(^1\) and gaskets. Discard gaskets.

3. Using a jet wrench or wide blade screwdriver, remove main jets A. Lift vent baffle off pegs.

4. Unscrew the power valve B and gasket C. Discard the gasket.

---

1. 3.0GL-B, 4.3GL-C, 5.0GL-D, 5.7GL-D and later models comply with California Air Resource Board (CARB) emission standards. If the engine will be used in California, the idle mixture screw covers must not be removed. If the covers are removed, the metering block must be replaced before operating in California.
Float Removal.

3.0 Models: First remove the inlet valve assembly. Loosen lock screw F and turn hex nut E counterclockwise. Remove the assembly 1. Remove two screws G holding float in place. Remove float and bracket.


1. Unscrew fuel inlet nut to service filtering device. Some models will have a screen inside the inlet nut (non-replaceable), while others will have a wire mesh or sintered bronze filter. Clean screen type filters (replace if necessary), and discard and replace bronze filter. Replace inlet nut gasket.

2. Remove accelerator pump cover 7, diaphragm J, and spring. Verify that the inlet check ball K has the necessary freedom of movement to allow the accelerator pump to fill properly. With the bowl inverted (check ball seated), the clearance between the ball and its retainer should be 0.011-0.013 in. (0.279-0.330 mm). Carefully bend the retainer to set the specified clearance. The accelerator pump inlet check ball is not serviced separately, and should not be removed.

3. Use a solvent soaked cloth to remove old gasket material from metering block and float bowl.
Disassembly of Main Body

1. Invert carburetor and remove throttle body retaining screws and lock washers B. Remove choke vacuum hose A from throttle body fitting. Remove throttle body and discard gasket.

2. Remove retainer C from lower end of choke rod. Remove thermostatic spring housing F, its retainer D, and gasket E.

3. Unscrew choke housing and discard vacuum passage gasket.

4. Remove accelerator pump discharge nozzle screw G, then lift pump discharge nozzle I and gaskets H out of main body. Invert main body and let accelerator pump discharge needle J fall into your hand.

5. Do not remove choke plate, choke shaft, choke rod, or nylon guide unless one of them needs to be replaced. The choke plate screws are staked and must be filed flush with choke shaft prior to removal. The choke rod must be lifted out of top of main body before nylon guide can be removed.
Disassembly of Throttle Plate Assembly

1. Remove accelerating pump operating lever K and retainer L.

2. Unscrew and remove throttle cable bracket M from throttle plate N.

Note! Note orientation of bolt holes on throttle cable bracket (M1 & M2) and respective holes on throttle plate assembly (N1 & N2) when removing the throttle cable bracket.

3. Note screw hole number on throttle plate N and accelerator cam O, then unscrew cam.

Cleaning, Inspection, and Repair

1. Clean carburetor in a carburetor cleaning solvent.

Note! DO NOT immerse throttle body assembly, any rubber parts, plastic parts, dia-phragms, or pump plungers in carburetor cleaner. Delrin cam on throttle lever and Teflon bushings on throttle shaft will not withstand soaking in carburetor cleaner. Spray with choke cleaner and blow dry.

2. Use a cloth soaked in solvent to remove old gasket material. Blow out all passages in castings with compressed air. DO NOT pass drills through jets or passages.

3. Inspect idle mixture needles for damage.

4. Examine inlet needle and seat for wear. If worn, replace with new inlet needle and seat assembly.

5. Inspect upper and lower surfaces of carburetor castings for damage. Make sure sealing beads on castings have not been damaged.

6. Inspect holes in levers for excessive wear or out-of-round condition. If worn, replace levers.

7. Check all throttle levers and valves for binding or other damage.

Note! Always use new gaskets and O-rings whenever a carburetor is disassembled or overhauled. Make sure that all holes in new gaskets are properly punched and that no foreign material adheres to gaskets. Be certain that accelerator pump diaphragm is not cut or torn.
Carburetor Assembly

Assembly of Throttle Body


2. Attach throttle cable bracket to throttle plate with two screws and elastic locknuts. Ensure that orientation is correct, as noted from Step 2 of the disassembly process. Tighten both screws securely.

3. Install accelerator pump operating lever K and retainer L.

Assembly of Main Body

1. Drop accelerator pump discharge needle J into its well. Position accelerator pump nozzle I (with nozzles down and slots facing air vent rib) and gaskets in main body H. Install retaining screw G.

2. Insert choke rod in choke housing shaft lever as choke housing is placed into position on main body. Be sure projection on choke rod is placed under fast idle cam, so that cam will be lifted when choke plate is closed. Install choke housing lock washers and screws. Using needle-nose pliers, install choke rod clip.

3. Place thermostatic housing gasket on choke housing. Install housing and engage thermostatic spring on choke lever. Install clamp and screws. Adjust thermostatic spring housing by aligning index mark T on cover with specified mark U on choke housing.

4. Invert main body and install throttle body gasket. Install throttle body to main body and secure with screws and lock washers B. Install vacuum hose A from throttle plate to choke housing.
Assembly of Fuel Bowl and Metering Block

1. Place accelerator pump diaphragm spring K and diaphragm J in accelerator pump chamber. The diaphragm must be positioned so that large end of lever disc will be against operating lever.

2. Install cover and retaining screws.

3. Move pump lever to compress diaphragm spring. This will make sure diaphragm is not pinched.

4. Tighten screws securely.

Float Installation.

3.0 Models: Install float assembly and retain with two screws G. Apply a light assembly oil or petroleum jelly to the inlet needle assembly O-ring 1. Install assembly into fuel bowl using gasket D, nut E, gasket D, and screw F. For float setting, refer to for proper procedure.
4.3 GL, 5.0 GL, and 5.7 GL Models: Install inlet needle seat 2 and new gasket. Install inlet needle and pull clip assembly 4. Slide baffle plate 3 onto ridges in fuel bowl. Install spring 5 on float and engage needle pull clip while sliding float onto shaft. Be sure float spring is between ridges on boss on floor of fuel bowl. Install float retainer 6 with needle-nose pliers. For float setting, refer to for proper procedure.

1. Install filtering device. Insert spring and bronze filter (open end with gasket faces inlet nut), or wire mesh filter, if applicable. Place a new gasket on inlet nut. **Install and tighten to specifications to prevent fuel leakage.**

2. Refer to for correct power valve identification number. The number 7 (example 6.5) is stamped on a flat on base of valve. There are two types of power valves, and each requires a different gasket. Valves having multiple drilled fuel openings require a gasket having three internal projections. Valves with two rectangular fuel openings require a gasket with no internal projections. Use of the wrong gasket will cause a fuel leak around the power valve.

3. Install correct power valve B and gasket C into metering block. Installation of wrong power valve will result in poor performance.

4. Using a jet wrench, install jets 10 into metering block. Refer to for correct jet number.

5. Using new gaskets, install idle mixture needles 8. Turn idle mixture needles in until they just touch seat. Back them off the correct number of turns for a preliminary idle adjustment. Refer to for correct idle mixture setting.

6. Position metering block gasket on dowels located on back of metering block. Push metering block and gasket onto main body. Position vent baffle 9 then float bowl gasket on metering block. Make sure accelerator passage 11 is not blocked. Place new gaskets on float bowl screws, then install float bowl on main metering block and retain with screws.

---

1. 3.0GL-B, 4.3GL-C, 5.0GL-D, 5.7GL-D and later models comply with California Air Resource Board (CARB) emission standards. If the engine will be used in California, the idle mixture screw covers must not be removed. If the covers are removed, the metering block must be replaced before operating in California.
Carburetor Adjustments

Note! If the carburetor has just been completely rebuilt, adjustments should be performed in the following sequence. This will ensure that a previous/subsequent adjustment is not affected. If a rebuild has not been done, perform only the adjustment(s) that will correct the operational problem.

WARNING! Do not spill fuel. This will create a fire hazard.

Float Level: 3.0 Models Only

1. Loosen screw D and invert fuel bowl. Turn nut B to get an initial adjustment. Top of float C should be level.

2. Secure float level setting by holding nut and then tightening lock screw.

Float Level: 4.3GL, 5.0GL, & 5.7GL Models Only

Drain fuel from carburetor and remove fuel bowl. Remove float baffle. With bowl inverted, carefully bend curved float arm A that contacts inlet needle to set float level (parallel to fuel bowl). Reinstall bowl using new gaskets.

Accelerator Pump Stroke

The accelerator pump stroke is controlled by the pump cam position. The proper amount of fuel is delivered when attachment screw is in specified hole of both cam O and throttle plate N. See for position.
Accelerator Pump Clearance
Block throttle plates in the wide open position, and manually depress accelerator pump arm B. Use a feeler gauge C to check for specified clearance between arm and pump lever screw head A.

Turn adjusting nut A IN to increase clearance and OUT to decrease clearance. This adjustment ensures maximum pump output, full primary throttle opening, plus prevents off-idle hesitation and over-extension of the accelerator pump diaphragm.

Note! After making this adjustment, check accelerator pump operation. The pump should start to move as soon as the throttle shaft moves. This is called “immediate pump pick-up”. Any delay in pump movement will result in an off-idle hesitation or lag. If pump fails to move immediately, check for bent or worn parts, misadjusted pump clearance, or an improperly positioned pump cam.

Choke Vacuum Qualification
1. Remove choke housing cover.
2. Push choke piston against the adjustable screw stop D. Use a convenient tool or a paper clip to push with. Exercise care not to scratch the inner piston ball-link seat or the casting bore.
3. With the piston held against the adjustable screw stop, apply light pressure to the choke housing lever in a closing direction, until all free play is removed from the linkage.
4. Check the choke opening with the correct drill size. Adjustments are made by turning the adjustment screw stop (inward for less opening, outward for more opening).

Note! Care must be taken not to back out the adjusting screw so much that the piston will partially pass the screw and then be gouged by inward screw adjustment.
**Electric Choke**

The electric choke has an adjustment to control its opening rate. By loosening the clamp screws that retain the thermostatic spring housing, the housing can be turned to alter adjustment. Turning housing in a counterclockwise direction will richen mixture and make choke stay on longer. Turning spring housing in opposite direction (clockwise) will lean out mixture and make choke come off sooner.

**Note!** The electric choke cap is grounded with an external ground wire. Make sure all ground components are clean and free of corrosion.

1. Set choke so that index mark on choke cover T is aligned relative to index marks on choke housing U as specified.
2. If a richer or leaner mixture during warmup period is desired, it can be obtained by rotating thermostat cover one mark at a time. Never set index mark on cover more than two graduations off specified setting.

**Choke Unloader**

1. Hold throttle valves in a wide open position. Insert correct size drill between lower edge V of choke valve and inner wall of air horn.
2. Press finger lightly against choke control lever. A slight drag should be felt as drill is pulled out.
3. To adjust, bend tab W on throttle shaft kick-down lever until correct opening has been obtained.

**Idle Mixture and Idle Speed**

1. Initially set idle mixture by turning idle mixture screws inward until they are lightly seated, then turn screws outward the specified turns. Do not turn screws tightly against seats. Both the screw tips and casting seats may be damaged. Replace screws with damaged tips.
2. Final adjustments are made with engine running at operating temperature. Refer to for correct idle RPM.
3. Use a tachometer to make final adjustments. Turn idle mixture screws inward until engine RPM begins to drop due to lean mixture. Back screws out evenly and alternately until the best idle RPM is reached. If RPM begins to drop (due to an overly rich mixture) before reaching the specified RPM, turn screws inward until maximum engine RPM and smoothness is achieved.
4. Readjust idle speed as necessary. Always adjust idle speed last.
Carburetor Troubleshooting

FLOAT ADJUSTMENT
Determines fuel level in float bowls

High Float Levels
1. Raises fuel level
2. Speeds main and secondary system start-up
3. Promotes primary and secondary flooding, stalling
4. Increases fuel consumption

Low Float Levels
1. Lowers fuel level
2. Delays main and secondary system start-up
3. Results in primary and secondary flat spots, hesitation
4. Can decrease maximum fuel flow capability

ACCELERATOR PUMP STROKE
Cam type and placement determines volume of fuel per stroke

Performance Problems
1. Lean or rich condition
2. Hesitation or acceleration lag throughout RPM range
3. Damage pump diaphragm

ACCELERATOR PUMP CLEARANCE
Provides full pump output

Performance Problems
1. Prevents overstroking pump
2. Prevents off idle hesitation

CHOKE VACUUM QUALIFICATION
Determines amount of choke plate opening that occurs after starting a cold engine

Performance Problems
Plate closes too far (too rich):
1. Engine loads up
2. Runs rough, may die
3. Increase fuel consumption

Plate opens too far (too lean):
1. Engine runs rough
2. Will die quickly
3. Hesitation upon acceleration

(Continued on next page)
Carburetor Troubleshooting (Continued)

**CHOKE ADJUSTMENT**
Determines how long choke stays on

**Performance Problems**

**Choke too rich:**
1. Increase fuel consumption
2. Difficult hot start

**Choke too lean:**
1. Poor cold engine performance
2. Difficult cold engine starting

**CHOKE UNLOADER**
Determine amount of choke plate opening at W.O.T. on a cold engine

**Performance Problems**
1. Affects cold engine at W.O.T.
2. Aids starting flooded engine

**IDLE MIXTURE**
Determines fuel/air volume exiting idle circuit

**Performance Problems**
1. Rough or unbalanced idle
2. Tendency to die
3. May diesel or run-on

**IDLE SPEED**
Used in conjunction with mixture screws to set idle RPM

**Performance Problems**
1. Idle RPM too high, may diesel or run-on
2. Idle RPM too low, may die

**SECONDARY THROTTLE PLATE OPENING**
Opens secondary throttle plates to allow secondary idle circuits to function

**Performance Problems**
1. Open too far - high idle RPM
2. Closed too much - hesitation during transition from primary to secondary throttle operation
3. Sticking closed - hesitation during transition from primary to secondary throttle operation
4. Hole in diaphragm - hesitation during transition from primary to secondary throttle operation
Electric Fuel Pump

4.3GL, 5.0GL, and 5.7GL Models

Operation

The electric fuel pump utilizes a 12 volt DC motor that runs continuously at 4000 RPM whenever the engine is cranked or running. The electric motor drives a metal gear pump that uses the fuel as coolant. The pump supplies fuel at variable PSI as determined by engine load and fuel consumption. Excess fuel circulates within the pump past an internal pressure regulator. When the regulator is in operation, fuel stops entering the pump. This design eliminates the need for a return line to the fuel tank.

The pump has excellent dry prime characteristics, and can run without fuel for up to 30-40 seconds, although running without fuel is not recommended. The carburetor float chamber will run out of fuel before damage could occur. The fuel pump has an in-line Radio Frequency Interference (R.F.I.) suppressor built into the motor’s plastic connector. A separate circuit breaker provides circuit overload protection.

When the key switch is turned to the “START” position, voltage is supplied to the fuel pump relay from the start (“S”) terminal of the assist solenoid. The relay is activated and battery voltage is applied to the pump motor and then to engine ground.

The alternator supplies voltage to the relay from the “light” terminal after the engine starts and the key switch is returned to the “RUN” position. The pump relay also receives voltage direct from the battery via the assist solenoid, and this circuit is protected by a 7.5 amp fuse.

A diode in the yellow/red lead prevents voltage feedback from the alternator to the assist solenoid. This keeps the starter motor from being energized after the engine starts. A diode in the alternator green lead prevents damage to the alternator during cranking. For specific wiring connections, see the Workshop Manual Supplement, Wiring Diagrams (PN 7743606).

Note! The fuel pump will not run if the key switch is in the “RUN” position and the engine is not running.

⚠️ **WARNING!** Do not substitute automotive parts. Volvo Penta marine components meet U.S. Coast Guard regulations for fuel leakage, external ignition proof operation, and marine use. Volvo Penta marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.
Electric Fuel Pump Replacement

WARNING! This pump has been designed to meet U.S. Coast Guard fuel systems regulations for marine use. Do not substitute other brands or models that may be similar in appearance. Use of a substitute pump could result in leakage of fuel or fumes, and cause fire and explosion.

Removal
1. Disconnect positive and negative cables at the battery.
2. Disconnect boat fuel supply line at fuel filter and plug threaded hole.
3. **Remove** screw A securing fuel pump guard B to bracket. Remove guard to allow complete access to fuel line and pump.
4. Cut cut tie straps holding electrical leads to pump. Pull connector C off pump suppressor.
5. Using two wrenches, one holding lower pump fitting nut E and other on fuel line nut D, unscrew carburetor fuel line F at pump and pull line out of fitting.
6. Hold the pump end cap G with an open end wrench, and remove fitting.

WARNING! If pump end cap is not held when removing fitting, end cap may rotate and damage internal O-ring that seals pump against external fuel leakage.

7. Remove two filter bracket bolts I. Slide pump out of grommet H in upper bracket after last bolt is removed.

WARNING! Fuel filter may contain fuel; be careful not to spill it.

8. To remove fuel filter and bracket from pump, hold pump end cap J with an open end wrench, and unscrew adapter at base of pump.

WARNING! If pump end cap is not held when removing adapter, end cap may rotate and damage internal O-ring that seals pump against external fuel leakage.

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1. Not used on 5.0GL-E and 5.7GL-E
Installation

Note! Electric fuel pumps look similar, but have different fuel flow rates. Do not inter-change these assemblies.

1. Place a new O-ring A on the filter bracket adaptor and position it against hex. Do not nick or cut O-ring on threads.

   **WARNING!** This O-ring is made of a special fuel resistant material. Substitution of parts of unknown quality could result in a fuel leak, and the possibility of fire and explosion.

2. Screw filter bracket assembly into pump. Hold lower pump end cap B with an open end wrench and tighten adaptor to 8-10 ft. lb. (11-14 Nm).

   **WARNING!** If pump and cap is not held when installing adapter, end cap may rotate and damage internal O-ring that seals pump against external fuel leakage.

3. Slide pump up through grommet C and install two bolts D. Tighten bolts to 20-25 ft. lb. (27-34 Nm).
4. Install a new O-ring onto the fitting. Do not nick or cut O-ring on threads.

**WARNING!** This O-ring is made of a special fuel resistant material. Substitution of parts of unknown quality could result in a fuel leak, and the possibility of fire and explosion.

5. Screw fitting A all the way into pump outlet. Hold pump end cap B with an open end wrench and tighten fitting to 60-84 in. lb. (6.8-9.5 Nm).

6. Connect fuel line C to pump fitting. Hold fitting with an open end wrench. Tighten fuel line securely.

**WARNING!** If pump end cap is not held when tightening fitting, end cap may rotate and damage internal O-ring that seals pump against external fuel leakage.

7. Align connector tabs and push connector D onto pump suppressor until it clicks into place.

8. If the electrical leads were secured to the pump body, secure them with a tie strap.

9. Install pump guard E and secure with screw F.

10. Remove plug and reconnect boat fuel line. Tighten securely. Attach positive and negative cables at the battery. Run engine and check for fuel leaks.

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1. Not used on 5.0GL-E and 5.7GL-E
Circuit Breaker Replacement

1. Remove both leads from circuit breaker. Remove screws and nuts, and lift circuit breaker out of bracket.
2. Install new circuit breaker and secure with screws and nuts. Tighten screws to 20-25 in. lb. (2.3-2.8 Nm).
3. Attach red lead to one circuit breaker stud, and red/purple lead to other stud. Tighten nuts to 20-25 in. lb. (2.3-2.8 Nm) and coat terminals with Liquid Electrical Tape or equivalent.

Filter Bracket Replacement

Note! The electric fuel pump filter has an internal seal around the fuel exit point that prevents leakage and drain back. Do not substitute other filters that may be similar in appearance. To replace filter canister, refer to elsewhere in this section.

1. Remove fuel pump and filter bracket assembly from mounting bracket.
2. Unscrew fuel inlet elbow and save for installation on new bracket.
4. Thoroughly clean adaptor threads to remove old sealer, then apply Volvo Penta sealing compound P/N 1141570 or equivalent to the threads.
5. Clamp new bracket in a vise. Screw in adaptor and pump assembly, and tighten to at least 10 ft. lb. (14 Nm). Continue tightening adaptor to achieve proper pump/bracket directional alignment. Do not exceed 32 ft. lb. (43 Nm) torque.
6. Thoroughly clean threads of inlet elbow to remove old sealer, then apply Volvo Penta sealing compound P/N 1141570 or equivalent to the threads. Screw in elbow and tighten to at least 12 ft. lb. (16 Nm). Continue tightening elbow to achieve proper directional alignment. Do not exceed 32 ft. lb. (43 Nm) torque.
7. Install fuel pump and filter bracket assembly in mounting bracket.
8. Run engine and check for fuel leaks.
Troubleshooting Electric Pump Fuel System GL Models

1. Start by verifying the pump is receiving a minimum of 12.0 ± 1 volt. Pull connector off pump suppressor. Disable ignition to prevent engine from running, then crank engine and check yellow/red lead with a voltmeter. Shut engine off, then check connector black lead with an ohmmeter for a good ground. If voltage is not as specified, or ground path is suspect, check:
   - relay and bracket
   - fuse
   - orange lead diode
   - green lead diode
   - alternator output at “P” terminal (13.9-14.7 volts)
   - wiring related to all of the above

Ensure all items are functioning correctly before proceeding. As voltage to the pump drops, so will its output capability.

2. Once it's been established that the pump is receiving proper voltage, separate the engine fuel system from the boat's fuel system. Disconnect the supply line at the pump's fuel filter, and place a pick-up hose in a vented fuel container. The pick-up hose must have a minimum I.D. of 3/8 in.

Note! Do not connect engine fuel system to any supply system having a pressure producing device such as an outboard fuel tank with primer bulb, or another electric fuel pump located elsewhere in the boat or at the fuel tank. The pump is sensitive to additional fuel pressure, and will add this to its own output. The result will be a continually flooding carburetor with the possibility of external fuel leaks, and the potential for fire and explosion.

3. Run engine to see if problem still exists. If problem has been eliminated, source is located somewhere in boat fuel system back to, and including, the boat fuel tank. If problem still occurs, it's located somewhere in engine fuel system.

Checking Engine Fuel System

1. The electric fuel pump requires an unrestricted, air tight fuel supply. Unscrew the pump fuel filter and check it for debris. Also check that the filter seals tightly against its fixture and the center mounting threads. Make sure the filter is the correct one for this application. Check threads of filter inlet elbow to ensure a tight seal. If any of these conditions are in doubt, correct them before continuing.

2. Remove the carburetor fuel inlet nut and inspect the inlet screen or filter for debris. Clean or replace this item before continuing.

3. Check fuel pump mounting position. Pump must always be located on engine in original factory position. This position is determined by U.S. Coast Guard regulations and must be complied with. Never relocate pump to transom, stringer, fuel tank, or any point other than its original location on the engine.

Pressure Testing Fuel System

Pump performance can be verified by checking pump PSI at specific engine RPM. This test must be performed with engine under load; either running in gear on water, or in gear and connected to a dynamometer. Use a good quality fuel pressure gauge and connect it into the fuel line between the fuel pump and the carburetor. Follow the gauge manufacturer's instructions for installation, and ensure that connections are leak free. Refer to the chart below, and run the engine at various RPM's to check pump operating pressure.

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1. See EFI Diagnostic Workshop Manual for fuel pump troubleshooting information on Fuel Injected engines.
Electric Fuel Pump Specifications

Pump Performance at a Minimum of 12.0 + 1 Volt

<table>
<thead>
<tr>
<th>RPM</th>
<th>P.S.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idle</td>
<td>4.9 – 8.5</td>
</tr>
<tr>
<td>1000</td>
<td>4.8 – 8.4</td>
</tr>
<tr>
<td>1500</td>
<td>4.7 – 8.3</td>
</tr>
<tr>
<td>2000</td>
<td>4.6 – 8.2</td>
</tr>
<tr>
<td>2500</td>
<td>4.5 – 8.1</td>
</tr>
<tr>
<td>3000</td>
<td>4.4 – 8.0</td>
</tr>
<tr>
<td>3500</td>
<td>4.3 – 7.9</td>
</tr>
<tr>
<td>4000</td>
<td>4.0 – 7.7</td>
</tr>
<tr>
<td>4500</td>
<td>–</td>
</tr>
<tr>
<td>4600</td>
<td>3.5 – 7.3</td>
</tr>
</tbody>
</table>

Note! New pumps will generally have lower operating pressures. As the pump gears break in, contact improves and pump pressure increases slightly.

Two other items that would require checking are the screens in each end of the fuel pump body. This requires removal of the upper elbow and the lower fuel filter adaptor. If screens cannot be sufficiently cleaned, replace the fuel pump. The screens are not serviced separately.

Checking Boat Fuel System

The most common causes of failures in the boat fuel system are due to line restrictions or air entry. Typical restrictions are:

- kinked, bent, or internally swollen fuel lines
- fuel lines and/or tank selector valve I.D.'s too small
- restricted or wrong anti-siphon valve
- cracked or blocked fuel pick-up or screen inside tank
- blocked tank vent

Air entry can occur at any point on the suction side of the fuel system. Air in the fuel system is usually indicated by a pump humming or squealing noise.

Note! Pump noise is caused by air being drawn through the fuel pump gears, but is not always an indicator that something is wrong. Momentary noise has several causes that are not linked to fuel system failures:

- pump may squeal for a short time upon start-up as air is expelled
- if ambient temperatures are high, the engine compartment will be subjected to hot operating conditions that may create vapor in the fuel lines
- a hot engine after shutdown will go into a “hot soak” condition that may produce fuel vapors
- the use of ethanol fuel will also aggravate this condition as it's more susceptible to vapor formation

All of these situations are temporary, but may produce vapor that would cause pump noise. Pump noise that is continuous, and/or cannot be attributed to any of these conditions, could be an indicator of fuel system problems.
Fuel Systems

Vacuum Testing Fuel System

**Note! This test must be performed with engine under load; either running in gear on water, or in gear and connected to a dynamometer. Ensure that all fuel line connections are leak free.**

1. Install Vacuum and Fuel Pressure Gauge such as Snap-on® Tools MT311JB or equivalent, and 8 in. (20.3 cm) of clear, fuel resistant vinyl hose into the fuel line at the filter bracket inlet.

2. Start engine and allow it to reach normal operating temperature. Run engine at full throttle for at least 2 minutes; observe vacuum gauge reading and check clear hose for air or vapor bubbles. Gauge reading must not exceed 4 in. of mercury (Hg) at any time, and there should be no bubbles visible in the clear hose. Compare observations to the following:

   **Gauge reads 1-4 in. of mercury - air bubbles present**
   - Supply side of fuel system has an air leak. Check points of possible failure as noted under Checking Boat Fuel System. Repair or replace suspect part, then make another vacuum test to verify repair.

   **Gauge reading exceeds 4 in. of mercury**
   - Supply side of fuel system has a restriction. Check points of possible failure as noted under Checking Boat Fuel System. Repair or replace suspect part, then make another vacuum test to verify repair.

Relay Wiring Diode Operation and Failure

**Alternator (Green) Lead Diode**

- This diode prevents current from the assist solenoid/starter relay reaching the alternator regulator during engine cranking. This diode can fail one of two ways. If the diode becomes shorted (continuity in both directions), the regulator may be damaged and the alternator might not produce the proper amount of current. If the diode becomes open (no continuity in either direction), the fuel pump will not run when the engine is running. After a short time, the engine will starve for fuel.

**Assist Solenoid/Starter Role (Orange) Lead Diode**

- This diode prevents current from the alternator “Light” terminal reaching the assist solenoid/starter relay while the engine is running. This diode can fail one of two ways. If the diode becomes shorted (continuity in both directions), the starter motor will try to engage while the engine is running. If the diode becomes open (no continuity in either direction), the fuel pump will not run when the engine is cranking and may be hard to start.
Relay Ohmmeter Tests

Note! Throughout this section two symbols are used to interpret electrical troubleshooting results.

A: This symbol indicates continuity or very low resistance.

B: This symbol indicates no continuity or very high resistance (\(\infty\)).

Note! To avoid damaging components when troubleshooting equipment, disconnect the battery cables from the battery and remove the relays before proceeding.

1. Use a continuity light or ohmmeter calibrated on appropriate scale to test continuity.

2. Connect meter leads to relay terminals 87a and 30 (1).
   - The meter must show continuity.

3. Connect meter leads to relay terminals 87 and 30 (2).
   - The meter must show no continuity.

4. Calibrate an ohmmeter on appropriate scale and connect the leads to relay terminals 85 and 86 (3).
   - The meter must show 70 - 100 ohms.

5. Connect meter leads to relay terminals 87 and 30. Connect a 12 volt source to relay terminals 85 and 86 (4).
   - The meter must show continuity.

6. Connect meter leads to relay terminals 87a and 30. Connect a 12 volt source to relay terminals 85 and 86 (5).
   - The meter must show no continuity.

7. Replace relay if your test results vary.
Electric Fuel Pump Circuit

4.3GL-A, 5.0GL-A/B, and 5.7GL-A/B Models

1. Battery
2. Black
3. Red
4. 40 Amp Fuse
5. Starter Motor
6. Red/Purple
7. Main Cable Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. 7.5 Amp Fuse
12. Remote Control
13. Yellow/Red
14. Alternator
15. Green
16. Diode
17. Orange
18. Relay
19. Fuel Pump
### 4.3GL-B/C, 5.0GL-C/D, and 5.7GL-C/D Models

1. Battery
2. Black
3. Red
4. 40 Amp Fuse
5. Starter Motor
6. Red/Purple
7. Main Cable Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. 7.5 Amp Fuse
12. Remote Control
13. Yellow/Red
14. Alternator
15. Green
16. Diode
17. Orange
18. Relay
19. Fuel Pump
4.3GL-D, 5.0GL-E, and 5.7GL-E Models

1. Battery
2. Black
3. Red
4. 20 Amp Fuse X 2
5. Starter Motor
6. Red/Purple
7. Main Cable Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. 7.5 Amp Fuse
12. Remote Control
13. Yellow/Red
14. Alternator
15. Green
16. Diode
17. Orange
18. Relay
19. Fuel Pump
Engine Fuel System Troubleshooting

ENGINE DOES NOT START - IMPROPER STARTING PROCEDURE USED
1. Check fuel level in tank, check fuel tank vent, check fuel in carburetor.
2. Check choke for proper operation.
3. Check for accelerator pump discharge.
4. Check fuel pump for correct pressure/vacuum.
5. Check fuel lines for blockage, tank to pump fuel line for air leaks, fuel filters for blockage.
6. Check idle mixture and idle speed adjustment.
7. Remove carburetor; check float level, inlet valve operation; check for dirt, water, varnish in passages, and worn parts.

ENGINE WILL START WHEN PRIMED - WILL NOT CONTINUE TO RUN
1. Check fuel supply.
2. Check idle mixture and idle speed.
3. Check fuel lines for blockage, air leaks.
4. Check for plugged fuel filters.
5. Check fuel pump for correct pressure/vacuum.
6. Remove carburetor; check for dirt, water, varnish deposits; check float level, and float inlet valve operation.
7. Check vacuum qualification adjustment.

ENGINE HARD STARTING, COLD
1. Check choke for proper operation.
2. Check for accelerator pump discharge.
3. Check fuel pump for correct pressure/vacuum.
4. Check for blockage in fuel lines, air leaks in fuel line from tank to fuel pump.
5. Remove carburetor; check float level, inlet valve operation; check for dirt, water, varnish deposits; check for worn parts, leaking gaskets

ENGINE HARD STARTING, HOT
1. Check carburetor for flooding (smell of raw gas).
2. Check choke for sticking, not open fully.
3. Remove carburetor; check float level, float inlet valve operation and condition.
4. Check for fuel line on or near hot surfaces, causing percolating in lines.
5. Check for correct carburetor base gasket.

ENGINE RUNS ROUGH, LOW SPEED
1. Check choke for proper operation; check idle mixture, idle speed.
2. Check for dirt or water in fuel, excessive or insufficient fuel pump pressure.
3. Remove carburetor; check for proper float level, internal blockage, defective parts, and varnish deposits in passages.
4. Check other systems; intake manifold for vacuum leaks, sticking valves, overheating, etc.
5. Check setting and operation of secondary throttle plate opening.
ENGINE RUNS ROUGH, HIGH SPEED
1. Check for sufficient fuel in tank, blocked tank vent, proper fuel.
2. Check choke for proper operation.
3. Check for water or dirt in fuel; check for correct fuel pump pressure/vacuum; check for blockage or air leaks in fuel line.
4. Remove carburetor; check float level, float inlet valve operation; check for proper high speed jet, power valve, internal blockage, varnish, and worn parts.
5. Check for plugged fuel filters.

ENGINE DIES (ON INITIAL ACCELERATION) OR HAS ACCELERATION FLAT SPOT
1. Check idle speed and idle mixture adjustment, check manifold for leaks.
2. Check vacuum diaphragm for premature opening.
3. Check fuel lines for fuel leaks or partially plugged tank vent.
4. Check carburetor accelerator pump for output and adjustment.
5. Check for water or dirt in fuel; check fuel pump for correct pressure/vacuum.
6. Remove carburetor; check for dirt and water; check float level and float inlet valve for operation; check for varnish in passages, worn parts; check for proper main jet.

ENGINE WILL NOT TURN RECOMMENDED RPM
1. Check throttle linkage adjustments to be sure throttle opens fully.
2. Check fuel lines for leaks; check fuel pump for correct pressure/vacuum.
3. Check choke for proper operation.
4. Remove carburetor; check float level; check for proper main jet, power valve; check passages for dirt and varnish.
5. Check boat for proper trim and propeller; check hull for marine growth.
6. Check ignition system components.
7. Check engine and drive unit for partial seizure.
8. Check fuel tank for plugged vent; check pickup tube for vacuum leaks.
9. Check for plugged fuel filters.
10. Check for full opening of secondary throttle.
11. Check exhaust system for restrictions.
12. Check for restricted air intake.
13. Check that secondary throttle plates are free to rotate when diaphragm stem is compressed.
14. Check that secondary diaphragm is not leaking and preventing throttle plates from opening correctly.
# Torque Specifications

**Inlet Needle Seat** .......................... 10 in. lb. (1.1 Nm)
**Inlet Nut Fitting** .......................... 80 in. lb. (9 Nm)
**Main Jets** .................................. 10 in. lb. (1.1 Nm)
**Power Valve** .................................. 100 in. lb. (11.3 Nm)

**Nuts**
- Carburetor Mounting .......................... 10-14 ft. lb. (13-19 Nm)
- Flame Arrestor Cover .......................... 25-35 in. lb. (2.8-4 Nm)

**Screws**
- Accelerator Pump Cover .......................... 5 in. lb. (0.6 Nm)
- Choke Housing .................................. 5 in. lb. (0.6 Nm)
- Choke Plate ................................... 6 in. lbs. (0.7 Nm)
- Fuel Bowl ...................................... 45 in. lb. (5.1 Nm)
- Pump Discharge Nozzle ......................... 15 in. lbs. (1.7 Nm)
- Thermostat Cover ................................ 5 in. lb. (0.6 Nm)
- Throttle Body .................................. 50 in. lb. (5.6 Nm)
- Throttle Plate .................................. 10 in. lb. (1.1 Nm)

*Note! Fuel bowl screws should be tightened once a year.*

## Carburator Specifications

### 3.0GS-A/B Models

**Volvo Penta #3857981** 500 CFM Model 2300-2V
- **Pump Lever Clearance** .......................... 0.010-0.015 in. (0.254-0.381 mm)
- **Choke Unloader** ................................. 0.300 in. (7.62 mm) Measured Lower Edge of Plate
- **Choke Setting** .................................. 5 Notches Lean
- **Initial Idle Mixture Setting** .................. 1 Turn Starboard - 1/2 Turn Port Off Seat
- **Main Jet** ........................................ 71
- **Power Valve** .................................... 2.5
- **Float Setting** ................................... Parallel to Fuel Bowl When Bowl Inverted
- **Choke Vacuum Qualification** ................... 0.365 in. (9.3 mm) Measured At Lower Edge of Plate
- **Pump Cam Position (orange cam)** ............. No. 2 Hole of Cam and Throttle Arm

### 3.0GS-C Models

**Volvo Penta #3863240** 500 CFM Model 2300-2V
- **Pump Lever Clearance** .......................... 0.010-0.015 in. (0.254-0.381 mm)
- **Choke Unloader** ................................. 0.300 in. (7.62 mm) Measured Lower Edge of Plate
- **Choke Setting** .................................. 5 Notches Lean
- **Initial Idle Mixture Setting** .................. 1 Turn Starboard - 1/2 Turn Port Off Seat
- **Main Jet** ........................................ 71
- **Power Valve** .................................... 2.5
- **Float Setting** ................................... Parallel to Fuel Bowl When Bowl Inverted
- **Choke Vacuum Qualification** ................... 0.365 in. (9.3 mm) Measured At Lower Edge of Plate
- **Pump Cam Position (orange cam)** ............. No. 2 Hole of Cam and Throttle Arm
3.0GL-B/C Models

Volvo Penta #3863240 500 CFM Model 2300-2V

Pump Lever Clearance ........................................... 0.010-0.015 in. (0,254-0,381 mm)
Choke Unloader .................................................. 0.300 in. (7,62 mm) Measured Lower Edge of Plate
Choke Setting ...................................................... 5 Notches Lean
Initial Idle Mixture Setting1 .................................... 3/4 Turn Off Seat
Main Jet - Port ..................................................... 72
Main Jet - Starboard .............................................. 71.1
Power Valve ......................................................... 2.5
Float Setting ....................................................... Parallel to Fuel Bowl When Bowl Inverted
Choke Vacuum Qualification ................................. 0.365 in. (9,3 mm) Measured At Lower Edge of Plate
Pump Cam Position (blue cam) .............................. No. 2 Hole of Cam and Throttle Arm

4.3GL-A Models

Volvo Penta #3858330 500 CFM Model 2300-2V

Pump Lever Clearance ........................................... 0.010-0.015 in. (0,254-0,381 mm)
Choke Unloader .................................................. 3/8 in. (9,525 mm) Measured Lower Edge of Plate
Choke Setting ...................................................... 5 Notches Lean
Initial Idle Mixture Setting1 .................................... 5/8 Turn Off Seat
Main Jet ............................................................. 70
Power Valve ......................................................... 2.5
Float Setting ....................................................... Parallel to Fuel Bowl When Bowl Inverted
Choke Vacuum Qualification ................................. 0.250 in. (6,35 mm) Measured At Lower Edge of Plate
Pump Cam Position (red cam) .............................. No. 1 Hole of Cam and Throttle Arm

4.3GL-B Models

Volvo Penta #3863241 500 CFM Model 2300-2V

Pump Lever Clearance ........................................... 0.010-0.015 in. (0,254-0,381 mm)
Choke Unloader .................................................. 3/8 in. (9,525 mm) Measured Lower Edge of Plate
Choke Setting ...................................................... 5 Notches Lean
Initial Idle Mixture Setting1 .................................... 5/8 Turn Off Seat
Main Jet ............................................................. 70
Power Valve ......................................................... 2.5
Float Setting ....................................................... Parallel to Fuel Bowl When Bowl Inverted
Choke Vacuum Qualification ................................. 0.250 in. (6,35 mm) Measured At Lower Edge of Plate
Pump Cam Position (red cam) .............................. No. 1 Hole of Cam and Throttle Arm

1. Idle mixture setting is non-adjustable for engines operated in California.
**Fuel Systems**

### 4.3GL-C/D Models

**Volvo Penta #3863241**

- **500 CFM Model 2300-2V**
  - Pump Lever Clearance: 0.010-0.015 in. (0,254-0,381 mm)
  - Choke Unloader: 3/8 in. (9,525 mm) Measured Lower Edge of Plate
  - Choke Setting: 5 Notches Lean
  - Initial Idle Mixture Setting: 3/4 Turn Off Seat
  - Main Jet: 70
  - Power Valve: 2.5
  - Float Setting: Parallel to Fuel Bowl When Bowl Inverted
  - Choke Vacuum Qualification: 0.250 in. (6,35 mm) Measured At Lower Edge of Plate
  - Pump Cam Position (red cam): No. 1 Hole of Cam and Throttle Arm

### 5.0GL-A/B & 5.7GL-A/B Models

**Volvo Penta #3858334**

- **500 CFM Model 2300-2V**
  - Pump Lever Clearance: 0.010-0.015 in. (0,254-0,381 mm)
  - Choke Unloader: 0.300 in. (7,62 mm) Measured Lower Edge of Plate
  - Choke Setting: 5 Notches Lean
  - Initial Idle Mixture Setting: 3/4 to 1 Turn Off Seat
  - Main Jet: 69
  - Power Valve: 4.5
  - Float Setting: Parallel to Fuel Bowl When Bowl Inverted
  - Choke Vacuum Qualification: 0.315 in. (8,00 mm) Measured At Lower Edge of Plate
  - Pump Cam Position (yellow cam): No. 1 Hole of Cam and Throttle Arm

### 5.0GL-C Models

**Volvo Penta #3863242**

- **500 CFM Model 2300-2V**
  - Pump Lever Clearance: 0.010-0.015 in. (0,254-0,381 mm)
  - Choke Unloader: 0.300 in. (7,62 mm) Measured Lower Edge of Plate
  - Choke Setting: 5 Notches Lean
  - Initial Idle Mixture Setting: 3/4 to 1 Turn Off Seat
  - Main Jet: 69
  - Power Valve: 4.5
  - Float Setting: Parallel to Fuel Bowl When Bowl Inverted
  - Choke Vacuum Qualification: 0.315 in. (8,00 mm) Measured At Lower Edge of Plate
  - Pump Cam Position (yellow cam): No. 1 Hole of Cam and Throttle Arm

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1. Idle mixture setting is non-adjustable for engines operated in California.
5.7GL-C Models

**Volvo Penta #3863244**

<table>
<thead>
<tr>
<th>Specification</th>
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<tbody>
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5.0GL-D/E Models

**Volvo Penta #3863242**

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<td>3/4 Turn Off Seat</td>
</tr>
<tr>
<td>Main Jet</td>
<td>72.2</td>
</tr>
<tr>
<td>Power Valve</td>
<td>8.5</td>
</tr>
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<td>Float Setting</td>
<td>Parallel to Fuel Bowl When Bowl Inverted</td>
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5.7GL-D/E Models

**Volvo Penta #3863244**

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1. Idle mixture setting is non-adjustable for engines operated in California.
Safety Section

Part A

Marine Products and Safety of People Who Use Them ........... S-2
Sterndrive Shift System ........................................... S-3
Sterndrive Throttle Control System ............................... S-4
Sterndrive Steering System ........................................ S-5
Sterndrive Fuel, Electrical System ............................... S-7

Part B

Marine Products and Safety of People Who Fix Them ........... S-11
Handling Engines ..................................................... S-11
Handling Lead Acid Batteries ..................................... S-12
Gasoline! Handle with Care ....................................... S-13
Hazardous Products ................................................. S-14
Enjoyable boating is the goal of people who design and build marine products. To reach this goal, manufacturers are careful to make sure...

- Product User is informed. . .
- Products are safe and reliable. . .

It's up to you, the People who. . .

- Install accessories. . .
- Service and Maintain the boat . .
- Service and maintain the sterndrive. . .
  . . . to keep the products safe and reliable.

This section talks about safe boating and how you can help keep it safe. Some things you may know . . . but others you may not.

First!

A word about fasteners . . . plain . . . special . . . all screws, nuts, washers and bolts.

Do Not Substitute Fasteners

They look the same, but . . . are they?

- The Same Size?
- The Same Strength?
- The Same Material?
- The Same Type?
- Standard or Metric Thread?

Don't substitute unless you know they are the same in all characteristics.

Second!

- Special locking screws and nuts are often used to attach steering, and remote control components to the sterndrive.
- When you remove any part from the sterndrive, keep track of special screws and nuts. Don't mix with other parts
- When reassembling the sterndrive, use only the special screws and nuts intended to hold steering, and control cables, plus related parts.
- Service with parts of known quality that meet Marine Industry (BIA/ABYC) Standard.
Sterndrive Shift System

The Shift System starts here at the remote control lever...

... and ends here at the propeller.

What's Most Important?

When the control lever is in Forward, Neutral or Reverse position...

... Shift mechanism must match control lever position.

What Could Happen?

- **If... Neutral**
  - Forward or Reverse

  ... Propeller is still powered (turning) unknown to operator, or engine will start in gear, boat will move unexpectedly.

- **If... Forward**

  ... boat will move opposite to direction intended by operator.

How Can Loss of Shift Control be Minimized? In pre-delivery inspection and when servicing...

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with ⚠️...
- Assemble parts and make adjustments carefully...
- Test your work. Don't guess. Make sure propeller does what the operator wants and nothing else.
Sterndrive Throttle Control System

The throttle Control System starts here and the remote control lever . . .

. . . and ends here on the engine.

What's Most Important?

When the control lever is moved from Forward (or Reverse) to Neutral . . .

. . . engine speed must slow to idle RPM and allow operator to shift into Neutral.

Operator must be able to stop propeller.

What Could Happen?

If operator cannot slow the engine to idle RPM and shift into neutral, (stop propeller), operator could panic and lose control of boat.

How Can Loss of Throttle Control be Minimized? In pre-delivery inspection and when servicing . . .

- Read, understand, and follow manufacturers instructions.
- Closely follow the warnings marked with ⚠️.
- Assemble parts and make adjustments carefully.
- Test your work. Don't guess. Make sure engine throttle response is smooth.
- Make sure full throttle operating RPM can be reached so operator won't overload engine.
Sterndrive Steering System

The Steering System starts here at the helm . . .

What's Most Important?

The Steering System . . .

- must be installed properly
- must be adjusted properly
- must be lubricated

What Could Happen?

- . . . if steering system comes apart, boat would turn suddenly and circle . . . passengers and/or operator may be thrown into water and could be hit.

- . . . if steering jams, operator may not be able to avoid obstacles. Operator could panic.

- . . . if steering is loose, operator may not be able to maintain a true course, and could result in loss of boat control.
How Can Loss of Steering Control be Minimized?

In pre-delivery inspection and when servicing:

- Use steering components which meet marine industry (ABYC) standards.
- Read, understand, and follow manufacturer's instructions.
- Assemble parts and make adjustments carefully.
- Closely follow the warnings marked with !.
- Keep parts moving freely. Lubricate parts as soon as shown in manuals.
- Use bolts, nuts, and washers supplied with steering attachment kits.

When power assisted or mechanical steering systems are used, check to uncover possible trouble!

- Cable housing in this area must not be restricted.
- Steering components must not bind.
- Why? Unit may go to full turn without turning steering wheel (Power assist models).
- Why? Possible jamming of steering system.

Power steering parts and push/pull cable must be free to move in order to actuate power steering valve when operator turns steering wheel.

- Engine stringer must not interfere with power steering pump and pulley.
- Maintain proper belt tension.

Check for damaged parts... impacts to the sterndrive like this or this... or ? ? ? can put stress on steering components. Look for...

- Cracked parts
- Bent parts
- Loose fasteners

Replace damaged parts. If weakened, parts could fail later... on the water... when least expected.
Sterndrive Fuel and Electrical Systems

The electrical System begins here at the battery . . .

. . . and ends here at the carburetor or fuel injectors

The fuel system starts here at the fuel tank . . .

. . . and ends here on the engine.

What's Important?

- Fuel leakage must be prevented.
- Electric sparks must not happen.

What Could Happen?

Gasoline can explode and/or burn easily:

- When boating, fuel leaking in the engine compartment could be ignited by a spark from a loose wire connection, or a damaged or deteriorated electrical component.

How Can Fire and Explosion Be Minimized?

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with ⚠️ . . .
- Do not substitute fuel or electrical parts with other parts which may look the same. These parts are designed and manufactured to meet special U. S. Coast Guard safety regulations to prevent fire and explosion.

If you work on marine engines, you must understand these U.S. Coast Guard requirements. If you don't have them, write to . . .

. . . and ask for copies of:

(1) Electrical System Compliance Guideline (AD/A-049-638)
(2) Fuel System Compliance Guideline (AD/A-047-767)

These are concise guidelines - easy to read and understand. They explain what must be done to prevent fire and explosions.
• Always use replacement parts specified by the manufacturer. They meet the U.S. Coast Guard requirements. Most automotive parts do not, especially electrical components that must meet ignition protection requirements of the U.S. Coast Guard regulations.

• When nonmetallic parts look to be in poor shape . . . replace them!

Wires Cracked!  Torn Boots!  Cracked Fuel Lines!

Using parts which meet U.S. Coast guard requirements is only half the job. The other half is your job . . .

It's time for replacement BEFORE sparks and/or fuel leaks occur.

• Replace parts carefully. Make sure nuts and bolts are tight especially when they anchor electrical wires (to prevent sparking). If lock washers are specified - use them. No short cuts or missing parts with either of these CRITICAL safety related systems.

• When refueling, always ground fuel nozzle to the inlet fitting on the boat to prevent the buildup of electrostatic sparks. If you use a funnel, make sure it's metal and ground the fuel nozzle to the funnel.

METAL FUNNEL  MAKE SURE NOZZLE TOUCHES!  WHEN REFUELING NEVER . . .!

STOP  • If you smell gasoline in the engine compartment . . . find its source and stop the leakage.
Follow "Starting Procedure" outlined in the operator's manual.

Always make sure there are no gasoline fumes in the engine compartment before starting the engine. Open the compartment and use your nose. Don't gamble.

- **Backfire flame arrestor** must be in place and securely attached to the air intake.

Do not alter the backfire flame arrestor.

If loose, damaged, or altered, an engine "backfire" may pass through the flame arrestor assembly into the engine compartment. If fumes are present in compartment, fire and explosion could result.
Summing Up

Now you know some things that can take the joy out of enjoyable boating.

No doubt about it . . . it takes time!

- Reading and understanding instructions.
- Reading and understanding warnings marked with ⚠ ⚠ ⚠ . . .
- Putting parts together correctly . . .
- Making correct adjustments . . .
- Testing you work.

and making sure

- Worn or damaged parts are replaced,
- Replaced parts are like originals . . . in every way.
- Customer is told of things which need attention . . .

But do you really want the alternative?
Part B - Marine Products and Safety of People* Who Fix Them

Part A talked about safe boating and how you, the mechanic, can help keep it safe for the boater. But what about you? Mechanics can be hurt while . . .

- Servicing boats
- Servicing sterndrives
- Troubleshooting problems
- Testing their work

Some items you'll know . . . others you may not.

When Lifting Engines

If hoist is poor shape . . . or too small for the job

- Engine may drop suddenly

- Make sure shop aids have extra capacity — and keep them in good repair!

When Running Engine with Engine Compartment Cover Removed

The engine compartment cover is a guard. When you remove the cover / guard to work on the engine, remember:

- Loose clothing (open shirt sleeves, neckties), long hair, jewelry (rings, watches, bracelets), hands, arms, belts can be caught by moving belts or spinning pulleys
- Handle high voltage ignition components carefully. They can shock you and may cause you to recoil into moving parts.

Two people working together on a running engine must look out for each other. Never, ever, turn the key to start the engine before signalling to your partner. (He may be leaning over the engine with his hands on a belt, or a "hot" electrical part, near the propeller, etc.) Remove the key(s) while working on the engine to prevent accidental starting.

*Mechanics, technicians, backyard do-it-yourselfers.
Exhaust gasses of running engines contain carbon monoxide. . . you can't see it. . . you can't smell it. . . you can't taste it. . . but it's there whenever an engine runs. . . and it's deadly!

When you smell the other gasses in the exhaust, you are inhaling carbon monoxide. Run engines only in well ventilated areas.

**Eyes Need help**

- Grinding
- End of Cables
- Sprayed Cleaners, Paints
- Acid
- Chiseling (steel on steel)
  (Tip: Use plastic or brass type hammers.
   They don't chip off as easily as steel hammers.)

**Handling Lead Acid Batteries**

- If spilled or splashed on any part of body..
- Wash with lots of water. . .
- If solution gets into eyes. . . Wash. . . and see a Doctor, fast!

**Charging Lead Acid Batteries**

1. Attach and remove these cables with charger unplugged from 110 volt wall socket. (Prevents shocks if the charger is defective.)
2. Observe correct polarity when connecting these charger leads.
3. Always charge in a well ventilated area. Charging causes acid solution to give off hydrogen gas through the vents in the caps. . . Make sure vents are open. If clogged, pressure inside may build. . . battery may explode.
Battery gas is explosive! While charging or discharging, remember...

Never yank cables off battery posts... it's a sure way to make lots of sparks... surrounded by battery gas

No Smoking
No Flames
No Sparks

Don’t check battery condition by placing metal objects across posts.

You’re sure to make sparks and serious burns are possible.

After Charging...

- Shut off charger
- Remove charger plug from wall socket
- Take charger cable off battery posts

Gasoline! Handle With Care

- When you smell any odor of gasoline, explosion is possible
- Gasoline fumes are heavier than air and will sink to the lowest point in the boat or room, and will stay there... waiting
- If the air around you is quiet... the pilot light in the heater may ignite the heavy fumes before your nose ever smells the fumes...

Gasoline explodes easily and violently when mixed with air

5 Parts Gasoline

100 Parts Air

Gas Fumes

What Can you Do?

- Store properly...
- Fill portable tanks outside boat to prevent spillage in boat
- Use fuel for fuel... not for a solvent
- If fumes are smelled (in shop, basement, garage), immediately:
  - Put out open flames, cigarettes, sparking devices
  - Wipe up spill or leak; get towels, rags outside fast
  - Check lowest area for fumes; open doors or windows

Store in sturdy, sealed gas can... and... keep outside

Safety
Know items in and around repair area which can ignite gasoline fumes . . . Control them if fumes are smelled.

- Matches, cigarettes, torches, welders
- Electric motors (with unsealed cases)
- Electric generators (with unsealed cases)
- Light switches
- Appliance pilot lights (furnace, dryer, water heater)
- ?????????

How many of these are in your area?

## Hazardous Products

Read the container label. It tells you . . .

- "How, and where, to use,"
- "How to give First Aid," and have "recommended" first aid materials on hand- should an emergency arise
- "How to dispose of can,"

Remember: Little children are very curious and will try to taste everything, so . . .

. . . yummmmmmmmmmmmm

Keep containers away from children