MERCURY

6.2L Mercury MerCruiser

SERVICE MANUAL

Serial Number 2A456613 and Above

Models Covered

Model	Serial Number
6.2 MPI ECT	2A456613 and above

Notice to Users of This Manual

Throughout this publication, warnings, cautions, and notices (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully!

These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures.

⚠ WARNING
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE
Indicates a situation which, if not avoided, could result in engine or major component failure.

IMPORTANT: Identifies information essential to the successful completion of the task.

NOTE: Indicates information that helps in the understanding of a particular step or action.

This manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein. We reserve the right to make changes to this manual without prior notification.

It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury Marine power products, including the use of mechanics' common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, when using a service procedure and/or tool that is not recommended by the manufacturer, be completely satisfied that neither your personal or product safety is endangered.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

Refer to dealer service bulletins, operation maintenance and warranty manuals, and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

It should be kept in mind, while working on the product, that the electrical and ignition systems are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material into the cylinders which could cause extensive internal damage when the engine is started.

During any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for reuse, care should be taken to select a replacement that matches the original.

Replacement Parts

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

Cleanliness and Care of Product

A Mercury Marine power product is a combination of many machined, honed, polished, and lapped surfaces with tolerances measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. It should be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever components are removed, they should be retained and marked for installation into their original locations. During the assembly process, the marked parts are quickly identified for installation into the same locations they were removed from.

Personnel should not work on or under an engine that is suspended. Engines should be secured to work stands, or lowered to the ground as soon as possible.

Copyright and Trademark Information

Manual Outline

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Important Information, Maintenance, and Troubleshooting

Section 1A - General Information

Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Threads of stainless steel fasteners	92-802859A 1

Introduction

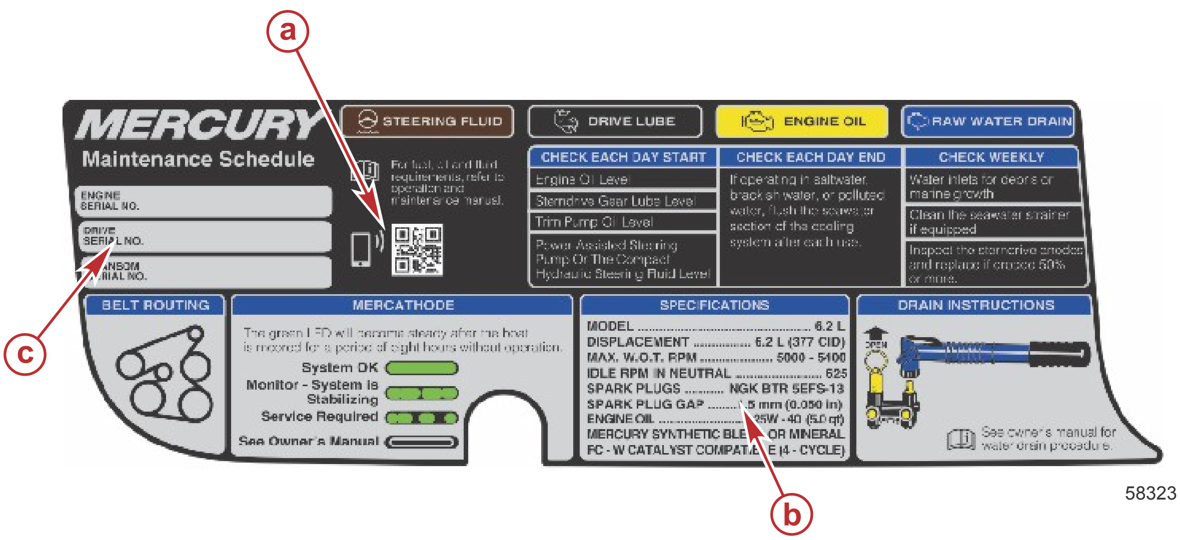
This overhaul and repair manual is intended as a comprehensive service guide for the models listed earlier. It provides specific information, including procedures for disassembly, inspection, assembly, and adjustment to enable dealers and service mechanics to repair these products.

Before attempting repairs we suggest that the procedure first be read in its entirety to gain knowledge of the methods and tools used and of the cautions and warnings required for safety.

Engine Serial Number

The serial number is located in two places on the engine. One is on the engine specification decal located on the engine cover, and the other is secured to the starboard side of the engine block near the starter motor.

A quick reference code on the engine cover or heat exchanger can be used to access additional information about the engine and safe boating practices.



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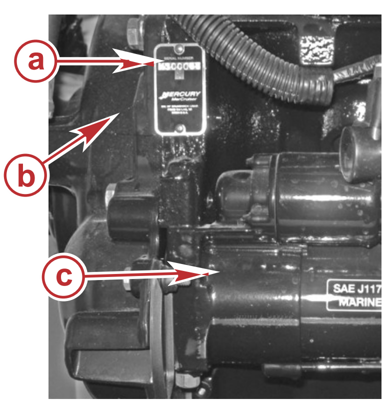
a - Quick reference code
b - Engine specification decal
c - Serial number decal strips



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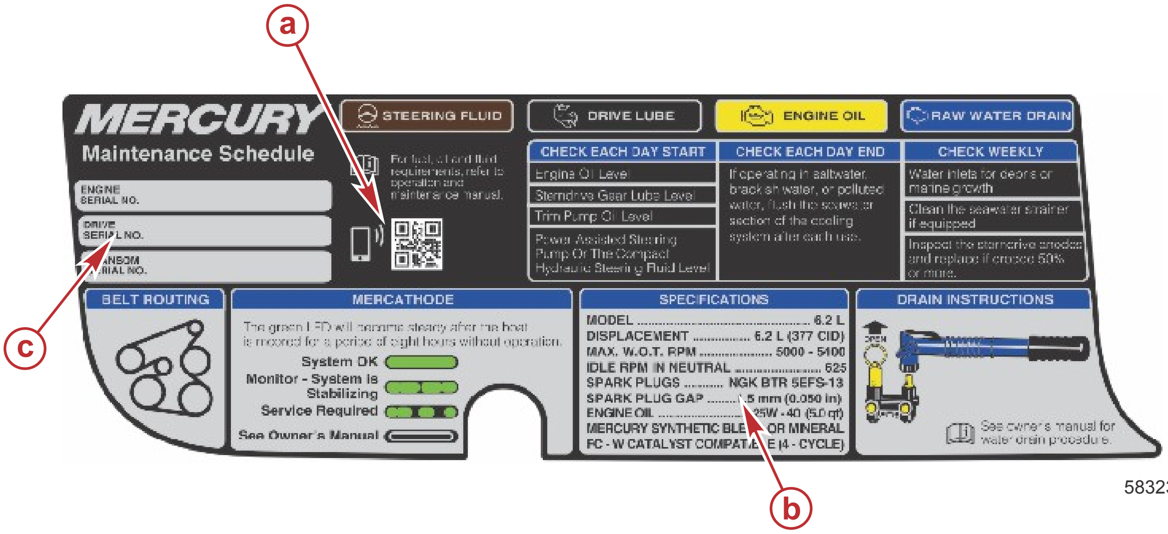
Engine block location
a - Engine serial number plate
b - Flywheel housing
c - Starter motor

Serial Number Decal Placement

There are three sets of engine, transom assembly, and sterndrive serial number decal strips provided with each power package. One should be used for each of the following:

- Engine specification decal
- Operation, Maintenance and Warranty Manual identification page
- Affix engine serial number decal to specification/serial number decal.



58323

a - Quick reference code
b - Engine specification decal
c - Serial number decal strips

Directional References

All directional references in this document follow traditional nautical convention:

- The bow is the front of the boat. The stern is the rear of the boat.
- Fore means toward the bow. Aft means toward the stern.
- Starboard is the right-hand side of the boat as one faces forward.
- Port is the left-hand side of the boat as one faces forward.

SeaCore

SeaCore Components and Castings

Mercury MerCruiser SeaCore power packages are equipped with additional stainless steel components and particular aluminum castings with special coatings. Do not replace SeaCore components with non-SeaCore. Use only the specified Mercury MerCruiser SeaCore components and castings on these power packages.

Stainless Steel Fasteners

SeaCore models are equipped with additional stainless steel fasteners to maximize corrosion resistance in saltwater environments.

Stainless steel fasteners are subject to galling when installed without lubrication. Galling can result in fastener destruction, improper clamp loads, or both. Galled fasteners may appear to tighten properly, but still have incorrect clamp loads.

Apply a lubricant, such as 2-4-C or an equivalent, on the threads of stainless steel fasteners during installation to avoid galling. Lubricate at least the first 6 mm (1/4 in.) of the threads before installation.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Threads of stainless steel fasteners	92-802859A 1

Proper Break-In

20-Hour Break-In Period

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

- Do not operate below 1500 RPM for extended periods of time for the first 10 hours. Shift into gear as soon as possible after starting and advance the throttle above 1500 RPM if conditions permit safe operation.
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during the first 10 hours. During the next 10 hours, occasional operation at full throttle is permissible (five minutes at a time maximum).
- Avoid full throttle acceleration from idle speed.
- Do not operate at full throttle until the engine reaches normal operating temperature.
- Frequently check engine oil level. Add oil as needed. It is normal for oil consumption to be high during the break-in period.

After the Break-In Period

To help extend the life of your Mercury MerCruiser power package, the following recommendations should be considered:

- Ensure that the propeller allows the engine to operate at or near the top of the specified wide-open throttle (WOT) RPM range (refer to **Section 1C** - **Maintenance**) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at WOT RPM.

Fuel Requirements

NOTICE
Running out of fuel can damage catalyst components. Do not allow the fuel tanks to become empty during operation.

IMPORTANT: Use of improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine and will not be covered under the limited warranty.

Fuel Ratings

Mercury MerCruiser engines will operate satisfactorily with any major brand of unleaded gasoline that meets the following specifications:

USA and Canada - A posted pump octane rating of 87 (R+M)/2, minimum, for all models. Premium gasoline 91 (R+M)/2 octane is also acceptable for all models. **Do not** use leaded gasoline.

Outside USA and Canada - A posted pump octane rating of 91 RON, minimum, for all models. Premium gasoline (95 RON) is also acceptable for all models. **Do not** use leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and is acceptable for use in your Mercury Marine engine. The only oxygenate currently in use in the USA is alcohol (ethanol, methanol, or butanol).

Gasoline Containing Alcohol

Bu16 Butanol Fuel Blends

Fuel blends of up to 16.1% butanol (Bu16) that meet the published Mercury Marine fuel rating requirements are an acceptable substitute for unleaded gasoline. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Methanol and Ethanol Fuel Blends

IMPORTANT: The fuel system components on your Mercury Marine engine will withstand up to 10% alcohol (methanol or ethanol) content in the gasoline. Your boat's fuel system may not be capable of withstanding the same percentage of alcohol. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing methanol or ethanol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Likelihood of phase separation (water and alcohol separating from the gasoline in the fuel tank)

⚠ WARNING
Fuel leakage is a fire or explosion hazard, which can cause serious injury or death. Periodically inspect all fuel system components for leaks, softening, hardening, swelling, or corrosion, particularly after storage. Any sign of leakage or deterioration requires replacement before further engine operation.

IMPORTANT: If you use gasoline that contains or might contain methanol or ethanol, you must increase the frequency of inspection for leaks and abnormalities.

IMPORTANT: When operating a Mercury Marine engine on gasoline containing methanol or ethanol, do not store the gasoline in the fuel tank for long periods. Cars normally consume these blended fuels before they can absorb enough moisture to cause trouble; boats often sit idle long enough for phase separation to take place. Internal corrosion may occur during storage if alcohol has washed protective oil films from internal components.

Engine Oil

For optimum engine performance and maximum protection, use the following oil:

Application	Recommended Oil
All MerCruiser engines	Mercury/Quicksilver 25W-40 Synthetic Blend Engine Oil, NMMA FC-W Catalyst Compatible rated

IMPORTANT: Lubrication requirements for catalyzed engines differ from the requirements for noncatalyzed engines. Some marine-grade lubricants contain high levels of phosphorus. Although these high-phosphorus lubricants may allow acceptable engine performance, exposure over time will damage the catalyst. Catalysts damaged by lubricants containing high levels of phosphorus may not be covered by the MerCruiser Limited Warranty.

If Mercury/Quicksilver 25W-40 Synthetic Blend Engine Oil is unavailable, use the following lubricants, listed in order of recommendation.

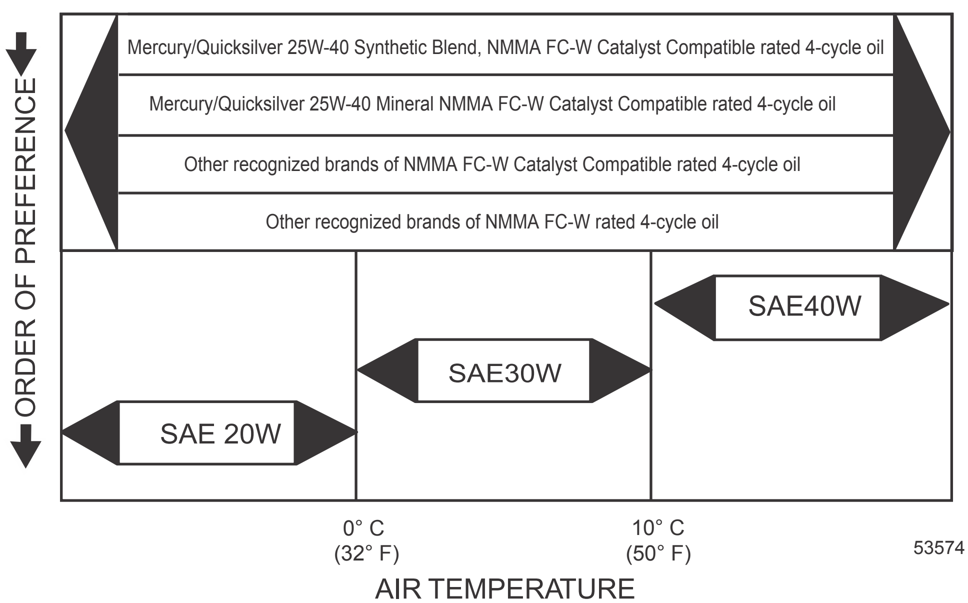
1. Mercury/Quicksilver 25W-40 Mineral NMMA FC-W Catalyst Compatible.

IMPORTANT: If you are servicing a catalyst engine, use the following oils for short periods of time only.

2. Other recognized brands of NMMA FC-W Catalyst Compatible rated 4-cycle oil.
3. Other recognized brands of NMMA FC-W rated 4-cycle oils.
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: *We do not recommend nondetergent oils, multi-viscosity oils (other than as specified), non-FC-W rated synthetic oils, low-quality oils, or oils that contain solid additives.*

Use the following information for selecting the type of oil according to the order of preference.



Notes:

Important Information, Maintenance, and Troubleshooting

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Section 1B - Emissions Control

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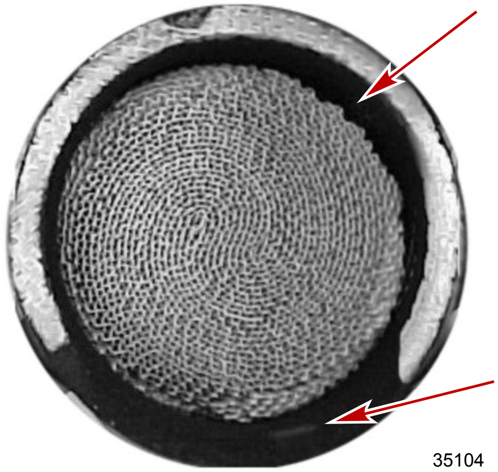
Protecting the Emissions System

Running Out of Fuel

NOTICE
Running out of fuel can damage catalyst components. Do not allow the fuel tanks to become empty during operation.

When the engine runs out of fuel, the temperature of the exhaust gases rises dramatically, reaching temperatures above 850° C (1500° F). These high temperatures can destroy catalysts rapidly. Never allow the engine to run out of fuel.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Catalyst damage due to running out of fuel

Preventing Contamination of the Emissions Control System

Catalyst and oxygen sensors can become contaminated, leading to component failure.

Phosphorus, found in some marine-grade oils, and other compounds will damage or destroy a catalyst's ability to clean the exhaust. Catalyst-friendly oil, such as Mercury MerCruiser Synthetic Blend Engine Oil, prevents this damage. Approved oils must be used in MerCruiser engines with Emissions Control Technology (ECT), except in special circumstances. Refer to **Section 1A** -**Engine Oil** for additional information.

NOTICE
Acetoxy silicone sealants and other compounds can damage oxygen sensors and catalysts. Use only compounds and sealants approved by Mercury Marine for use on catalyzed engines, such as Loctite 587 High Performance Blue.

Fiberglass is a silica-based material that can contaminate the catalyst and the oxygen sensors. To reduce the possibility that the engine will ingest harmful fiberglass and poison the emission control components, protect the engine from fiberglass dust and debris during construction and clean-up.

Fuel system and engine cleaners in the form of an aerosol sprayed near or into the intake of an operating engine can contaminate the catalyst and the oxygen sensors. The use of spray cleaners could cause irreversible damage to the catalytic converter leading to component failure.

NOTICE
Aerosol fuel system and engine cleaners sprayed near or into the intake of an operating engine can damage the catalyst and the oxygen sensors. Do not spray aerosol cleaners near or into the intake of an operating engine. Use only approved fuel system additives.

The recommended method for fuel system and engine cleaning on an operational engine equipped with ECT is to use approved cleaners added to the fuel system. The cleaners approved by Mercury MerCruiser include Quickare, Quickleen, and Quickstor. Refer to the manufacturer's instructions for proper use.

Emissions Regulations

International Regulations Compliance

MerCruiser products are designed and manufactured to meet the host of regulatory requirements set forth by the following standards and regulatory organizations:

- ABYC (American Boat and Yacht Council)
- USCG (United States Coast Guard)
- SAE (Society of Automotive Engineers)
- ISO (International Standards Organization)
- CARB (California Air Resources Board)
- EU (European Union)
- SAV (Schweizer Abgas Vorschriften—Swiss Gas Regulations)
- JCI (Japan Craft Inspection Organization)

California Regulations for 2007—Low-Permeation Fuel Hose

California regulations mandate that any spark-ignition inboard/sterndrive pleasurecraft manufactured in 2007 or later and sold in the state of California use low permeation fuel line hose for the primary fuel line connecting the fuel tank to the engine of said boat. For full details, refer to (2007) 13 C.C.R. §2442(b).

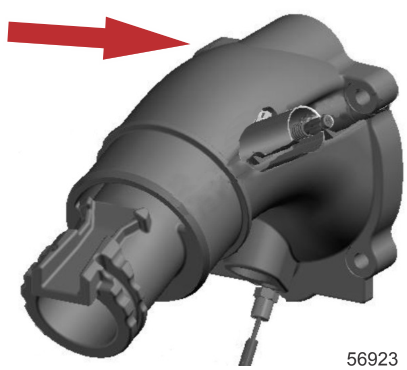
Low permeation fuel line hose is USCG Type A1-15, defined as not exceeding 15 $g/m^2/24\ h$ with CE10 fuel at 23° C as specified in SAE J 1527—Marine Fuel Hoses.

Exhaust Emissions Sampling

Exhaust gas emission regulations require field access to uncontaminated and undiluted engine exhaust. Mercury MerCruiser models covered by these regulations are equipped with (or have available) exhaust system components that allow access to the exhaust gas stream suitable for analysis.

IMPORTANT: To comply with exhaust gas emission regulations, design considerations determined by the boatbuilder and specific engine installations must allow for field access to the exhaust gas sampling port area.

The exhaust gas sampling access area is located on the exhaust elbow.



Access area for exhaust gas sampling

Emissions Information on the Product

Emission Control Information Label Request Form

To obtain a decal request form, contact warranty registration at 920.929.5054.

Emission Certification Star Label

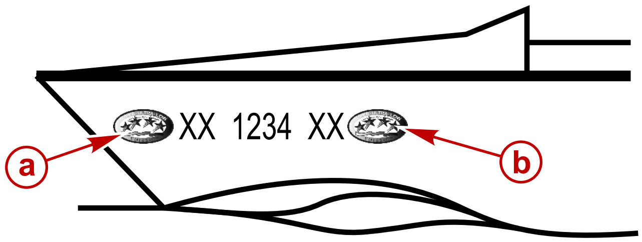
Your boat is labeled on the hull with one of the following star labels. The symbol for Cleaner Marine Engines means:

1. Cleaner air and water - for a healthier lifestyle and environment.
2. Better fuel economy - burns up to 30–40 percent less gas and oil than conventional carbureted two-stroke engines, saving money and resources.
3. Longer emission warranty - protects consumer for worry free operation.

Beginning January 1, 2003, one Three-Star or Four-Star label will be included with each factory-certified Mercury MerCruiser engine.

All Mercury MerCruiser engines (500 hp and below) will have a Three-Star Ultra Low Emission rating or Four-Star Super Ultra Low Emission rating. The Star label identifies that these engines meet the California Air Resources Board's sterndrive and inboard marine engine 2007 and later exhaust emission standards. Engines meeting these standards have 65–90% lower emissions than One-Star - Low Emission engines.

The Star label will be affixed on the left side of the hull as shown.



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a - Recommended location
b - Secondary location

One Star - Low emission	
 22531	The one-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted two-stroke engines. These engines are equivalent to the U.S. EPAs 2006 standards for marine engines.
Two Stars - Very Low emission	
 42537	The two-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low-Emission engines.
Three Stars - Ultra Low emission	
 42538	The three-star label identifies engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2008 exhaust emission standards or the sterndrive and inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.
Four Stars - Super Ultra Low emission	
 42539	The Four Star label identifies engines that meet the Air Resources Board's sterndrive and inboard marine engine 2009 exhaust emission standards. Personal Watercraft and Outboard marine engines may also comply with these standards. Engines meeting these standards have 90% lower emissions than One Star - Low Emission engines.

Important Information, Maintenance, and Troubleshooting

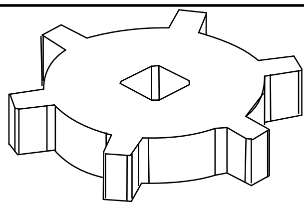
Section 1C - Maintenance

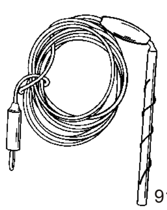
Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Battery Terminal Sealant	Battery terminal connections	Obtain Locally
87	High Performance Gear Lubricant	Gear lube monitor Sterndrive unit	92-858064K01
95	2-4-C with PTFE	Steering cable grease fitting Exposed part of the steering cable	92-802859A 1
114	Power Trim and Steering Fluid	Power trim pump Power-assisted steering system	92-858074K01
115	Premium Plus 2-Cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
120	Corrosion Guard	Painted surfaces	92-802878 55
122	Extended Life Antifreeze/ Coolant	Closed-cooling system	92-877770K1
124	Quickstor Fuel Stabilizer	Fuel system	92-8M0047932
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Oil filter sealing ring All MerCruiser engines	92-8M0078629

Special Tools

Fuel Filter Removal/Installation Tool	91-896661
 24896	Aids in the removal and installation of the fuel filter cap assembly.

Reference Electrode	91-76675T 1
 9188	Senses and electrical current in the water when testing the MerCathode system. Use to check hull potential.

Flushing Device	91-44357Q 2
 9192	Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.

Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1
 9194	Blocks off the front water inlet holes on the dual water inlet gearcases.

Engine and Tune-Up Specifications

Notes on Engine Specifications

- Performance specifications are obtained and corrected in accordance with SAE J1228 (crankshaft power) and ISO 8665 (standard power).
- All measurements are taken with the engine at normal operating temperature.
- RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.
- Oil pressure must be checked with the engine at normal operating temperature.
- Oil pressure specifications are for reference and may vary.

IMPORTANT: Do not mix spark plug types in an engine. All spark plugs should have the same part number.

6.2 MPI ECT and 6.2 MPI Non-ECT

Crankshaft power		224 kW (300 hp) Sterndrive/Inboard only
		238 kW (320 hp) TowSport only
		261 kW (350 hp) Sterndrive/Inboard only
		275 kW (370 hp) TowSport only
Displacement		6.2 L (377 cid)
Alternator amperage	Hot	72 A
	Cold	65 A
RPM	WOT operating range	5000–5400
	Rev limiter	5550
	Idle in neutral	625—not adjustable
	Idle in gear	650—not adjustable
Minimum oil pressure	At 2000 RPM	124 kPa (18 psi)
	At idle	41 kPa (6 psi)
Thermostat	Seawater-cooled models	60° C (140° F)
	Models with closed cooling	77° C (170° F)
Timing at idle		Not adjustable
Firing order		1-8-4-3-6-5-7-2
Minimum battery rating		800 CCA, 1000 MCA, 190 Ah
Spark plug type	Factory installed	NGK BPR5EFS-13
Spark plug gap		1.30 mm (0.051 in.)
Emission control system (ECT models)		Electronic control (PCM112), wideband sensor (HO2S), catalyst

Fluid Specifications

Engine

IMPORTANT: It may be necessary to adjust the oil levels depending on the installation angle of the engine and the type of cooling system—the heat exchanger and the fluid lines, on the engine.

NOTE: Measure the oil level with the boat in the water.

NOTE: All capacities listed are approximate fluid measures.

Description	Capacity	Fluid Type
Engine oil—with filter	4.7 L (5 US qt)	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil
Seawater-cooling system winterization use only	26.5 L (28 US qt)	Propylene glycol and purified water 50/50
Closed-cooling system	17 L (17.9 US qt)	Mercury Extended Life Coolant/Antifreeze or extended-life ethylene glycol coolant/antifreeze mixed 50/50 with purified water

Power-Assisted Steering and Power Trim Fluids

Approved Power-Assisted Steering Fluids

Description	Part Number
Power Trim and Steering Fluid	92-858074K01

Approved Power Trim Fluids

Description	Part Number
Power Trim and Steering Fluid	92-858074K01
SAE Engine Oil 10W-30	Obtain locally
SAE Engine Oil 10W-40	

Maintenance Intervals

Maintenance intervals and the corresponding tasks to be performed, as shown in this schedule, are based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. Therefore, it is important that the boat owner and the servicing dealer discuss the maintenance schedule and develop appropriate maintenance intervals to coincide with individual operating habits, the environment, and maintenance requirements.

Maintenance Schedule—Inboard Models

Routine Maintenance

NOTE: *Only perform maintenance that applies to your particular power package.*

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. You can extend this interval based on experience with the product. • Check the transmission fluid level.
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Check the transmission fluid.
Every two months or 50 hours	• If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.

Scheduled Maintenance

NOTE: *Only perform maintenance that applies to your particular power package.*

Task Interval	Maintenance to Be Performed
25 hours	• Change the transmission fluid. Models equipped with a transmission filter must also have the filter changed at this time.

Task Interval	Maintenance to Be Performed
Every 100 hours or annually (whichever occurs first)	• Touch up the paint on the power package. • Change the engine oil and filter. • If the condition of the spark plugs, spark plug wires was satisfactory at the initial inspection (as listed in **Every 300 hours or 3 years**), inspect the condition of these components every year and replace as necessary. • Inspect the water-separating fuel filter and replace if debris is visible. • Check the crankcase ventilation hoses and inspect the PCV valve, if equipped. • Inspect the condition and the tension of the belts. • Check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section. • Change the transmission oil and filter where applicable. This should be done once a year or every 300 hours, whichever comes first. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn.
Every 300 hours or 3 years (whichever occurs first)	• Clean the flame arrestor. • Check the engine mounts for tightness and tighten to specifications if necessary. • Inspect the condition of the spark plugs, spark plug wires. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. • Check the electrical system for loose, damaged, or corroded fasteners. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • Clean the seawater section of the closed-cooling system. Clean, inspect, and test the pressure cap. • Replace the vent valve on each exhaust elbow (port and starboard).
Every 5 years	• Replace the coolant/antifreeze. Replace every two years if not using extended-life coolant/ antifreeze.

Maintenance Schedule—TowSport Models

Routine Maintenance

NOTE: Only perform maintenance that applies to your particular power package.

Task Interval	Maintenance To Be Performed
Each day start	• Check the engine oil level. You can extend this interval based on experience with the product. • Check the transmission fluid level.
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the transmission fluid.
Every two months or 50 hours	• If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.

Scheduled Maintenance

NOTE: Only perform maintenance that applies to your particular power package.

Task Interval	Maintenance to Be Performed
25 hours	• Change the transmission fluid. Models equipped with a transmission filter must also have the filter changed at this time.

Task Interval	Maintenance to Be Performed
Every 100 hours or annually (whichever occurs first)	• Touch up the paint on the power package. • Change the engine oil and filter. • Inspect and replace the water-separating fuel filter and replace if debris is visible. • Inspect the condition and the tension of the belt. • If the condition of the spark plugs, spark plug wires was satisfactory at the initial inspection (as listed in **Every 300 hours or 3 years**), inspect the condition of these components every year and replace as necessary. • Check the crankcase ventilation hoses and inspect the PCV valve, if equipped. • Change the transmission oil and filter where applicable. This should be done once a year or every 300 hours, whichever comes first. • Check the remote control cable neutral position on the transmission. Adjust if necessary. • Inspect the transmission anode once a year. Replace if over 50% eroded. *NOTE: The anode should be inspected more often when exposed to brackish or saltwater.*
Every 300 hours or 3 years (whichever occurs first)	• Check the engine mounts for tightness and tighten to specifications if necessary. • Clean the flame arrestor. • Inspect the condition of the spark plugs, spark plug wires. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. • Check the electrical system for loose, damaged, or corroded fasteners. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Replace the vent valve on each exhaust elbow (port and starboard).

Maintenance Schedule—Sterndrive Models

Routine Maintenance

NOTE: Only perform maintenance that applies to your particular power package.

New Bravo sterndrive installations may require as much as 470 mL (16 fl oz) of gear lube added to the monitor bottle during the break-in period (20 hours of running time). It is important to monitor and maintain the gear lube level during the break-in period. During the initial drive installation, air may be trapped in the top of the driveshaft housing. This void is filled from the gear lube monitor during the sterndrive break-in period. As the air is purged from the sterndrive through the monitor bottle, the lube level in the bottle will drop.

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. (You can extend this interval based on experience with the product.) • Check the sterndrive gear lube level. • Check the trim pump oil level. • Check the power-assisted steering pump or the compact hydraulic steering fluid level, depending on the steering system of your model.
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Inspect the sterndrive anodes and replace if eroded 50% or more. • Verify the operation of the MerCathode module, if equipped.

Task Interval	Maintenance to Be Performed
Every two months or 50 hours of operation	• Remove the propeller and lubricate the propeller shaft and torque the nut. (If operating only in freshwater, you can extend the interval to every four months.) • If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. (If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.)

Scheduled Maintenance

***NOTE:** Only perform maintenance that applies to your particular power package.*

Task Interval	Maintenance to Be Performed
50 hours or 2 months (whichever occurs first)	Lubricate the engine coupler. (If operated at idle for prolonged periods of time, lubricate the coupler every 50 hours.
Every 100 hours or annually (whichever occurs first)	• Touch-up the paint on the power package. • Change the engine oil and filter. • Change the sterndrive gear lube. • If the condition of the spark plugs and spark plug wires was satisfactory at the initial inspection (as listed in **Every 300 hours or 3 years**), inspect the condition of these components. Replace as necessary. • On models with closed-cooling, check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section. • Tighten the connection of the gimbal ring to the steering shaft to specifications. • Inspect the water-separating fuel filter and replace if debris is visible. • Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages. • Check the continuity circuit for loose or damaged connections. Test the MerCathode unit output if equipped. • Inspect the condition and the tension of the belt. • Driveshaft extension models: Lubricate the driveshaft U-joints and tailstock input and output bearings. • Inspect the PCV valve and replace if necessary.
Every 300 hours or 3 years	• Check the engine mounts for tightness and torque if necessary. • Check the electrical system for loose, damaged, or corroded fasteners. • Clean the flame arrestor and the crankcase ventilation hoses. • Inspect the condition of the spark plugs and spark plug wires. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • On models with closed-cooling, clean the seawater section of the closed-cooling system. Clean, inspect, and test the pressure cap. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Check the engine alignment. • Inspect the U-joints, the splines, and the bellows, and check the clamps. • Lubricate the U-joint splines and cross bearing. • Inspect the gimbal bearing for roughness. Replace if necessary. See your certified Mercury MerCruiser dealer. • Lubricate the engine coupler. • Replace the vent valve on each exhaust elbow (port and starboard).

Task Interval	Maintenance to Be Performed
Every 5 years	• Replace the coolant/anitifreeze. Replace every two years if not using extended-life coolant/antifreeze.

Engine Oil

Checking and Filling the Engine Oil

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

Oil Level—Overfilled

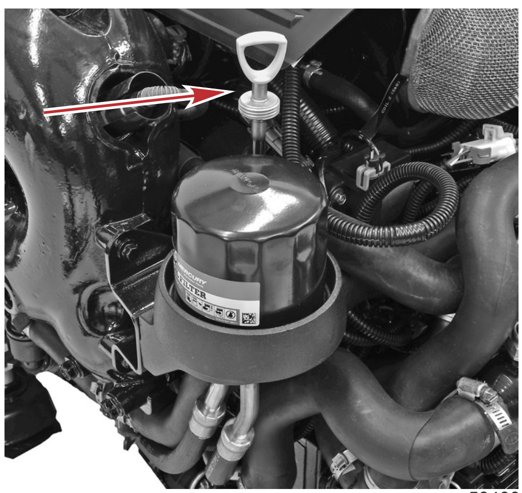
An overfilled crankcase—oil level too high, can cause a fluctuation or drop in oil pressure, and rocker arm clatter. This condition results in the engine crankshaft splashing and agitating the oil, causing it to foam—become aerated. The aerated oil causes the hydraulic valve lifters to bleed down. This, in turn, results in rocker arm clatter and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking the engine oil level. The oil level must be maintained between the minimum and maximum marks on the dipstick. To avoid getting a false reading, adhere to the following procedures.

Checking

1. Stop the engine. Allow approximately five minutes for the oil to drain into the oil pan. The boat must be at rest in the water.
2. Remove the dipstick. Wipe the oil from the dipstick.

   NOTE: *Ensure that the dipstick is installed with oil level indication marks facing the rear of the engine—flywheel end.*
3. Install the dipstick fully into the dipstick tube. Wait one minute to allow trapped air to vent.



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58402

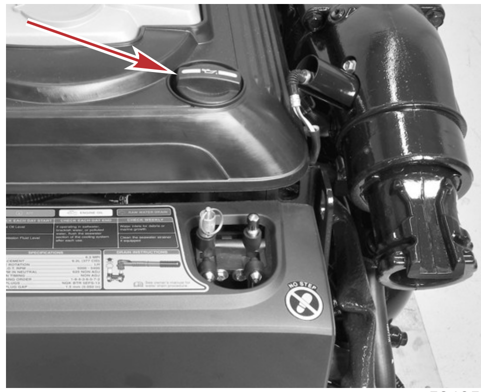
In-line drive model shown

4. Remove the dipstick and observe the oil level. The oil level must be no higher than the maximum oil level mark and no lower than the minimum oil level mark.
5. If the oil level is low, refer to **Filling**.
6. Install the dipstick into the dipstick tube.

Filling

IMPORTANT: Always use the dipstick to determine the exact quantity of oil or fluid required.

1. Remove the oil fill cap from the oil fill tube.



58405

Oil fill cap

58404

In-line drive model shown

IMPORTANT: Do not overfill the engine with oil.

2. Add the specified engine oil to bring the level up to, but not over, the maximum fill line on the dipstick.

Engine Oil Capacity	Fluid type
4.73 L (5.0 US qt)	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil

3. Confirm that the engine oil level is now up to, but not over, the maximum fill line on the dipstick.
4. Install the oil fill cap.

Changing the Engine Oil and Filter

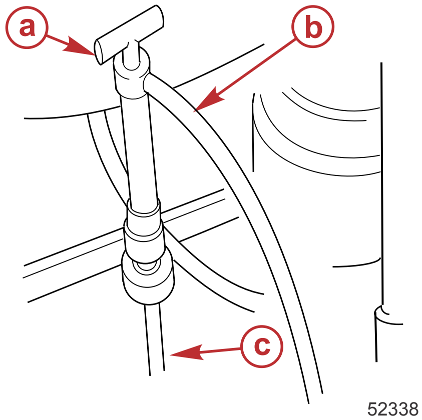
Refer to the maintenance schedule for the change interval. Engine oil should be changed before placing the boat in storage.

IMPORTANT: Change the engine oil when the engine is warm from operation. Warm oil flows more freely, carrying away more impurities. Use only recommended engine oil (refer to Fluid Specifications).

Draining Using a Crankcase Oil Pump

1. Loosen the oil filter to vent the system.
2. Remove the dipstick.

3. Tighten the oil pump threaded fitting onto the dipstick tube threaded fitting.

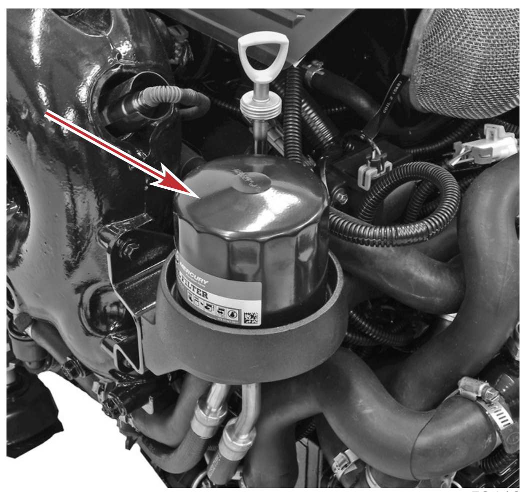


a - Typical oil pump
b - Oil drain hose
c - Dipstick tube

4. Insert the end of the hose on the oil pump into an appropriate container and, using the handle, pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing the Oil Filter

1. Remove and discard the oil filter.



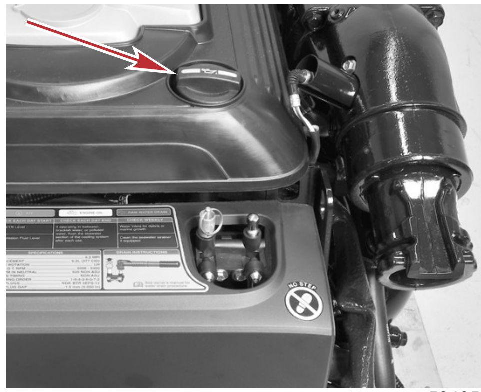
Engine oil filter

2. Using a clean, lint-free cloth, wipe the old oil and debris from the filter mounting flange.
3. Apply clean engine oil to the sealing ring on the new filter.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Oil filter sealing ring	92-8M0078629

4. Install the oil filter. Tighten the filter securely following the filter manufacturer's instructions. Do not overtighten.

5. Remove the oil fill cap.



58405

Oil fill cap V-drive model shown

IMPORTANT: Always use the dipstick to determine exactly how much oil is required.

6. Add the specified engine oil to bring the level up to the minimum oil fill mark on the dipstick.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	All MerCruiser engines	92-8M0078629

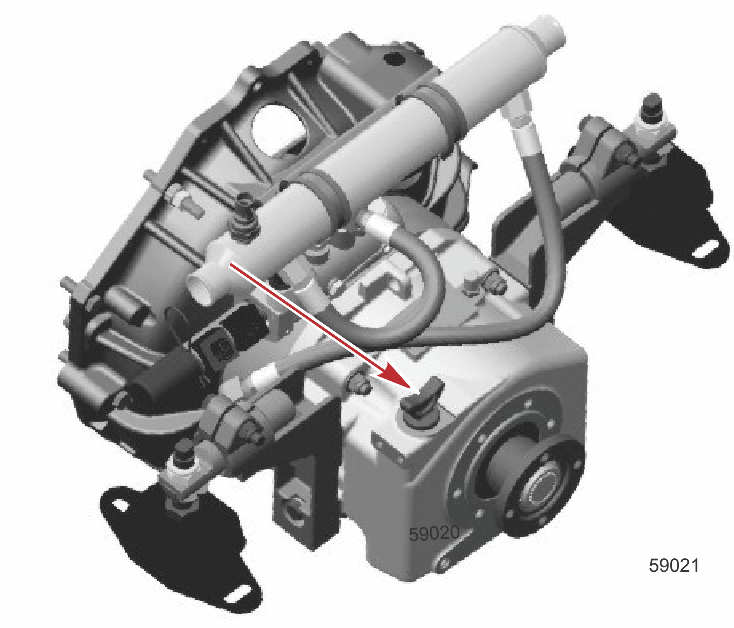
7. With the boat at rest in the water, remove the dipstick and check the oil level. Add the specified engine oil to bring the level up to, but not over, the maximum oil fill mark on the dipstick.
8. Start the engine, run the engine for three minutes, and check for leaks. Stop the engine immediately if leaks exist. Check the installation.
9. Allow approximately five minutes for the oil to drain into the oil pan.
10. With the boat at rest in the water, remove the dipstick and check the oil level.
11. If needed add additional oil, but not over, the maximum oil mark on the dipstick.

Transmission Fluid

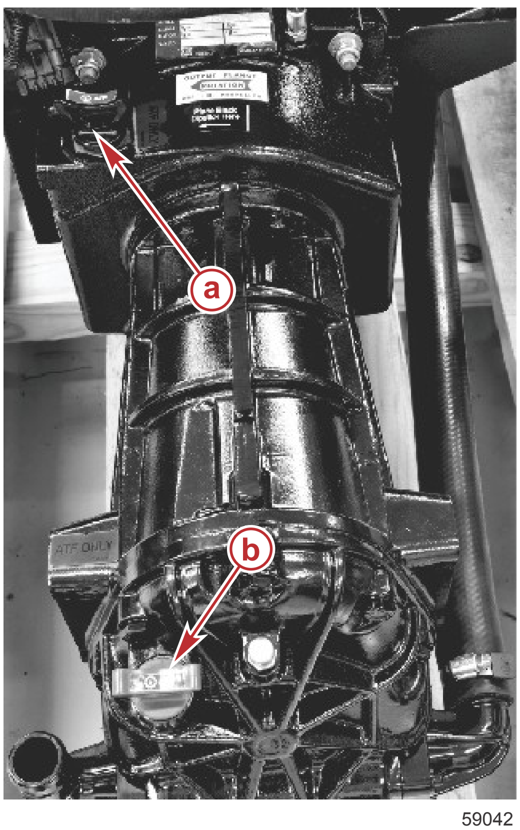
Checking the Fluid Level Before Operation

IMPORTANT: Always check the fluid level before starting and operating.

1. Remove the dipstick and wipe it with a clean towel.



45C transmission shown, others similar



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a - Front dipstick black

b - Rear dipstick red

2. Insert the dipstick without turning it in.
3. Remove the dipstick and observe the fluid level on the dipstick. The fluid level must be between the minimum and maximum marks. Add fluid if necessary, but do not overfill.
4. Install the dipstick and tighten the T-handle securely. Do not overtighten.

Checking the Fluid Level When Hot

The process for checking the fluid level when hot is the same as checking the fluid level before operation.

Changing

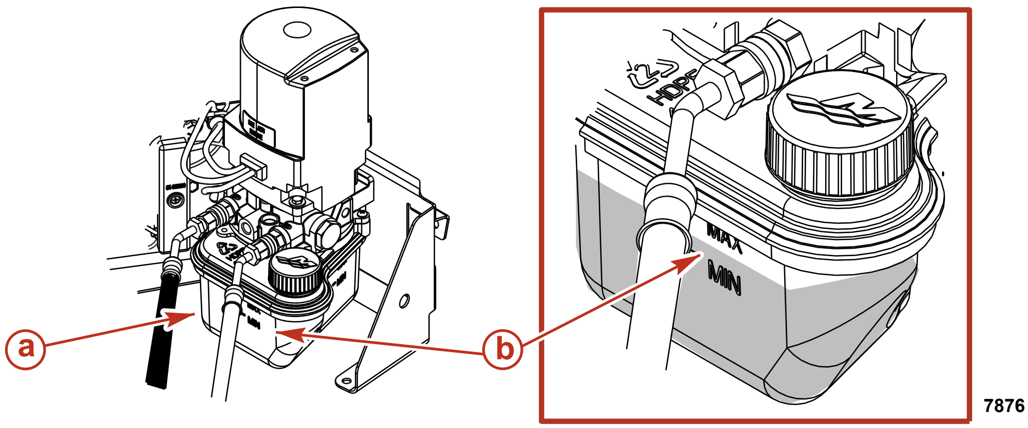
Contact your authorized Mercury MerCruiser dealer.

Power Trim Fluid

Checking

IMPORTANT: Check the fluid level with the sterndrive unit in the full down (in) position only.

1. Place the sterndrive unit in full down (in) position.
2. Observe the fluid level. The fluid level must be between the "MIN" and "MAX" lines on the reservoir.



a - Reservoir
b - "MIN" and "MAX" lines

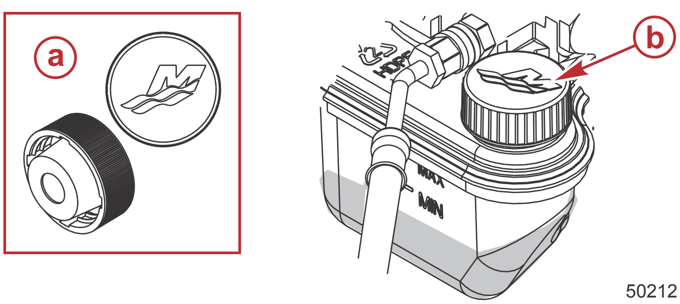
3. Fill as necessary with the specified fluid. Refer to **Filling**.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim pump	92-858074K01

Filling

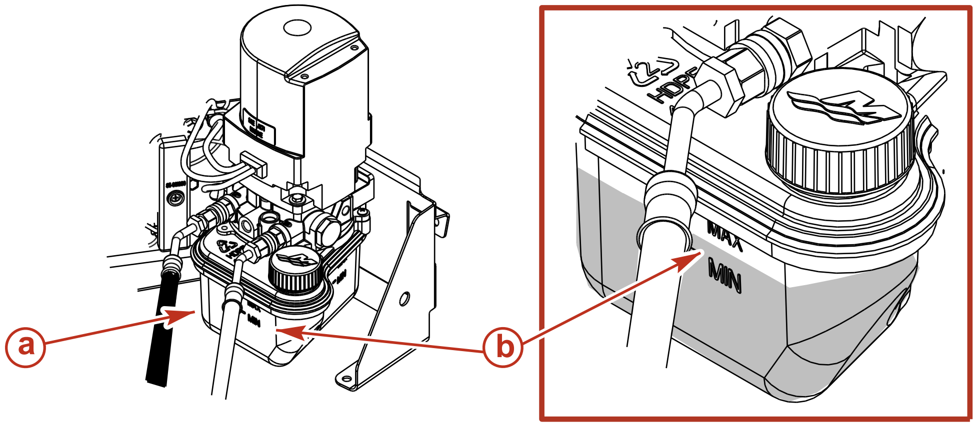
1. If the fluid level is below the "MIN" line, the specified fluid must be added.
2. Remove the fill cap from the reservoir.

   NOTE: The fill cap is vented.



Power trim pump reservoir shows the oil level is below the "MIN" line
a - Fill cap assembly
b - Fill cap installed

3. Add the specified fluid until the fluid level is between the "MIN" and "MAX" lines on the reservoir.



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a - Reservoir
b - "MIN" and "MAX" lines

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim pump	92-858074K01

4. Install the fill cap.

Changing

Power trim fluid does not require changing unless it becomes contaminated with water or debris.

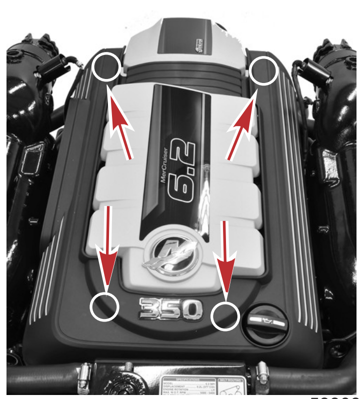
1. Remove the contaminated power trim fluid from the power trim pump reservoir.
2. Fill the power trim pump reservoir to the proper level with the appropriate power trim fluid. Refer to **Filling.**
3. Raise and lower the sterndrive 6–10 times to cycle the power trim fluid, and to purge contaminants from the system.
4. Repeat the above process until the power trim fluid is no longer contaminated.

Flame Arrestor

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. There are two engine covers you must remove to access the flame arrestor:
   a. Pull the outside engine cover up to remove it from the four rubber mount grommets.
   b. Carefully guide the cover past the O_2 sensors.



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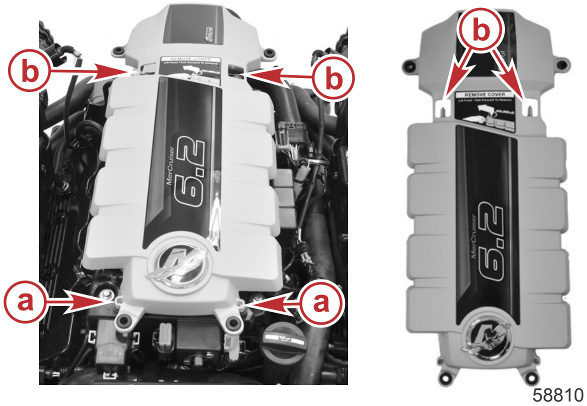
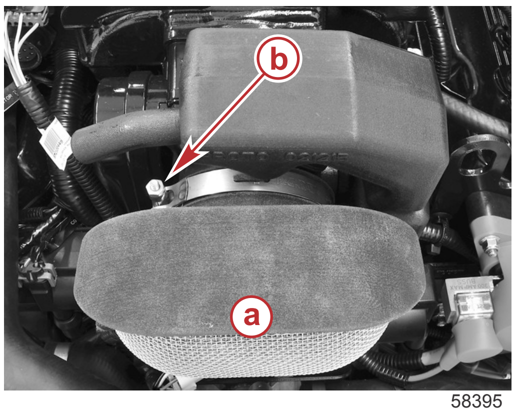
c. Lift up on the front of the second cover to disengage the cover from the front grommets. Pull the cover towards the front of the vessel to remove it from the two rear grommets.



a - Front attaching pegs
b - Rear attaching pegs

2. Loosen the clamp securing the flame arrestor and remove the flame arrestor.



a - Flame arrestor
b - Clamp securing the flame arrestor

3. Clean the flame arrestor with warm water and a mild detergent.
4. Inspect the flame arrestor for holes, cracks, or deterioration. Replace if necessary.
5. Allow the flame arrestor to air dry completely before use.
6. Install the flame arrestor and tighten the flame arrestor clamp to the specified torque.

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp nut	4	35.4	–

7. Install the engine covers.

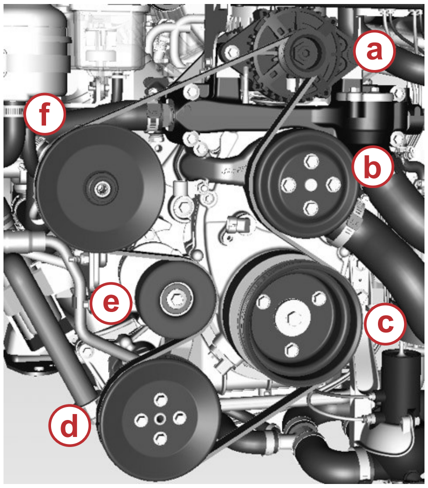
Serpentine Drive Belt

⚠ WARNING

Inspecting the belts with the engine running may cause serious injury or death. Turn off the engine and remove the ignition key before adjusting tension or inspecting belts.

IMPORTANT: The brackets and washers on the pulleys must be in a certain order or the serpentine belt will come off. All pulleys are referenced as though you were standing in front of the engine looking at the belt.

Inspection and Routing



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With a seawater pump

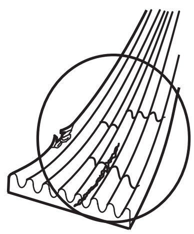
- **a -** Alternator pulley
- **b -** Water circulating pump pulley
- **c -** Crankshaft pulley
- **d -** Seawater pump pulley
- **e -** Belt tensioner
- **f -** Power steering pump pulley

Checking

Inspect the drive belt for the following:

- Excessive wear
- Cracks

  NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in the direction of the belt length) that join the transverse cracks are NOT acceptable.



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- Fraying
- Glazed surfaces
- Proper tension—13 mm (1/2 in.) deflection, with moderate thumb pressure, on the belt at the location that has the longest distance between two pulleys

Replacing Belt

IMPORTANT: If the belt is removed and is found to be in acceptable condition to use, you must install it in the same direction of rotation as before.

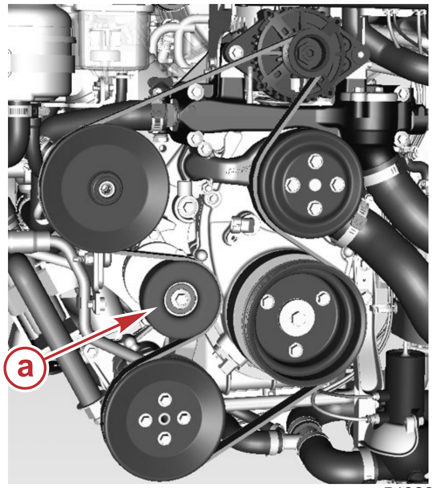
NOTE: All power packages have a decal on the front of the engine. The decal shows the serpentine belt routing. Refer to the decal when installing the serpentine belt.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops. See your authorized MerCruiser dealer for service if these conditions exist.

⚠ CAUTION
Rapid release of the belt tensioner, or allowing the tensioner to snap back quickly, could cause injury or product damage. Relieve the spring tension slowly.

1. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner counterclockwise away from the belt until it stops.

2. Remove the belt from the idler pulley and slowly relieve the tension on the breaker bar.



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Freshwater cooling shown, raw water cooling similar

a - Belt tensioner

3. Inspect the belt for damage and replace as necessary.
4. Route the belt according to the diagram on the decal.
5. Carefully release the tensioner and ensure that the belt stays positioned properly.
6. Check the belt tension.

NOTE: Proper tension is a measurement of deflection with moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

Description	
Deflection	13 mm (½ in.)

Fuel System

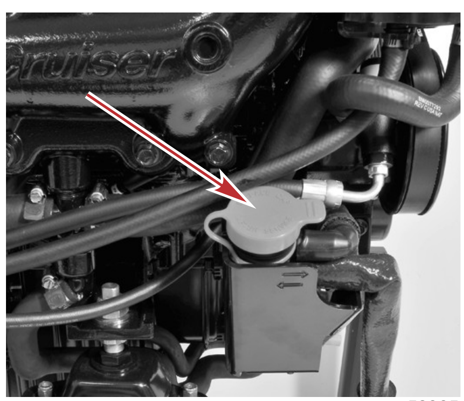
Water-Separating Fuel Filter

The water-separating fuel filter is a low-pressure filter that removes debris and water before the fuel reaches the high-pressure fuel pump. It is best to service the water-separating fuel filter when the engine is cold or after the engine has not run for several hours. Although the engine may not have run for hours, high ambient air temperatures can cause the fuel system to become pressurized. The amount of pressure within the system is dependent on the type of fuel system installed on the vessel.

Refer to the **Scheduled Maintenance** for the proper maintenance interval.

Filter Housing Removal

1. Verify the ignition key switch is off and remove the ignition key.
2. Disconnect the batteries.
3. Locate the water-separating fuel filter on the starboard front side of the engine.



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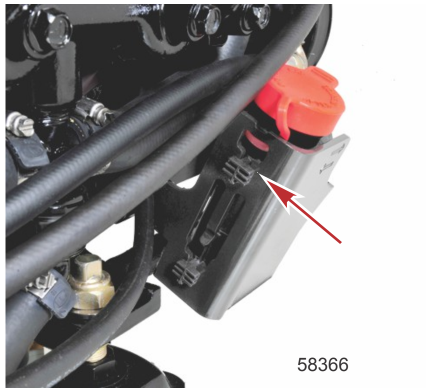
4. Remove the red service cap.
5. Place a rag or towel around the fuel filter housing to prevent the fuel from leaking or spraying.
6. Use the fuel filter removal/installation tool or the shaft of a screwdriver between the lugs on the filter cover and turn the fuel filter cover counterclockwise to loosen it. Do not remove the cover.

Fuel Filter Removal/Installation Tool	91-896661

7. Slide the filter housing up to release it from the bracket. The fuel hoses have enough slack to remove the filter housing from the bracket.



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Draining the Filter Housing

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

Tip the filter housing and remove the filter cover to drain the fluid into an approved container. Dispose of the fuel according to local regulations.

58367

Fuel Filter Inspection

The fuel filter is an important component in the fuel delivery system and should be inspected for debris or degradation every 100 hours of operation. Replace the fuel filter when necessary.

Filter Housing Installation

1. Place the filter housing mounting tabs into the slots on the bracket and push down on the filter housing to slide the mounting tabs into the lock position.
2. Lubricate the filter O-ring seals with clean oil.
3. Install the filter and tighten the cover securely.
4. Install the red service cap.
5. Connect the battery cables.
6. Turn the ignition key to the ON or RUN position. Do not start the engine.
7. Inspect the filter housing and hoses for leaking fuel.

IMPORTANT: Inspect for leaking fuel before starting the engine.

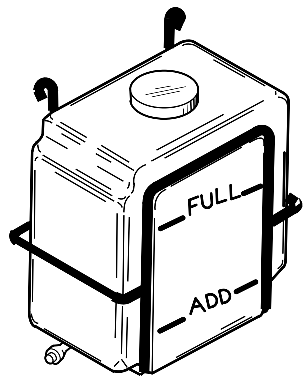
Closed-Cooling System

Checking Coolant Level

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

1. Remove the cap from the heat exchanger and observe the fluid level.
2. The coolant level in the heat exchanger should be at the bottom of the filler neck.
   IMPORTANT: When reinstalling the pressure cap, tighten it until it seats on the filler neck.
3. With the engine at normal operating temperature, check the coolant level in the coolant recovery bottle.
4. The coolant level should be between the "ADD" and "FULL" marks.



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5. Add the specified fluid as necessary.

Tube Ref No.	Description	Where Used	Part No.
122	Extended Life Antifreeze/ Coolant	Closed-cooling system	92-877770K1

Cleaning and Inspection

NOTE: Refer to ***Section 6C****.*

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.
3. Clean the seawater section.
4. Clean, inspect and test the pressure cap.

Changing Coolant

The coolant should be changed periodically based on the use of the specified coolant; refer to the **Maintenance Schedules** for the interval. For the coolant changing procedures, refer to **Section 6C**.

Power-Assisted Steering Fluid

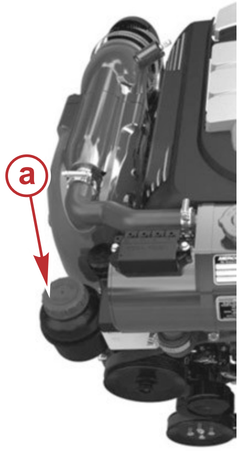
Power-Assisted Steering Fluid—Sterndrive only

Checking

Engine at Normal Operating Temperature

1. Stop the engine.
2. Center the sterndrive.

3. Remove the fill cap/dipstick from the power-assisted steering pump and note the fluid level.



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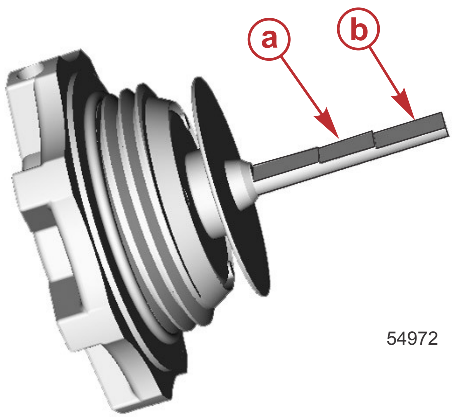
a - Fill cap/dipstick

4. The fluid level with the engine at normal operating temperature should be within the warm range on the dipstick.



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a - Warm range
b - Cold range

5. Proper fluid level with the engine cold should be within the cold range. Do not overfill.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

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

Filling and Bleeding

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

1. With the engine stopped, center the sterndrive.
2. Remove the fill cap/dipstick from the power-assisted steering pump.
   IMPORTANT: Use only specified fluid in the power-assisted steering system.
3. Add the specified fluid, as required, to bring the level up to the appropriate mark on the dipstick depending on the fluid temperature.

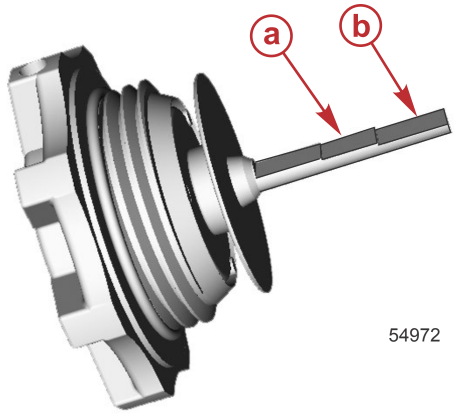
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

4. Turn the steering wheel back and forth to the end of travel in each direction several times.
5. Recheck the fluid level and add fluid, if necessary.
6. Install the fill cap/dipstick. Tighten securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. Supply cooling water to the engine.
8. Start the engine and operate at fast idle—1300 RPM, until the engine reaches normal operating temperature. During this time, turn the steering wheel back and forth to the end of travel in each direction several times.
9. Center the sterndrive and stop the engine.
10. Remove the fill cap/dipstick from the pump.
11. Allow any foam in the pump reservoir to disperse.
12. Check the fluid level and add fluid, as required, to bring the level up to the warm range on the dipstick. Do not overfill.



a - Warm range
b - Cold range

13. Install the fill cap/dipstick. Tighten securely.
    IMPORTANT: The drive unit must be centered and the power-assisted steering fluid must be hot to accurately check the fluid level.
14. If the fluid is still foamy—in step 10, repeat steps 7–13 until the fluid does not foam and the level remains constant.

Changing

Power-assisted steering fluid does not require changing unless it becomes contaminated. Refer to **Section 8A - Power-Assisted Steering Pump and Related Components**.

Compact Hydraulic Steering

Complete instructions are listed in **Section 8B - Compact Hydraulic Steering**.

⚠ WARNING

Failure to fill the system properly can damage steering components, causing serious injury or death from loss of boat control. Completely retract the cylinder rod before checking or adding hydraulic fluid.

Setting the Fluid Level

The system must be filled and purged as outlined in **Section 8B - Compact Hydraulic Steering** before setting the fluid level.

1. Ensure that the cylinder rod is fully retracted.
2. With the filler tube screwed into the helm filler plug hole, fill the tube approximately half full of air-free hydraulic fluid.
3. Open the starboard bleeder valve and slowly turn the steering wheel clockwise until the fluid level in the filler tube is at the top of the plastic filler fitting. Continue turning steering wheel clockwise ¼ turn more, and then stop. Close the bleeder valve.
4. Remove the filler tube. The fluid level should be at the bottom of the filler hole. Install the vent/fill plug.

Maintaining the Fluid Level

To maintain proper fluid level, observe the following:

- Do not allow the fluid level to drop more than 6 mm (1/4 in.) below the bottom of the filler hole.
- Check the fluid level periodically.

System Check

After filling, purging, and setting the fluid level the system must be checked for proper connections, possible leaks, and complete purging of air.

IMPORTANT: In the following procedure, turn the wheel with enough force to exceed the pressure relief valve in the helm. This action should not harm the helm or the system.

1. Turn the steering wheel (any wheel on a multi-steering station) very hard to port to pressurize the system.
2. While maintaining pressure, check all port fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before using.
3. Turn steering wheel (any wheel on multi-steering station) very hard to starboard to pressurize system.
4. While maintaining pressure, check all starboard fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before using.

   NOTE: Observing a significant drop in the fluid level at the helm while performing the system check may mean you are compressing air. Further filling and purging would be required.
5. If no leaks are present, the system is ready for service.

Bravo Sterndrive Gear Lube

Checking

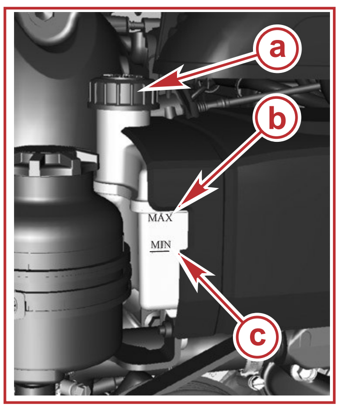
NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

IMPORTANT: The gear lube level fluctuates during operation. Check before starting, when the engine is cold.

NOTE: The gear lube monitor bottle has a sensor in it that is connected to the engine warning system.

1. Check the gear lube level in the monitor bottle. Keep the gear lube level within the recommended operating range.



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a - Gear lube monitor cap
b - Maximum range
c - Minimum range

2. Inspect the gear lube condition. If any water is visible in the bottom of the gear lube monitor, if water appears at the fill and drain plug hole, or if the gear lube appears discolored, there may be a water leak in the sterndrive.

Filling

New installations may require as much as 470 mL (16 fl oz) of gear lube added to the monitor bottle during the break-in period (20 hours of running time). It is important to monitor and maintain the gear lube level during the break-in period.

IMPORTANT: The gear lube monitor must be checked and filled if necessary at the beginning of each day when the engine is cold. If the gear lube alarm sounds during the day's activity, add the appropriate amount of gear lube to the monitor bottle.

*NOTE: If filling the entire sterndrive, see **Changing**.*

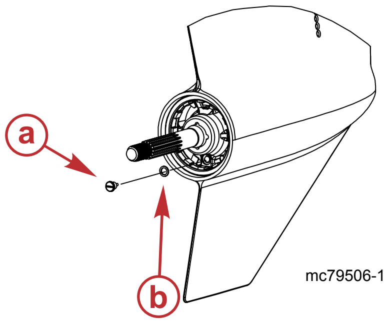
1. Remove the gear lube monitor cap.
2. Fill the monitor with the specified fluid until the gear lube level is in the operating range. Do not overfill.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01

3. Replace the cap.

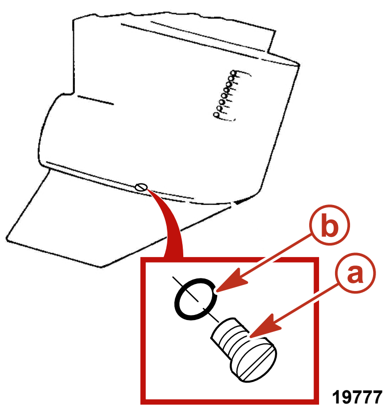
Changing

1. Remove the gear lube monitor cap.
2. Bravo One models:
    a. Remove the propeller.
    b. Position the sterndrive unit to the full down position.
    c. Remove the oil fill and drain screw and sealing washer.
    d. Drain the fluid into a suitable container.



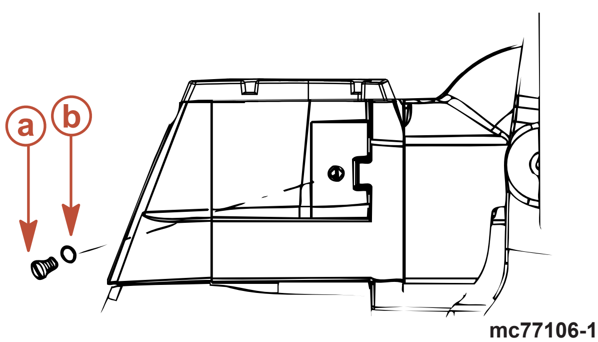
a - Oil fill and drain screw
b - Sealing washer

3. All other models:
    a. Place the sterndrive unit in full trim out position.
    b. Remove the oil fill and drain screw and sealing washer.
    c. Drain the fluid into a suitable container.



a - Oil fill and drain screw
b - Sealing washer

4. Remove the oil vent screw and sealing washer. Allow the fluid to drain completely.



a - Oil vent screw
b - Sealing washer

IMPORTANT: If any water drains from the unit, or if the fluid appears milky, the sterndrive unit is leaking. See your authorized Mercury MerCruiser dealer.

5. Lower the sterndrive unit so the propeller shaft is level.
   IMPORTANT: Use only Mercury/Quicksilver High Performance Gear Lubricant in the sterndrive unit.
6. Fill the sterndrive unit through the oil fill and drain hole with specified gear lubricant until an air-free stream of lubricant flows from the oil vent hole.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Sterndrive unit	92-858064K01

7. Install the oil vent screw and sealing washer.
8. Continue to pump gear lubricant into the drive through the oil fill and drain hole until gear lubricant appears in the gear lube monitor.
9. Fill the monitor so that the oil level is in the operating range. Do not overfill.
10. Ensure that the rubber gasket is inside the cap and install. Do not overtighten.

    NOTE: Oil capacities include the gear lube monitor.

Model	Capacity	Fluid Type
Bravo One	2736 ml (92-1/2 oz)	High Performance Gear Lubricant
Bravo Two	3209 ml (108-1/2 oz)	
Bravo Three (single seawater pickup)	2972 ml (100-1/2 oz)	
Bravo Three (dual seawater pickup)	2736 ml (92-1/2 oz)	

11. Remove the pump from the oil fill and drain hole. Quickly install the sealing washer and screw. Tighten securely.
12. Install the propeller. Refer to **Propellers**.
13. Check the oil level after the first use.

IMPORTANT: Oil level in the gear lube monitor rises and falls during operation. Always check the oil level when the sterndrive is cool and the engine is off.

Visual Inspections

Battery

NOTE: Refer to the manufacturer's instructions.

1. Ensure that the battery connections are secure.
2. Check the fluid level.

Instruments

1. Ensure that all gauges are properly secured. Tighten the mounting bracket nuts, if they are loose. Do not overtighten.
2. Ensure that all gauge and wiring connections are tight and insulated where necessary.
   IMPORTANT: The gauge may be scored or damaged if wiped with abrasive material such as sand, saline or detergent compounds or washed with solvents such as trichloroethylene and turpentine.
3. Clean the gauges with fresh water to remove sand and salt deposits. Wipe with a soft cloth moistened with water.

Remote Control

1. Inspect the remote controls.
2. Ensure that there are no loose, missing, or damaged components.
3. Repair or replace, as necessary.

Electrical System

*NOTE: Refer to **Section 4** for specific procedures.*

1. Inspect the spark plugs.
2. Inspect the spark plug wires.
3. Inspect the distributor cap.
4. Inspect the entire electrical system for loose, damaged, or corroded fasteners.
5. Repair or replace as necessary.

Exhaust System

*NOTE: Refer to **Section 7**.*

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.
3. Repair or replace as necessary.

Seawater Pump

NOTE: Refer to ***Section 6A****.*

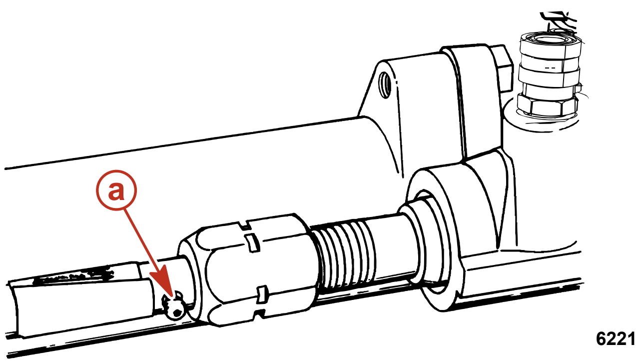
Inspect the seawater pump components. Replace as necessary.

Steering System Lubrication

⚠ WARNING
Incorrect cable lubrication can cause hydraulic lock, leading to serious injury or death from loss of boat control. Completely retract the end of the steering cable before applying lubricant.

Lubricate the steering system as follows.

1. If the steering cable has a grease fitting:
   a. Turn the steering wheel until the steering cable is fully retracted into the cable housing.
   b. Apply approximately three pumps of grease from a typical hand-operated grease gun to the steering cable grease fitting.

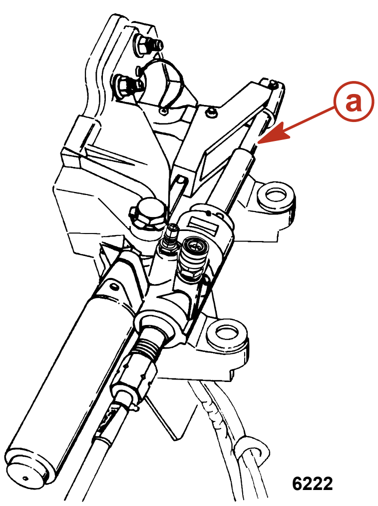


a - Steering cable grease fitting

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Steering cable grease fitting	92-802859A 1

NOTE: If the steering cable does not have a grease fitting, the cable's inner wire cannot be greased.

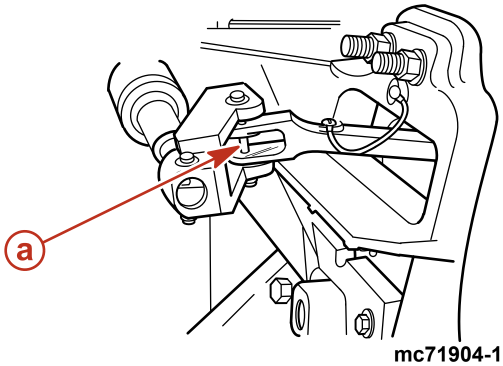
2. Turn the steering wheel until the steering cable is fully extended. Lightly lubricate the exposed part of the cable with 2-4-C.



a - Extended steering cable

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Exposed part of the steering cable	92-802859A 1

3. Lubricate the steering system pivot points with clean engine oil.



a - Steering system pivot points

4. **On dual-engine boats:** Lubricate the tie bar pivot points with clean engine oil.
5. Upon first starting the engine and before getting underway, turn the steering wheel several times to starboard and then to port to ensure that the steering system operates properly.

Corrosion Prevention

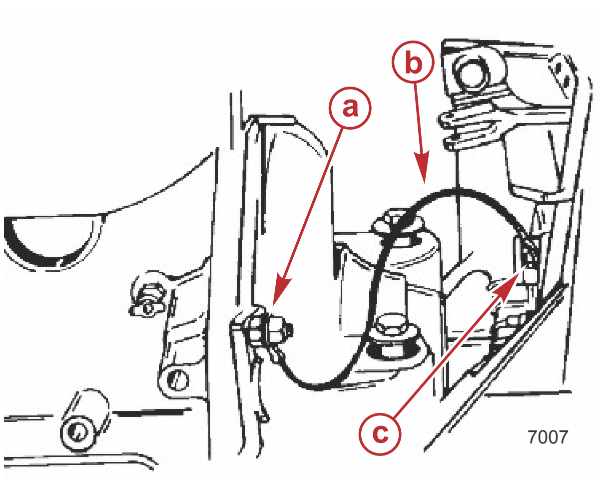
Refer to the **Mercury Precision Parts / Marine Corrosion Protection Guide** available on MercNet. PN is NLA.

Maintaining Ground Circuit Continuity

The transom assembly and sterndrive are equipped with a ground wire circuit to ensure good electrical continuity between the engine, transom assembly, and sterndrive components. Good continuity is essential for the anode and the MerCathode system to function effectively.

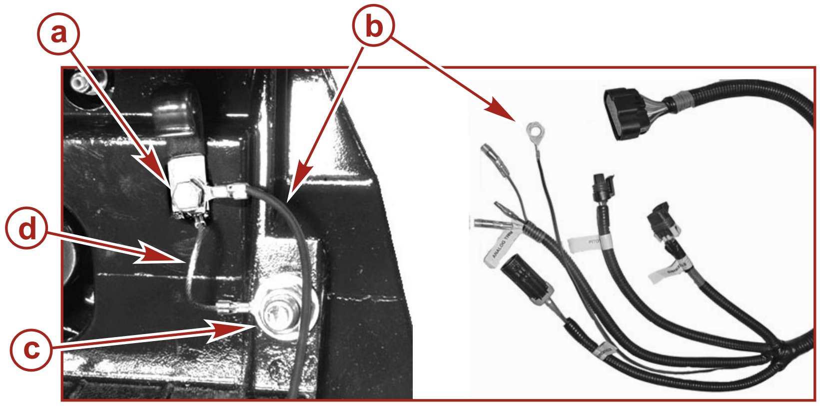
Inspect all ground circuit components for loose connections and broken or fraying wires.

Models equipped with a separate ground wire must have the wire connected between the engine flywheel housing and the transom plate.



a - Engine flywheel housing bolt
b - Ground wire
c - Inner transom plate grounding screw

Models equipped with a transom harness must connect its ground wire to the grounding screw on the gimbal housing.



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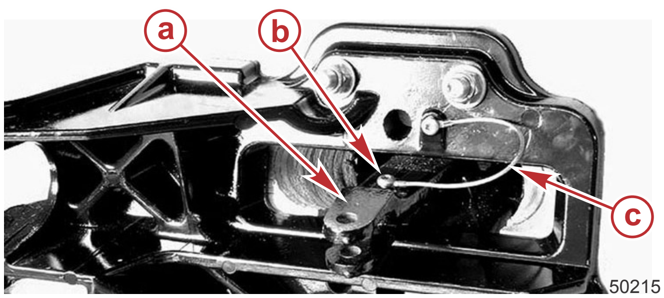
- a - Gimbal housing grounding screw
- b - Transom harness ground wire to engine harness
- c - Transom plate grounding stud and nut
- d - Grounding wire gimbal housing to transom plate



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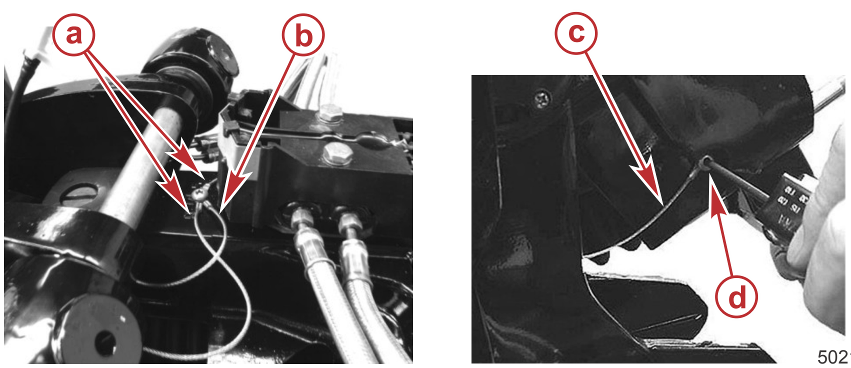
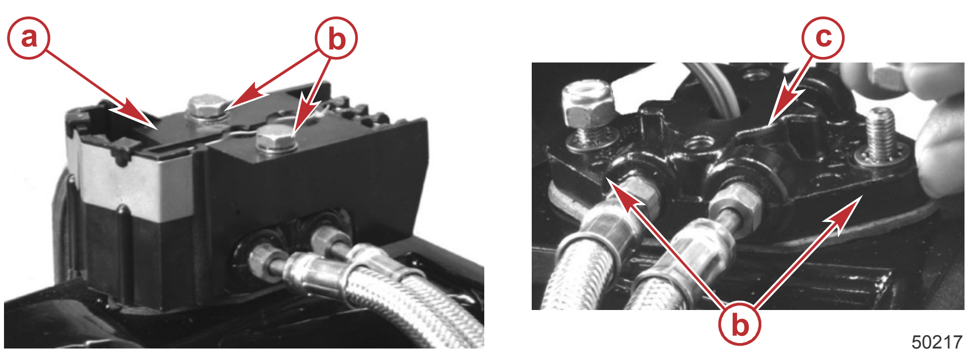
- a - Steering lever
- b - Torx® screw
- c - Continuity wire



50216

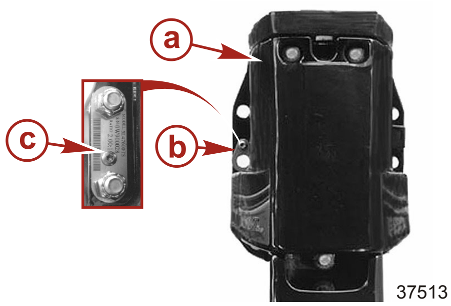
Bravo model shown

- a - Trim-cylinder-to-gimbal-ring ground wire (2)
- b - Gimbal-housing-to-gimbal-ring ground wire
- c - Gimbal-ring-to-bell-housing ground wire
- d - Screw



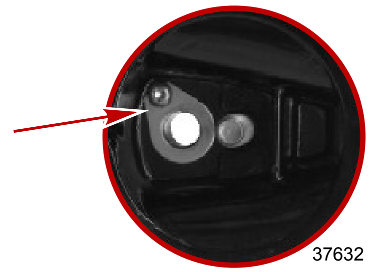
50217

- a - MerCathode
- b - Continuity washers
- c - Hydraulic manifold

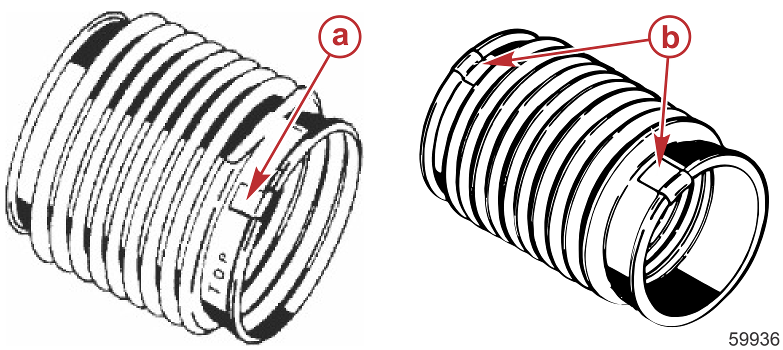


Bravo sterndrive shown

- **a -** Sterndrive
- **b -** Ground washer
- **c -** Ground plate (later model)



Ground washer shown inside anode cavity of Bravo Three gear housing, other models similar



- **a -** U-joint bellows ground clip
- **b -** Exhaust bellows ground clip

MerCathode

If the boat is equipped with a MerCathode system, the system should be tested to ensure that it is providing adequate output to protect the underwater metal parts on the boat. The test should be made with the boat moored, using a reference electrode and test meter.

Reference Electrode	91-76675T 1

Refer to the appropriate Mercury MerCruiser sterndrive service manual for testing procedures.

Power Package Exterior Surfaces

1. Spray the entire power package at recommended intervals with Corrosion Guard. Follow the instructions on the can for proper application.

Tube Ref No.	Description	Where Used	Part No.
120	Corrosion Guard	Painted surfaces	92-802878 55

2. Clean the entire power package. External surfaces that have become bare should be repainted with the recommended primer and spray paint at recommended intervals.

Description		Part Number
Mercury Light Gray Primer	Painted surfaces	92-802878 52
Mercury Phantom Black	Painted surfaces	92-802878Q 1

Seawater System

Cleaning the Seawater Strainer, If Equipped

NOTICE

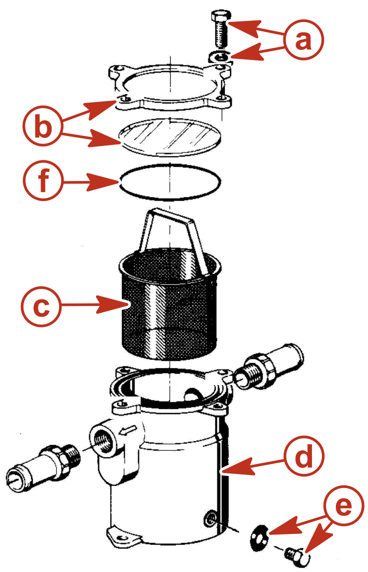
An open seawater strainer or seacock during some service or maintenance procedures can introduce water into the boat, causing damage or sinking the boat. Always close the water supply from the seawater pump, water inlet, or seacock when performing service or maintenance on the cooling system.

1. With the engine off, close the seacock, if equipped, or remove and plug the seawater inlet hose.
2. Remove the screws, washers, and cover.
3. Remove the strainer, drain plug, and sealing washer.
4. Clean all the debris from the strainer housing. Flush both the strainer and housing with clean water.
5. Check the cover gasket and replace when damaged or if it leaks.
6. Reinstall the strainer, drain plug, and sealing washer.

CAUTION

Seawater leaking from the seawater strainer could cause excess water in the bilge, damaging the engine or causing the boat to sink. Do not overtighten the cover screws, or the cover may warp and introduce seawater into the bilge.

7. Install the seal and cover using the screws and washers. Do not overtighten the cover screws.



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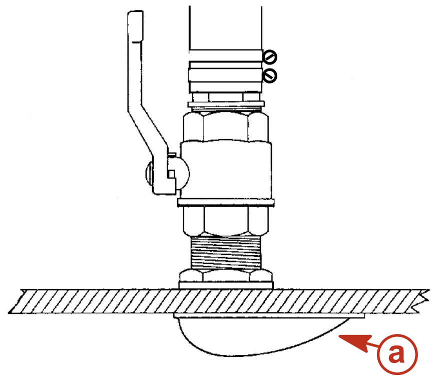
a - Screws and washers
b - Cover with glass
c - Strainer
d - Housing
e - Drain plug and sealing washer
f - Seal

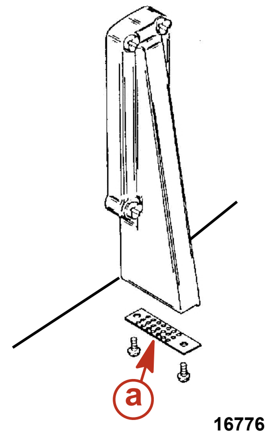
8. Open the seacock, if equipped, or remove the plug and reconnect the seawater inlet hose.
9. Upon first starting the engine, check for leaks or air in the system that would indicate an external leak.

Checking the Seawater Pickups

Ensure that the water inlet holes for the seawater pickup are clean and unobstructed.



Typical through-the-hull seawater pickup



Typical through-the-transom seawater pickup

a - Water inlet holes

Draining the Seawater System

Draining the Raw Water

⚠ CAUTION
Water can enter the bilge when the drain system is open, damaging the engine or causing the boat to sink. Remove the boat from the water or close the seacock, disconnect and plug the seawater inlet hose, and ensure the bilge pump is operational before draining. Do not operate the engine with the drain system open.

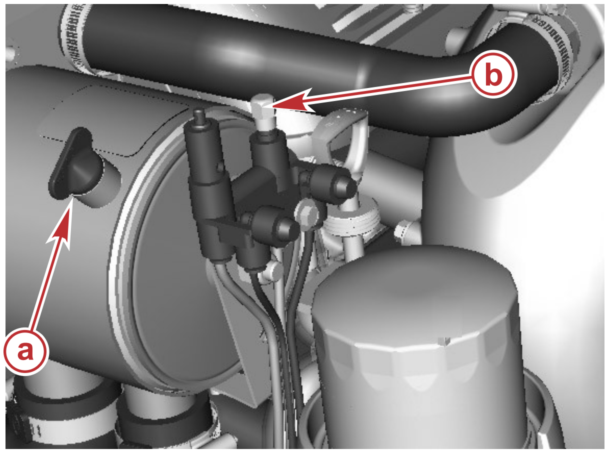
IMPORTANT: Only drain the raw water section of the closed cooling system. Raw water is sometimes referred to as seawater.
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.
IMPORTANT: The engine must not be operating at any point during the draining procedure.
IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the raw water section of the cooling system during freezing temperatures or for extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Air Actuated Single-Point Drain System (Closed Cooling, Inboard Models)

The following instructions apply to draining procedures performed on engines in vessels that are in the water. For vessels that are not in the water, you do not need to close the seacock (if equipped) or remove and plug the water inlet hose.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue plug from the heat exchanger.

3. Remove the cap from the air actuated valve assembly.



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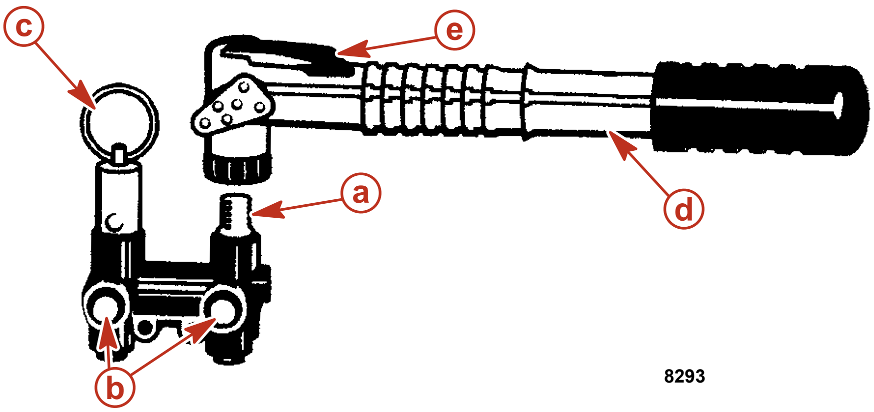
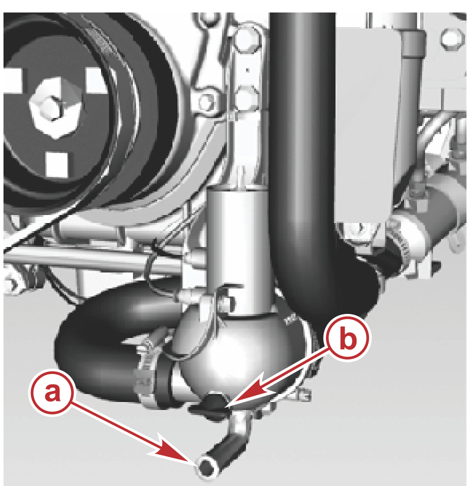
a - Blue plug
b - Cap

4. Ensure that the lever on top of the air pump is flush with the handle (horizontal).
5. Install the air pump on the actuator fitting.
6. Pull the lever on the air pump (vertical) to lock the pump onto the fitting.



a - Actuator fitting
b - Green indicators
c - Manual release valve
d - Air pump
e - Lever (locking)

7. Pump air into the system until both green indicators extend out of the actuator assembly.
8. Check to ensure water drains out of the distribution housing.
   IMPORTANT: If water does not drain from the distribution housing when both green indicators are extended, remove the blue plug on the distribution housing.

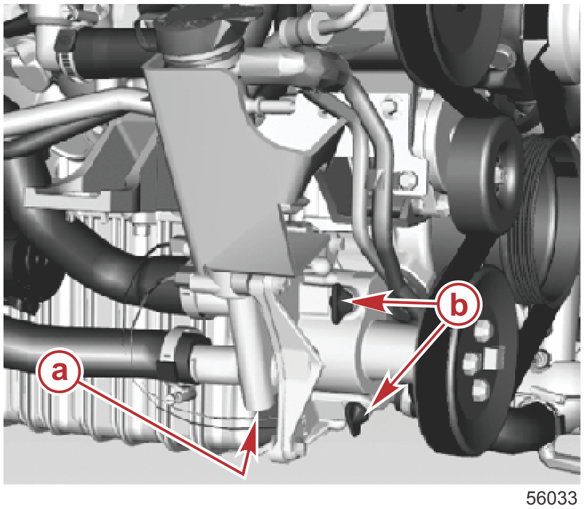


55101

a - Distribution housing water drain
b - Blue plug

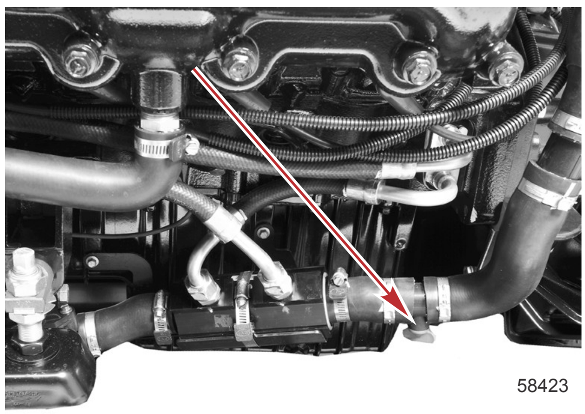
9. Check to ensure water drains out of the seawater pump housing.

IMPORTANT: If water does not drain from the seawater pump housing when both green indicators are extended, remove the blue plugs on the seawater pump housing.

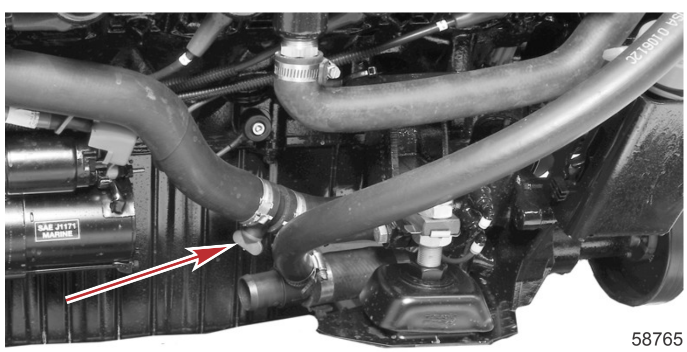


a - Seawater pump housing water drain
b - Blue plugs

10. There are power packages that require specific drain plugs removed because the engine angle is greater than the air actuated drain system allows for proper draining of the system. Remove the blue plugs shown in the following illustrations.



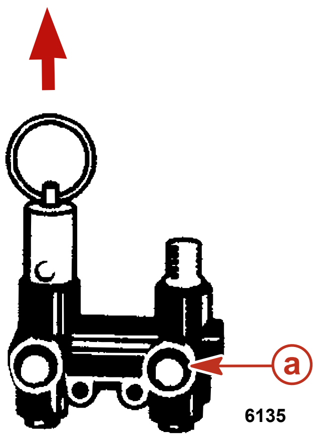
Port side view



Starboard side view

11. Allow the system to drain for a minimum of ten minutes. Pump air as necessary to keep the green indicators extended.
12. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow the engine to start.
    IMPORTANT: This engine has an automatic start function controlled by the PCM. The start function can be terminated by turning the key to the OFF position.
13. After the water has drained from the engine, install the blue plugs on the distribution housing and seawater pump if they were removed and tighten securely.

14. Push the locking lever down on the air pump and remove the pump from the air actuator assembly. Install the cap on the fitting.
15. Install the blue plug on the heat exchanger and tighten securely.
16. The drain system should remain open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
17. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



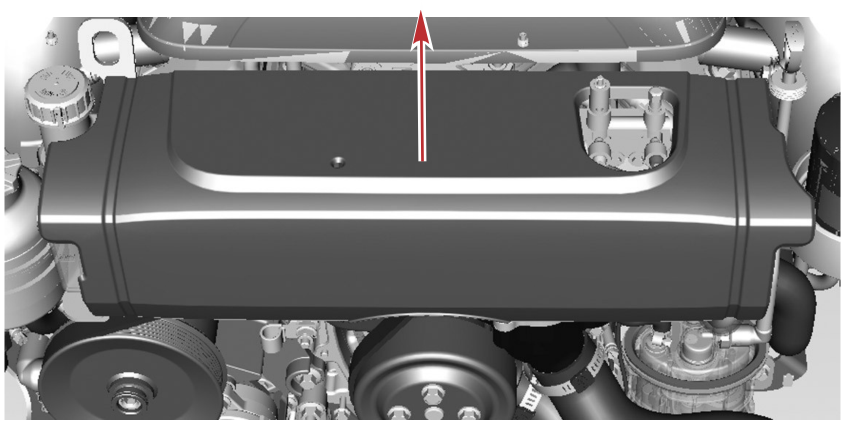
a - Green indicators

18. Open the seacock, if equipped, or unplug and connect the water inlet hose prior to operating the engine.

Air Actuated Single-Point Drain System (Standard Cooling)

The following instructions apply to draining procedures performed on engines in vessels that are in the water. For vessels that are not in the water, you do not need to close the seacock (if equipped) or remove and plug the water inlet hose.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the engine front cover by pulling it up.



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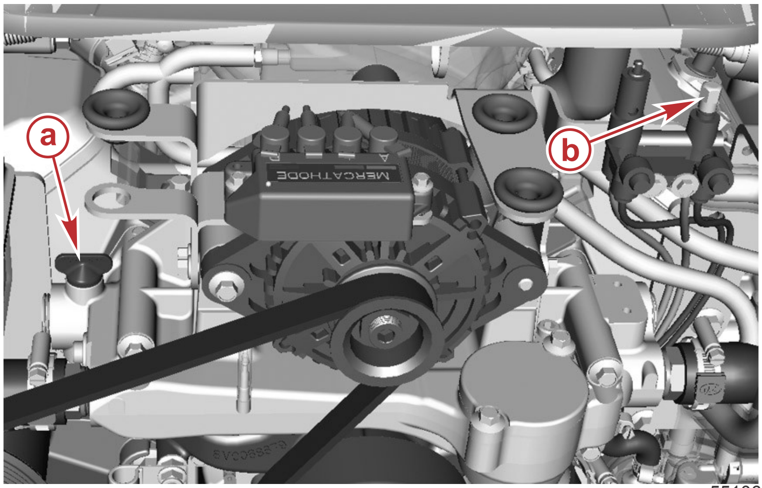
3. Remove the blue plug from the engine block crossover.

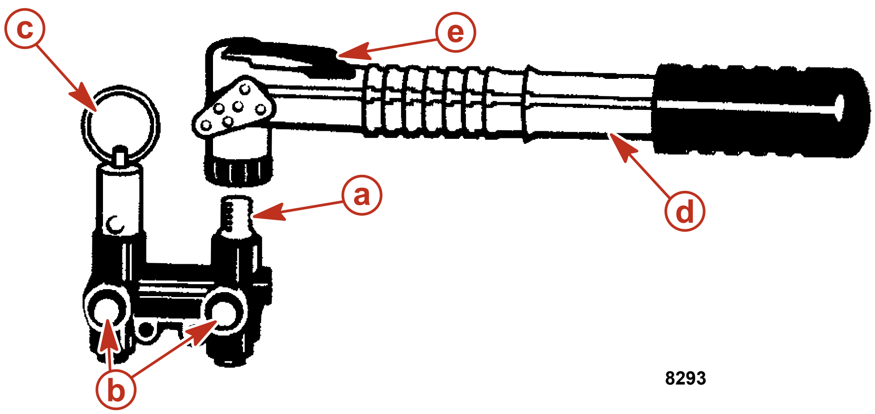
4. Remove the cap from the air actuated valve assembly.



55106

a - Blue plug
b - Cap

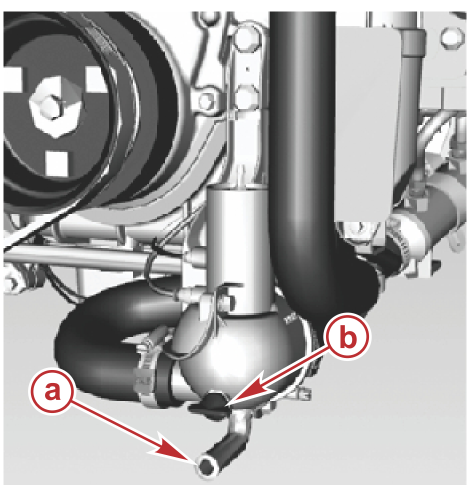
5. Ensure that the lever on top of the air pump is flush with the handle (horizontal).
6. Install the air pump on the actuator fitting.
7. Pull the lever on the air pump (vertical) to lock the pump onto the fitting.



8293

a - Actuator fitting
b - Green indicators
c - Manual release valve
d - Air pump
e - Lever (locking)

8. Pump air into the system until both green indicators extend out of the actuator assembly.
9. Water should begin to drain out of the distribution housing.
IMPORTANT: If water does not drain from the distribution housing when both green indicators are extended, remove the blue plug on the distribution housing.

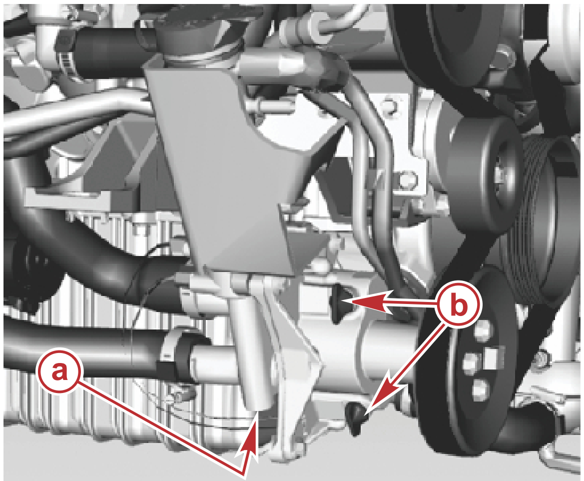


55101

a - Distribution housing water drain
b - Blue plug

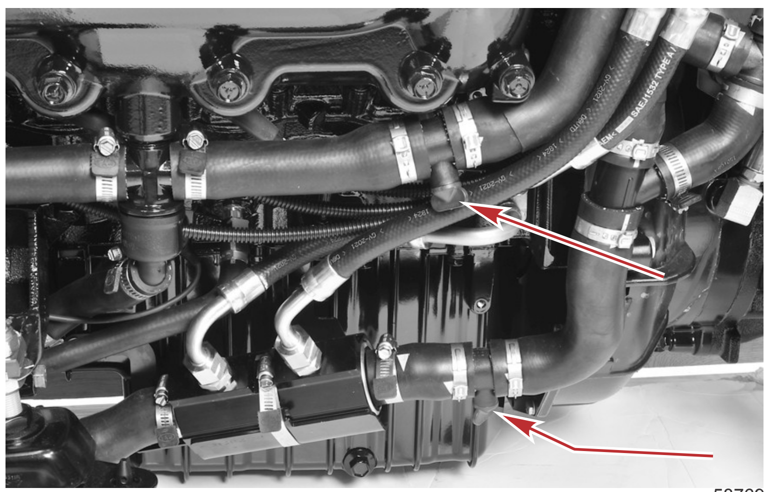
10. Check to ensure water drains out of the seawater pump housing.

IMPORTANT: If water does not drain from the seawater pump housing when both green indicators are extended, remove the blue plugs on the seawater pump housing.

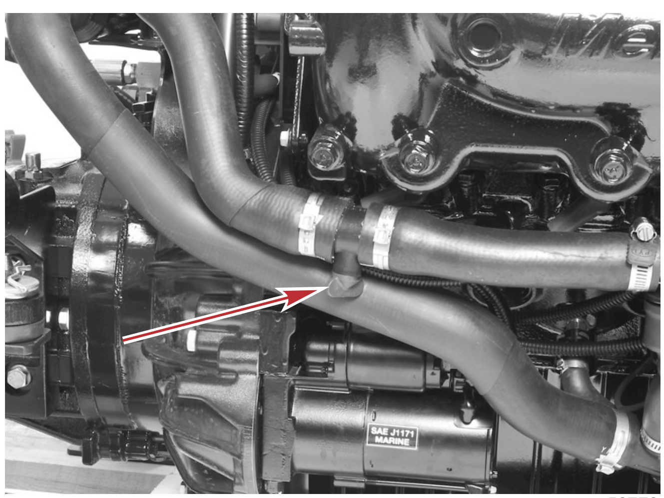


a - Seawater pump housing water drain
b - Blue plugs

11. There are power packages that require specific drain plugs removed because the engine angle is greater than the air actuated drain system allows for proper draining of the system. Remove the blue plugs shown in the following illustrations.



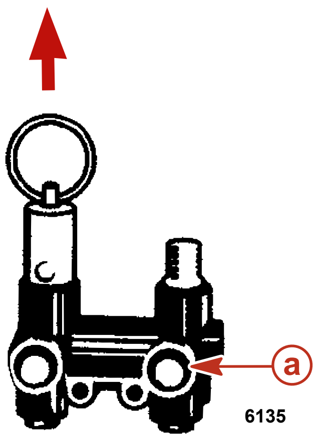
TowSport standard cooling in-line transmission port side view



TowSport standard cooling in-line transmission starboard side view

12. Allow the system to drain for a minimum of ten minutes. Pump air as necessary to keep the green indicators extended.

13. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow the engine to start.
    IMPORTANT: This engine has an automatic start function controlled by the PCM. The start function can be terminated by turning the key to the OFF position.
14. Do not allow the engine to start.
15. After the water has drained from the engine, install the blue plugs on the distribution housing and seawater pump if they were removed and tighten securely.
16. Push the locking lever down on the air pump and remove the pump from the air actuator assembly. Install the cap on the fitting.
17. Install the blue plug on the engine block crossover and tighten securely.
18. The drain system should remain open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
19. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



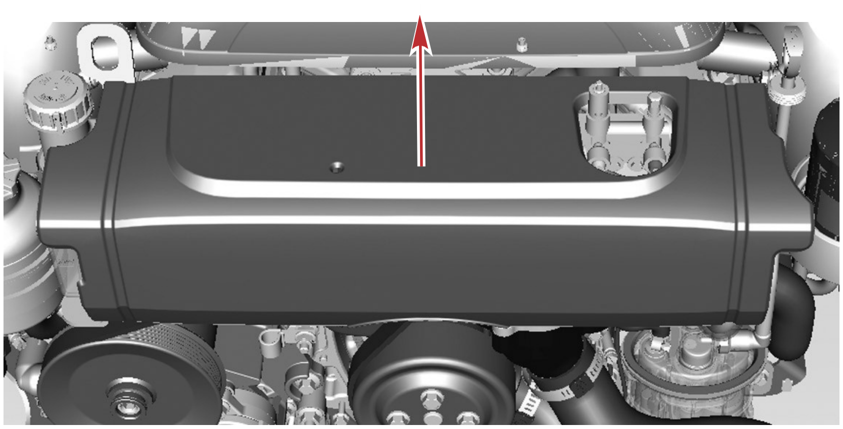
a - Green indicators

20. Open the seacock, if equipped, or unplug and connect the water inlet hose prior to operating the engine.

Air Actuated Single-Point Drain System—Bravo Seawater Cooling

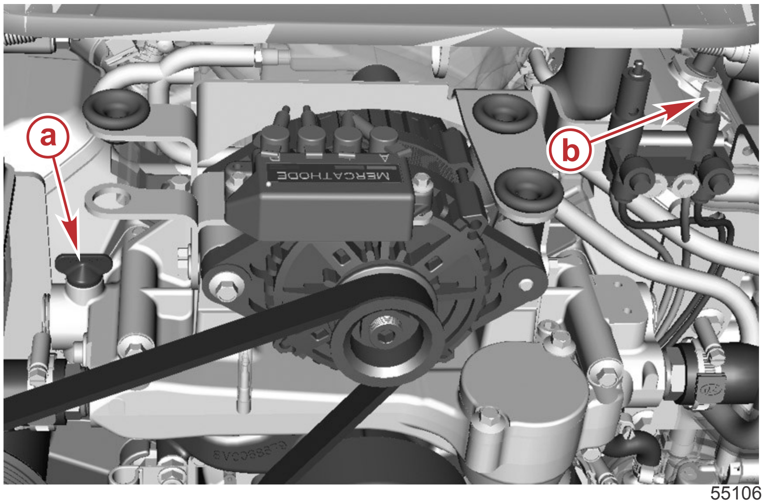
The following instructions apply to draining procedures performed on engines in vessels that are in the water. For vessels that are not in the water, you do not need to close the seacock (if equipped) or remove and plug the water inlet hose.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the engine front cover by pulling it up.



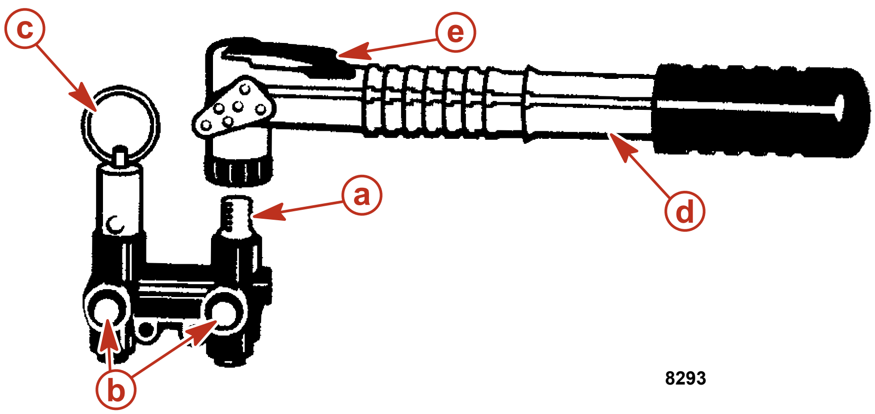
3. Remove the blue plug from the engine block crossover.

4. Remove the cap from the air actuated valve assembly.



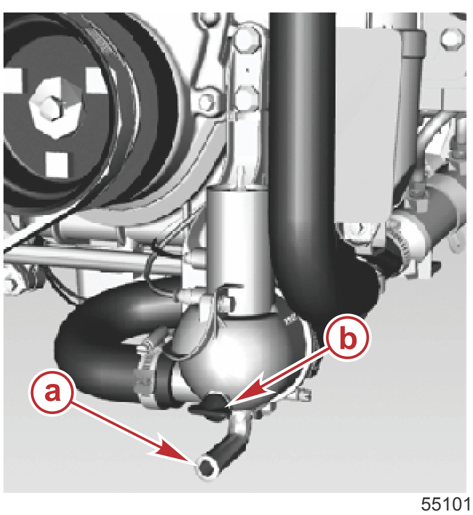
a - Blue plug
b - Cap

5. Ensure that the lever on top of the pump is flush with the handle (horizontal).
6. Install the air pump on the actuator fitting.
7. Pull the lever on the air pump (vertical) to lock the pump onto the fitting.



a - Actuator fitting
b - Green indicators
c - Manual release valve
d - Air pump
e - Lever (locking)

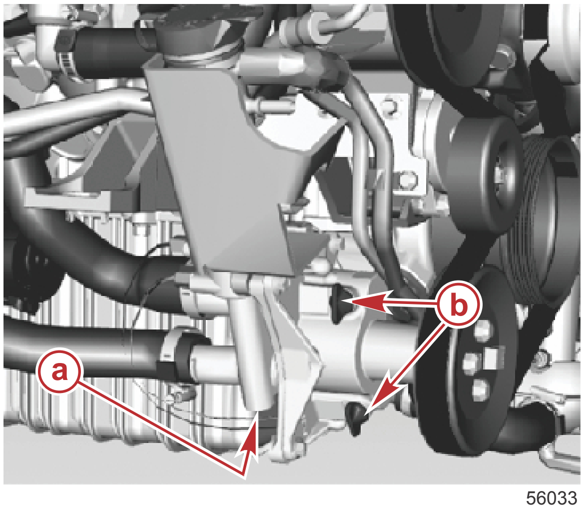
8. Pump air into the system until both green indicators extend out of the actuator assembly.
9. Water should begin to drain out of the distribution housing.
   IMPORTANT: If water does not drain from the distribution housing when both green indicators are extended, remove the blue plug on the distribution housing and the seawater pump housing.



a - Distribution housing water drain
b - Blue plugs

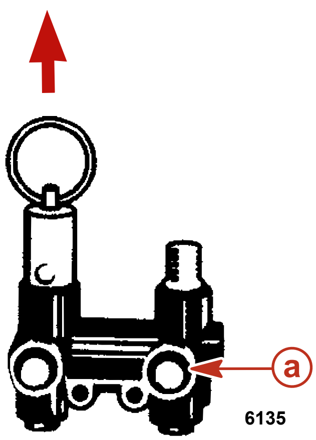
10. Check to ensure water drains out of the seawater pump housing.

IMPORTANT: If water does not drain from the seawater pump housing when both green indicators are extended, remove the blue plugs on the seawater pump housing.



a - Seawater pump housing water drain
b - Blue plugs

11. Allow the system to drain for a minimum of ten minutes. Pump air as necessary to keep the green indicators extended.
12. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow the engine to start.
13. After the water has drained from the engine, install the blue plugs on the distribution housing and seawater pump if they were removed and tighten securely.
14. Push the locking lever down on the air pump and remove the pump from the air actuator assembly. Install the cap on the fitting.
15. Install the blue plug on the heat exchanger and tighten securely.
16. Mercury MerCruiser recommends the drain system remain open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
17. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



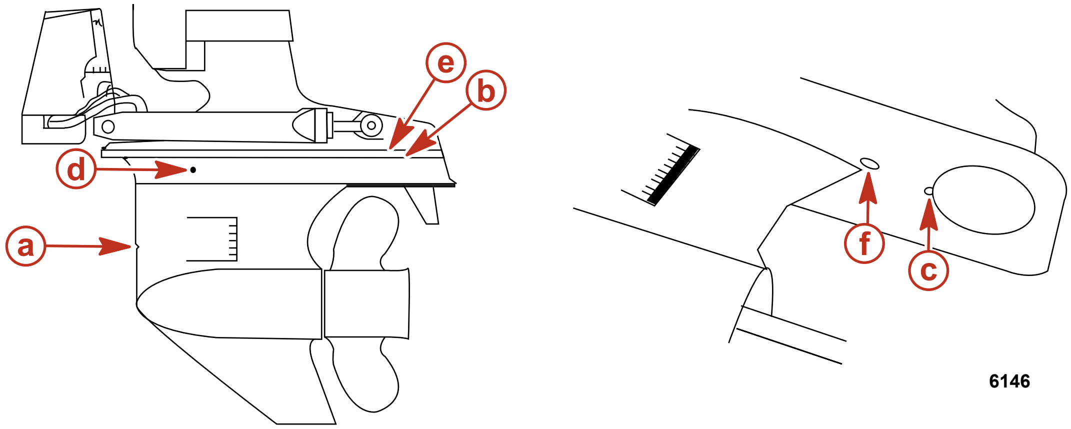
a - Green indicators

18. Open the seacock, if equipped, or unplug and connect the water inlet hose prior to operating the engine.

Draining the Sterndrive

NOTE: This procedure is needed only for salty, brackish, mineral-laden, or polluted water applications; and for freezing temperatures or extended storage.

1. Insert a small wire repeatedly to ensure that vent holes, water drain holes, and passages are unobstructed and open.



Sterndrive water drain holes

a - Speedometer pitot tube
b - Trim tab cavity vent hole
c - Trim tab cavity drain passage
d - Gear housing water drain hole (1 each - port and starboard)
e - Gear housing cavity vent hole
f - Gear housing cavity drain hole

NOTICE

The universal joint bellows may develop a set when stored in a raised or up position, causing the bellows to fail when returned to service and allowing water to enter the boat. Store the sterndrive in the full down position.

2. Lower the sterndrive unit to the full down/in position.
3. For additional assurance against freezing and rust, after draining, fill the cooling system with propylene glycol mixed to the manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage.
   IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Draining the Seawater System

Draining the Raw Water

⚠ CAUTION

Water can enter the bilge when the drain system is open, damaging the engine or causing the boat to sink. Remove the boat from the water or close the seacock, disconnect and plug the seawater inlet hose, and ensure the bilge pump is operational before draining. Do not operate the engine with the drain system open.

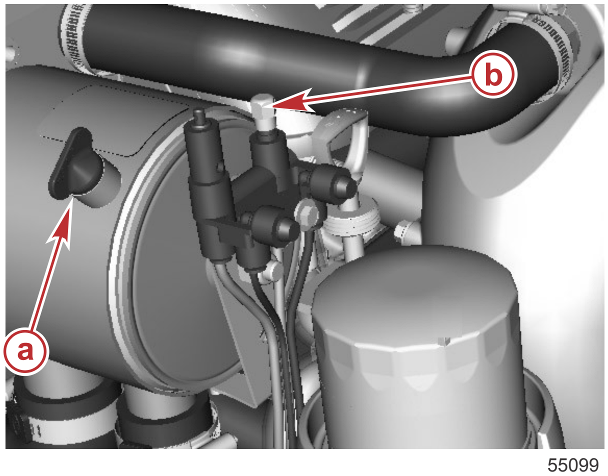
IMPORTANT: Only drain the raw water section of the closed cooling system. Raw water is sometimes referred to as seawater.
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.
IMPORTANT: The engine must not be operating at any point during the draining procedure.
IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the raw water section of the cooling system during freezing temperatures or for extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Air Actuated Single-Point Drain System (Closed Cooling)

The following instructions apply to draining procedures performed on engines in vessels that are in the water. For vessels that are not in the water, you do not need to close the seacock (if equipped) or remove and plug the water inlet hose.

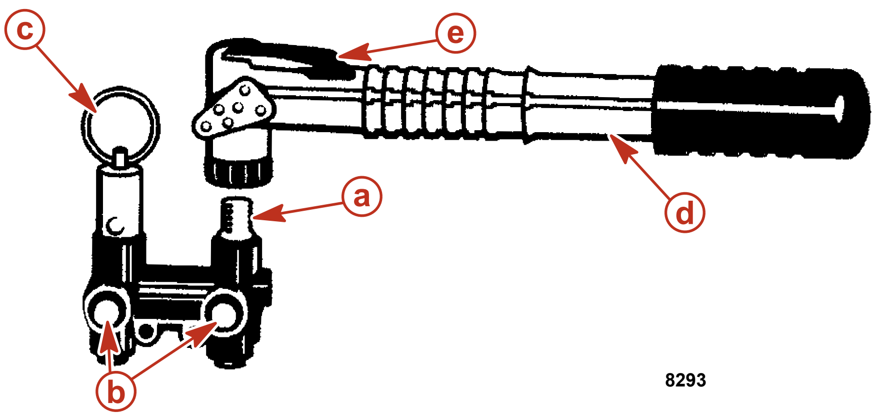
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue plug from the heat exchanger.

3. Remove the cap from the air actuated valve assembly.



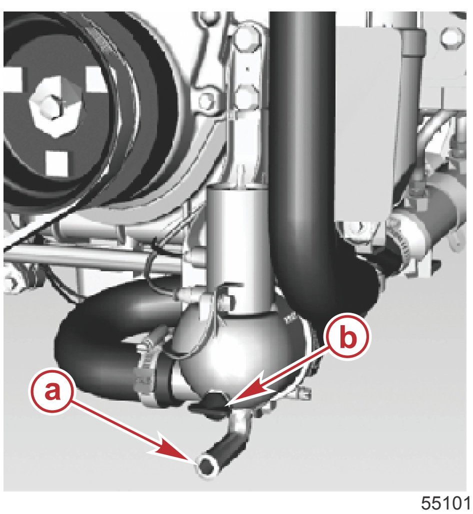
a - Blue plug
b - Cap

4. Ensure that the lever on top of the air pump is flush with the handle (horizontal).
5. Install the air pump on the actuator fitting.
6. Pull the lever on the air pump (vertical) to lock the pump onto the fitting.



a - Actuator fitting
b - Green indicators
c - Manual release valve
d - Air pump
e - Lever (locking)

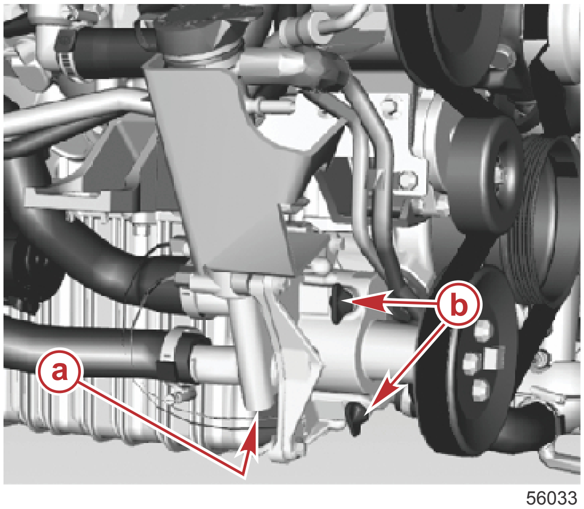
7. Pump air into the system until both green indicators extend out of the actuator assembly.
8. Check to ensure water drains out of the distribution housing.
   IMPORTANT: If water does not drain from the distribution housing when both green indicators are extended, remove the blue plug on the distribution housing.



a - Distribution housing water drain
b - Blue plug

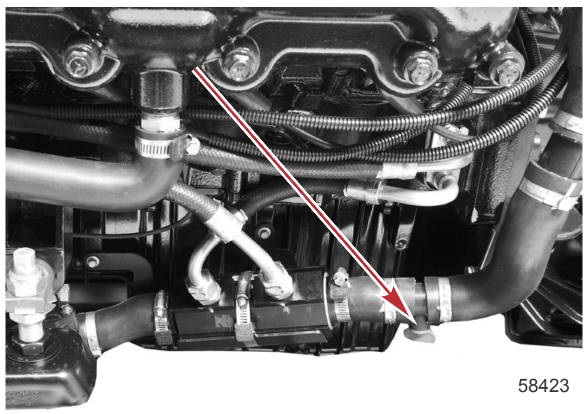
9. Check to ensure water drains out of the seawater pump housing.

IMPORTANT: If water does not drain from the seawater pump housing when both green indicators are extended, remove the blue plugs on the seawater pump housing.

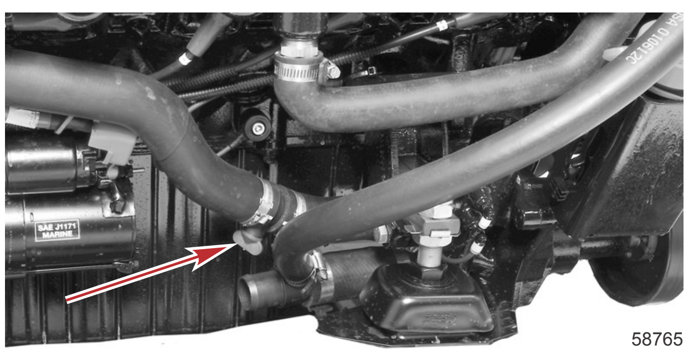


a - Seawater pump housing water drain
b - Blue plugs

10. There are power packages that require specific drain plugs removed because the engine angle is greater than the air actuated drain system allows for proper draining of the system. Remove the blue plugs shown in the following illustrations.



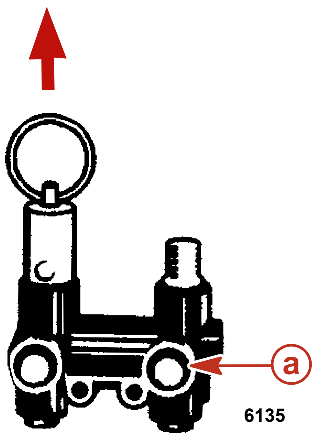
TowSport closed cooling in-line transmission port side view



TowSport closed cooling in-line transmission starboard side view

11. Allow the system to drain for a minimum of ten minutes. Pump air as necessary to keep the green indicators extended.
12. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow the engine to start.
    IMPORTANT: This engine has an automatic start function controlled by the PCM. The start function can be terminated by turning the key to the OFF position.
13. After the water has drained from the engine, install the blue plugs on the distribution housing and seawater pump if they were removed and tighten securely.

14. Push the locking lever down on the air pump and remove the pump from the air actuator assembly. Install the cap on the fitting.
15. Install the blue plug on the heat exchanger and tighten securely.
16. The drain system should remain open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
17. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



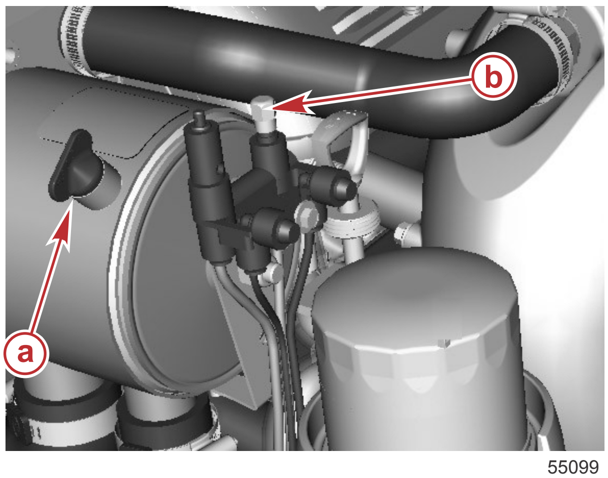
a - Green indicators

18. Open the seacock, if equipped, or unplug and connect the water inlet hose prior to operating the engine.

Air Actuated Single-Point Drain System (Closed Cooling, Inboard Models)

The following instructions apply to draining procedures performed on engines in vessels that are in the water. For vessels that are not in the water, you do not need to close the seacock (if equipped) or remove and plug the water inlet hose.

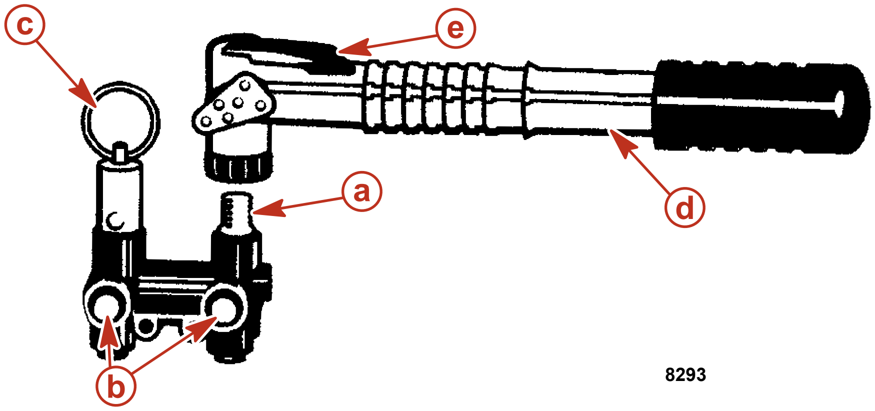
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue plug from the heat exchanger.
3. Remove the cap from the air actuated valve assembly.



a - Blue plug
b - Cap

4. Ensure that the lever on top of the air pump is flush with the handle (horizontal).
5. Install the air pump on the actuator fitting.

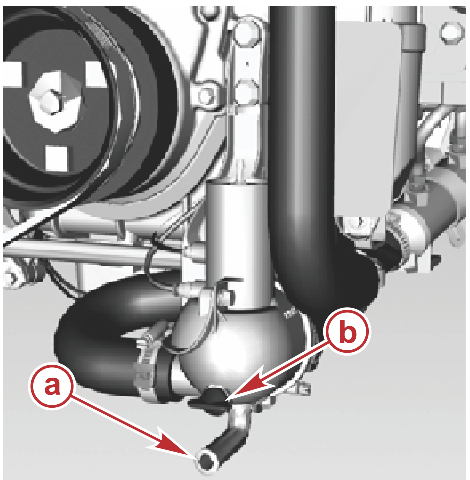
6. Pull the lever on the air pump (vertical) to lock the pump onto the fitting.



8293

a - Actuator fitting
b - Green indicators
c - Manual release valve
d - Air pump
e - Lever (locking)

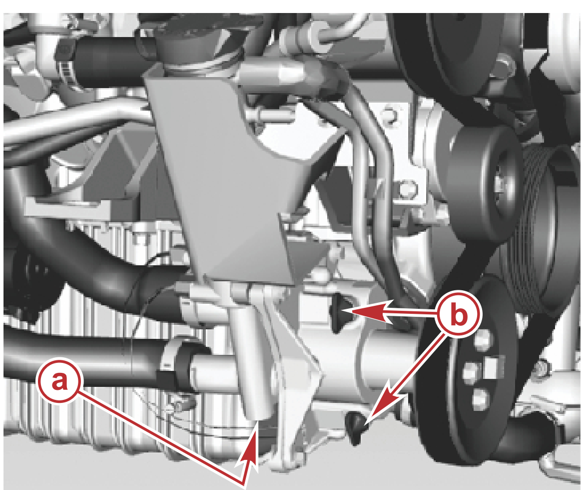
7. Pump air into the system until both green indicators extend out of the actuator assembly.
8. Check to ensure water drains out of the distribution housing.
IMPORTANT: If water does not drain from the distribution housing when both green indicators are extended, remove the blue plug on the distribution housing.



55101

a - Distribution housing water drain
b - Blue plug

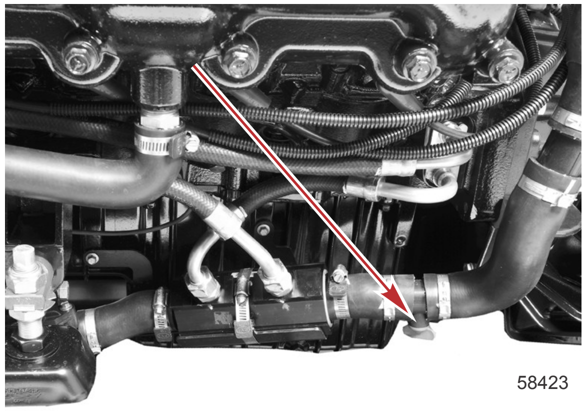
9. Check to ensure water drains out of the seawater pump housing.
IMPORTANT: If water does not drain from the seawater pump housing when both green indicators are extended, remove the blue plugs on the seawater pump housing.



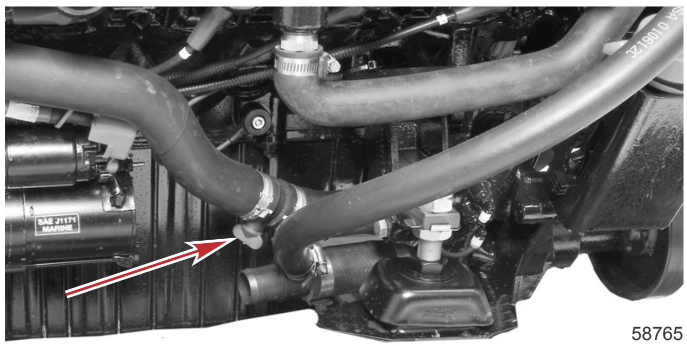
56033

a - Seawater pump housing water drain
b - Blue plugs

10. There are power packages that require specific drain plugs removed because the engine angle is greater than the air actuated drain system allows for proper draining of the system. Remove the blue plugs shown in the following illustrations.



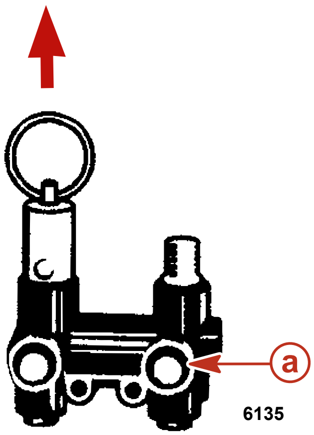
Port side view



Starboard side view

11. Allow the system to drain for a minimum of ten minutes. Pump air as necessary to keep the green indicators extended.
12. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow the engine to start.
    IMPORTANT: This engine has an automatic start function controlled by the PCM. The start function can be terminated by turning the key to the OFF position.
13. After the water has drained from the engine, install the blue plugs on the distribution housing and seawater pump if they were removed and tighten securely.
14. Push the locking lever down on the air pump and remove the pump from the air actuator assembly. Install the cap on the fitting.
15. Install the blue plug on the heat exchanger and tighten securely.
16. The drain system should remain open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.

17. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



a - Green indicators

18. Open the seacock, if equipped, or unplug and connect the water inlet hose prior to operating the engine.

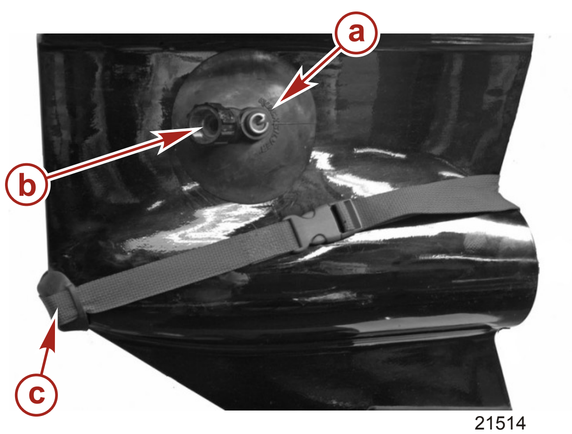
Flushing the Power Package (Bravo)

Flushing the Power Package

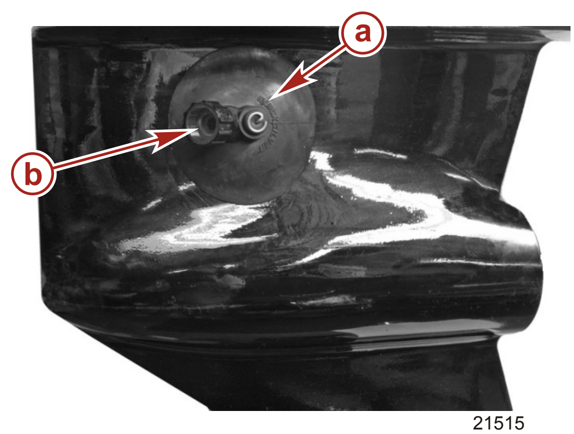
The boat can be equipped with a combination of any of three different types of water pickups: through-the-hull, through-the-transom, and through-the-sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups.

IMPORTANT: Engines that require dual water pickups require a through-the-hull or through-the-transom pickup in addition to the sterndrive water inlets.
IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through-the-hull or through-the-transom pickup need a supply of cooling water available to both the sterndrive and to the engine during operation.

Flushing Attachments



Flushing attachments for dual water pickup



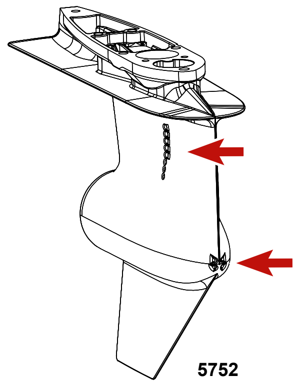
Flushing attachments for side water pickup

a - Flushing device
b - Hose attachment
c - Dual water pickup flush gearcase seal kit

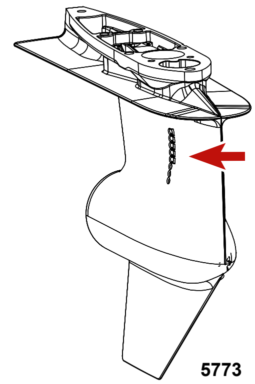
Flushing Device	91-44357Q 2
Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1

Sterndrive Water Pickups

There are two types of water pickups available on Mercury MerCruiser sterndrives: dual water and side water pickups. Dual water pickups require the flushing device and the flush gearcase seal kit. Side water pickups require the flushing device.



Dual water pickup



Side water pickup

NOTE: *Flushing is needed only for salty, brackish, mineral laden or polluted water applications. Flushing is recommended after each outing for best results.*

NOTICE
Flushing the engine with the boat in the water can cause seawater to flow into the engine, resulting in engine damage. Close the seacock before flushing the engine. Keep the seacock closed until starting the engine.

1. On models with the sterndrive seawater inlet blocked, supply water to the sterndrive and to the engine. Refer to **Alternative Water Pickups**.
2. On models using the sterndrive seawater inlet and a through-the-hull or through-the-transom alternative water pickup, supply water to only the sterndrive by taking the following steps to block, or disconnect and block, the hose from the alternative seawater pickup pump inlet Y-fitting.
   a. If equipped with a seacock, close the seacock in the hose from the alternative water pickup.
   b. If not equipped with a seacock, disconnect the hose from the alternative water pickup and plug both ends.
   c. If there is not a hose running to the transom, refer to **Alternative Water Pickups**.
3. On models using the sterndrive water pickups for water supply: proceed to step 4 or step 5.
4. If flushing the cooling system with the boat in the water:
   a. Raise the sterndrive to trailer position.
   b. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
   c. Lower sterndrive to full down (in) position.
5. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive to full down (in) position.

⚠ WARNING
Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

   b. Remove propeller.
   c. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
6. Connect hose between flushing attachment and water source.
7. With the sterndrive in normal operating position, fully open the water source.
8. Place the remote control in the neutral idle speed position and start the engine.

NOTICE
Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

9. Press the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).

10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in neutral for about 10 minutes or until the discharge water is clear.
12. Slowly return the throttle to idle speed position.
13. Stop the engine.
14. Shut off the water and remove the flushing attachment.
15. Remove the seawater inlet hose from the seawater pump and plug the hose to prevent water from siphoning into the engine.
16. Tag the ignition switch with an appropriate tag requiring the seawater inlet hose to be reconnected prior to operating the engine.

Alternative Water Pickups

IMPORTANT: Two water sources are needed for this procedure.

NOTE: Flushing is needed only for salty, brackish, mineral-laden or polluted water applications. Flushing is recommended after each outing for best results.

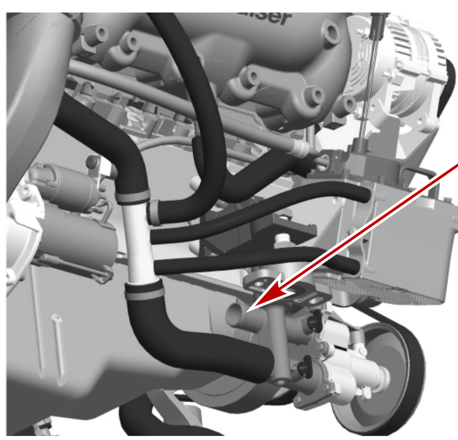
IMPORTANT: Models with the sterndrive water inlet blocked off at the gimbal housing and using a through-hull water inlet need a supply of cooling water available to both the sterndrive and to the engine during operation.

1. If flushing the cooling system with the boat in the water:
   a. Raise the sterndrive to the trailer position.
   b. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
   c. Lower the sterndrive unit to the full down (in) position.
2. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive to the full down (in) position.

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

   b. Remove the propeller. Refer to the appropriate sterndrive service manual for details.
   c. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
3. Connect a hose between the flushing attachment and a water source.
4. Close the seacock, if equipped, to prevent water from siphoning into the engine or boat.
5. Remove the seawater inlet hose from the seawater pump at the location shown. Plug the hose to prevent water from siphoning into the engine or boat.



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Seawater inlet hose connection

6. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. With the sterndrive in normal operating position, open the water source fully.
8. Place the remote control in neutral idle speed position and start engine.

NOTICE
Operating the engine out of the water at high speeds creates suction, which can collapse the water supply hose and overheat the engine. Do not operate the engine above 1400 RPM out of the water and without sufficient cooling water supply.

9. Slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in neutral for about 10 minutes or until discharge water is clear.
12. Slowly return the throttle to the idle speed position.
13. Stop the engine.
14. Shut off the water and remove the flushing attachments.
15. If the boat is out of the water, install the water inlet hose to the aft side of the seawater pump. Tighten the hose clamp securely.
16. If the boat is in the water, tag the ignition switch with an appropriate tag requiring the seawater inlet hose to be reconnected prior to operating the engine.

SeaCore Power Package Flushing Procedure

NOTE: Flushing is needed only for salt, brackish, mineral-laden or polluted water applications. Flushing is recommended after each outing for best results.

IMPORTANT: Flushing the SeaCore power package with the boat and sterndrive in the water is less effective. Flushing the SeaCore power package is most effective when performed with the boat and sterndrive out of the water, such as on a boat lift or trailer.

Models Using the Sterndrive Water Pickup

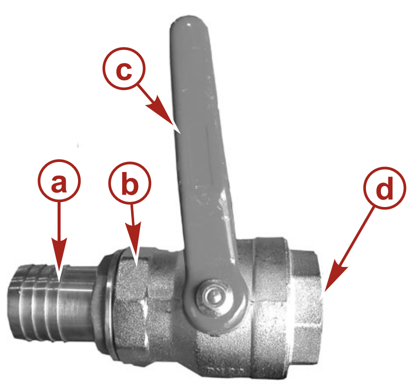
IMPORTANT: The system is designed to flush the Bravo sterndrive and the engine with one water source. Do not block or remove the inlet water hose from the sterndrive to the engine.

NOTE: Engines with the sterndrive water inlet blocked off at the gimbal housing: refer to ***Alternative Water Pickups****.*

⚠ WARNING
Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

IMPORTANT: Do not allow the engine to pull air or seawater from alternative water pickup sources during the flushing procedure. If equipped, ensure that all alternative water inlet hoses are plugged at both ends.

1. Remove the boat from the water.
2. Close the seacock, if equipped.



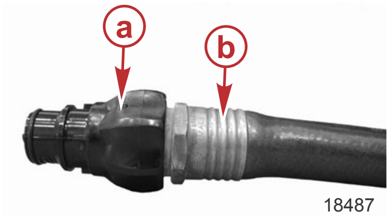
18510

For visual clarity, the seacock shown is not installed

a - Hose fitting to engine
b - Seacock
c - Handle (closed position)
d - To water source pickup attachment

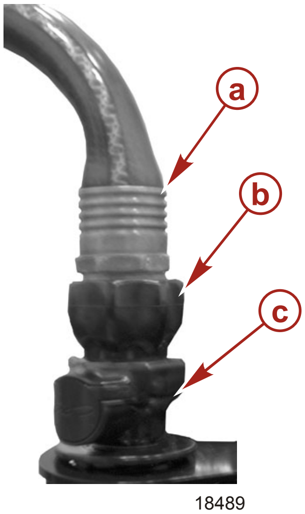
3. If equipped with an alternative water pickup and not equipped with a seacock, disconnect the water hose from the alternative water pickup and plug both ends, excluding the Bravo sterndrive.
4. Ensure that the inlet water hose from the sterndrive to the engine is connected.
5. Remove the quick-connect fitting from the parts bag supplied with the engine.

6. Attach the quick-connect fitting to a water hose.



a - Quick connect fitting (water hose end)
b - Water hose

7. Snap the quick-connect fitting with the water hose into the flush socket on the engine.



a - Water hose
b - Quick-connect fitting (water hose end)
c - Flush socket

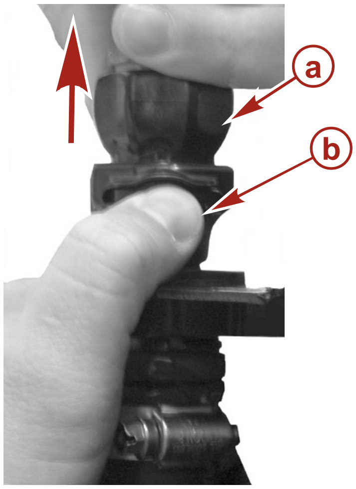
8. Open the water source of the water hose to a full flow.
9. Allow the water to flush the sterndrive for 30 seconds.
10. Place the remote control in neutral idle speed position and start the engine.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

11. Operate the engine at idle speed in neutral gear. Do not exceed 1200 RPM.
12. Monitor the engine temperature while operating the engine.
13. Flush the engine for 5 to 10 minutes or until discharge water is clear.
14. Shut off the engine.
15. Allow the water to flush the sterndrive for 10 seconds.
16. Turn off the water source.

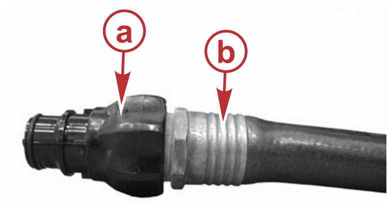
17. Disconnect the quick-connect fitting and water hose from the flush socket on the engine by pressing the release button on the flush socket.



18488

a - Quick-connect fitting (water hose end)
b - Flush socket release button

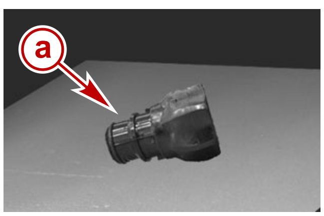
18. Remove the quick-connect fitting from the water hose.



18487

a - Quick-connect fitting (water hose end)
b - Water hose

19. Retain the quick-connect fitting with the water hose end for repeated use by storing it separately in a storage compartment on the boat for easy access.
IMPORTANT: Do not store the quick-connect fitting in the flush socket on the engine. Doing so would allow the seawater pump to suck air during engine operation causing an overheating problem. Damages due to engine overheating are not covered by Mercury MerCruiser Warranty.



25900

Quick-connect fitting stored in the boat
a - Quick-connect fitting (water hose end)

20. Insert the dust cover in the flush socket on the engine.

18490

Dust cover installed in the flush socket
a - Dust cover
b - Flush socket

IMPORTANT: If the unit is to be stored in the water, the seacock should remain closed until time of usage. If unit is to be stored out of the water, open the seacock.

21. Open the seacock, if equipped, or reconnect the alternative water inlet source prior to operating the engine.

Cold Weather or Extended Storage

IMPORTANT: Mercury MerCruiser strongly recommends that this service be performed by an authorized Mercury MerCruiser dealer. Damage caused by freezing temperatures is not covered by the Mercury MerCruiser Limited Warranty.

NOTICE
Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

NOTE: As a precautionary measure, attach a tag to the key switch or steering wheel of the boat reminding the operator to open the seacock or unplug and reconnect the water inlet hose before starting the engine.

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Preparing Power Package for Storage—MPI Models

Multipoint fuel injection (MPI) systems must have a special mix of fuel, stabilizer, and lubricant, completely fill the fuel delivery system. This fuel mix stabilizes the fuel and lubricates the fuel pumps, fuel pressure regulator, fuel injectors and, reduces internal oxidation of the fuel system metal components.

IMPORTANT: This special fuel mix can be used on Mercury Marine catalyzed gasoline engines.

Special Fuel Mix

⚠ WARNING
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ WARNING
Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

1. Fill a 23 liter (6 US gal) remote fuel tank with 19 L (5 US gal) regular unleaded 87 octane (90 RON) gasoline.
2. Pour into the remote fuel tank 1.89 L (2 US qt) of Premium Plus 2-Cycle TC-W3 Outboard Oil and 29.5 ml (1 oz) of Mercury Quickstor Fuel Stabilizer.

Tube Ref No.	Description	Where Used	Part No.
115	Premium Plus 2-Cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
124	Quickstor Fuel Stabilizer	Fuel system	92-8M0047932

3. Install the remote fuel tank cap and ensure the added ingredients are thoroughly mixed with the fuel.

Engine and Fuel System Preparation

⚠ WARNING
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

NOTICE

Running out of fuel can damage catalyst components. Do not allow the fuel tanks to become empty during operation.

1. Check the antifreeze concentration where applicable. Refer to the **Specifications** section.
2. Before adding Mercury Quickstor Fuel Stabilizer to the fuel in the tank, determine the type of fuel that is in the fuel tanks and proceed with the following:
   a. Vessels using fuel without alcohol—fill the vessel fuel tanks with fresh gasoline that does not contain alcohol and add a sufficient amount of Mercury Quickstor Fuel Stabilizer to treat the gasoline. Follow the instructions on the container.
   b. Vessels using fuel containing alcohol—drain the fuel tanks as low as possible and add a sufficient amount of Mercury Quickstor Fuel Stabilizer to treat the remaining gasoline. Follow the instructions on the container.
3. Flush the cooling system. Refer to the **Maintenance** section.
4. Supply cooling water to the engine. Refer to the **Maintenance** section.
5. Close the fuel shut off valve, if equipped, or disconnect and plug the boat fuel tank hose.
6. Connect the remote fuel tank with the special fuel mix to the fuel inlet fitting.
7. Start the engine and run the engine at 1300 RPM for five minutes. This is usually enough time for the special fuel mix to circulate through the fuel system. Check to ensure there are no oil leaks. Shut the engine off.
   IMPORTANT: Do not allow the engine to run out of fuel.
8. Disconnect the special fuel mix hose from the inlet fitting. Connect the boat fuel tank hose to the inlet fitting. Open the fuel shut off valve, if equipped.
9. Change the oil and oil filter.
10. Replace the water separating fuel filter element where applicable.
11. Drain the engine seawater cooling system. Refer to **Draining the Seawater System**.

NOTICE

Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

12. Fill the seawater cooling system with propylene glycol mixed to the manufacturer's recommendation to protect the engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage. This will also prevent the formation of exfoliating rust in the cooling system passages.
13. Store the battery according to the manufacturer's instructions.

Power Package Recommissioning

1. Ensure that all cooling system hoses are connected properly and hose clamps are tight.

CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect the cables. Tighten each cable clamp securely.
3. Coat the terminal connections with a battery terminal sealant.

Tube Ref No.	Description	Where Used	Part No.
	Battery Terminal Sealant	Battery terminal connections	Obtain Locally

4. Perform the following prior to starting the engine:
   a. Install the bilge drain plug.
   b. Open the engine hatch.
   c. Turn the battery switch on.

d. Operate the bilge blowers.
e. Open the fuel shut-off valve.
f. Open the seacock, if equipped.
g. Close the drain system.
h. Check the engine oil.
i. Listen for the audio warning alarm to sound when the ignition switch is moved to the "ON" position.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

5. Start the engine and closely observe the instrumentation to ensure that all systems are functioning correctly.
6. Carefully inspect the engine for fuel, oil, fluid, water, and exhaust leaks.
7. Inspect the steering system, shift, and throttle control for proper operation.

Notes:

Important Information, Maintenance, and Troubleshooting

Section 1D - Troubleshooting

Table of Contents

Introduction

Before You Begin Troubleshooting

It is important to be methodical when diagnosing an electronically controlled engine. Before you get started, consider the following:

1. Use the provided **Diagnostic Roadmap** to stay on a logical path.
2. Make sure that you completely understand the customer complaint before proceeding. Additional questions and clarifications at the beginning will save time and frustration.
3. While it may be logistically difficult, time and effort spent duplicating the customer complaint ensures that you fully understand the problem and that it is real. Failing to do so often results in lost time and unnecessary expenses, as well as increased customer frustration if you are unable to correct the problem in your first attempt.
4. The CDS G3 service tool is required to access all of the available information in the PCM 112 controller. Refer to **CDS G3 Service Tool**. The CDS G3 service tool is purchased through Mercury Parts and Accessories.
5. PCM 112 engines have a generic onboard diagnostics - marine (OBD-M) data connector that allows connection of generic J1939 scan tools.

Situational Awareness

Always be aware of the actual conditions under which the engine is operating and compare them with the conditions that the sensors are transmitting to the PCM.

The PCM recognizes abnormally high or low voltage signals as sensor failures and stores a fault message to that effect. If a sensor fails internally, but transmits a signal that the PCM recognizes as acceptable, the PCM may not make the appropriate adjustments.

For example, if a sensor indicates that the air temperature is 32 °C (90 °F) instead of an actual temperature of 10 °C (50 °F), or if the sensor is telling the PCM that the engine is warm when it is actually cold, the engine may not operate properly. Being aware of the situation and making comparisons to actual conditions can point out failed sensors not recognized by the PCM.

General Troubleshooting Guidelines

The diagnostic process is seen by many as being as much art as it is science; however, there's nothing mysterious about it. A methodological approach, combined with experience, knowledge, and the right tools, can eliminate guesswork from the process.

1. Talk to the customer to get as much information as possible about the complaint. There is a reason the boat was brought in. Did a warning light come on or alarm sound? When did the problem first start? At what speeds does it occur?
2. Verify the symptom, if possible while the customer is present.
3. Perform a brief visual inspection.
4. Scan the PCM 112 for faults. For a list of applicable faults, refer to **CDS G3 Fault List**. For fault troubleshooting information, refer to the **PCM 112 Service Manual**.
   - Fix any active faults first.
   - Examine the freeze frame buffers, which do not relate to active or inactive faults. Be careful about faults that happened a long time ago and only happened once or twice.
   - Continue to troubleshoot faults until you can clear them and they don’t come back after a test run on the water.
5. If there are no faults but a symptom exists, then perform an in-depth visual/physical inspection. Refer to **Visual/Physical Check**. Basically, you must:
   - Isolate the problem to the boat or the engine.
     i. Use a shop or other portable fuel tank that has known good fuel and no restrictions.
     ii. For non-DTS engines, use a key switch harness at the main harness connector. Remove all leads from the battery except those required by the engine.
     iii. Use all of your senses. Listen, look, touch, and smell to determine if the engine is running correctly.
   - If the problem is associated with the engine, isolate the problem to the different systems (starting, charging, ignition, fuel, intake, exhaust, or mechanical systems).
     i. Verify the integrity of the electrical system (cranking and charging).
     ii. Verify the integrity of the ignition system. Ensure that spark is present at the correct time.
     iii. Verify the integrity of the fuel system (correct pressure at the rail, and each injector fires when commanded).
     iv. Verify the integrity of the engine’s mechanical (compression) components.
6. Do not chase a problem that does not exist. If there are no faults and you cannot replicate the customer's complaint, it may be more prudent to return the boat to service.

7. It is not the PCM. Just because you replace the PCM and the problem seems to go away does not mean that the PCM was bad. There are many reasons that replacing a good PCM could make a problem disappear.
   - The simple act of unplugging and plugging the PCM connectors can clear oxidation from the contacts and restore a bad connection.
   - Simply moving the harness as you unplug the connectors and then reconnect them to the replacement PCM can cause an open or short to disappear.
   - A marginal actuator that is pulling too much current may cause the PCM to fail, but will work for a while with the new PCM. This causes many technicians to assume the PCM was the root cause, when it was actually the result of the root cause.
   - The replacement PCM may have an updated calibration that eliminates the running quality issue you may have been experiencing. This is not a PCM failure, since reprogramming the original PCM with the new calibration would have also fixed the problem

Visual/Physical Check

1. Ensure that the safety lanyard is correctly installed and that the customer understands the correct starting procedure.
2. Verify that the battery is fully charged and of sufficient capacity for the engine being tested. If necessary, substitute a known good battery.
3. Check the fuses and circuit breaker.
4. Check the battery cable connections. Ensure that they are clean and tight. If wing nuts are being used, discard them and replace them with corrosion-resistant hex nuts. A corrosion-resistant terminal cable washer nut should be installed between the battery terminal and the cable end (the stack sequence must be battery terminal, washer, cable, and nut). Ensure that the cable connections are tight at the starter solenoid and that the block fuse on the starter solenoid is tight and the through bolt is not loose. Also ensure that the ground stud is not loose in the engine block and that the nut is tight.
5. Check that all grounds are clean and tight. If the negative battery cable is connected to the ground stud that does not contain all of the EFI and engine wiring harness ground leads, consider moving the negative battery cable to that ground stud.
6. If there is any doubt about the mechanical condition of the engine, perform a compression test and a cylinder leak-down test.

⚠ WARNING
Performing tests with the engine running may cause the propeller to rotate and result in serious injury or death. Use caution when performing a test that requires the engine running, and remove the propeller to avoid injury.

7. Unplug and inspect the main harness connector between the engine and boat harnesses. If there is any doubt about the boat harness, substitute a shop harness and key switch assembly, and rerun the boat. If the problem disappears, the problem is in the boat harness, not the MerCruiser engine harness. For non-DTS engines, a test harness can be purchased: MerCruiser 2-foot instrument harness cable for 14 pin (84-896537K02).

   NOTE: *The red/yellow wires for the neutral safety switch on this harness must be tied together to crank the engine and perform this test.*
8. Check for adequate fuel pressure at the fuel rail.
   a. If there is no fuel pressure, check that all fuel pumps are actually operating. The pumps must run for at least two seconds each time the key is turned to the on position. If the fuel pumps and the warning horn are not operating as the key is turned on, ensure that the PCM is powering up (check the fuses and the wake-up line).
   b. On PCM models, fuel pressure varies with engine vacuum. Fuel pressure will be high during cranking, lower at idle, and increase proportionally as the throttle is opened to the wide-open position. Disconnect the vacuum line on the fuel regulator to find the regulator's rated pressure. Connect the vacuum line to ensure that the pressure drops at idle. Pressure usually drops about 28–41 kPa (4–6 psi) at idle (from the regulator's rated specification).

      NOTE: *Refer to* **Section 5A** - ***Fuel Pressure Specifications***.
   c. If the fuel pressure drops at higher speed and higher engine loads, check for restrictions in the boat's fuel system by connecting an accurate vacuum gauge and a clear hose at the water-separating fuel filter inlet. As you run the engine from idle to wide-open throttle and then back to idle, there must not be any air bubbles passing through the clear hose and the vacuum gauge must not read higher than 6.7 kPa (2 in. Hg). Refer to **MerCruiser Service Bulletin 99-7** for additional information.
   d. If the supply system tests OK, but the fuel pressure is low at high speeds and loads, replace the water-separating fuel filter and retest. If pressure is still low, most likely the fuel pump or regulator is defective.
9. Check all vacuum lines for splits, kinks, and proper connections. The fuel regulator on all PCM models must be connected to the manifold vacuum. The PCV valve, if equipped, is a calibrated air leak. If it is missing or plugged, or if the incorrect valve is installed, engine operation will be affected.
10. Check for any other additional air leaks in the induction system, such as at the throttle body and intake manifold gaskets.

11. Unplug and inspect as many of the sensors and actuators as possible. Look for signs of tampering, corrosion, damage to the pin locking mechanisms, melted insulation, and any other evidence of shorts or other damage. Based on the results of this inspection, further inspection of the harness may be necessary. Remember that there are many internal splices in the harness that may be damaged or defective. If there is damage at the external connections, you will have to inspect several of the internal splices to verify that the damage is not also present at these locations.
12. Check for adequate secondary spark. If an air gap tester is used, ensure it will not ignite any fuel vapors that may be present in the bilge. A KV meter can also be used to check for adequate secondary voltage. Ensure that the secondary wires are in good condition (correctly routed and that the boots are not split at either end).
    IMPORTANT: The pins in the PCM connectors are delicate. Disconnect the PCM to inspect the pins only if there is reason to suspect that the pins may be damaged.
13. Unplug and inspect the PCM connectors. Ensure that there are no bent PCM pins and that all of the correct pins are present. Look for signs of tampering, corrosion, damage to the pin locking mechanisms, melted insulation, and any other evidence of shorts or other damage.

Emission Control Fault Indicators

Depending on the application, engines with emissions control can inform the operator of a fault with the system in one of several ways:

- A warning horn that will sound for five seconds and repeat at one-half-second intervals for 60 seconds.
- An OBD-M malfunction indicator lamp (MIL), a stand-alone indicator that illuminates while the OBD-M fault is active.
- An engine icon incorporated into another display, such as VesselView or SmartCraft, which may be accompanied by an audible alarm.

Early engines were not equipped with OBD-M MILs. Update kits are available for those who wish to purchase this feature.

Diagnostic Roadmap

This is your starting point for diagnosing an emissions controlled engine. Start with step 1, answer the question and proceed accordingly. Do not skip any step, as each step depends on the results of previous steps to ensure success. You may be directed to other sections in this manual or to a different manual entirely.

Step	Question	Technical Details	Yes	No
1	Does the engine system power up when the key switch is turned to the run position?	The warning horn completes a self-test. The engine gauges power up. If present, the OBD-M system completes a self-test.	Go to step 2.	Go to **Chart R1**.
2	Does the CDS G3 service tool communicate with the PCM?	CDS G3 must display PCM data on the module data screen.	Go to step 3.	Refer to **CDS G3 Service Tool**.
3	Does the engine crankshaft rotate when you attempt to start the engine?	The engine must rotate at least 50 RPM before a crankshaft sensor signal will be seen.	Go to step 4.	Go to **Chart R3**.
4	Does the engine start and continue to run?	If the engine starts and immediately dies, your answer must be **no**.	Go to step 5.	Go to **Chart R4**.
5	Does the engine start hard?	The engine starts, but not readily. It may or may not stall.	Go to **Chart R5**.	Go to step 6.
6	Does the engine stall when attempting to idle, or run so poorly it is unusable?	It is difficult or impossible to use the engine to maneuver the boat. The engine does not respond to shift and throttle commands as expected.	Go to **Chart R6**.	Go to step 7.
7	Does the engine start and continue to run with the warning horn or engine gauges indicating an active diagnostic fault?	The engine may or may not run normally, but it keeps running without difficulty. There is at least one diagnostic fault. The OBD-M lamp or engine icon may be on or off.	Refer to the **PCM 112 Service Manual**.	Go to step 8.
8	Can you tell that the engine is not running properly by sight, sound, smell, or touch? Do you observe a symptom, yet there are no diagnostic faults?	The engine gauges do not indicate any diagnostic faults. The warning horn is silent. The OBD-M lamp or engine icon may be on or off. The PCM does not detect any problems, yet the engine has a problem.	Refer to **Diagnosis by Symptom**.	The problem has been resolved or is not presenting itself at this time. Diagnosis is complete.

Chart R1: Engine System Fails to Power Up

This procedure is intended to diagnose a PCM 112 system that does not turn on. You are here because you answered no to step 1 of the diagnostic roadmap.

The PCM 112 receives continuous battery power and ground through a special 2-wire PCM power harness that contains a 5-amp fuse. The helm is powered separately through the battery cables. This circuit includes the 90-amp block fuse, the 50-amp circuit breaker, and a 20-amp fuse.

The remainder of the engine harness receives battery power through the battery cables, which may or may not be connected to a battery switch. If the key switch is turned to the run position while the battery switch is off, diagnostic faults will be set.

Step	Diagnostic Process	Details	Yes	No
1	**Are the battery switches set for normal operation?**	Not all boats will have a battery switch. They are optional.	Go to step 2.	Reset the switches for normal operation.
2	Check the condition and state of charge of the main engine battery. **Is the battery serviceable?**	Refer to the engine service manual for battery specifications.	Go to step 3.	Charge or replace the battery.
3	Check the battery cable connections at both the engine and battery. **Are the battery connections good?**	Ensure that the ground stud is tightened securely in the engine block. Ensure that corrosion-resistant hex nuts are used instead of wingnuts.	Go to step 4.	Clean and tighten all connections.
4	Check the 5-amp PCM power fuse, and check for correct routing of the PCM power circuit. **Is the fuse good and the harness routing correct?**	The PCM power harness must be connected directly to the main engine battery. It cannot be connected to a battery switch. The PCM power harness connects the battery to a 2-pin engine harness connector.	Go to step 5.	Replace the fuse. Reroute or reconnect the harness as necessary. Install the harness if it is missing.
5	Check for battery voltage at the red lead of the helm harness key switch connector. **Is the voltage within 1.0 V of battery?**	Voltage must be present continuously, regardless of battery switch position. If the main engine battery is connected, voltage must be present.	Go to step 6.	Repair or replace circuit. This circuit includes the battery cable, 90-amp block fuse, 50-amp circuit breaker, and a 20-amp fuse. It includes the red lead in pin A of the 14-pin connectors on the engine, main data harness, and helm harness.
6	Turn the key switch to the run position. Check for battery voltage at the purple lead of the helm harness key switch connector. **Is the voltage within 1.0 V of battery?**	Voltage must be present when the key switch is in the run position, but not when the key switch is in the off position.	Go to step 7.	Replace the key switch, as necessary.
7	Check the battery voltage between the black lead of the helm harness key switch connector and the positive terminal of the main engine battery. **Is the voltage within 1.0 V of battery?**	Voltage must be present continuously. This test verifies the ground circuits between the PCM power harness and the helm.	Go to step 8.	Repair or replace circuit. This circuit includes the battery, PCM power harness black lead, 14-pin main harness black lead, and helm harness to the key switch black lead.
8	Turn the key switch to the run position. Check for battery voltage at the warning horn purple lead. **Is the voltage within 1.0 V of battery?**	–	Go to step 9.	Repair or replace the purple circuit between the key switch and the warning horn.

Step	Diagnostic Process	Details	Yes	No
9	Turn the key switch to the run position. Disconnect the warning horn brown lead. Temporarily ground the warning horn brown lead. **Does the warning horn sound?**	The horn must sound anytime the purple lead has battery voltage and the brown lead is grounded.	Go to step 10.	Replace the warning horn and retest.
10	Test the circuit between the helm harness brown warning horn connector and the engine harness brown/blue lead at PCM 112 connector A, pin 1E for continuity. **Does the circuit have continuity?**	The PCM grounds this circuit to sound the warning horn. The circuit changes from brown (boat) to brown/ blue (engine) at the 14-pin engine connector.	Go to step 11.	Repair or replace the defective circuit between the warning horn and PCM 112.
11	Test PCM 112 connector B, pin 4G for battery voltage when the key switch is in the run position. **Is the voltage within 1.0 V of battery?**	The PCM 112 turns on when it sees battery voltage at this pin.	Go to step 12.	Repair the purple wake circuit.
12	Test for battery voltage between the positive terminal of the battery and each of the following PCM 112 connector pins: A-4C, C-1G, and C-2G. **Does each circuit measure within 1.0 V of battery?**	–	Go to step 13.	Repair or replace the defective PCM 112 ground circuit.
13	**Does the engine system power up?**	If the engine system does not power up after successfully completing all of the previous steps, there may be a problem with the PCM 112.	Go to step 14.	Call MerCruiser Service for assistance.
14	**Does the OBD-M lamp self-test?**	The OBD-M lamp should complete a self-test on engine system power up.	The engine system is now powering up properly. Return to the **Diagnostic Roadmap** and continue with step 2.	Go to **Chart R2**.

Chart R2: OBD-M Lamp Does Not Self-Test

This procedure is intended to diagnose an OBD-M lamp that does not self-test. You are here because you answered no to step 14 in **Chart R1**.

If the engine is equipped with an OBD-M indicator lamp, it must complete a self-test each time the system is turned on. Failure to self-test is an indication that the light is not working and cannot be used to indicate the status of the emissions control system. Use the following table to diagnose an OBD-M lamp that does not self-test.

Step	Diagnostic Process	Details	Yes	No
1	Turn the key switch to the run position. Check for battery voltage at the white lead at the OBD-M lamp. **Is the voltage within 1.0 V of battery?**	The key switch purple lead connects to the engine harness through the 14-pin main data harness and connectors. It changes color from purple (engine side) to white (OBD-M light harness) at the engine's 2-pin OBD-M light connector. The white lead is the positive side of the light.	Go to step 2.	Check the engine's 2-amp OBD-M lamp fuse. Repair or replace the circuit between the key switch purple lead and the OBD-M lamp white lead.

Step	Diagnostic Process	Details	Yes	No
2	Disconnect the black lead from the OBD-M lamp. Turn the key switch to the run position. Ground the OBD-M lamp's empty terminal with a suitable jumper wire. **Does the OBD-M lamp light when grounded?**	The black lead is the negative side of the light.	Go to step 3.	Replace the defective OBD-M lamp.
3	Test the circuit between the OBD-M lamp black lead and the PCM 112 connector A, pin 1F for continuity. **Does the circuit have continuity?**	The OBD-M light black lead connects directly to the engine harness. It changes to light blue in the engine harness, across the 2-pin OBD-M light connector. The PCM grounds this circuit to turn on the OBD-M lamp.	Go to step 4.	Repair or replace the defective circuit.
4	**Does the OBD-M lamp self-test when the key switch is turned to the run position?**	If the OBD-M lamp does not self-test after successfully completing all of the previous steps, there may be a problem with the PCM 112.	The lamp is working correctly. Return to the **Diagnostic Roadmap** and continue with step 2.	Call Mercury Product Service.

Chart R3: Crankshaft Fails to Rotate

This procedure is intended to diagnose a PCM 112 mechanical shift engine that does not rotate the crankshaft when the key switch is held in the start position. You are here because you answered no to step 3 of the diagnostic roadmap.

The key switch controls the starter relay on the engine. The starter relay controls the starter solenoid (mounted on the starter motor). The starter solenoid sends heavy current from the battery through the starter motor. The PCM 112 does not control any of these functions, everything is mechanical. The engine will continue to crank until the key switch is released.

All MerCruiser engines are designed to use a neutral safety switch. The switch is inside the remote control on sterndrive engines and mounted to the transmission on inboard engines. The switch must be closed when in neutral, and open when in gear.

Step	Diagnostic Process	Details	Yes	No
1	**Is the remote control in the neutral, idle position?**	The remote control must be in neutral for the engine to start.	Go to step 2.	Reposition the control levers.
2	**Are all battery switches set for normal operation?**	Not all boats will have a battery switch. They are optional.	Go to step 3.	Reset the switches for normal operation.
3	Check the main engine battery rating, condition, and state of charge. **Is the battery good for this application?**	A weak battery may engage the relay or solenoid, but not crank the engine.	Go to step 4.	Charge, retest, or replace the battery.
4	Check the battery cable connection at both the engine and battery. **Are the connections good?**	Ensure that the ground stud is tightened securely in the engine block. Ensure that the battery wingnuts have been replaced with corrosion-resistant hex nuts.	Go to step 5.	Clean and tighten all connections.
5	**Does the starter motor make any sound when the key switch is turned to start?**	If the starter motor energizes and spins, it will make an audible noise. (The exact noise it makes can be a further clue to an experienced technician.)	Go to step 10.	Go to step 6.
6	**Does the starter solenoid click when the key switch is turned to start?**	The starter solenoid will produce an audible click as it engages.	Go to step 10.	Go to step 7.
7	Check all engine fuses and the circuit breaker. **Are all fuses and the circuit breaker good?**	Check the 90-amp block fuse, 50-amp circuit breaker, and the 15-amp and 20-amp engine fuses.	Go to step 8.	Reset or replace as necessary.

Step	Diagnostic Process	Details	Yes	No
8	Verify that at least 9.5 V are available to the solenoid at terminal "S," during cranking. **Is there adequate voltage to engage the starter solenoid?**	Refer to **Section 4A** - **Low Voltage Tests** .	Replace the starter solenoid or the starter motor assembly.	Go to step 9.
9	With the key in the start position, check for battery voltage at terminal 86 of the starter relay socket. **Is the voltage within 1.0 V of battery?**	–	Test the relay (refer to **PCM 112–Section 3A** - **Component testing**). • If the relay is bad, replace it and retest the system. • If the relay is good, there is an open between the relay and the solenoid.	There is a problem in the circuit that supplies voltage to terminal 86 of the starter relay.
10	Verify that at least 9.5 V are available to the starter motor during cranking. **Is there adequate voltage to turn the starter motor?**	Refer to **Section 4A** - **Low Voltage Tests** .	Go to step 11.	Perform the **Voltage Drop Test** in **Section 4A** - **Starting System**.
11	Remove the starter assembly from the engine. Test it with a 12-volt source. **Does the starter operate correctly?**	–	Inspect the flywheel ring gear for damage. If it appears okay, reinstall the starter. Go to step 12.	The starter assembly is bad.
12	Uncouple the engine from the sterndrive. **Does the engine turn over with the sterndrive disconnected?**	–	The problem is in the sterndrive. Refer to the appropriate sterndrive service manual.	Go to step 13.
13	**Is the motor locked up?**	Check for water in cylinders, internal mechanical issues, and corrosion.	Refer to **Section 3** - **Engine Mechanical**.	Contact Mercury Product Service.

Chart R4: Engine Cranks Over but Will Not Start

This procedure is intended to diagnose a PCM 112 mechanical shift engine that rotates the crankshaft, but will not start when the key switch is held in the start position. You are here because you answered no to step 4 of the diagnostic roadmap.

Step	Diagnostic Process	Details	Yes	No
1	**Did you complete the Visual/Physical Check?**	–	Go to step 2.	Perform the **Visual/Physical Check**.
2	Use the CDS G3 service tool to check for faults. **Are there any faults?**	If a sensor has failed, it will normally set a fault in the PCM. For the CPS, see the note, following.	Troubleshoot the faults. Refer to the **PCM 112 Service Manual**.	Go to step 3.
3	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	–	Go to step 4.	Go to **Chart T4**.
4	Connect a known good fuel source in place of the boat's fuel tank. **Does the engine start?**	–	The problem is with the boat fuel supply.	Go to step 5.
5	Inspect the fuel filter. **Is the fuel filter obstructed?**	–	Clean or replace the fuel filter. Test the fuel for contaminants.	Go to step 6.
6	Check the fuel pressure at the fuel rail. **Was the fuel pressure within specification when the pump was operating?**	Refer to **Section 5A** - **Fuel Pressure Gauge Setup and Use**.	Go to step 7.	Go to **Chart T3**.

Step	Diagnostic Process	Details	Yes	No
7	Complete a compression test on the engine. **Was a problem found?**	Refer to **Section 3C - Compression Gauge Testing**.	Locate and repair the problem. Retest the system.	Contact Mercury Product Support.

NOTE: The crankshaft position sensor (CPS) is an exception. It will ***not*** *set a fault if it fails completely.*

Chart R5: Hard Start

This procedure is intended to diagnose a PCM 112 mechanical shift engine that readily rotates the crankshaft, but takes a long time to start. You are here because you answered yes to step 5 of the diagnostic roadmap.

Step	Diagnostic Process	Details	Yes	No
1	**Did you complete the Visual/ Physical Check?**	–	Go to step 2.	Perform the **Visual/ Physical Check**.
2	Use the CDS G3 service tool to check for faults. **Are there any faults?**	If a sensor has failed, it will normally set a fault in the PCM. For the CPS, see the note, following.	Troubleshoot the faults. Refer to the **PCM 112 Service Manual**.	Go to step 3.
3	Check for bad fuel or problems with the fuel filters. **Was a problem found?**	Check for contaminated fuel. Check fuel filters and the water-separating fuel filter. Try starting the engine with a portable tank of known good fuel. Check for poor fuel quality and improper octane rating.	Use known good fuel. Replace fuel filters.	Go to step 4.
4	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	–	Go to step 5.	Go to **Chart T4**.
5	Check the fuel pressure at the fuel rail. **Was the fuel pressure within specification when the pump was operating?**	Refer to **Section 5A - Fuel Pressure Gauge Setup and Use**.	Go to step 6.	Go to **Chart T3**.
6	**Is a scan tool being used?**	–	Go to step 8.	Go to step 7.
7	Check for an ECT sensor shifted in value. With the engine completely cool, measure the resistance of the ECT sensor. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. **Are the readings similar?**	Refer to **PCM 112–Section 3A -Component testing**.	Go to step 10.	Replace the ECT sensor. Retest the system.
8	Check for an ECT sensor shifted in value. Using the scan tool with the engine completely cool, compare the ECT sensor temperature with an accurate reading of ambient air temperature. **Are the temperatures within 5.5° C (10° F) of each other?**	–	Go to step 9.	Replace the ECT sensor. Retest system.

Step	Diagnostic Process	Details	Yes	No
9	Using the scan tool, display the ECT sensor temperature and record the value. Check the resistance of the ECT sensor. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. **Is the ECT sensor temperature near the resistance temperature?**	Refer to **PCM 112–Section 3A -Component testing**..	Go to step 10. Retest the system.	Locate and repair high-resistance or poor connection in the ECT signal circuit or the ECT sensor ground.
10	Check for intermittent opens or shorts to ground in the MAP sensor circuit. **Was a problem found?**	Wiggle the MAP sensor harness while monitoring data on the CDS G3.	Locate and repair the open in the harness.	Go to step 11.
11	Using the scan tool, check for proper operation of the TPS. **Was a problem found?**	–	Locate and repair the problem with the TPS. Retest the system.	Go to step 12.
12	Check for engine mechanical problems. **Was a problem found?**	Check for the following: • Low compression • Leaking cylinder head gaskets • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system	Refer to **Section 3 - Engine Mechanical**.	Go to step 13.
13	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system			

NOTE: The crankshaft position sensor (CPS) is an exception. It will ***not*** *set a fault if it fails completely.*

Chart R6: Engine Stalls

This procedure is intended to diagnose a PCM 112 mechanical shift engine that starts without difficulty, but stalls while attempting to idle or runs so poorly as to be unusable. You are here because you answered yes to step 6 of the diagnostic roadmap.

Step	Diagnostic Process	Details	Yes	No
1	Connect a known good fuel source in place of the boat's fuel tank. **Does the engine still stall?**	–	Go to step 2.	The problem is with the boat fuel supply.
2	Inspect the fuel filter. **Is the fuel filter obstructed?**	–	Clean or replace the fuel filter. Test the fuel for contaminants.	Go to step 3.
3	Check the fuel pressure. **Is the fuel pressure steady?**	–	Go to step 4.	Go to **Chart T3**.
4	Check the ground wires for loose connections or corrosion. **Were problems found?**	–	Correct the problems and retest the engine.	Go to step 5.
5	Check for mechanical engine problems. **Were problems found?**	Check for the following: • Low compression • Worn camshaft • Restricted intake or exhaust system	Correct the problems and retest the engine.	Contact Mercury Product Support.

Diagnosis by Symptom

Chart S1: Engine Surges

Definition: Engine power variation under steady throttle. Feels like the engine speeds up or slows down with no change in the throttle position.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 4.
4	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 5.
5	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, the cause of the fouling must be determined before replacing the spark plugs.* **Were the spark plugs damaged?**	Replace the spark plugs.	Go to step 6.
6	Check the ignition coil for cracks or carbon tracking. **Was a problem found?**	Repair or replace the ignition coil. Retest the system.	Go to step 7.
7	• Check the integrity of the primary and secondary wiring. • Check the wire routing. • Check the condition of the spark plug wires. **Was a problem found?**	Repair or replace bad spark plug wires. Retest the system.	Go to step 8.
8	Check the vacuum hoses for splits, kinks, and improper connections. **Was a problem found?**	Repair or replace the vacuum hoses.	Go to step 9.
9	Check the fuel injector wiring harness for improper connections and intermittent opens or shorts. **Was a problem found?**	Repair or replace the fuel injector wiring harness. Retest the system.	Go to step 10.
10	Inspect the PCM harness connections and ground connections for being tight, clean, and connected properly. **Was a problem found?**	Repair. Retest the system.	Go to step 11.
11	Check the alternator voltage output. **Is the output 13.9–14.7 V?**	Go to step 12.	Refer to **Section 4C - Charging System**.
12	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S2: Lack of Power, Sluggish, or Spongy

Definition: Engine delivers less than expected power. Little or no increase in speed when the throttle lever is advanced partially.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.

Step	Action	Yes	No
3	**Is the engine in Guardian?**	Verify the engine fault and repair accordingly. Refer to the **PCM 112 Service Manual.**	Go to step 4.
4	If possible compare engine performance with an engine of the same model. **Is the engine performance similar?**	No problem found.	Go to step 5.
5	Check the flame arrestor for dirt, damage, or any restriction. **Was a problem found?**	Clean or replace the flame arrestor.	Go to step 6.
6	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 7.
7	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 8.
8	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, the cause of the fouling must be determined before replacing them.* **Were the spark plugs damaged?**	Replace the spark plugs.	Go to step 9.
9	Check the ignition coil for cracks or carbon tracking. **Was a problem found?**	Repair or replace the ignition coil. Retest the system.	Go to step 10.
10	Check for intermittent open or shorts in the ECT sensor, MAP sensor, and TPS circuits. **Was a problem found?**	Locate and repair the open or short in the harness.	Go to step 11.
11	Inspect the PCM harness connections and ground connections for being tight, clean, and connected properly. **Was a problem found?**	Repair. Retest the system.	Go to step 12.
12	Check the alternator voltage output. **Is the output 13.9–14.7 V?**	Go to step 13.	Refer to **Section 4C - Charging System**.
13	Check for excessive resistance on the bottom of the boat, such as dirt or barnacles. **Was a problem found?**	Clean the boat bottom. Retest the system.	Go to step 14.
14	Check for proper propeller size and pitch for the boat application. **Was a problem found?**	Replace the propeller with one appropriate for the application.	Go to step 15.
15	Check for the following: • Low compression • Leaking cylinder head gaskets • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 16.
16	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S3: Detonation or Spark Knock

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	**Is the engine propped to operate in the recommended operating RPM range?**	Go to step 4.	Check propping procedures.
4	Check the spark plugs for: • Proper type (refer to **Section 1C - Maintenance**) • Proper gap (refer to **Section 1C - Maintenance**) • Damage **Was a problem found?**	Replace the problem spark plugs with those specified for the application.	Go to step 5.
5	Check the spark plug wires for continuity or damage. **Was a problem found?**	Replace the questionable spark plug wire. Retest the system.	Go to step 6.
6	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 7.
7	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 8.
8	**Is the engine operating above the normal temperature range?**	Go to step 9.	Go to step 10.
9	Check for obvious overheating issues: • Loose serpentine belt • Faulty or incorrect seawater pump • Restriction in the cooling system • Faulty or incorrect thermostat **Was a problem found?**	Repair or replace. Retest the system.	Go to step 10.
10	**Is a scan tool being used?**	Go to step 12.	Go to step 11.
11	Check for an ECT sensor shifted in value. With the engine completely cool, measure the resistance of the ECT sensor. Refer to **PCM 112–Section 3A - Component testing Sensor**. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. **Are the readings similar?**	Go to step 13.	Replace the ECT sensor. Retest the system.
12	Check for an ECT sensor shifted in value. Using the scan tool with the engine completely cool, compare the ECT sensor temperature with an accurate reading of ambient air temperature. **Are the temperatures within 5.5° C (10° F) of each other?**	Go to step 13.	Replace the ECT sensor. Retest the system.
13	Check for loose fasteners, sensors, and connections.	Tighten and secure.	Go to step 14.
14	Check for the following: • Low compression • Leaking cylinder head gaskets • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system **Was a problem found?**	Engine mechanical problem, refer to **Section 3 - Engine Mechanical**.	Go to step 15.

Step	Action	Yes	No
15	Using an engine cleaner, remove excessive carbon buildup from the combustion chambers. *NOTE: Refer to the instructions on the engine cleaner.* Retest the system. **Is detonation still present?**	Go to step 16.	Done.
16	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data *NOTE: If there is an active fault **Engine_Misfire**, refer to the **PCM 112 Service Manual** or to **MerCruiser Service Bulletin 2011-11R2**.* • All of the electrical connections within a suspect circuit or system		

Chart S4: Hesitation, Sag, or Stumble

Definition: Momentary lack of response as the throttle lever is advanced. Can occur at all engine speeds, but usually more severe when first starting out. May cause engine to stall in severe cases.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/ Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	Inspect the flame arrestor for restrictions, dirt, or damage. **Was a problem found?**	Clean or replace the flame arrestor. Retest system.	Go to step 4.
4	Check for intermittent opens or shorts to ground in the MAP sensor circuit. **Was a problem found?**	Locate and repair the problem in the harness. Retest system.	Go to step 5.
5	• Using the scan tool, check for proper operation of the TPS. • Check throttle linkage for sticking, binding, or wear. **Was a problem found?**	Locate and repair the problem with the TPS or the throttle linkage. Retest system.	Go to step 6.
6	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace fuel filters.	Go to step 7.
7	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 8.
8	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 9.
9	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, determine the cause of the fouling before replacing the spark plugs.* **Was a problem found?**	Replace the spark plugs.	Go to step 10.
10	Check the alternator voltage output. **Is the output 13.9–14.7 V?**	Go to step 11.	Refer to **Section 4C - Charging System**.
11	Check for obvious overheating issues: • Loose serpentine belt • Faulty or incorrect seawater pump • Restriction in the cooling system • Faulty or incorrect thermostat **Was a problem found?**	Repair or replace. Retest system.	Go to step 12.

Step	Action	Yes	No
12	Check for the following: • Low compression • Deposits on the intake valves **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 13.
13	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S5: Engine Misses

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle, low speed, or on hard acceleration. Fuel starvation can cause the engine to miss.

IMPORTANT: For additional information on diagnosing engine misfires, refer to the **PCM 112 Service Manual.**

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/ Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 4.
4	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 5.
5	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 6.
6	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	Go to step 8.	Go to **Chart T4**.
7	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, the cause of the fouling must be determined before replacing the spark plugs.* **Was a problem found?**	Replace the spark plugs.	Go to step 8.
8	Check for electromagnetic interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or tachometer. A sudden increase in RPM with little change in actual engine RPM indicates EMI is present. **Was a problem found?**	Locate and correct the EMI source. Retest the system.	Go to step 9.
9	Check for the following: • Low compression • Sticking or leaking valves • Bent push rods • Worn rocker arms • Broken valve springs • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 10.
10	Check the intake and exhaust manifolds for casting flash. **Was a problem found?**	Repair or replace. Retest the system.	Go to step 11.

Step	Action	Yes	No
11	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S6: Rough, Unstable, or Incorrect Idle and Stalling

Definition: Engine operates unevenly at idle. If severe, the engine or vessel may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/ Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 4.
4	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 5.
5	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 6.
6	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	Go to step 7.	Go to **Chart T4**.
7	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, determine the cause of the fouling before replacing the spark plugs.* **Was a problem found?**	Replace the spark plugs.	Go to step 8.
8	Check for the following: • Low compression • Vacuum leaks • Sticking or leaking valves • Bent push rods • Worn rocker arms • Broken valve springs • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 9.
9	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S7: Poor Fuel Economy

Definition: Fuel economy is noticeably lower than expected. Also, economy is now lower than it was on this engine at one time.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/ Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	Check the operator's driving habits. • Are excessively heavy loads being carried? • Is the operator accelerating too much or too often? **Was a problem found?**	System normal.	Go to step 4.
4	Check all fuel lines and connections for leaks. **Was a problem found?**	Repair or replace. Retest the system.	Go to step 5.
5	• Check for excessive resistance on the bottom of the boat such as dirt or barnacles. • Check for a damaged propeller. • Check for proper propeller size and pitch for that application. **Was a problem found?**	• Clean the boat bottom. • Repair or replace the propeller.	Go to step 6.
6	Check the flame arrestor for dirt, damage, or any restriction. **Was a problem found?**	Clean or replace the flame arrestor.	Go to step 7.
7	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 8.
8	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 9.
9	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 10.
10	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	Go to step 11.	Go to **Chart T4**.
11	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, the cause of the fouling must be determined before replacing the spark plugs.* **Was a problem found?**	Replace the spark plugs.	Go to step 12.
12	Check the vacuum hoses for splits, kinks, and improper connections. **Was a problem found?**	Repair or replace the vacuum hoses.	Go to step 13.
13	Check engine compression. **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 14.
14	Check the exhaust system for possible restrictions. Inspect the exhaust system for damaged or collapsed pipes. **Was a problem found?**	Repair or replace.	Go to step 15.
15	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data *NOTE: If there are any active onboard diagnostics - marine (OBD-M) faults, refer to the* ***PCM 112 Service Manual****.* • All of the electrical connections within a suspect circuit or system		

Chart S8: Dieseling or Run-On

Definition: Engine continues to operate roughly after the key is moved to the off position.

If the engine operates smoothly, first check the ignition switch and adjustment.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 4.
4	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 5.
5	Check for obvious overheating issues: • Loose serpentine belt • Faulty or incorrect seawater pump • Restriction in the cooling system • Faulty or incorrect thermostat **Was a problem found?**	Repair or replace. Retest the system.	Go to step 6.
6	Check the fuel pump relay for proper operation. **Was a problem found?**	Repair or replace. Retest the system.	Go to step 7.
7	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Chart S9: Backfire

Definition: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Step	Action	Yes	No
1	Was the **Visual/Physical Check** completed?	Go to step 2.	Go to the **Visual/ Physical Check**.
2	Did the onboard diagnostic (OBD) system check complete?	Go to step 3.	Connect the CDS G3 service tool and scan for faults.
3	Check the flame arrestor for dirt, damage, or any restriction. **Was a problem found?**	Clean or replace the flame arrestor.	Go to step 4.
4	• Check for contaminated fuel. • Check fuel filters and the water-separating fuel filter. • Check for poor fuel quality and improper octane rating. **Was a problem found?**	Use known good fuel. Replace the fuel filters.	Go to step 5.
5	Check for proper fuel pressure while the condition exists. **Was a problem found?**	Go to **Chart T3**.	Go to step 6.
6	Check the fuel injectors. **Was a problem found?**	Repair or replace the faulty injector.	Go to step 7.
7	Check the spark plug wires for open circuits, cracks in the insulation, or improper seating of the terminals at the spark plugs and coil tower. **Was a problem found?**	Locate and repair or replace. Retest the system.	Go to step 8.
8	Check the ignition coil for cracks or carbon tracking. **Was a problem found?**	Repair or replace the ignition coil. Retest the system.	Go to step 9.
9	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	Go to step 10.	Go to **Chart T4**.

Step	Action	Yes	No
10	Remove the spark plugs and check them for moisture, cracks, wear, improper gap, burned electrodes, or heavy deposits. *NOTE: If the spark plugs are fouled with gas or oil, the cause of the fouling must be determined before replacing the spark plugs.* **Was a problem found?**	Replace the spark plugs.	Go to step 11.
11	Check for intermittent opens or shorts to ground in the MAP sensor circuit. **Was a problem found?**	Locate and repair the open in the harness. Retest the system.	Go to step 12.
12	• Check for proper operation of the TPS. • Check for throttle linkage sticking, binding, or wear causing TPS voltage to be higher than normal. **Is the TPS operating improperly or is the voltage higher than normal?**	Locate and repair the problem with the TPS or the throttle linkage. Retest the system.	Go to step 13.
13	Check for the following: • Low compression • Sticking or leaking valves • Worn rocker arms • Broken valve springs • Worn camshaft • Improper valve timing or valve train problem • Restricted exhaust system **Was a problem found?**	For repair, refer to **Section 3 - Engine Mechanical**.	Go to step 14.
14	Review all of the procedures in this table. If all procedures have been completed and no problem found, inspect the following: • CDS G3 scan tool data • All of the electrical connections within a suspect circuit or system		

Troubleshooting Tests

Chart T1: Main Power Relay Test

Step	Action	Yes	No
1	• Turn the ignition key switch on. • Listen for the main power relay (MPR). • Turn the ignition key switch off. **With the initial ignition key on, did the MPR turn on (you should hear a click)?**	No problem found.	Go to step 2.
2	• Remove the MPR. • Turn the ignition key switch on. • Using the DMT connected to ground, check for battery voltage (B+) at the MPR harness connector terminal 30 and 86. • Turn the ignition key switch off. **With the ignition key on, was B+ present?**	Go to step 3.	Locate and repair the open or short in the harness. Retest system.
3	Check for continuity between the MPR harness connector terminal 85 and the PCM harness connector pin A-3D. **Was continuity present?**	Install a known good MPR onto the engine. Retest system.	Locate and repair the open in the harness. Retest system.

Chart T2: Fuel System Electrical Test

Step	Action	Yes	No
1	• Turn the ignition key switch on. • Listen for the fuel pump to operate. • Turn the ignition key switch off. **Did the fuel pump operate for 3–5 seconds?**	No problem found.	Go to step 2.
2	• Disconnect the fuel pump harness connector. • Turn the ignition key switch on. • Using the DMT connected to ground, check for battery voltage (B+) at the fuel pump harness connector pin A. • Turn the ignition key switch off. **With the ignition on, was B+ present?**	Install a known good fuel pump. Retest system.	Reconnect the fuel pump harness connector. Go to step 3.
3	• Remove the fuel pump relay (FPR). • Turn the ignition key switch on. • Using the DMT connected to ground, check for B+ at FPR harness connector terminal 30. • Turn the ignition key switch off. **With the ignition on, was B+ present?**	Go to step 4.	Locate and repair the open or short in the harness. Retest system.
4	Check for continuity between FPR harness connector terminal 86 and PCM harness connector pin A-2D. **Was continuity present?**	Install a known good FPR. Retest system.	Locate and repair the open or short in the harness. Retest system.

Chart T3: Fuel System Diagnosis

IMPORTANT: Before starting fuel system diagnosis, verify that there is fuel in the tank.

Step	Action	Yes	No
1	• Disconnect both battery cables from the battery. • Install a fuel pressure gauge. • Connect the battery cables to the battery. • Turn the ignition key switch on. • The fuel pump will operate for 3–5 seconds. Note the fuel pressure while the pump is operating. The pressure may drop after the pump stops, but should not drop immediately to 0 kPa (0 psi). • Turn the ignition key switch off. **Was the fuel pressure within specification while the pump was operating?**	Go to step 2.	Go to step 4.
2	Attempt to start the engine and allow it to idle. **Did the engine start?**	Go to step 3.	Go to step 5.
3	With the engine idling, connect an external vacuum source to the fuel pressure regulator and apply 34 kPa (10 in. Hg) of vacuum. **Did fuel pressure decrease by approximately 34.5 kPa (5 psi)?**	Problem is intermittent or the fuel supply to the engine is low or restricted.	Replace faulty fuel pressure regulator. Retest system.
4	**Was fuel pressure present?**	Go to step 5.	Go to **Chart T2**.
5	**Does the system establish fuel pressure and then quickly decrease to 0 kPa (0 psi)?**	Go to step 6.	Retest system.
6	• Turn the ignition key switch off. • Block the fuel pressure line between the fuel pump and the fuel rail. • Turn the ignition key switch on. **Does the fuel pressure remain steady?**	Locate and repair leaking fuel injectors or fuel line connections.	Go to step 7.
7	• Turn the ignition key switch off. • Block the fuel return line using the fuel shut off valve tool. • Turn the ignition key switch on. **Does the fuel pressure remain steady?**	Replace faulty fuel pressure regulator. Retest system.	Install a known good fuel pump. Retest system.

Chart T4: Ignition System Test

Step	Action	Yes	No
1	• Connect an analog tachometer to the auxiliary tachometer lead located near the PCM. • Try to start the engine. • Turn the ignition key switch off. **Was there any tachometer signal on the analog tachometer while cranking the engine?**	Go to step 2.	Confirm tach link configured correctly. Engine mechanical problem, refer to **Section 3 - Engine Mechanical**.
2	Check the spark plug wires for open circuits, cracks in the insulation, or improper seating of the terminals at the spark plugs and coil tower. **Was a problem found?**	Locate and repair or replace. Retest the system.	Go to step 3.
3	Check for adequate spark at all of the spark plugs. **Was adequate spark present?**	Go to step 4.	Go to step 5.
4	Check the spark plugs for damage and wear. **Was a problem found?**	Replace with a new spark plug gapped correctly.	Go to step 10.
5	• Turn the ignition key switch on. • Using the DMT, check for B+ at the coil connector A. • Turn the ignition key switch off. **With the ignition key on, was B+ present?**	Go to step 6.	Locate and repair the open in the harness. Retest the system.
6	Check for continuity between the coil harness connectors B and C, and the coil driver harness connector D. **Was continuity present?**	Go to step 7.	Locate and repair the open in the harness. Retest the system.
7	• Turn the ignition key switch on. • Using the DMT, check for B+ at the coil driver harness connector A. • Turn the ignition key switch off. **With the ignition key on, was B+ present?**	Go to step 8.	Locate and repair the open in the harness. Retest the system.
8	Check continuity between the coil driver harness connector C and the engine ground. **Was continuity present?**	Go to step 9.	Locate and repair the open in the harness. Retest the system.
9	Check continuity between the coil driver harness connector B and the PCM connector pin A-4A. **Was continuity present?**	Replace the coil and coil driver. Retest the system.	Locate and repair the open in the harness. Retest the system.
10	• Disconnect the harness from the crankshaft position sensor (CPS). • Turn the ignition key switch on. • Using a DMT, check for 5 V at the harness connector. a. Connect the red meter lead to the gray wire (pin 3). b. Connect the black meter lead to the black/pink wire (pin 2). • Turn the ignition key switch off. **With the ignition key on, was 5 V present?**	Go to step 11.	Locate and repair the open in the harness. Retest the system.
11	Check continuity between CPS harness connector B and engine ground. **Was continuity present?**	Go to step 12.	Locate and repair the open in the harness. Retest the system.
12	Check continuity between CPS harness connector C and PCM harness connector B-4H. **Was continuity present?**	No problem found. Retest the system.	Locate and repair the open in the harness. Retest the system.

Troubleshooting Shift Problems

If hard shifting, chucking, or racheting is encountered when shifting into forward gear, refer to the remote control manual or to the appropriate sterndrive service manual for troubleshooting information.

PCM 112 Calibration Information

IMPORTANT: All of the following items are determined by the calibration of the PCM. Upgrading the calibration can result in changes to these settings. For additional information refer to the **PCM 112 Service Manual**.

Default Sensor Values

Default sensor values are preprogrammed amounts used by the PCM to calculate fuel and ignition values, when the sensor in question has exceeded its preprogrammed diagnostic limits. Default sensor values typically are used when the sensor has a circuit high or circuit low fault.

Most temperature sensors default to 0° C (32° F). This can be verified by unplugging the sensor in question and watching the data stream value with CDS G3.

Most pressure sensors also default to a preprogrammed number. MAP sensors, for example, usually default to 100 kPa (29.5 in. Hg). The default value for a given pressure sensor can be verified by unplugging the sensor and watching the data stream value.

Fault Conditions

Most faults can be detected either with the engine running or with the key on and the engine off. However, some faults can only be detected with the engine running. Examples of such faults include all injector faults (fuel and direct).

In addition, some faults are programmed to ignore certain engine speeds. For example, the low block pressure sensor fault (sea pump pressure on a MerCruiser) is typically not enabled until enough RPM has been achieved to develop a reasonable amount of water pressure. Therefore, this fault will not be set at idle.

Faults also take a certain time to set. The time it takes to set a fault varies greatly and can also vary with engine RPM. Faults generally set faster at higher engine speeds.

Sticky and Nonsticky Faults

All faults are classified as either sticky or nonsticky. Sticky means that the fault, once set, will continue to show up as active, even if the circuit or problem has corrected itself. A key switch cycle is required to reset a sticky fault.

A nonsticky fault is a fault that will change its status from active to inactive without requiring a key switch cycle.

CDS G3 will continue to display a sticky fault as active, even though the cause of the fault has been corrected. Cycle the key to reset all faults if there is difficulty correcting a fault.

OBD-M Faults

There are two classes of OBD-M faults, corresponding with the severity of the fault. An OBD-M 1 fault is one that requires immediate action, such as a TPS fault. An OBD-M 2 fault is one that will not endanger the engine or the occupant. OBD-M 2 faults are only set after a second occurrence and are used primarily for emissions control components.

OBD-M faults can be cleared with CDS G3. Refer to the **PCM 112 Service Manual** for further information on OBD-M faults.

CDS G3 Service Tool

Introduction

G3 is a standalone program that provides diagnostic support for select engines and Mercury joystick piloting systems. Additionally, all configuration functions necessary for preparing these systems for delivery are also supported. G3 allows for CAN-based multiple-processor communication through a clean, easy-to-navigate interface.

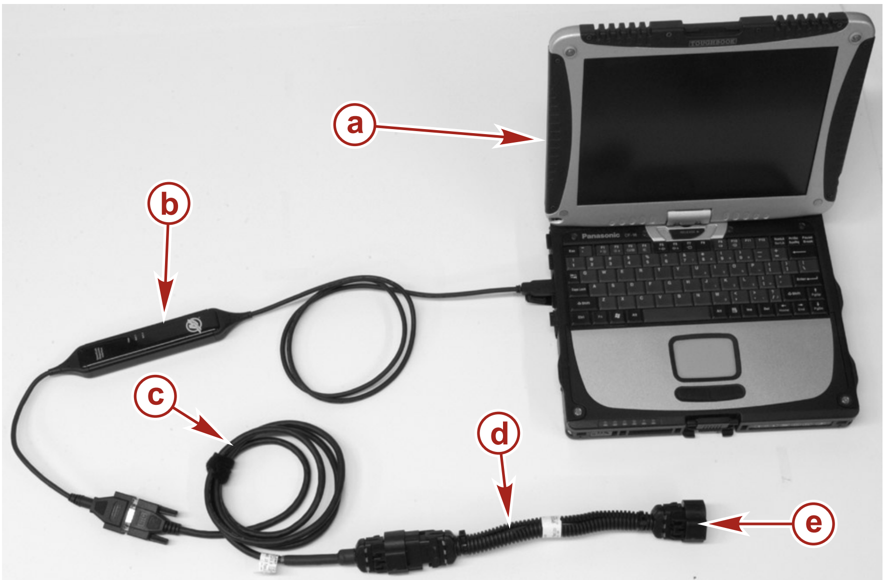
This manual assumes that you have successfully installed G3 on your computer and have updated it to the most current version. For installation instructions, refer to the user manual loaded onto the computer diagnostic system laptop (in the Windows® **Start** menu > All Programs > Mercury Marine > User Manual) or on the G3 software installation disc.

Connecting and Starting G3

Connection to the Engine

1. Insert the G3 SmartCraft diagnostic interface USB connector into a powered USB port on your computer.
2. Connect the SmartCraft diagnostic interface 9-pin connector to the CAN P/CAN H adapter harness 9-pin connector.
3. Connect the CAN P/CAN H adapter harness to the G3 engine harness adapter.
4. Remove the CAN P/CAN H termination resistor from the engine harness.
5. Connect the G3 engine harness adapter to the CAN P/CAN H engine harness connector.

IMPORTANT: The G3 engine harness adapter (84-8M0046081) provides the proper resistance for communication on CAN P and CAN H.



a - Computer
b - G3 SmartCraft diagnostic interface
c - CAN P/CAN H adapter harness
d - G3 engine harness adapter
e - Connect to the engine CAN P/CAN H connector

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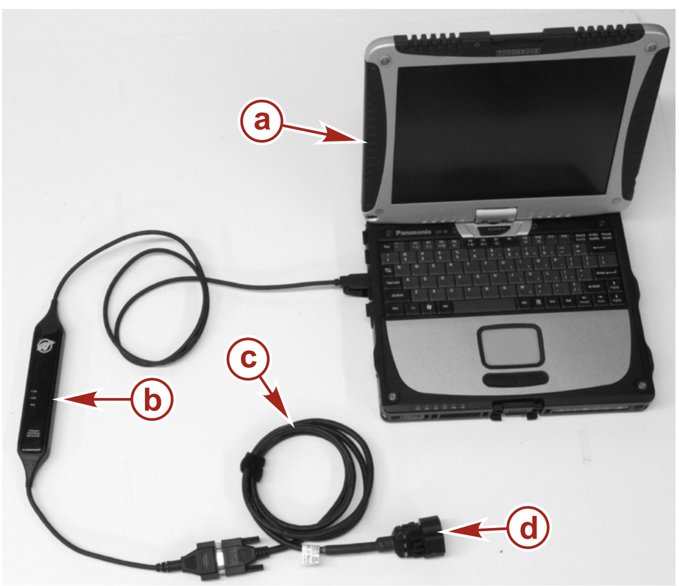
Connection to the Junction Box or Diagnostic Port

1. Insert the G3 SmartCraft diagnostic interface USB connector into a powered USB port.
2. Connect the SmartCraft diagnostic interface 9-pin connector to the CAN P/CAN H adapter harness 9-pin connector.
3. Connect the CAN P/CAN H adapter harness to the junction box or diagnostic port.
   IMPORTANT: Ensure that the correct termination resistors are installed on the CAN P and CAN H buses. The CAN P and CAN H buses must be properly terminated for the tool to communicate. Improper termination will result in communication errors or complete loss of communication.

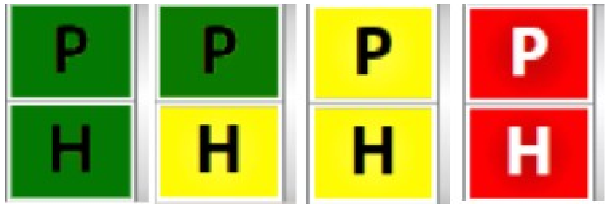


a - Computer
b - G3 SmartCraft diagnostic interface
c - CAN P/CAN H adapter harness
d - Connect to junction box or diagnostic port

47946

Starting G3

With the G3 computer correctly connected to the vessel's CAN P bus and the G3 program running, turn the key to the on position. The CAN P indicator should turn green, indicating that CAN traffic exists between the PCM and the computer.



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CAN traffic indicators

The CAN indicators will let you know the communication status on CAN P and CAN H.

Green—The computer is communicating on the CAN bus.

Yellow—The computer is communicating with the cable but no data is being received on the CAN bus.

Red—The computer is not connected to the SmartCraft diagnostic interface cable.

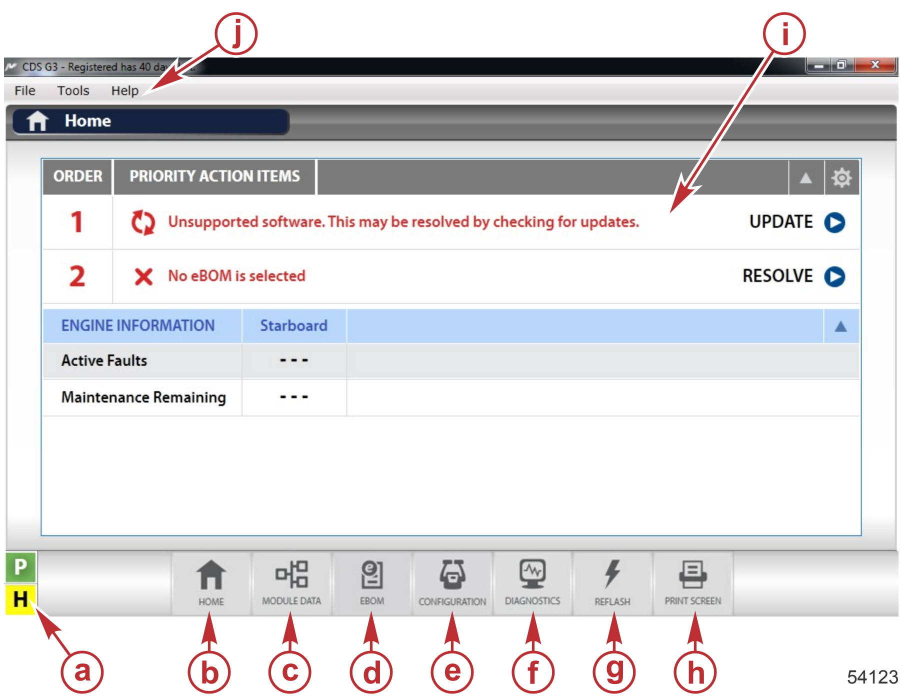
If G3 Does Not Communicate with the Engine

If the G3 CAN P traffic indicator is green, the cable is communicating properly with the G3 program and the CAN bus it is mapped to.

If the G3 CAN P traffic indicator is red or yellow, then there is a communication issue. Refer to the user manual loaded onto the computer diagnostic system laptop (in the Windows® **Start** menu > All Programs > Mercury Marine > User Manual) or on the G3 software installation disc.

CDS G3 Service Tool Home Screen Overview

The CDS G3 service tool home screen is your main menu for selecting the major tasks you wish to perform or data you wish to view. Each of these choices will open up additional menus and screens for you to choose from.



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Home screen
- a - CAN traffic indicators
- b - **Home** screen button
- c - **Module Data** button
- d - **EBOM** button
- e - **Configuration** button
- f - **Diagnostics** button
- g - **Reflash** button
- h - **Print Screen** button
- i - Priority action items—issues that need to be resolved
- j - Tool bar, including **File**, **Tools** (options, updates, registration), and **Help**

CAN traffic—These indicators show whether the SmartComms diagnostic interface is communicating on the CAN P and CAN H buses.

Home screen—This button is used to return to the home screen. Refer also to **Priority Action Items**.

Module Data—This screen displays all pertinent information about each module found on the CAN bus: the module status, type of module, CAN City ID, the CAN bus it is on, calibration ID, and any general information available on the module.

EBOM—An electronic bill of materials (eBOM) is a list of all the information needed to communicate with a module or system. A specific eBOM is needed for each type of engine or system that the tool is capable of communicating with. If the interface cable is connected and the ignition key is on, the system will automatically detect the most compatible eBOMs and put them at the top of the list of available eBOMs. If an eBOM is not selected, the functionality of the tool is limited.

Configuration—This part of the tool is used to set up new engines or systems. For example, the configuration screens are used to configure the levers of an electronic remote control (ERC).

Diagnostics—These special functions allow the user to command the module to perform certain operations, such as actuating a fuel injector on the connected engine.

Reflash—Reflash is the reprogramming of a module with a newer or improved calibration. Not all modules can be reflashed.

Print Screen—This tool is used to print the data being displayed by the tool at any given time. The print function creates a pdf file of the screen, not an actual piece of paper. The pdf file can be used to review and print a physical copy whenever desired. The file location can be specified under the **Options** tab.

Priority Action Items—Once G3 establishes communication with the engine controller and the program is started, the **Home** screen will appear and list any priority action items that need to be resolved before proceeding.

CDS G3 Fault List

IMPORTANT: For additional information on troubleshooting faults, refer to the PCM 112 Service Manual.

Notes:

Removal and Installation

Section 2A - Removal

2
A

Table of Contents

Preparation

1. Remove the boat from the water.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

2. Disconnect the battery cables from the battery.

   NOTE: The sterndrive must be removed before removing the engine.

3. Remove the sterndrive. (Refer to the appropriate sterndrive service manual.)
4. Disconnect propshaft on TowSport and inboard models.
5. Remove the engine cover.

Disconnecting the Fluid Systems

Fuel Hose

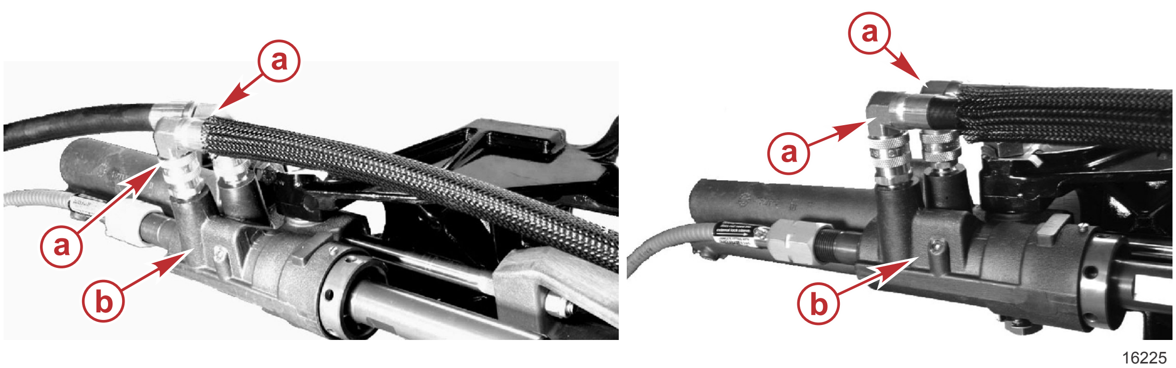
⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Close the fuel shut-off valve, if equipped.
2. Loosen the hose clamp retaining the fuel line to the fuel inlet.
3. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.

Steering Hoses (Sterndrive)

1. Disconnect the hydraulic hoses from the steering actuator.



Typical power-assisted steering connections

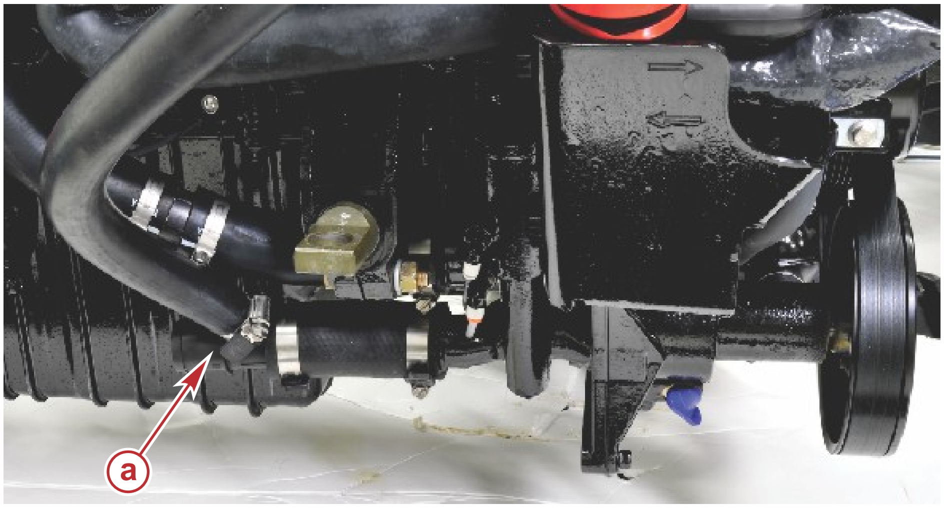
a - Hydraulic hoses

b - Power-assisted steering actuator

2. Plug or cap all open fittings to prevent contamination and loss of fluid.

Seawater Hoses

Disconnect the seawater hose on all models.



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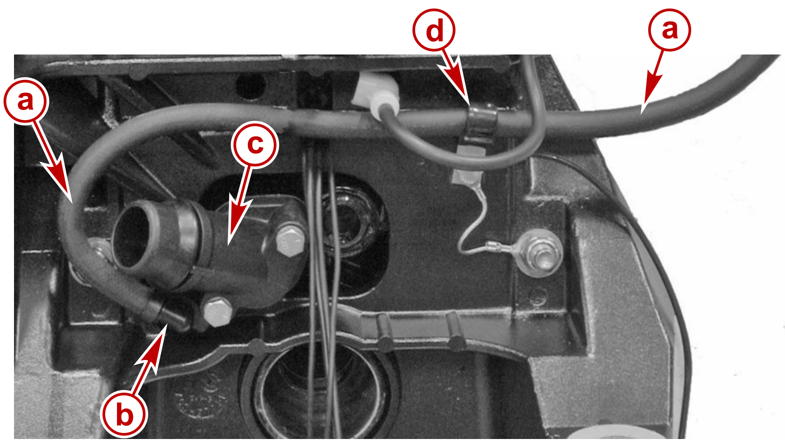
Typical 6.2L seawater pickup

a - Seawater inlet hose connection

Gear Lube Monitor (Sterndrive)

1. Disconnect the gear lube monitor from the transom.

   NOTE: The quick-disconnect shown below is located at the transom. Some models have a quick-disconnect fitting in the gear lube monitor hose closer to the engine. It may be more convenient to disconnect the hose at this alternate location.



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Typical Bravo drive connection

a - Hose

b - Quick-disconnect 90° fitting

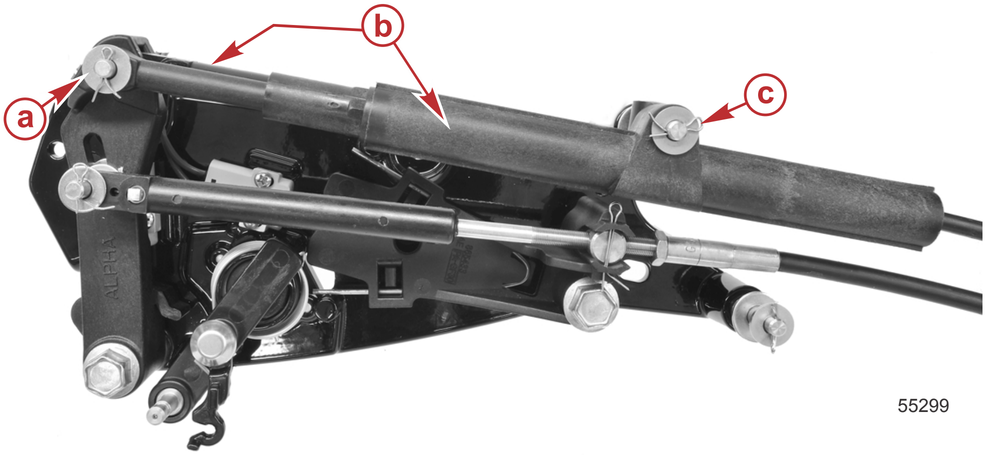
c - Seawater inlet fitting

d - J-clip

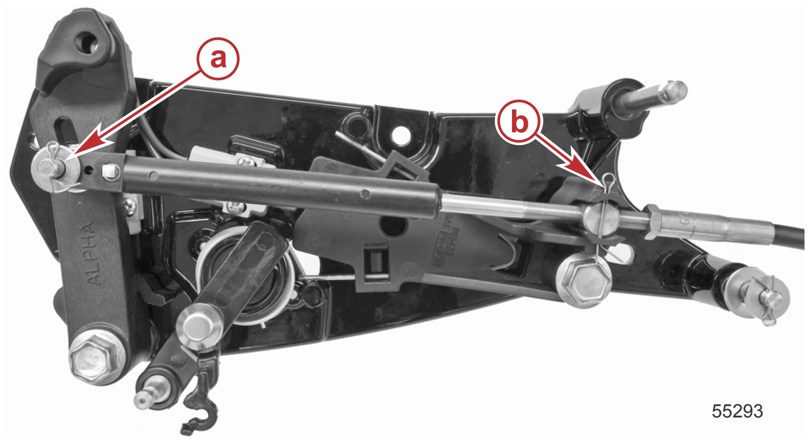
2. Place the hose out of the way.

Disconnecting the Shift Cable and Throttle Cable

1. Disconnect the remote control shift cable from the shift plate and retain the hardware.



a - Washer and cotter pin securing clevis pin
b - Remote control shift cable and shift-assist assembly
c - Washer and cotter pin



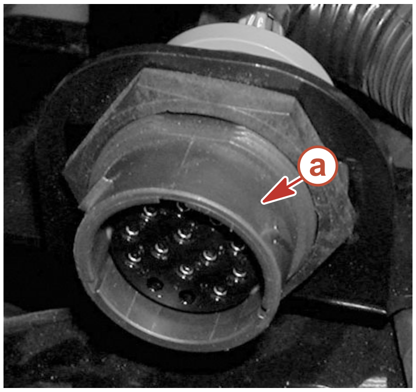
Without shift-assist assembly
a - Washer and cotter pin
b - Cotter pin

2. Disconnect the intermediate shift cable from the shift plate, and retain the hardware.

Throttle cable
a - Throttle demand sensor pin clip
b - Throttle stop
c - Washer and cotter pin

Disconnecting the Electrical Components

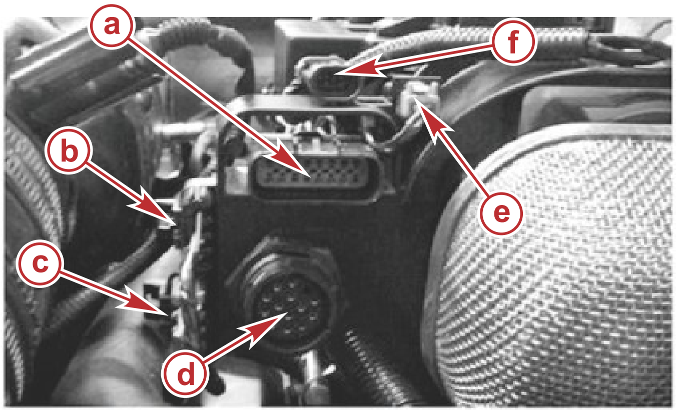
1. Turn the locking ring on the 14-pin connector, and remove the boat harness from the engine harness connector.



23135

a - Engine harness connector

2. If equipped, disconnect the transom harness 16-pin connector from the engine harness.
3. If equipped, disconnect the tank level connector from the engine harness.
4. If equipped, disconnect the depth transducer from the data link connector (DLC) on the engine harness.
5. Disconnect any ground wires and accessories that are connected to the engine.



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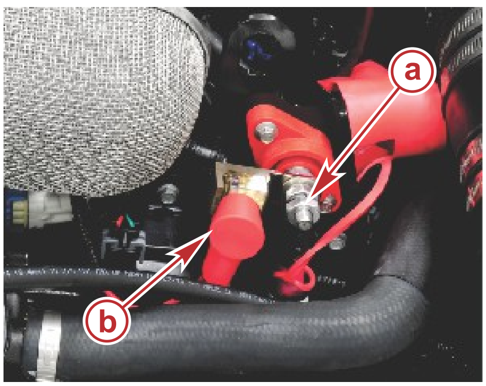
a - 16-pin transom harness
b - Onboard diagnostics - marine (OBD-M) light connector
c - Tank level connector
d - 14-pin engine harness connector
e - OBD-M MIL light
f - 7A clean power



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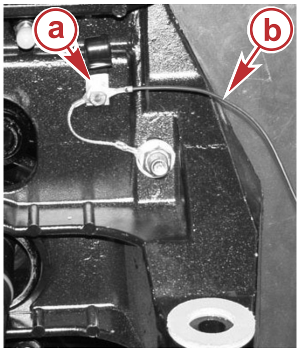
a - Hot stud
b - 90-amp fuse

Continuity Wire Removal (Sterndrive)

Disconnect the continuity circuit wire that runs from the engine to the transom assembly.

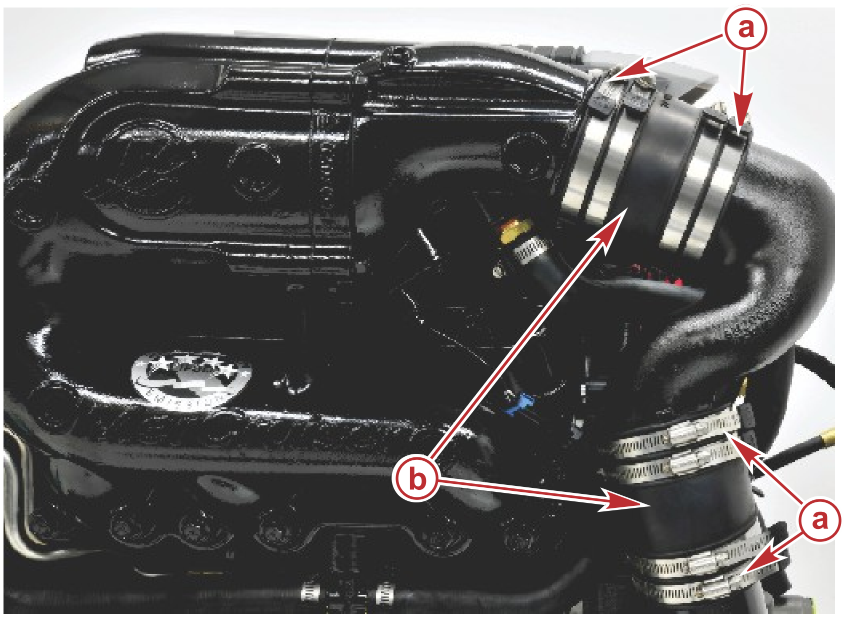


57238

a - Bonding strap screw
b - Continuity circuit wire

Removing the Engine

1. Loosen the exhaust tube hose clamps on the exhaust elbow, Y-pipe shown.



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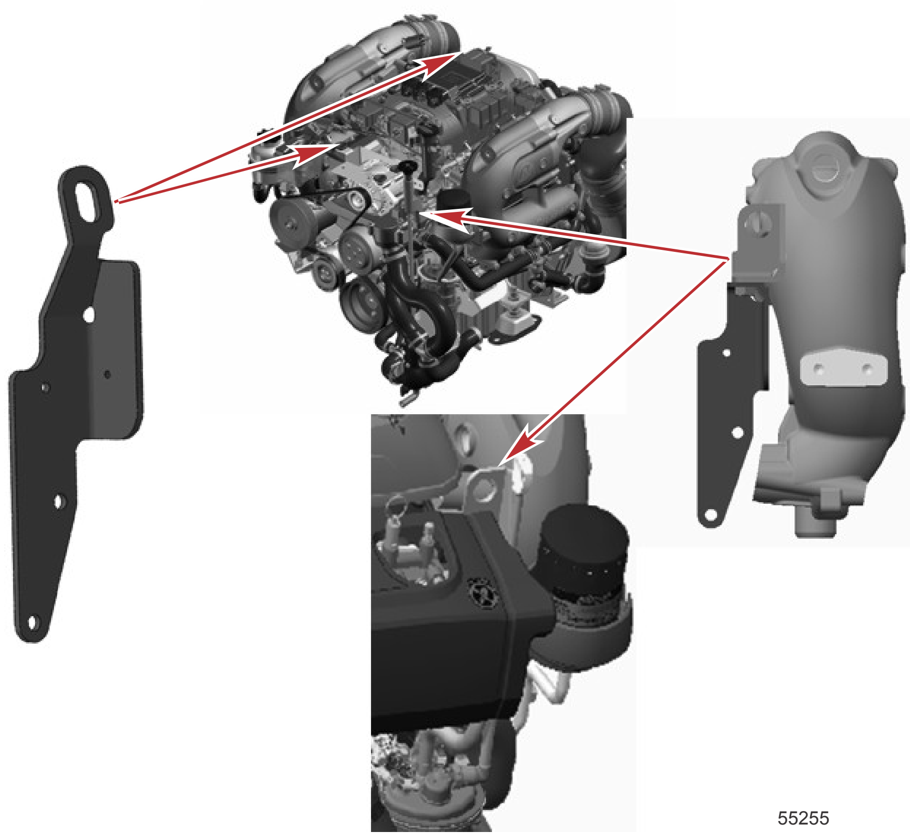
a - Two hose clamps at each exhaust connection point
b - Exhaust tube

> **⚠ CAUTION**
>
> **Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.**

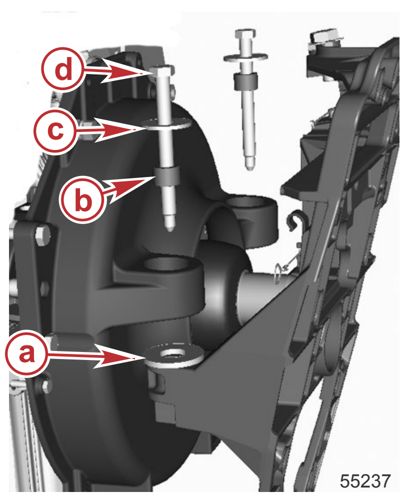
IMPORTANT: Engine compartment size may necessitate the removal of additional components.

2. On models with a driveshaft extension:
   a. Remove the bolts and nuts securing the engine-end top driveshaft shield.
   b. Remove the top shield.
   c. For reference during assembly, scribe a mark across the yokes for the driveshaft U-joint and the bearing support U-joint (output flange).
   d. Remove the bolts securing the driveshaft to the bearing support U-joint yoke.
   e. Separate the driveshaft from the bearing support yoke.

3. Support the engine with a suitable sling through the lifting eyes on the engine. Using the rear lifting eye and the opposite side front lifting eye, maintain a minimum 26 inches on each length or use a spreader bar so that no components are damaged.

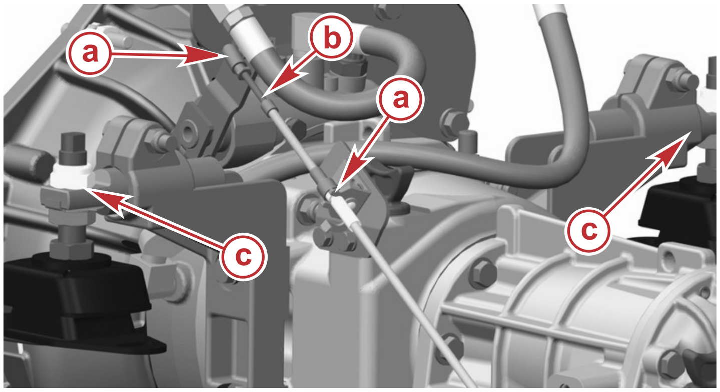


4. Remove the two rear engine mount bolts on sterndrive models.



- **a -** Rubber washer
- **b -** Spacer
- **c -** Washer
- **d -** Bolt

5. On TowSport and inboard models remove shift cables at the transmission.



59853

45 IV transmission shown, others similar

a - Shift cable pivot points
b - Shift cable guide
c - Mounts

6. Remove the mounts at the transmission.
7. Remove the transmission assembly.
8. Remove the fasteners (for example, lag bolts) that hold the front mounts to the engine bed. Retain the fasteners and hardware.

57182

a - Lag bolt (with washers)

9. Removal of water-cooled shaft log seal connection for TowSport and inboard models.
10. Carefully remove the engine. Do not damage the power-assisted steering control valve.

Removal and Installation

Section 2B - Installation

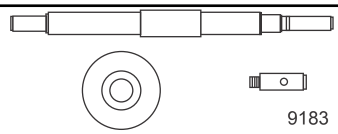
2
B

Table of Contents

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Coupler splines	8M0071842
	Loctite Silver Graphite Anti-Seize Spray	Front mount studs	92-898101390
	Battery connection sealant	Battery terminal connections	Obtain Locally
9	Loctite 567 PST Pipe Sealant	After the first thread of the audio warning temperature switch	92-809822
19	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02
25	Liquid Neoprene	Battery terminals	92- 25711 3
		All electrical connections	
		Exposed terminals and connections	
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally

Special Tools

Alignment Tool Assembly	91-805475A 1
 9183	Aligns the engine and the sterndrive unit during installation.

Shift Cable Adjustment Tool	91-12427T
 9186	Attaches over the shift cable, and aids in proper shift cable adjustment at the shift plate.

Dual Water Pick-up Flush Seal Kit	91-881150K 1
 9194	Blocks off the front water inlet holes on the dual water inlet gearcases.

Flushing Attachment	91-44357Q 2
 9192	Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.

Flushing Kit	91-849996T 1
 9195	Use for flushing gearcases with low water inlets.

Torque Specifications

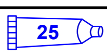
NOTE: Securely tighten all fasteners not listed below.

Description	Nm	lb-in.	lb-ft
Speedometer pickup barb fitting	1.5	13.5	–
Power steering hydraulic hose fittings	34	–	25
Power trim pump hose fittings	14	123.9	–
Rear engine mounts	47	–	34.7
Steering cable coupler nut	47	–	34.7
Pivot bolts	34	–	25
Water inlet block-off screws	5	44.3	–
Trim cylinder bolt	23	–	17
Trim cylinder end cap	61	–	45
Seawater inlet nut	47	–	34.7
Exhaust tube clamps	4	35.4	–
Hose clamps	4	35.4	–
Mounting clip screw	12	106.2	–
Fuel line connectors	23	–	17
Battery stud	9	79.6	–
Flame arrestor clamp nut	4	35.4	–

Preparation

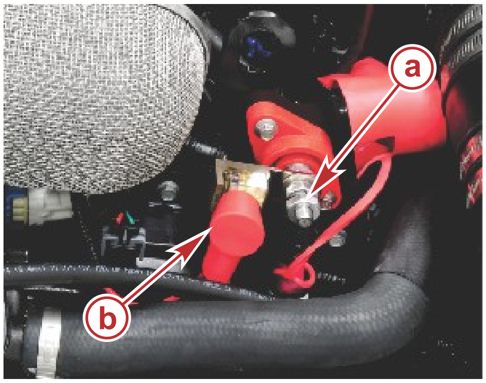
1. Connect the battery cables to the engine. Observe the following:
   a. Ensure that the grounding stud and hot stud terminal are free of paint or any other material that could cause a poor electrical connection.
   b. Install the battery positive (+) cable directly to the hot stud.
   c. Install the negative (–) battery cable to the ground stud on the flywheel housing.
   d. After the battery cables are connected, apply a thin coat of Liquid Neoprene to the terminals.

Description	Nm	lb-in.	lb-ft
Battery stud	9.5	84	–

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Battery terminals	92- 25711 3

   e. Slide the rubber boot over the positive (+) terminal after making the connection.
2. Temporarily lay the battery cables over the top of the engine to prevent interference during installation.

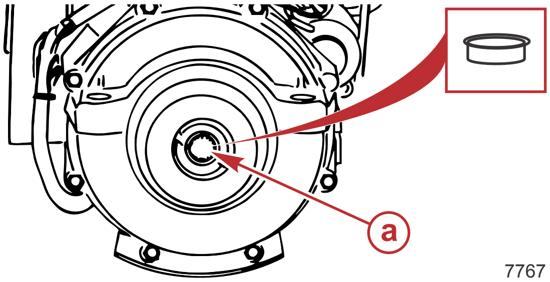
IMPORTANT: There is a fuse located next to the hot stud. Do not remove this fuse.



56282

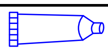
a - Hot stud
b - 90-amp fuse

3. If not already done, remove the shipping plug from the coupler and lubricate the splines with Extreme Grease.



7767

a - Shipping plug

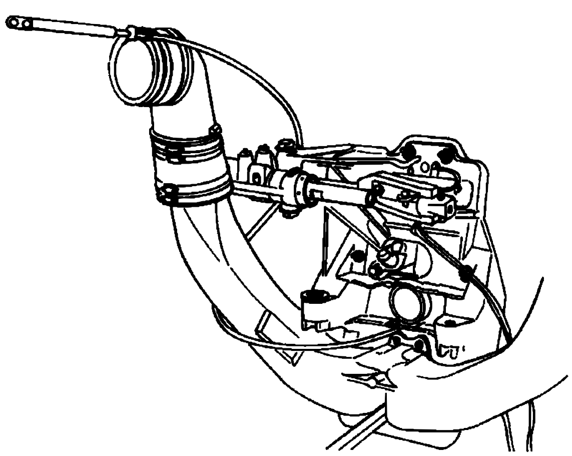
Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Coupler splines	8M0071842

Shift Cable Routing

Route the intermediate shift cable from the transom assembly to the shift actuator as follows:

1. The cable should come through the transom, above the exhaust pipe and turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing.
2. The cable should then be routed under the starboard rear engine mount and turn toward the transom.
3. The cable should then go up behind the power steering valve and loop over to the shift actuator on the engine.

NOTE: Following this routing will prevent the engine coupler from damaging the cable.

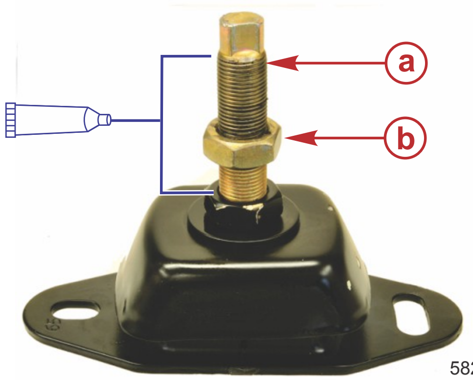


8995

Engine Installation and Alignment (Sterndrive)

1. Clean the threads on the front mount studs.
2. Apply Loctite Silver Graphite Anti-Seize Spray to the entire length of the stud threads.
   IMPORTANT: Do not use any other type of anti-seize compound on the stud threads.

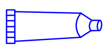
3. Install the front mount adjustment nuts midway on the studs so that adequate up and down adjustment exists for engine alignment.



58233

Front mount

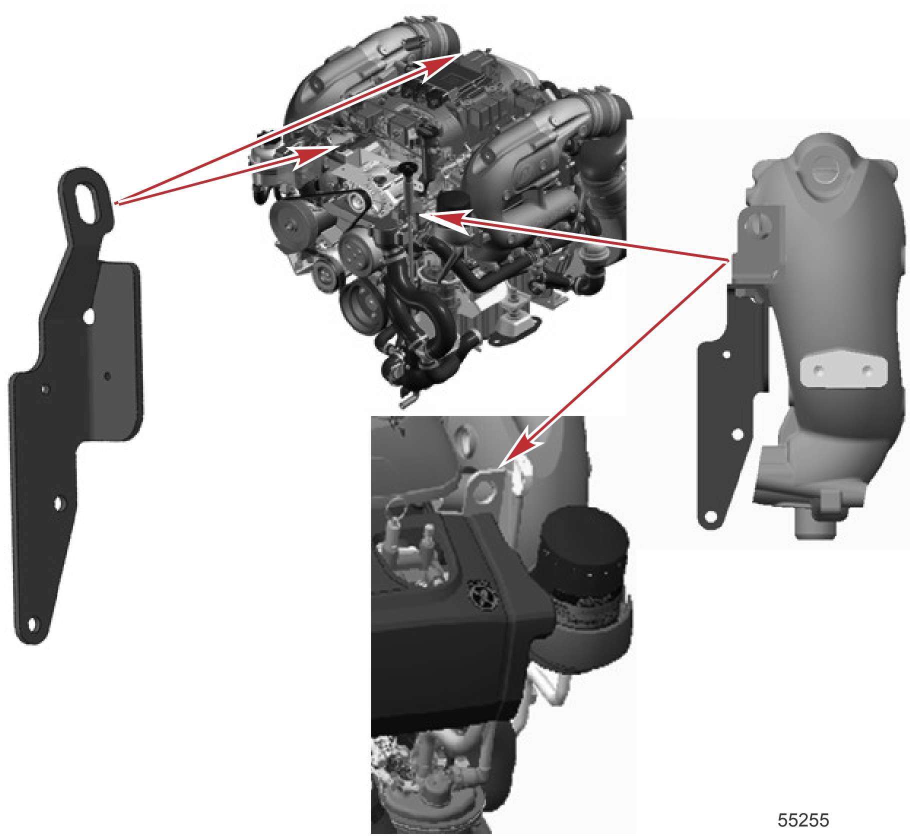
a - Front mount stud
b - Adjustment nut

Tube Ref No.	Description	Where Used	Part No.
	Loctite Silver Graphite Anti-Seize Spray	Front mount studs	92-898101390

⚠ CAUTION

Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

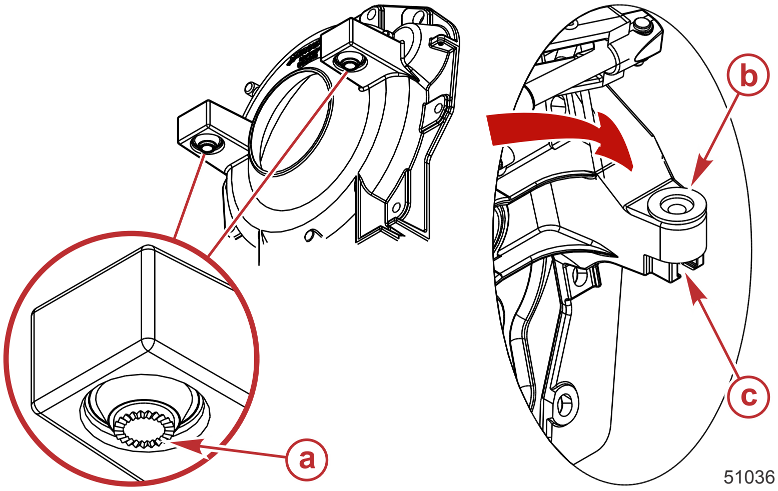
4. Attach a suitable sling, lifting corner to corner across the engine and lifting arm to the engine lifting eyes and adjust it so that the engine is level when suspended.


55255

IMPORTANT: Maintain a minimum 66 cm (26 in.) on each length or use a spreader bar so that no components are damaged.

5. Lift the engine into position in the boat using an overhead hoist.
IMPORTANT: When lowering the engine into position do not set the engine on the shift cable.

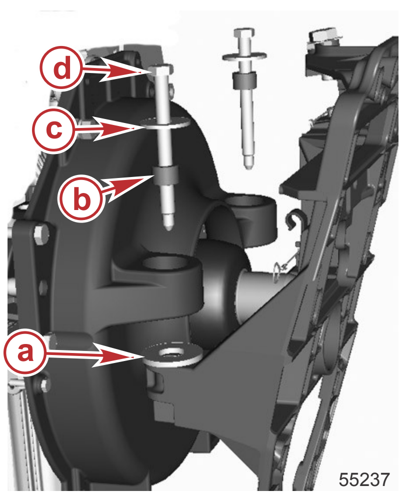
6. Ensure that the fiber washers and locknuts are on the inner transom plate mounts.



Starboard side shown, port side similar

a - Knurled surface
b - Fiber washer
c - Locknut (not shown)

7. Lower the engine and align the rear engine mounts with the inner transom plate mounts. Align the exhaust elbow with the exhaust tube. Then, set the engine onto the inner transom plate mounts, simultaneously connecting the exhaust elbow bellows with the exhaust tube. Do not relieve the hoist tension.
   IMPORTANT: Engine mounting hardware must be installed in the order shown.
8. Using the hardware as shown, install and tighten both rear engine mounting bolts to the specified torque.



a - Rubber washer
b - Spacer
c - Washer
d - Bolt

Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	47	–	34.7

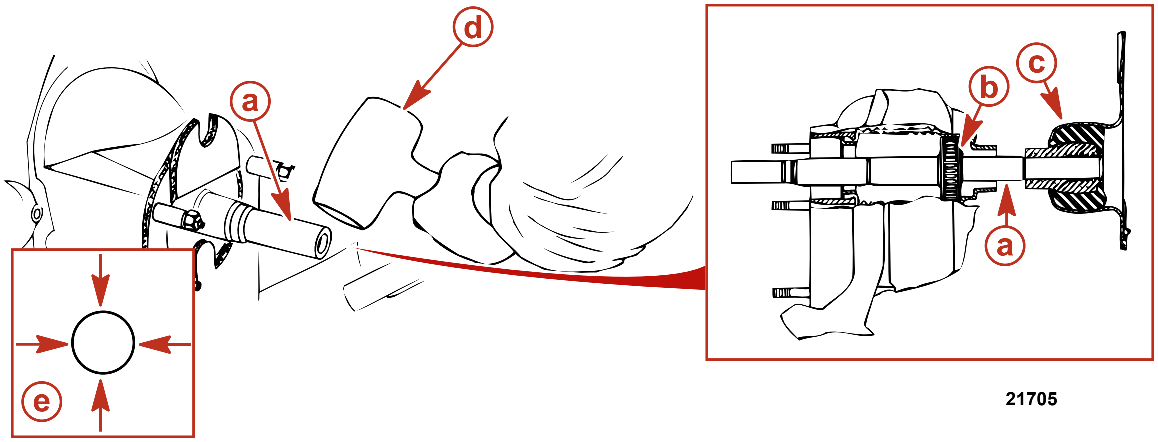
9. Adjust the front engine mounts until they rest on the boat stringers.
10. Set the engine on the boat stringers.
11. After the alignment is set, turn the front mount adjusting nuts two full turns up.
    NOTE: This compensates for the softer front mount when weight is applied.
12. Relieve the hoist tension entirely and fasten both mounts to the boat stringer using the appropriate hardware.
13. Disconnect the sling from the engine lifting eyes.
    IMPORTANT: Alignment tools from other manufacturers may cause improper alignment and damage to the gimbal bearing or engine coupler. Use only the Mercury alignment tool.

NOTICE

Improper use of the alignment tool may result in personal injury or damage to the gimbal bearing or engine coupler. Do not operate the engine with the alignment tool installed. Do not attempt to force the alignment tool, raise or lower the engine with the tool inserted in the gimbal bearing or engine coupler, or raise the engine mount bracket above the top of the engine mount stud.

14. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.

15. If necessary, firmly strike the sides of the alignment tool with a synthane hammer at 90° increments to help align the gimbal bearing to the coupler.

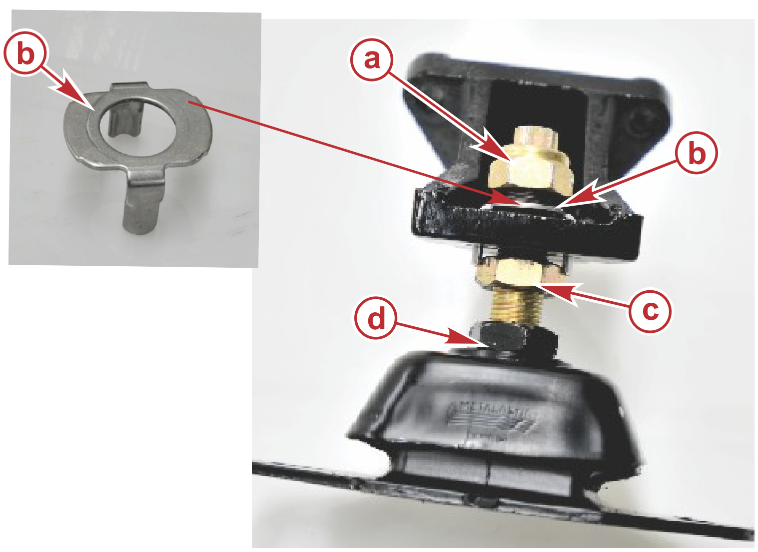


21705

a - Mercury alignment tool
b - Gimbal bearing
c - Engine coupler
d - Synthane hammer
e - 90° increments

Alignment Tool Assembly	91-805475A 1

16. If the alignment tool does not fit, remove it and carefully adjust the front engine mounts:
IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in the direction required to align the engine.
    a. To adjust the engine up or down, loosen the locknuts on both front mounts. Turn the adjustment nuts as necessary.



57135

a - Nylock top nut
b - Lock collar
c - Adjustment nut
d - Jam nut

NOTE: Do not use the jam nut at anytime for adjustment.

    b. When the alignment is correct, insert the lock collar and tighten the nylock top nut.
    c. If alignment has to be adjusted, the nylock top nut must be almost completely removed so that the lock collar can be lifted above the adjustment nut.

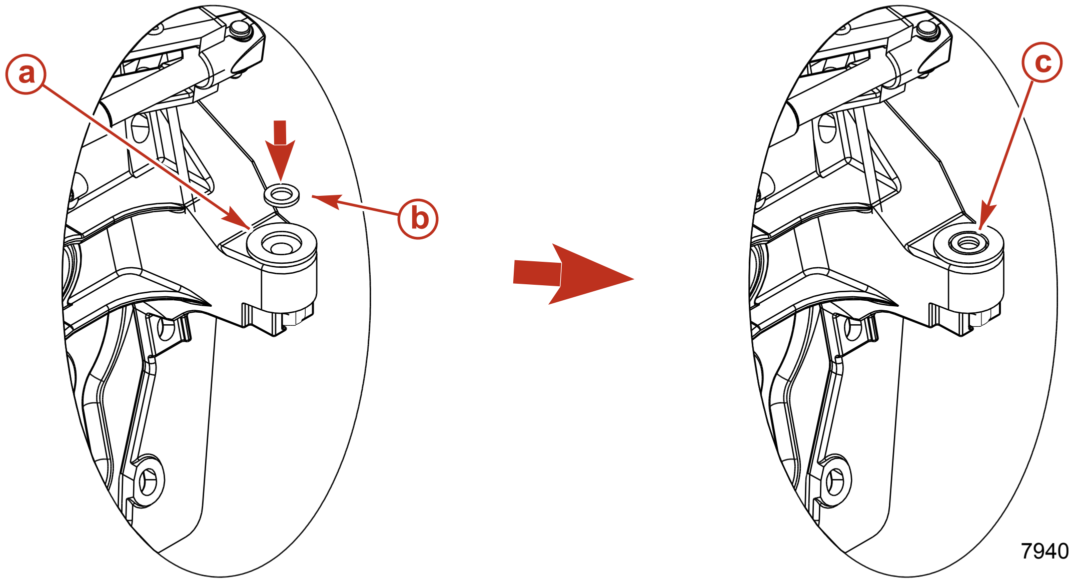
17. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
NOTE: A spacer kit (12-892619A01) is available to raise the rear of the engine. This kit is only necessary if alignment cannot be obtained with the normal adjustment. If the front or side mounts are lowered fully and the front of the engine needs to be lowered more to obtain alignment, the spacer kit can be installed in the rear mount to raise the rear of the engine.

18. On models where the front engine mounts cannot be lowered enough to allow for proper engine alignment:
    a. Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that the engine is level when suspended.

b. Remove the rear engine mounting bolts and hardware.

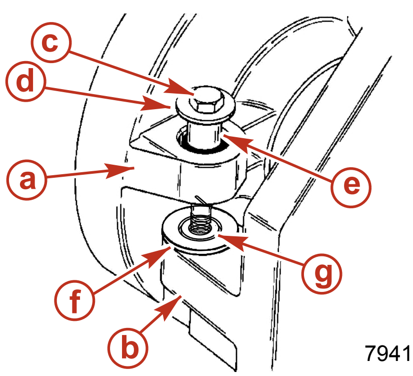
c. Using an overhead hoist, lift the engine enough to install a stainless steel washer inside the inner diameter of both fiber washers.

NOTE: This will position the washer between the new engine mount and the transom mounting support, raising the engine slightly for additional front mount adjustment.



a - Fiber washer
b - Steel washer
c - Corrected mount area

d. Using the appropriate hardware as shown, install and tighten both rear engine mounting bolts to the specified torque.



a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer
g - Steel washer

Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	51	–	37.6

e. Set the engine on the boat stringers.

f. Relieve the hoist tension.

g. Disconnect the sling from the engine lifting eyes.

19. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
20. Repeat the necessary steps until the alignment tool easily slides (freely with two fingers) all the way into and out of the engine coupler splines. Do not check by turning the alignment tool.
21. Fasten the front mount assemblies to the boat stringers using the appropriate hardware.
22. Tighten both front mount locking (jam) nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Front mount locking (jam) nuts	80	–	59

23. Recheck the alignment with the alignment tool. The tool must enter the coupler splines freely. If not, remove the alignment tool and readjust the front mounts.

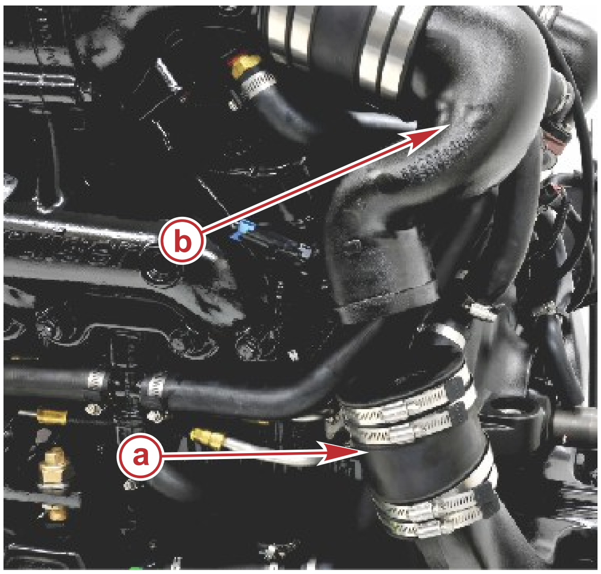
24. Remove the alignment tool.
25. If operating in a saltwater environment, apply Perfect Seal to the threads and nuts of the engine mounting hardware to help protect against corrosion. This will allow for easier loosening in the future, if readjustment becomes necessary.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02

NOTICE

Hot spots in exhaust hoses can damage hoses and cause leaks. Ensure that discharge water from the exhaust elbow flows without restriction through all hoses and fittings.

26. Align the exhaust tubes.



56296

Typical
a - Exhaust tube
b - Intermediate exhaust elbow

IMPORTANT: Exhaust hoses and tubes must be secured at each connection with at least two hose clamps.

27. Securely tighten all exhaust hose or exhaust tube clamps.

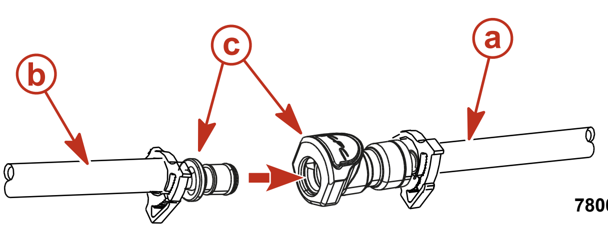
Description	Nm	lb-in.	lb-ft
Tridon® hose clamp (exhaust tube)	4–4.7	35.4–41.6	–

Connecting the Fluid Systems

Gear Lube Monitor Connection

IMPORTANT: Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. Avoid kinks, and route the hose in a straight path to avoid low spots (traps) in the system.

1. Position the gear lube monitor quick connect at the rear of the engine.
2. Position the gear lube monitor quick connect at the transom.
   IMPORTANT: The hose must not come in contact with the steering system components, engine coupler, U-joint shaft, or driveshaft.
3. Fasten the quick connect.



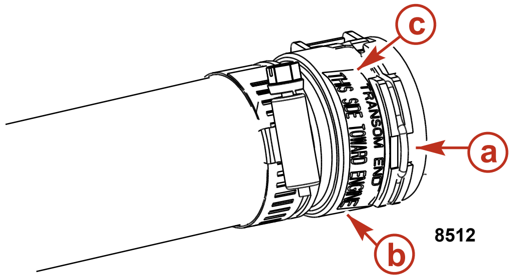
7800

a - Gear lube monitor hose assembly from transom
b - Gear lube monitor hose assembly from gear lube monitor
c - Quick-connect fitting

Bravo Seawater Inlet Fitting Connection

NOTE: The retainer clip must be in the closed position prior to installation.

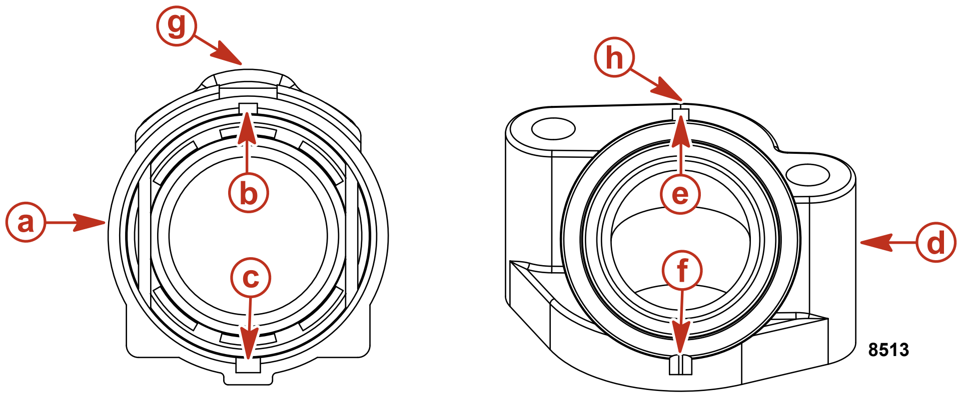
1. Install the seawater inlet hose assembly to the water inlet fitting.
   a. Position the retainer clip in the closed position.



Seawater inlet hose assembly

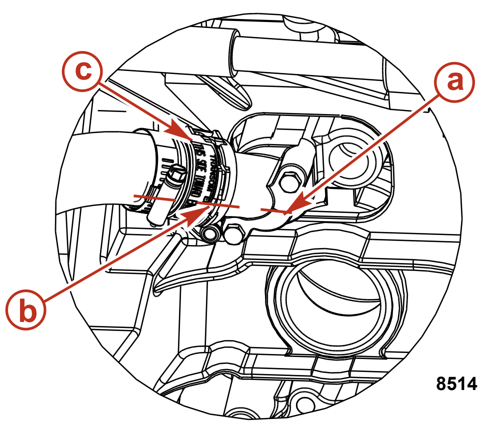
a - Retainer clip closed
b - Quick connect fitting
c - Hose decal

   b. Position the seawater inlet hose assembly with the center of the retainer clip and the hose decal toward the engine.
      IMPORTANT: Tabs and slots are sized to mate only at the correct orientation. Mate the small tab with the small slot.
   c. Align the slots of the quick connect fitting to the tabs of the water inlet fitting.



a - Quick connect fitting
b - Small slot
c - Large slot
d - Seawater inlet fitting
e - Small tab
f - Large tab
g - Center of retainer clip (toward engine)
h - Centerline of water inlet fitting (toward engine)

   d. Ensure that the center line of the water inlet fitting and the center of the retainer clip are positioned toward the engine.
2. Push the seawater inlet hose assembly onto the water inlet fitting until they are connected.
   NOTE: The retainer clip snaps into place and assumes the closed position when properly connected.

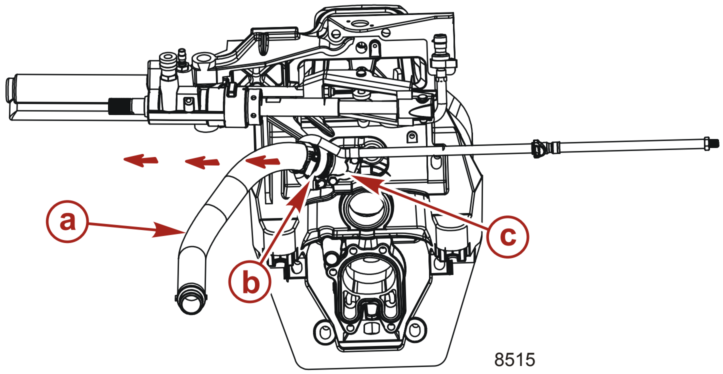


Shown with engine removed for visual clarity

a - Centerline of water inlet fitting
b - Retainer clip in closed position
c - Hose decal

3. Perform a pull test on the water hose quick connection.

a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 N (25 lbf). If the seawater inlet hose does not become separated from the seawater inlet fitting when force is applied, the seawater inlet hose is connected and sealed properly.



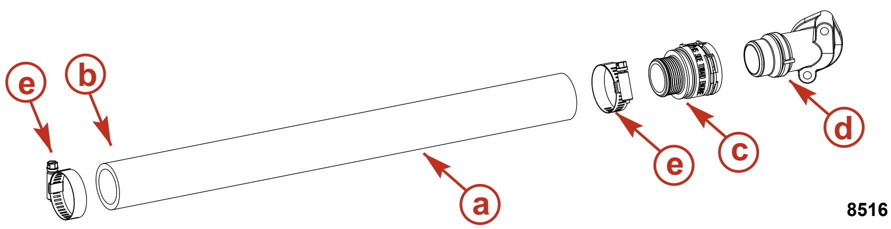
Shown with engine removed for visual clarity
- a - Seawater inlet hose
- b - Quick connect fitting
- c - Seawater inlet fitting

b. If the seawater inlet hose does become separated from the seawater inlet fitting, reinstall as specified.

c. When all steps have been completed, check for any leaks at this connection.

4. Connect the seawater inlet hose to the engine seawater pump.

NOTE: The seawater inlet hose connects to the engine and the transom.

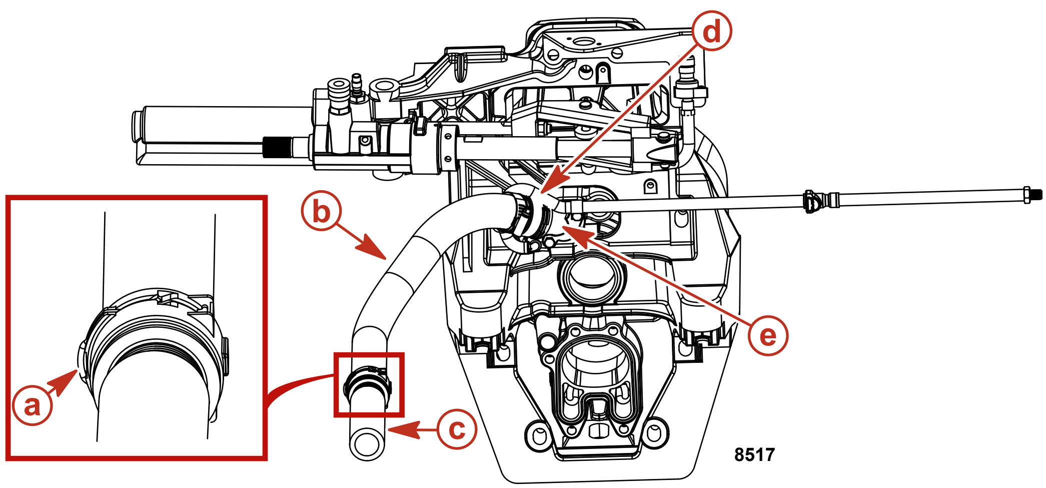


Seawater inlet hose assembly
- a - Seawater inlet hose
- b - To engine
- c - Quick connect fitting
- d - Seawater inlet fitting
- e - Hose clamps

5. Models using the seawater extension hose assembly:

NOTE: The seawater inlet hose connects to the engine and the transom. The seawater extension hose assembly connects to the transom and the seawater inlet hose.

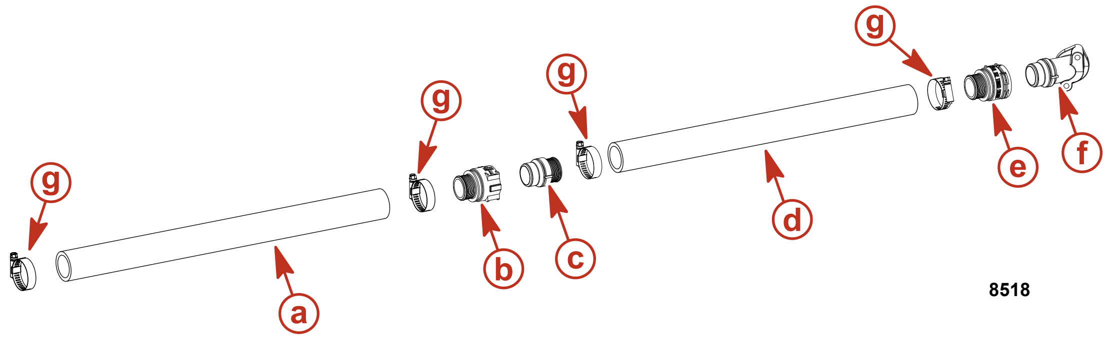
a. When connecting the seawater extension hose assembly to the seawater inlet hose assembly, position the center of the retainer clip away from the engine.



Shown with engine removed for visual clarity
- a - Retainer clip position (away from engine)
- b - Seawater extension hose
- c - Seawater inlet hose (to engine seawater pump)
- d - Quick connect fitting (to seawater inlet fitting)
- e - Seawater inlet fitting (to transom)

b. Perform a pull test at the seawater inlet connection to ensure that the seawater inlet hose is connected properly.

NOTE: The seawater extension hose assembly connects to the transom and the seawater inlet hose.

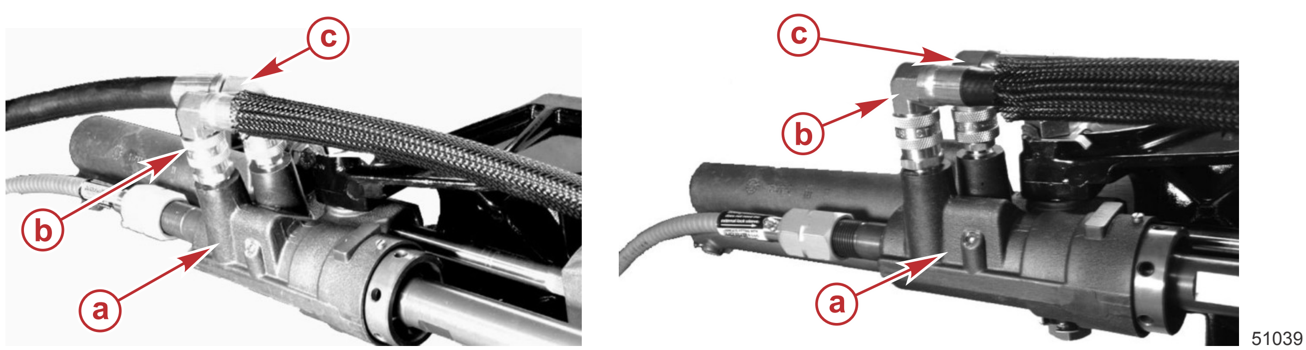


- **a -** Seawater inlet hose
- **b -** Quick connect fitting to extension hose
- **c -** Quick connect male fitting
- **d -** Extension hose
- **e -** Quick connect fitting to seawater inlet fitting
- **f -** Seawater inlet fitting
- **g -** Hose clamp

Power-Assisted Steering Hoses

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaks.

1. Route the hoses to avoid contact with the steering system components.
2. If required, use extra hose clips to secure the hoses to the transom.
3. On models with quick-connect fittings, connect the power-assisted steering hoses to the actuator. Ensure that the quick-connect fittings snap into place.



- **a -** Power-assisted steering actuator
- **b -** High-pressure hydraulic supply hose
- **c -** Low-pressure hydraulic return hose

4. On models without quick-connect fittings, connect the power-assisted steering hoses to the actuator. Tighten both fittings to the specified torque.

Description	Nm	lb-in.	lb-ft
Low-pressure hydraulic return hose fitting	34	–	25
High-pressure hydraulic hose fitting	54	–	40

NOTE: Ensure that the steering fluid level is correct before first operation.

Speedometer and Pitot Connections

Refer to the appropriate sterndrive service manual for details on connecting the speedometer and pitot sensor.

Bravo Shift Cable Installation and Adjustment

Bravo Models Shift Cable Installation

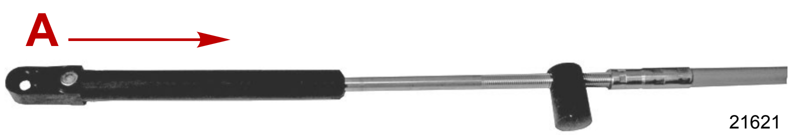
IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables.

IMPORTANT: Sterndrive propeller rotation is determined by the shift cable installation in the remote control.

- Bravo One/Two - If the shift cable end guide moves in direction A when the remote control lever is placed into forward, remote control is set up for right-hand (RH) propeller rotation.
- Bravo One/Two - If the shift cable end guide moves in direction B when the remote control lever is placed in forward, the remote control is set up for left-hand (LH) propeller rotation.

Arrow indicates direction of motion

- Bravo Three - The front propeller on the sterndrive is always left-hand rotation and the rear propeller is always right-hand rotation. The shift cable end guide must move in direction A when the remote control lever is placed into forward gear position.

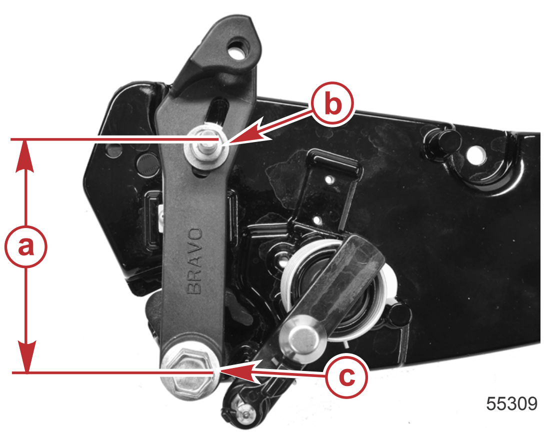


Bravo Models Remote Control Shift Cable Adjustment

NOTE: The shift cable adjustment tool (91-12427T) should be used to adjust the remote control shift cable, with or without the sterndrive installed.

Shift Cable Adjustment Tool	91-12427T

1. Remove the adjustment tool.
2. Measure the distance from the center of the shift arm pin to the center of the pivot bolt. This distance must be exactly 76 mm (3.0 in.). If the dimension is not correct, loosen the shift arm pin nut and move the pin to the specified measurement. Tighten the nut to the specified torque.



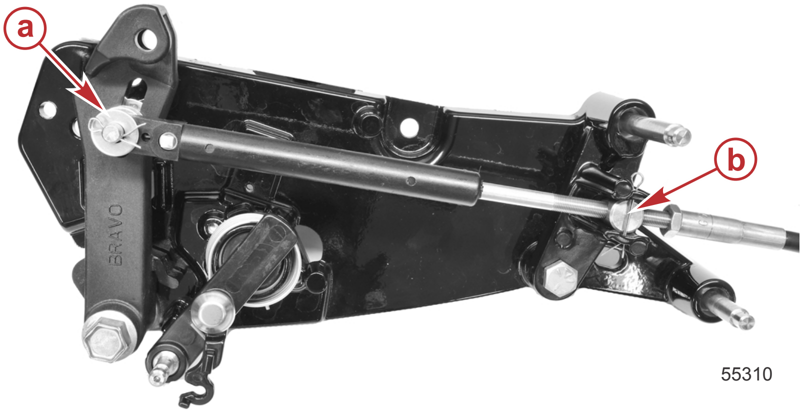
a - 76 mm (3.0 in.)
b - Shift arm pin nut
c - Pivot bolt

Description	Nm	lb-in.	lb-ft
Shift arm pin nut	10	88.5	–

3. Install a washer onto the shift arm pin.
4. Install the intermediate shift cable.

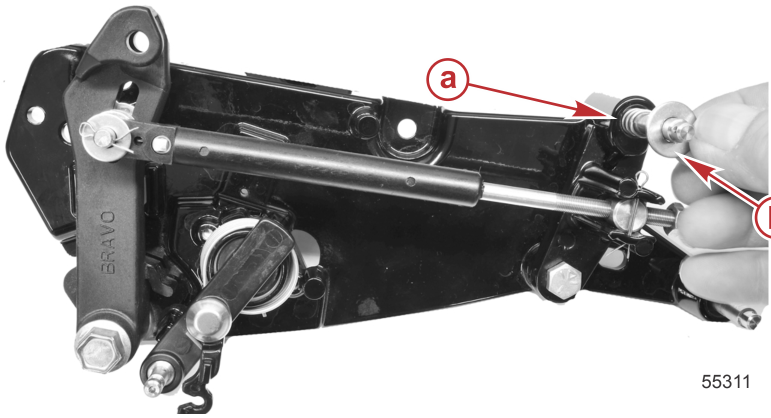
   NOTE: The transom assembly intermediate shift cable is factory set and does not require adjustments.

5. Install a washer onto the shift arm pin and secure the shift cable with two cotter pins. Spread the ends of the cotter pins.



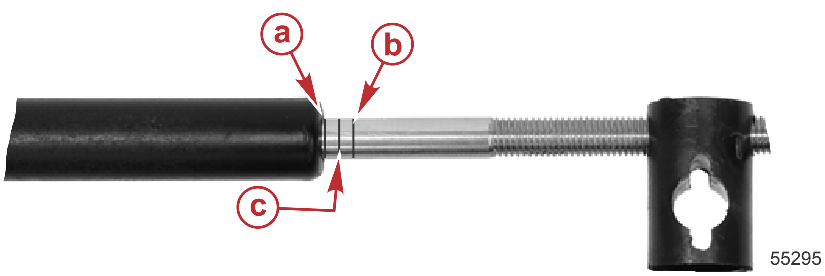
a - Washer and cotter pin securing clevis pin
b - Cotter pin

6. Install a spring and washer on the shift plate barrel stud.

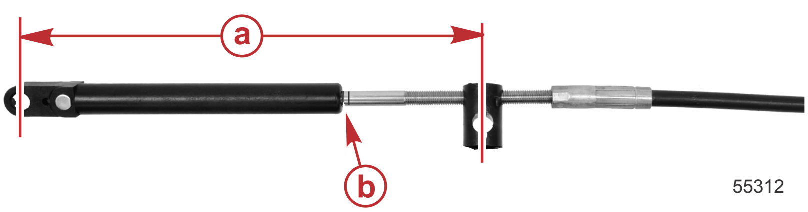


a - Spring
b - Washer

7. Place the remote control handle in neutral.
8. Find the center of the shift cable end play.
   a. Pull on the remote control shift cable end guide to remove end play and mark the cable tube "a."
   b. Push on the remote control shift cable end guide to remove end play and mark the cable tube "b."
   c. Measure the distance between "a" and "b" and place another mark "c" in the center.



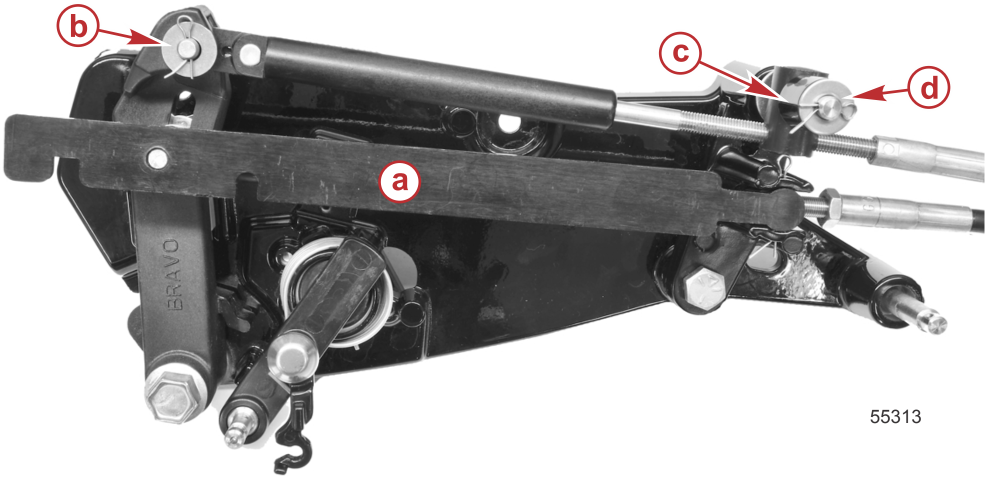
9. Adjust the shift cable barrel so the center to center measurement is 181.0 mm (7.125 in.). Verify the measurement is achieved when the cable end guide is at the center mark "c." This measurement can be used as a starting point prior to installing the remote control cable onto the shift plate.



a - 181.0 mm (7.125 in.)
b - Center mark "c"

10. Install the shift cable adjustment tool over the intermediate shift cable. Secure the tool in place with a piece of tape over the barrel end if necessary.
11. Install the remote control shift cable barrel onto the stud.

12. Install a spacer onto the stud and secure with a washer and cotter pin. Spread the ends of the cotter pin.
13. Align the shift cable end guide with the shift arm and insert the clevis pin through all components.
14. Retain the clevis pin and the shift cable barrel with a washer and cotter pin. Spread the ends of the cotter pins.



a - Adjustment tool
b - Washer and cotter pin securing clevis pin
c - Spacer
d - Washer and cotter pin

15. Inspect the remote control shift cable for alignment of the center mark "c." Adjust the barrel as needed.
16. Remove the shift alignment tool.
17. Lubricate the shift cable pivot points.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally

18. Shift the remote control lever into forward gear position. Place the end of the adjustment tool in the barrel retainer. If the slot on the adjustment tool does not fit onto the stud, loosen the nut securing the shift arm pin and slide the pin up or down until tool slot fits onto the pin. When adjustment is correct, tighten the nut.
19. Lift the adjustment tool so that the slot is above the stud.
20. Shift the remote control into reverse gear position and repeat the adjustment process.

a - Right-hand rotation forward: Bravo One, Two, and Three. Left-hand rotation reverse: Bravo One, Two, and Three.
b - Left-hand rotation forward: Bravo One and Two. Right-hand rotation reverse: Bravo One, Two, and Three.

21. Remove the adjustment tool.
22. Ensure that all cotter pins are secure and that the ends of the cotter pins are spread to 180 degrees.

Throttle Cable Installation

The following throttle cable installation shows the Alpha drive shift plate. The throttle cable installation is identical for the Bravo drive.

1. Place the remote control in neutral position.
2. Compress the remote control throttle cable end guide towards the cable barrel.
3. Rotate the barrel to align the throttle cable end guide with the throttle demand sensor pin and the cable barrel with the shift plate stud.
4. After the throttle cable is properly aligned with the throttle demand sensor pin and shift plate stud, rotate the barrel two turns away from the end guide to apply a slight preload on the cable and install the throttle cable.

5. Secure the throttle cable to the throttle demand sensor pin with the clip. Secure the barrel to the shift plate stud with a washer and cotter pin. Spread the end of the cotter pin.

55304

a - Throttle demand sensor pin clip
b - Throttle stop
c - Washer and cotter pin

Connecting the Electrical Components

Electrical Connections

IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system.

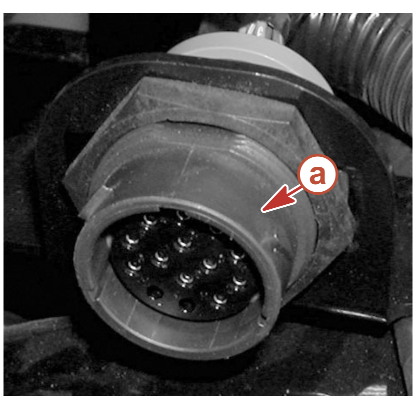
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on engine and to avoid contact with moving parts.

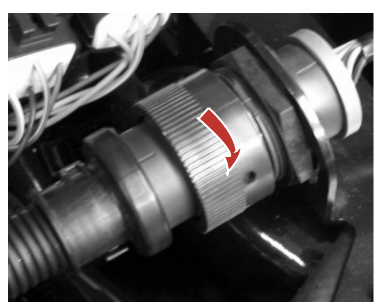
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All electrical connections	92- 25711 3

Engine Harness Connections

1. Route the instrumentation wiring harness back to the engine, making sure that the harness does not rub or get pinched. If an extension harness is required, ensure that the connection is properly secured.
2. Fasten the harnesses to the boat at least every 46 cm (18 in.) using the appropriate fasteners.
3. Connect the instrumentation wiring harness to the engine harness connector. Turn the locking ring until it firmly snaps.



23135



23136

Typical

a - Engine harness connector

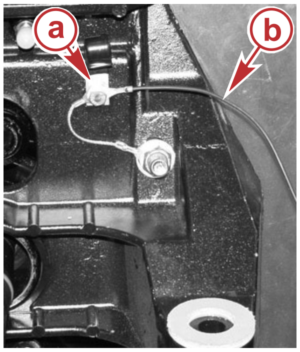
4. Connect the transom harness.
5. Connect the depth transducer connector to the data link connector on the engine harness.
6. Connect the paddle wheel/tank level connector.
7. Connect the power harness (with 5-amp fuse) connector.

8. If equipped, connect the trim sender wires.

Continuity Wire Connection

Connect the continuity circuit wire from the engine to the transom assembly.

IMPORTANT: Do not attach any accessory ground (–) wires to the transom plate ground point. Accessory ground wires must only be attached to the ground stud on the engine.



57238

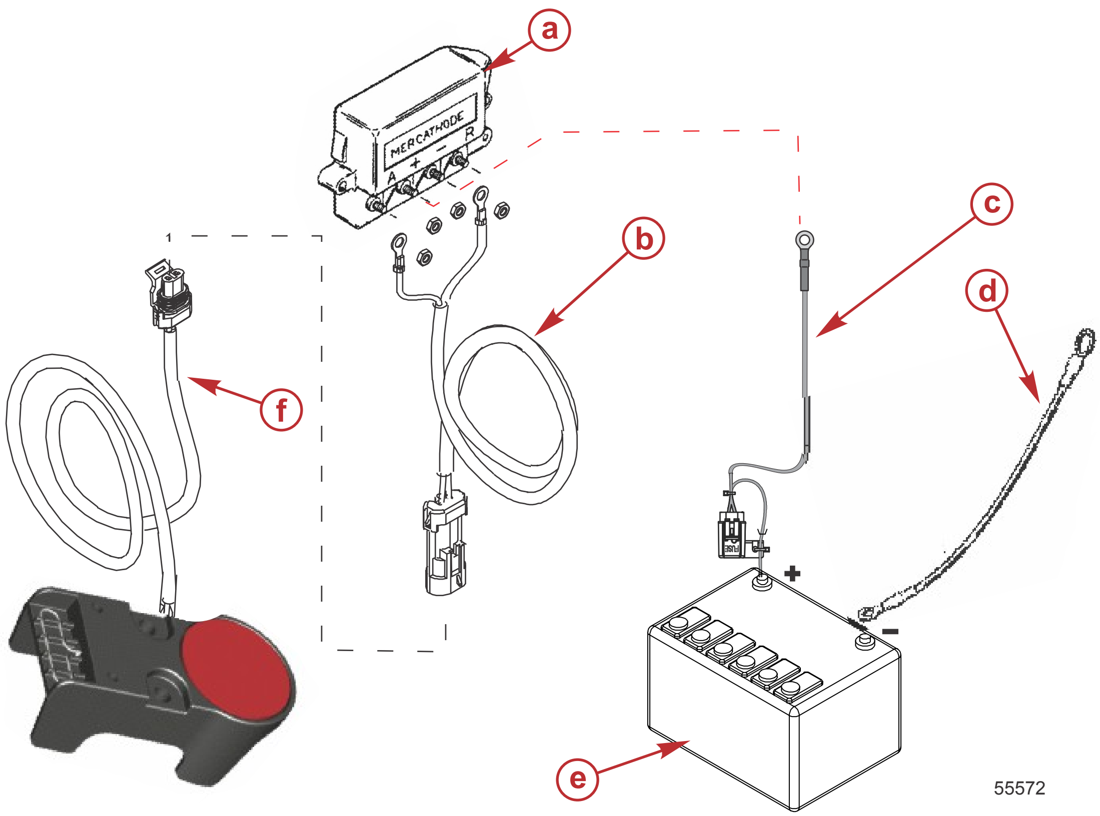
a - Bonding strap screw
b - Continuity wire

Quick-Connect MerCathode System Connection

NOTE: MerCathode systems are standard on Bravo applications; they are optional on Alpha applications.

1. Mount the MerCathode controller in an accessible area within reach of the harness when installed.
2. Connect the MerCathode harness wires to the MerCathode controller assembly—the orange wire to the A terminal, and the brown wire to the R terminal.

3. Connect the MerCathode harness to the electrode assembly harness.



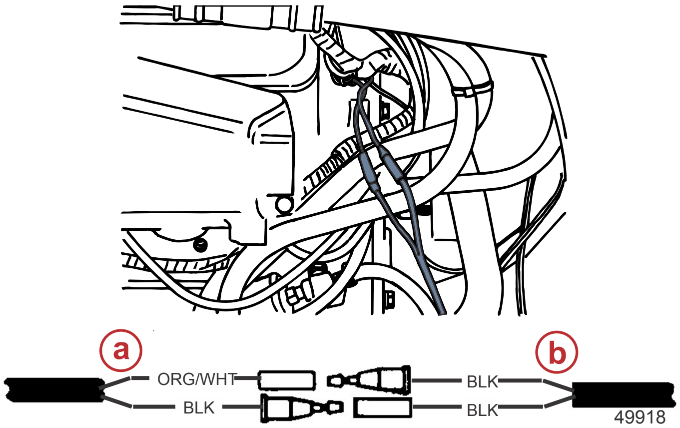
a - MerCathode controller
b - MerCathode harness
c - Positive power harness with 5-amp fuse
d - Ground cable
e - Battery
f - Electrode assembly harness

4. Connect one end of the positive power harness with 5-amp fuse to the positive (+) terminal of the MerCathode controller, and connect the other end directly to the positive terminal of the battery.
5. Connect one end of the ground cable to the negative terminal of the MerCathode controller. Secure the ground ring terminal to the screw on the port side of the transom plate.
6. Apply a sealant to all wire connections to prevent corrosion.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Exposed terminals and connections	92- 25711 3

Trim Position Sender Connections

Connect the trim position sender wires from the transom assembly to the engine harness. Use the orange/gray wire for analog gauges and the orange/white wire for digital gauges.



Digital gauge connection shown, analog similar

a - Engine harness bullet connectors

b - Transom assembly bullet connectors

Installing the Sterndrive Unit

Refer to the appropriate Mercury MerCruiser sterndrive service manual for procedures related to the installation of the sterndrive unit.

Battery Connection

IMPORTANT: The sterndrive must be installed before connecting the battery. Refer to the appropriate Mercury MerCruiser sterndrive service manual.

1. Ensure that the power trim pump, the MerCathode controller, and the accessory wiring (if equipped) are properly connected to the battery terminals.
2. Connect the battery cables to the battery by first connecting the positive (+) battery cable (usually red) to the positive (+) battery terminal. Tighten the clamp securely.
3. Connect the negative (–) battery cable (usually black) to the negative (–) battery terminal. Tighten the clamp securely.
4. Ensure that all of the battery terminal connections are tight. Spray the terminals with a battery connection sealant to help retard corrosion.

Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminal connections	Obtain Locally

5. Apply sealant to the exposed terminals and electrical connections.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Exposed terminals and connections	92- 25711 3

Troubleshooting Shift Problems

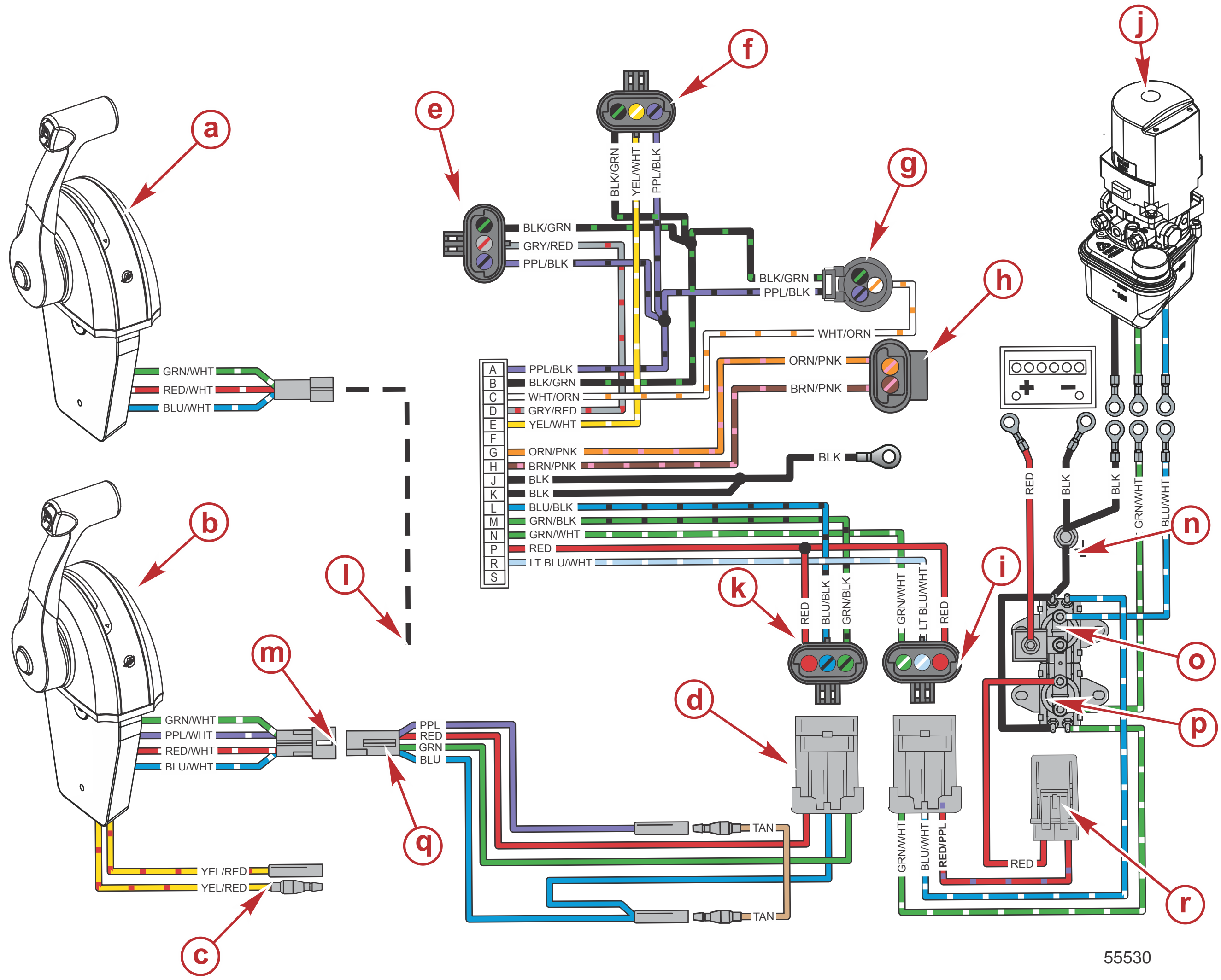
If hard shifting, chucking, or racheting is encountered when shifting into forward gear, refer to the remote control manual or to the appropriate sterndrive service manual for troubleshooting information.

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Power Trim System

NOTE: Outboard or MerCruiser control may be used depending on the application. If MerCruiser control is used then a power trim extension harness also will be used.



a - Outboard control
b - MerCruiser control
c - To key switch harness
d - Power trim extension harness
e - To steering
f - To digital trim
g - To pitot
h - MerCathode
i - Transom harness
j - Trim pump
k - From helm
l - To key switch harness
m - MerCruiser control harness
n - Ground
o - Up solenoid
p - Down solenoid
q - Power trim extension harness
r - 20-amp fuse

Boat Harness Installation Guidelines—MPI Sterndrive

Boat Harness Connector to Engine

Select the boat harness by length.

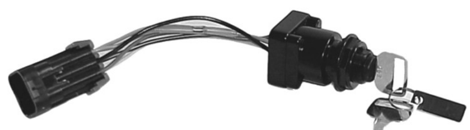
Boat Harness		
Length of the Boat Harness	**Boat Harness and Key Switch Three Position (off/run/start)**	**Boat Harness (key switch is not included)**
61 cm (2 ft)	84-896537 K02	84-896537 A02
4.6 m (15 ft)	84-896537 K15	84-896537 A15
6.0 m (20 ft)	84-896537 K20	84-896537 A20
7.3 m (24 ft)	84-896537 K24	84-896537 A24
8.8 m (29 ft)	84-896537 K29	84-896537 A29
12.2 m (40 ft)	84-896537 K40	84-896537 A40

NOTE: Extension harnesses are available if longer length is needed.

Key Switch Connector

- A mounting bezel is not available for the three position key switch.

  NOTE: Decal and washer kit 899203A01 is available for the three position key switch if needed.



25046

Typical three position key switch (off/run/start)

- The four position key switch is available with mounting hardware.

25045

25044

Typical four position key switch (off/accessory/run/start)

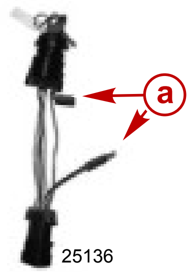
NOTE: When installing the key switch, verify that the drain hole in the barrel of the key switch is positioned downward for proper drainage.

- **For non-DTS applications:** For dual helm installation, a key switch is used at the upper and lower station. The key switches must operate independently.
- **For DTS applications:** For dual helm installation, a start and stop switch is used at the upper station. The lower station can use either a key switch at the helm, or a key switch at the main panel and a start and stop switch at the lower helm.

  IMPORTANT: For dual helm installation, both key switches used must be modified to operate independently.

  IMPORTANT: Cutting the black/yellow stripe wire disconnects the E-stop circuit incorporated in the key switch. Do not alter key switches on DTS applications.

- To modify the non-DTS key switches, cut the black/yellow stripe wire at each key switch and cover both open wire ends with heat shrink tubing.

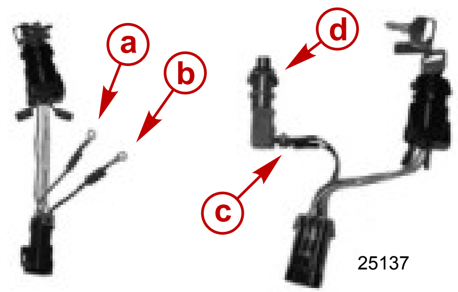


Typical key switch

a - Black/yellow stripe wire

IMPORTANT: The key switch at the station being used should be the only key switch in the run position. If both station key switches are in the run position the engine cannot be turned off with the key switch and the lanyard stop switches will not function.

- If a momentary stop switch is added, the stop switch will override the key switch and the engine will shut off when the stop switch is activated.
- If a stop button is desired on a dual helm installation, the black wire and black/yellow stripe wire can be clipped at the key switch and connected to a normally open momentary button switch. Any marine momentary push button, rocker style switch or toggle switch could be utilized to create the stop switch. Label the switch on the dash after installation.
- To install a momentary stop switch:
  a. Cut the black wire at the key switch and cover the cut wire at the key switch with heat shrink tubing.
  b. Install an eye terminal on the black wire from the connector side. Cover cut wire ends with heat shrink tubing.
  c. Install an eye terminal on the black/yellow stripe wire from the connector side. Cover cut wire ends with heat shrink tubing.
  d. Connect the black wire and the black/yellow stripe wire eye terminals to a momentary switch.



Typical key switch with momentary stop switch for MPI models

a - Black wire with eye terminals

b - Black/yellow stripe wire with eye terminals

c - Eye terminals connected to momentary switch

d - Momentary switch

Trim Switch

The trim switch connection on the helm harness is only used on Mercury outboard remote controls.

MerCruiser models require a separate trim harness from the trim control to the power trim pump connection. A Y-harness is available with adapters to connect the dual helm power trim harnesses together to connect to the transom harness. DTS models do not need the separate trim harness.

Use the power trim adapter harness for the single helm harness connection on the remote control to the power trim pump.

Power trim adapter harness

For dual helm installation, use a power trim extension harness from the upper and lower helm to a Y-harness.

An adapter harness connects the Y-harness to the power trim pump.

Neutral Safety Switch

Quicksilver remote controls for mechanical shift (cable) models are equipped with a microswitch to prevent accidental starting in gear. Do not remove this switch from the remote control.

Lanyard Stop Switch

Purple and purple/white wires are connected together through a normally closed stop switch only with MerCruiser remote control.

When the lanyard is pulled and the switch is tripped, the circuit is opened and the power to the engine, ECM, or ignition system is interrupted and the engine is shut off on MerCruiser remote control equipped boats.

If a lanyard stop switch is not used, or an E-stop switch is used, these two wires must be plugged together for the engine to run.

Optional E-Stop

The E-stop lanyard switch connection is used on Mercury outboards and can be used on MerCruiser MPI engines.

The black and black/yellow wires are connected together through a lanyard switch that is normally open. When the lanyard is pulled and the switch is tripped, the circuit will close and ground the ECM to shut the engine off.

When this connection is not used, the wires should be kept separate and capped.

Warning Horn

The audio warning horn and connections are included with the Mercury harness assemblies. (Another horn is also supplied with the engine for those using custom wiring systems.)

Accessory Relay Connection

The 14-pin wiring system is able to provide up to 15 amps of accessory power to the helm through the purple wire (key controlled) or the red wire (constant on) circuit. This harness is fuse protected on the engine with a 15-amp fuse on the engine. If the fuse is blown, the engine will not start or continue to run.

An accessory relay kit connected to this location can provide up to 40 amps of accessory power. The key switch will power-up the relay in the "accessory" position and "run" position.

Relay with power harness

Additional Relay Kit

An additional 40-amp relay kit can be installed and connected to a junction box at the dash gauge connection location. This location will power-up with the key in the "run" position only.

The use of both relay kits will result in a maximum of 80 amps of key controlled power at the helm. This multiplies out on dual engine and dual helm applications as long as the power wires to the helm are adequate to carry the total current demand.


25144

Accessory relay harness

CAN P (CAN 1) Connections

CAN P (CAN 1) data bus—Connection with a terminator resistor in place:

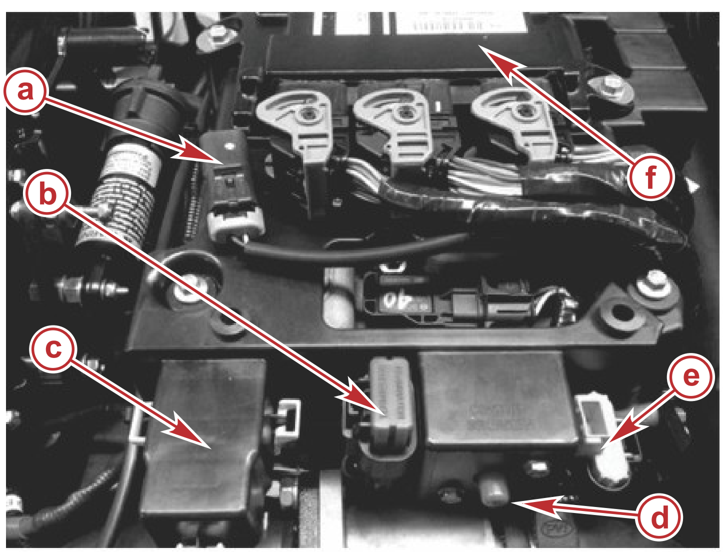
- The CAN P (CAN 1) data bus is terminated at each engine. Terminator resistors must be removed from the helm harness or junction box and a jumper harness must be installed at the helm to connect the port and starboard CAN P (CAN 1) lines together.
- If the boat is dual engine and dual helm, the terminator resistor at the lower helm is removed from the connector. The 2-pin link harness is installed at the upper station.


25149

2-pin link harness—CAN

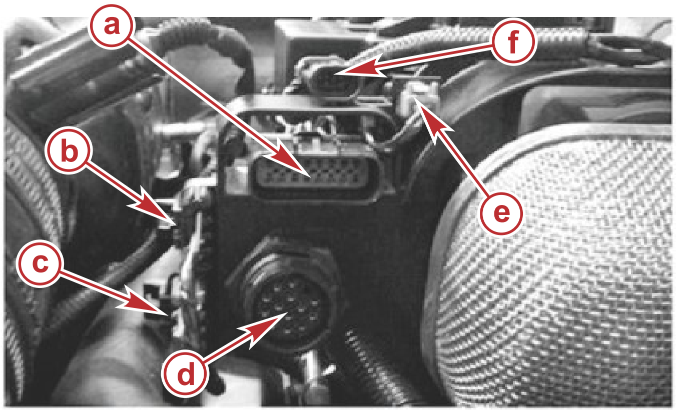
General Repower Information

- A 6-pin fuel paddle boat harness is required.



55203

a - Can X terminator DTS only
b - 10-pin diagnostics
c - Fuses
d - Circuit breaker
e - J1939 diagnostic connection
f - PCM 112



55204

a - 16-pin transom harness
b - Depth/RS-485
c - Boat harness (tanks)
d - 14-pin data harness
e - OBD-M MIL light
f - 7A clean power

Description	Part Number
Fuel tank, auxiliary tank, and paddle wheel harness	84-859743T03

Transom Harness—DTS/Mechanical Shift

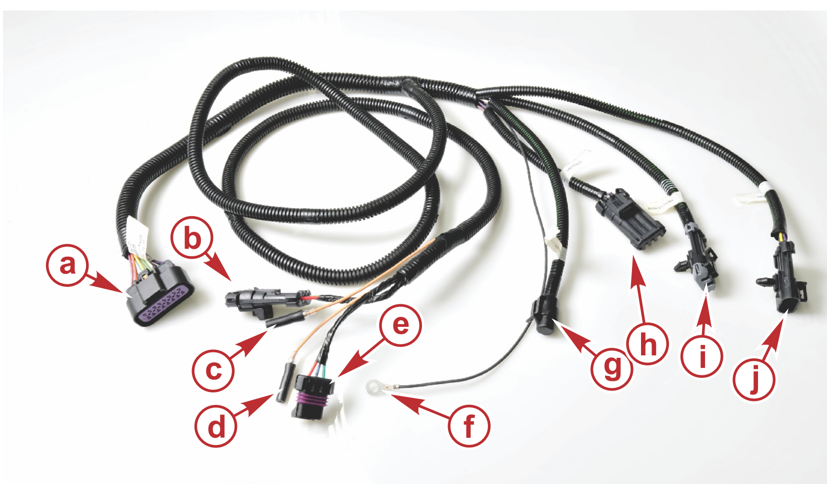
This transom harness is designed so that connections can be made after the transom is installed in the boat but before the engine is installed. Connections made before the engine is installed are:

- MerCathode connection
- Trim connections
- Ground connection
- SmartCraft sensor connections

Secure the wiring and position the engine connector out of the way until the engine is installed.

After the engine is in place, make the single connection between the transom and the engine.

DTS engines are shipped with an adapter to connect the transom harness to the power trim pump.



55991

Transom harness—DTS

a - 16-pin connector to engine harness
b - Trim from helm
c - Trim bypass
d - Trim bypass
e - Trim pump
f - Ground
g - Pitot
h - Digital trim
i - MerCathode
j - Steering

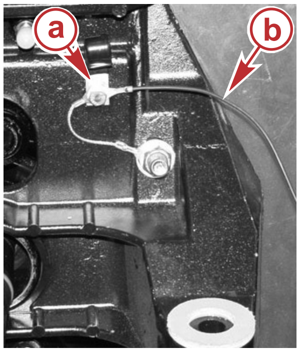
Transom Ground Connection

The ground wire for the transom is incorporated into the transom harness included with the engine.

Connect the ground wire in the transom harness under the bonding strap screw on the transom. Do not connect any other ground wires here.

Use the ground studs on the flywheel housing for other grounding needs.

NOTE: In some cases, a ground wire to connect to the flywheel housing may be attached to the bonding strap screw on the transom. This ground wire is not needed with the transom harness, but can be connected to the flywheel housing or removed. In any case the grounding wire in the transom harness must be connected to the bonding strap screw.



57238

Continuity wire from the transom harness to the transom bonding strap screw

a - Bonding strap screw
b - Continuity wire

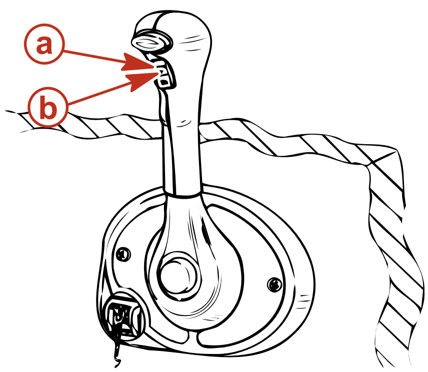
Bravo Sterndrive Shift Check (Engine Running)

The following procedure is performed with the boat out of the water and the engine running.

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Use the sterndrive tilt switch on the remote control handle to lower the sterndrive to the down/in position. Do not allow the sterndrive skeg to contact the ground.



4805

Typical single handle remote control shown

a - Drive trim switch
b - Drive trailer button

2. Connect a water hose between the flushing attachment and a water source.

Dual Water Pick-up Flush Seal Kit	91-881150K 1
Flushing Attachment	91-44357Q 2
Flushing Kit	91-849996T 1

3. Partially open the water source until water continuously flows out around the flushing attachment.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through-the-hull water inlet need a supply of cooling water available to both the sterndrive and the engine during operation.

4. Place the remote control handle in neutral, idle speed position and start the engine.

   NOTE: The sterndrive is shifting properly when the sterndrive shifts with minimal effort in and out of each gear (forward, neutral, and reverse) at idle speed position.

   NOTE: The operator at the remote control handle should feel a slight detent before and after each gear: forward, detent, neutral, detent, reverse.

IMPORTANT: The sterndrive is not shifting properly if the sterndrive shifts after the engine throttle is advanced.

5. Move the remote control handle to the forward, idle speed position.
6. Check that the sterndrive propeller shaft is turning in the forward direction.
7. Shift the remote control handle to the neutral, idle speed position.
8. Check that the sterndrive propeller shaft is not turning.
9. Shift the remote control handle to the reverse, idle speed position.
10. Check that the sterndrive propeller shaft is turning in the reverse direction.
11. If the sterndrive will not shift:
    a. Remove the sterndrive and check the shift linkage assembly and shift cable.
    b. Check the shift cable installation and adjustment. Refer to the Bravo sterndrive service manual for detailed instructions.
    IMPORTANT: Be sure that the shift cables are routed in such a way as to avoid sharp bends and contact with moving parts. Do not fasten any items to the shift cables.

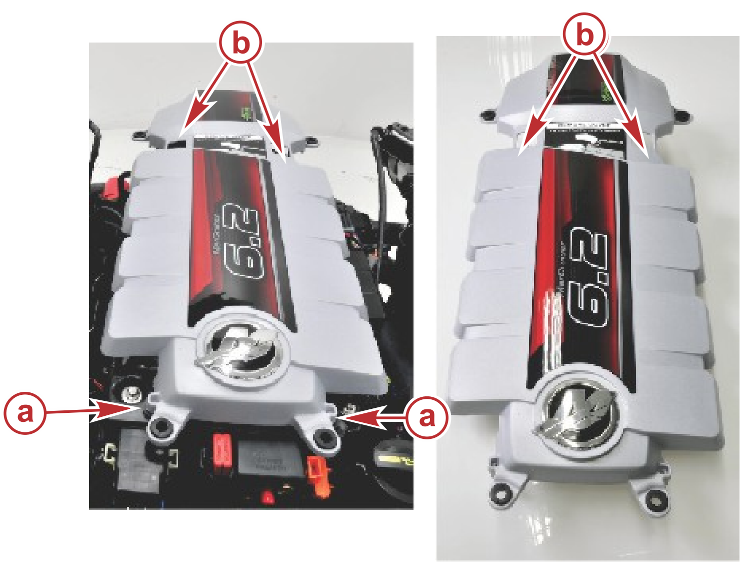
Engine Installation and Initial Engine Alignment—TowSport, Inboard

Engine Mount Preadjustment

1. Remove the two engine covers shown in the following:
    a. Pull the outside engine cover up to remove it from the four rubber mount grommets.

58715

    b. Lift up on the front of the second cover to disengage the cover from the front grommets. Pull the cover toward the front of the vessel to remove it from the two rear grommets.



a - Front grommets
b - Rear grommets

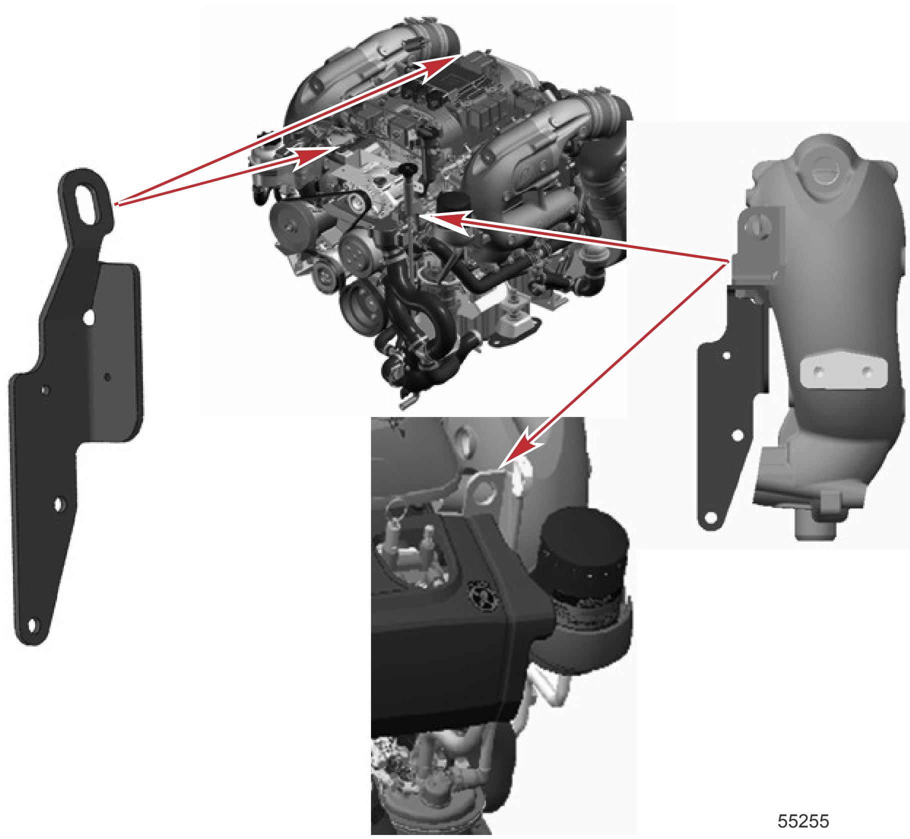
58714

2. Remove all of the hardware holding the engine to the shipping pallet.
3. Attach a suitable sling to the lifting eyes on the engine, and adjust the sling so that the engine is level when suspended.
4. Lift the engine from the pallet with an overhead hoist.

⚠ CAUTION

Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

IMPORTANT: Maintain a minimum length of 66 cm (26 in.) on each chain or use a spreader bar so that no components are damaged.

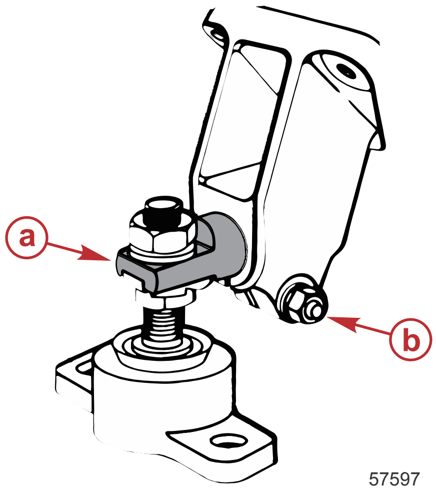


5. Check all four engine mounts (two front, two rear) to ensure that the distance from the bottom of the mount to the bottom of the trunnion is as shown. If not, loosen the mount locking nut and turn the adjusting nut in the direction required to obtain the proper dimension, then tighten the locking nut. Be sure to leave the mount positioned so that the slot is forward.
6. Loosen the clamping bolts and the nuts on all four of the engine mount brackets to ensure the following:
   - The large diameter of the mount trunnion is extended.
   - The mount base slotted mounting hole is positioned forward, if so designed.

IMPORTANT: Long trunnion installation: The trunnions are 14 cm (5.5 in.) long. The trunnions included in the front engine mounts are shorter to allow them to be fully retracted without interfering with components on the engine. Use the 14 cm (5.5 in.) trunnions, if the ones already in the mounts do not allow enough adjustment outward.
Before installing the engine into the vessel, ensure that the trunnions used in the front engine mounts are long enough to span the required distance. If they are not, use the long trunnions.

1. Remove the short trunnions from the front engine mounts.
2. Insert the long trunnions into the front engine mounts.
3. Install and align the engine.
4. Ensure that the trunnion clamping bolts and locknuts are tightened to the specified torque.

Description	Nm	lb-in.	lb-ft
Trunnion clamping bolt and locknut	68	–	50.2



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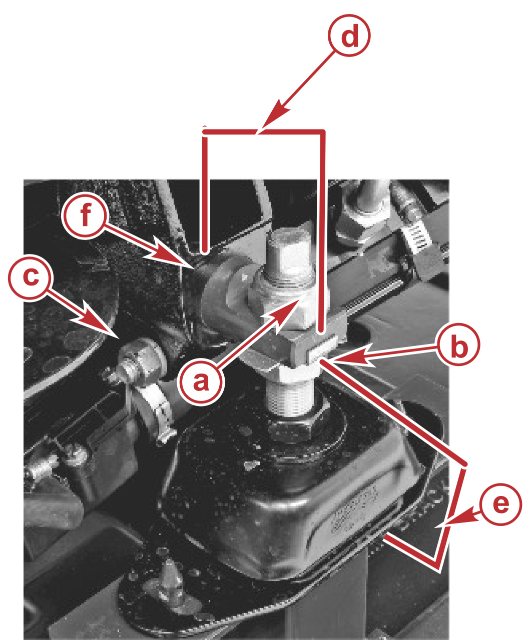
Typical front engine mount
a - Trunnion
b - Trunnion clamping bolt and locknut

7. Tighten the clamping bolts and nuts slightly to prevent them from moving in or out. The mounts must be free to pivot when installing the engine.



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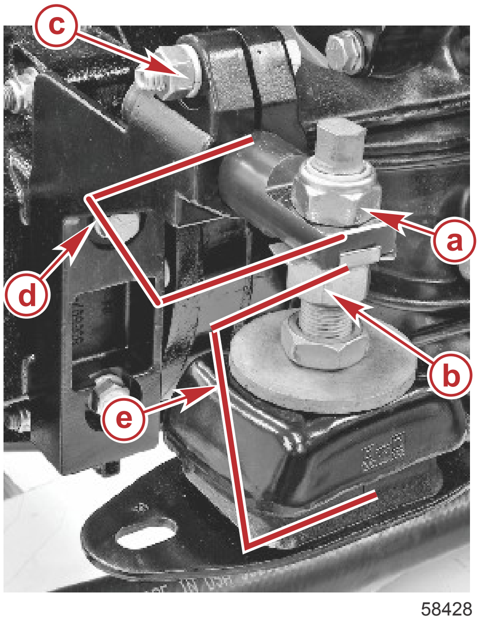
Front mount
a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolt and nut with lockwasher
d - 10 mm + 2 mm (3/8 in. + 1/16 in.)
e - 67 mm + 2 mm (2-5/8 in. + 1/16 in.)



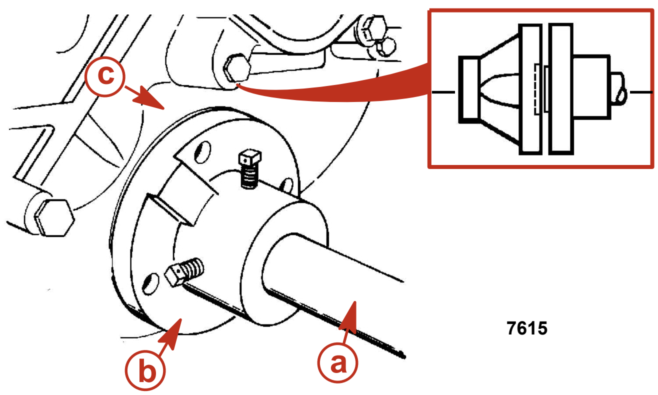
Typical rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolt and nut with lockwasher
d - 10 mm + 2 mm (3/8 in. + 1/16 in.)
e - 67 mm + 2 mm (2-5/8 in. + 1/16 in.)

NOTE: Check the stringer for proper width for rear mount foot print.

Models with 8 Degree Down-Angle Transmissions

1. Lift the engine into position in the boat using an overhead hoist.
2. Position the engine on the engine bed so that the transmission output flange and propeller shaft flange are aligned so that no gap can be seen between flange coupling faces when they are butted together. Adjust the engine bed height if necessary to obtain the proper alignment. Do NOT use the mount adjustments to adjust the engine position at this time.
IMPORTANT: The engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all four mounts after performing initial alignment. This is necessary to allow for the final engine alignment.



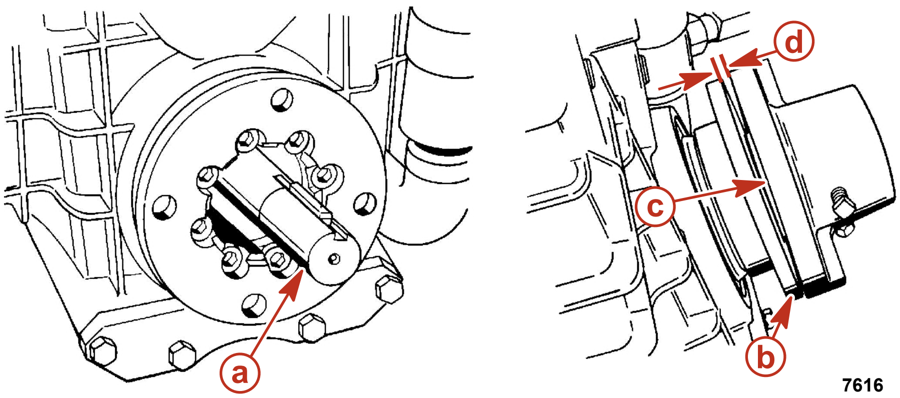
a - Propeller shaft
b - Propeller shaft flange
c - Transmission output flange

3. Ensure that all four mounts are still positioned properly, then fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts of sufficient length and flat washers. Tighten the lag bolts securely.
4. Ensure that the quick drain oil fitting is more than 13 mm (1/2 in.) above the boat bottom.
5. Disconnect the overhead hoist and remove the sling.

Models with V-Drive Transmissions

1. Remove the engine cover.
2. Attach a suitable sling to the lifting eyes on the engine, and adjust it so that the engine is level when suspended.
3. Lift the engine into position in the boat using an overhead hoist.
4. Install a quick drain oil hose plug into the oil drain hose.
5. Position the engine so that enough of the propeller shaft protrudes through the transmission and output flange for the propeller shaft flange to be attached. Then install the flange and position the engine so that no gap can be seen between the flange coupling faces when butted together. Adjust the engine bed height if necessary to obtain the proper alignment. Do not use the mount adjustments to adjust the engine position at this time.

IMPORTANT: The engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all four mounts after performing initial alignment. This is necessary to allow for the final engine alignment.



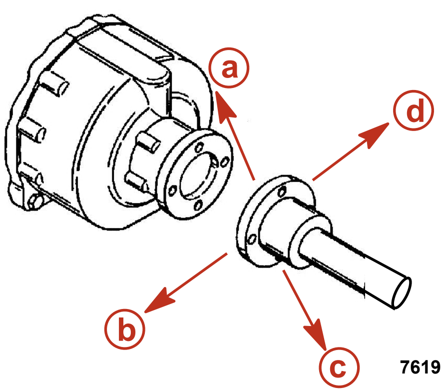
ZF Marine 63IV
- a - Propeller shaft
- b - Propeller shaft flange
- c - Transmission output flange
- d - No visible gap allowed

6. Ensure that all four mounts are still positioned properly. Fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts of sufficient length and flat washers. Tighten lag bolts securely.
7. Ensure that the quick drain oil fitting is more than 13 mm (1/2 in.) above the boat bottom.
8. Disconnect the overhead hoist and remove the sling.

Final Engine Alignment—TowSport, Inboard

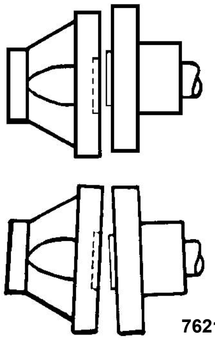
IMPORTANT: Engine alignment must be checked with the boat in the water, fuel tanks filled, and with a normal load onboard.

1. Check the mating faces on the transmission output flange and propeller shaft flange to ensure that they are clean and flat.
2. Center the propeller shaft in the shaft log as follows:
   a. Push down and then lift the shaft as far as it will move. Then place the shaft in the middle of the movement.
   b. Move the shaft to port and then to starboard as far as the shaft will move. Then place the shaft in the middle of the movement.
   c. With the shaft in the center of the shaft log as determined by the above procedures, align the engine with the shaft.



Typical down angle (V-drive similar)
- a - Up
- b - Port
- c - Down
- d - Starboard

3. Check that the flange coupling centerlines align by butting the propeller shaft flange against the transmission output flange. The shoulder on the propeller of the shaft flange face should engage the recess on the transmission output flange face with no resistance.



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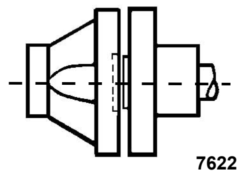

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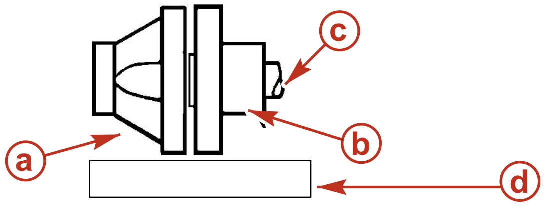
Correct

NOTE: Some propeller shaft flanges may not have a shoulder on the mating face. On these installations, use a straightedge to check centerline alignment.



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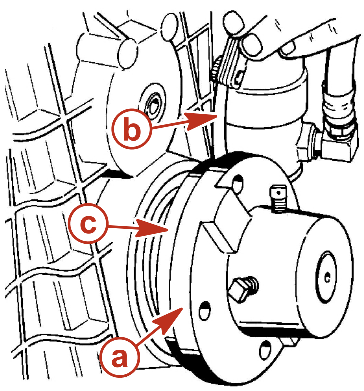
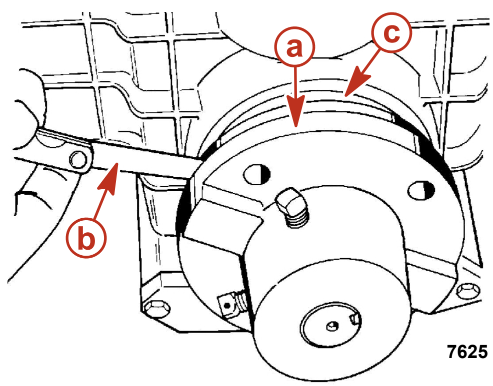
a - Transmission output flange
b - Propeller shaft flange
c - Propeller shaft
d - Straightedge

4. Check for angular misalignment by holding the flange coupling faces tightly together by hand, and checking for a gap between them with a 0.07 mm (0.003 in.) feeler gauge. Check the gap at 90° intervals.





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ZF Marine

a - Propeller shaft flange
b - Feeler gauge
c - Transmission output flange

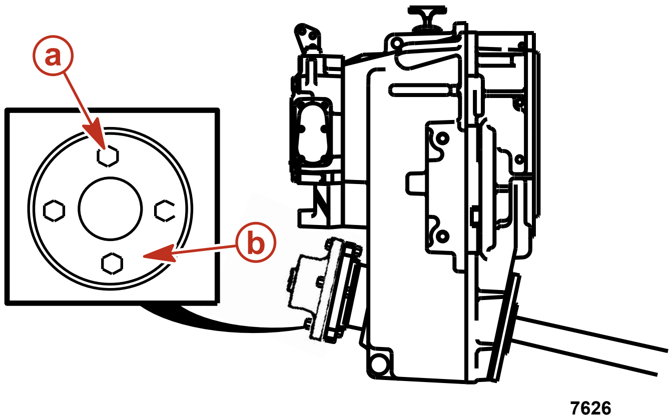
5. If the flange coupling centerlines are not aligned or if the flange coupling faces are more than 0.07 mm (0.003 in.) out of parallel, adjust the engine mounts.
   a. To adjust the engine up or down: Loosen the locking nut on the mounts requiring adjustment and turn the adjusting nuts in the desired direction to raise or lower.
      IMPORTANT: Both the front mount (or rear mount) adjusting nuts must be turned equally to keep the engine level from side to side.
   b. To move the engine to the left or right: Loosen the clamping bolts and nuts on all four of the mount brackets and move the engine to the left or right as necessary to obtain the proper alignment. A small amount of adjustment can be obtained with the slot on the front end of some mounts. Loosen the lag bolts that fasten the mounts to the engine bed, and move the engine, as required. Tighten the lag bolts securely.

IMPORTANT: The large diameter of the mount trunnion must not extend over 45 mm (1-3/4 in.) from the mount brackets on any of the mounts.

6. After the engine has been properly aligned, secure the engine mounts.
7. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Clamping bolts and nuts	68	–	50.2

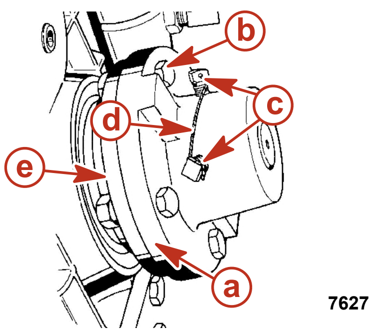
8. Tighten the locknuts on all four mounts.
9. Bend one of the tabs on the tab washer down onto the flat of the adjusting nut.
   IMPORTANT: All flange bolts must be SAE grade 8 (metric grade 10.9) or better, with a shoulder (grip length) sufficient to pass through the mating face plane of the flanges.
10. Secure the flange coupling together with bolts, lockwashers, and nuts. Tighten the fasteners to the specified torque.



a - Bolts
b - Transmission flange

Description	Nm	lb-in.	lb-ft
Flange coupling bolts	68	–	50.2

a. If the propeller shaft flange has set screws, remove the set screws, and mark the dimple locations using a transfer punch.
b. To drill dimples, remove the propeller shaft flange and drill shallow dimples at locations marked with a punch.
c. Install the propeller shaft flange and tighten the bolts to the specified torque. Install the set screws and tighten securely. Safety wire the set screws to ensure that they do not loosen.



a - Propeller shaft flange
b - Bolts
c - Set screws
d - Safety wire
e - Transmission output flange

Exhaust System Guidelines—TowSport

IMPORTANT: If the provided system is not used with the engine, no warranty claims will be allowed for water ingestion issues.

These engines are equipped with a wet exhaust system in which exhaust is mixed with water in the exhaust elbows. This cools the exhaust and allows the use of heat-resistant rubber hose on the outlet side of the system. These specifications must be observed by the OEM and muffler manufacturer when installing the exhaust system:

- Use heat resistant exhaust hose that complies with specifications SAE J2006 or UL 1129 (ABYC standard).
- Exhaust hoses should be no smaller than the minimum sizes. Use larger hoses on applications with long hose runs.

Minimum Exhaust Hose Size	
Model	Dual Muffler outlet
All Models	88.9 mm to 102 mm (3.5 in.) to (4.0 in.)

- Avoid sharp bends in exhaust hoses.
- Exhaust hoses can be installed at up to a 5° angle relative to the exhaust elbow outlets. Refer to **Exhaust Hose Connections**.
- Exhaust elbows must be the prescribed distance above the waterline. Install risers if needed. Refer to **Measuring Exhaust Elbow Height**.
- The exhaust hose attached to exhaust elbow must have a minimum of 10° downward slope.
- The exhaust hose must have a continuous downward slope so that a low spot does not exist at any point.
- Through-hull exhaust fittings (flanges, outlets) must be equipped with internal shutters and external flappers to prevent the reverse flow of water into the engine. Refer to **Mercury MerCruiser Product Applications Manual**.
- Exhaust outlets must be below the waterline with the boat at rest in the water and a full load aboard.
- Every exhaust hose connection should be secured with two hose clamps. The clamps should be stainless steel and at least 13 mm (1/2 in.) wide. Clamps that rely solely on spring tension should not be used (ABYC Standard).
- The system must have the capability to be serviced, reassembled, and replaced while maintaining all of the specifications. The boat builder must provide documentation, such as manuals, drawings, or orientation marks on production assemblies.
- Horizontal or vertical water lift mufflers are not permitted for use. Installers must use exhaust system provided with the engine.

Exhaust System Guidelines—Inboard Models

These engines are equipped with a wet exhaust system in which exhaust is mixed with water in the exhaust elbows. This cools the exhaust and allows the use of heat-resistant rubber hose on the outlet side of the system. These specifications must be observed by the OEM and muffler manufacturer when designing and installing the exhaust system:

- Heat-resistant exhaust hose that complies with specifications SAE J2006 or UL 1129 should be used (ABYC standard).
- Exhaust hoses should be no smaller than the minimum sizes. Larger hoses should be used on applications with long hose runs.

Minimum Exhaust Hose Size				
Model	Muffler Outlet	Dual Outlet System	Single Outlet System	
			Dual Hose Portion	Single Hose Portion
All Models	127 mm (5.0 in.)	102 mm (4 in.)	102 cm (4 in.)	102 mm (4 in.)

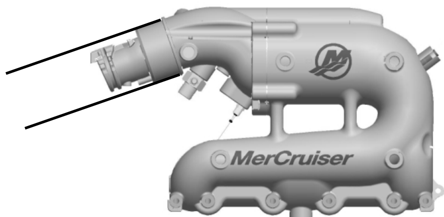
- Sharp bends in exhaust hoses should be avoided.
- Exhaust hoses can be installed at up to a 5° angle relative to the exhaust elbow outlets. Refer to **Exhaust Hose Connections**.
- Exhaust elbows must be the prescribed distance above the waterline. Install risers if needed. Refer to **Measuring Exhaust Elbow Height**.
- The exhaust hose attached to the exhaust elbow must have a minimum of 10° downward slope. On longer hose applications, the slope can be reduced to 3° in the portion of exhaust system that is more than 457 mm (18 in.) away from the elbow.
- The drop in the exhaust hose must be continuously sloping downward so that a low spot does not exist at any point.
- Through-the-hull exhaust fittings (flanges, outlets) must be equipped with internal shutters and idle relief to prevent the reverse flow of water into the engine. Refer to **Mercury MerCruiser Product Applications Manual**.
- Idle relief hose should be 7.62 cm (3 in.) minimum diameter with the outlet above the waterline.
- Exhaust outlets must be below the waterline with the boat at rest in the water, and when the boat is underway with a full load.
- Every exhaust hose connection should be secured with two hose clamps. The clamps should be stainless steel and at least 13 mm (1/2 in.) wide. Clamps that rely solely on spring tension should not be used (ABYC Standard).
- The exhaust system must be adequately supported for proper orientation and to prevent overstressing the exhaust manifolds and elbows. The support requirements will vary with exhaust system design and the G-forces to be encountered.
- The exhaust system must meet the exhaust back pressure specification. Refer to **Mercury MerCruiser Product Applications Manual**
- The system must have the capability to be serviced, reassembled, and replaced while maintaining all of the specifications. The boatbuilder must provide documentation, such as manuals, drawings, or orientation marks on production assemblies.
- If a waterlift or collector system is used, the waterline is defined as the waterline inside the collector. All measurements must be taken from that waterline to measure exhaust elbow weight.
- Horizontal waterlift mufflers are **not** permitted.

- In-line mufflers, collectors, and hoses must self drain after engine shut-down. Refer to **Mercury MerCruiser Product Applications Manual**

Exhaust Hose Connections—Inboard

NOTICE
Hot spots in exhaust hoses can damage hoses and cause leaks. Ensure that discharge water from the exhaust elbow flows without restriction through all hoses and fittings.

Exhaust hoses must be properly installed onto the exhaust elbow outlets. Discharge water from the exhaust elbow must flow around the entire inside diameter of the hose to avoid causing hot spots that could burn through the hose. Exhaust hoses must be installed at the angle shown following.



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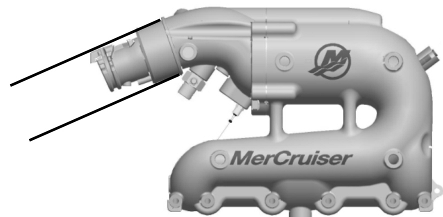

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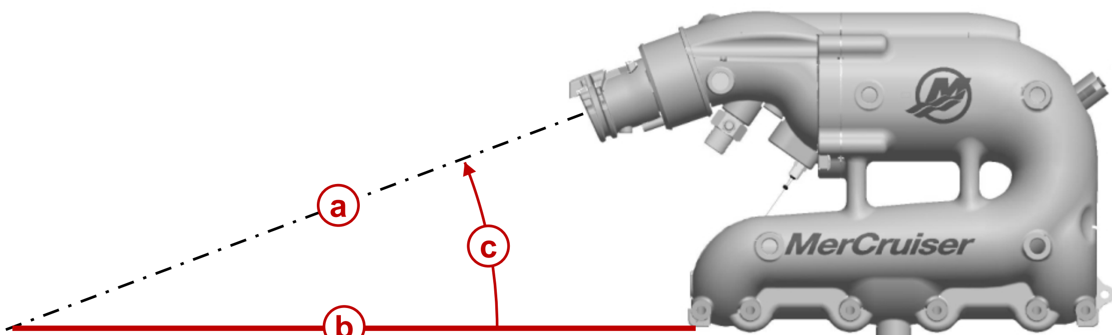

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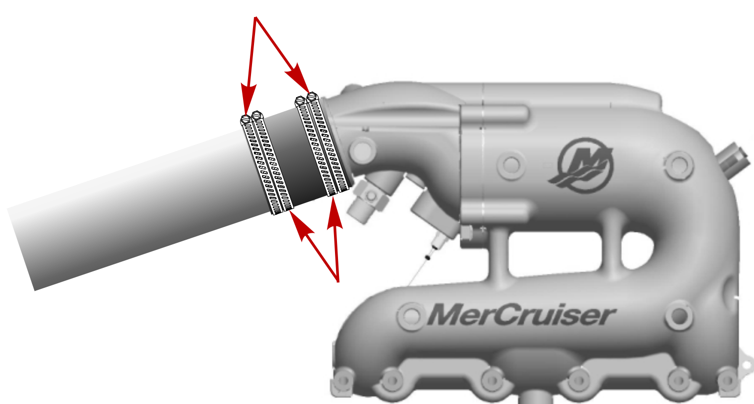
a - Exhaust outlet centerline
b - Parallel with crankshaft centerline
c - Exhaust angle 14° ± 5°

Secure all exhaust connections, including those at the exhaust elbow, with two hose clamps. ABYC standards also specify the use of stainless steel clamps with a minimum 13 mm (1/2 in.) bandwidth. Do not use spring tension clamps.



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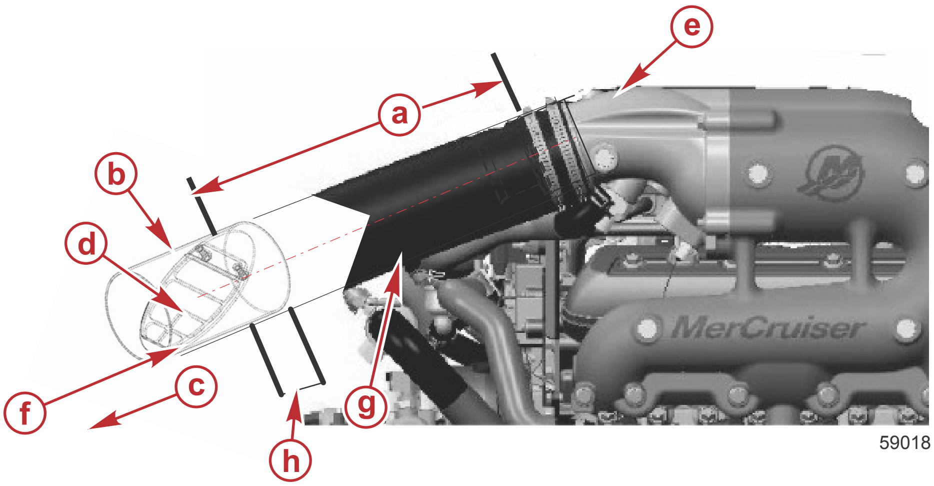
Hose clamps



a - 25.4–66.04 cm (10–26 in.) after elbow
b - Shutter assembly
c - Flow
d - Flapper down position
e - Elbow
f - Outlet
g - Hose
h - Minimum amount shutter assembly inserted into hose 50.8 mm (2 in.)

Measuring Exhaust Elbow Height—TowSport

General Information

The height of the exhaust elbows must be within the dimensions specified to prevent water intrusion problems. Exhaust elbow risers must be installed, if needed, to obtain the proper exhaust elbow height, and exhaust angle. Risers are limited to 152.4 mm (6 in.). Measurement must be taken with the boat in the water. It is important that the boat be loaded as outlined to simulate the maximum loading conditions likely to be encountered in normal operation.

IMPORTANT: Load distribution recommendations are the responsibility of the boat manufacturer. Any load distribution conditions that will affect the exhaust system must be clearly communicated to the operator in the owner's manual. For example, the number of people that can be located on the swim platform simultaneously should be included in the manual, if this could pose a problem.

Measurements under all loading conditions must be within the following specifications.

Minimum Exhaust Elbow Height	
Model	**Specification**
TowSport 6.2 in-line models	33 cm (13 in.)
TowSport 6.2 V-drive models	33 cm (13 in.)

Minimum Exhaust Hose Slope	
Model	**Specification**
TowSport 6.2	Within 406.4 mm (16 in.) of engine
	10°

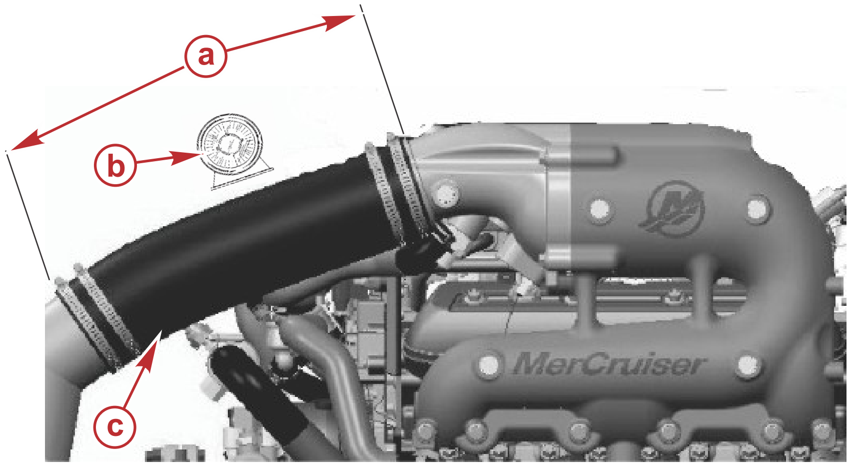
If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to the appropriate **Mercury Precision Parts and Accessory Guide** for part numbers.

The maximum exhaust riser height is specified in the table below.

Riser Options			
Model	**Low**	**Medium**	**High**
TowSport 6.2	51 mm (2 in.)	102 mm (4 in.)	152 mm (6 in.)

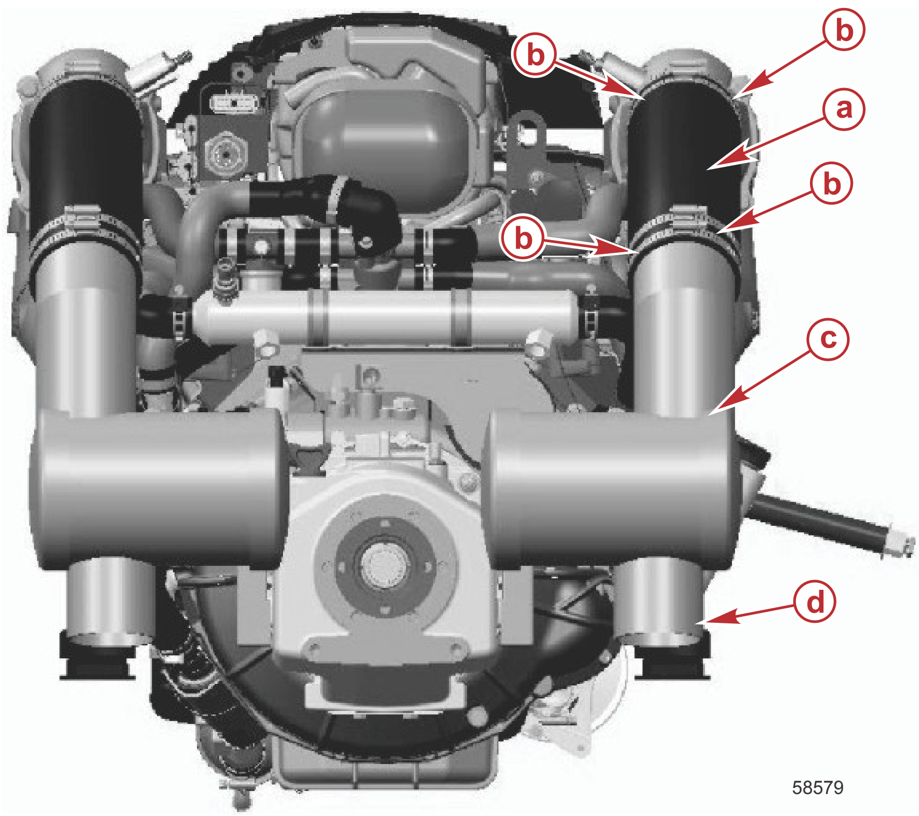
Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet continuing along each section to the exhaust exit point of the boat. All exhaust angle measurements must be performed with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. Refer to **Loading Requirements**.



Typical exhaust

- a - Minimum 152.4 mm (6 in.), Maximum 406.4 mm (16 in.)
- b - Inclinometer
- c - Exhaust hose or tube



Typical muffler assembly

- a - Hose
- b - Hose clamps
- c - Muffler
- d - 3.5 in. outlet

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on nonproduction boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**
- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**

- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boatbuilder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at the OEM boatbuilder must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 181.45 kg (400 lb) to the swim platform.
   c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 226.80 kg (500 lb) to the swim platform.

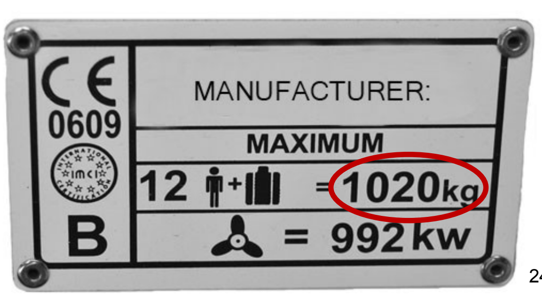
Loading the Boat (Boats with a Capacity Plate)

For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lbs, persons, gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb) per person. This gives the whole number and remainder of 74.84 kg (165 lb) persons to load onto the boat.
3. Put the remainder of a person in the next available seat. See the boat loading diagram.



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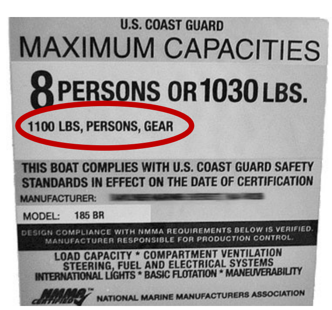
CE capacity plate



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USCG capacity plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.

NOTE: The following example is provided as a reference.

Example

NOTE: This example uses a boat that is less than 8.84 m (29 ft) long, not including a boat that is 8.84 m (29 ft) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 kg (400 lb) to the swim platform.

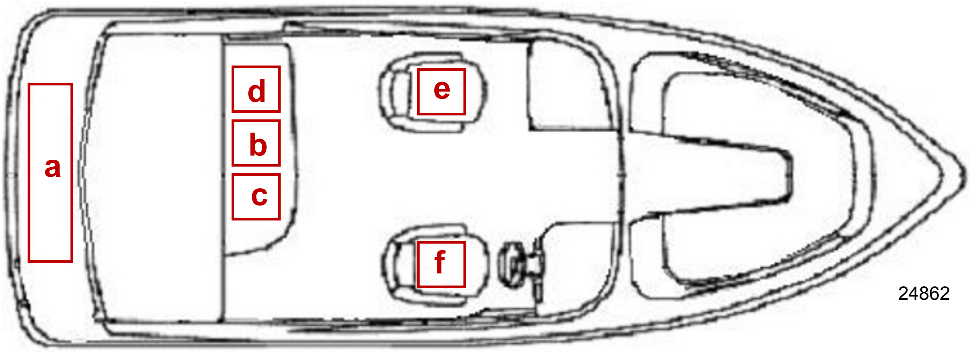
NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb – 400 lb = 700 lb
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat.
   - 700 lb ÷ 165 lb = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons.
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight.
   - 0.24 × 165 lb = 40 lb

   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
5. Using the totals in this example, load four 165-lb persons and one 40-lb person onto boat seating with 400 lb on the swim platform.

- 400 lb + 165 lb = 565 lb
- 565 lb + 165 lb = 730 lb
- 730 lb + 165 lb = 895 lb
- 895 lb + 165 lb = 1060 lb

- 1060 lb + 40 lb = 1100 lb



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb (MerCruiser person weight) = XXXX lb maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb per person. This gives the number of 165-lb persons to load onto the boat. Round up to next whole number.
   IMPORTANT: To account for cargo, add a weight of 25 lb per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

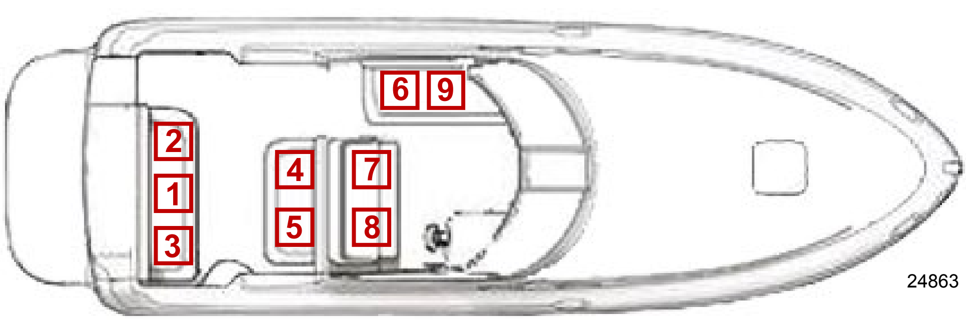
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: The following example is provided as a reference.
This example uses a boat that is 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 kg (500 lb) to the swim platform.

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



Designated seating diagram

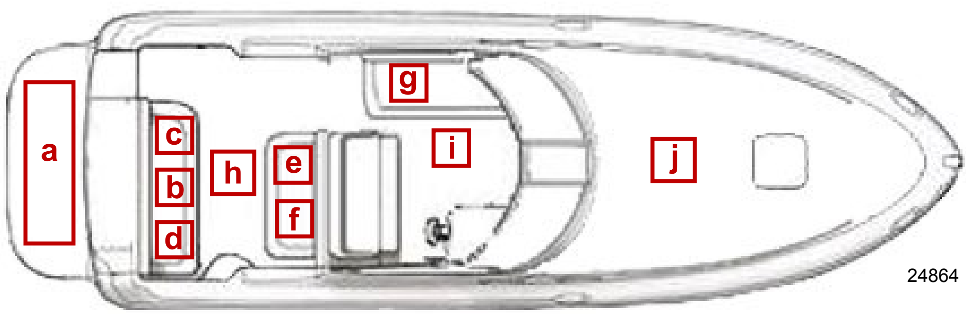
This example uses nine persons as the maximum passenger load.

NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb = 225 lb
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%.
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%.
   a. 225 lb × 50% = 112.50 lb
   b. 112.50 lb rounded up = 113 lb
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%.
   - 225 lb × 25% = 56.25 lb
   - 56.25 lb rounded down = 56 lb
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb (MerCruiser person weight) to get a 1485 lb (total passenger load).
   - 9 passengers × 165 lb = 1485 lb
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb – 500 lb = 985 lb

7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb ÷ 165 lb = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb cargo in the aft storage, 113 lb cargo in the center storage, and 56 lb cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb passengers, onto the boat with 500 lb on the swim platform.

- 500 lb + 225 lb = 725 lb
- 725 lb + 165 lb = 890 lb
- 890 lb + 165 lb = 1055 lb
- 1055 lb + 165 lb = 1220 lb
- 1220 lb + 165 lb = 1385 lb
- 1385 lb + 165 lb = 1550 lb
- 1550 lb + 165 lb = 1715 lb

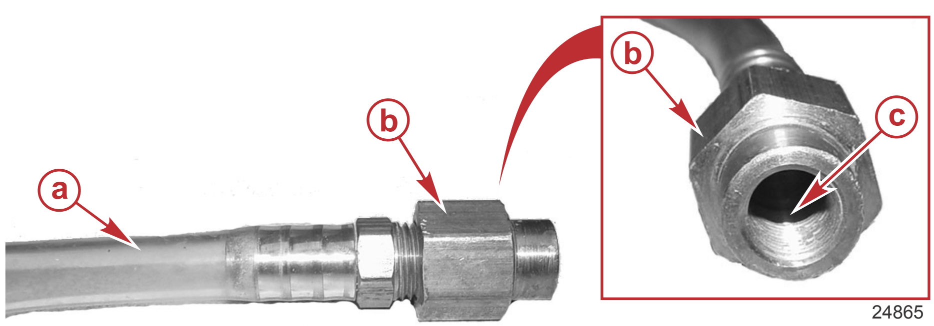


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

1. Obtain an 8–10 mm (5/16–3/8 in.) ID (inner diameter) clear hose approximately 4.5 m (15 ft) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.

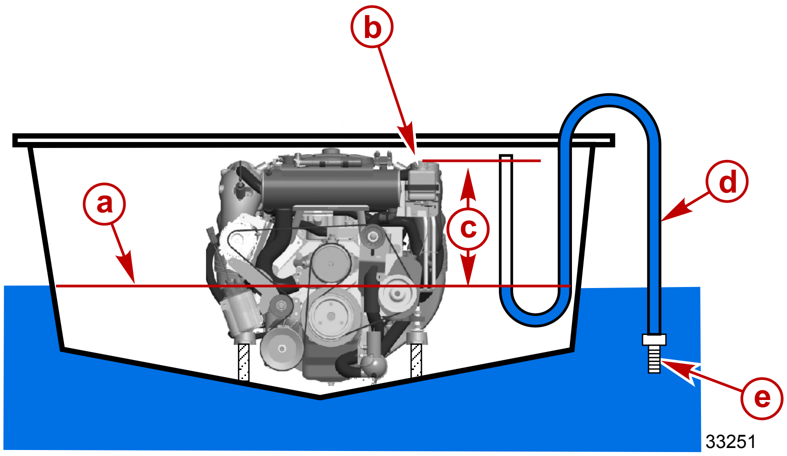


a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.

4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.
8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height.



33251

a - Waterline
b - Top of exhaust elbow
c - Waterline to top of exhaust elbow measurement
d - Clear hose
e - Weight

Electrical Connections—TowSport, Inboard

IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system.

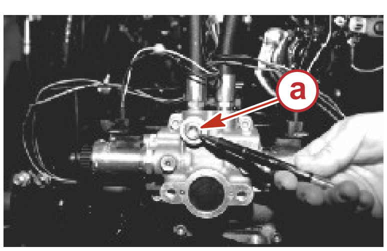
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on the engine and to avoid contact with moving parts.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All electrical connections	92- 25711 3

Audio Warning Temperature Switch Installation—Inboard

1. Remove the plug using a 5/16 in. Allen wrench.



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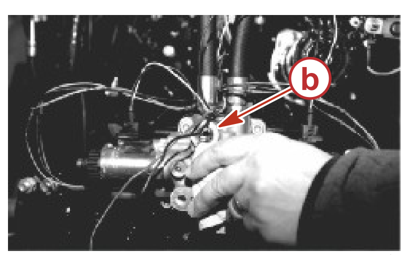

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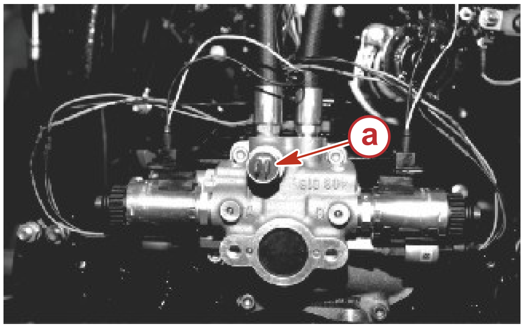
DTS electronic shift transmission
a - Plug
b - Plug removed

2. Apply sealant to the audio warning temperature switch. The first thread should have no sealant to reduce the risk of contamination.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	After the first thread of the audio warning temperature switch	92-809822

3. Install the switch by hand until resistance is felt.

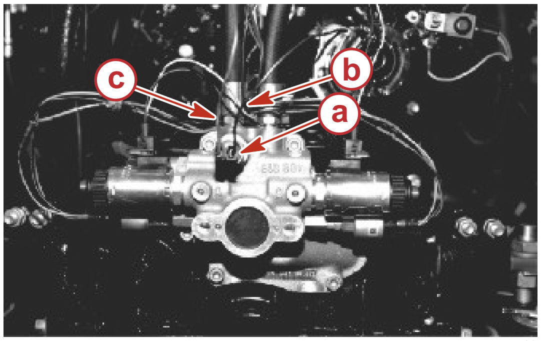
4. Tighten the switch using a 7/8 in. wrench 1 to 1-1/2 turns.



DTS electronic shift transmission

a - Audio warning temperature switch

5. Connect the black and blue/tan wires.



DTS electronic shift transmission

a - Audio warning temperature switch

b - Black wire

c - Blue/tan wire

NOTICE

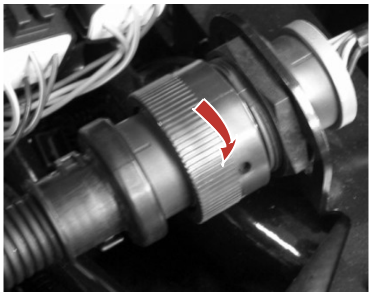
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. Supply cooling water to the engine.
7. Start the engine and check for oil leaks at the threaded connection.

Boat Harness and Instrumentation Connections—Inboard

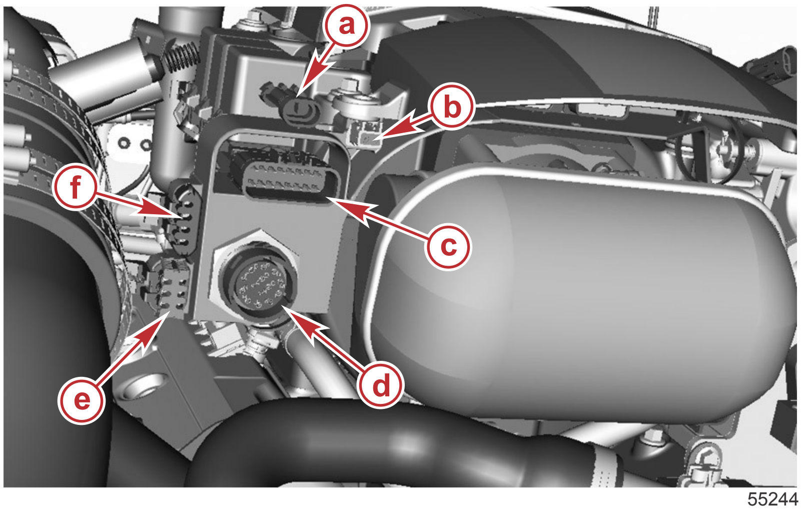
IMPORTANT: The maximum accessory load on the engine harness is 15 amps. If additional accessory load is needed, an accessory kit is available.

1. If an extension harness is required, connect the boat harness to the extension harness and connect the extension harness to the engine harness. Ensure that the harness does not rub or get pinched.
2. Fasten the harnesses to the boat at least every 46 cm (18 in.) using appropriate fasteners.
3. Connect the 14-pin harness to the engine. Turn the locking ring until a firm snap is felt.



Typical 14-pin connection

4. Connect the remaining harnesses to the engine.



a - 5-amp clean power
b - OBD-M MIL
c - 16-pin transom harness
d - 14-pin connection
e - Boat harness (tanks)
f - Depth/RS-485

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are: RPM, coolant temperature, water pressure, battery voltage, fuel consumption, engine operating hours, engine alarm data, and potential problems. The SmartCraft instrument package will also aid in engine diagnostics.

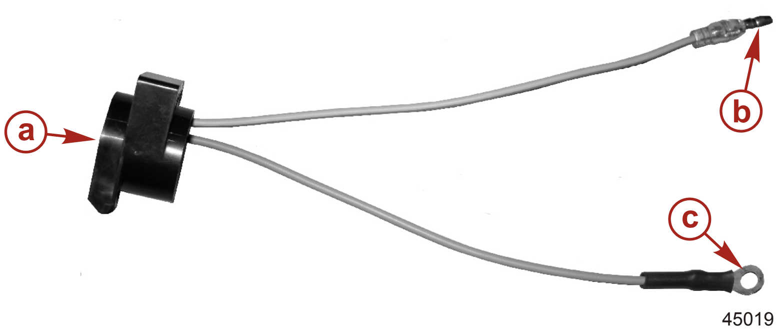
Audio Warning System Connections—TowSport, Inboard

⚠ WARNING

Installing non-potted electrical components in explosive environments can result in serious injury or death from fire or explosion. Install all non-potted electrical components such as warning alarms away from environments where fuel or fuel vapor is present such as engine or fuel tank compartments.

1. Select a location for the audio warning alarm that meets all of the following:
   - Alarm can be easily heard, yet is out of sight.
   - Alarm can be easily accessed for installation and maintenance.
   - Alarm will remain dry.
   - Alarm is within length limits of the 46 cm (18 in.) purple alarm wire that connects to the "I" terminal or 12 volt source on switched side of ignition switch.

   NOTE: *The terminal to which the wire is attached must have no voltage when the ignition switch is in the "OFF" position.*
2. Place the alarm in the desired location and secure it to the wire bundle with the cable tie provided.
3. Connect the tan/blue wire from the alarm to the tan/blue wire from the instrument harness.
4. Connect the purple wire from the alarm to any purple wire terminal on the instrument gauge or ignition switch. Tighten the connection securely.

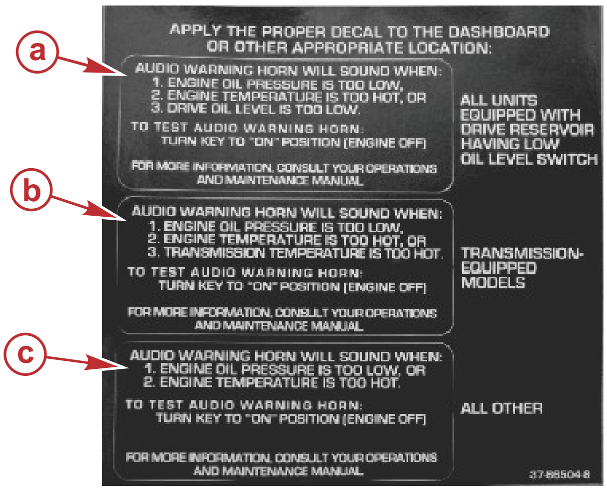


a - Alarm
b - Tan/blue wire
c - Purple wire

5. Place the small transparent alarm decals on the bottom of the water temperature and the oil pressure gauges.

Small transparent alarm decals

6. Choose the proper large decal for the engine package installed and place it on the instrument panel or other appropriate location easily viewed by the operator.



- **a -** Models equipped with a drive reservoir having low oil level switch
- **b -** Models equipped with a transmission
- **c -** All other models

7. Test the audio warning system as detailed.
   a. Turn the ignition switch to the "ON" position without cranking the engine.
   b. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Service Engine Light and OBD-M MIL Kit

Boats powered by emissions control technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash-mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash-mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

SC 1000 gauge and service engine light

Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL will remain illuminated for four seconds if the visual indication system is functioning correctly.

Battery Cables Connection

IMPORTANT: Engine electrical system is negative (–) ground.

1. Connect engine positive (+) battery cable (usually red) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually black) to negative (–) battery terminal.
3. Install the power harness. Refer to **Section 7** - **Power Harness**.
4. Secure the battery cables and the power harness leads to the battery with hex nuts. Tighten the hex nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Hex nut	13.5	120	–

5. Spray battery terminals with a battery connection sealant to help prevent corrosion.

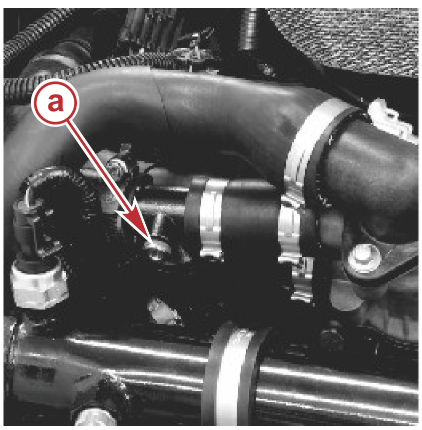
Shaft Log Seal Connection

NOTICE

Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.

The propeller shaft log seal hose should be routed so that a portion of the hose extends above the top of the engine exhaust elbows to prevent a siphoning action when the engine is not running. The hose must be securely fastened to keep it properly positioned.

A plug is installed at the factory into the proper port on the poppet valve hose assembly.



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a - Shaft log seal plug

IMPORTANT: If not using a shaft log seal, this plug must remain installed.

1. Remove the plug from the poppet valve hose assembly.
2. Install the reducer fitting shipped with the parts bag.
3. Attach the shaft log seal cooling water hose to the reducer fitting.
4. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows.
5. Fasten the hose securely to keep it properly positioned.

Propeller Selection

IMPORTANT: The installed propeller must allow the engine to run at its specified maximum WOT RPM. Use an accurate service tachometer to verify engine operating RPM.

It is the responsibility of the boat manufacturer or the selling dealer to equip the power package with the correct propeller. Specified engine WOT and operating RPM range are listed in the **Mercury MerCruiser Operation, Maintenance and Warranty Manual** attached to the engine.

Select a propeller that will allow the engine power package to operate at or near the top end of the recommended WOT operating RPM range with a normal load.

If full throttle operation is below the recommended range, the propeller must be changed to prevent loss of performance and possible engine damage. On the other hand, operating an engine above the recommended operating RPM range will cause higher than normal wear or damage.

After initial propeller selection, the following common problems may require that the propeller be changed to a lower pitch.

- Warmer weather and greater humidity cause a loss of RPM.
- Operating in a higher elevation causes a loss of RPM.
- Operating with increased load (additional passengers, pulling skiers) causes a loss of RPM.

For better acceleration, such as is needed for waterskiing, use the next lower pitch propeller. Do not operate at full throttle when using the lower pitch propeller but not pulling skiers.

Because of the many variables of boat design, only testing will determine the best propeller for a particular application. Available propellers are listed in the **Mercury Precision Parts Accessories Guide**.

6.2L Maximum RPM Specification

Maximum Rated RPM		
Engine	**Model**	**Maximum RPM**
6.2L (sterndrive/inboard)	223 kW (300 hp)	5000–5400
	260 kW (350 hp)	5000–5400
6.2L (TowSport)	238 kW (320 hp)	5000–5400
	275 kW (370 hp)	5000–5400

Boat-in-the-Water Tests

Engine Idle Speed

The engine should idle at the RPM as specified in the appropriate Operation, Maintenance and Warranty Manual with boat in the water, drive unit in forward gear, and the engine at normal operating temperature. If the idle speed is incorrect, ensure that the throttle cable has been adjusted properly.

Adaptive Speed Control (ASC) Propping with G3

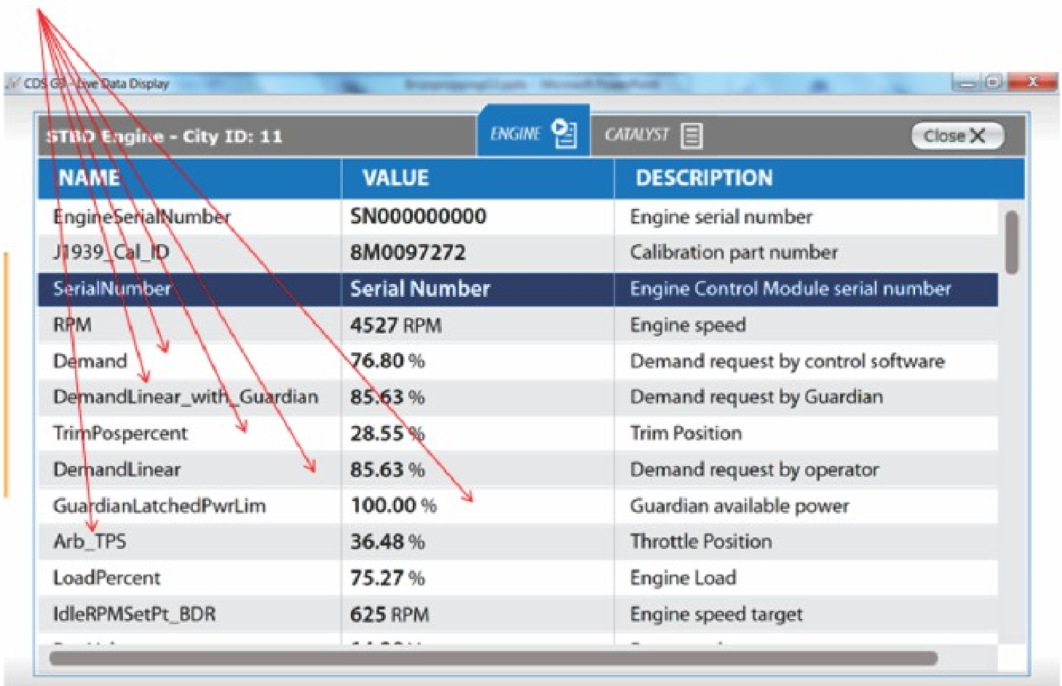
IMPORTANT: **Propping of the boat can be done as normally done with all other MerCruiser products, but to achieve the best optimum propeller selection you can use the propping procedure with the G3 tool to verify your propeller selection.**

NOTE: *The following procedure explains propping on an engine with a RPM specification that is 4800–5200. This same process can be used for other ASC engines with a different RPM range. The dynamic principle is the same. Refer to your engine's wide-open throttle (WOT) range and substitute the minimum/maximum WOT RPM in the following procedure.*

A special propping procedure using CDS G3 should be used for optimum propping.

- Install the best guess propeller.
- Run the engine at 100% Demand Linear (demand request by operator) with optimum trim. The Demand (demand request by control software) and Demand Linear with Guardian (demand request by Guardian) should both equal 100%.
- If RPM is less than 4800 but the Demand (demand request by control software), Demand Linear (demand request by operator), and Demand Linear with Guardian (demand request by Guardian) are all 100%, install a smaller pitch propeller.
- If RPM is greater than 5200 even momentarily, and Demand (demand request by control software) and Demand Linear with Guardian (demand request by Guardian) cannot both reach 100%, install a larger pitch propeller. (This means software Demand is pulling back on the throttle to stop from overspeed.)

- If RPM is between 4800 and 5200, the propeller is correct, depending on the customer's preference.

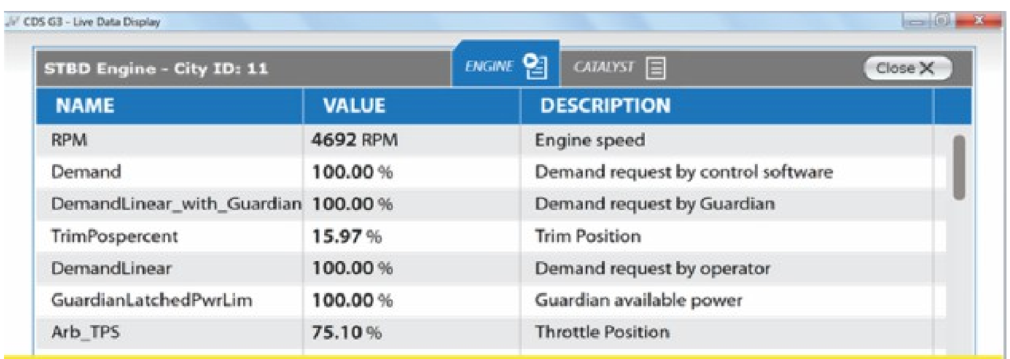


NAME	VALUE	DESCRIPTION
EngineSerialNumber	SN000000000	Engine serial number
J1939_Cal_ID	8M0097272	Calibration part number
SerialNumber	Serial Number	Engine Control Module serial number
RPM	4527 RPM	Engine speed
Demand	76.80 %	Demand request by control software
DemandLinear_with_Guardian	85.63 %	Demand request by Guardian
TrimPospercent	28.55 %	Trim Position
DemandLinear	85.63 %	Demand request by operator
GuardianLatchedPwrLim	100.00 %	Guardian available power
Arb_TPS	36.48 %	Throttle Position
LoadPercent	75.27 %	Engine Load
IdleRPMSetPt_BDR	625 RPM	Engine speed target

57315

Data values moved in G3 data list for 4.5L optimum propping procedure

- Alpha SS Mirage 21 pitch propeller
- Demand request by control software at 100%
- Demand request by Guardian at 100%
- Trim position percent at 15.97% optimum trim for this boat
- Demand request by operator 100%
- RPM at 4692, indicating that the engine is overpropped



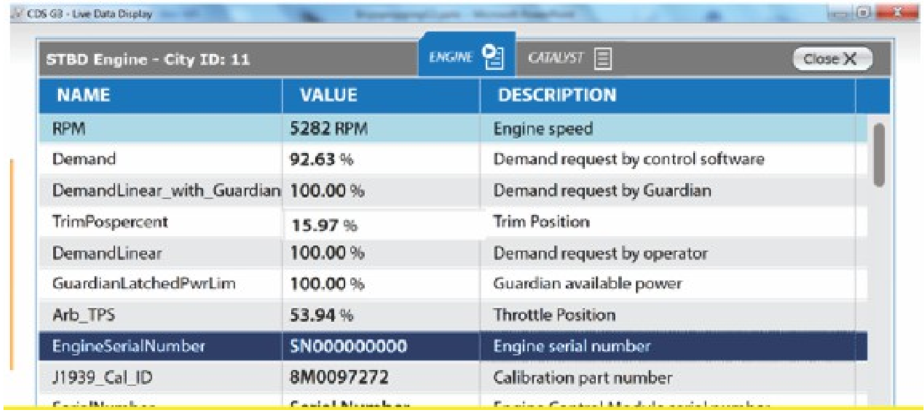
NAME	VALUE	DESCRIPTION
RPM	4692 RPM	Engine speed
Demand	100.00 %	Demand request by control software
DemandLinear_with_Guardian	100.00 %	Demand request by Guardian
TrimPospercent	15.97 %	Trim Position
DemandLinear	100.00 %	Demand request by operator
GuardianLatchedPwrLim	100.00 %	Guardian available power
Arb_TPS	75.10 %	Throttle Position

57316

Nonoptimal propping set up, overpropped

- Alpha SS Mirage 21 pitch propeller
- Demand request by control software at 92.63%
- Demand request by Guardian at 100%
- Trim position percent at 15.97% optimum trim for this boat
- Demand request by operator 100%

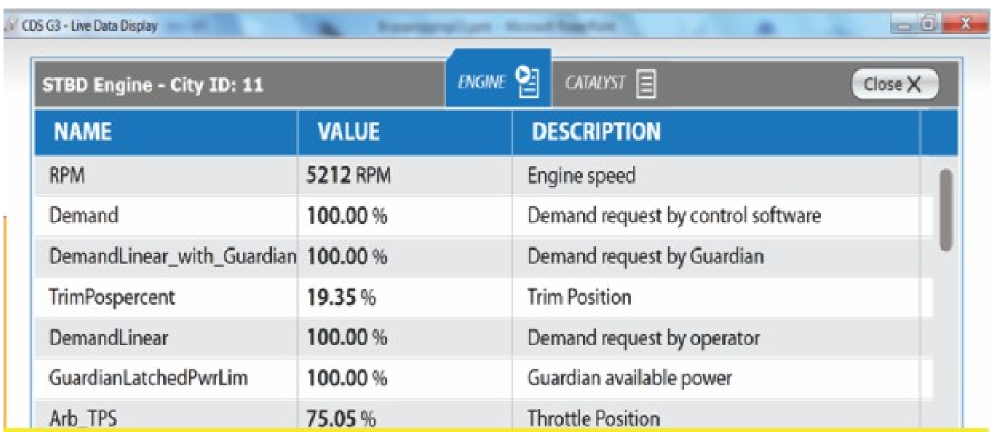
- RPM at 5282, indicating that the engine is underpropped and causing the software to limit the demand and pulling back on the RPMs



57317

Nonoptimal propping set up, underpropped

- Alpha SS Mirage 19 pitch propeller. Data would indicate the optimum propping of this boat.
- Demand request by control software at 100%
- Demand request by Guardian at 100%
- Trim position percent at 19.35% optimum trim for this boat
- Demand request by operator 100%
- RPM at 5212 running at optimum speed



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Example and the order to set up G3 data for the optimum propping using the parameters shown

Wide-Open Throttle Propping Without G3 Test

IMPORTANT: To operate the engine at full throttle before the break-in period is complete, follow this procedure.

1. Place the remote control in neutral, idle speed, and start the engine.
2. Slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
3. Watch all gauges for normal readings.
4. When the engine reaches normal operating temperature, run the boat up on plane.
5. Advance the engine RPM (in 200 RPM increments) until the engine reaches its maximum rated RPM.

Maximum Rated RPM		
Engine	Model	RPM
6.2L (sterndrive/inboard)	223 kW (300 hp)	5000–5400
	260 kW (350 hp)	5000–5400

Maximum Rated RPM		
6.2L (TowSport)	238 kW (320 hp)	5000–5400
	275 kW (370 hp)	5000–5400

6. To test if the correct propeller has been installed, operate the boat (with normal load onboard) at WOT and check RPM with an accurate tachometer. The engine RPM should be near the top of the specified range so that, under a heavy load, the engine speed will not fall below specifications. If the engine speed is too high, replace the propeller with a higher pitch propeller. Normally a 25 mm (1 in.) propeller pitch change causes an RPM change of 150 RPM.
7. Return to idle speed.
8. Shut off the engine.
9. Check the coolant level and add coolant if necessary.

Checking Shift Operation

With sterndrive unit installed and engine operating, ensure that the drive unit shifts properly, as explained following:

1. Shift into forward and reverse gear, ensuring that the clutch engages before the engine begins to accelerate.
2. Accelerate engine while in forward and reverse gear to ensure that the engine does not stop.
3. If the proper results are not achieved in the previous steps, shift cables must be readjusted.
4. Shifting from forward and reverse to neutral: ensure drive unit is in neutral before remote control shift lever comes to the neutral detent position. Perform this check using various shifting rates to ensure that the drive unit shifts the same whether shifting fast or slow.

Notes:

Engine Mechanical

Section 3A - Engine Disassembly

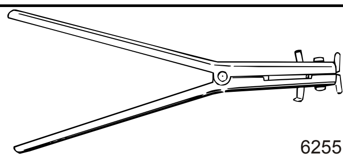
Table of Contents

3
A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Cylinder bores and other machined surfaces	Obtain Locally

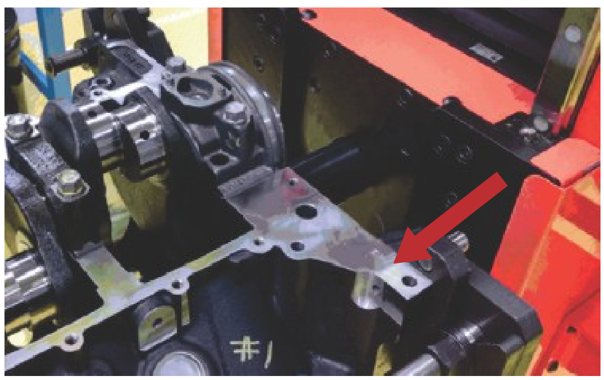
Special Tools

Piston Ring Expander	91-24697
 6255	Expands piston rings for removal and installation.

Engine Block Codes

Identification

The engine can be determined by using the block code. This code contains a component code, family code, and year and time code.



57249

Block code stamped on starter mounting boss

Position	Description	Example
1	Component code	A - Head assembly
		B - **Cast block**
		C - Crank
		D - Camshaft
		E - Electric box assembly
		F - IAFM
		G - Gearcase
		H - Cast head
		J - Power trim assembly
		K - Fuel supply module
		L - AMS counter rotation
		M - IOM
		N - Fuel rail
		P - Connecting rod
		R - AMS standard rotation
		S - Supercharger
		T - Balance shaft
2	Family code	A - Verado 4 cylinder SC, 6 cylinder SC
		B - Verado 4 cylinder SC
		C - Verado 6 cylinder SC
		D - Verado 4 cylinder NA
		E - Available
		F - Available
		G - Verado 4 cylinder SC, 4 cylinder NA
		H - Verado 4 cylinder SC, 4 cylinder NA and 6 cylinder SC
		J - 4 cylinder 135/150 hp
		K - 4 cylinder SC 175 hp
		L - Bedrock
		M - MerCruiser common
		N - MerCruiser V6
		P - MerCruiser V8
		T- Tigershark
		Z - Verado 350 hp racing
		X - Multi-Family part usage
3	Year	The last digit of the build year
4–6	Julian day	The julian day of the build year
7–8	Military hour	Two digit military hour of the build day
9–10	Sequence number	The build sequence within the build hour

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.

Tools

Kent-Moore

The tools listed below are some of those available from Kent-Moore Corporation. Equivalent tools may be available from other tool manufacturers. Regardless of supplier, always use the correct tool for the task at hand.

IMPORTANT: Part numbers are subject to change. Verify the correct tool part number with Kent-Moore.

Kent-Moore
28635 Mound Road
Warren, MI 48092-3499
1-800-345-2233

Description	Part Number
Valve spring compressor (cylinder head on the engine)	J5892-D
Valve spring compressor (cylinder head off the engine)	J8062
Valve spring compressor (for testing)	J9666
Carbon removing brush	J8089
Piston ring groove cleaner	J3936-O3
Piston ring compressor	J8037
Cam bearing remover and installer	J6098-O1
Cam bearing remover and installer adapter	J6098-10
Harmonic damper remover and installer	J23523-F
Front cover seal installer	J35468
Crankshaft sprocket puller	J5825-A
Spark plug port adapter	J23590
Main bearing shell remover	J8080
Rear main seal installer (modifications needed)	J35621-B
Fuel line disconnect tool	J44581
Bushing/bearing remover (modifications needed)	J26941

Precautions

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ CAUTION

Using compressed air can cause serious injury. Always wear eye protection when working with compressed air to prevent injury from ruptured hoses or flying debris.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

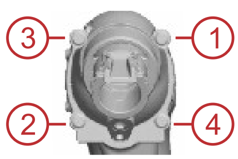
NOTICE

Water trapped in the seawater section of the cooling system can cause corrosion or freeze damage. Drain the seawater section of the cooling system immediately after operation or before any length of storage in freezing temperatures. If the boat is in the water, keep the seacock closed until restarting the engine to prevent water from flowing back into the cooling system. If the boat is not fitted with a seacock, leave the water inlet hose disconnected and plugged.

IMPORTANT: Lubricate all moving engine components with clean engine oil or other specified lubricant during assembly.

Torque Specifications

External Engine Components

Description		Nm	lb-in.	lb-ft
Alternator mounting fasteners		27	–	20
Engine coolant temperature (ECT) sensor		16.3	144.2	–
Engine mount, front bracket		62	–	45.7
Exhaust manifold screws—use torque sequence listed for each pass	First pass	27	–	20
	Second pass	54	–	39.8
 59457	Final pass	54	–	39.8
Exhaust elbow screws—tighten screws using an X-pattern, use torque sequence listed for each pass	First pass	46	–	33.9
 57899	Final pass	46	–	33.9
Fuel rail bracket screws		12.2	108	–
Coil to coil bracket screws		4.5	39.8	–
MAPT sensor screw		7	61.9	–
Seawater pump bracket to block		40.6	–	29.9
Seawater pump bracket to block—steel stud/nut		67.7	–	49.9
Starter motor screws		47.5	–	35
Engine flywheel screws		80	–	59
Engine block coolant drain hole plug		20	177	–
Flywheel housing studs and screws		50	–	36.9
Flywheel housing cover		9	79.6	–
Oil drain plug		24	–	17.7
Oil pressure sensor—top of engine		17	150.4	–
Oil line to oil filter base screws		13.1	115.9	–
Oil pump cover screw		10.5	92.9	–
Thermostat cap to crossover screws—standard and closed cooling		27	–	20
Crossover to head screws—standard and closed cooling		27	–	20
Throttle body screws		11	97.3	–
Water circulating pump fasteners—3 screws, 1 stud		29	–	21.4
Water pump pulley screws		27	–	20

General Information

Repair Guidelines

- Follow all warning, cautions, and notices contained in this manual.
- Disconnect the battery prior to performing any repair procedures.
- Boat design factors and the nature of particular repairs may require that the engine be removed from the boat. Place the engine on a repair stand for major repairs.
- Lubricate all moving parts during assembly with clean engine oil or as specified. Apply appropriate lubricant, sealant, or adhesive to all fasteners as specified.

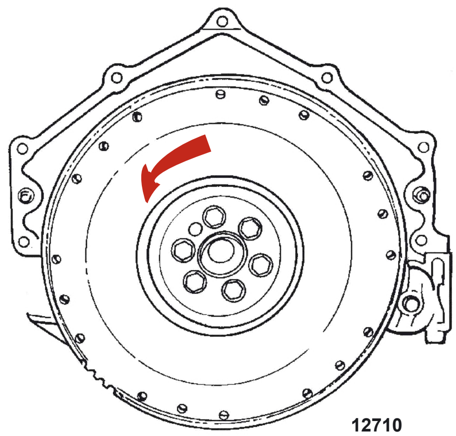
IMPORTANT: To facilitate service or repair, some external components that are not mentioned in this section's procedural steps must be removed. Refer to the appropriate sections of this manual for service information concerning any external component that interferes with engine service or repair.

Engine Rotation

Engine rotation is observed from the rear of the engine (transmission or sterndrive end) looking forward (water pump end).

Engine rotation is not necessarily the same as propeller rotation.

IMPORTANT: All engines covered by this service manual are left-hand (LH) rotation.

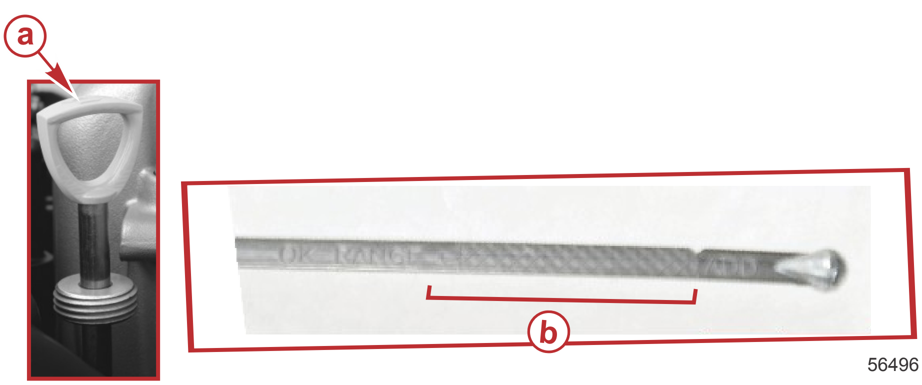


Left-hand rotation (counterclockwise)

Crankcase Oil Dipstick Measurements

IMPORTANT: Crankcase dipsticks from different applications are not interchangeable.
IMPORTANT: Do not overfill engine crankcase with oil. Fill to the operating range only.

1. Stop the engine. Allow approximately five minutes for the oil to drain into the oil pan. The boat must be at rest in the water.

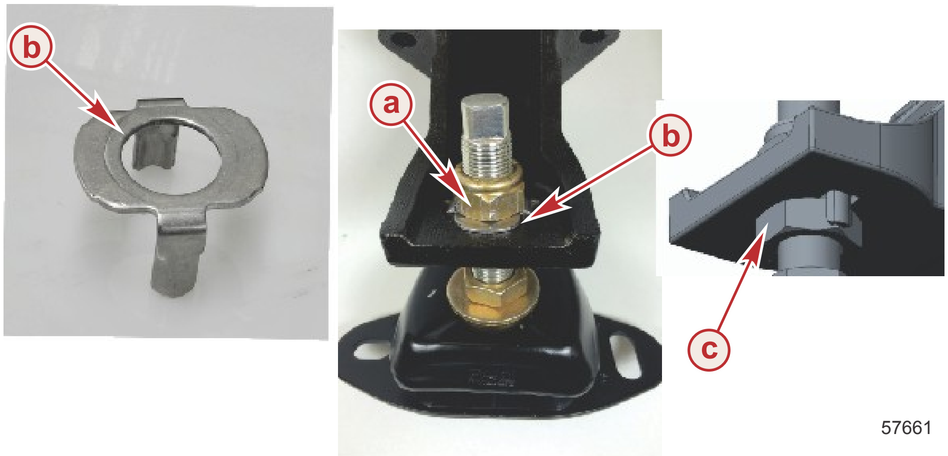


a - Oil dipstick handle
b - Operating range

2. Remove the dipstick. Wipe clean and insert fully into the dipstick tube. Wait 60 seconds to allow trapped air to vent.

Sterndrive Engine Mounts

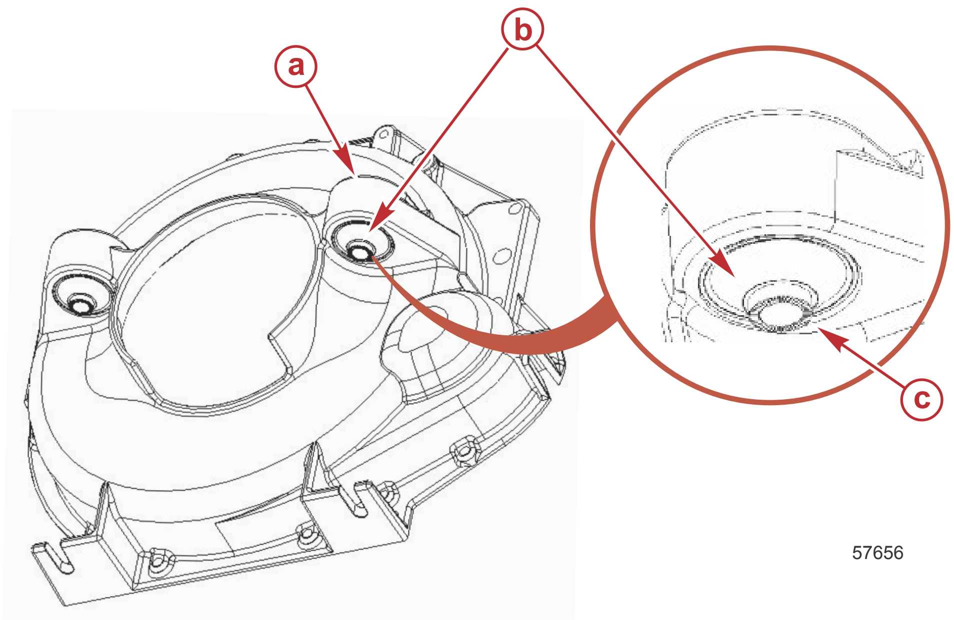
Front Mounts



- a - Nylock top nut
- b - Lock collar
- c - Adjustment nut

Rear Mounts

NOTE: White or yellow paint is used to identify the top of the mount assembly. The bottom has a knurled edge.

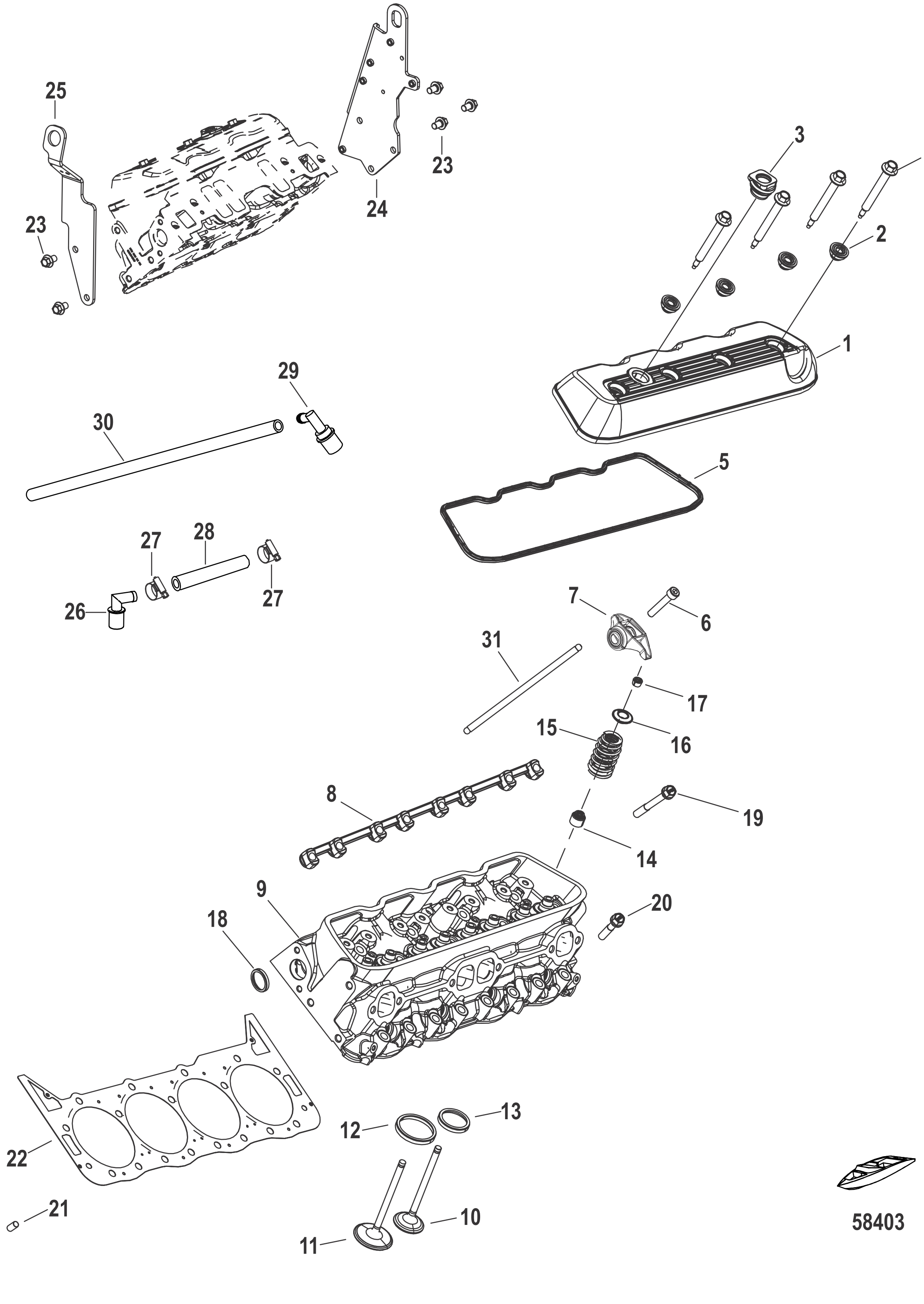


Typical flywheel housing, all similar

- a - Painted end (not visible)
- b - Mount bottom
- c - Knurled edge

Engine Components

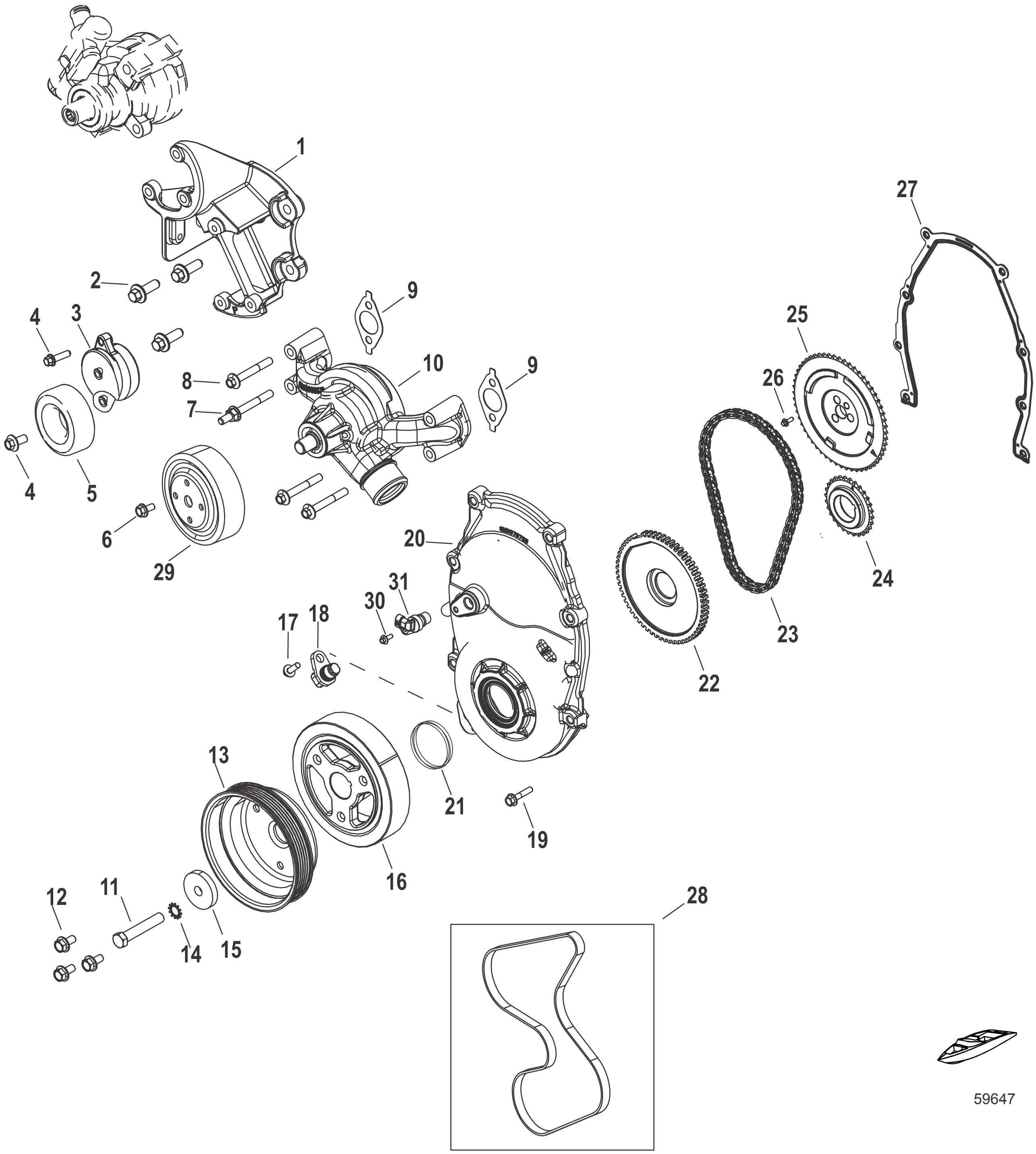
Cylinder Head and Rocker Cover Components



Cylinder Head and Rocker Cover Components

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	2	Rocker cover				
2	4	Grommet				
3	2	Grommet				
4	8	Rocker cover screw		15	132.7	–
5	2	Rocker cover seal				
6	16	Rocker arm bolts	First	30	–	22.1
			Second	Rotate engine 360°		
			Final torque	30	–	22.1
7	16	Rocker arm				
8	2	Rocker arm support				
9	2	Cylinder head				
10	8	Exhaust valve				
11	8	Intake valve				
12	8	Valve seat—not serviced				
13	8	Valve seat—not serviced				
14	16	Valve seal				
15	16	Spring				
16	16	Retainer				
17	32	Keeper				
18	2	Expansion plug				
19	18	Head bolt (M10 x 1.5 x 49)	First	15	132.7	–
			Second	30	–	22.1
			Final torque	+45°		
20	16	Head bolt (M10 x 1.5 x 86)	First	15	132.7	–
			Second	30	–	22.1
			Final torque	+45°		
21	4	Dowel pin				
22	2	Head gasket				
23	7	Screw		57	–	42
24	1	Starboard rear—lifting eye bracket				
25	1	Starboard front—lifting eye bracket				
26	1	Elbow, 90°				
27	2	Clamp				
28	1	Hose				
29	1	PCV valve				
30	1	Hose				
31	16	Pushrod				

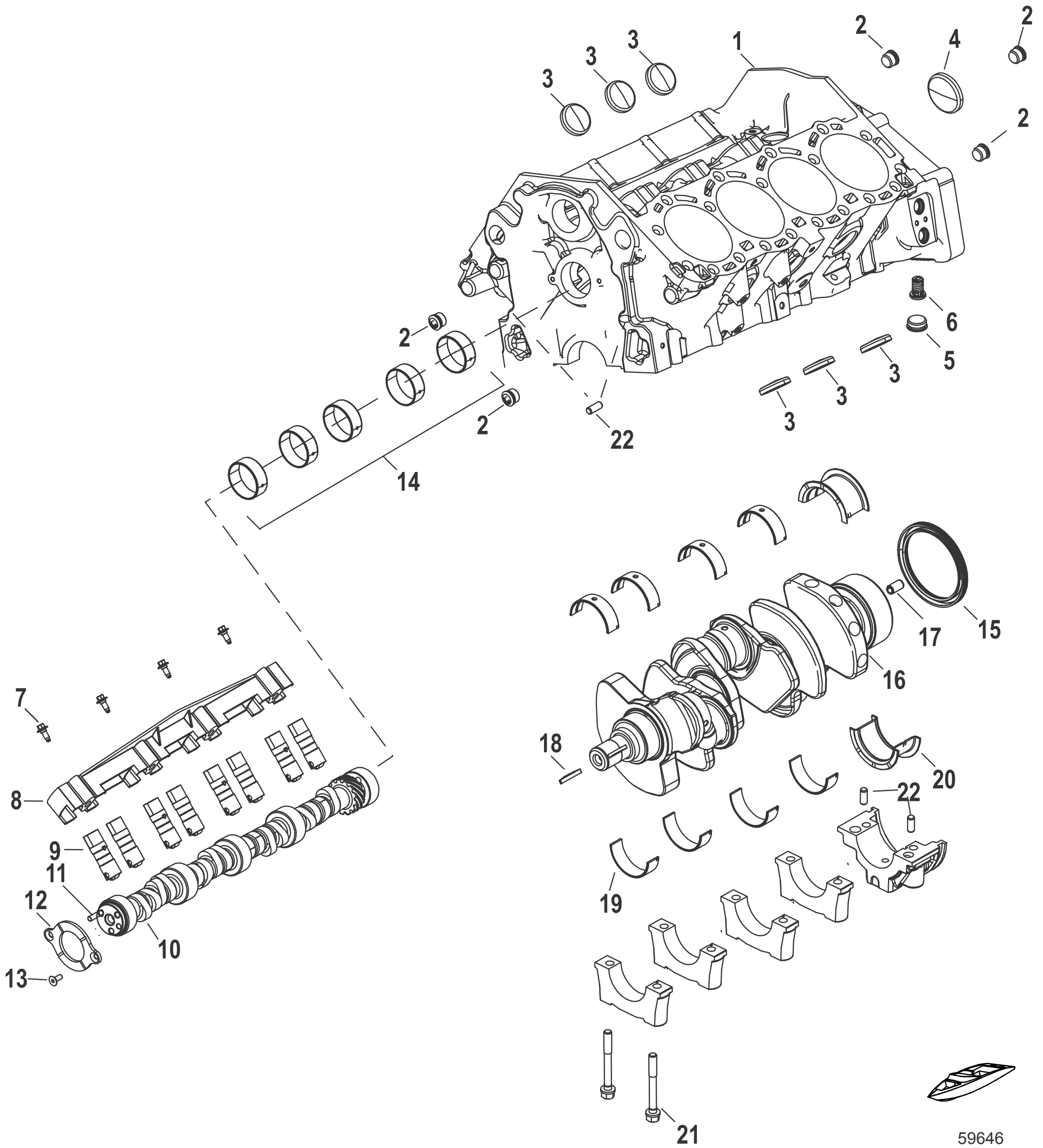
Timing Chain and Front Cover Components



Timing Chain and Front Cover Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Steering pump bracket			
2	3	Screw			
3	8	Belt tensioner			
4	2	Screw			
5	1	Pulley			
6	4	Screw	26.4	–	19.5
7	3	Stud	29	–	21.4
8	1	Bolt	29	–	21.4
9	2	Gasket			
10	1	Water pump			
11	1	Screw	102	–	75.2
12	3	Screw	27	–	19.9
13	1	Crankshaft pulley			
14	1	Lockwasher			
15	1	Washer			
16	1	Harmonic damper			
17	1	Crank sensor screw	10	88.5	–
18	1	Crank sensor			
19	6	Screw	12	106.2	–
20	1	Timing front cover			
21	1	Seal			
22	1	Reluctor wheel			
23	1	Timing chain			
24	1	Crankshaft timing gear			
25	1	Cam timing gear			
26	3	Timing gear screws	30	–	22.1
27	1	Timing front cover gasket			
28	1	Belt			
29	1	Water pump pulley			
30	1	Screw	10	88.5	–
31	1	Cam sensor			

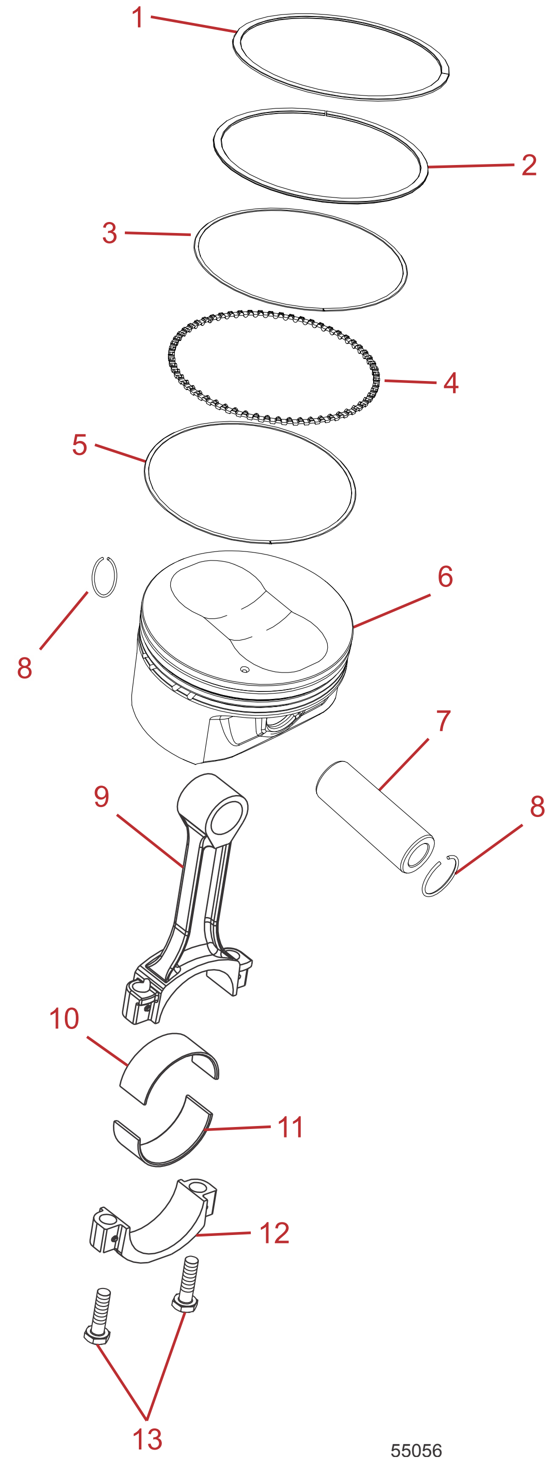
Crankshaft and Camshaft



Crankshaft and Camshaft

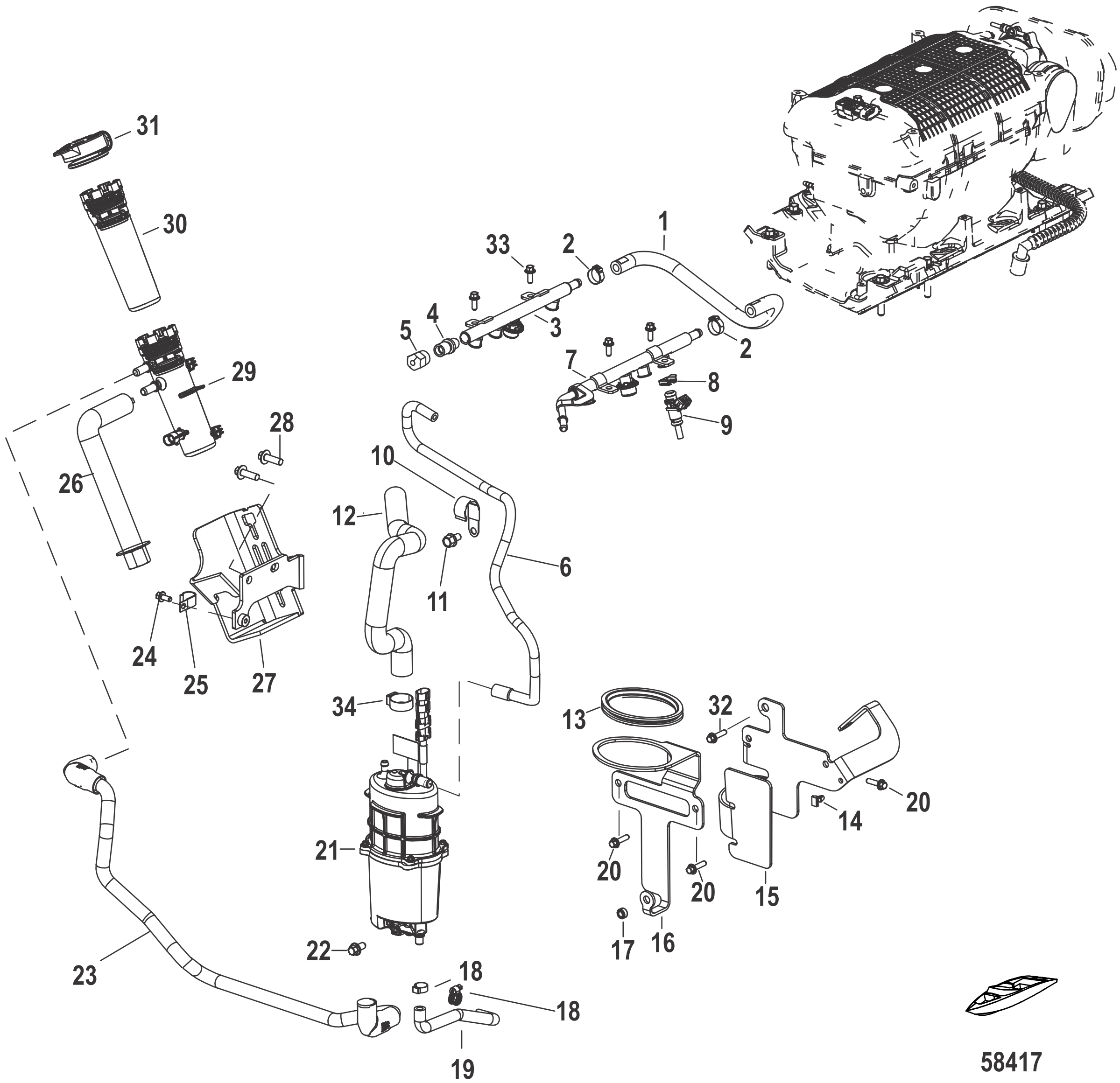
<table>
<tr><th rowspan="2">Ref. No.</th><th rowspan="2">Qty.</th><th rowspan="2" colspan="2">Description</th><th colspan="3">Torque</th></tr>
<tr><th>Nm</th><th>lb-in.</th><th>lb-ft</th></tr>
<tr><td>1</td><td>1</td><td colspan="2">Block</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>5</td><td colspan="2">Plug</td><td>22</td><td>–</td><td>16.2</td></tr>
<tr><td>3</td><td>6</td><td colspan="2">Expansion plug</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>1</td><td colspan="2">Plug</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>1</td><td colspan="2">Plug</td><td>55</td><td>–</td><td>40.5</td></tr>
<tr><td>6</td><td>1</td><td colspan="2">Oil bypass valve</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>8</td><td colspan="2">Screw</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>2</td><td colspan="2">Lifter guide</td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>16</td><td colspan="2">Lifter</td><td></td><td></td><td></td></tr>
<tr><td>10</td><td>1</td><td colspan="2">Camshaft</td><td></td><td></td><td></td></tr>
<tr><td>11</td><td>1</td><td colspan="2">Dowel pin—part of camshaft not serviced separate</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>1</td><td colspan="2">Retainer</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td>2</td><td colspan="2">Screw</td><td>12</td><td>106.2</td><td>–</td></tr>
<tr><td>14</td><td>1</td><td colspan="2">Camshaft bearing set</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>1</td><td colspan="2">Crankshaft oil seal</td><td></td><td></td><td></td></tr>
<tr><td>16</td><td>1</td><td colspan="2">Crankshaft</td><td></td><td></td><td></td></tr>
<tr><td>17</td><td>1</td><td colspan="2">Dowel pin</td><td></td><td></td><td></td></tr>
<tr><td>18</td><td>1</td><td colspan="2">Key</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>1</td><td colspan="2">Main bearing set</td><td></td><td></td><td></td></tr>
<tr><td>20</td><td>1</td><td colspan="2">Thrust bearing</td><td colspan="3"></td></tr>
<tr><td rowspan="3">21</td><td rowspan="3">10</td><td rowspan="3">Main bearing bolt</td><td>First torque</td><td>15</td><td>132.7</td><td>–</td></tr>
<tr><td>Second torque</td><td>40</td><td>–</td><td>29.5</td></tr>
<tr><td>Final torque</td><td colspan="3">+90°</td></tr>
<tr><td>22</td><td>4</td><td colspan="2">Dowel pin</td><td></td><td></td><td></td></tr>
</table>

Piston and Connecting Rod



Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	6	Upper compression ring				
2	6	Lower compression ring				
3	6	Upper oil control ring				
4	6	Oil control ring spacer				
5	6	Lower oil control ring				
6	6	Piston				
7	6	Piston pin				
8	12	Snap ring (2)				
9	6	Connecting rod				
10	6	Upper bearing half				
11	6	Lower bearing half				
12	6	Bearing cap				
13	12	Bolts	First torque	25	–	18.4
			Final (angle torque)	+ 90°		

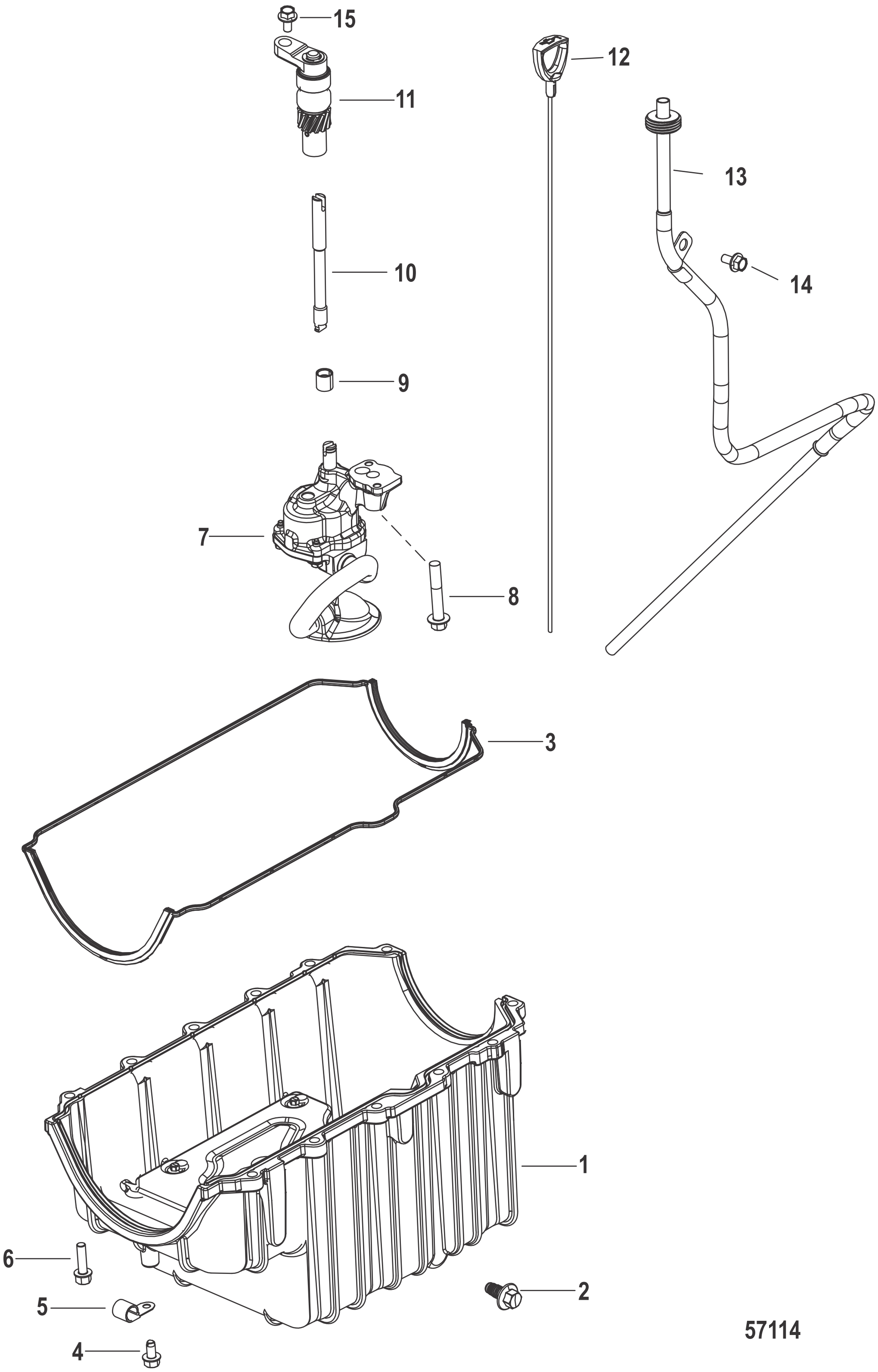
Intake Manifold and Fuel Rail (MPI)



Intake Manifold and Fuel Rail (MPI)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Balance hose			
2	2	Clamp			
3	1	Starboard fuel rail			
4	1	Valve assembly			
5	1	Cap			
6	1	Fuel regulator hose			
7	1	Port fuel rail			
8	3	Clip			
9	8	Fuel injector			
10	1	J-clip			
11	1	Screw			
12	1	Fuel supply module to fuel rail hose			
13	1	Grommet			
14	1	Clip			
15	1	Bracket			
16	1	Bracket			
17	1	Stainless steel washer			
18	2	Worm gear clamp			
19	1	Fuel module to water strainer hose			
20	3	Screw			
21	3	Fuel supply module—dual pump			
22	1	Screw	10	88.5	–
23	1	Fuel filter to fuel module line			
24	1	Screw			
25	1	Clamp			
26	1	Hose to fuel tank			
27	1	Bracket			
28	2	Screw	27	–	19.9
29	1	Filter assembly			
30	1	Fuel filter			
31	1	Cap			
32	1	Screw			
33	4	Stainless steel screw	12	106.2	–
34	1	Worm gear clamp			

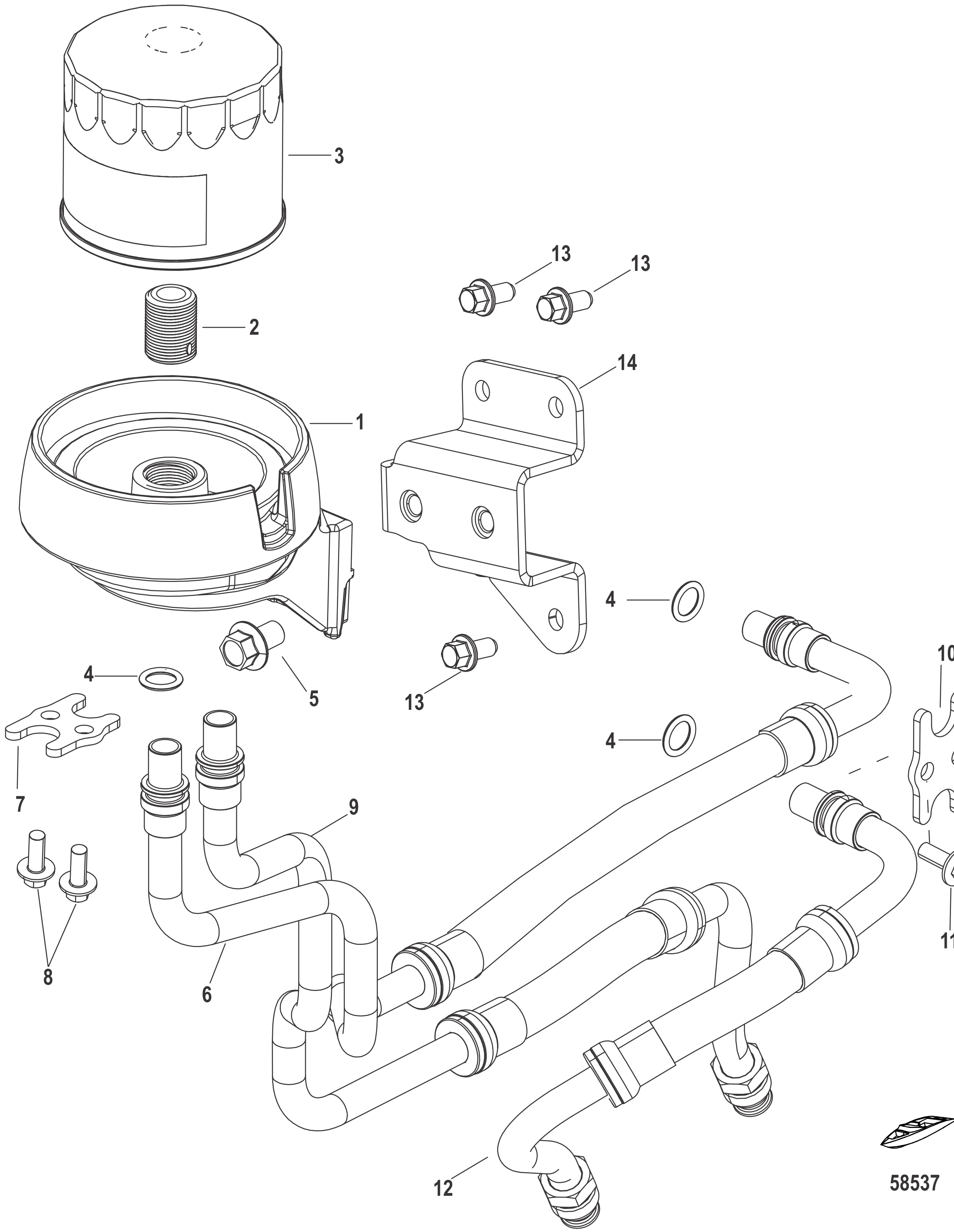
Oil Pan and Oil Pump



Oil Pan and Oil Pump

<table>
<tr><th rowspan="2">Ref. No.</th><th rowspan="2">Qty.</th><th rowspan="2" colspan="2">Description</th><th colspan="3">Torque</th></tr>
<tr><th>Nm</th><th>lb-in.</th><th>lb-ft</th></tr>
<tr><td>1</td><td>1</td><td colspan="2">Oil pan</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>1</td><td colspan="2">Oil drain plug</td><td>24</td><td>–</td><td>17.7</td></tr>
<tr><td>3</td><td>1</td><td colspan="2">Oil pan gasket</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>1</td><td colspan="2">Screw</td><td>24</td><td>–</td><td>17.7</td></tr>
<tr><td>5</td><td>1</td><td colspan="2">U-clamp</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>12</td><td colspan="2">Oil pan screw</td><td>35</td><td>–</td><td>25.8</td></tr>
<tr><td>7</td><td>1</td><td colspan="2">Oil pump</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">1</td><td rowspan="2">Oil pump screw</td><td>First torque</td><td>20</td><td>177</td><td>–</td></tr>
<tr><td>Final torque</td><td colspan="3">+ 65º</td></tr>
<tr><td>9</td><td>1</td><td colspan="2">Retainer</td><td></td><td></td><td></td></tr>
<tr><td>10</td><td>1</td><td colspan="2">Oil pump shaft</td><td></td><td></td><td></td></tr>
<tr><td>11</td><td>1</td><td colspan="2">Oil pump drive</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>1</td><td colspan="2">Dipstick</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td>1</td><td colspan="2">Dipstick tube</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>1</td><td colspan="2">Dipstick tube screw</td><td>11.5</td><td>101.8</td><td>–</td></tr>
<tr><td>15</td><td>1</td><td colspan="2">Screw</td><td>30</td><td>–</td><td>22.1</td></tr>
</table>

Remote Oil Filter



Remote Oil Filter

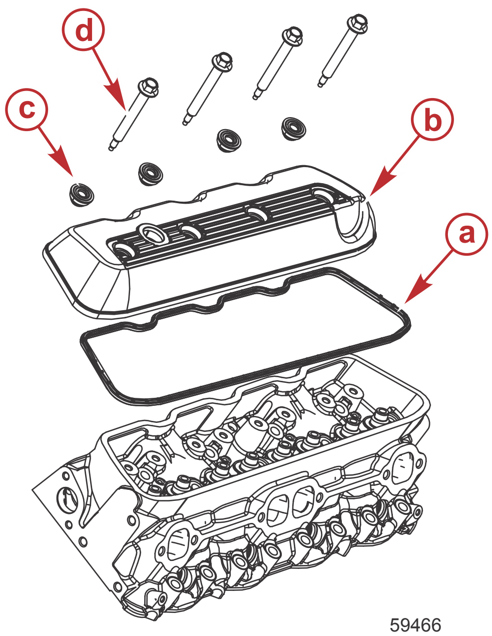
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Remote oil filter housing			
2	1	Fitting			
3	1	Oil filter			
4	4	O-ring			
5	2	Screw, M10 x 16			
6	1	Oil filter to block oil line			
7	1	Bracket			
8	2	Screw, M6 x 12	31.1	–	22.9
9	1	Oil cooler to filter oil line			
10	1	Bracket			
11	2	Screw, M6 x 12	31.1	–	22.9
12	1	Block to cooler oil line			
13	3	Screw, M8 x 16			
14	1	Bracket			

Rocker Arm Cover

Removal

*NOTE: For some applications it may be necessary to remove the exhaust manifold before removing a rocker arm cover. Refer to **Section 7** for exhaust manifold removal.*

1. Remove the engine wiring harness. Refer to **Section 3D** - **Engine Wiring Harness.**
2. Disconnect the crankcase ventilation hoses.
3. Remove any items that interfere with the removal of the rocker arm covers.
4. Remove the rocker arm covers.



59466

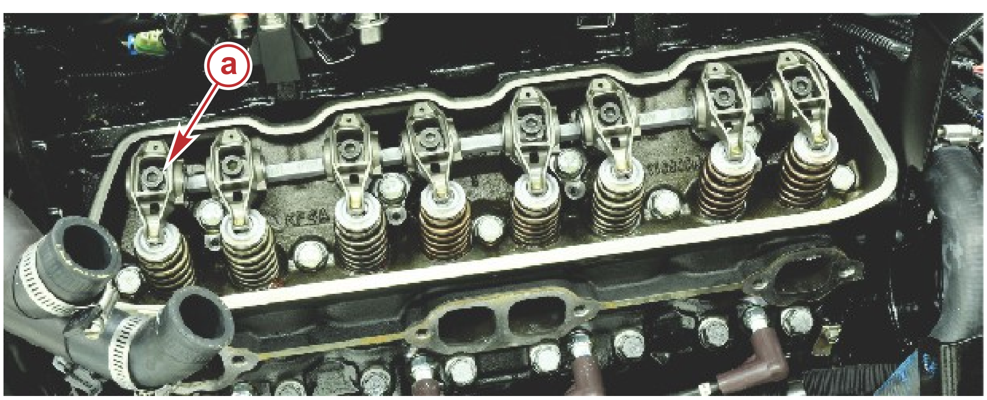
a - Rocker arm cover gasket
b - Rocker arm cover
c - Grommets
d - Screws

Rocker Arms and Valve Pushrods

Removal

NOTE: When servicing only one cylinder's rocker arms, bring that cylinder's piston up to top dead center (TDC) before removing the rocker arms. When servicing all rocker arms, bring cylinder number 1 piston up to TDC before removing the rocker arms.

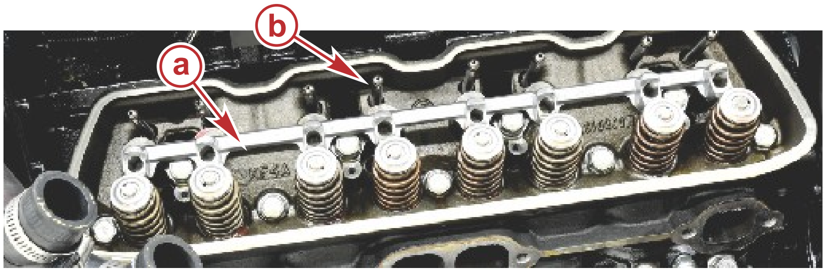
1. Remove the rocker arms.



59507

a - Rocker arm retaining screw

2. Remove the rocker arm support assemblies and pushrods.



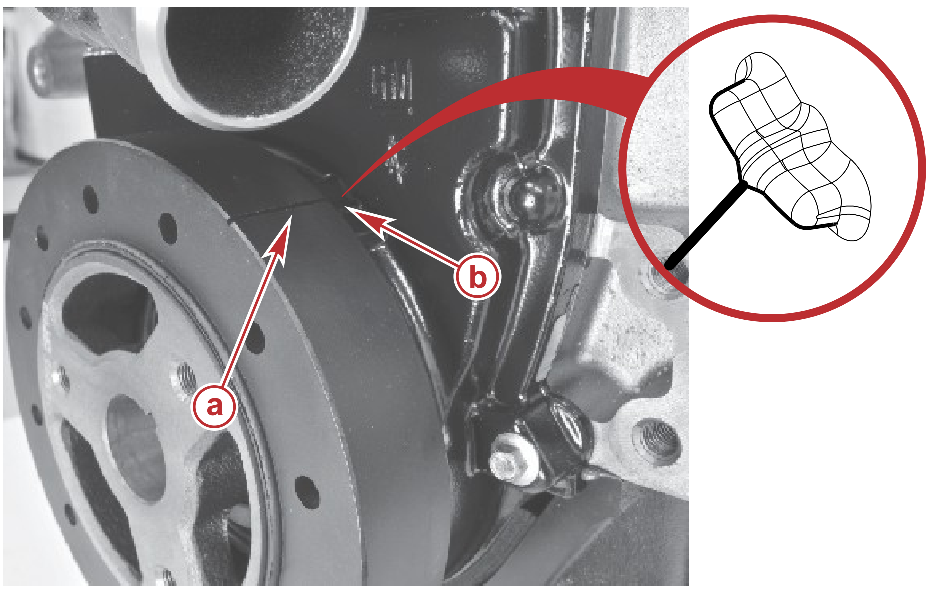
59510

a - Rocker arm support assemblies
b - Pushrod

NOTE: Organize and store the rocker arm assemblies and pushrods in sets for assembly in their original locations.

Finding Top Dead Center (TDC)

IMPORTANT: Do not insert anything into a spark plug hole while turning the engine over.



54990

0° timing mark on harmonic damper **Pulley and belt removed for clarity**

a - Timing mark on harmonic damper
b - Timing mark on timing chain cover

NOTE: Cylinder number 1 is the foremost cylinder on the left side of the engine, as observed from the rear of the engine.

Position cylinder number 1 at TDC. Use one of the following methods:

Method 1

1. Remove the cylinder number 1 spark plug.
2. Attach a suitable socket wrench to the crankshaft pulley nut.
3. Place a finger over the plug hole and turn the engine over in its normal rotation until compression is felt in the number 1 cylinder.
4. Continue turning the engine over by hand until the block-mounted timing pointer aligns with the 0° timing mark on the harmonic damper.

Method 2

1. Attach a suitable socket wrench to the crankshaft pulley nut.
2. Remove the left (as observed from the rear of the engine) rocker arm cover and turn the engine in its normal rotation until the number 1 cylinder intake valve is fully closed.
3. Continue turning the engine over by hand until the block-mounted timing pointer aligns with the 0° timing mark on the harmonic damper.

Intake Manifold Assembly

NOTE: The intake manifold may be removed as an assembly. Unless service is required, it is not necessary to remove individual intake manifold components other than as outlined. See ***Section 5*** *for disassembly, cleaning, inspection, and assembly of individual intake manifold components.*

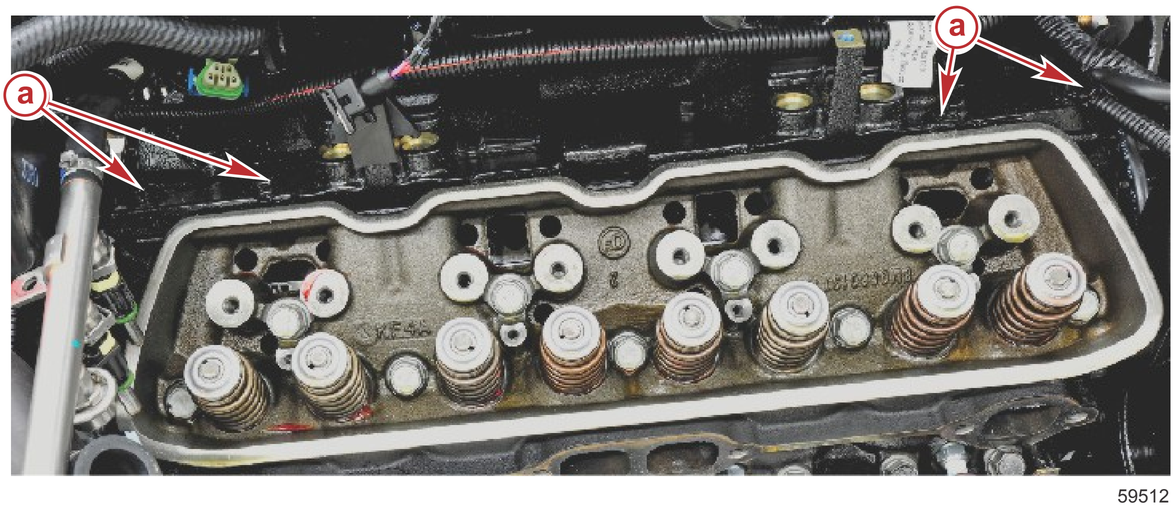
Removal

1. Remove the fuel injectors with the fuel rail. Refer to **Section 5A** - **Fuel Rail.**

⚠ WARNING
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

IMPORTANT: Do not allow dirt or debris to enter the fuel system. Seal the ends of the open fuel lines.

2. Remove the alternator. Refer to **Section 4C** - **Alternator Removal.**
3. Disconnect any other items that interfere with the removal of the intake manifold.
4. Remove the eight intake manifold bolts.

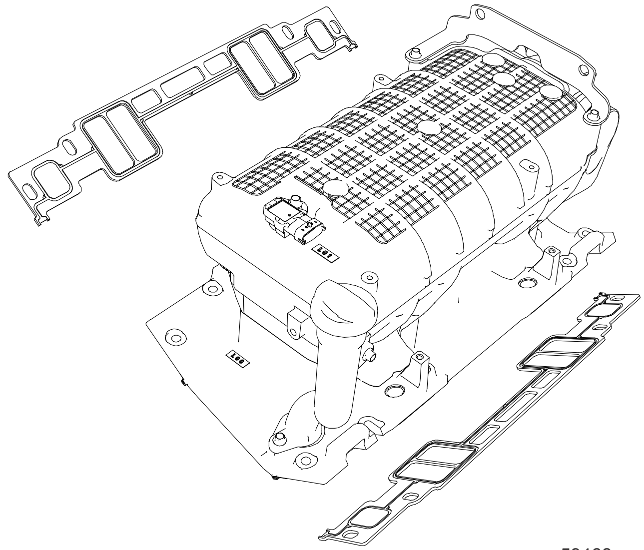


Left side shown

a - Intake manifold bolts

IMPORTANT: It may be necessary to pry the intake manifold away from the cylinder heads and block. Use extreme care to prevent damage to the sealing surfaces.

5. Remove the intake manifold assembly.



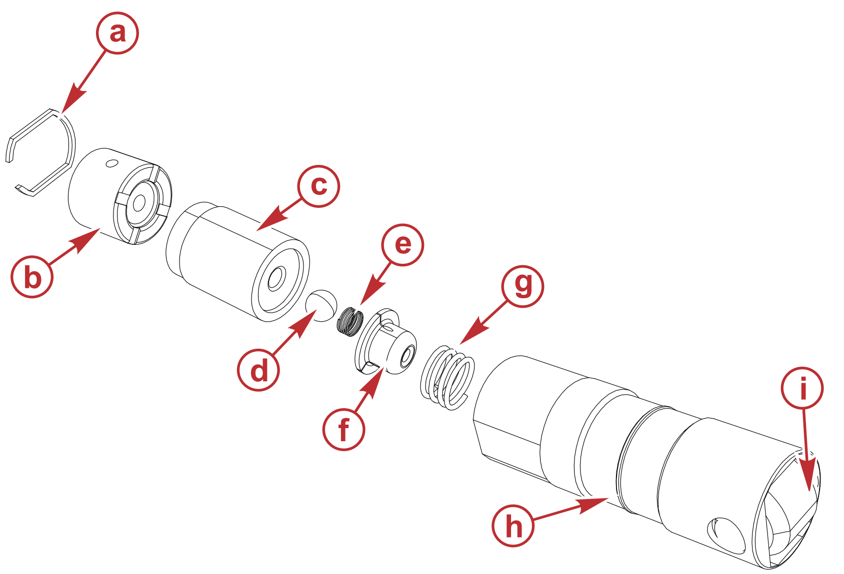
59468

6. Remove and discard the intake manifold gaskets.

NOTE: If the intake manifold requires replacement, transfer all components to the new manifold.

Hydraulic Valve Lifters

Exploded View



55004

- a - Pushrod seat retainer clip
- b - Pushrod seat
- c - Plunger
- d - Check ball
- e - Check ball spring
- f - Check ball retainer
- g - Plunger spring
- h - Lifter body
- i - Roller

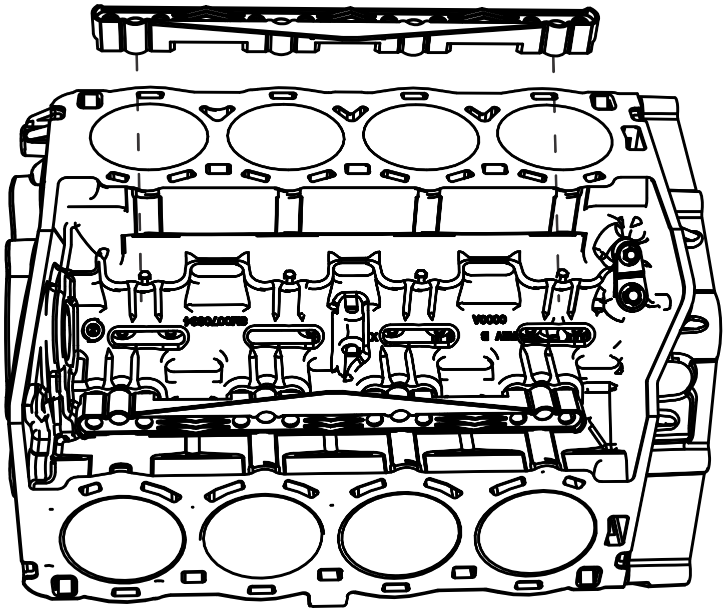
Special Information

Hydraulic valve lifters require little attention. These lifters are extremely simple in design. Normally, adjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Removal

IMPORTANT: Organize and store the rocker arm assemblies, pushrods, and valve lifters in matched sets for assembly and installation in their original locations.

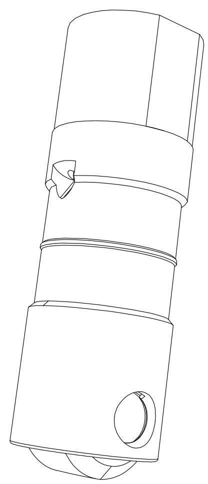
1. Remove the lifter guide retainer.



59470

IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.

2. Remove the valve lifters. Store the lifters in the upright position in the order of removal.



55006

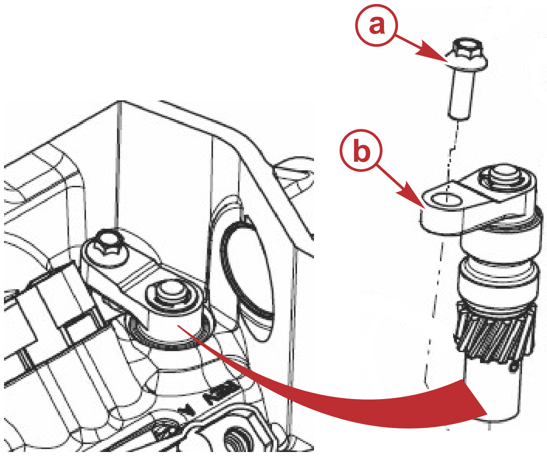
Valve lifter

Oil Pump Drive

Removal

The oil pump drive connects the oil pump to the camshaft via the intermediate shaft.

Remove the flange screw.



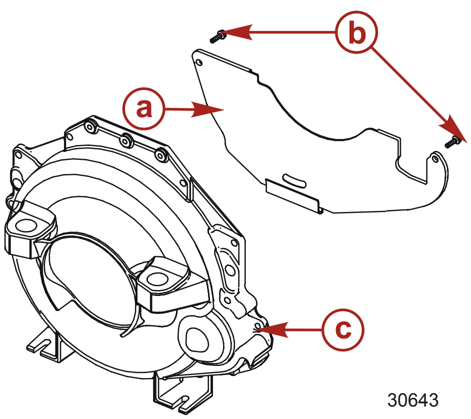
a - Flange screw
b - Oil pump drive

56464

Flywheel and Housing

Flywheel Housing Removal

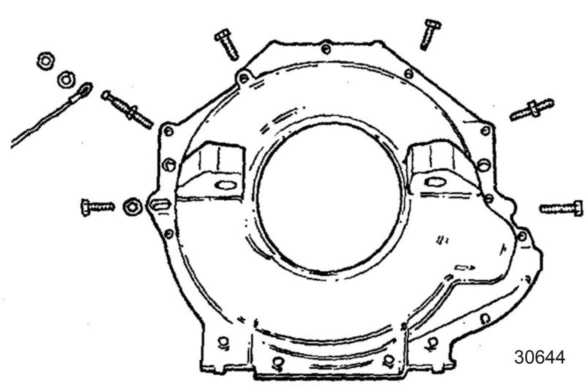
1. Remove the flywheel housing cover.



a - Flywheel housing cover
b - Screws (2)
c - Flywheel housing

30643

2. Remove the ground wires from the flywheel housing.
   IMPORTANT: The flywheel housing bolts must be installed in the same location as removed.
3. Remove the screws and studs from the flywheel housing.
4. Remove the flywheel housing.

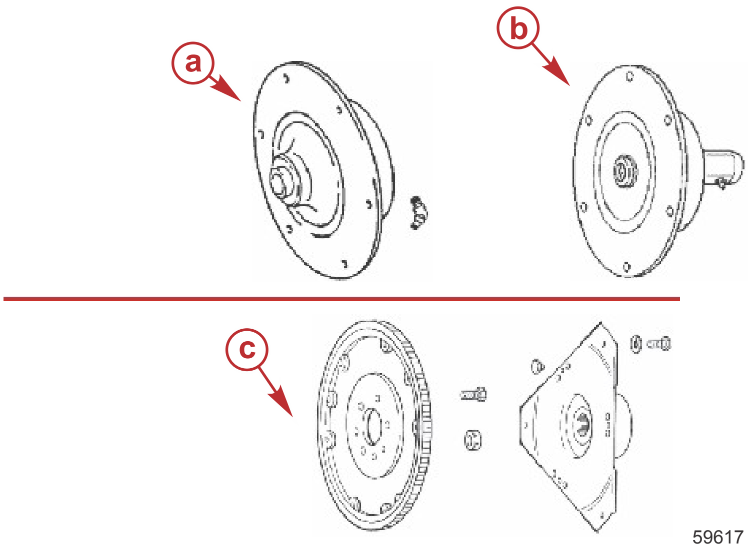


30644

Flywheel Removal

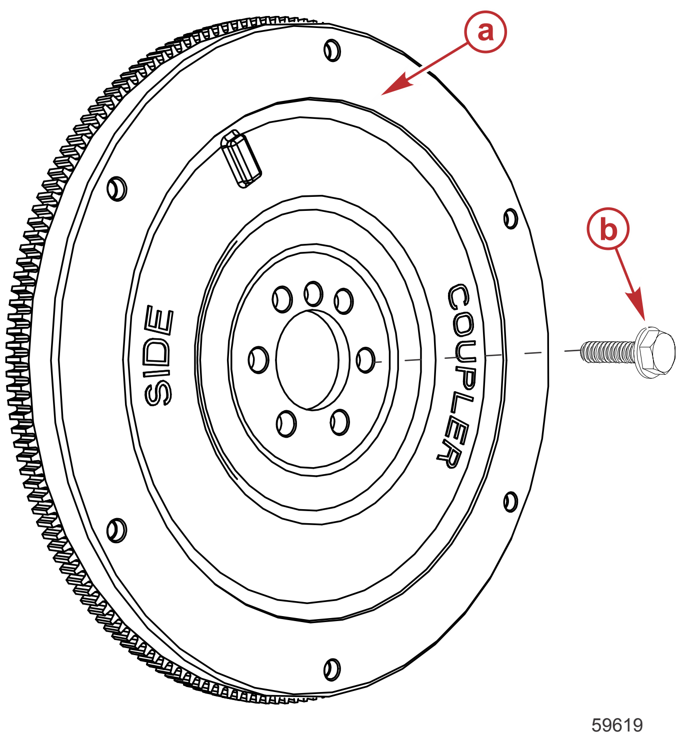
1. Remove the flywheel housing.

2. Remove the coupler or drive plate.



a - Bravo coupler
b - HD Bravo coupler
c - Driveshaft extension coupler

3. Remove the flywheel.



a - Flywheel
b - Screws (6)

Oil Pan

Removal

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Drain the engine oil from the oil pan.

NOTICE

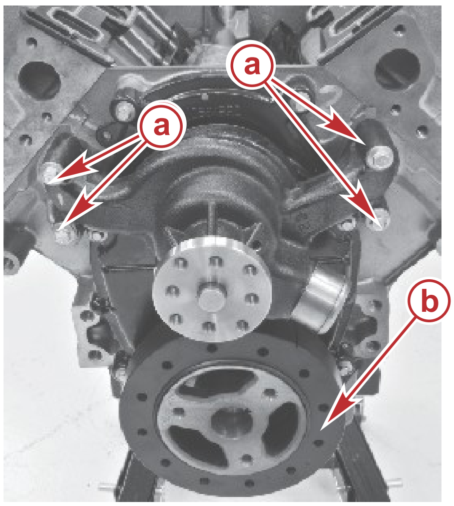
Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

2. Remove the screws and nuts securing the oil pan to the block.
3. Remove the oil pan.
4. Remove and discard the oil pan gasket.

Front Engine Cover

Removal

1. Drain the seawater and closed cooling systems.
2. Remove the serpentine belt.
3. Remove the serpentine belt tensioner and bracket.
4. Remove the idler pulley with bracket.
5. Remove the crankshaft pulley.



55009

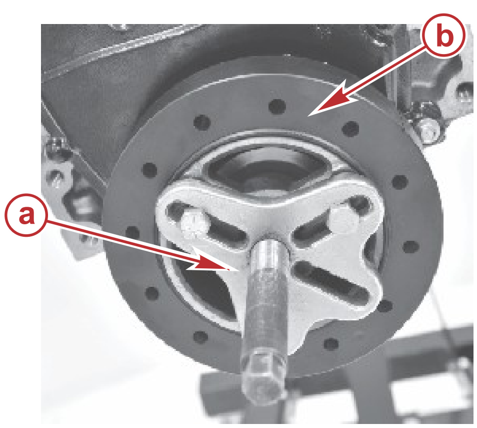
a - Water circulating pump bolts
b - Crankshaft harmonic damper

6. Remove the hoses from the water circulating pump.

   NOTE: Do not use a universal claw type puller to remove the crankshaft harmonic damper. The outside ring of the harmonic damper is bonded to the hub with rubber. Use of a claw type puller may damage the harmonic damper.

7. Remove the crankshaft harmonic damper with a crankshaft harmonic damper remover and installer tool.

Description	Part Number
Kent-Moore crankshaft harmonic damper remover and installer	J23523-F

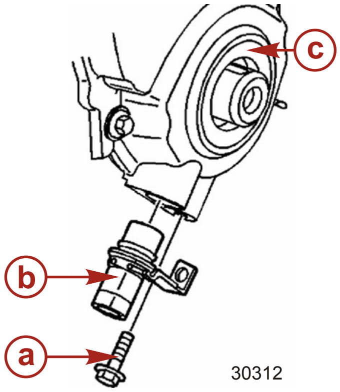


55361

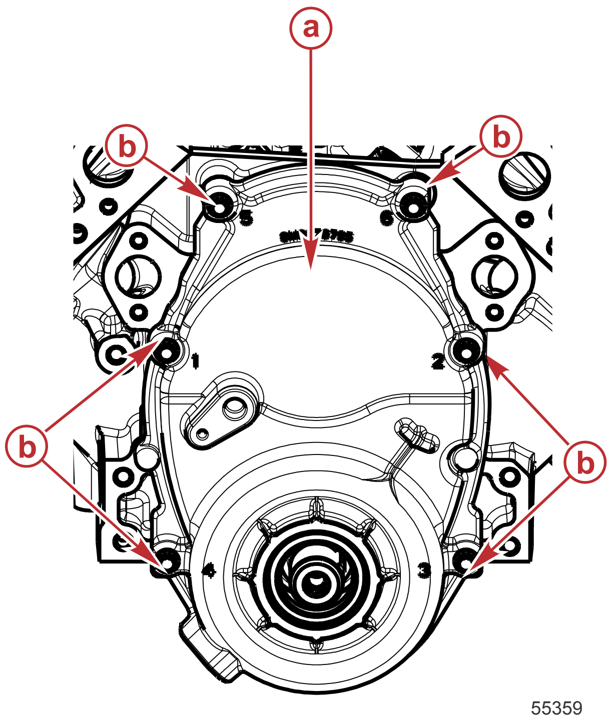
a - Crankshaft harmonic damper puller
b - Crankshaft harmonic damper

8. Remove the water circulating pump.

9. Remove the crankshaft position sensor.



a - Screw
b - Crankshaft position sensor
c - Crankcase front cover



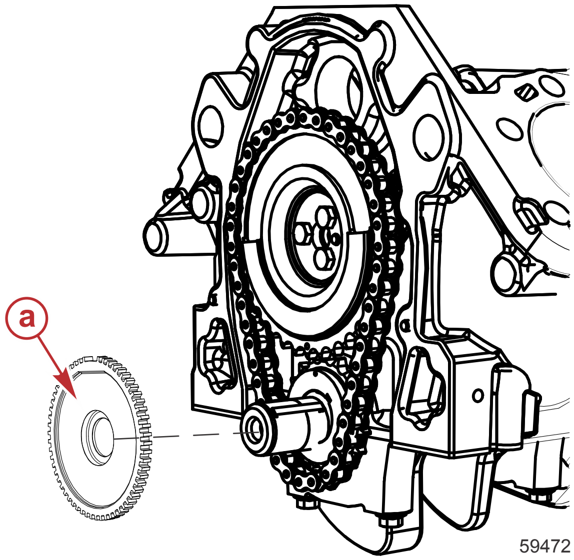
a - Crankcase front cover
b - Cover screws (6)

10. Remove and inspect the crankcase front cover.
    IMPORTANT: The crankcase front cover is reusable. Gasket must be replaced if removed.

Timing Chain and Sprockets

Removal

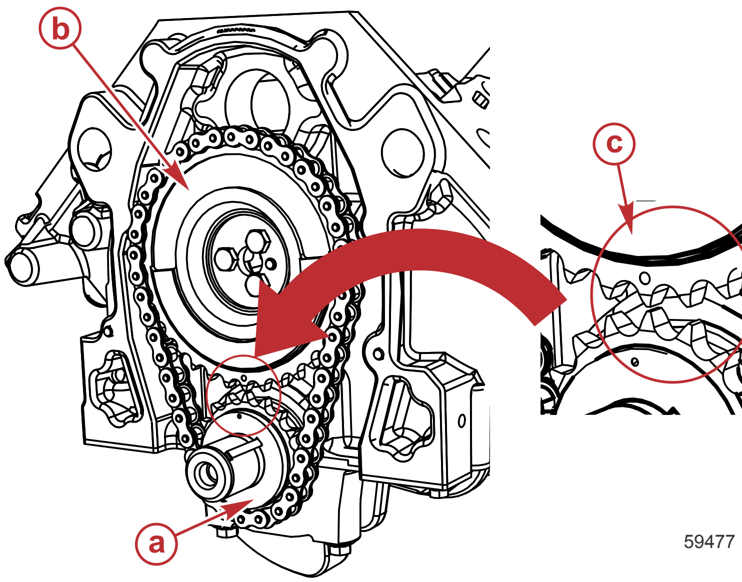
1. Remove the crankshaft position sensor reluctor wheel.



56X reluctor wheel

a - 56X reluctor wheel

2. Turn the crankshaft to align the timing marks on the crankshaft and camshaft timing sprockets or turn the crankshaft to cylinder number 1 TDC.



a - Crankshaft sprocket

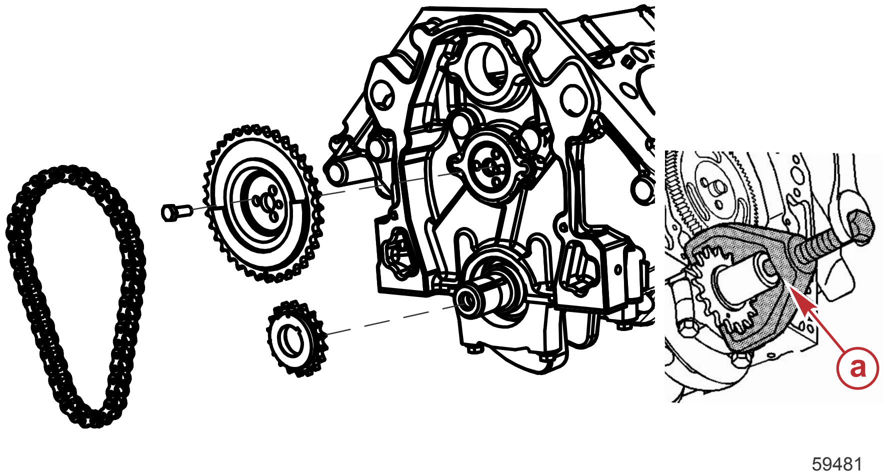
b - Camshaft sprocket

c - Timing marks

3. Check the timing chain deflection. Refer to **Section 3B** - **Checking Timing Chain Deflection**.
4. Remove the camshaft sprocket.

   NOTE: *If the sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.*

5. Remove the timing chain.



a - Crankshaft sprocket remover

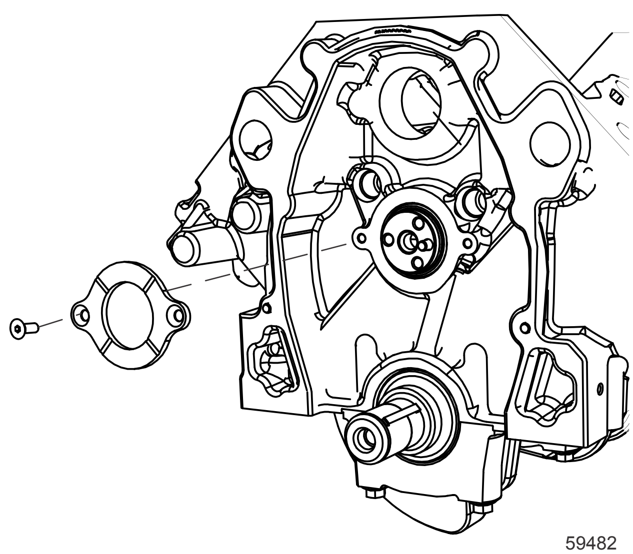
6. Remove the crankshaft sprocket using the crankshaft sprocket remover tool.

Description	Part Number
Kent-Moore crankshaft sprocket puller	J5825-A

Camshaft

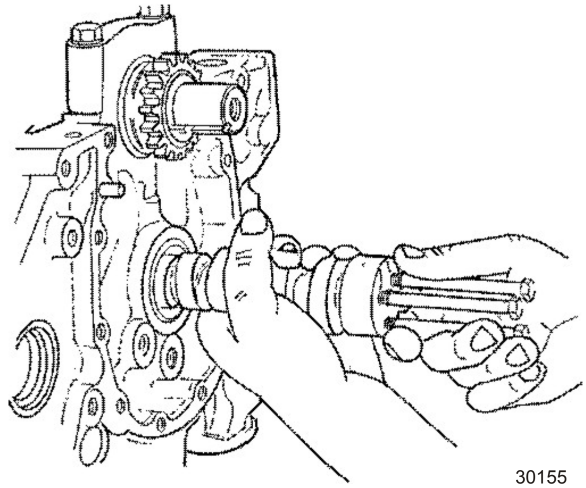
Removal

1. Remove the camshaft thrust plate.



2. Install three 5/16-18 x 5 in. long bolts in the camshaft bolt holes.

3. Carefully rotate and remove the camshaft as shown.



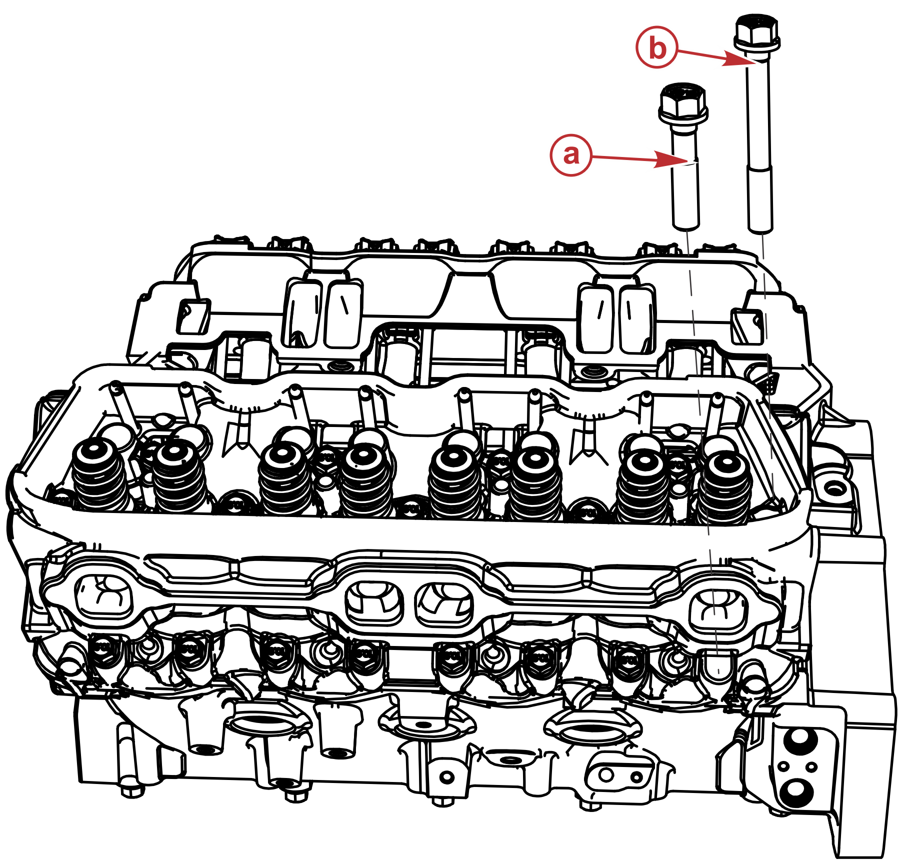
30155

Removing camshaft

Cylinder Head

Removal

1. Remove the spark plugs.
2. Remove the cylinder head bolts.

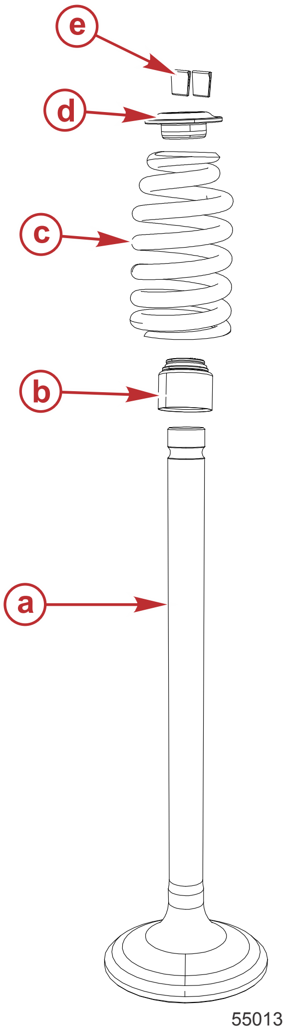


59486

a - Short bolts (M10 x 1.5 x 49)
b - Long bolts (M10 x 1.5 x 86)

3. Remove the cylinder head.
4. Place the cylinder head on wooden blocks, a rubber mat, or other material that will prevent damage to the gasket surfaces.
5. Repeat this process for the second cylinder head.

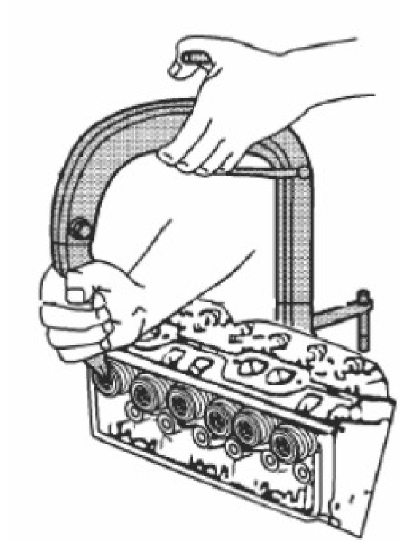
Valve Spring Assembly Exploded View



a - Valve
b - Valve stem oil seal
c - Valve spring
d - Valve spring retainer
e - Valve spring keeper

Valve Spring Assembly Removal

1. Use the valve spring compressor to compress the valve springs, and remove the valve spring keepers. Slowly release the tool.

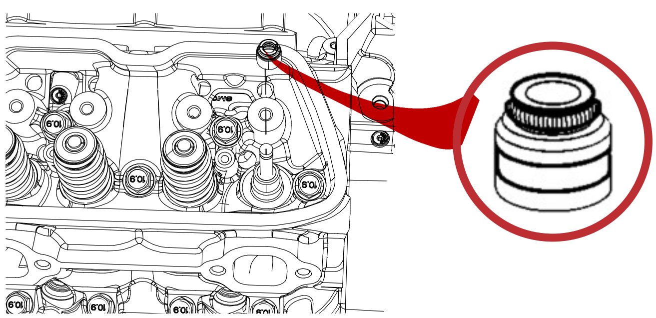


54010

J8062 valve spring compressor shown on V6, V8 similar

Description	SPX Part Number
Kent-Moore valve spring compressor (cylinder head off the engine)	J8062

2. Carefully release the valve spring compressor.
3. Remove the valve spring cap and valve spring.
   IMPORTANT: Keep components together as a matched set. Mark and organize parts so that they can be installed in the same location later.
4. Remove and discard the valve stem oil seal.



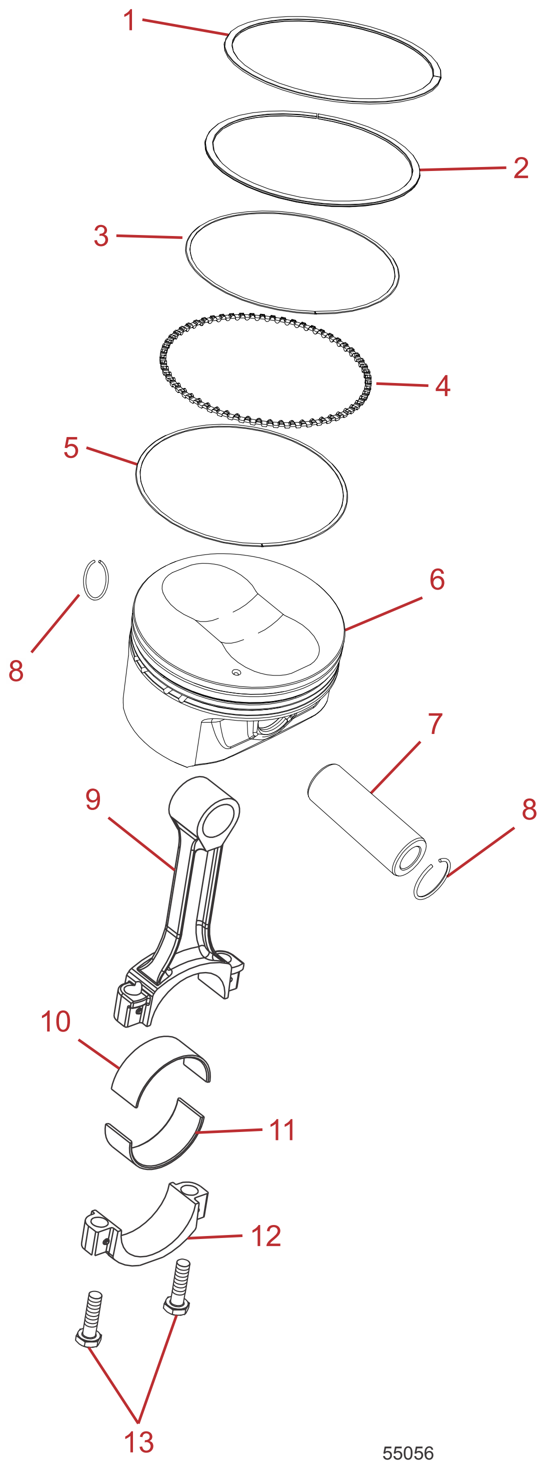
55050

Typical valve stem oil seal

5. Repeat for each valve.

Connecting Rod, Bearings, and Piston Assembly

Exploded View



Piston and connecting rod

1 - Upper compression ring
2 - Lower compression ring
3 - Upper oil control ring
4 - Oil control ring spacer
5 - Lower oil control ring
6 - Piston
7 - Piston pin
8 - Snap ring (2)
9 - Connecting rod
10 - Upper bearing half
11 - Lower bearing half
12 - Bearing cap
13 - Screw (2)

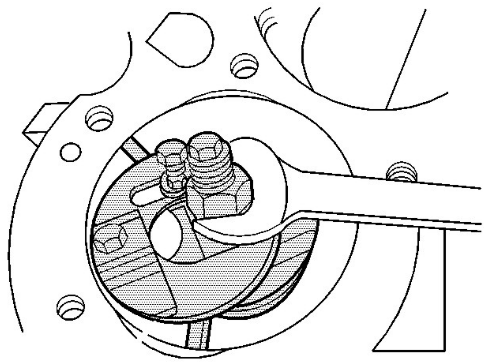
Removal

1. Using a ridge reamer, remove any ridge or combustion deposits from the top of the cylinder bore.

Description	Part Number
Cylinder bore ridge reamer	Obtain Locally

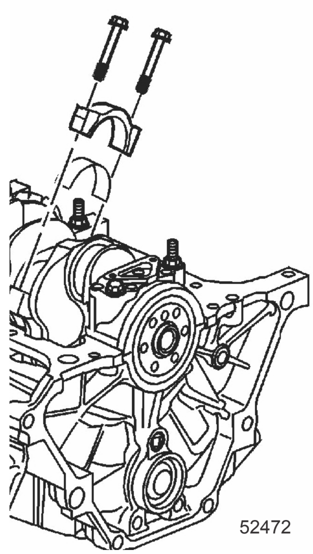
   a. Turn the crankshaft until the piston is at the bottom of the stroke.
   b. Place a cloth on top of the piston to collect cuttings.

c. Use the cylinder bore ridge reamer to remove the ridge or deposits.
d. Turn the crankshaft until the piston is at the top of the stroke.
e. Remove the cloth and cuttings.



Cylinder bore ridge reamer

2. Turn the crankshaft to gain access to the connecting rods and screws.
   IMPORTANT: Mark the location of each connecting rod assembly so that they can be assembled in the same location later.
3. Mark connecting rods and bearing caps to the corresponding cylinder number (port bank 1, 3, 5, and 7; starboard bank 2, 4, 6, and 8 from front to rear on the same side as the piston thrust).
   IMPORTANT: Before removing the connecting rod cap, mark and organize the connecting rods and caps so that they can be installed in the same location later.
4. Remove the connecting rod bearing cap.



Connecting rod bearing cap

IMPORTANT: Wrap a clean, lint free towel around the connecting rod ends when removing the piston from the cylinder so as not to damage the crankshaft journals or cylinder bore.

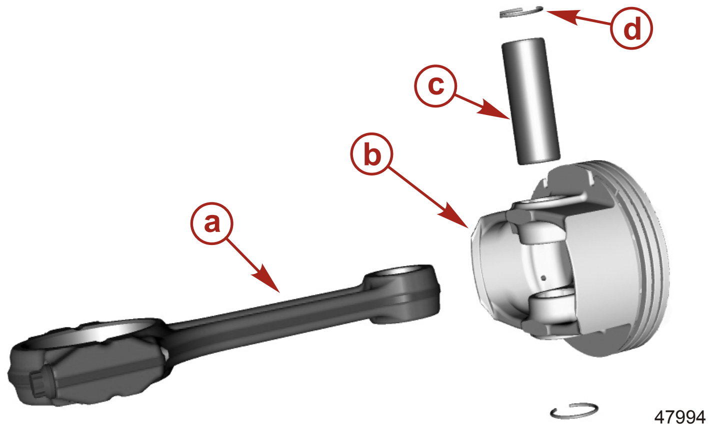
5. Push the piston and connecting rod out of the cylinder.
   IMPORTANT: The mating surfaces of the connecting rods and the connecting rod bearing caps form an individual fit and as a result must not be interchanged or damaged under any circumstances. To avoid damage, do not lay connecting rods or connecting rod bearing caps on their mating surfaces.
6. Remove the connecting rod bearings. Keep the bearings with the original connecting rod and connecting rod cap together as a matched set.

Disassembly

1. Remove the piston rings from the pistons.

Piston Ring Expander	91-24697

2. Remove the retaining clips and remove the piston pin.



a - Connecting rod
b - Piston
c - Piston pin
d - Piston pin retaining clip (2)

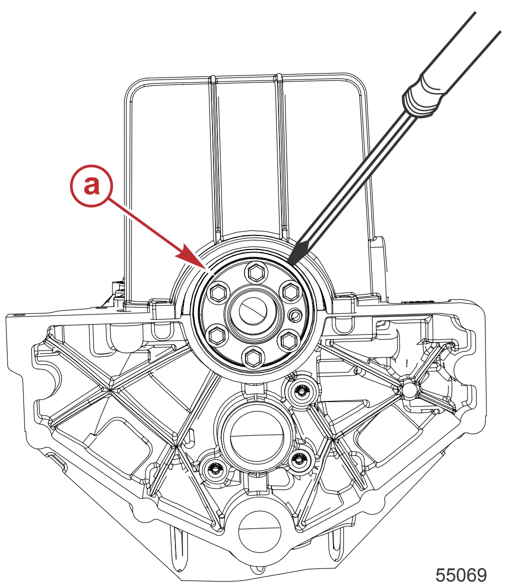
3. Mark, separate, and organize parts so that they can be installed in the same locations.

Rear Oil Seal

Removal

The rear main crankshaft oil seal can be replaced without removing the oil pan or the rear main bearing cap from the engine.

1. Remove the flywheel.
2. Remove the seal by carefully using a screwdriver to pry it out of the engine block as shown.



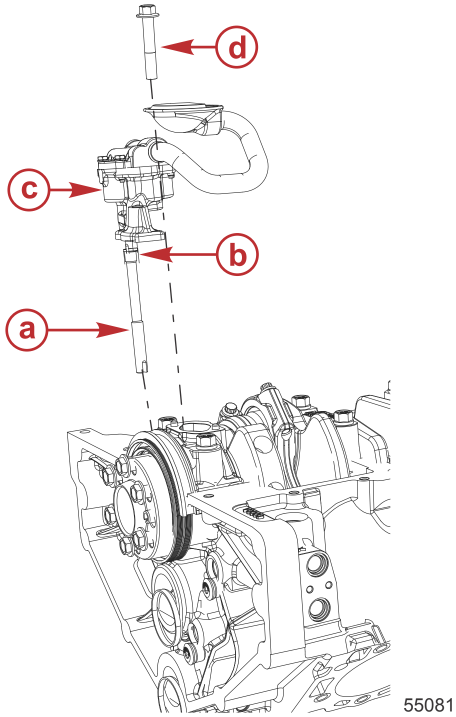
a - Rear main seal

IMPORTANT: Do not nick or gouge the engine block or the rear main bearing cap sealing surface. Protect the crankshaft to seal running surface from damage.

Oil Pump

Removal

1. Remove the oil pump screw.



a - Driveshaft
b - Driveshaft retainer
c - Oil pump
d - Screw

2. Remove the oil pump.

Disassembly

IMPORTANT: No service parts are available for the pump.

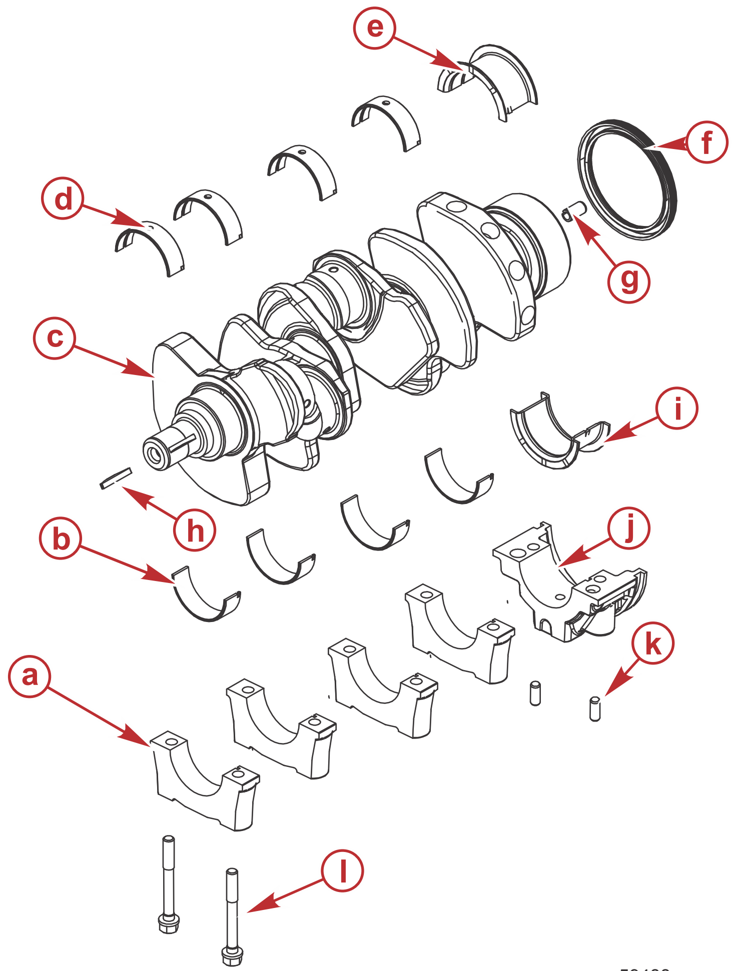
1. Remove the pump cover.
   IMPORTANT: Gear teeth must be marked for exact positioning when reassembled.
2. Make alignment marks on the idler gear and drive gear teeth.
3. Remove the idler gear and drive gear from the pump body.

⚠ CAUTION
The plunger and diaphragm are spring-loaded and can be forcefully expelled from the diaphragm body. Always wear eye protection when servicing the fuel pump diaphragm body. Use caution when removing the diaphragm retaining pin.

4. Remove the retaining pin, spring, and pressure regulator valve from the pump cover.
   IMPORTANT: The suction pipe and pickup screen assembly are not serviceable and should not be removed.

Crankshaft, Main Bearings, and Engine Block

Exploded View



59488

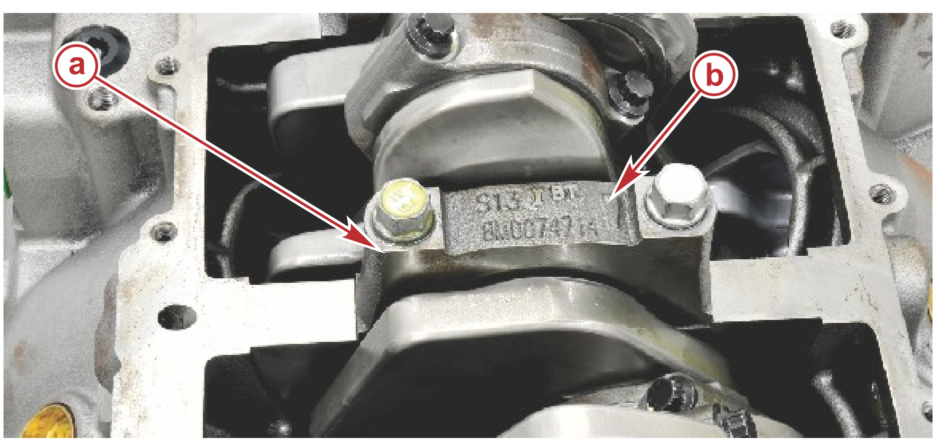
- a - Main bearing cap
- b - Main bearings upper
- c - Crankshaft
- d - Main bearings lower
- e - Lower thrust bearing
- f - Oil seal
- g - Crankshaft dowel
- h - Crankshaft key
- i - Upper thrust bearing
- j - Rear bearing cap
- k - Dowel rear bearing cap
- l - Main bearing bolts

Removal

If only the main bearings are being serviced, refer to **Section 3B** - **Main Bearings without Crankshaft Removed**.

NOTE: Engine port and starboard cylinder heads are removed for illustration clarity.

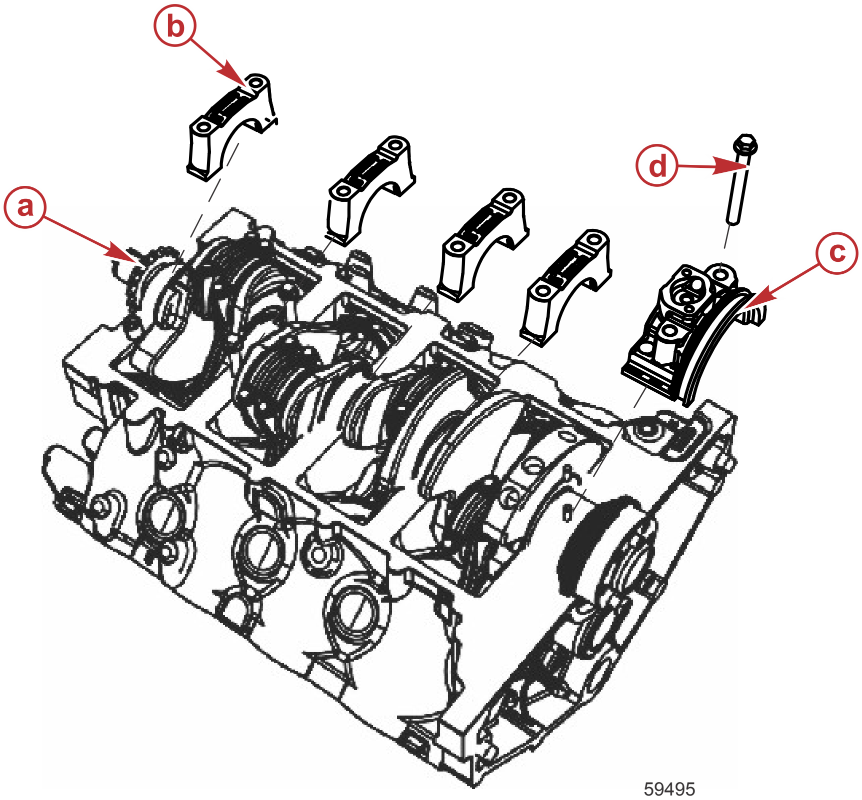
1. Ensure that all bearing caps are marked so that they can be installed in their original locations.



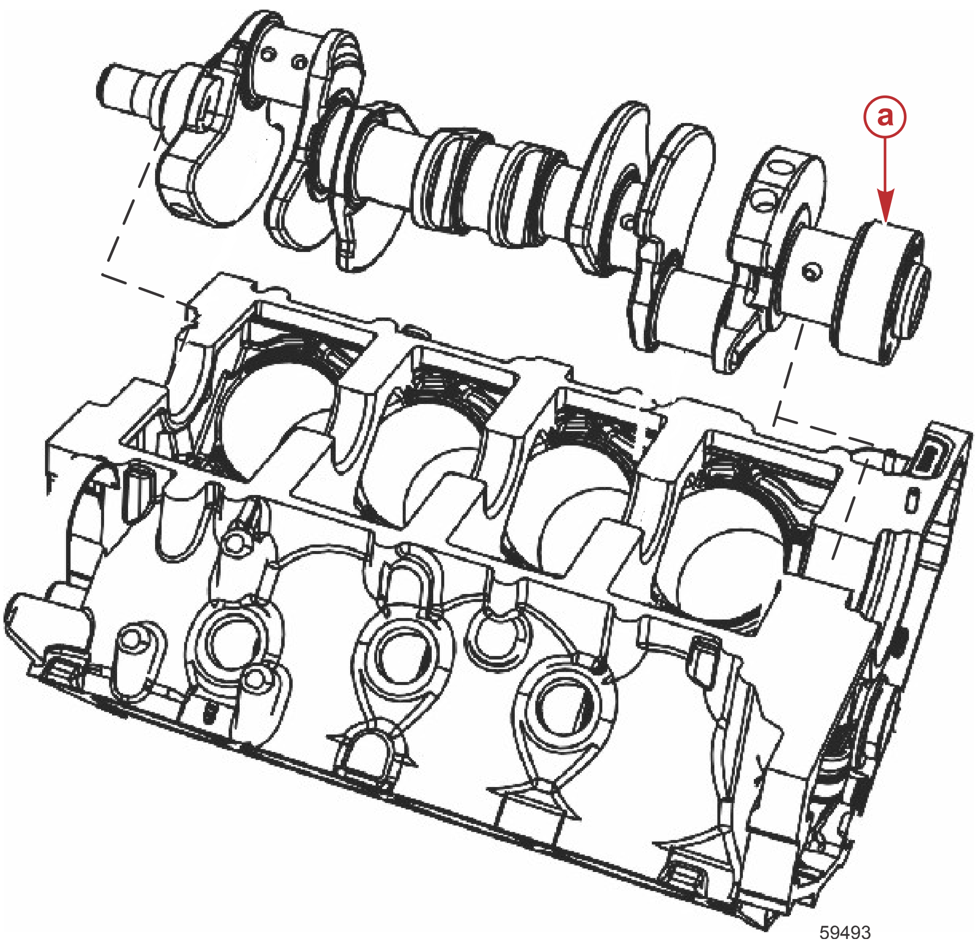
55071

- a - Main bearing cap
- b - Bearing cap marks

2. Remove the main bearing caps and carefully lift the crankshaft out of the engine block.



a - Crankshaft
b - Main bearing cap
c - Rear main bearing cap
d - Main bearing cap screw



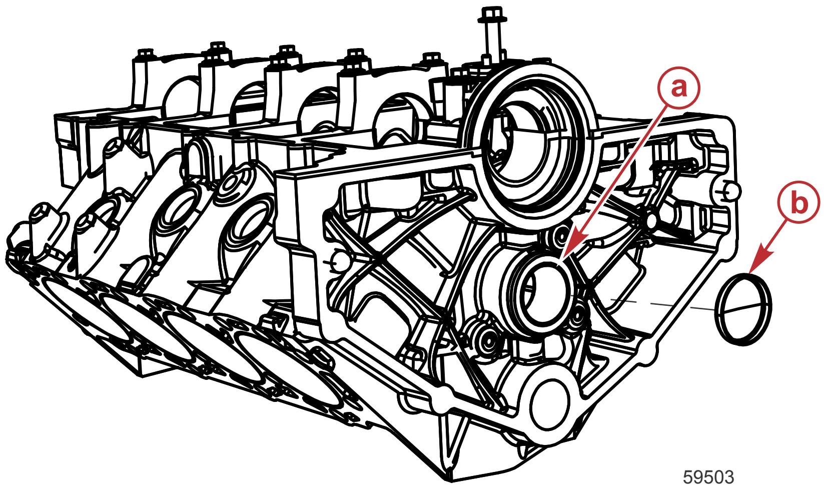
a - Crankshaft

3. If new main or connecting rod bearings are to be installed, remove the main bearing inserts from the engine block and the bearing caps or connecting rod bearing inserts from the connecting rods and caps. Install new bearings.

Engine Block

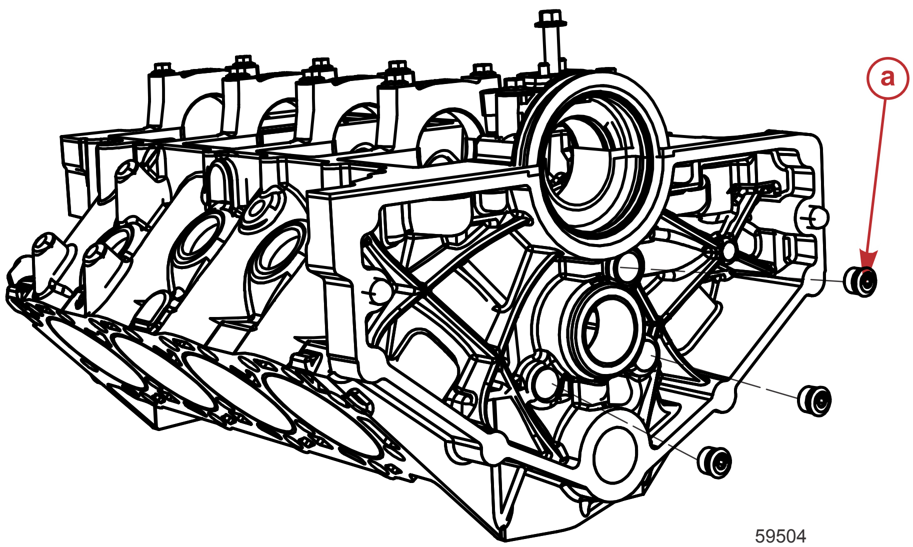
Disassembly

1. Remove all engine components.
2. Remove the camshaft rear bearing hole expansion cup plug.

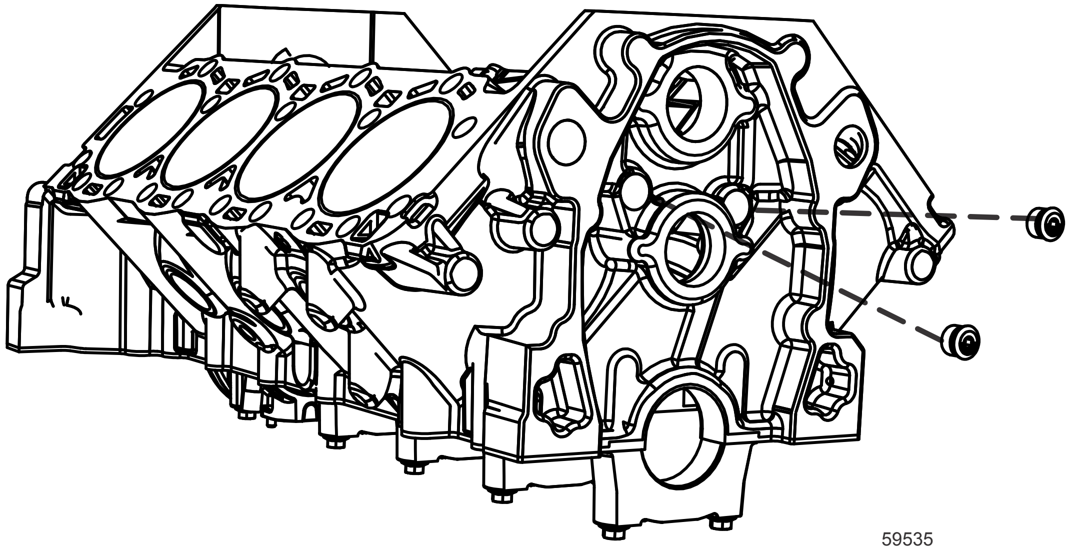


a - Rear of engine block camshaft opening
b - Rear camshaft expansion plug

3. Unscrew the oil gallery plugs.

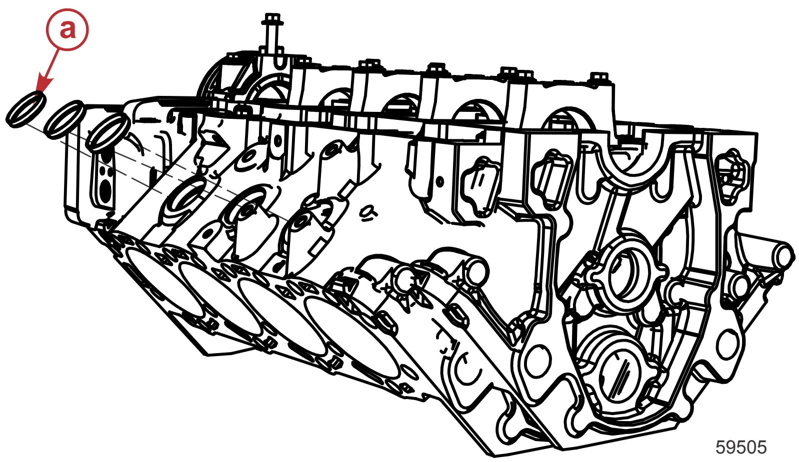


a - Rear oil gallery plugs



Front oil gallery plugs

4. Remove and discard the engine block core hole expansion plugs on both sides of the block.



a - Freeze plug (6 used)

5. Clean all sealing surfaces.
6. Remove all gasket and sealant residue.
7. Clean the engine block with cleaning solvent.
8. Flush the engine block with clean water or steam clean.
9. Clean the cylinder bores.
10. Clean the oil galleries and oil passages.
11. Clean scale and deposits from the coolant passages.
12. Clean the engine block cylinder head bolt holes and dry with compressed air.
13. After cleaning the engine block, spray or wipe the cylinder bores and other machined surfaces with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Cylinder bores and other machined surfaces	Obtain Locally

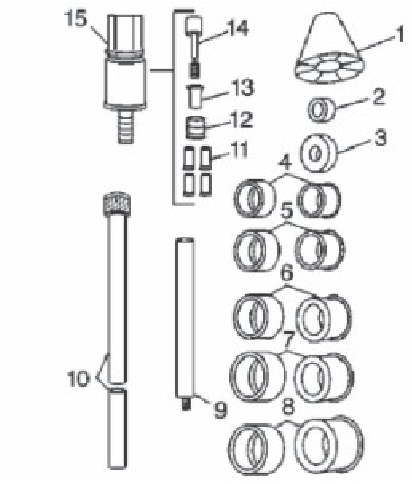
Camshaft Bearings

1. Inspect camshaft bearings for excessive wear or scoring. If any camshaft bearing is excessively worn or scored, replace all the camshaft bearings.
2. Inspect the camshaft bearings for correct fit into the engine block camshaft bearing bores. The camshaft bearings have an interference fit to the engine block camshaft bearing bores and must not be loose in the bores.

Camshaft Bearings Removal

1. The camshaft bearing service kit is required to remove and install the camshaft bearings.

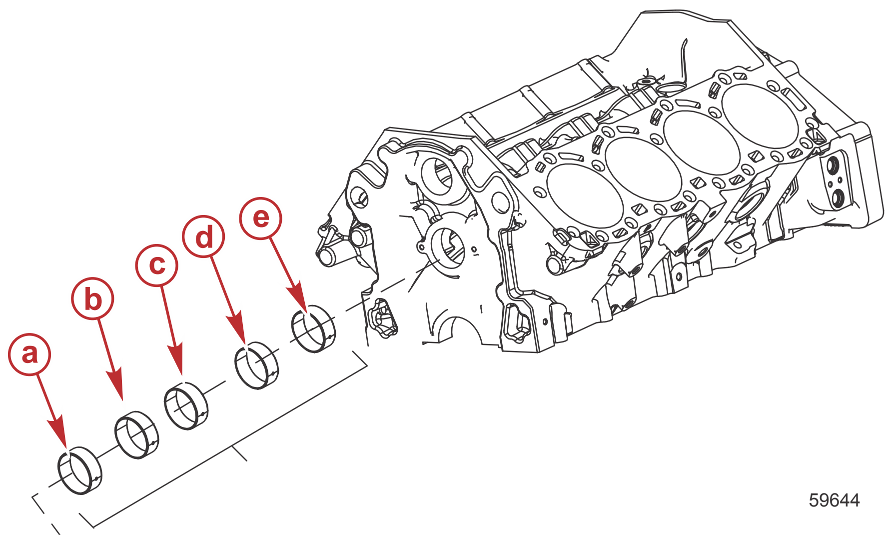
Description	Part Number
Camshaft bearing service kit	J33049



53617

1 - Cone
2 - Washer
3 - Washer
4 - Expanding driver
5 - Expanding driver
6 - Expanding driver
7 - Expanding driver
8 - Expanding driver
9 - Handle extension
10 - Handle
11 - Bushings
12 - Spacer
13 - Spacer
14 - Pin
15 - Expander assembly

2. Select the cone (1), the handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15) from the service kit. Assemble the J33049.

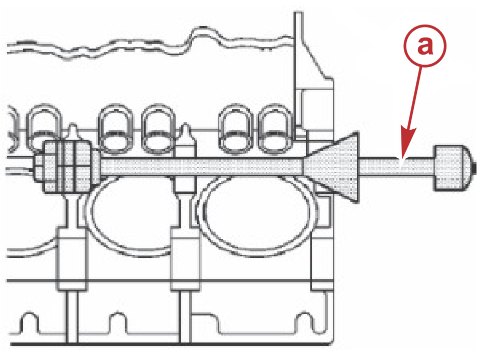


59644

a - Position 1 cam bearing
b - Position 2 cam bearing
c - Position 3 cam bearing
d - Position 4 cam bearing
e - Position 5 cam bearing

NOTE: The cam bearings are the same size.

IMPORTANT: Always remove the camshaft inner bearings #2, #3, and #4 first. The camshaft outer bearing #1 and #5 serve as a guide for the J33049.



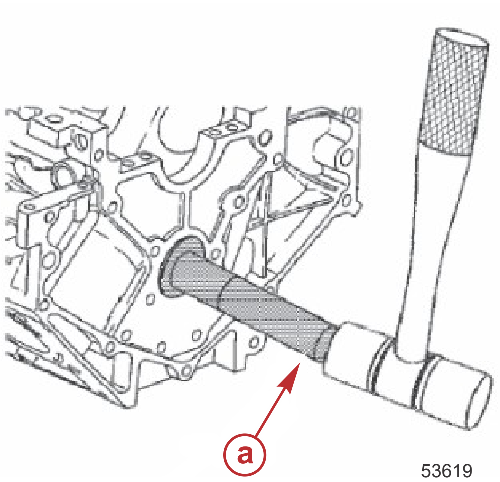
53618

a - Camshaft bearing tool assembled (J33049)

3. Remove the camshaft inner bearing #2, #3, and #4.
    a. Insert the J33049 through the front of the engine block and into the camshaft inner bearing #2.

- b. Tighten the J33049 expander assembly nut until snug.
- c. Push the J33049 guide cone into the camshaft front bearing in order to align the J33049.
- d. Drive the camshaft inner bearing #2 from the camshaft inner bearing bore #2.
- e. Loosen the J33049 expander assembly nut.
- f. Remove the camshaft inner bearing #2 from the J33049 expander assembly.
- g. Insert the J33049 expander assembly into the camshaft inner bearing #3.
- h. Tighten the J33049 expander assembly nut until snug.
- i. Push the J33049 guide cone into the camshaft front bearing in order to align the J33049.
- j. Drive the camshaft inner bearing #3 from the camshaft inner bearing bore #3.
- k. Loosen the J33049 expander assembly nut.
- l. Remove the camshaft inner bearing #3 from the J33049 expander assembly.
- m. Insert the J33049 expander assembly into the camshaft inner bearing #4.
- n. Tighten the J33049 expander assembly nut until snug.
- o. Push the J33049 guide cone into the camshaft front bearing in order to align the J33049.
- p. Drive the camshaft inner bearing #4 from the camshaft inner bearing bore #4.
- q. Loosen the J33049 expander assembly nut.
- r. Remove the camshaft inner bearing #4 from the J33049 expander assembly.

4. Remove the J33049 from the engine block.
5. Remove the camshaft outer bearings #1 and #5.
   - a. Insert the J33049 into the camshaft outer bearing #1.
   - b. Tighten the J33049 expander assembly nut until snug.
   - c. Drive the camshaft outer bearing #1 from the camshaft outer bearing bore #1.
   - d. Loosen the J33049 expander assembly nut.
   - e. Remove the camshaft outer bearing #1 from the J33049 expander assembly.
   - f. Remove the J33049 from the engine block.
   - g. Insert the J33049 expander assembly into the camshaft outer bearing #5.
   - h. Tighten the J33049 expander assembly nut until snug.



a - Camshaft bearing service kit driver (J33049)

   - i. Drive the camshaft outer bearing #4 from the camshaft outer bearing bore #5.
   - j. Loosen the J33049 expander assembly nut.
   - k. Remove the camshaft outer bearing #5 from the J33049 expander assembly.
6. Remove the J33049 from the engine block.
7. Discard the camshaft bearings.

Notes:

Engine Mechanical

Section 3B - Engine Inspection and Assembly

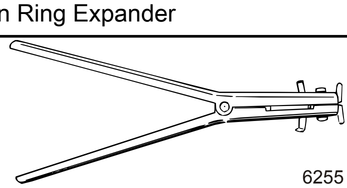
3
B

Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of oil gallery plugs and oil pressure sender	Obtain Locally
66	Loctite 242 Threadlocker	Expansion cup plug (camshaft rear bearing hole)	92-809821
		Outside diameter of engine block core hole expansion plug	
		Camshaft thrust plate retainer bolt threads	
		Outside diameter of core expansion plug	
		Intake manifold bolt threads	
80	SAE Engine Oil 30W	The seal to retainer mating surfaces, the seal lip	Obtain Locally
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Each end of the lower intake manifold gaskets on the cylinder head side	92-809826
		A wide bead of adhesive to the front and rear of the engine block, extending the adhesive bead	
		Crankshaft front cover mating surface of the seal	
136	Lubriplate SPO 255	Main bearings and crankshaft bearing journals	Obtain Locally
		Piston pin	
		Threads and mating faces of connecting rod cap and screw	
		Camshaft journals, camshaft, and camshaft lobes	
		Valve stem	
		Outside surface of valve stem bore and all surfaces of the valve stem oil seal	
		Valve stem keepers	
		Camshaft lobes and valve lifters	
		Valve lifters	
		Outer surfaces and ends of valve pushrods	
		Rocker arm and rocker arm ball contact surfaces	
		Upper and lower bearing	
137	Loctite 5512 Adhesive	Both right and left side joints of the rear seal retainer and joints of the front cover	92-858006K02
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Cylinder walls	92-8M0078629
		Connecting rod bearings, pistons, rings, and cylinder walls	
		Front cover crankshaft seal	
		Crankshaft position sensor O-ring seal	
		O-rings	
		Rubber sealing surface	
142	Loctite 598 RTV Sealant	Keyway of the harmonic damper	Obtain Locally
		Keyway	

Special Tools

Piston Ring Expander	91-24697
 6255	Expands piston rings for removal and installation.

General Specifications

Description	Specification
Bore	101.609 mm (4.00 in.)
Stroke	95.25 mm (3.75 in.)
Firing order	1–8–4–3–6–5–7–2
Compression ratio	9.4:1
Heads	Cast iron

Description	Specification
Block	Cast iron (two bolt main bearing caps)
Rods	Forged steel
Crankshaft	Forged steel
Pistons	Cast aluminum
Camshaft	Steel
Intake manifold	Aluminum

Engine Specifications

Cylinder Head

Description		**6.2 Liter (377 cid)**
Surface flatness	At exhaust manifold deck	0.05 mm (0.0020 in.)
	At engine block deck with an 150 mm (5.90 in.) area	0.05 mm (0.0020 in.)
	At intake manifold deck	0.10 mm (0.0039 in.)
	Intake manifold flatness	0.10 mm (0.0039 in.)

Cylinder Bore

Description		**6.2 Liter (377 cid)**
Diameter		101.009–101.018 mm (3.976–3.977 in.)
Out of round	Production	0.012 mm (0.0005 in.) maximum
	Service	0.05 mm (0.0020 in.)
Taper	Production—thrust side	0.012 mm (0.0005 in.) maximum
	Production—relief side	0.025 mm (0.0010 in.) maximum
	Service	0.025 mm (0.0010 in.) over production

Oil Pump

Description	**Height**
Oil pump dowel pin	8.067–9.683 mm (0.3175–0.3812 in.)

Piston Bore Clearance

Description	**6.2 Liter (377 cid)**
Production	0.055–0.083 mm (0.0022–0.0032 in.)

Piston Rings

Top Compression

Description		**6.2 Liter (377 cid)**
Groove clearance	Production	0.030–0.075 mm (0.0012–0.0029 in.)
Gap	Production	0.38–0.52 mm (0.015–0.020 in.)

Second Compression

Description		**6.2 Liter (377 cid)**
Groove clearance	Production	0.020–0.060 mm (0.0008–0.0023 in.)
Gap	Production	0.63–0.82 mm (0.025–0.032 in.)

Oil Control

Description		6.2 Liter (377 cid)
Groove clearance	Production	0.020–0.165 mm (0.0008–0.0065 in.)
Gap	Production	0.18–0.72 mm (0.007–0.028 in.)

Piston Pin

Description		6.2 Liter (377 cid)
Diameter		21.997–22.000 mm (0.8660–0.8661 in.)
Clearance	Production	0.004–0.014 mm (0.0002–0.0005 in.)
Clearance in connecting rod		0.016–0.029 mm (0.0006–0.0011 in.) interference

Crankshaft

Main Bearing Journal

Description		6.2 Liter (377 cid)
Diameter	Number 1, 2, 3, 4	62.195–62.215 mm (2.4486–2.4494 in.)
	Number 5	62.181–62.201 mm (2.4481–2.4488 in.)
Taper	Production	0.008 mm (0.0003 in.) maximum
Out of round	Production	0.008 mm (0.0003 in.) maximum

Main Bearing Clearance

Description		6.2 Liter (377 cid)
Production	Number 1, 2, 3, 4	0.043–0.107 mm (0.0017–0.0042 in.)
	Number 5	0.043–0.107 mm (0.0017–0.0042 in.)

Connecting Rod Journal

Description		6.2 Liter (377 cid)
Diameter		53.3095–53.3295 mm (2.0988–2.0995 in.)
Taper	Production	0.005 mm (0.0002 in.) maximum
Out of round	Production	0.008 mm (0.0003 in.) maximum

Miscellaneous

Description	6.2 Liter (377 cid)
Runout	0.065 mm (0.0025 in.) maximum
End play (thrust clearance)	0.025–0.305 mm (0.001–0.012 in.)

Connecting Rod

Connecting Rod Bearing

Description		6.2 Liter (377 cid)
Clearance	Production	0.047–0.110 mm (0.0019–0.0043 in.)
Rod side clearance		0.312–0.588 mm (0.013–0.023 in.)

Valve

Clearance (Lash)

Description	6.2 Liter (377 cid)
Intake and exhaust	Net lash No adjustment

Lifter

Description		6.2 Liter (377 cid)
Type		Hydraulic roller
Rocker arm ratio		1.70:1
Valve lift	Intake	12.11 mm (0.4767 in.)
	Exhaust	12.06 mm (0.4780 in.)

Head and Stem

Description		6.2 Liter (377 cid)
Valve diameter	Intake	50.8 mm (2.0 in.)
	Exhaust	39.4 mm (1.55 in.)
Face angle	Intake	45°
	Exhaust	45°
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum
Production stem diameter	Intake	7.96 mm (0.3133 in.)
	Exhaust	7.97 mm (0.3137 in.)
Valve stem oil seal	Installed height *NOTE: Measured from the top of the valve guide bevel to the bottom of the oil stem seal.*	0 mm (0 in.)

Stem Clearance

Description		6.2 Liter (377 cid)
Production	Intake	0.023–0.065 mm (0.0009–0.0025 in.)
	Exhaust	0.033–0.075 mm (0.0012–0.00295 in.)

Seat

Description		6.2 Liter (377 cid)
Seat angle	Intake and exhaust	46°
Top correction cut angle		30°
Bottom correction cut angle		60°
Width	Intake	1.016–1.651 mm (0.040–0.065 in.)
	Exhaust	1.65–2.489 mm (0.065–0.098 in.)
Runout	Intake and exhaust	0.05 mm (0.002 in.) maximum

Spring

Description		6.2 Liter (377 cid)
Free length		53.39 mm (2.10 in.)
Load	Valve closed	350 N (78.68 lb) at 46.19 mm (1.818 in.)
	Valve open	1084 N (243.69 lb) at 32.3 mm (1.2717 in.)
Installed height	Intake	46.19 mm (1.818 in.)
	Exhaust	
Approximate number of coils		6

Camshaft

Description		6.2 Liter (377 cid)
Journal diameter		47.465–47.490 mm (1.868–1.8697 in.)
Journal out of round		0.05 mm (0.0020 in.) maximum
Lobe lift	Intake	6.973 mm (0.275 in.)
	Exhaust	6.994 mm (0.275 in.)
End play		0.040–0.270 mm (0.0015–0.010 in.)

Timing Chain

Description	6.2 Liter (377 cid)
Chain deflection	11 mm (0.4331 in.) maximum

Flywheel

Description	6.2 Liter (377 cid)
Runout	0.203 mm (0.0080 in.) maximum

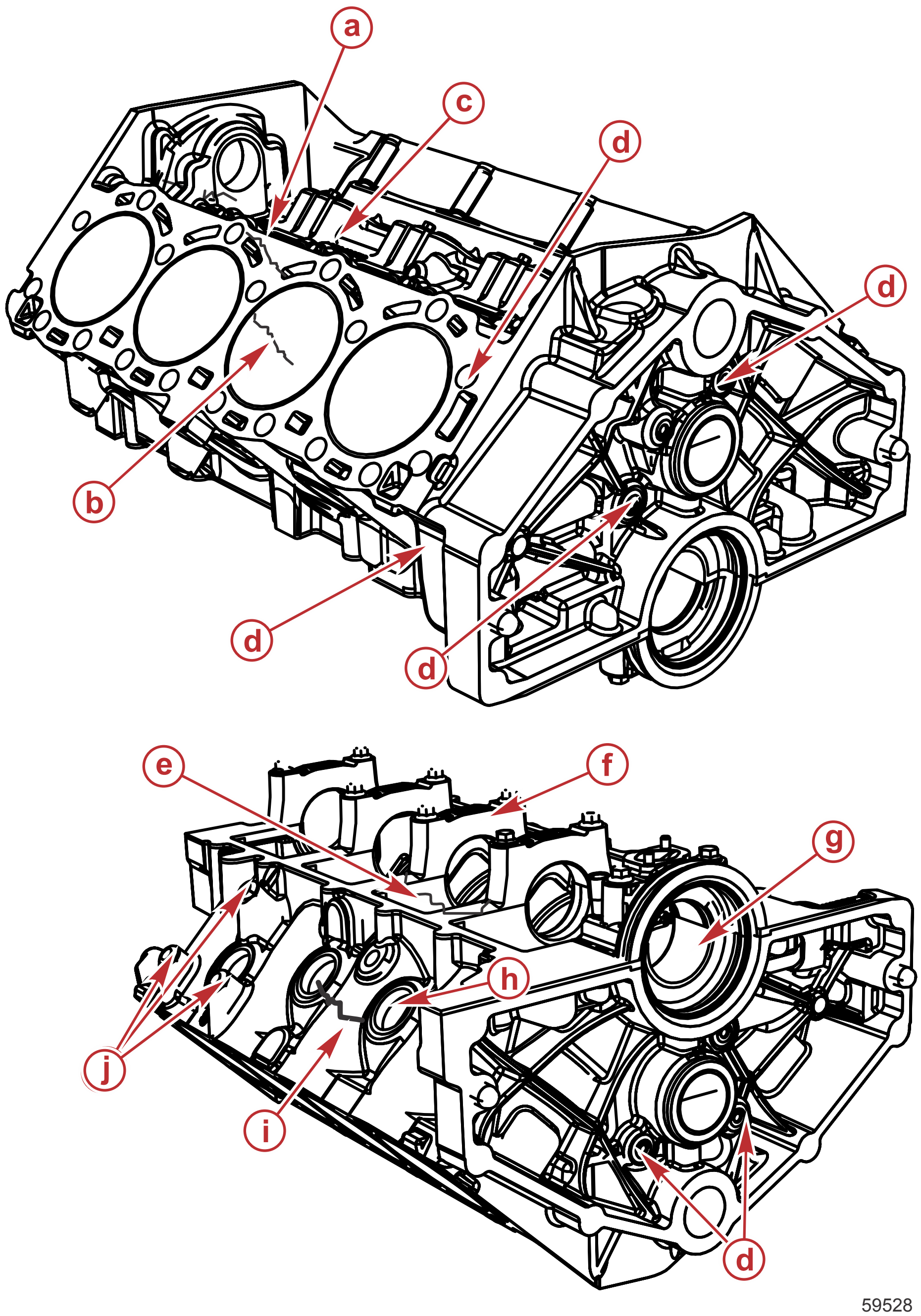
Engine Block

Clean and Inspect

1. Clean the engine block with cleaning solvent.
2. Flush the engine block with clean water or steam.
3. Clean the cylinder bores.
4. Clean the oil galleries and the oil passages.
5. Clean the scale and the deposits from the coolant passages.

   NOTE: Clean all debris, dirt, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners, or damage to the components.
6. Clean the engine block cylinder head bolt holes.

7. After cleaning the engine block, spray or wipe the cylinder bores and the machined surfaces with clean engine oil.



a - Coolant jackets
b - Cylinder bores
c - Valve lifter bores
d - Threaded holes
e - Crankshaft bearing webs
f - Crankshaft bearing caps
g - Crankshaft bearing bores
h - Core hole plug bores
i - Engine block
j - Engine mount bosses

8. Inspect the following areas:
   a. Coolant jackets for cracks.
   b. Cylinder bores for scratches or gouging.
   c. Valve lifter bores for excessive scoring or wear.
   d. Threaded holes for damage.
   e. Crankshaft bearing webs for cracks.
   f. Crankshaft bearing caps and the crankshaft bearing bores for damage.
   g. Engine block core hole plug bores for damage.
   h. Engine block for cracks or damage.
   i. Engine mount bosses for damage.

Cylinder Reconditioning

NOTE: The effectiveness of cylinder reconditioning depends upon engine condition at time of repair.

NOTE: If engine block inspection indicates that the block is suitable for continued service, out of round, or tapered cylinders can be reconditioned by honing or boring and honing.

1. If cylinders have less than 0.127 mm (0.005 in.) wear, they can be reconditioned with a hone and fitted with high limit standard size pistons. If there is more than 0.127 mm (0.005 in.) wear, bore and hone to fit the smallest oversized piston that will permit the complete resurfacing of all cylinders.
2. Clean cylinder bores with hot soapy water. Rinse thoroughly. After cleaning, lightly lubricate the cylinder walls with engine oil and a clean cloth. Wipe off excess oil with a clean dry cloth.

Cylinder Boring

IMPORTANT: Before using any type of boring bar, file the top of the engine block to remove dirt or burrs. This prevents boring bar tilt (the bored cylinder wall is not at right angles to the crankshaft).

1. File the top of the engine block to smooth any irregular surface and remove any deposits or burrs.
2. Clean the cylinders with warm water and detergent. Rinse thoroughly.
3. Measure the piston to be fitted with a micrometer. Take measurements at the center of the piston skirt and at right angles to the piston pin.

   *NOTE: Hone cylinders as outlined under **Cylinder Honing** and **Piston Selection**.*
4. Bore the cylinder to the same diameter as the piston and hone to provide the specified clearance.
5. Carefully observe equipment manufacturer's instructions.

Cylinder Honing

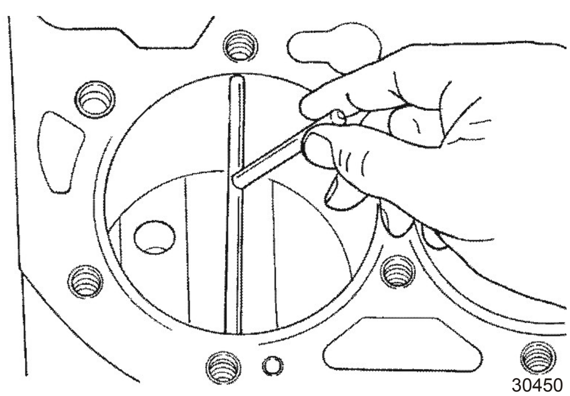
1. Follow the instructions provided with the cylinder hone kit.

Description	Part Number
Kent-Moore cylinder hone tool kit	J5902-01

2. Frequently clean the cylinder bore and check the piston for a correct fit in the cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a 30 degree cross hatch pattern. Finish marks should be clean but not sharp, free from embedded particles, and torn or folded metal.
4. As each piston is fitted to a cylinder, permanently mark each with its corresponding cylinder number.
   IMPORTANT: Handle pistons with care and do not attempt to force them into a cylinder until it is honed to the correct size.
5. Thoroughly clean cylinder bores with hot soapy water. Scrub each cylinder with a stiff, synthetic bristle brush, and rinse thoroughly with hot water. Lightly lubricate the cylinders with light engine oil on a clean cloth, then wipe clean with a clean dry cloth. Repeat this process several times until the oiled cloth remains clean and free of machining debris. The cylinder should not be cleaned with kerosene or gasoline. Clean the engine block to remove dirt and debris left by the reconditioning process.

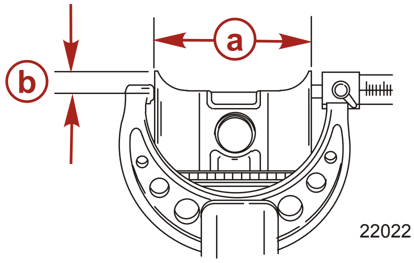
Piston Selection

1. Check used piston to cylinder bore clearance:
   a. Measure the cylinder bore diameter with a telescope gauge 64 mm (2.5 in.) from the top of the cylinder bore.



Measuring cylinder bore diameter

b. Measure the piston diameter at the skirt 12 mm (0.472 in.) from the bottom of the skirt at a right angle to the piston pin bore.



a - Piston diameter
b - Measurement location

c. Subtract the piston diameter from the cylinder bore diameter to determine piston to bore clearance.

d. Determine if the piston to bore clearance is in an acceptable range.

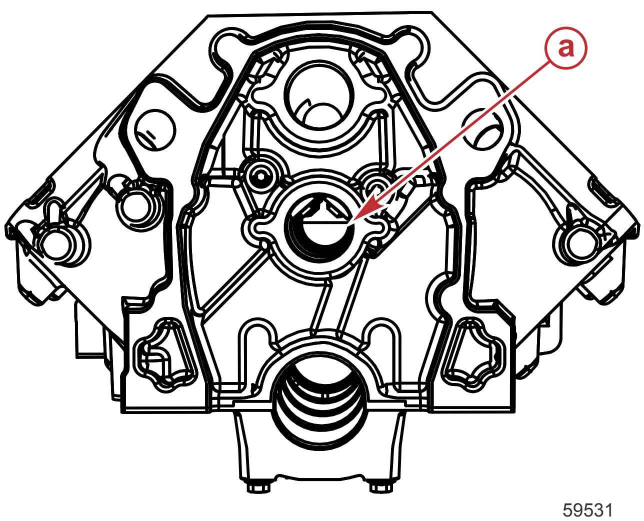
Description	6.2 Liter (377 cid)
Production piston to bore clearance	0.055–0.083 mm (0.0022–0.0032 in.)

2. If a used piston is not satisfactory, determine if a new piston can be selected to fit the cylinder bore within the specified range.
3. If the cylinder bore must be reconditioned, measure the new piston diameter, then hone the cylinder bore to the correct clearance.
4. Mark each piston to identify the cylinder for which it was fitted.

Camshaft Bearings

Camshaft Bearing Installation

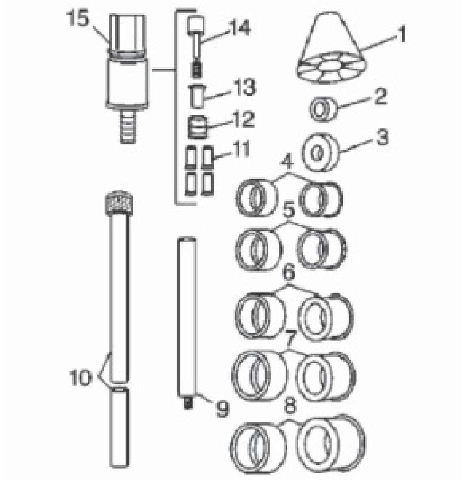
IMPORTANT: When installing the camshaft bearings, always look to ensure that the camshaft bearing lubrication hole is located at the 3 o'clock position. The proper positioning of the camshaft bearing lubrication hole is to ensure the best lubrication of the engine camshaft journals.



a - 3 o'clock position

1. Select the handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15) from the J33049.

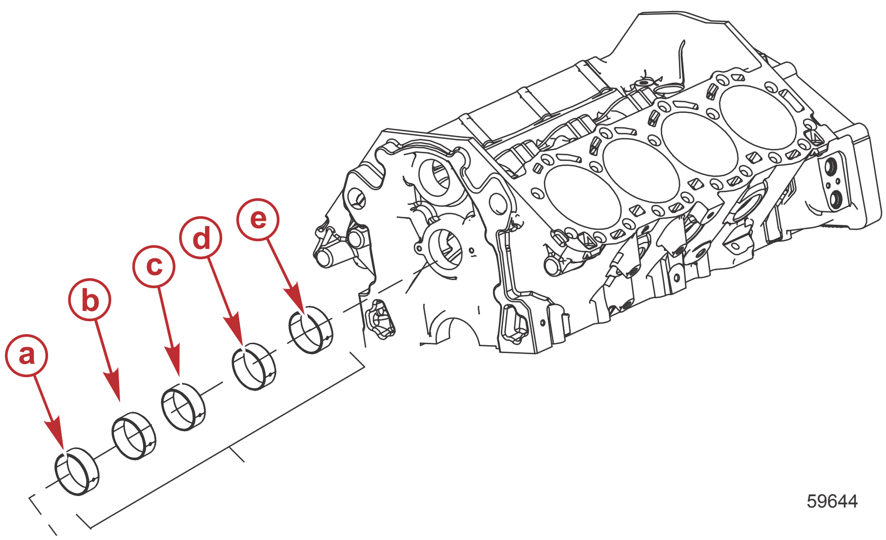
2. Assemble the J33049.



53617

1 - Cone
2 - Washer
3 - Washer
4 - Expanding driver
5 - Expanding driver
6 - Expanding driver
7 - Expanding driver
8 - Expanding driver
9 - Handle extension
10 - Handle
11 - Bushings
12 - Spacer
13 - Spacer
14 - Pin
15 - Expander assembly

Description	Part Number
Camshaft bearing service kit	J33049



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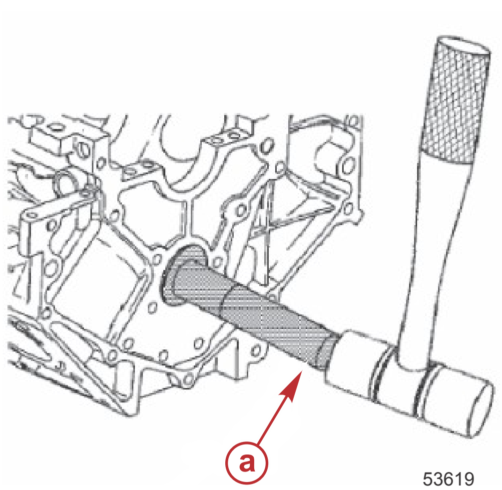
a - Position 1 cam bearing
b - Position 2 cam bearing
c - Position 3 cam bearing
d - Position 4 cam bearing
e - Position 5 cam bearing

IMPORTANT: The camshaft bearings vary in size. When ordering the new camshaft bearings, be sure to order the correct camshaft bearings for the application to be serviced. Always install the camshaft outer bearings #1 and #5 first. The camshaft outer bearings serve as a guide for the J33049 and help center the camshaft inner bearings during the installation process.



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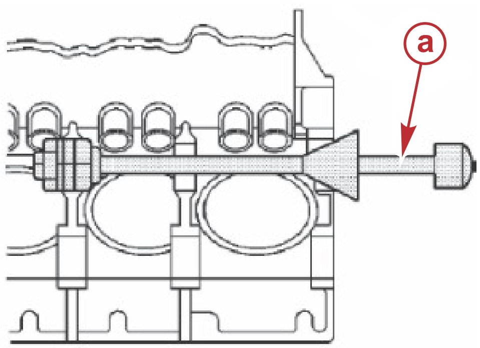
a - Camshaft bearing service kit driver (J33049)

3. Install the new camshaft outer bearings #5 and #1.
    a. Install the new camshaft outer bearing #5 onto the J33049 expander assembly.
    b. Tighten the J33049 expander assembly nut until snug.
    c. Align the lubrication hole of the camshaft outer bearing #5 above the 3 o'clock position of the camshaft outer bearing bore #5 at the rear of the engine block.
    d. Drive the camshaft outer bearing #5 into the camshaft outer bearing bore #5 at the rear of the engine block.
    e. Loosen the J33049 expander assembly nut.
    f. Remove the camshaft outer bearing #5 from the J33049 expander assembly.
    g. Install the new camshaft outer bearing #1 onto the J33049 expander assembly.
    h. Tighten the J33049 expander assembly nut until snug.
    i. Align the lubrication hole of the camshaft outer bearing #1 above the 3 o'clock position of the camshaft outer bearing bore #1 at the front of the engine block.
    j. Drive the camshaft outer bearing #1 into the camshaft outer bearing bore #1 at the front of the engine block.
    k. Loosen the J33049 expander assembly nut.
    l. Carefully slide the J33049 into the engine block until the J33049 expander assembly is positioned between the camshaft inner bearing bores.
4. Install the camshaft inner bearings #4, #3, and #2.

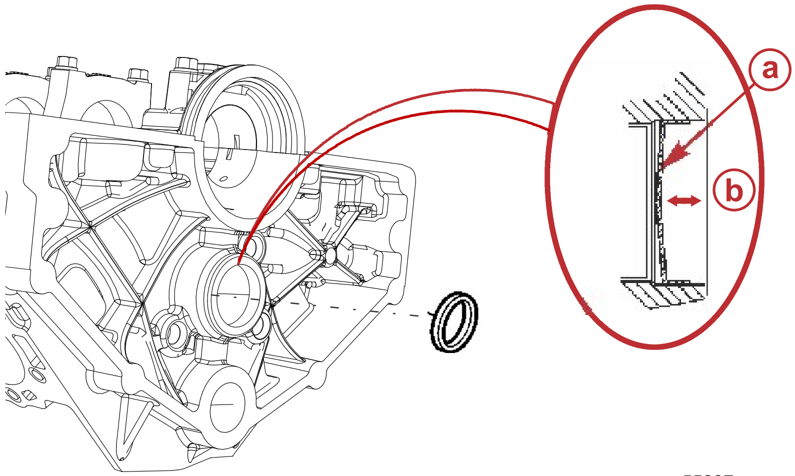


53618

a - Camshaft bearing tool assembled (J33049)

    a. Install the new camshaft inner bearing #4 onto the J33049 expander assembly.
    b. Tighten the J33049 expander assembly nut until snug.
    c. Align the lubrication hole of the camshaft inner bearing #4 at the 3 o'clock position of the camshaft inner bearing bore #4 of the engine block.
    d. Push the J33049 guide cone into the camshaft front bearing bore #1 in order to align the J33049.
    e. Drive the camshaft inner bearing #4 into the camshaft inner bearing bore #4 of the engine block.
    f. Loosen the J33049 expander assembly nut.
    g. Install the new camshaft inner bearing #3 onto the J33049 expander assembly.
    h. Tighten the J33049 expander assembly nut until snug.
    i. Align the lubrication hole of the camshaft inner bearing #3 at the 3 o'clock position of the camshaft inner bearing bore #3 of the engine block.
    j. Push the J33049 guide cone into the camshaft front bearing bore #1 in order to align the J33049.
    k. Drive the camshaft inner bearing #3 into the camshaft inner bearing bore #3 of the engine block.
    l. Loosen the J33049 expander assembly nut.
    m. Carefully slide the J33049 until the J33049 expander assembly is positioned between the camshaft inner bearing bore #2 and the camshaft outer bearing bore #1.
    n. Install the new camshaft inner bearing #2 onto the J33049 expander assembly.
    o. Tighten the J33049 expander assembly nut until snug.
    p. Align the lubrication hole of the camshaft inner bearing #2 at the 3 o'clock position of the camshaft inner bearing bore #2 of the engine block.
    q. Push the J33049 guide cone into the camshaft front bearing bore #1 in order to align the J33049.
    r. Drive the camshaft inner bearing #2 into the camshaft inner bearing bore #2 of the engine block.
    s. Loosen the J33049 expander assembly nut.
5. Carefully remove the J33049 from the engine block.

6. Coat the outer diameter of a new camshaft rear bearing hole expansion cup plug with sealant.
7. Install a new camshaft rear bearing hole expansion plug.
   IMPORTANT: The camshaft rear bearing hole plug must be installed 1 mm (0.039 in.) past the chamfer.



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a - Camshaft rear bearing hole expansion cup plug
b - Measurement—1 mm (0.039 in.) past the chamfer

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Expansion cup plug (camshaft rear bearing hole)	92-809821

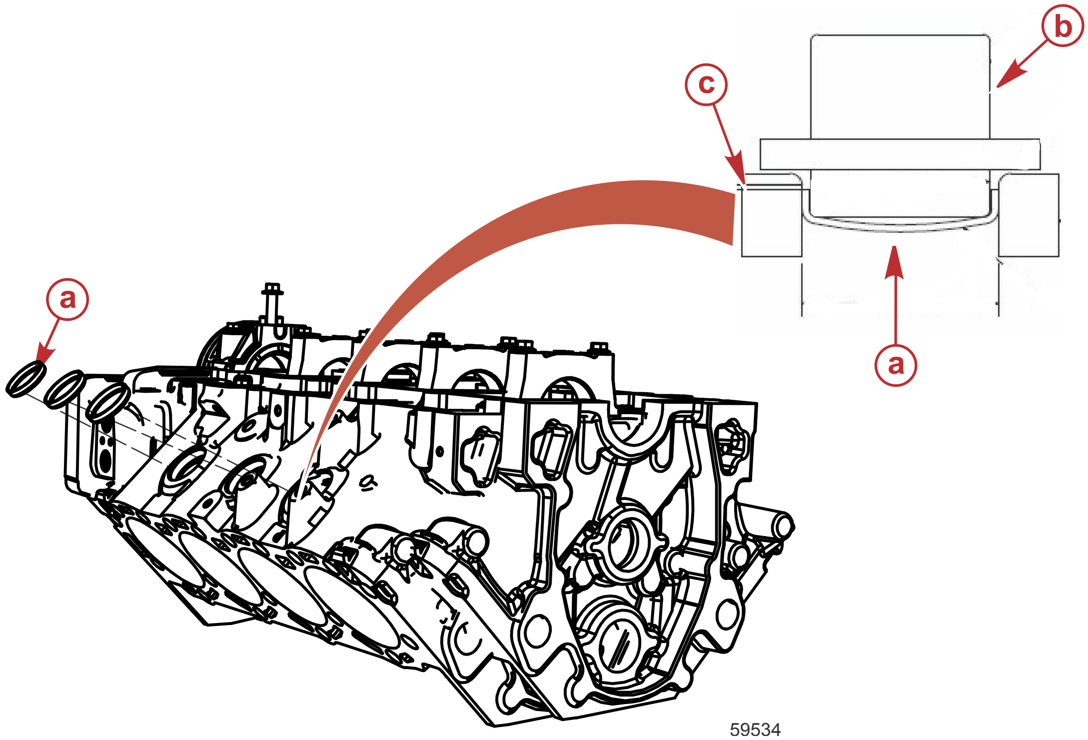
Engine Block Plugs

Installation

⚠ CAUTION
Wear eye protection when performing the following procedure. Failure to do so may cause personal injury.

1. Apply Loctite 242 Threadlocker sealant to the outside diameter of each new engine block core hole expansion plugs.

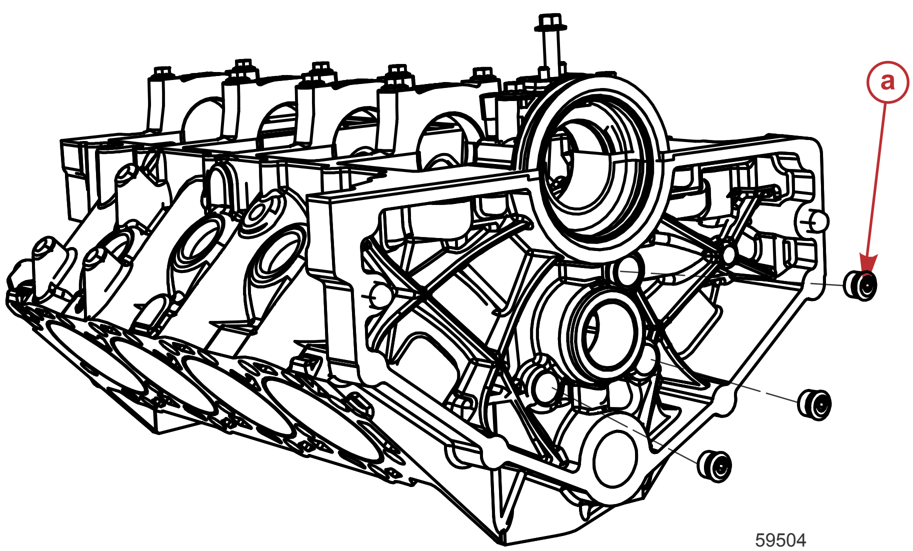
2. Install the engine block core hole expansion plugs a minimum of 1/32" below the end of the lead in chamfer of the block hole.



a - Core hole expansion plug
b - Tool
c - Minimum 1/32" below the end of the chamfer

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Outside diameter of engine block core hole expansion plug	92-809821

3. Apply sealant to the threads of the oil gallery plugs.
4. Install the oil gallery plugs indicated. Tighten the oil gallery plugs to the specified torque.



a - Rear oil gallery plugs

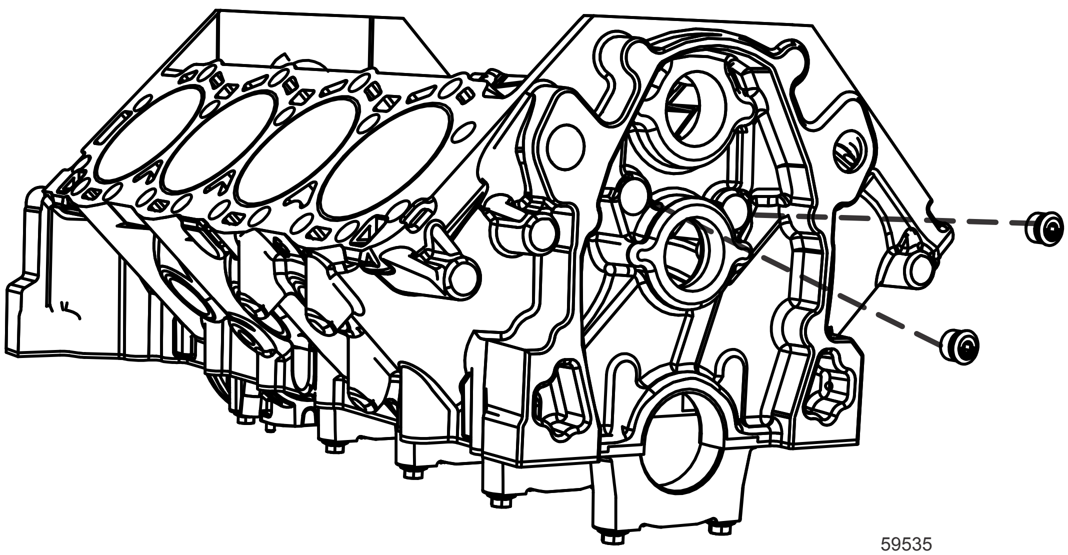
Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of oil gallery plugs and oil pressure sender	Obtain Locally

Description	Nm	lb-in.	lb-ft
Oil gallery plug—10 mm	9	79.6	–
Oil gallery plug—18 mm	22	–	16.2
Oil gallery plug—24 mm	55	–	40.5

5. Coat the threads of the new engine block oil gallery plugs.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of the engine block oil gallery plugs	Obtain Locally

6. Install the front oil gallery plugs. Tighten the oil gallery plugs to the specified torque.



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Engine block front surface oil gallery plugs

Description	Nm	lb-in.	lb-ft
Oil gallery plug—10 mm	9	79.6	–
Oil gallery plug—18 mm	22	–	16.2
Oil gallery plug—24 mm	55	–	40.5

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of the oil gallery plugs	Obtain Locally

7. Coat the threads of the engine block coolant drain hole plugs.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Threads of the engine block coolant drain hole plugs	Obtain Locally

8. Install the engine block coolant drain hole plugs. Tighten the plugs to the specified torque.

Description	Nm	lb-in.	lb-ft
Engine block coolant drain hole plugs	20	177	–

Crankshaft and Pistons

Cleaning

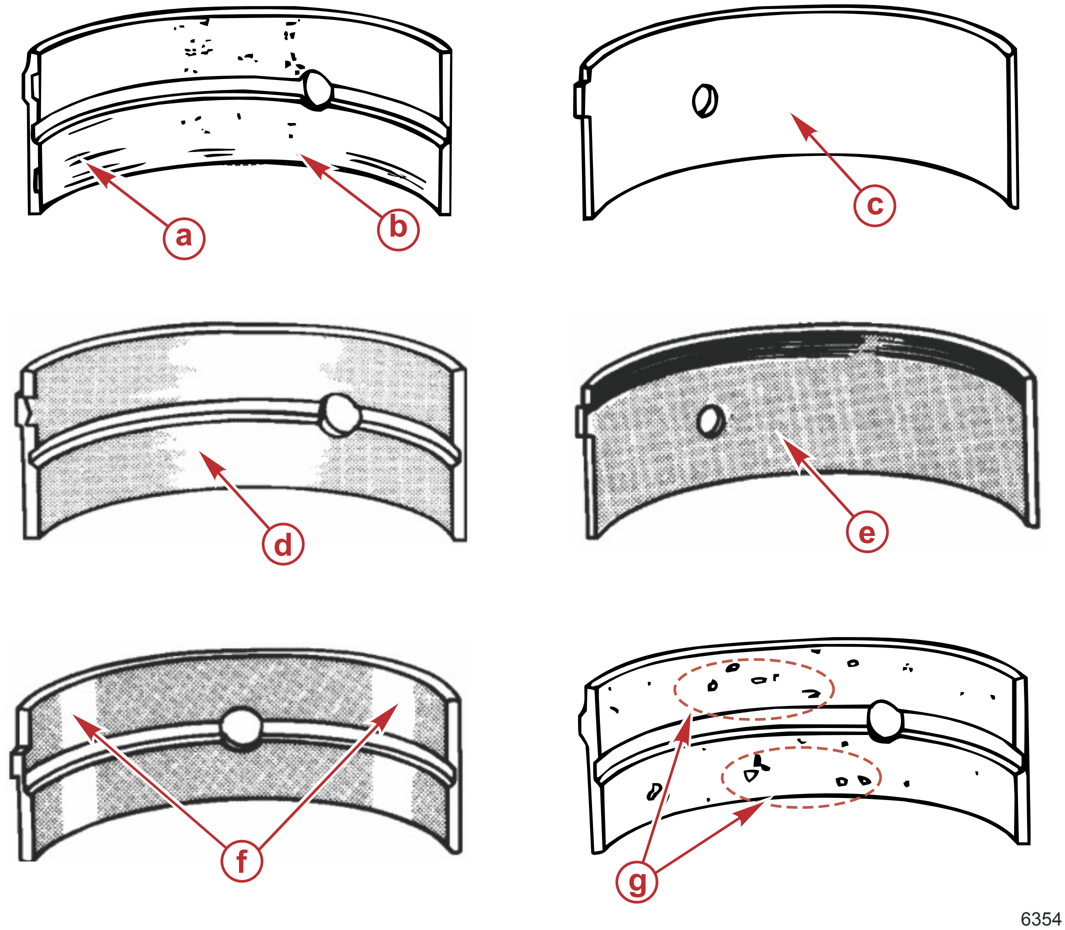
1. Connecting rods
   a. Clean the connecting rods in cleaning solvent.

   b. Dry parts with compressed air.
2. Connecting rod bearings
   a. Clean the connecting rod bearings in cleaning solvent. Do not scratch the bearing contact surfaces.
   b. Wipe the bearings clean with a soft cloth.
   c. Dry parts with compressed air.
3. Pistons
   a. Clean the pistons in cleaning solvent.
   b. Clean varnish from the piston skirt and pin with a suitable cleaning solvent.
   c. Clean the piston ring grooves.
   d. Clean the piston oil lubrication holes and slots.
   e. Dry parts with compressed air.
4. Piston pin
   a. Clean the parts in cleaning solvent.
   b. Dry the parts with compressed air.

Main Bearing Inspection

This MerCruiser engine uses precision insert type main bearings. If the installed bearing clearance exceeds specification then the bearing assembly must be replaced. Service bearings are available in standard size and 0.0508 mm (0.002 in.), 0.254 mm (0.010 in.), and 0.508 mm (0.020 in.) undersized.

Due to loading factors, the lower half of a crankshaft bearing set will generally exhibit the most wear. If inspection indicates the lower bearing half is suitable for reuse, it can be assumed that the upper bearing half can also be reused. If the lower bearing half shows evidence of wear or damage, replace the entire bearing set. Never replace one half of a bearing set without replacing the other half.



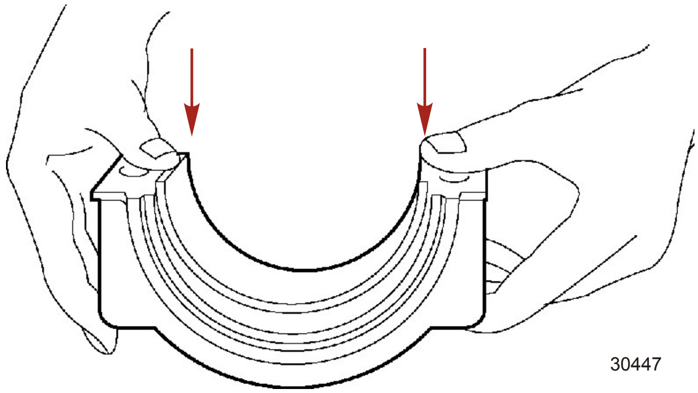
Main bearing failure example

- a - Contamination scratches
- b - Contamination particles
- c - Tapered journal
- d - Oil starvation
- e - Radius ride
- f - Improper seating
- g - Fatigue failure

Crankshaft Installation

Main Bearing Tension

IMPORTANT: Ensure that the main bearing is installed under tension. It should require firm pressure to fit the bearing into position.

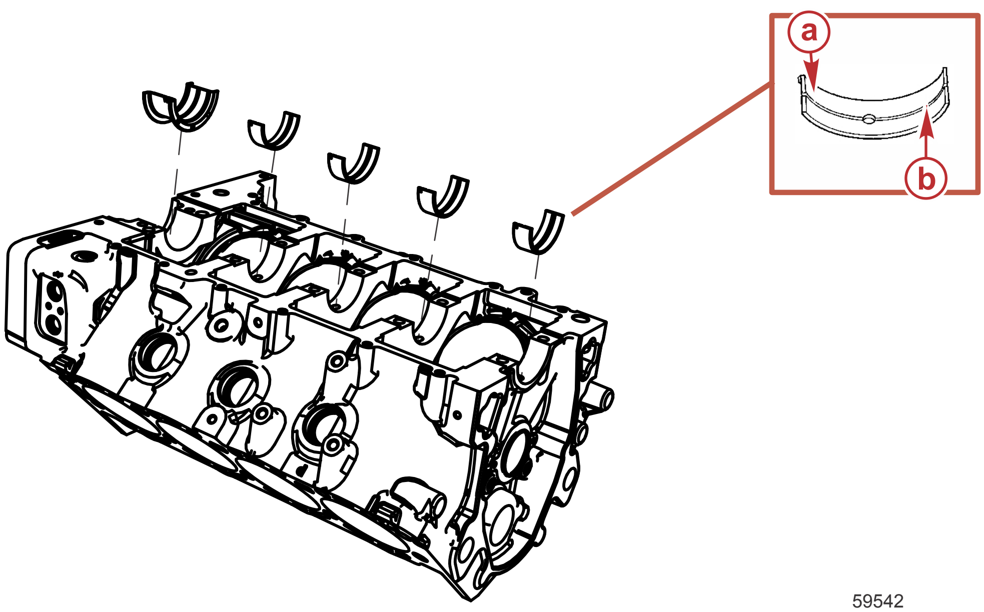


Main bearing tension

Main Bearings and Crankshaft

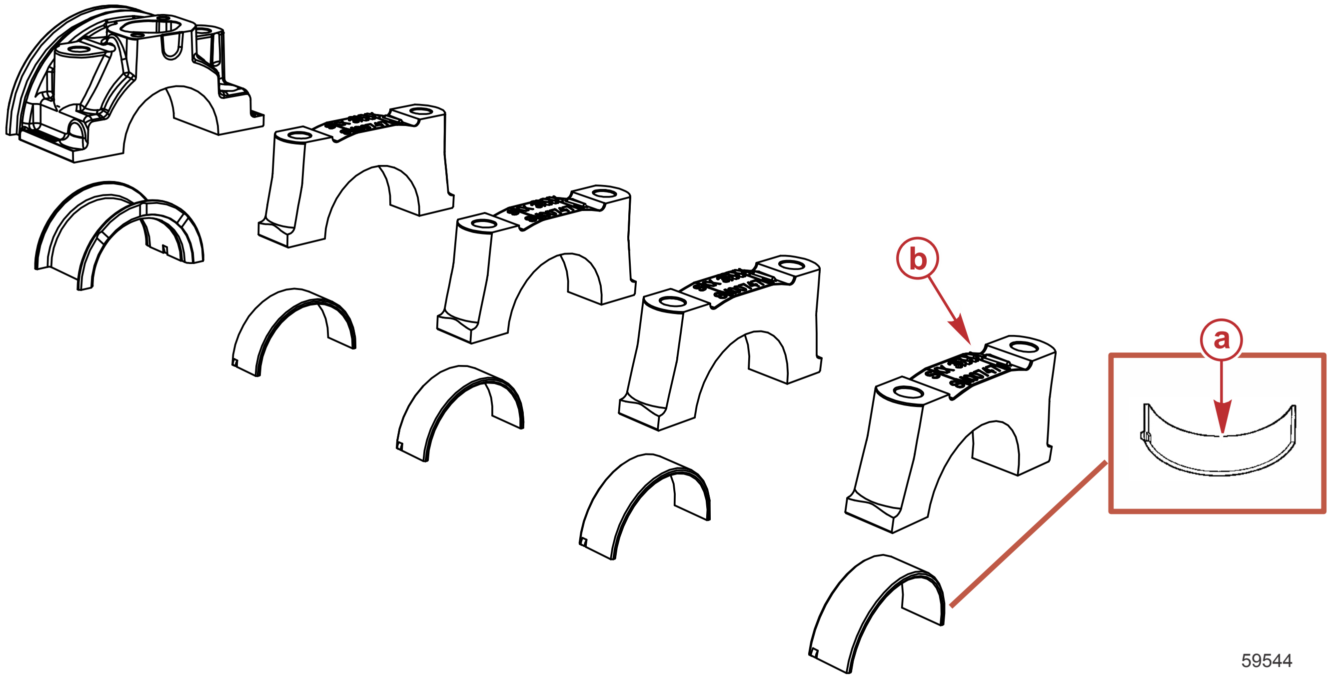
1. Remove the timing sprocket from the old crankshaft and install on the new crankshaft.
2. On the driveshaft extension models—if the old pilot bushing is to be reused, the bushing can be removed without damage as follows:
   a. Fill the pilot bushing cavity with grease.
   b. Insert an old transmission input shaft in the bore of the bushing and hit it with a hammer. This will create hydraulic pressure in the pilot bushing cavity that should force the bushing out.

   IMPORTANT: Ensure that all bearings and crankshaft journals are clean.
3. Install the upper main bearing inserts in the engine block.



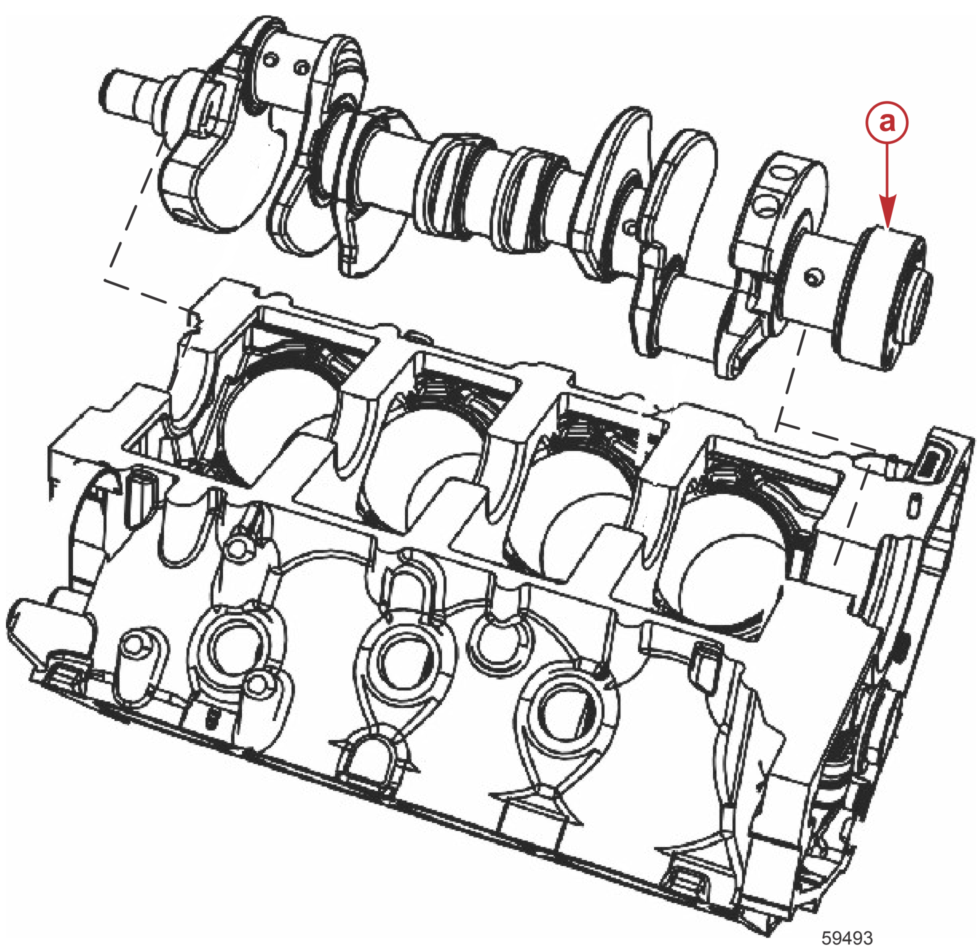
a - Upper insert
b - Oil groove

4. Install the lower main bearing insert into the main bearing caps.



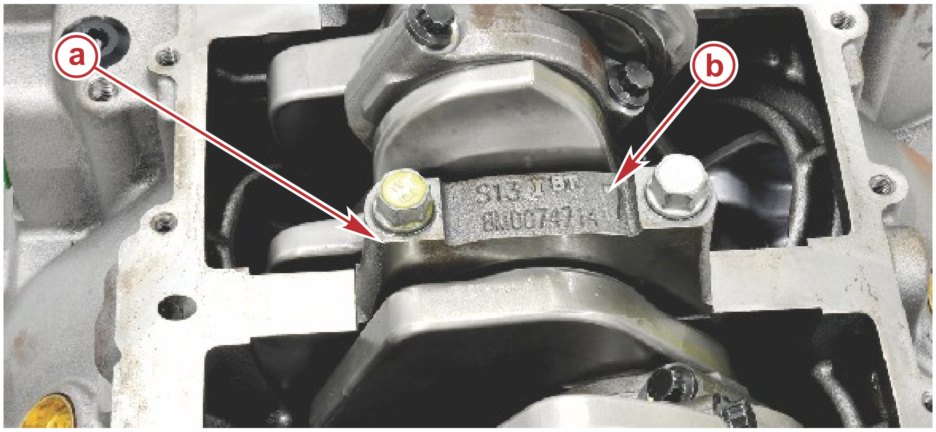
a - Lower insert
b - Main bearing cap

5. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.



a - Crankshaft

6. Install the main bearing caps in the original location with the markings pointing toward the front of the engine.



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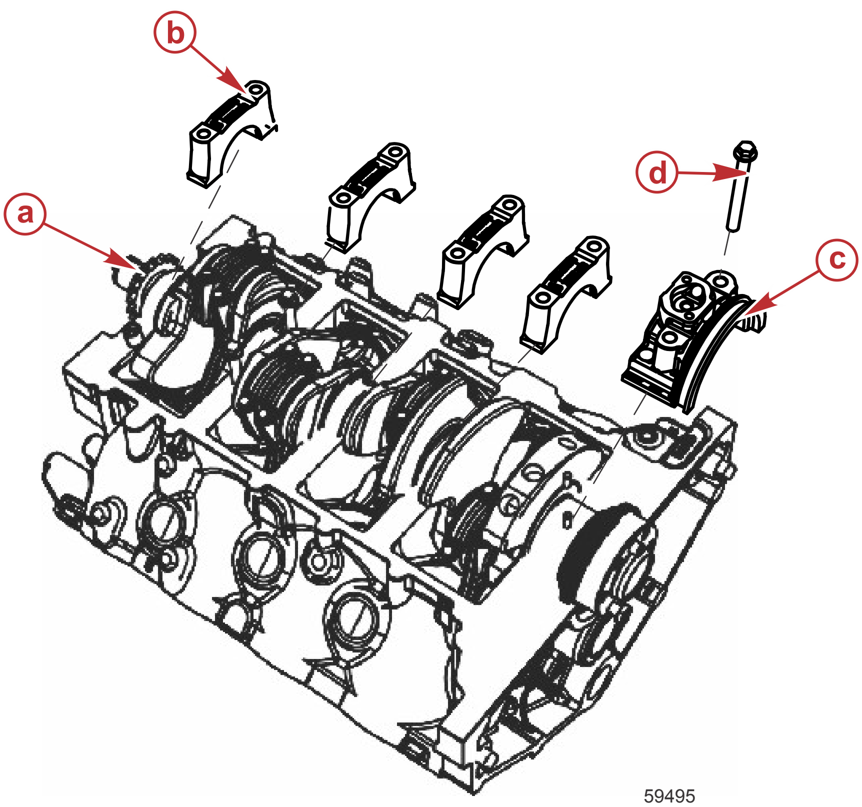
a - Main bearing cap
b - Bearing cap marks

7. Check the clearance of each main bearing, following the procedure outlined under **Main Bearing Clearance, Plastigauge Method.**
8. When bearing clearances meet specifications, lubricate the main bearings and crankshaft bearing journals.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Main bearings and crankshaft bearing journals	Obtain Locally

9. Install the main bearing caps.



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a - Crankshaft
b - Main bearing cap
c - Rear main bearing cap
d - Main bearing cap bolt

10. Check main bearing clearance using plastigauge. Refer to **Main Bearing Clearance, Plastigauge Method**.
11. Tighten all main bearing caps, except the rear main cap, to the specified torque.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt—preferred method	**First**	15	132.7	–
	Second	40	–	29.5
	Final	+90°		

12. Tighten the rear main bearing cap. Using the following method:
    Preferred method:
    a. Do the first step torque on the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt—preferred method	**First**	15	132.7	–

    b. Using a lead hammer, tap the end of the crankshaft to the rear.
    c. Using a lead hammer, tap the end of the crankshaft to the front.
    d. Do the second step torque on the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt—preferred method	**Second**	40	–	29.5

    e. Do the final step torque on the bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt—preferred method	**Final**	+90°		

13. Check the crankshaft end play.
14. Install the rear main seal retainer and seal.
15. Check the clearance for each connecting rod bearing. Refer to **Connecting Rod Bearing Clearance, Micrometer Method** or **Connecting Rod Bearing Clearance, Plastigauge Method**.

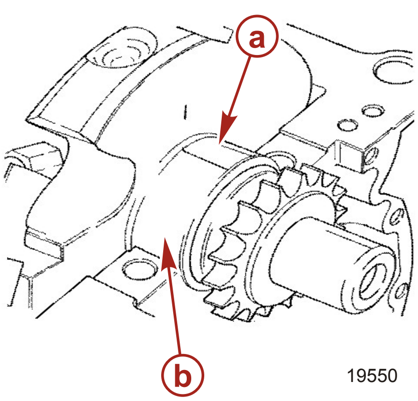
Main Bearing Clearance, Plastigauge Method

To obtain accurate measurements while using plastigauge or its equivalent, the engine must be out of the boat and upside down so the crankshaft will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal.

To ensure the proper seating of the crankshaft, all bearing cap bolts should be at the specified torque. In addition, the surface of the crankshaft journal and bearing must be wiped clean of oil.

NOTE: When checking the number 1 main bearing, loosen the accessory drive belt to prevent obtaining a tapered reading with the gauging plastic.

1. Remove the bearing cap and wipe any oil from the journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing and parallel to the crankshaft centerline as shown.



Main bearing plastigauge measurement
a - Gauging plastic
b - Bearing journal

IMPORTANT: The bearing caps must be tightened to the specified torque to ensure correct measurements. Do not rotate the crankshaft with the plastigauge installed.

3. Install the bearing cap and evenly tighten the main bearing cap bolt or stud to the specified torque.

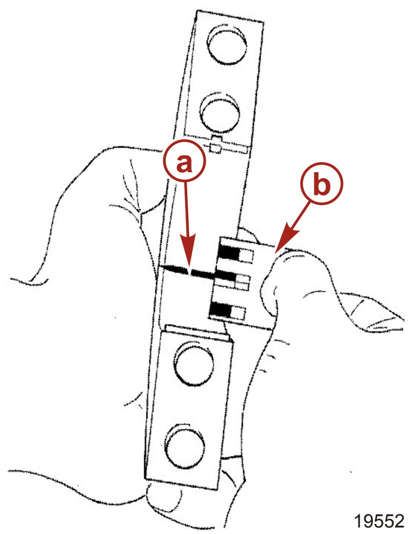
Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt—preferred method	**First**	15	132.7	–
	Second	40	–	29.5
	Final	+90°		

4. Remove the bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or the journal.

5. On the edge of the gauging plastic envelope there is a graduated scale that is correlated in thousandths of an inch. Without removing the gauging plastic from the crankshaft bearing or journal, measure its compressed width at the widest point with the graduated scale.

   NOTE: Normally main bearing journals wear evenly and are not out of round.

   - If a bearing is being fitted to an out of round journal of 0.0254 mm (0.001 in.) maximum, be sure to fit to the maximum diameter of the journal.
   - If the bearing is fitted to the minimum diameter and the journal is out of round 0.0254 mm (0.001 in.) maximum, interference between the bearing and journal will result in rapid bearing failure.
   - If the flattened gauging plastic tapers toward the middle or ends, the difference in clearance indicates taper or another irregularity of the bearing or journal.
   - Measure the journal with a micrometer if the flattened gauging plastic indicates more than 0.0254 mm (0.001 in.) difference.



Measuring clearance with plastigauge

a - Compressed gauging plastic

b - Scale

Main Bearing Clearance		
Description		**6.2 Liter (377 cid)**
Production	Number 1, 2, 3, 4	0.043–0.107 mm (0.0017–0.0042 in.)
	Number 5	0.043–0.107 mm (0.0017–0.0042 in.)

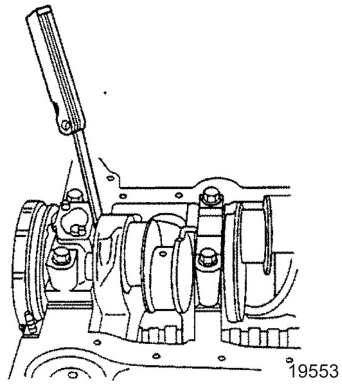
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a set.
7. A standard or 0.0254 mm (0.001 in.) undersized bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersized bearing.

   IMPORTANT: After selecting a new bearing, recheck clearance.
8. Check clearance with a newly selected bearing. If the bearing clearance is within specifications, the bearing insert is satisfactory. If not, repeat previous steps.
9. Proceed to the next bearing. After all bearings have been checked, oil and install the selected bearings and rotate the crankshaft to check for excessive drag.

Crankshaft End Play

1. Firmly force the crankshaft rearward.
2. Firmly force the crankshaft forward.

3. Measure the clearance at the front end of the rear main bearing with a feeler gauge as shown.



Measuring crankshaft end play

Description	**6.2 Liter (377 cid)**
End play (thrust clearance)	0.025–0.305 mm (0.001–0.012 in.)

Preliminary Inspection

IMPORTANT: All measurements should be taken when components are at room temperature.

1. Connecting rod
   a. Check for twisted or bent connecting rods.
   b. Inspect for nicks and cracks.
   c. Inspect for damage to the bearing cap or bolt threads.
   d. Replace damaged connecting rods.
2. Connecting rod bearings

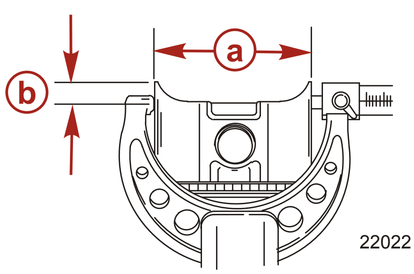
   NOTE: Refer to ***Main Bearing Inspection*** *for examples of common bearing failures.*

   a. Inspect the connecting rod bearings for craters, pockets, or flattened sections.
   b. Inspect the connecting rod bearings for excessive scoring, discoloration, or damage.
   c. Inspect the connecting rod bearings for dirt or debris embedded in the bearing material.
   d. Replace damaged or faulty bearings.

Piston Inspection

NOTE: Cylinder bore and taper must be within specifications before pistons can be considered for reuse.

1. Inspect the piston for cracked ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts, and eroded areas at the top of the piston.
2. Inspect the ring grooves for nicks and burrs that may cause the rings to bind.
3. Inspect the piston for wear by checking the piston to bore clearance:
   a. Measure the piston diameter 12 mm (0.472 in.) from the bottom of the skirt at a right angle to the piston pin bore as shown.



Measuring piston diameter

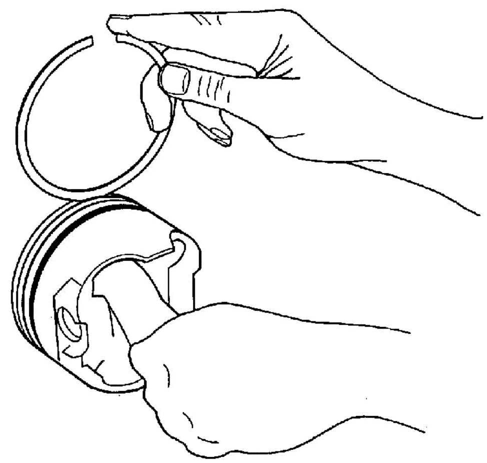
a - Piston diameter

b - Measurement location

   b. Measure the cylinder bore diameter with a telescope gauge. Refer to **Piston Selection**.
   c. Subtract the piston diameter from the cylinder bore diameter to determine piston to bore clearance.
   d. Replace the piston if the piston to bore clearance is less than specified. Refer to **Piston Selection** for cylinder reconditioning and piston replacement.

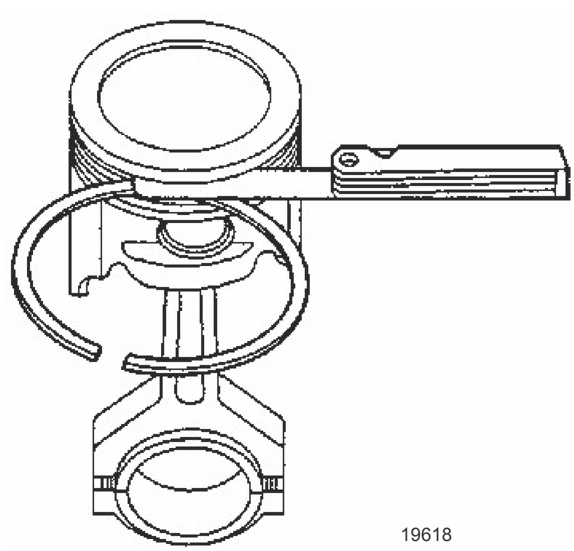
Piston Bore Clearance	
Description	**6.2 Liter (377 cid)**
Production	0.055–0.083 mm (0.0022–0.0032 in.)

4. Insert the appropriate type of piston ring into each of the piston ring grooves.
5. Roll the ring around the groove to ensure that the ring moves freely around the entire piston.
   - If the ring binds, check the piston ring groove for deposits. Clean out all deposits.
   - If the ring binds, check the piston ring groove for nicks or burrs. Minor internal damage can be dressed with a fine file.
   - If the piston ring groove is clean and free of defects, check the groove with a different ring. The ring used for inspection may be bent.



Checking piston ring grooves

6. Using a feeler gauge, measure the clearance between the piston ring and the piston ring groove at several points around the piston.



Measuring piston ring to piston clearance

Top Compression		
Description		**6.2 Liter (377 cid)**
Groove clearance	Production	0.030–0.075 mm (0.0012–0.0029 in.)

Second Compression		
Description		**6.2 Liter (377 cid)**
Groove clearance	Production	0.020–0.060 mm (0.0008–0.0023 in.)

Oil Control		
Description		**6.2 Liter (377 cid)**
Groove clearance	Production	0.020–0.165 mm (0.0008–0.0065 in.)

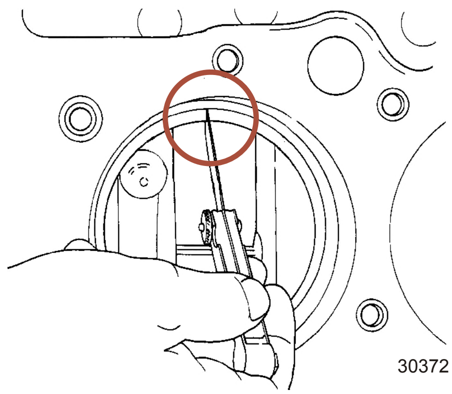
7. Replace the piston if groove clearance exceeds the specified limit.

Piston Ring Gap Inspection

IMPORTANT: Fit each compression ring to the cylinder in which it is going to be used.

1. Insert a piston ring into the cylinder bore.
2. Use an inverted piston to push the piston ring 6 mm (1/4 in.) into the cylinder bore.

   NOTE: Ensure that the piston and ring are square with the cylinder wall.
3. Remove the piston.
4. Using a feeler gauge, measure the piston ring gap.



Measuring piston ring gap

Description		**6.2 Liter (377 cid)**
Top compression ring gap	Production	0.38–0.52 mm (0.015–0.020 in.)
Second compression ring gap	Production	0.63–0.82 mm (0.025–0.032 in.)
Oil control ring gap	Production	0.18–0.72 mm (0.007–0.028 in.)

5. Replace the ring if the gap exceeds service limits. If the ring gap is below specifications, remove the ring and try another.

Assembly

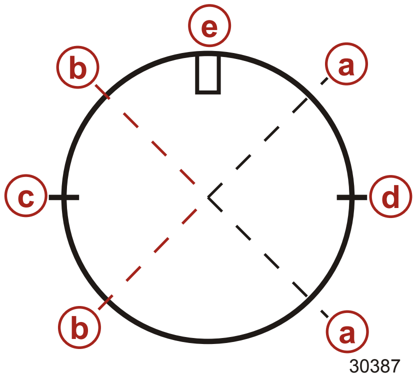
Piston Ring Installation

IMPORTANT: All compression rings are marked on the upper side of the ring. When installing compression rings, ensure that the marked side is toward the top of the piston.

NOTE: Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings appropriate for the cylinder bore and piston size.
2. Install the oil control ring spacer in its groove.

3. Hold the spacer ends together and install the lower oil control ring with its gap properly located.



Ring gap locations
a - Oil ring spacer gap
b - Oil ring gaps
c - Lower compression ring gap
d - Upper compression ring gap
e - Front of engine

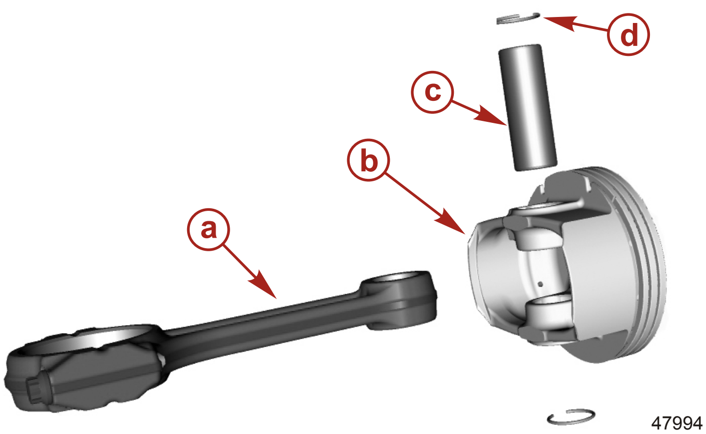
4. Install the upper oil control ring with its gap properly located.
5. Flex the oil ring assembly to ensure that the rings move freely.
   IMPORTANT: Use the piston ring expander for compression ring installation.

Piston Ring Expander	91-24697

6. Using a piston ring expander, install the lower and upper compression rings with the marked side up.

Piston/Connecting Rod Assembly

1. Install the connecting rod into the piston with the odd number cylinder: Connecting rod dot down, piston dome dot up. Even number cylinder: connecting rod dot up, piston dome dot up.
2. Lubricate the piston pin with Lubriplate SPO 255.
3. Assemble the piston, connecting rod, piston pin, and secure with new piston pin retaining clips.



a - Connecting rod
b - Piston
c - Piston pin
d - Piston pin retaining clip (2)

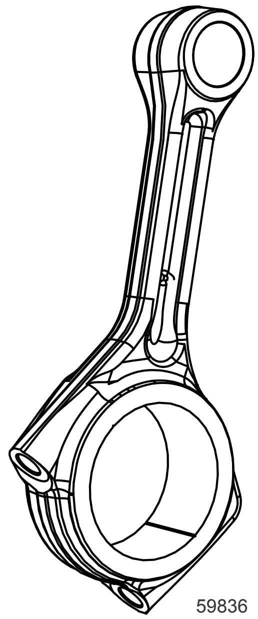
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Piston pin	Obtain Locally

Piston and Rod Installation

IMPORTANT: Cylinder bores must be thoroughly clean before piston installation.

IMPORTANT: When assembling the pistons and connecting rods, the following must be kept in mind:

- **If the original pistons or connecting rods are being used, install them into the cylinder from which they were removed.**
- **The connecting rod bearing tangs are always oriented toward the outside of the engine block.**



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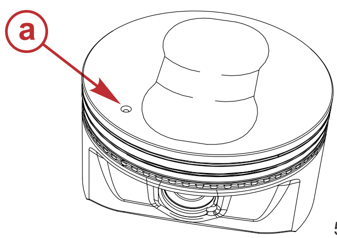
- **The marking on the top of the piston must be positioned toward the front of the engine (water pump end).**



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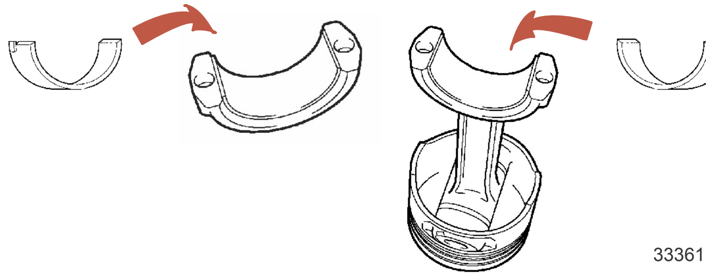
a - Piston marking

1. Cylinder bore preparation:
   a. Clean the cylinder bores with a light honing oil, as necessary.
   b. Clean with hot water and detergent.
   c. Rinse thoroughly.
   d. Lightly oil the cylinder bores with a clean, lint free white cloth, with engine oil. Repeat until the cloth remains clean.
   e. Wipe down the cylinder bores a final time with a clean, lint free white cloth.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Cylinder walls	92-8M0078629

2. Rotate the crankshaft until the crankpin is at before dead center (BDC) for the cylinder that is ready for the first piston to be installed.
3. Carefully wipe any foreign material from the connecting rod bearings and the connecting rod bearing fitting surfaces.
   IMPORTANT: Do not apply oil to the back of the bearings or the connecting rod bearing mating surfaces.

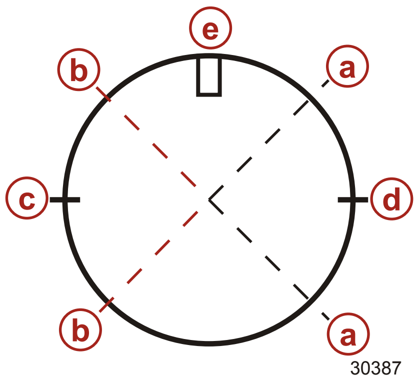
4. Insert the bearing shells into the connecting rod and its matching rod cap.



5. Liberally lubricate the connecting rod bearings, pistons, rings, and cylinder walls.

Tube Ref No.	Description	Where Used	Part No.
139	25W-40 Synthetic Blend 4-Stroke Marine Engine Oil	Connecting rod bearings, pistons, rings, and cylinder walls	92-8M0078629

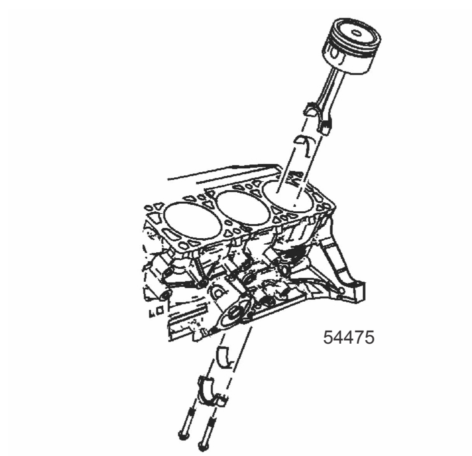
6. Position ring gaps as shown.

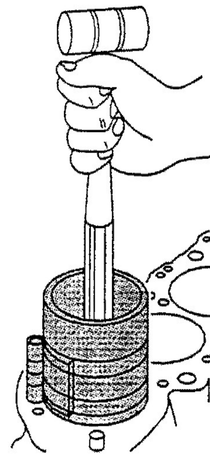


Ring gap locations

a - Oil ring spacer gap
b - Oil ring gaps
c - Lower compression ring gap
d - Upper compression ring gap
e - Front of engine

7. Use the piston ring compressor and compress rings.





Piston ring compressor use

Description	Part Number
Piston ring compressor	J8037

IMPORTANT: Install new pistons in the same cylinders for which they were fitted and install used pistons in the same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at the front of the engine (1, 3, 5, and 7 from the left bank and 2, 4, 6, and 8 from the right bank). Numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

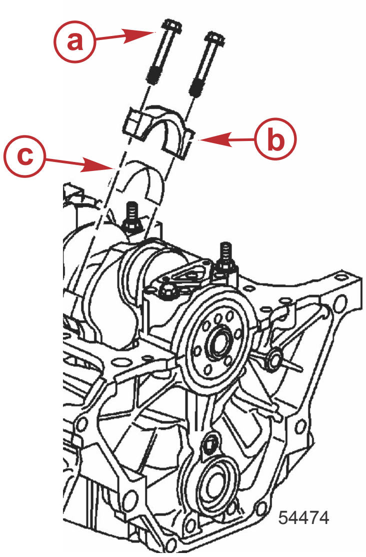
8. Install each connecting rod and piston assembly in its respective bore with the piston notch toward the front of the engine.
9. Hold the piston ring compressor firmly against the engine block until all piston rings have entered the cylinder bore.
10. Using a wooden or plastic hammer handle, lightly tap the piston into its bore.
11. Apply a lubricant to the threads and mating faces of each connecting rod cap and screw.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Threads and mating faces of connecting rod cap and screw	Obtain Locally

NOTICE

Connecting rods and end caps are matched sets. Mismatching the original pairs will result in catastrophic engine damage. Install all connecting rods with their matched end caps.

12. Install the connecting rod cap.



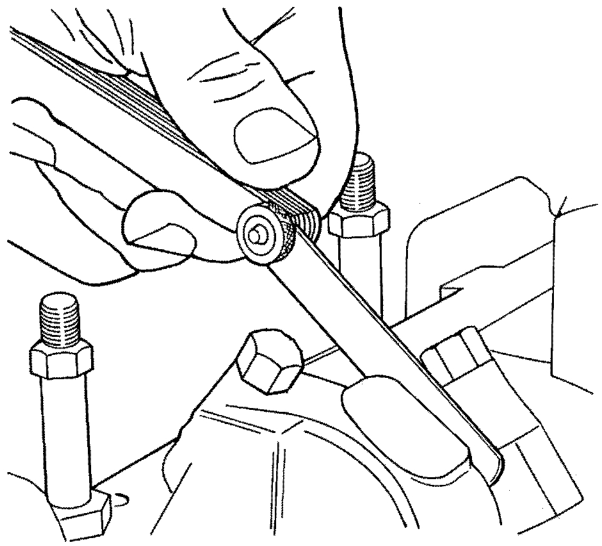
Installing connecting rod caps

- a - Connecting rod screws (2)
- b - Connecting rod cap
- c - Lower bearing half

13. In a two pass sequence, tighten connecting rod cap screws to the specified torque.

Description		Nm	lb-in.	lb-ft
Connecting rod cap screw	**First**	25	–	18.4
	Final	+90°		

14. Lightly tap each connecting rod assembly parallel to the crankpin to set side clearance.
15. Check rod bearing clearance using plastigauge method. Refer to **Connecting Rod Bearing Clearance, Plastigauge Method**.
16. Measure all connecting rod side clearances between the connecting rod caps.



Measuring connecting rod side clearance

Description	6.2 Liter (377 cid)
Rod side clearance	0.312–0.588 mm (0.013–0.023 in.)

Connecting Rod Bearing Clearance, Micrometer Method

IMPORTANT: The micrometer method is the preferred method of determining connecting rod bearing clearance.
IMPORTANT: All measurements should be taken when components are at room temperature.

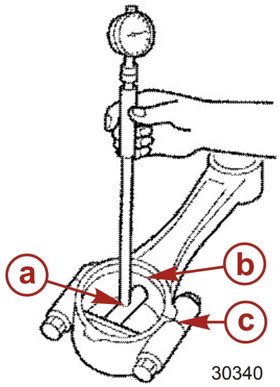
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. Replace the bearing if clearance is found to be excessive. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersized for use with new and used standard size crankshafts. They are also available in 0.010 in. and 0.020 in. undersized for use with reconditioned crankshafts.

1. Wipe both upper and lower connecting rod bearings clean with a soft cloth.
2. Install the upper and lower connecting rod bearings.
3. Install the bearing cap.
4. In a two step sequence, tighten the bearing cap screws to the specified torque.

Description		Nm	lb-in.	lb-ft
Bearing cap screws	**First**	25	–	18.4
	Final	+90°		

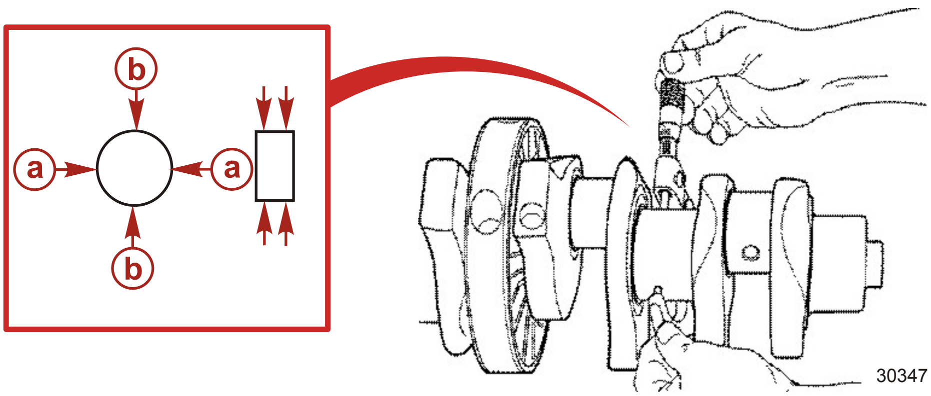
5. Use an inside dial indicator to measure the connecting rod bearing inside diameter and out of round and taper. Measure in several places approximately 90° apart and average the measurements.

IMPORTANT: Do not measure inside diameter close to the connecting rod and bearing split line.



a - Inside dial indicator
b - Assembled rod and bearings
c - Split line

6. Record the measurements.
7. Wipe the crankshaft connecting rod journal with a clean cloth. Remove any oil film.
8. Measure the crankshaft connecting rod journal diameter with a micrometer. Take a second measurement at a position on the connecting rod journal at a point 90° from the first measurement.



a - Measurement point "a"
b - Measurement point "b"

Description		6.2 Liter (377 cid)
Diameter		53.3095–53.3295 mm (2.0988–2.0995 in.)
Taper	Production	0.005 mm (0.0002 in.) maximum
Out of round	Production	0.008 mm (0.0003 in.) maximum

NOTICE

Inadequate clearance or interference between the bearing and its mating surface will result in rapid bearing wear and catastrophic component failure. Check all bearing clearances.

9. If the crankshaft rod bearing journal diameters are not within specifications, replace or recondition the crankshaft.
10. If the crankshaft rod bearing journal diameters are within specifications, determine bearing clearance by subtracting the crankshaft connecting rod journal outer diameter from the inner diameter of the bearing from step 5.

Description		6.2 Liter (377 cid)
Clearance	Production	0.047–0.110 mm (0.0019–0.0043 in.)

11. If the clearance exceeds specifications, select a new, correct size bearing, and recheck the bearing clearance.

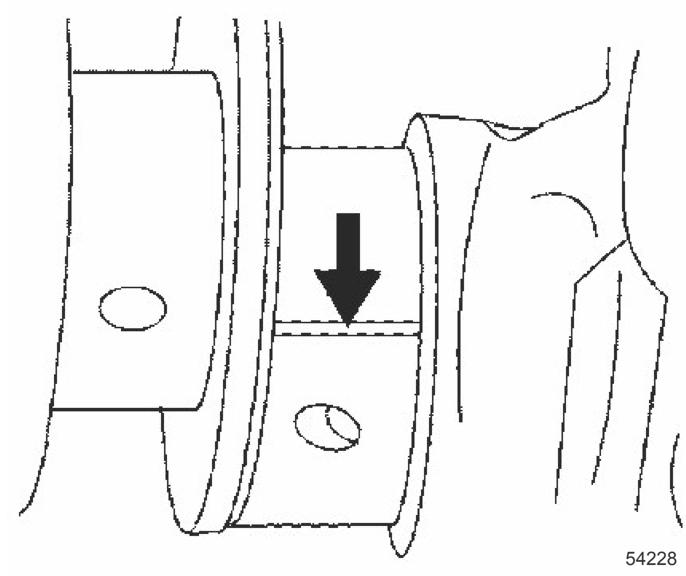
Connecting Rod Bearing Clearance, Plastigauge Method

The plastic gauge method is an optional method of determining connecting rod bearing clearance. Micrometer measurement is the preferred method.

1. Wipe both upper and lower bearings and the crankshaft connecting rod journal with a clean soft cloth. Remove any oil film.
2. Install the bearings in the connecting rod and cap.
   IMPORTANT: To obtain accurate measurements the connecting rod and upper bearing must be seated against the connecting rod journal before installing the lower bearing and rod cap.
3. Rotate the crankshaft or move the connecting rod until the upper bearing is fully seated against the connecting rod journal being measured.

IMPORTANT: Position the Plastigauge on the crankshaft journal so that it will be centered as it lays across the bearing shell.

4. Place a piece of gauging plastic parallel to the crankshaft on the middle of the open crankshaft connecting rod journal surface as shown. Install the gauging plastic the full width of the journal.



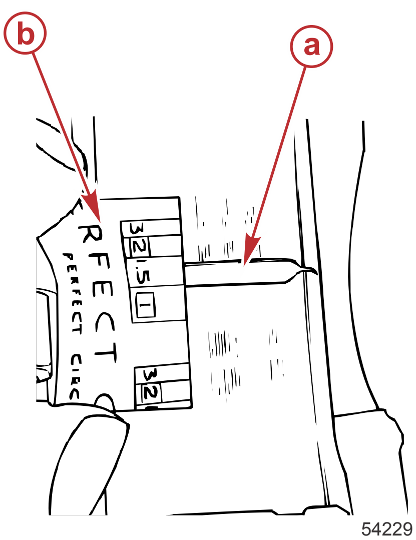
Plastigauge placement

5. Install the bearing cap.
6. Tighten the bearing cap screws in two steps to the specified torque.

Description		Nm	lb-in.	lb-ft
Bearing cap screws	**First torque**	25	–	18.4
	Final torque	+90°		

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

7. Without rotating the crankshaft, remove the bearing cap and use the scale on the gauging plastic envelope to measure the Plastigauge width at the widest point.



a - Compressed gauging
b - Scale

Description		**6.2 Liter (377 cid)**
Journal clearance	Production	0.047–0.110 mm (0.0019–0.0043 in.)

8. If the clearance is not within specifications, select a new, correct size bearing and recheck the clearance.

NOTE: If clearance cannot be brought to within specifications, the crankshaft connecting rod journal will have to be ground undersized. If the connecting rod journal is already at maximum undersized, replace the crankshaft.

9. Coat the selected bearing surface with oil.
10. Install the connecting rod cap.
11. Tighten the bearing cap screws in two steps to the specified torque.

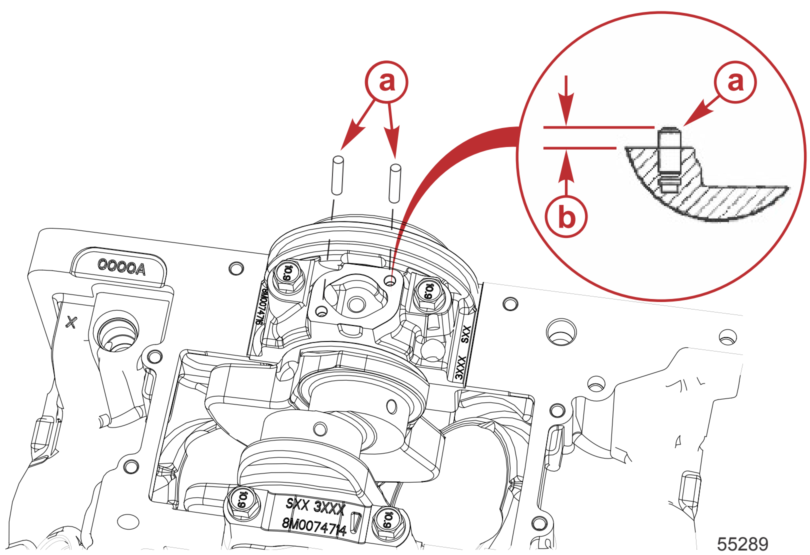
Description		Nm	lb-in.	lb-ft
Bearing cap screws	**First torque**	25	–	18.4
	Final	+90°		

Oil Pump

Inspection

IMPORTANT: Pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.

1. Inspect the pump body and cover for cracks or excessive wear.
2. Inspect the pump gears for damage and excessive wear, such as chipped teeth and galling.
3. Check the gear shafts in the pump body for galling, scoring, or excessive shaft-to-bore clearance.
4. Inspect the inside of the pump cover for wear that would permit oil to leak past the gears.
5. Inspect the pickup screen and suction pipe assembly for damage or blockage.
6. Check the pressure regulator valve for smooth, nonbinding fit in its bore in the oil pump cover.
7. Inspect the oil pump locator dowel pins for damage and proper height.



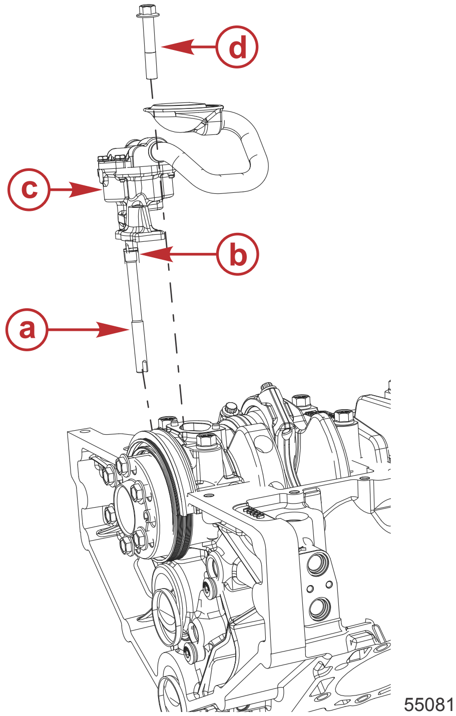
a - Dowel pins
b - Oil pump dowel pin height

Description	Height
Oil pump dowel pin	8.067–9.683 mm (0.3175–0.3812 in.)

Installation

1. Align the oil pump driveshaft with the intermediate shaft.

IMPORTANT: Do not reuse the oil pump driveshaft retainer.



a - Driveshaft
b - Driveshaft retainer
c - Oil pump
d - Screw

2. Install the oil pump driveshaft, a new driveshaft retainer, and the oil pump to the rear main bearing cap.
3. Tighten the oil pump screw to the specified torque.

Description		Nm	lb-in.	lb-ft
Oil pump screw (to rear crankshaft bearing cap)	**First**	20	177	–
	Final	+65°		

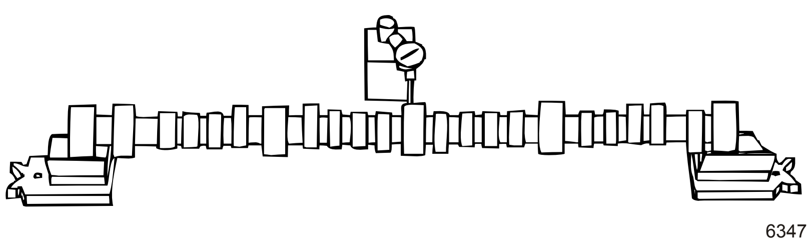
Camshaft

Inspection

1. Inspect the camshaft thrust plate for damage. Replace if damaged or worn.
2. Inspect the camshaft for worn, scored, or damaged bearing journals or lobes.
3. Inspect the camshaft for bolt hole threads.
4. Inspect the camshaft sprocket locator pin.
5. Measure the camshaft bearing journals with a micrometer. If journals are not within specifications, the camshaft should be replaced.

Description	**6.2 Liter (377 cid)**
Journal diameter	47.465–47.490 mm (1.8687–1.8697 in.)
Journal out of round	0.05 mm (0.0020 in.) maximum

6. Measure for a bent camshaft or excessive camshaft runout with a dial indicator. If the runout exceeds the specified amount, the camshaft should be replaced.

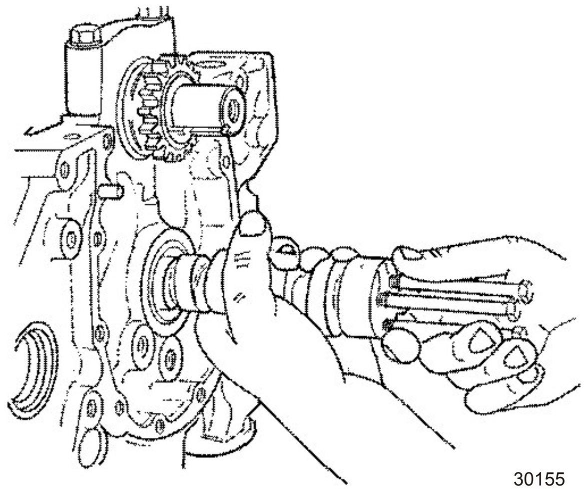


Checking camshaft alignment

Description	6.2 Liter (377 cid)
Camshaft runout	0.050 mm (0.0020 in.) maximum

Installation

1. Install three 5/16-18 x 5 in. bolts into the camshaft bolt holes.



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Installing camshaft

2. Lubricate the camshaft journals with engine oil and install the camshaft. Be careful not to damage the bearings.

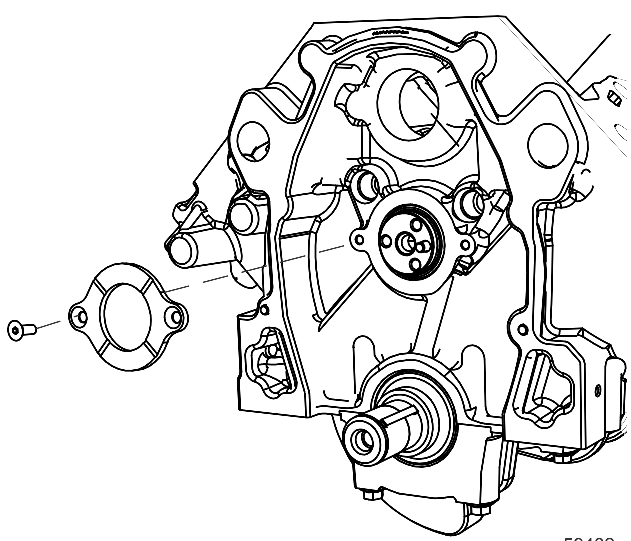
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Camshaft journals, camshaft, and camshaft lobes	Obtain Locally

3. Lubricate the camshaft lobes with Lubriplate SPO 255 or equivalent.
4. Remove the three bolts in the camshaft bolt holes.
5. Coat the threads of the camshaft thrust plate retainer bolts with Loctite 242 Threadlocker adhesive.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Camshaft thrust plate retainer bolt threads	92-809821

6. Install the camshaft thrust plate retainer and bolts. Tighten the bolts to the specified torque.

   ***NOTE:** Oil relief grooves face outward on camshaft thrust plate.*



59482

Description	Nm	lb-in.	lb-ft
Camshaft thrust plate retainer bolts	12	106.2	–

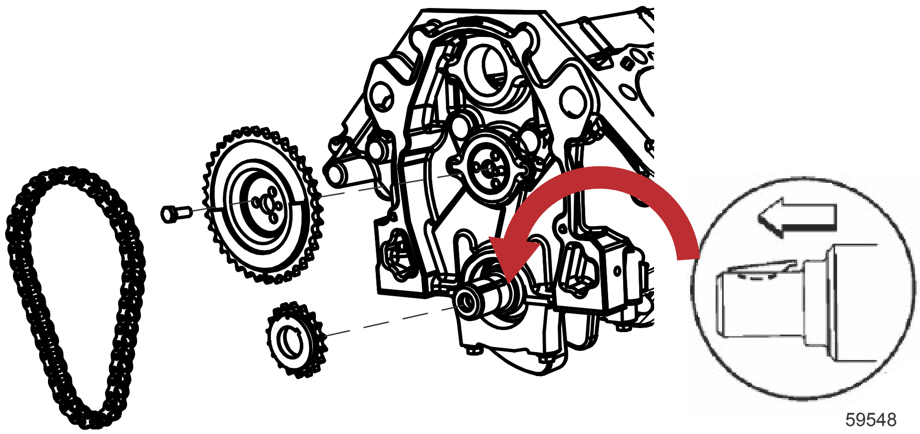
Timing Chain

Inspection

1. Inspect the timing chain for wear and damage.
2. Inspect the sprockets for wear and damage.
3. Replace the components as necessary.

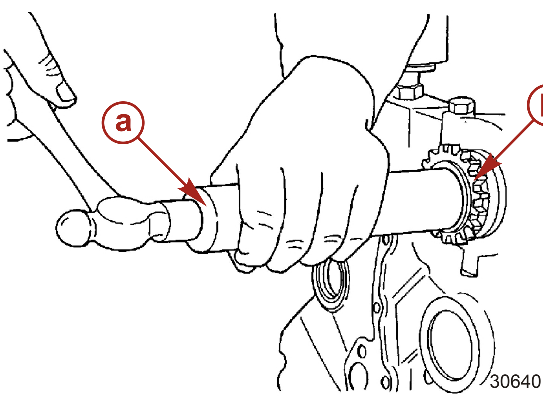
Assembly

1. Install the crankshaft balancer key into the crankshaft keyway.



Crankshaft keyway

2. Align the keyway of the crankshaft sprocket with the crankshaft balancer key.
3. The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.
4. Install the sprocket on the crankshaft by using the rear pinion bearing race installer tool.

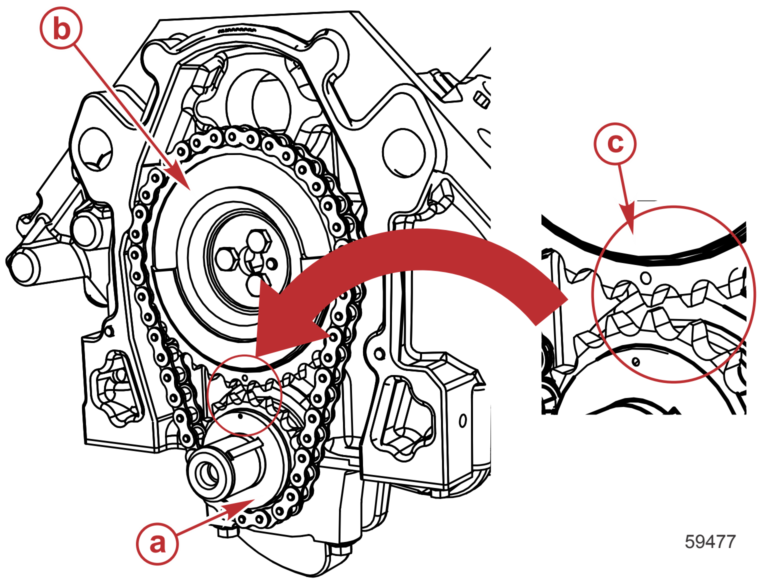


a - Rear pinion bearing race installer
b - Crankshaft sprocket

Description	Part Number
Rear pinion bearing race installer	J5590

5. Align the marks on the crankshaft and the camshaft sprockets.

6. Install the camshaft sprocket and timing chain. Tighten the sprocket screws to the specified torque.

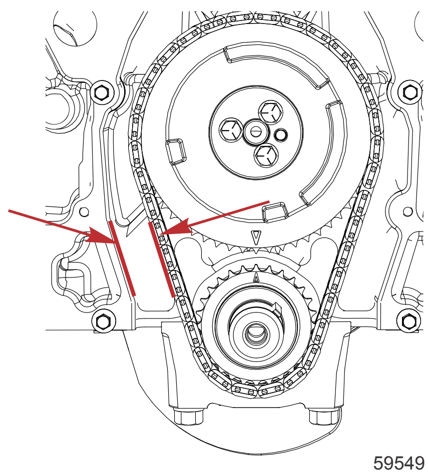


a - Crankshaft sprocket
b - Camshaft sprocket
c - Timing marks

Description	Nm	lb-in.	lb-ft
Camshaft sprocket screws	25	–	18.4

Checking Timing Chain Deflection

1. Rotate the camshaft (in either direction) to place tension on one side of the chain.
2. Establish and mark a reference point on the block (on taut side of chain) and measure from this point to the chain.



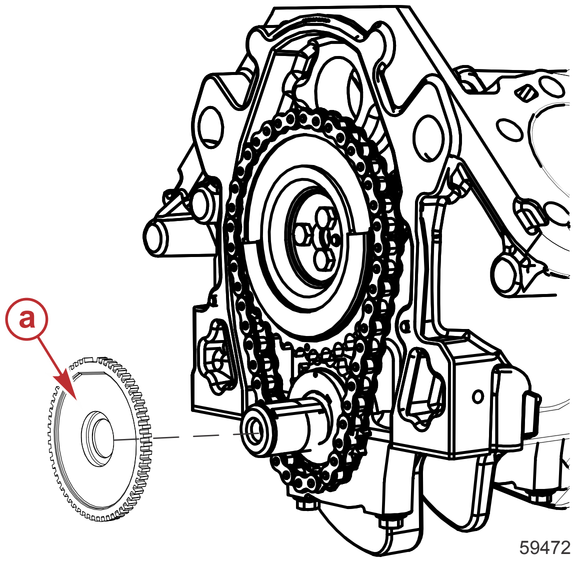
Measuring timing chain deflection

3. Rotate the camshaft in the opposite direction to provide slack in the chain.
4. Push the chain in toward the sprockets and measure the distance between the reference point and timing chain.
5. The deflection is the difference between these two measurements. If the deflection exceeds specification, the timing chain should be replaced.

Description	6.2 Liter
Chain deflection	11 mm (0.4331 in.) maximum

Installation

Install the crankshaft position reluctor wheel.



a - 56X reluctor wheel

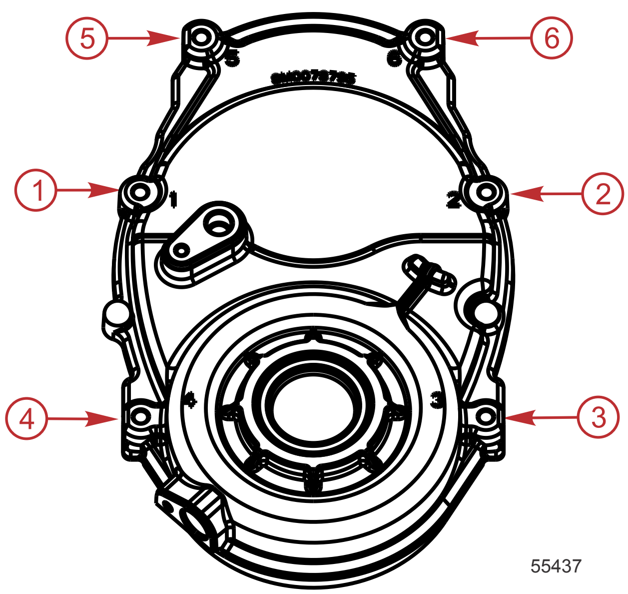
Crankcase Front Cover

Installation

1. Lubricate the new crankshaft seal with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Front cover crankshaft seal	92-8M0078629

2. Install the crankcase front cover using a new gasket, ensuring that the holes in the cover align with the dowel pins in the block. Tighten the screws in sequence to the specified torque.



Tighten the screws in sequence shown

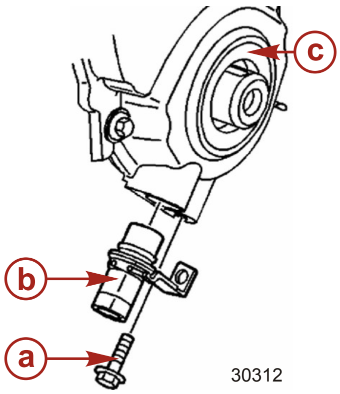
Description	Nm	lb-in.	lb-ft
Front cover screw	12	106.2	–

3. Install a new crankshaft position sensor O-ring seal and lubricate the seal with clean engine oil.

IMPORTANT: The crankshaft position sensor must be fully seated in the front cover. Erratic engine operation can occur if sensor is not properly installed.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Crankshaft position sensor O-ring seal	92-8M0078629

4. Install the crankshaft position sensor. Ensure that the sensor is fully seated in the cover.



a - Screw
b - Crankshaft position sensor
c - Crankcase front cover

5. Install the crankshaft position sensor screw. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft position sensor screw	8	70.8	–

IMPORTANT: Use Loctite 598 RTV Sealant to the keyway of the harmonic damper to prevent oil migration past the key.

6. Install the crankshaft harmonic damper. Tighten the screw to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Keyway of the harmonic damper	Obtain Locally

Description	Nm	lb-in.	lb-ft
Crankshaft harmonic damper screw	102	–	75.2

7. Install the water circulating pump. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Water circulating pump screws	29	–	21.4

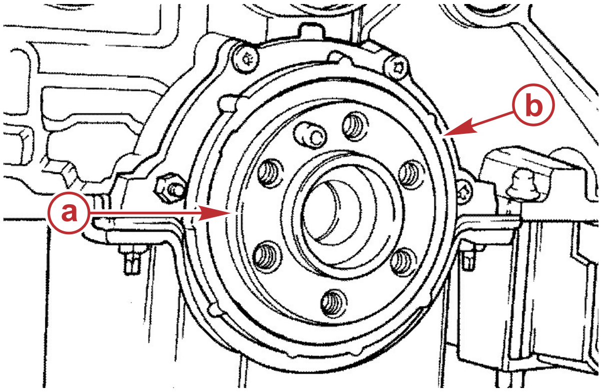
8. Install the hoses to the water circulating pump.
9. Install the crankshaft pulley. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Crankshaft pulley screws	27	–	20

Rear Seal Installation

1. Remove the installation guide from the new crankshaft rear oil seal.

2. Apply engine oil to the seal to retainer mating surfaces, the seal lip.

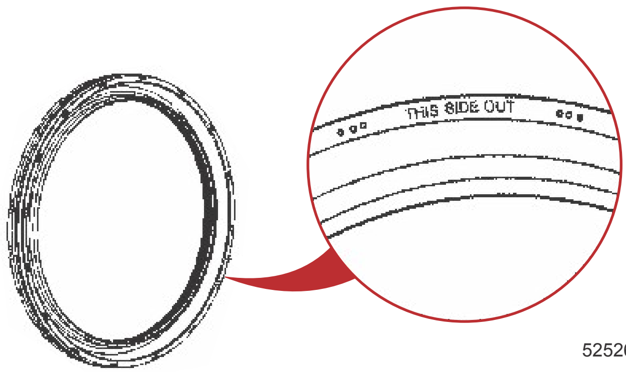


59837

a - Flywheel pilot flange
b - Seal to retainer mating surface

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	The seal to retainer mating surfaces, the seal lip	Obtain Locally

3. Orient the seal so that the seal lip is facing toward the inside of the engine and place squarely into the rear main seal installer.
   IMPORTANT: The oil seal must be orientated correctly to prevent oil leaks.



52526

IMPORTANT: Note the direction of the rear oil seal. The new design seal is a reverse style as opposed to what has been used. "THIS SIDE OUT" has been stamped into the seal as shown in the graphic.

NOTE: The dowel pin on the crankshaft may have to be removed to allow seal installation using tool or tool may need modification.

Description	Part Number
Kent-Moore rear main seal installer	J35621-B

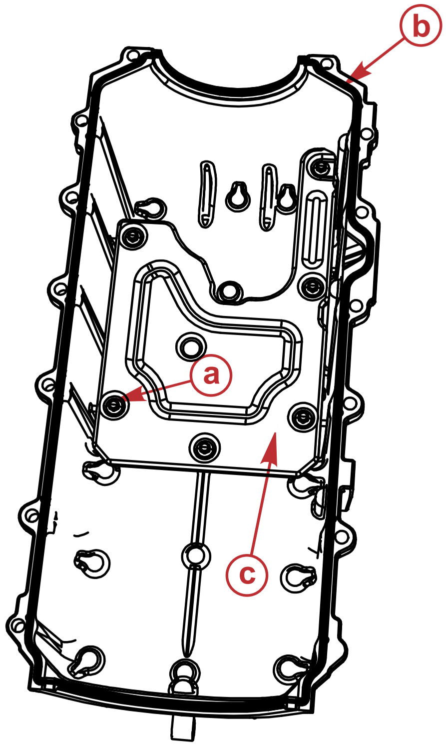
4. Install the seal using the rear main seal installer.
   a. Attach the rear main seal installer to the crankshaft and evenly tighten the attaching screws until the installer is squarely flush against the engine.
   b. Turn the installer wing-nut clockwise until the seal is evenly seated in the seal retainer.
   c. Turn the installer wing-nut counterclockwise to release the installer from the oil seal.
5. Remove the installer.
6. Wipe off any excess oil.

Oil Pan

Inspection

1. Inspect the oil pan for cracks, holes, warped sealing surfaces, or other damage.

2. Replace the oil pan if necessary.



a - Bolt (6)
b - Oil pan
c - Oil pan baffle

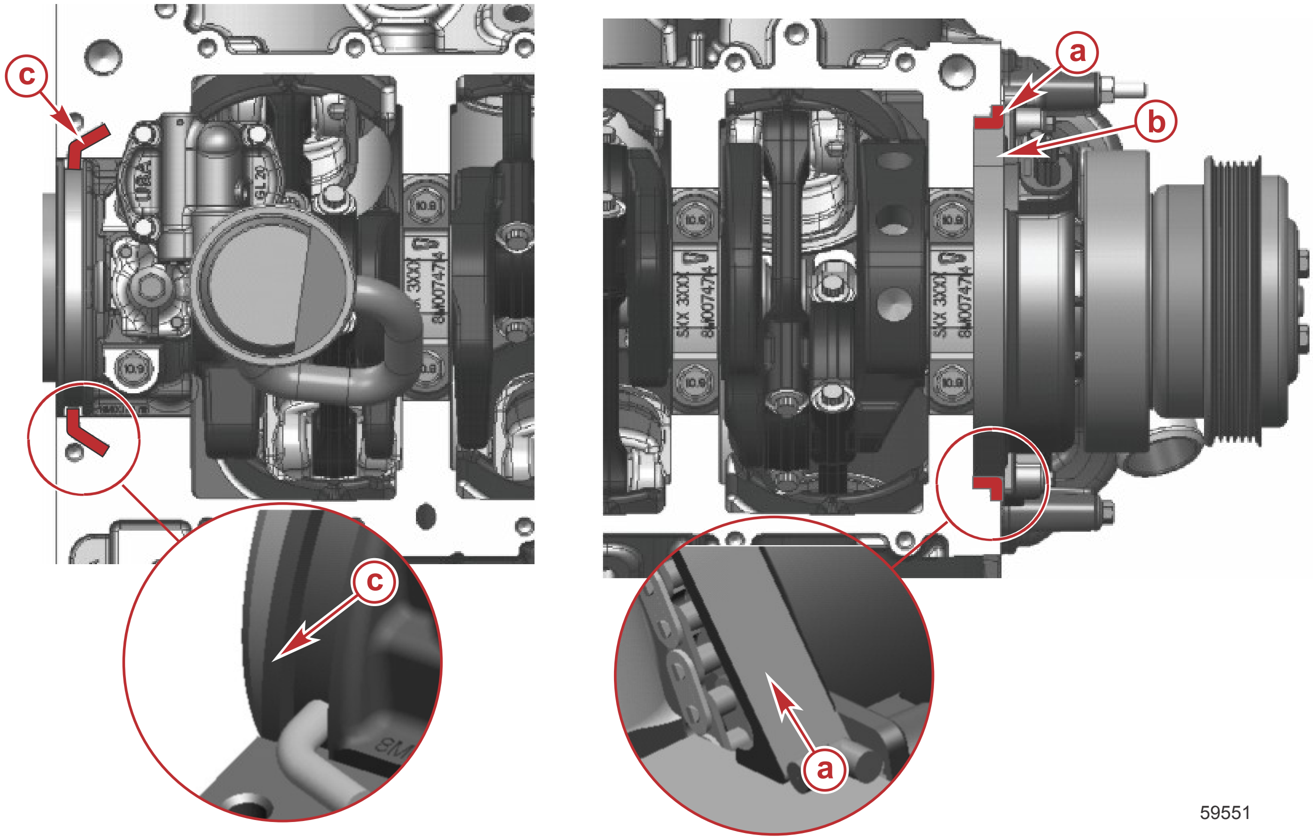
3. Remove and clean the oil pan baffle.
4. Install the oil pan baffle and the bolts. Tighten the oil pan baffle bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil pan baffle bolt	15	132.7	–

Installation

IMPORTANT: The adhesive sets up in about 15 minutes. Complete the assembly while the adhesive is still wet.

1. Apply a 6.35 mm (0.250 in.) wide and 25 mm (1.00 in.) long bead of Loctite 5512 Adhesive to both the right and left side joints of the rear seal retainer and joints of the front cover.



a - 1/4 in. wide bead Loctite 5512 Adhesive, 1 in. long at front cover
b - Front cover
c - 1/4 in. wide bead Loctite 5512 Adhesive, 1 in. long at rear seal retainer

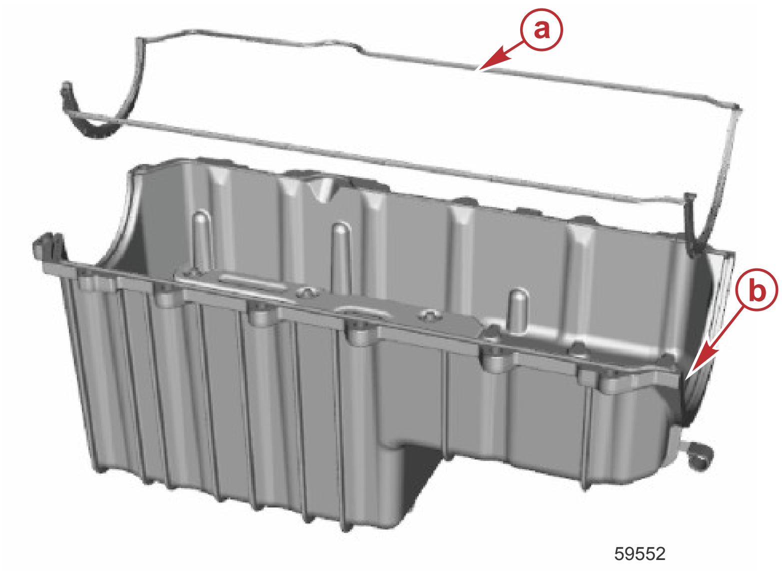
Tube Ref No.	Description	Where Used	Part No.
137	Loctite 5512 Adhesive	Both right and left side joints of the rear seal retainer and joints of the front cover	92-858006K02

IMPORTANT: Always install a new oil pan gasket.

NOTE: *The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.*

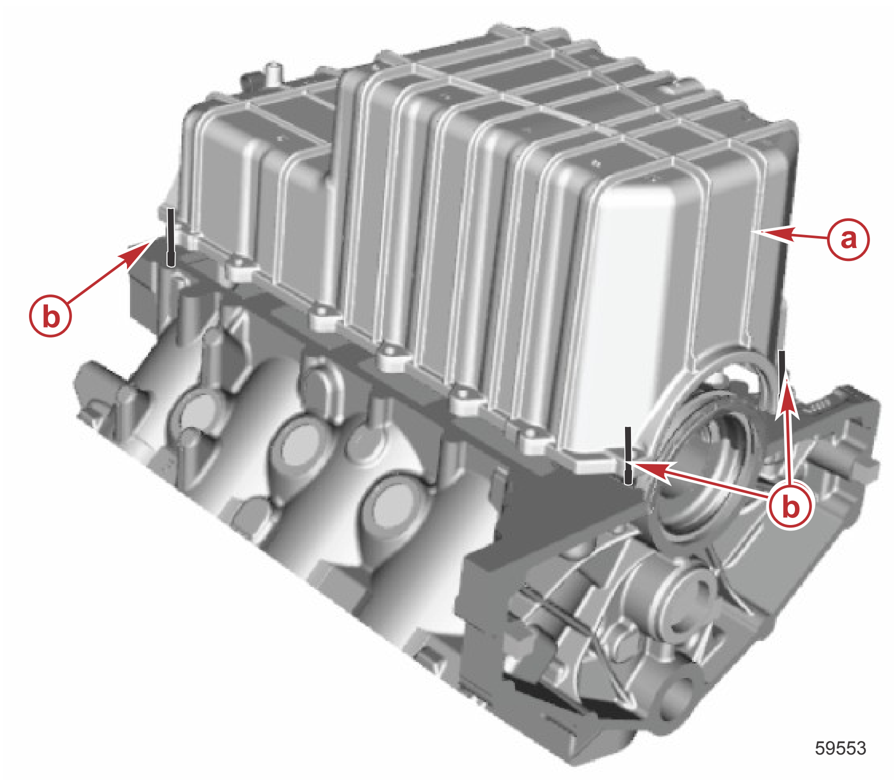
2. Install a new oil pan gasket.
3. Install the new oil pan gasket into the groove in the oil pan.

IMPORTANT: The oil pan alignment must always be flush or forward no more than 0.3 mm (0.011 in.) from the rear face of the engine block.



a - Gasket
b - Groove in the oil pan

4. Using four guide pins in the front and rear corner holes, install the oil pan onto the engine block. Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.



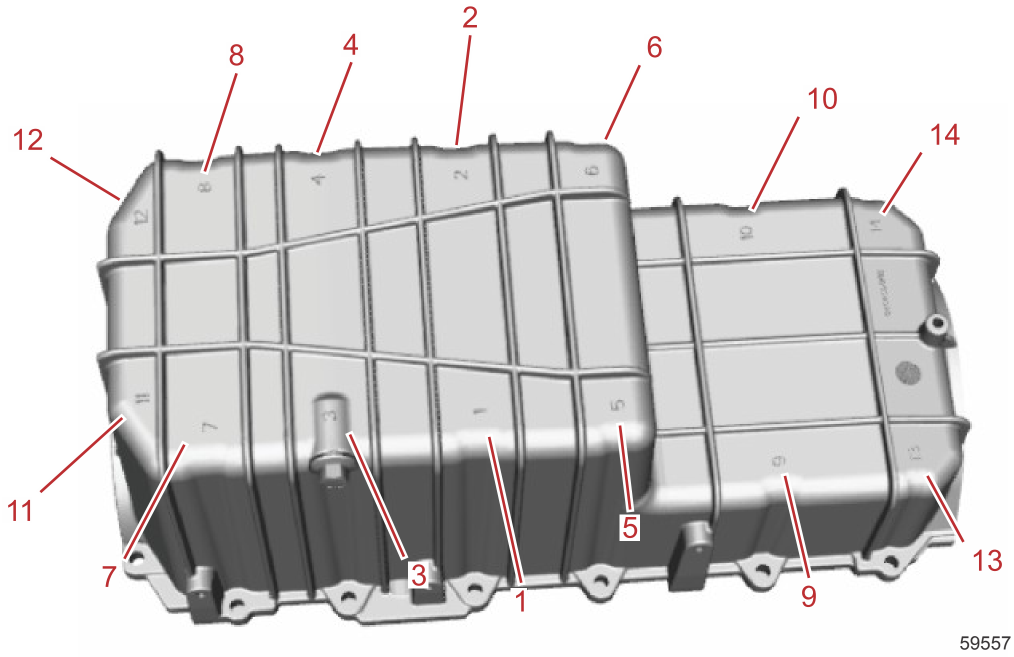
a - Oil pan
b - Guide pins (2)

Oil Pan Guide Pins	Obtain locally

5. Install the oil pan screws, but do not tighten.
6. Measure the pan-to-transmission housing clearance using a feeler gauge and a straightedge. Use a feeler gauge to check the clearance between the oil pan-to-housing measurement points. If the clearance exceeds 0.3 mm (0.011 in.) at any of the three oil pan-to-housing measurement points, then repeat the step until the oil pan-to-housing clearance is within the specification. The oil pan must always be forward of the rear face of the engine block.

NOTE: If the clearance is more than 0.3 mm (0.011 in.), powertrain durability may be reduced.

7. Tighten the oil pan screws in sequence (1–14) to the specified torque.

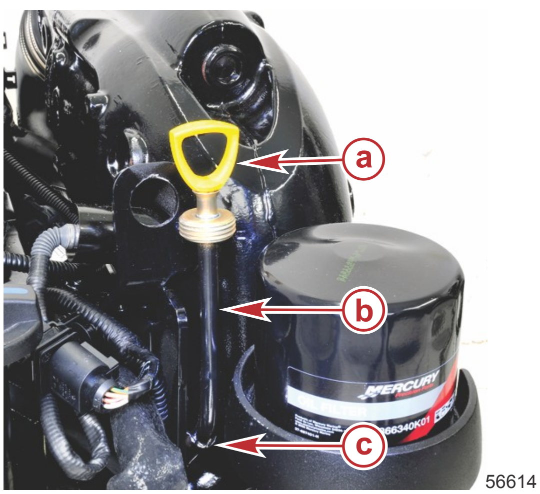


Description	Nm	lb-in.	lb-ft
Oil pan screws	35	–	25.8

8. Tighten the oil drain plug to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil drain plug	24	–	17.7

9. Install the appropriate engine oil dipstick.



a - Dipstick
b - Dipstick tube
c - Clamp

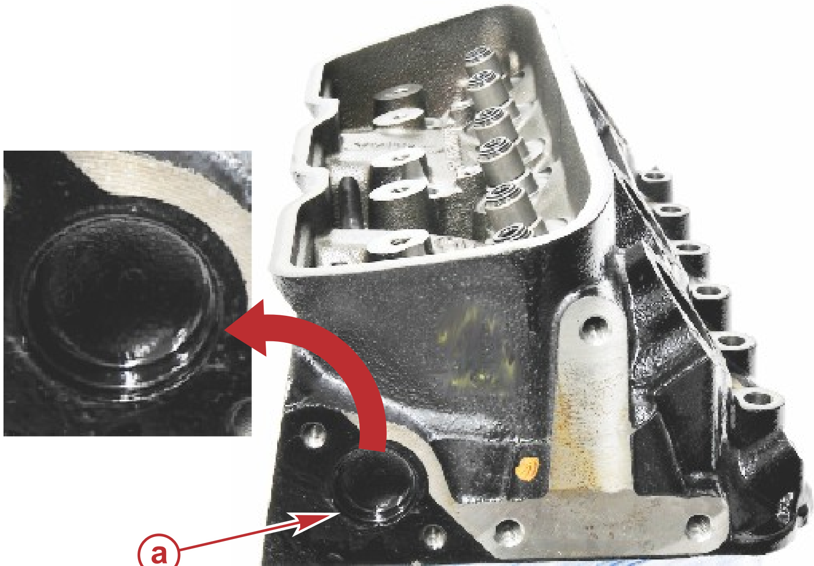
Cylinder Head

Core Plug Installation

The cylinder head assembly is unidirectional and needs a core plug installed in the aft end of the cylinder head. This is determined on what side of the engine it is installed on.

1. Apply Loctite 242 Threadlocker sealant to the outside diameter of the new engine head core expansion plug.

2. Install the cylinder head core hole expansion plug. Core plug should be recessed 0.158 cm (0.062 in.) with the inside chamfer of the cylinder head core hole on the aft end of cylinder head.



Core expansion plug installed in aft end of head

a - Core expansion plug

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Outside diameter of core expansion plug	92-809821

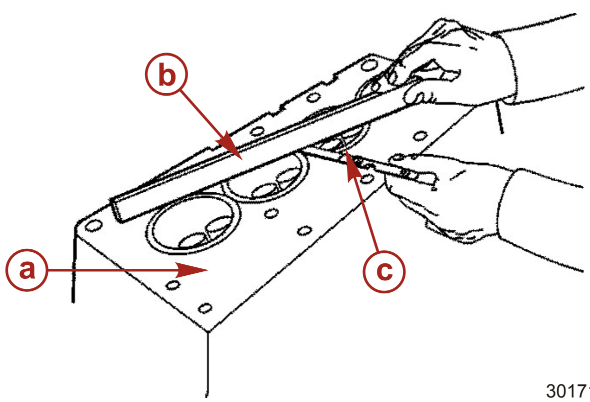
3. Repeat procedure on opposite head.

   NOTE: Each head needs a core plug installed in the aft end of the cylinder head.

Inspection

Cylinder Head

1. Inspect the sealing surfaces for burrs, scratches, deep nicks, erosion, or other damage.
2. Inspect for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats).
3. Replace the cylinder heads if necessary.
4. Inspect for rusted, damaged, or leaking core plugs. Replace core plugs if necessary.
5. Inspect for corrosion around cooling passages.
6. Check the flatness of cylinder head gasket surfaces—head, exhaust, and intake gaskets, using a machinist's straightedge and feeler gauge. Take measurements diagonally across the cylinder head from all four corners and lengthwise straight down the center of the cylinder head.



Head deck shown, exhaust and intake decks are similar

a - Cylinder head deck

b - Machinist's straightedge

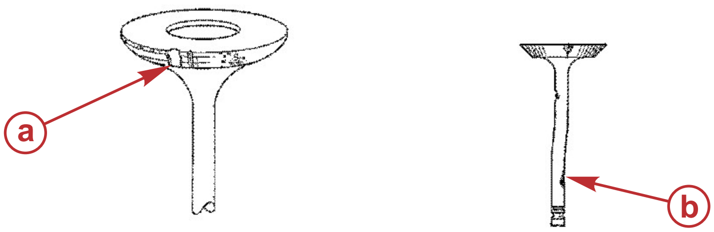
c - Feeler gauge

Description		6.2 Liter (377 cid)
Surface flatness	At exhaust manifold deck	0.05 mm (0.0020 in.)
	At engine block deck with an 150 mm (5.90 in.) area	0.05 mm (0.0020 in.)
	At intake manifold deck	0.10 mm (0.0039 in.)
	Intake manifold flatness	0.10 mm (0.0039 in.)

7. If a measured value is greater than specified, the cylinder head must be repaired to specifications or replaced.

Valve

1. Inspect the valves for burned heads, cracked or pitted faces, or damaged stems.

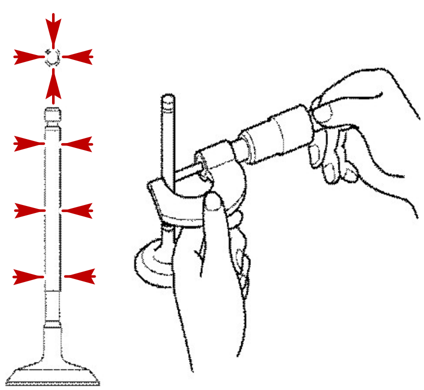


32988

a - Cracked and pitted face
b - Damaged stem

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possibly broken valves. Insufficient clearance will result in noisy, binding valves.

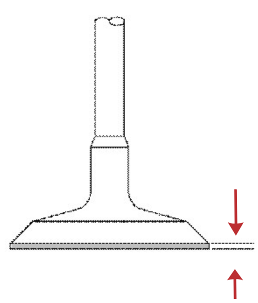
2. Measure the valve stem diameter in three places.
3. If the measured value is less than the specified limit, the valve must be replaced.



32989

Description		6.2 Liter (377 cid)
Production stem diameter	Intake	7.96 mm (0.3133 in.)
	Exhaust	7.97 mm (0.3137 in.)

4. Measure the valve head margin.
5. If the measured value is less than specified, the valve must be replaced.

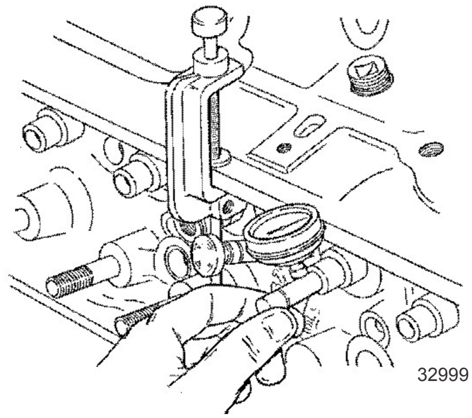


32997

Description		6.2 Liter (377 cid)
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum

Valve Stem to Bore Clearance

1. Using a valve with a specified stem diameter or a new valve, measure valve stem clearance.
2. Attach a dial indicator to the cylinder head. Position it against the valve stem and close to the valve guide.
3. Holding the valve head off the seat about 0.158 cm (1/16 in.), move the valve stem side to side in the guide as shown. Compare the stem clearance with the specifications.



Measuring stem clearance

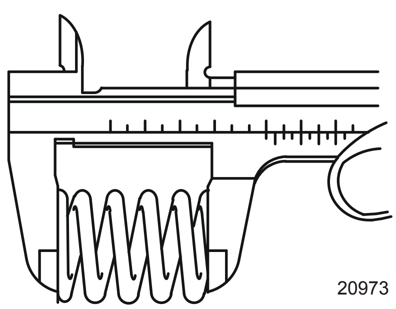
Description		6.2 Liter (377 cid)
Production	Intake	0.023–0.065 mm (0.0009–0.0025 in.)
	Exhaust	0.033–0.075 mm (0.0012–0.00295 in.)
Service	Intake	0.025–0.094 mm (0.0010–0.0037 in.)
	Exhaust	0.025–0.094 mm (0.0010–0.0037 in.)

4. If the clearance exceeds specifications on the exhaust valve and exhaust guide: it is necessary to replace the cylinder head or install thin wall valve guide inserts.
5. If the clearance exceeds specifications on the intake valve and intake guide: it is necessary to install thin wall valve guide inserts (Goodson, K-Line) or replace the cylinder head. Intake valves are not available with oversize stems.

   NOTE: The only engine machine shop reconditioning of the valve guides should be done with thin wall valve guide inserts (Goodson, K-Line, etc).

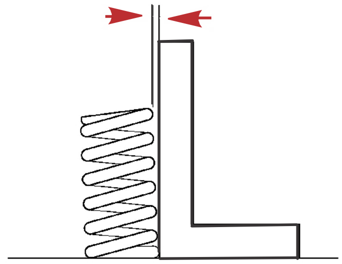
Valve Springs

1. Use a vernier caliper to measure the valve spring free length. This is for reference only, springs should be measured for load at specified heights to determine if they are good.



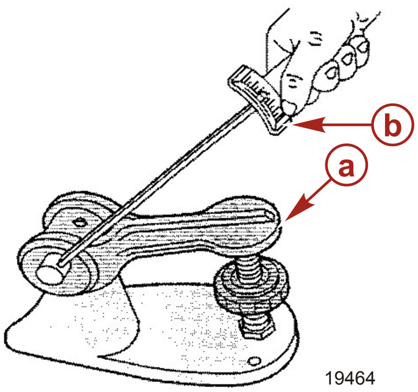
Description	6.2 Liter (377 cid)
Free length	53.39 mm (2.10 in.)

2. Measure the valve spring for squareness.



33344

3. Replace the valve spring if not square.
4. Use a spring compressor to measure the valve spring tension. Replace the spring if the measured value is less than the specified limit.



19464

a - Valve spring compressor
b - Torque wrench

Description	Part Number
Valve spring compressor	J9666

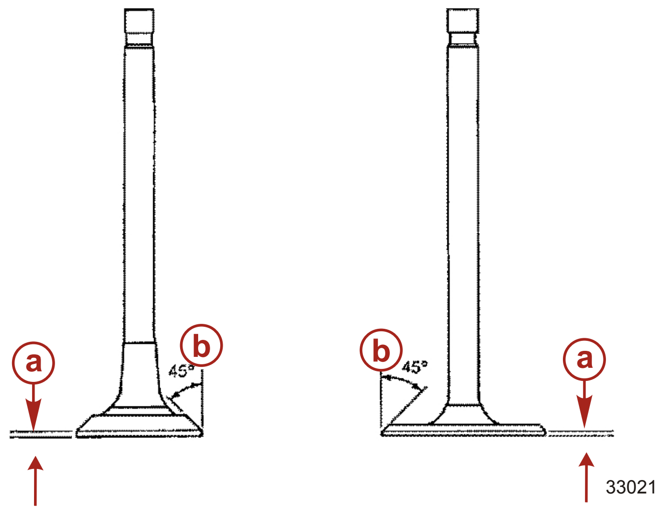
Description		6.2 Liter (377 cid)
Pressure	Valve closed	350 N (78.68 lb) at 46.19 mm (1.818 in.)
	Valve open	1084 N (243.69 lb) at 32.3 mm (1.2717 in.)

Repair

Valve Reconditioning

1. Recondition the valve face to the proper angle if the valve face is pitted or worn.
2. Measure the valve margin. If the valve margin is less than the specified amount after reconditioning, replace the valve.

NOTE: Several different types of equipment are available for reconditioning valves. The manufacturer's recommendation should be carefully followed to attain proper results. Valves that do not meet specifications should be replaced.



Exhaust

Intake

a - Margin
b - Face angle

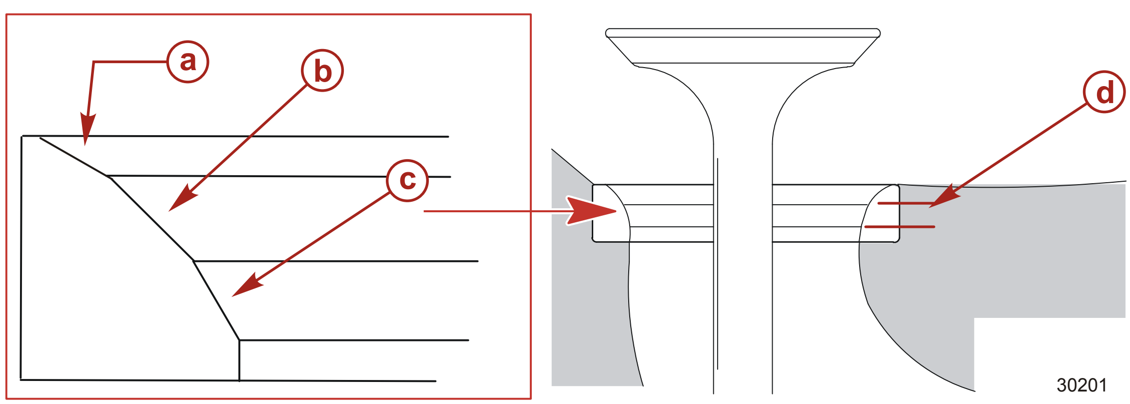
Description		6.2 Liter (377 cid)
Face angle	Intake	45°
	Exhaust	45°
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum

Valve Seat

IMPORTANT: Regardless of the type of equipment, it is essential that the valve guide bores be free from carbon or dirt to achieve proper centering of the pilot in the valve guide, ensuring concentricity when reconditioning the valve seats.

NOTE: Several different types of equipment are available for reconditioning valve seats. Equipment manufacturer's recommendations should be followed to attain proper results.

1. Recondition the valve seats if pitted or worn.

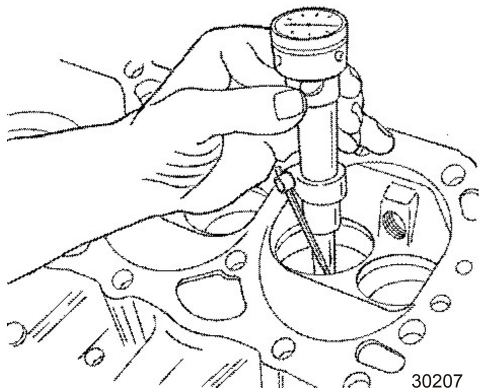


Typical 3 angle valve seat

a - Top correction cut angle
b - Seat angle
c - Bottom correction cut angle
d - Seat width

Description		6.2 Liter (377 cid)
Seat angle	Intake and exhaust	46°
Top correction cut angle	Intake and exhaust	30°
Bottom correction cut angle	Intake and exhaust	60°
Width	Intake	1.016–1.651 mm (0.040–0.065 in.)
Width	Exhaust	1.65–2.489 mm (0.065–0.098 in.)

2. Measure the valve seat concentricity.
3. Recondition the seat if the measured value exceeds the specified limit.



Measuring valve seat concentricity

Description		6.2 Liter (377 cid)
Runout	Intake	0.05 mm (0.002 in.) maximum
Runout	Exhaust	0.05 mm (0.002 in.) maximum

Cylinder Head Reassembly

IMPORTANT: Install each valve in the port from which it was removed or for which it has been fitted.

1. Assemble a valve into its proper port and valve guide. Apply clean engine oil to the valve stem.

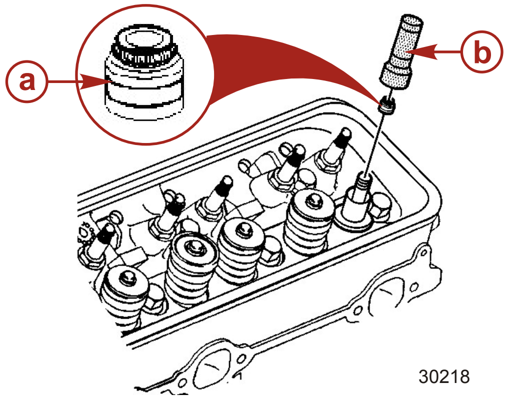
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve stem	Obtain Locally

2. Select the appropriate valve stem oil seal.
3. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Outside surface of valve stem bore and all surfaces of the valve stem oil seal	Obtain Locally

4. Assemble the valve stem oil seal onto the valve stem and slide down until it contacts the valve spring seat.

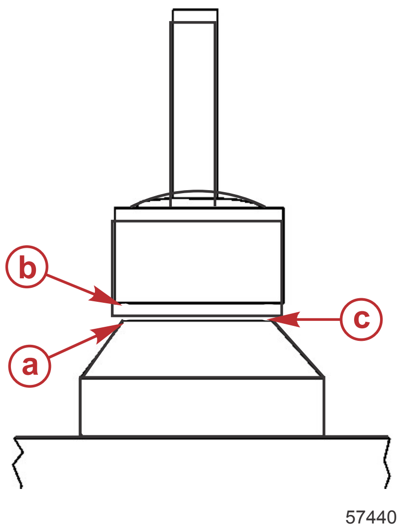
5. Press the valve stem oil seal with the valve stem seal installer until the seal contacts the chamfer on the cylinder head guide.



Typical
a - Valve stem seal
b - Valve stem seal installer

Description	Part Number
Kent-Moore valve stem seal installer	J42073

6. For all intake and exhaust valves, ensure that the installed height is as specified.



a - Valve guide boss
b - Bottom of valve stem oil seal
c - Installed height (no gap)

Description		**6.2 Liter (377 cid)**
Valve stem oil seal	Installed height ***NOTE:** Measured from the top of the valve guide bevel to the bottom of the oil stem seal.*	0 mm (0 in.) minimum

7. Install the valve spring.
8. Place a spring retainer on the valve spring.

⚠ CAUTION

Improperly compressed springs or improperly locked valve caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.

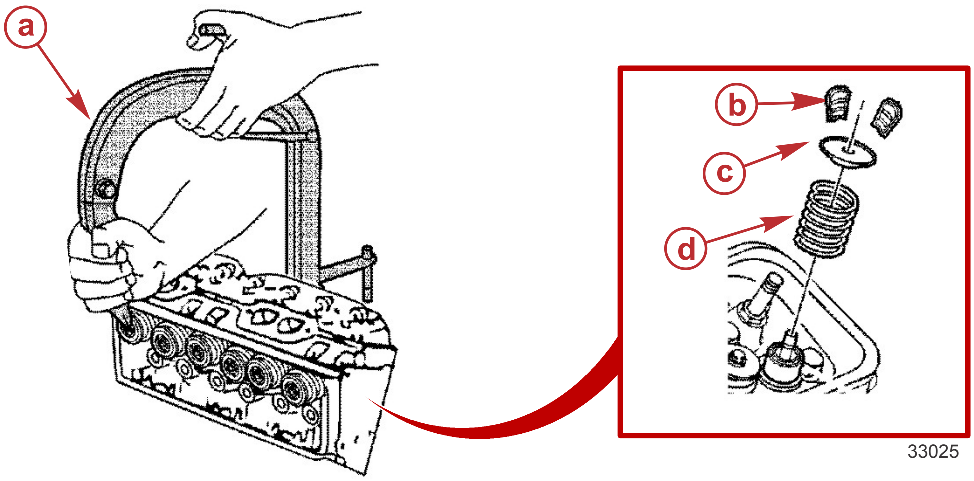
9. Compress the valve spring using a valve spring compressor.

Description	Part Number
Valve spring compressor	J8062

10. Coat the valve stem keepers with lubricant to hold in place.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve stem keepers	Obtain Locally

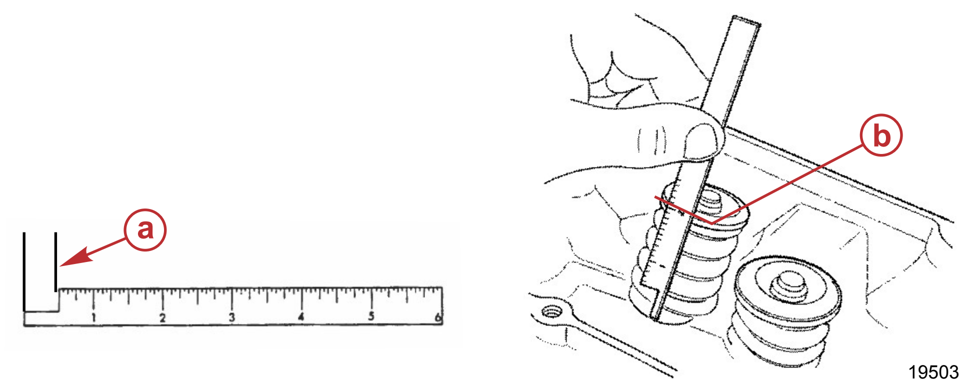
11. Install the valve stem keepers.
12. Confirm that the valve stem keepers are properly seated in the grooves of the valve stem.



a - Valve spring compressor
b - Valve stem keepers
c - Retainer
d - Valve spring

13. Slowly release the valve spring compressor.
14. Set the assembly by tapping the valve stem with a soft plastic hammer.
15. Check the installed height of the valve springs using a narrow, thin scale. Measure from the spring seat to the top of the valve spring.
    IMPORTANT: To ensure correct measurement, measure the spring height from the top of the valve spring, not the top of the valve.
    IMPORTANT: If measurement exceeds specified height, install a valve spring shim and recheck. Do not shim valve springs to give an installed height less than the minimum specified.

Description		6.2 Liter (377 cid)
Valve spring installed height	Intake	46.19 mm (1.818 in.) minimum
	Exhaust	

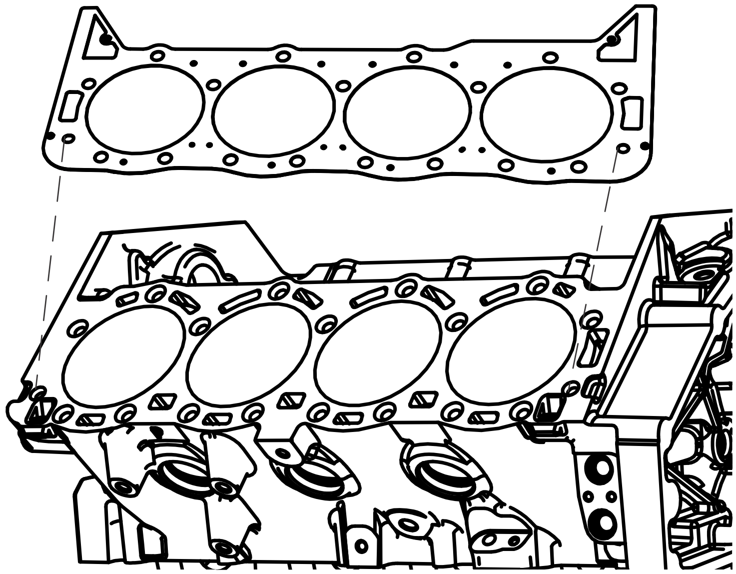


Typical
a - Cut away scale
b - Valve spring installed height

Installation

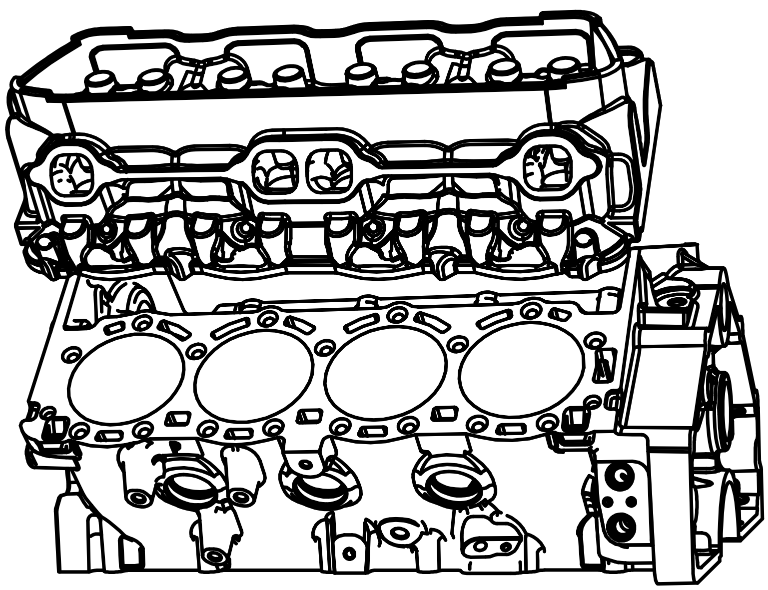
1. Ensure that the engine block and cylinder head sealing surfaces are clean.

2. Place a new head gasket in position over the dowel pins.



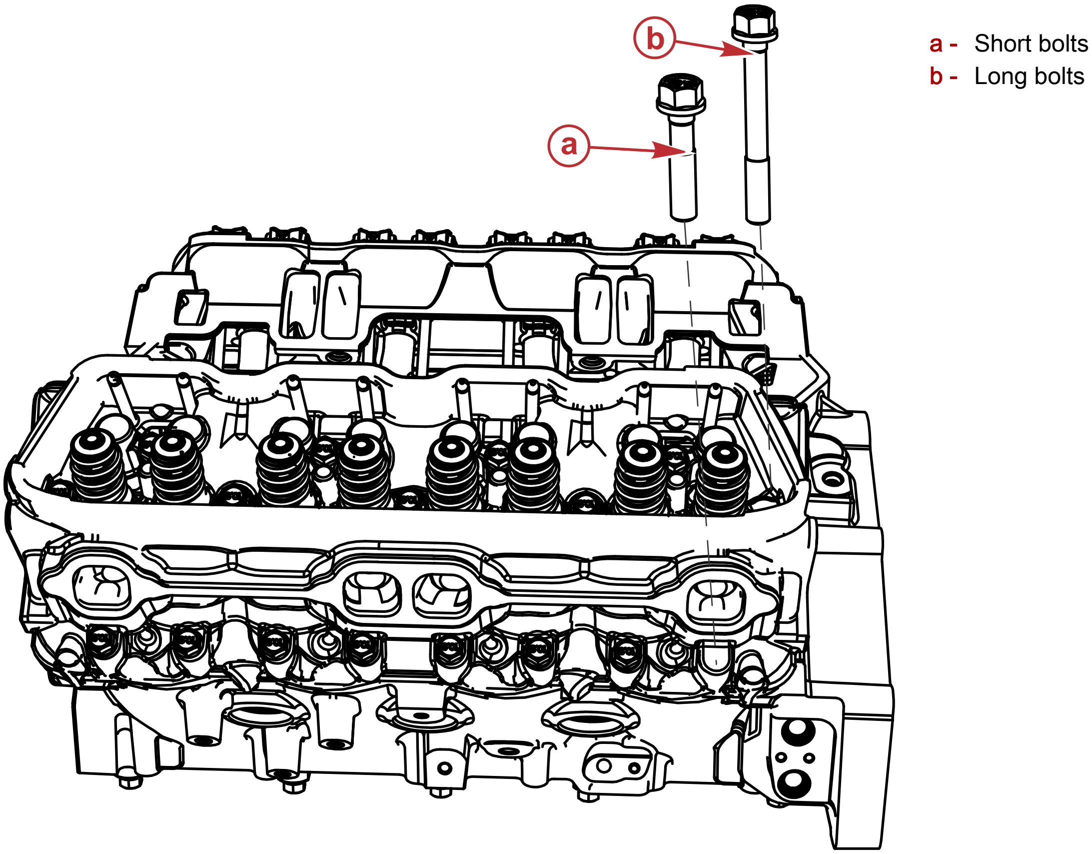
59563

3. Carefully set the cylinder head in place over the dowel pins.

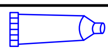


59565

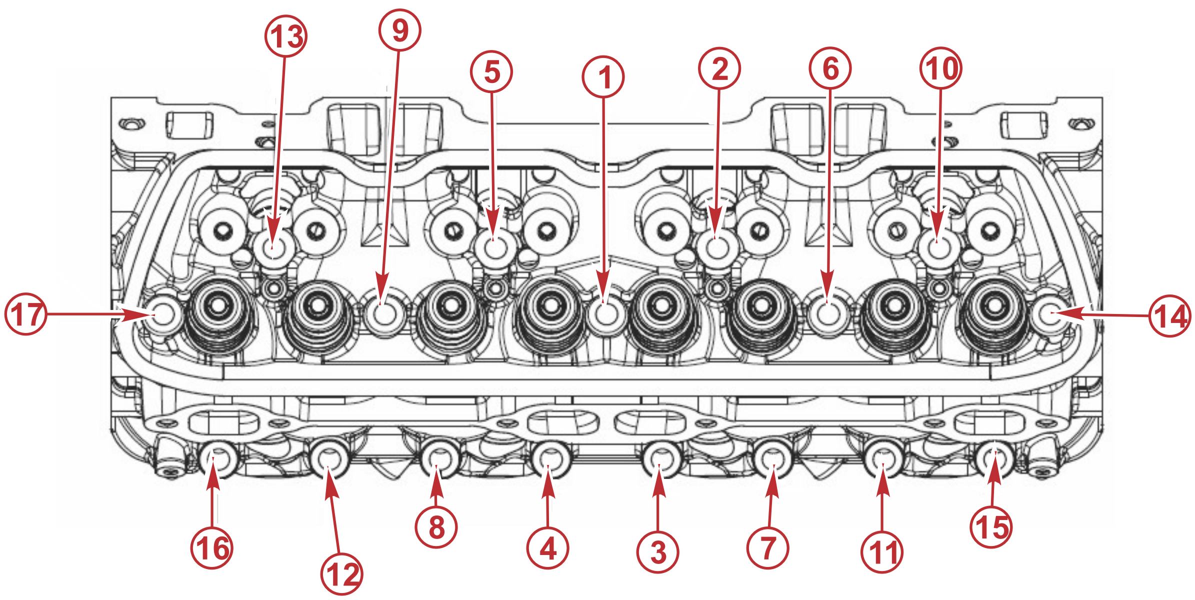
4. Coat the threads of the cylinder head bolts with sealant and install the screws finger-tight.



59486

Tube Ref No.	Description	Where Used	Part No.
	Loctite 565 PST	Cylinder head bolt threads	Obtain Locally

5. Tighten the cylinder head bolts to the specified torque in (passes) using the numbered sequence shown.



59571

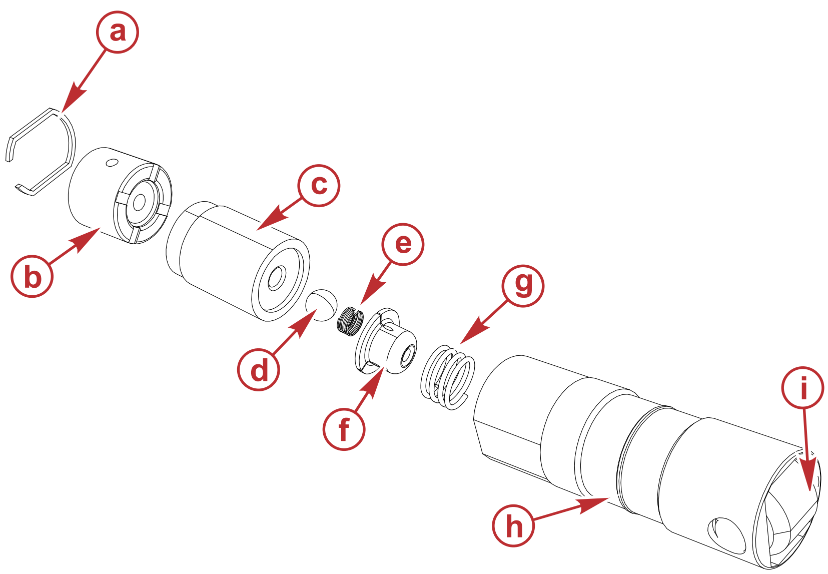
Cylinder Head Torque Sequence	
Long bolts	1, 2, 5, 6, 9, 10, 13, 14, and 17
Short bolts	3, 4, 7, 8, 11, 12, 15, and 16

Description			Nm	lb-in.	lb-ft
Cylinder head bolt					
All bolts in sequence	**First torque**		15	132.7	–
	Second torque		30	–	22.1
In sequence angle torque	**Final torque**	Long bolts	+60°		
		Short bolts	+45°		

Lifters

Inspection

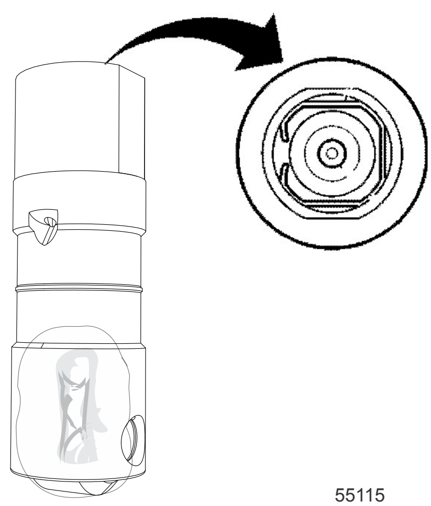
1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect the pushrod seat. If the seat is scuffed or worn, inspect the pushrod.
3. Inspect the outer lifter body wall. If the wall is scuffed or worn, inspect the engine block lifter bore.
4. Inspect the roller of the valve lifter. If the roller is scuffed or worn, inspect the camshaft lobe.
5. Ensure that the oil hole is unobstructed.
6. Inspect all parts carefully. Replace the valve lifter assemblies that are damaged or excessively worn.



55004

Lifter inspection points

- a - Seat retainer clip
- b - Pushrod seat
- c - Valve lifter body
- d - Check ball
- e - Check ball spring
- f - Check ball retainer
- g - Plunger spring
- h - Oil hole
- i - Roller



55115

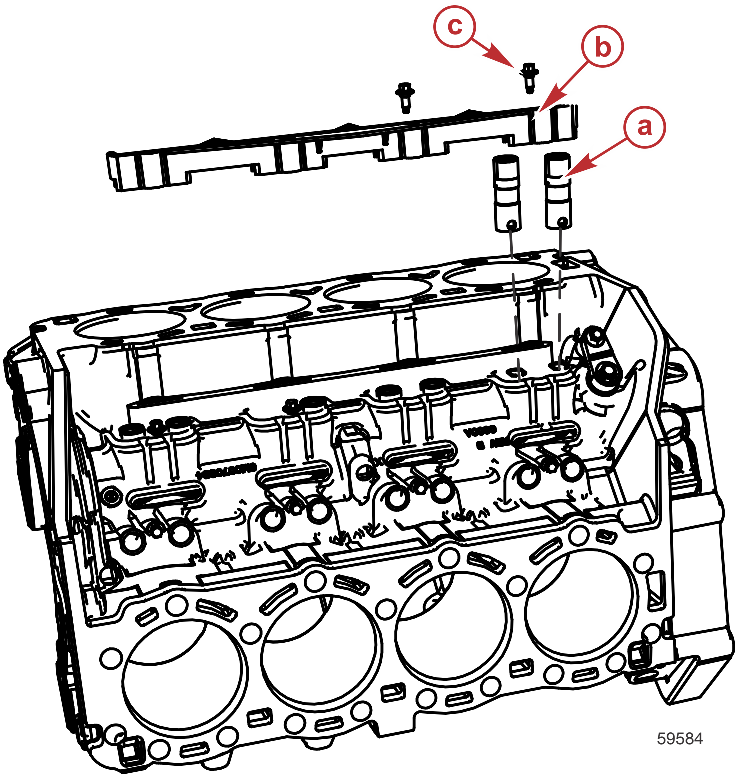
7. Inspect the lifters for scoring or wear.

Lifter Installation

IMPORTANT: Do not install used valve lifters if a new camshaft has been installed.
IMPORTANT: Before installing the valve lifters, coat the camshaft lobes and valve lifters with engine assembly lubricant.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Camshaft lobes and valve lifters	Obtain Locally

1. Lubricate and install the valve lifters. Install the valve lifters in their original locations if being reused.



a - Lifter
b - Lifter guide retainer (2)
c - Retainer bolt (8)

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve lifters	Obtain Locally

2. Install the lifter guide retainer. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Valve lifter guide retainer bolt	12	106.2	–

Oil Pump Drive

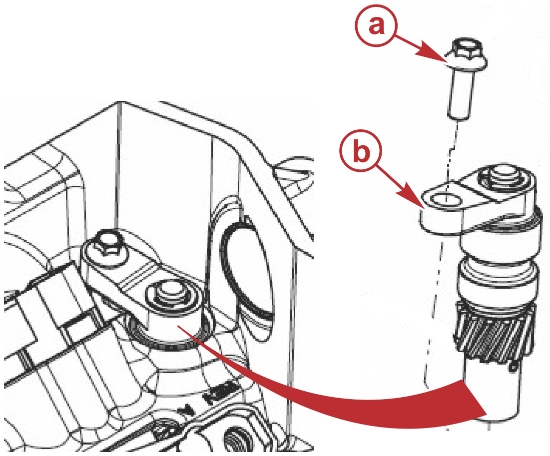
Inspection

Inspect the drive gear on the oil pump drive for wear.

Installation

1. Install the oil pump drive in the block. Rotate the shaft to engage the drive with the camshaft and intermediate shaft.

IMPORTANT: The oil pump drive is not properly installed if it is not resting on the engine block and engaged with the camshaft and intermediate shaft.



56464

a - Flange screw
b - Oil pump drive

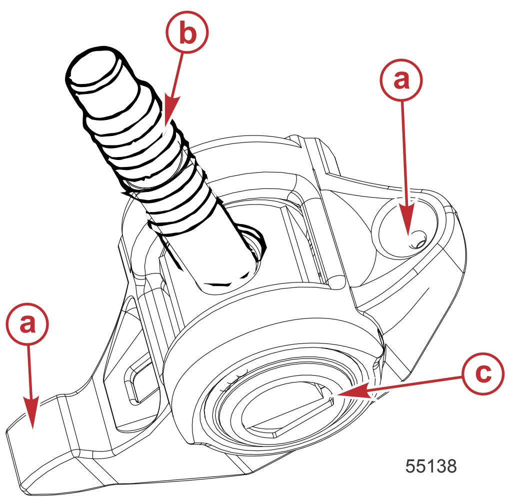
2. Ensure that the mechanism is resting on the engine block as shown.
3. Install the flange screw. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Oil pump drive flange screw	30	–	22.1

Rocker Arms and Pushrods

Inspection

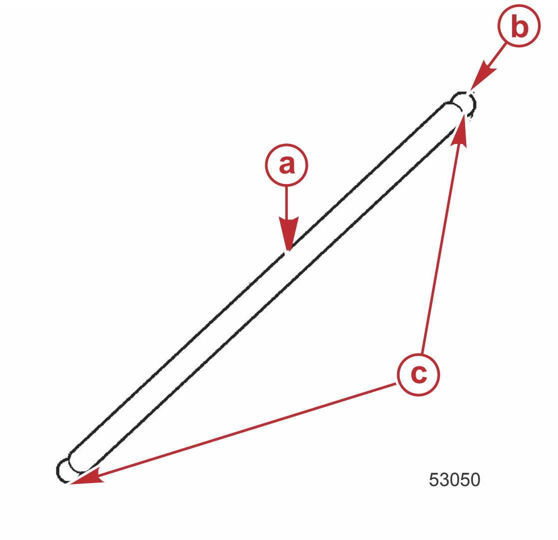
1. Inspect all contact surfaces for excessive wear or scoring.
2. Inspect threads for damage.
3. Inspect pivot points for binding or damage.



55138

a - Contact surfaces
b - Threads
c - Pivot points

4. Inspect the pushrods.



a - Shaft
b - Oil passage
c - End contact surfaces

a. Inspect the shaft for bends.
b. Inspect for oil passage restriction.
c. Inspect for wear or scoring of the end contact surfaces.

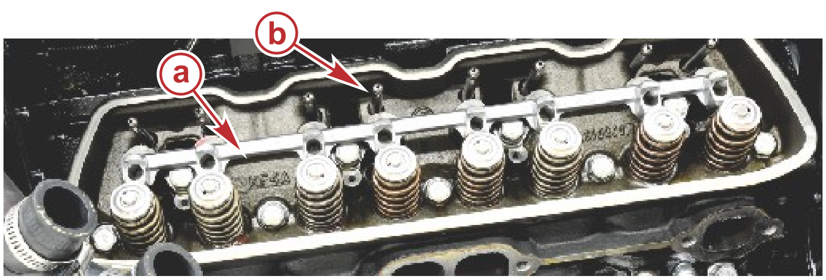
5. Replace any damaged or excessively worn components.

Installation

1. Lubricate the outer surfaces and ends of the valve pushrods.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Outer surfaces and ends of valve pushrods	Obtain Locally

2. Install the valve pushrods in their original locations. Ensure that the pushrods seat in the lifter socket.
3. Install the rocker arm supports.

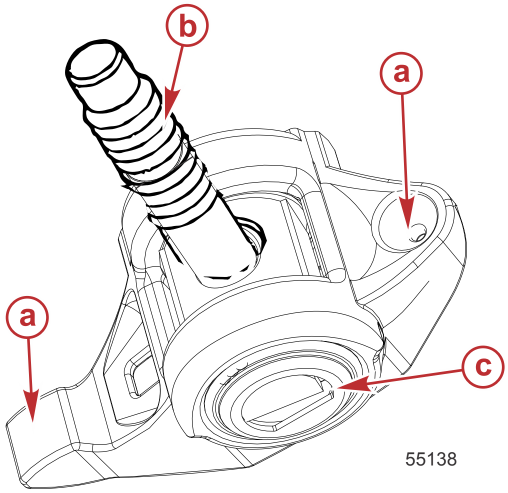


a - Rocker arm support assemblies
b - Pushrod

4. Lubricate the rocker arm and rocker arm ball contact surfaces.

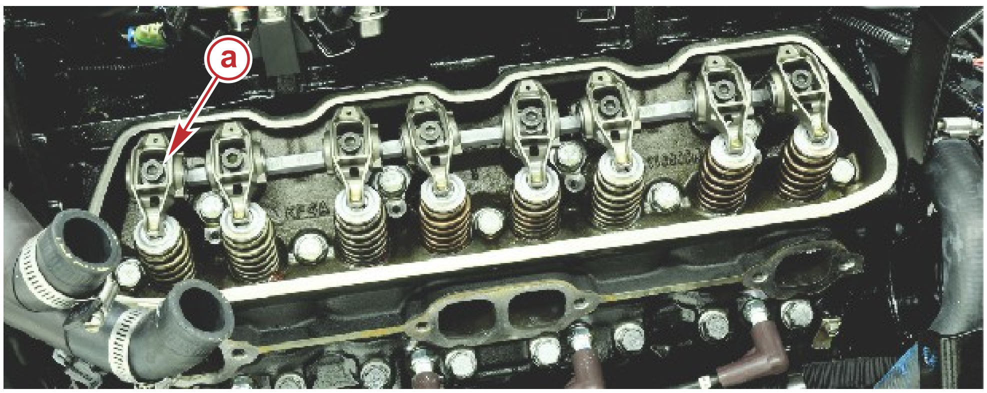
Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Rocker arm and rocker arm ball contact surfaces	Obtain Locally

5. Install the rocker arm assemblies in their original locations.



55138

a - Contact surfaces
b - Threads
c - Pivot points



59507

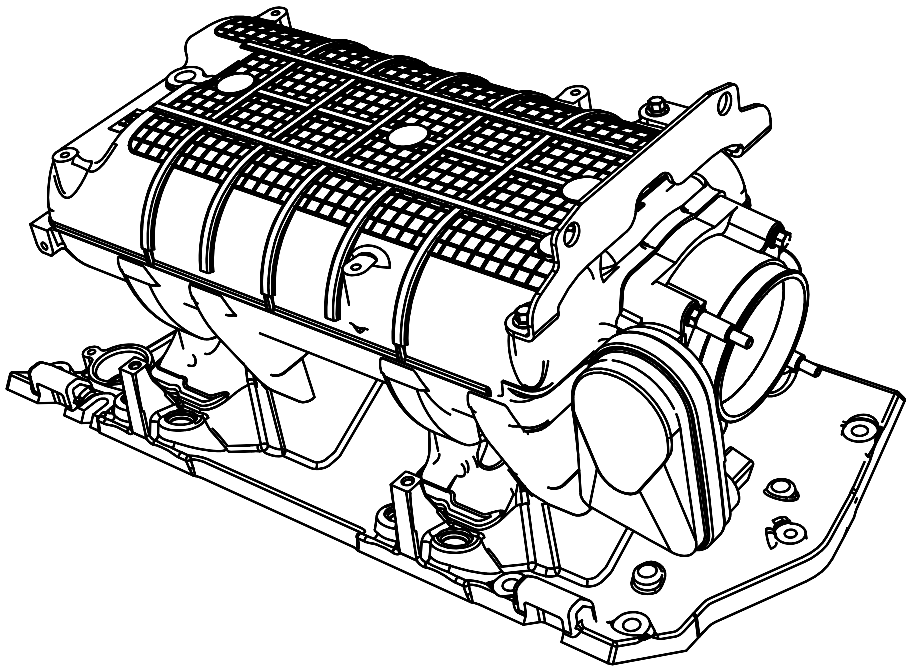
a - Rocker arm retaining bolt

6. Align the crankshaft and camshaft alignment marks. Tighten the rocker arm bolts to the specified torque. Rotate the crankshaft one full revolution and check all rocker bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Rocker arm bolts	30	–	22.1

Intake Manifold Assembly

Intake Manifold



59591

Refer to **Section 5** for disassembly, cleaning, inspection, and reassembly of the individual components.

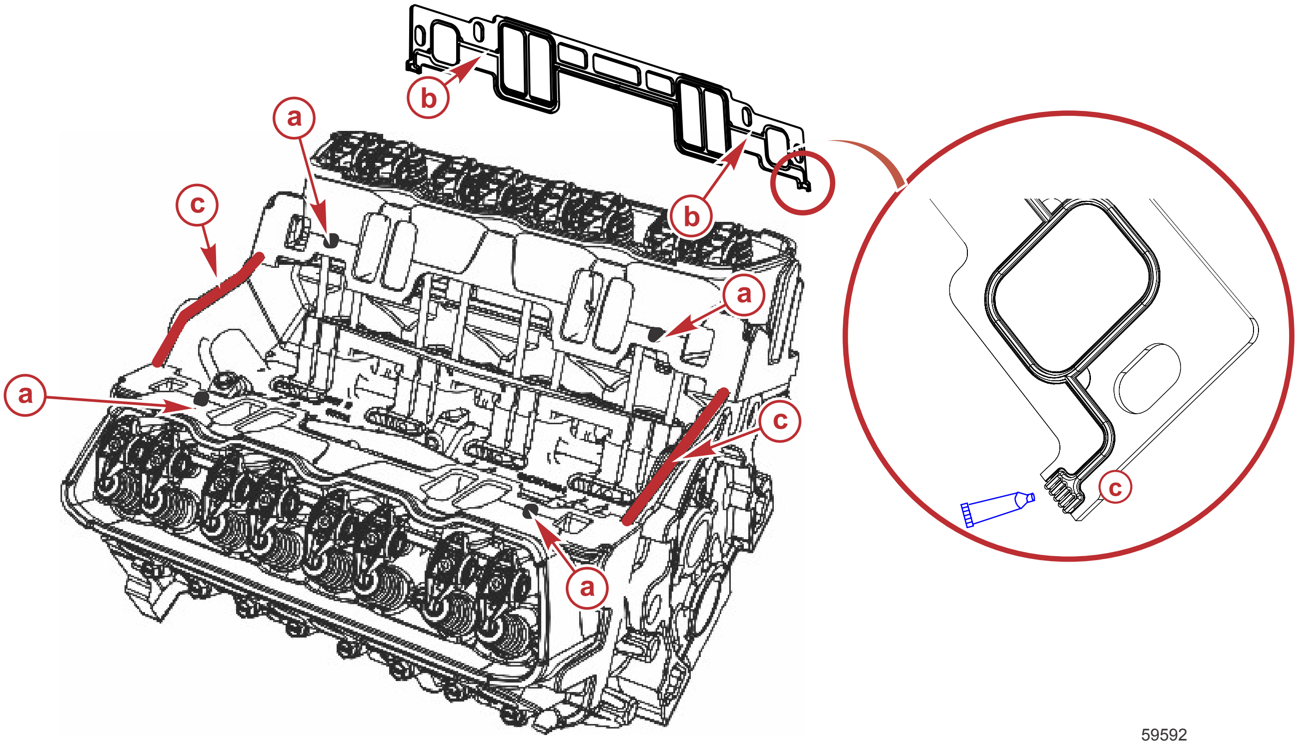
Installation

IMPORTANT: Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.

1. Apply a 4 mm (0.157 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do not get sealer into the oil sending unit hole.

   NOTE: For proper adhesion, the intake manifold gasket must be installed while the adhesive is still wet.

2. Align the intake manifold gaskets with the locator pins. Install the lower intake manifold gaskets onto the cylinder heads.



a - Locator pin hole
b - Locator pins
c - Area for sealant

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Each end of the lower intake manifold gaskets on the cylinder head side	92-809826

3. Apply a 5 mm (0.197 in.) wide bead of adhesive to the front and rear of the engine block as shown. Extend the adhesive bead 13 mm (0.51 in.) up on the intake gaskets.
IMPORTANT: Do not get sealer into the oil sending unit hole at the rear of the engine.

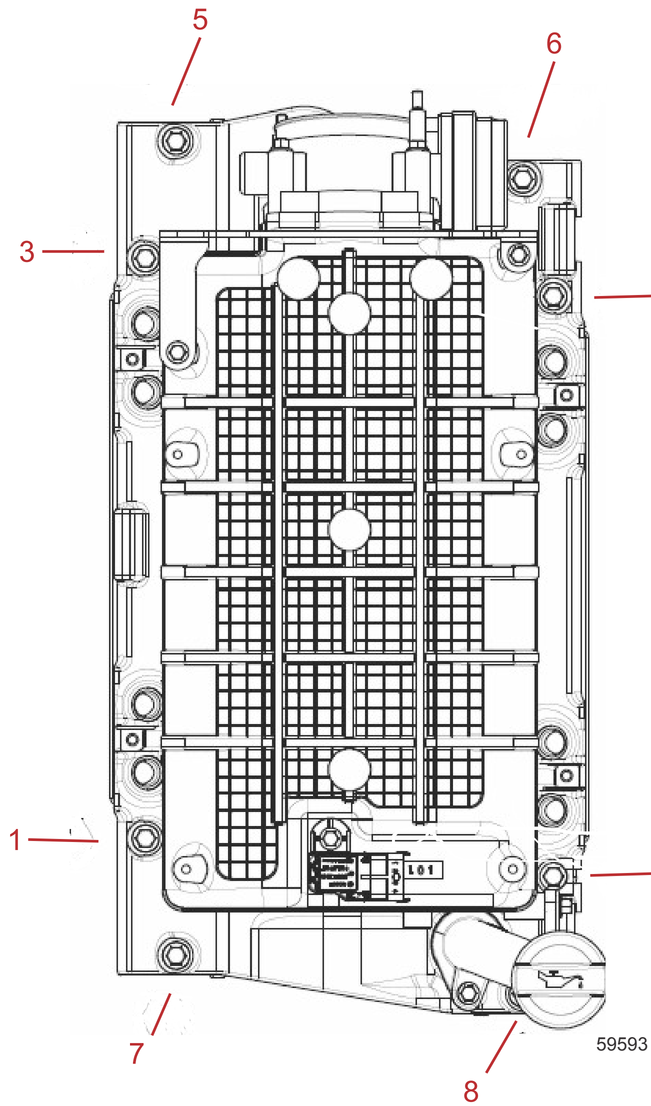
Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	A wide bead of adhesive to the front and rear of the engine block, extending the adhesive bead	92-809826

4. Coat the threads of the intake manifold bolts with sealant.
5. Carefully install the intake manifold assembly onto the engine block.
IMPORTANT: Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the passes required.

NOTICE

The crankshaft bearings are matched sets. Mismatching the bearings can result in engine damage. Replace and install the bearings in matched pairs.

6. Tighten the intake manifold bolts to the specified torque in the sequence and steps indicated.



Torque sequence

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Intake manifold bolt threads	92-809821

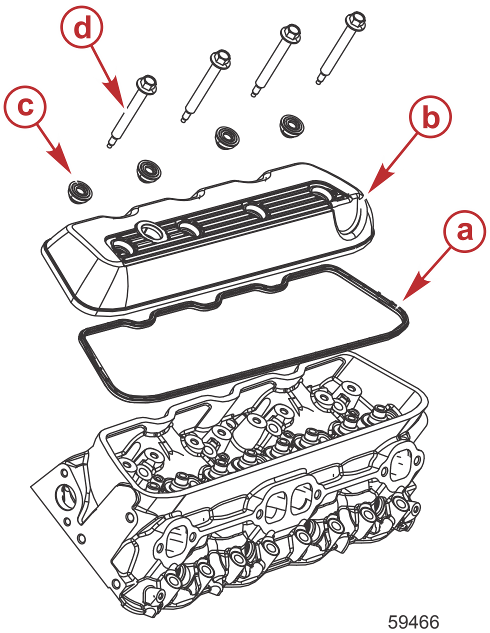
Description		Nm	lb-in.	lb-ft
Intake manifold bolts	**First torque**	12	106.2	–
	Second torque	24	–	17.7

7. Install the alternator. Refer to **Section 4C** - **Alternator Installation**.
8. Install the fuel injector rail with injectors. Refer to **Section 5A** - **Fuel Rail Installation**.
9. Connect the injector wire harness.
10. Install the fuel line.
11. Connect all ignition and electrical leads.
12. Install other ignition components and connect the wires.
13. Connect the crankcase ventilation hoses.
14. Connect any items that were disconnected.

Rocker Arm Cover

Installation

1. Place a new rocker arm cover gasket in position.



59466

- a - Rocker arm cover gasket
- b - Rocker arm cover
- c - Grommets
- d - Bolts

2. Install the rocker arm cover. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Rocker arm cover bolt	12	106.2	–

3. Install any items that were removed.
4. Connect the crankcase ventilation hoses.
5. Refer to **Section 7** for **Exhaust Manifold Installation**.

Flywheel

Cleaning and Inspection

1. Clean the mating surfaces of the flywheel and crankshaft. Remove any burrs. The mating surfaces must be clean, bare metal.
2. Inspect the flywheel ring gear for worn and missing teeth.
3. Inspect the splines in the drive plate or coupler for damage or excessive wear.
4. Replace components as necessary.

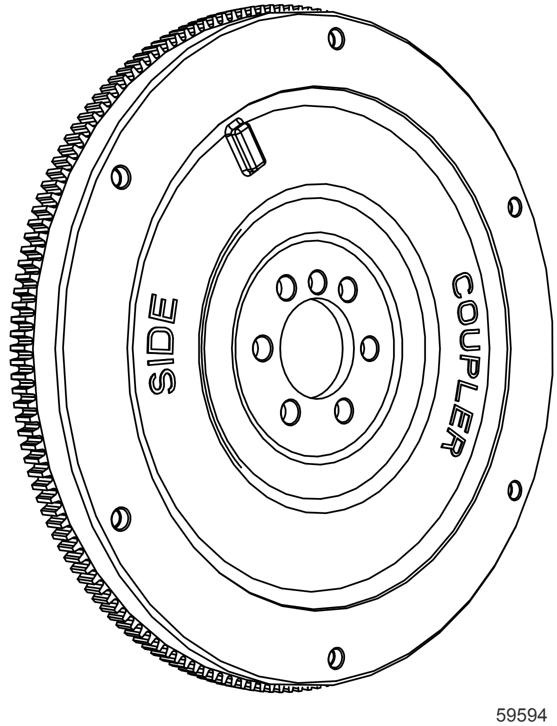
Installation

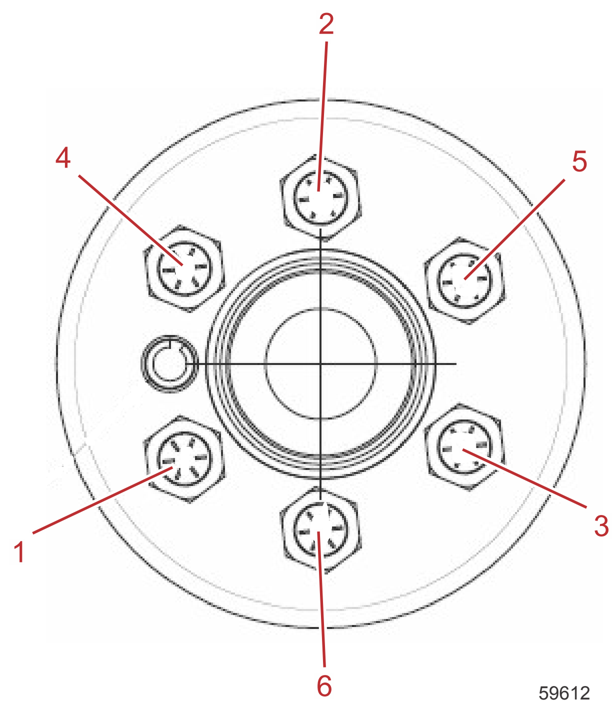
NOTE: Two designs of flywheels are used. The first design has a three hole pattern in the flywheel. The second design has a six hole pattern in the flywheel.

NOTE: If the crankshaft is to be replaced on a driveshaft extension application, but the old pilot bushing is to be reused, the bushing can be removed without damage by filling the pilot bushing cavity with grease, then inserting an old transmission input shaft into the bore of the bushing and hitting it with a hammer. This will create hydraulic pressure in the pilot bushing cavity forcing the bushing out.

1. Clean the mating surfaces of the flywheel and the crankshaft until the metal is bare.

2. Align the dowel hole in the flywheel with the dowel in the crankshaft and install the flywheel. Tighten the screws in sequence to the specified torque.



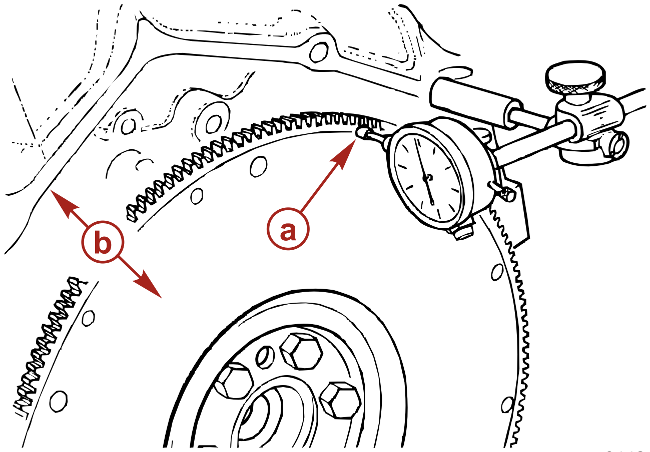


Tighten sequence

Description	Nm	lb-in.	lb-ft
Flywheel mounting screws	80	–	59

3. Check the flywheel runout:
   a. Attach a dial indicator to the engine block.
   b. Push in on the flywheel to remove any crankshaft end play.

c. Turn the flywheel in the direction of normal engine rotation and measure flywheel runout at the smooth outer edge of the flywheel just inside the ring gear.

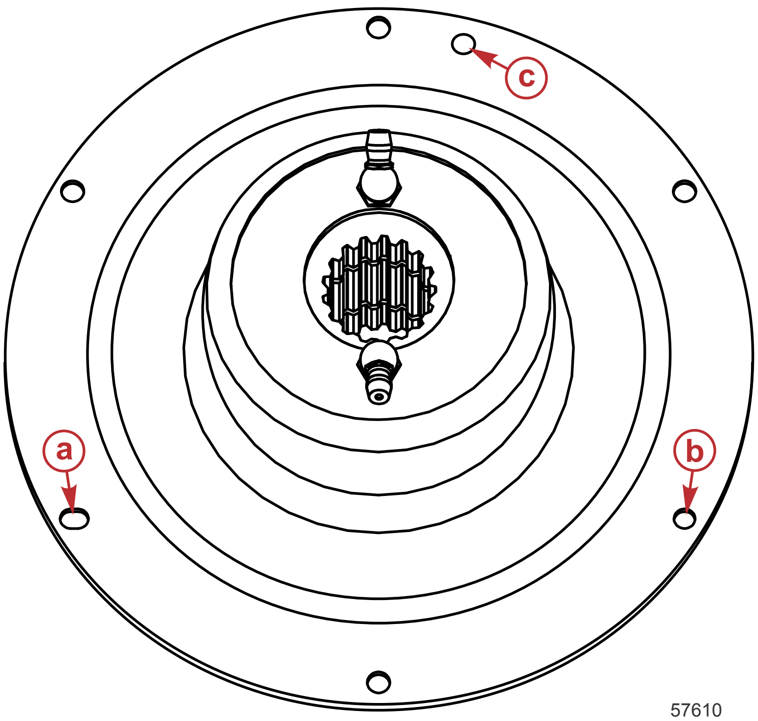


a - Dial indicator
b - Runout measurement

6442

Description	6.2 Liter (377 cid)
Runout	0.203 mm (0.0080 in.) maximum

4. Assemble coupler to the flywheel using six screws and washers, driving them loosely into place.

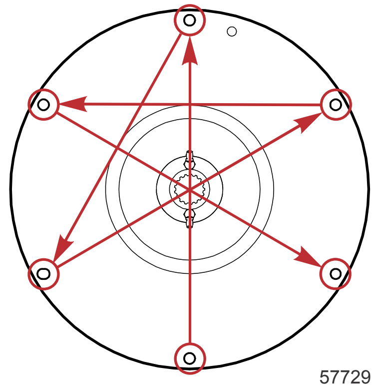


a - Slotted hole used for alignment
b - Small hole tightly held diameter, used for alignment
c - This hole is used for manufacturing, not for assembly

57610

5. Run the heads of the screws down flush with the coupler, but do not tighten any of them at this point. This will allow the alignment holes to locate the coupler.

6. After all six screws with washers are loosely driven in flush to the coupler, tighten the screws in a star pattern to the specified torque.



Star pattern torque sequence example

Description	Nm	lb-in.	lb-ft
Drive coupler mounting screws	48	–	35.4

NOTE: It does not matter which screw is the starting or ending screw during this operation, if they have been run in loosely as per step one.

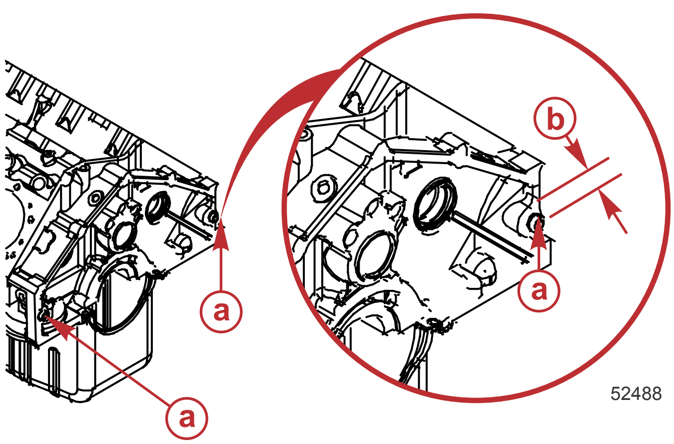
Flywheel Housing

Cleaning

1. Clean all parts in solvent.
2. Dry the parts with compressed air.

Inspection

1. Inspect the flywheel housing for cracks, damaged bolt or stud holes, and excessive wear. Replace if necessary.
2. Inspect the guide dowels for the correct amount of protrusion from the engine block. Repair if necessary.



a - Guide dowels (2)
b - Measured protrusion 13 mm (0.5 in.)

Installation

1. Align the flywheel housing on the guide dowels of the engine.
   IMPORTANT: The flywheel housing fasteners must be installed in the same location as removed.
2. Install the studs and screws into their original locations.
3. Tighten the flywheel housing fasteners to the specified torque.

Description	Nm	lb-in.	lb-ft
Flywheel housing fasteners	41	–	30

4. Install the flywheel housing cover. Tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Flywheel housing cover screws	9	80	–

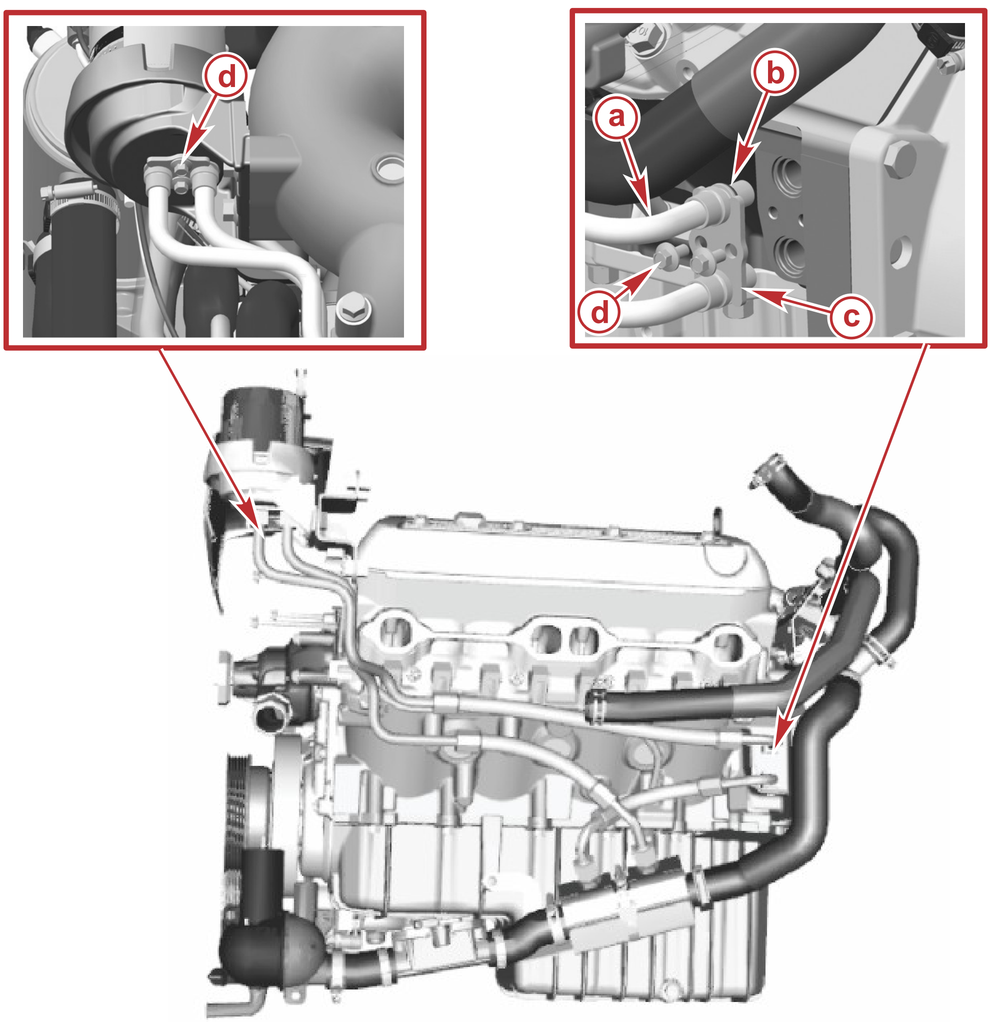
5. Install the ground wires.
6. Install the power steering cooler (if equipped).
7. Install the water hoses.
8. Install the power package in the boat.

Oil Lines

1. Install the O-rings onto the oil lines.
2. Lubricate the O-rings with Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	O-rings	92-8M0078629

3. Install the oil lines along with the retaining bracket onto the engine block.
4. Secure the retaining bracket with two screws. Do not tighten the screws.
5. Install the oil lines along with the retaining bracket onto the oil filter housing.
6. Secure the retaining bracket with two screws.
7. Verify the oil lines are properly seated and tighten the screws to the specified torque.



a - Oil lines
b - O-rings (four, 1 on each oil line)
c - Retaining bracket (two)
d - Screws (four)

59596

Description	Nm	lb-in.	lb-ft
Screw	31.1	–	23

Crankcase Front Cover Oil Seal (Without Removing Front Cover)

Removal

1. Remove the belt and crankshaft pulley.
2. Remove the crankshaft harmonic damper.
3. Pry the seal out of the front of the cover with a seal removal tool. Be careful not to distort the front cover or damage the crankshaft.

Description	Part Number
Seal removal tool	J45000

Installation

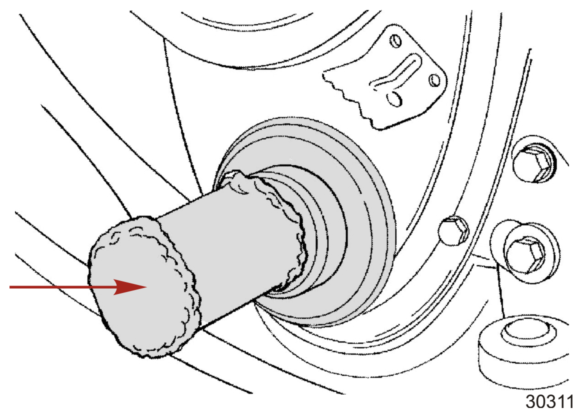
1. Apply sealant to the crankshaft front cover mating surface of the seal.

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Crankshaft front cover mating surface of the seal	92-809826

2. Lubricate the rubber sealing surface.

Tube Ref No.	Description	Where Used	Part No.
139	Mercury 25W-40 Synthetic Blend 4-Stroke Engine Oil	Rubber sealing surface	92-8M0078629

3. Install the new seal with the open end of the seal facing inward. Using the crankcase front cover aligner and seal installer, drive the seal in until it seats.
IMPORTANT: Do not use excessive force to drive in the seal.



Crankcase front cover aligner and seal installer

Description	Part Number
Crankcase front cover aligner and seal installer	J35468

4. Install the crankshaft harmonic damper.
IMPORTANT: Use Loctite 598 RTV Sealant on the crankshaft harmonic damper keyway to prevent oil migration past the key.

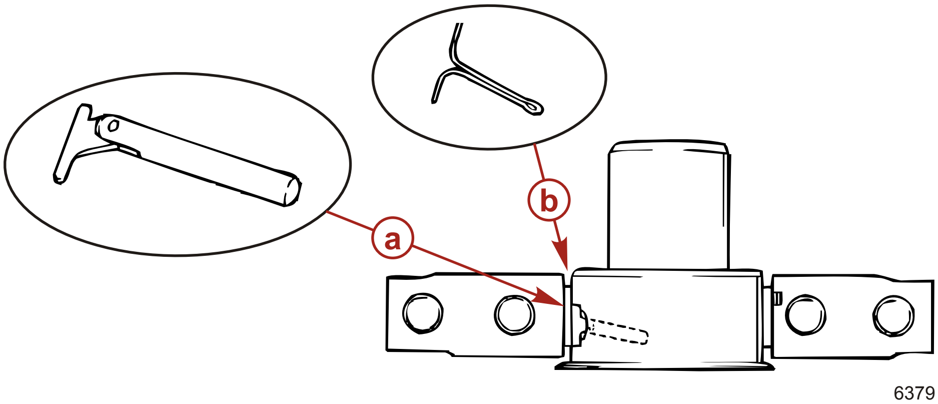
Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Keyway	Obtain Locally

5. Install the crankshaft pulley and belt.

Main Bearings, Without Crankshaft Removed

Installation

1. Remove the cap on the main bearing requiring replacement.
2. Remove the bearing from the cap.
3. Install the main bearing remover and installer tool in the oil hole in the crankshaft journal. If this tool is not available, a cotter pin may be bent as shown and used.



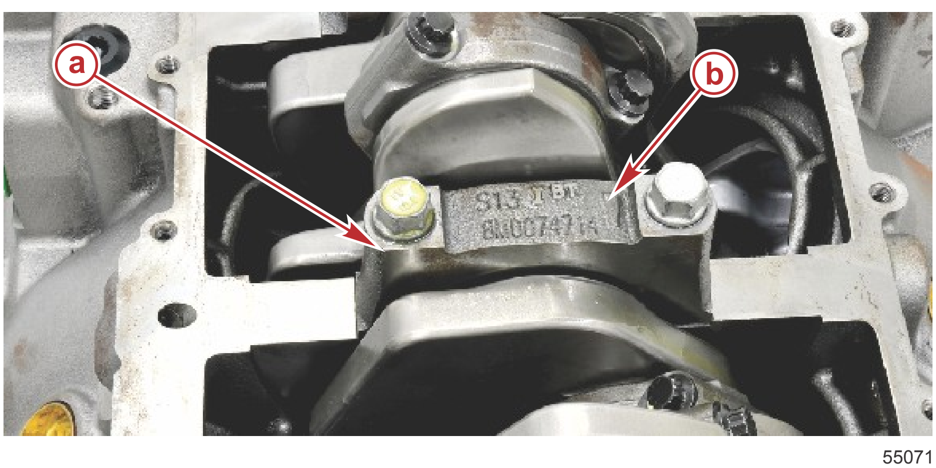
a - Main bearing remover and installer tool
b - Cotter pin

Description	Part Number
Kent-Moore main bearing remover and installer tool	J8080

4. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper bearing out of the engine block.
5. Lubricate a new upper bearing.
6. Insert the plain (unnotched) end between the crankshaft and the indented or notched side of the engine block.
7. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
8. Lubricate a new lower bearing and install in the bearing cap.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Upper and lower bearing	Obtain Locally

9. Install the main bearing cap in the original location with the markings pointing toward the front of the engine.



a - Main bearing cap
b - Bearing cap marks

10. Tighten all main bearing caps, except the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt—preferred method	**First torque**	25	–	18.4
	Final torque	+90°		

11. Tighten the rear main bearing cap. Using the method described below.

Preferred Method:

1. Do the first step torque on the rear main bearing cap.

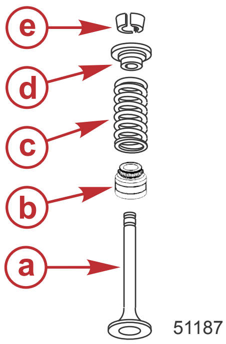
Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt—preferred method	**First torque**	25	–	18.4

2. Using a lead hammer, tap the end of the crankshaft to the rear.
3. Using a lead hammer, tap the end of the crankshaft to the front.
4. Do the final step torque on the bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt—preferred method	**Final torque**	+90°		

Valves and Seals (Without Removing Head)

Valve Spring Assembly Exploded View



a - Valve
b - Valve stem oil seal
c - Valve spring
d - Valve spring retainer
e - Valve spring lock

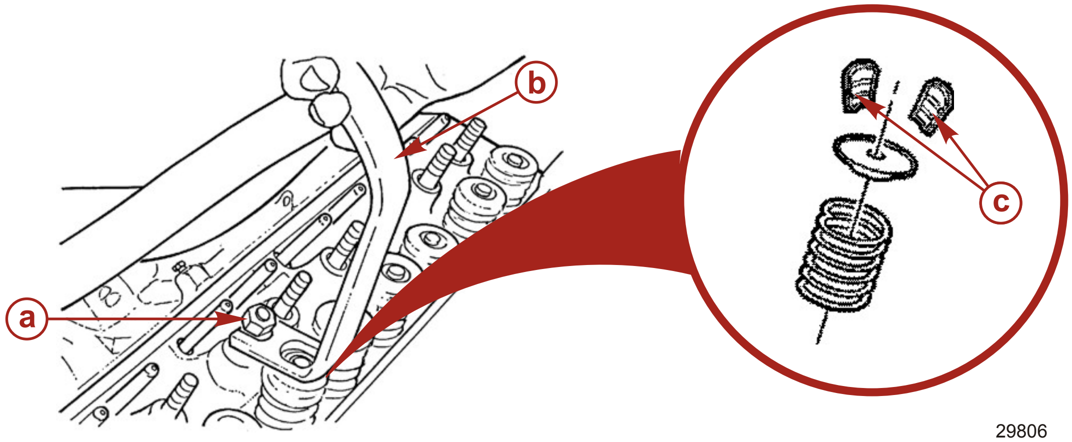
Valve Spring Assembly Removal

1. Remove the rocker arm cover.
2. Remove the spark plug of the cylinder being serviced.
3. Remove the rocker arm assembly.
   IMPORTANT: Keep air pressure in the cylinder while springs, caps, and valve locks are removed or the valves will fall into the cylinder.
4. Install a spark plug port adapter in the spark plug hole and apply 138–206 kPa (20–30 psi) of compressed air to hold the valves in place.

Description	SPX Part Number
Spark plug port adapter	J23590

NOTE: If compressed air is not available, the piston may be brought up to TDC to keep the valves from falling out of the cylinder head.

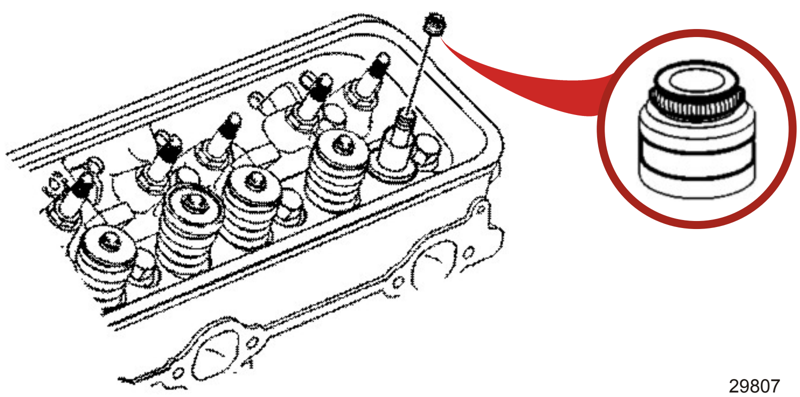
5. Insert a valve spring compressor under the rocker arm nut, compress the valve spring, and remove the valve keepers.



a - Rocker arm nut
b - Valve spring compressor
c - Valve keepers

Description	SPX Part Number
Valve spring compressor (cylinder head on engine)	J5892-D

6. Carefully release the valve spring compressor.
7. Remove the valve spring cap and valve spring.
   IMPORTANT: If compressed air is not available, do not turn the crankshaft while valve springs, retainers, and locks are removed or the valves will fall into the cylinder.
8. Remove and discard the valve stem oil seal.



Typical valve stem oil seal

Engine Mechanical

Section 3C - Engine Troubleshooting

Table of Contents

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C

Special Tools

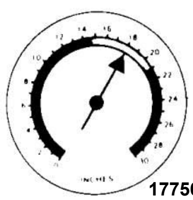
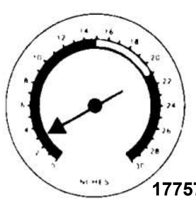
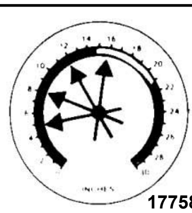
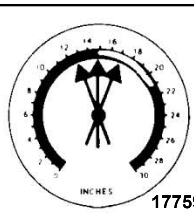
Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system and can be used in conjunction with Computer Diagnostic System (CDS).

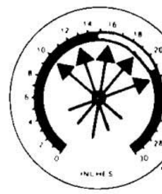
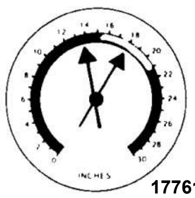
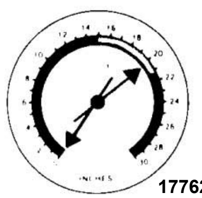
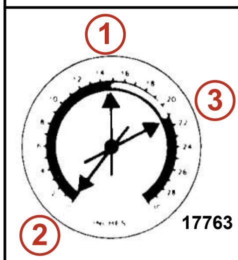
Troubleshooting With a Vacuum Gauge

Most engines have a normal gauge reading of 51–71 kPa (15–21 in. Hg) vacuum. Before using the vacuum gauge the engine must be at normal operating temperature. Use a tachometer to be certain that the engine is running at the specified RPM. The vacuum gauge must be connected to the intake manifold at a manifold vacuum source.

The following table indicates possible malfunctions of various vacuum readings.

Vacuum Gauge Troubleshooting Guide

Gauge Reading	Symptom	Cause	Action
 17756	**Steady reading 51–71 kPa (15–21 in. Hg) at idle RPM**	Normal	No action necessary.
 17757	**Extremely low reading, but indicator steady at idle RPM**	Vacuum leak at intake manifold or incorrect timing, or underpowered boat.	Determine the source of the vacuum leak and repair. Replace the propeller. If the problem persists, contact the manufacturer about the correct power package.
 17758	**Indicator fluctuates between high and low at idle RPM**	Blown cylinder head gasket between two adjacent cylinders. (Check with compression test.)	Determine the cause and replace the cylinder head gasket.
 17759	**Indicator fluctuates 13.5–17 kPa (4–5 in. Hg) very slowly at idle RPM**	Valves are sticking or spark plug gap is too narrow.	Inspect the spark plugs and service or replace if necessary. Correct sticking valve.

Gauge Reading	Symptom	Cause	Action
 17760	**Indicator fluctuates rapidly at idle, steadies as RPM is increased**	Valve guides may be worn.	Ream the valve guides and install a valve with an oversized stem or replace the cylinder head.
 17761	**Indicator continuously fluctuates between low and normal reading at regular intervals at idle RPM**	Burned or leaking valve.	Replace the valve.
 17762	**Indicator drops to zero as engine RPM is increased**	Exhaust system is restricted.	Clear exhaust system.
 17763	**Indicator holds steady at 41–54 kPa (12–16 in. Hg): (1) Drops back to zero (2) and back to about 71 kPa (21 in. Hg) (3) as the throttle is engaged and released**	Possible piston ring leak (check the compression).	Repair or replace as needed.

Measuring Vacuum

IMPORTANT: Use an accurate digital vacuum gauge that reads in either inches of mercury (in. Hg) or kilopascals (kPa) to check engine vacuum. Dial vacuum gauges are not accurate enough.

Digital Pressure Meter	91-892651A01

Carefully follow the gauge manufacturer's instructions to ensure accurate vacuum measurement.

Mechanical Engine Noise

⚠ WARNING

Moving parts can cause serious injury or death. Wear eye protection and keep hands, hair, and clothing away from moving parts when performing tests or checking adjustments on an operating engine.

No definite rule or test will positively determine a source of engine noise. Use the following information only as a general guide to engine noise diagnosis.

- Use a timing light to determine if noise is timed with engine speed or half of the engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to half engine speed are valve train related.
- If noise is suspected to be confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, the problem is isolated to that cylinder. Noise confined to one cylinder is normally related to a problem with a wrist pin, rod bearing, or piston slap.
- Try to isolate the noise to one location in the engine. Identify an area front to back or top to bottom. This can help determine which components are at fault.

- The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, exercise caution.

Description	Part Number
Stethoscope	Obtain locally

- Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler, exhaust flappers rattling against exhaust pipe, the crankshaft striking the pan, a rocker arm striking valve cover, or a loose flywheel cover. In many cases if this is found to be the problem, a complete engine tear-down is not necessary.
- When noise is isolated to a certain area and component, removal and inspection is required. Refer to proper sections of the **Service Manual** for information required for service.
- If noise cannot be isolated to the engine or the drive unit, remove the drive from the boat. Bring a water supply directly to the engine. Operate the engine without the drive to determine if noise is still present.

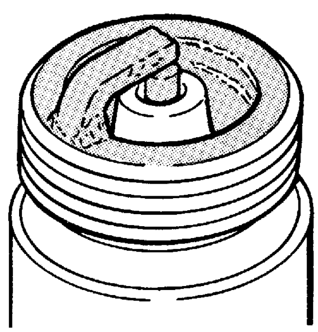
Used Spark Plug Analysis

Spark plug condition can suggest a variety of possible engine malfunctions and indicate needed engine repairs. When the old plugs are replaced, replace the entire set. Perform plug service only on those plugs suitable for additional service using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open the electrode gap wide enough to permit cleaning and filing.
3. Remove the combustion deposits from the firing end of the spark plug with a plug cleaner. Use compressed air to remove abrasives.
4. File the electrode surfaces to restore clean, sharp edges. Remove filings with compressed air.
5. Reset the gap to specifications by bending only the side electrode with the proper tool.

Normal Condition

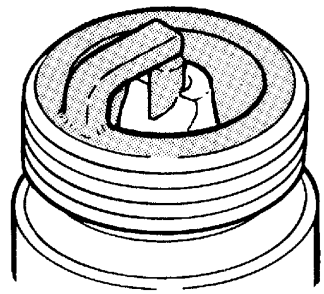
Few deposits are present and probably will be light tan or gray in color. This plug shows that the plug heat range is compatible with the engine, and the engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file, and regap), this plug can be reinstalled with good results.



27643

Chipped Insulator

A chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split the insulator firing ends. Replace the spark plugs.

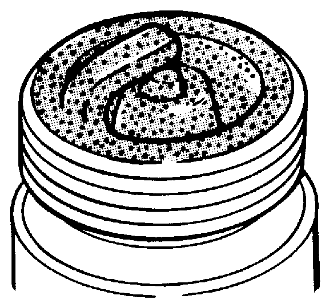


27644

Wet Fouling (Oil Deposits)

The plug becomes shorted by excessive oil entering the combustion chamber, usually in the engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering the combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

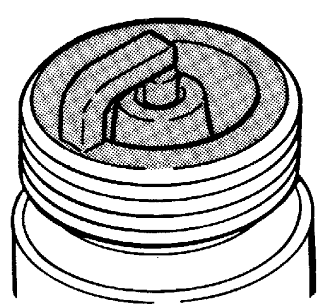
IMPORTANT: New engines or recently overhauled engines may wet foul the plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file, and regap) and reinstalled.



27645

Cold Fouling

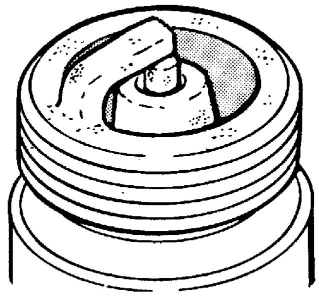
Dry, black deposits indicate a rich fuel mixture or a weak ignition. A clogged flame arrestor, a flooding engine, a sticky choke, or weak ignition components all are probable causes. If, however, only one or two plugs in the set are fouled, check for sticking valves or bad ignition leads. After correcting the cause, service (clean, file, and regap) plugs and reinstall.



27647

Overheating

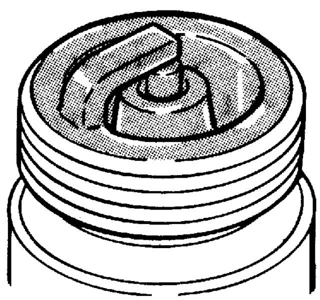
The insulator is dull white or gray and appears blistered. The electrodes are eroded and there is an absence of deposits. Ensure that the correct plug heat range is being used. Also check for incorrect rotor location, cooling system malfunction, lean fuel and air mixtures, leaking intake manifold, or sticking valves. Replace the spark plugs.



27648

High Speed Glazing

The insulator has yellowish, varnish-like color, indicating that the temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace the spark plugs. If the condition recurs, use colder heat range plug and service plugs more frequently.



27649

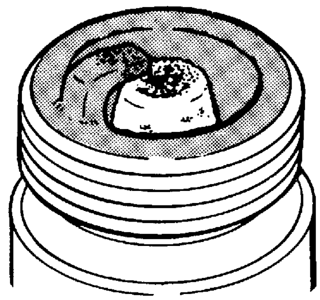
Scavenger Deposits

Powdery white or yellow deposits are built up on the shell, the insulator, and the electrodes. This is the normal appearance with certain branded fuels. Accumulation on the ground electrodes and the shell areas may be unusually heavy, but may be easily chipped off. Service (clean, file, and regap) plugs and reinstall.

27650

Preignition Damage

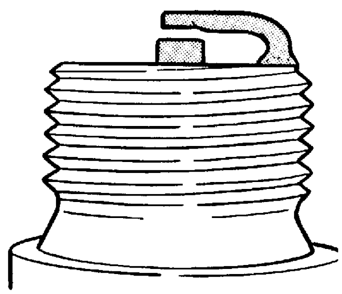
Preignition damage is caused by excessive high temperatures. The center electrode melts first, followed by the ground electrode. Normally, the insulators are white, but may be dirty if the plug has been misfiring. Check for the correct plug heat range, incorrect rotor location, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold, or lack of lubrication. Replace the spark plugs.



27651

Reversed Coil Polarity

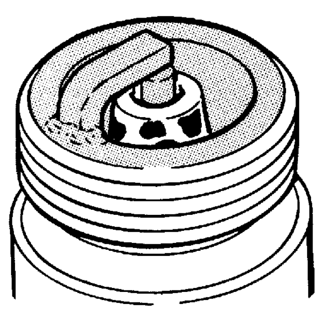
Concave erosion of the ground electrode is an indication of reversed polarity. The center electrode will show only normal wear. The engine will misfire and idle rough. To correct, reverse the primary coil leads. Replace the spark plugs.



27652

Splashed Deposits

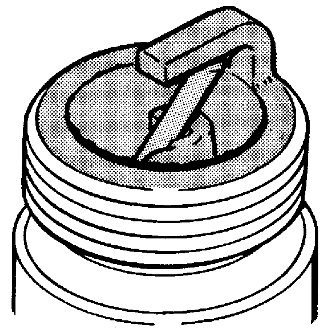
Splashed deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon the installation of the new plugs, the deposits loosen from the top of the piston and the cylinder head and are thrown against the hot insulator. Service (clean, file, and regap) plugs and reinstall.



27653

Mechanical Damage

Mechanical damage to the spark plug firing end is caused by a foreign object in the combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, the intake manifold, and the exhaust material to prevent further damage. Replace the spark plugs.

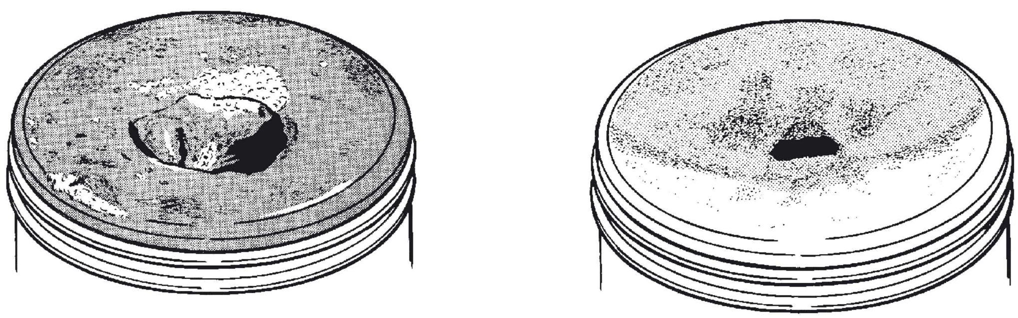


27654

IMPORTANT: When working on the engine, the spark plug holes, the intake, and the throttle body should be kept covered to prevent foreign objects from entering the combustion chamber.

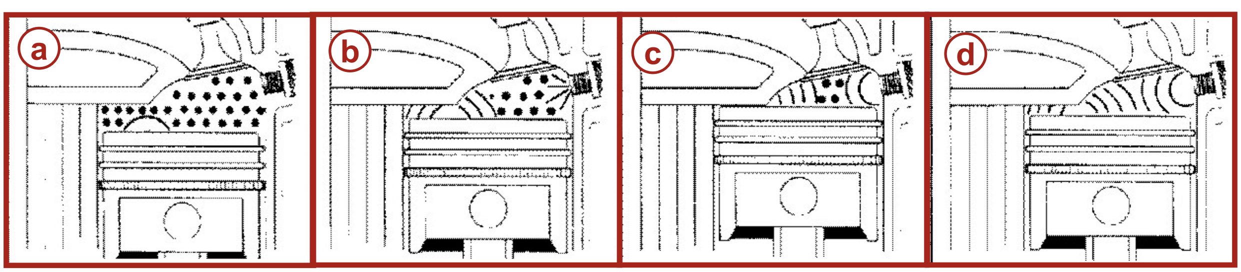
Piston Inspection

1. Replace pistons that are damaged or show signs of excessive wear.
2. Inspect the piston for damage caused by preignition.



14394

Typical preignition damage



30341

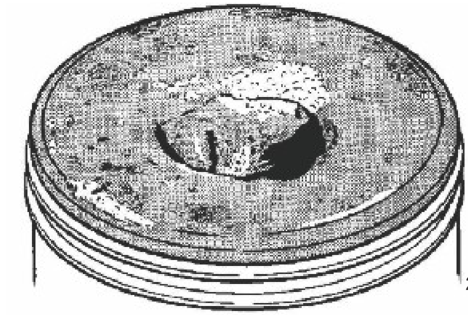
- a - Preignition begins
- b - Controlled ignition spark
- c - Remaining fuel ignition
- d - Flame front collision

NOTE: Engine failures that result from these conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.

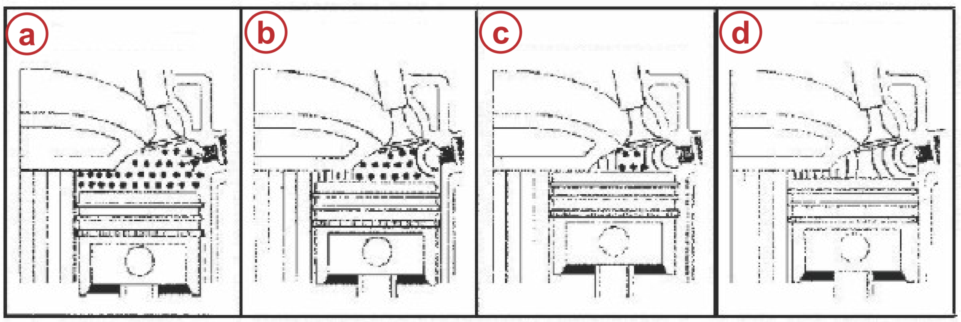
3. If indicated, inspect the engine for causes of preignition damage to pistons:
   - Combustion chamber hot spots caused by damaged components, foreign material, or combustion chamber deposits.

- Overheated spark plug electrodes (improper heat range or defective plug).
- Inadequate engine cooling.

4. Inspect the piston for damage caused by detonation (knock).



Typical detonation damage



a - Controlled ignition spark
b - Combustion begins
c - Continued combustion
d - Detonation occurs

NOTE: The use of poor quality, contaminated, or incorrect fuels will cause poor performance and engine damage.

5. If indicated, inspect the engine for causes of detonation damage to pistons:
   - Use of low octane gasoline or neglecting engine maintenance
   - Lean fuel mixture at or near full throttle (could be caused by leaking intake manifold)
   - Cross-firing ignition system
   - The accumulation of deposits on the piston and/or combustion chamber that result in a higher compression ratio
   - Inadequate engine cooling

   NOTE: Engine failures that result from these conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.

Starter Motor Will Not Crank Engine, or Cranks Slowly

Possible Cause	Remedy
Battery switch turned off.	Turn the switch on.
Remote control not in neutral position.	Position the control lever in neutral.
Open circuit breaker or fuse.	Check and reset the main power circuit breaker or replace the fuse. Check the 5-amp fuse on the power harness connected to the battery, and replace if necessary. Inspect the corresponding circuit to determine the cause of failure.
Loose or dirty electrical connections or damaged wiring.	Check all electrical connections and wires (especially battery cables). Clean and tighten all faulty connections.
Bad battery or low battery voltage.	Test the battery and charge if necessary; replace if bad.
Lanyard stop switch activated.	Check the lanyard stop switch.

Engine Will Not Start or Is Hard to Start

Possible Cause	Remedy
Lanyard stop switch activated.	Reset the lanyard stop switch.
Improper starting procedure.	Read and follow the starting procedure.
Insufficient fuel supply.	Fill the fuel tank or open valve.
Faulty ignition system component.	Service the ignition system.
Clogged fuel filter.	Replace the fuel filter.
Stale or contaminated fuel.	Drain the fuel tank. Fill with fresh fuel.
Fuel line or tank vent line kinked or clogged.	Replace kinked lines or blow out lines with compressed air to remove obstruction.
Faulty wire connections.	Check wire connections.
MPI system fault.	Check the fuel system. Refer to **MerCruiser ECM Fault Information and Troubleshooting**.

Engine Runs Rough, Misses, or Backfires

Possible Cause	Remedy
Clogged fuel filter.	Replace the fuel filter.
Stale or contaminated fuel.	Drain the fuel tank. Fill with fresh fuel.
Fuel line or tank vent line kinked or clogged.	Replace kinked lines or blow out lines with compressed air to remove obstruction.
Flame arrestor dirty.	Clean the flame arrestor.
Faulty ignition system component.	Service the ignition system.
Idle speed too low.	Check the fuel system. Refer to **Section 5**.
MPI system fault.	Check the fuel system. Refer to **MerCruiser ECM Fault Information and Troubleshooting**.

Poor Performance

Possible Cause	Remedy
Throttle not fully open.	Inspect the throttle body for proper operation.
Damaged or improper propeller.	Replace the propeller.
Excessive bilge water.	Drain and check for cause of entry.
Boat overloaded or load improperly distributed.	Reduce load or redistribute load more evenly.
Flame arrestor dirty.	Clean the flame arrestor.
Boat bottom fouled or damaged.	Clean or repair as necessary.
Ignition problem.	Refer to **Engine Runs Rough, Misses, or Backfires**.
Engine overheating.	Refer to **Engine Overheat**.
MPI system fault.	Check the fuel system. Refer to **MerCruiser ECM Fault Information and Troubleshooting**.

Engine Overheat

Possible Cause	Remedy
Water inlet or seacock closed.	Open the inlet or seacock.
Drive belt loose or in poor condition.	Replace or adjust belt.
Seawater pickups or sea strainer obstructed.	Remove obstruction.
Faulty thermostat.	Replace the thermostat.
Coolant level (if equipped) low in the closed-cooling section.	Check for cause of low coolant level and repair. Fill system with proper coolant solution.
Heat exchanger or fluid cooler plugged with foreign material.	Clean heat exchanger, engine oil cooler, and transmission oil cooler (if equipped).
Loss of pressure in the closed-cooling section.	Check for leaks. Clean, inspect, and test the pressure cap.
Faulty seawater pickup pump.	Repair.

Possible Cause	Remedy
Seawater discharge restricted or plugged.	Clean exhaust elbows.

Low Engine Temperature

Possible Cause	Remedy
Faulty thermostat.	Replace the thermostat.

Low Engine Oil Pressure

Possible Cause	Remedy
Insufficient oil in the crankcase.	Check and add oil.
Excessive oil in the crankcase (causing it to become aerated).	Check and remove the required amount of oil. Check for the cause of excessive oil (improper filling).
Diluted or improper viscosity oil.	Change the oil and oil filter, using the correct grade and viscosity oil. Determine the cause for dilution (excessive idling).

NOTE: *Refer to PCM 112 Diagnostic Manual for more information.*

Water in the Engine

Important Information

IMPORTANT: First determine the location of the water in the engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are water on top of the pistons, water in the crankcase oil, and when both of those conditions occur simultaneously.

1. After locating the water, remove all the water from the engine by removing all the spark plugs and cranking the engine over to pump out the cylinders.
2. Change the oil and the filter.
3. Start the engine and see if the problem can be duplicated. If the problem can be duplicated, a mechanical problem exists. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If the water is contained to the cylinders only, it is usually entering through the exhaust system. If the water is contained to the crankcase only, it is usually caused by water entering through the intake manifold, a flooded bilge, or condensation. If the water is located in both the cylinders and the crankcase, it is usually caused by water in the cylinders getting past the piston rings and valves or complete submersion. Checking for water trails in the intake manifold or the exhaust manifolds is a good idea. Water trails are a clue that water entered these areas.

Symptom	Cause	Action
1. Water on top of the pistons.	**1.0** The operator shut the engine off at a high RPM.	**1.0** Refer to **Section 3 - On the Water** in the **Operation, Maintenance and Warranty Manual**.
	1.1 Water ingestion through the exhaust system.	**1.1** Verify the exhaust elbow height. Repair the exhaust system.
	1.2 Improper engine or exhaust hose installation.	**1.2** Check the engine installation specifications.
	1.3 Cracked exhaust manifold.	**1.3** Replace the exhaust manifold.
	1.4 Corroded exhaust elbow.	**1.4** Replace the exhaust elbow.
	1.5 Loose cylinder head bolts.	**1.5** Tighten the cylinder head bolts.
	1.6 Blown cylinder head gasket.	**1.6** Determine the cause of the blown gasket and replace the gasket.
	1.7 Cracked valve seat.	**1.7** Replace the valves.
2. Water in the crankcase oil.	**2.0** Water in boat bilge.	**2.0** Drain the water from the bilge.
	2.1 Engine stored outside, or with the engine cover missing.	**2.1** Ensure the engine is properly covered.
	2.2 Intake manifold leaking near a water passage.	**2.2** Inspect the intake manifold for cracks. Check the gaskets.
	2.3 Cracked or porous casting.	**2.3** Check the cylinder head, the cylinder block, and the intake manifold for cracks or porosity.

Compression Gauge Testing

IMPORTANT: Use a fully charged battery during this testing procedure.

IMPORTANT: Compression test failures generally indicate a serious engine malfunction has occurred. The engine should be repaired prior to being returned to service.

IMPORTANT: Follow the instructions provided by the compression test gauge manufacturer. Use the correct threaded adapter.

1. With the engine cold, verify that the battery is fully charged.
   IMPORTANT: Ground the ignition coil to distributor cap wire directly to engine ground to prevent spark from the disconnected spark plug wires. A remote starting tool may energize the ignition coil through the "R" terminal of the starter solenoid even though the key and lanyard stop switches are in the OFF position.
2. Disable the ignition system.
3. Remove all of the spark plugs.
4. Temporarily stop the throttle lever in the WOT position to hold the throttle plate completely open.
5. Install the compression gauge to the cylinder being tested.
6. Zero the compression gauge.
7. Crank the engine, cycling the test cylinder through four compression strokes.
8. Record the compression test results for each cylinder.

Compression Test Diagnosis	
Minimum compression	690 kPa (100 psi)
Compression difference (The lowest compression cylinder should be no less than 70% of the highest compression cylinder.)	70%

   NOTE: *Example: If the highest compression cylinder has 150 psi (1035 kPa) of compression, the lowest allowable pressure for any other cylinder would be 105 psi (725 kPa). (150 × 70% = 105 psi [1035 × 70% = 725 kPa]).*
9. Repeat until all the cylinders have been tested.
10. The interpretation of low cylinder compression test results can be aided by injecting three squirts of oil from a pump style oil can into the test cylinder combustion chamber and rechecking compression.

Possible Cause	Test Result	Further Testing
Normal	Compression builds quickly and evenly in each cylinder.	None.
Leaking piston rings	Compression is low on the first stroke, increases on the following strokes but does not reach normal compression.	Inject three squirts of oil into the cylinder and retest. Compression should improve significantly.
Leaking valves	Compression is low throughout the test cycle.	Inject three squirts of oil into the cylinder and retest. No effect.
Leaking head gasket	Two adjacent cylinders have low compression.	Inject three squirts of oil into both cylinders and retest. No effect.

Leak-Down Testing

Additional diagnosis of low compression cylinders can be performed using pressurized air to identify the source of combustion chamber leaks.

1. Rotate the engine by hand until the number 1 cylinder is at top dead center (TDC) of the compression stroke.
2. Identify and note the engine firing order.
3. Rotate the crankshaft 90° to position the next cylinder in the firing order at TDC. Repeat until the first targeted test cylinder is positioned at TDC.
   NOTE: *Example with a firing order of 1-8-4-3-6-5-7-2: To test cylinder number 3, rotate the engine an additional 270° (3 × 90°) to position the fourth cylinder of the firing order, cylinder number 3, at TDC of its compression stroke. To continue the test and check cylinder number 6, rotate the engine an additional 90°.*
4. Thread the air supply adapter into the spark plug hole.
   IMPORTANT: The air supply must be regulated to provide 138–206 kPa (20–30 psi) of air pressure. Use the appropriate compression-gauge style threaded adapter to introduce the pressurized air into the test cylinder.
   IMPORTANT: Do not rotate the engine by turning the crankshaft balancer bolt.
5. Hold the crankshaft balancer bolt with a large wrench to prevent the crankshaft from rotating when applying air pressure to the cylinder.
   IMPORTANT: The engine will try to rotate when air pressure is applied. Maintain a firm grip on the wrench to prevent unexpected motion.

6. Apply 138–206 kPa (20–30 psi) of air pressure through the adapter hose into the cylinder to be tested. Keep the crankshaft from rotating.
7. Test result interpretation:

Possible Cause	Test Result
Leaking intake valve	Air is heard leaking up through the intake manifold at the throttle body.
Leaking exhaust valve	Air is heard leaking into the exhaust system.
Leaking piston or piston rings	A high volume of air leaks into the test cylinder's rocker arm cover and can be felt flowing out of the oil fill or breather cap. (Low volume air bleed past the rings is normal.)

Notes:

Engine Mechanical

Section 3D - Engine Wiring Harness

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Engine Wiring Harness

Harness Removal

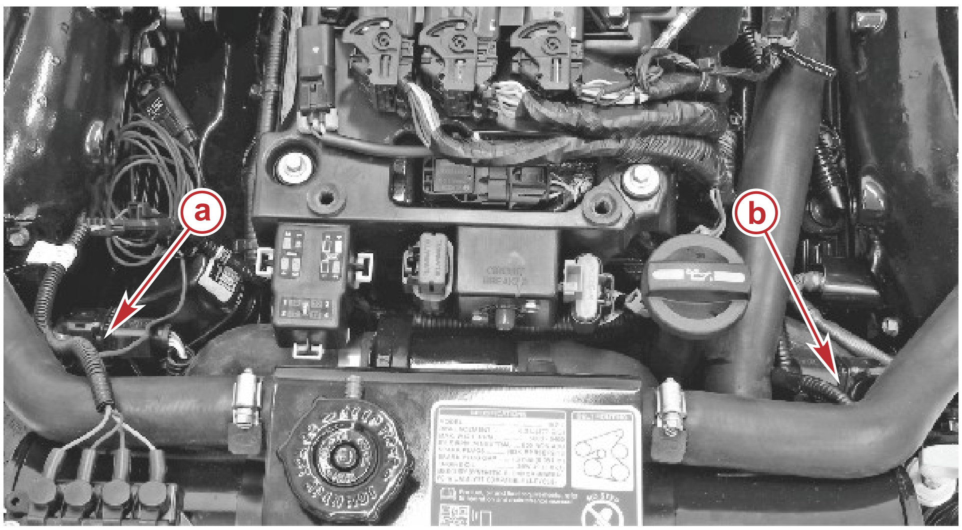
⚠ WARNING

Damaged wires can cause electrical problems, resulting in system failure. In some cases, this can affect boat operation, leading to personal injury. Use conduit, hose clamps, grommets, or other appropriate measures to protect all electrical wires. Do not overtighten clamps and keep harnesses away from heat sources during installation.

⚠ CAUTION

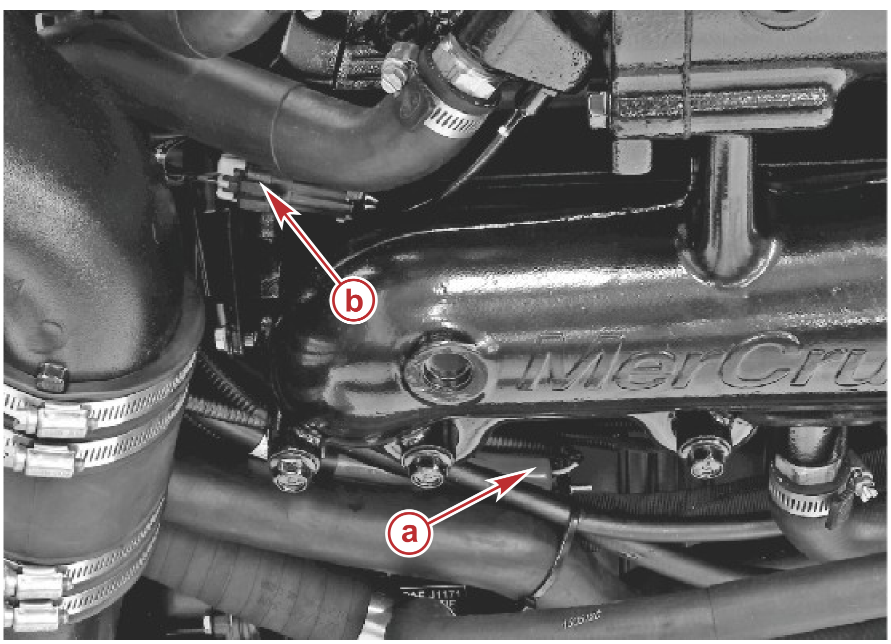
Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

1. Disconnect the battery negative (–) ground cable.
2. Disconnect the oxygen sensors.



59362

a - Starboard precatalyst oxygen sensor
b - Port precatalyst oxygen sensor

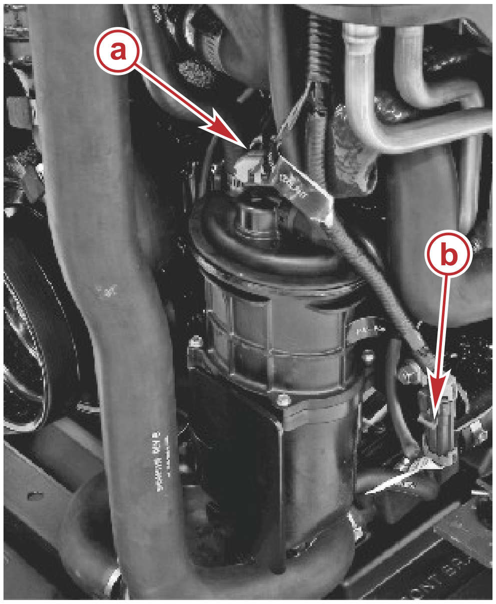


59363

a - Starter connection
b - Starboard exhaust temperature sensor

3. Disconnect the wires at the starter.
4. Disconnect the starboard and port exhaust temperature sensors.

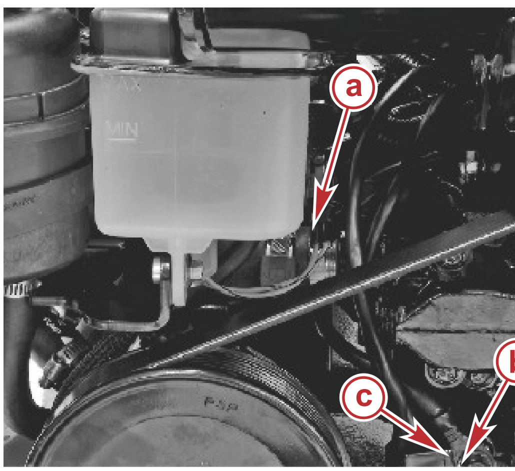
5. Remove the coolant sensor connector and the fuel pump connector.



a - Coolant sensor connector
b - Fuel pump connector

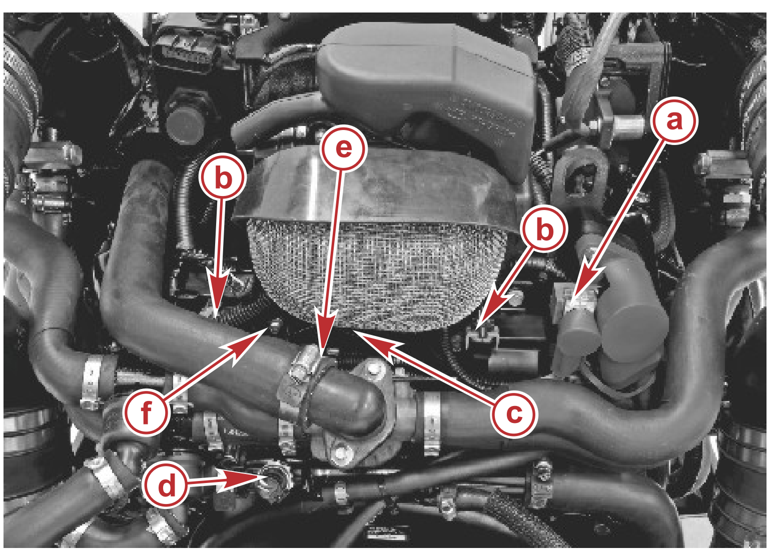
59364

6. Disconnect the drive lube connector, ground harness, crank sensor connector, and J-clip.



a - Drive lube connector
b - Ground harness
c - Crank sensor connector

59365

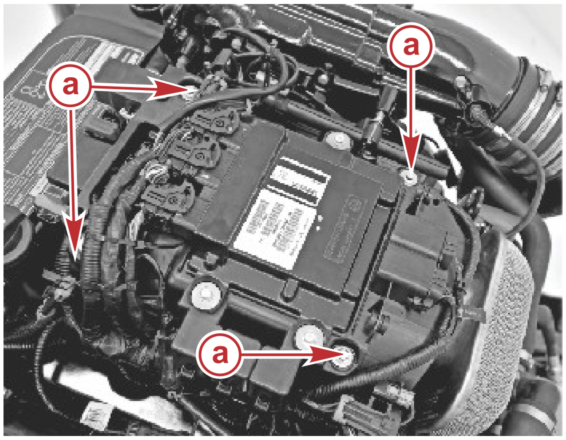


a - Fused connector
b - Coils
c - Throttle body
d - Temperature sensor
e - Oil pressure sensor
f - Ground stud

59367

7. Remove the fused connector.

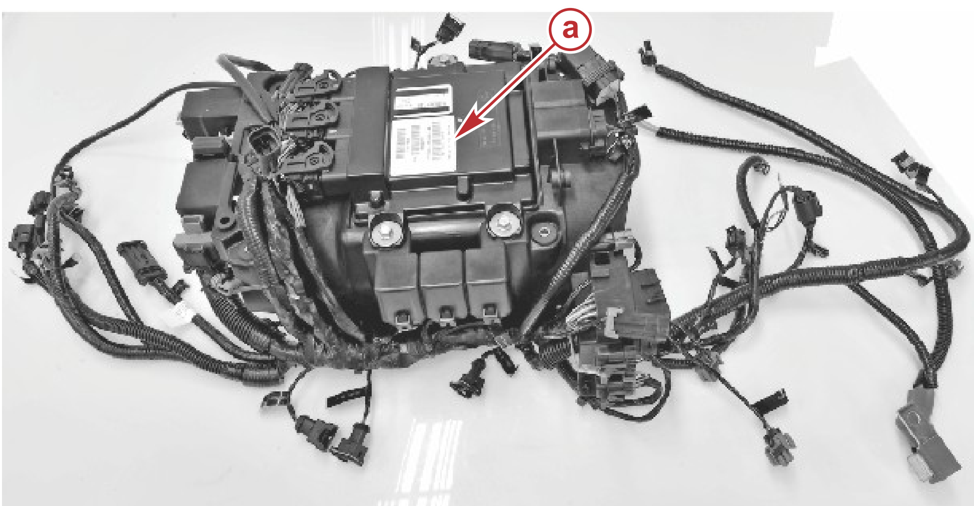
8. Disconnect the coils and the throttle body.
9. Disconnect the temperature sensor and the oil pressure sensor.
10. Disconnect the ground stud.
11. Remove four mounting screws attaching the PCM relay bracket to the manifold.



56506

a - Mounting screws

12. Remove the PCM relay bracket with harness from the engine.

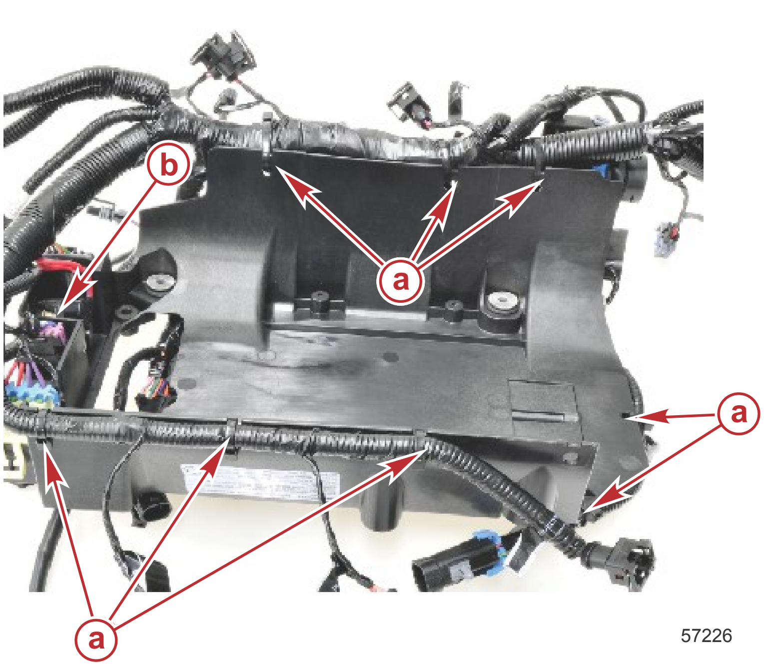


57212

a - PCM relay bracket with harness

13. Remove the relays and fuses from the PCM relay bracket.
14. Remove the circuit breaker from the PCM relay bracket.

15. Remove the cable ties and remove harness from the PCM relay bracket.

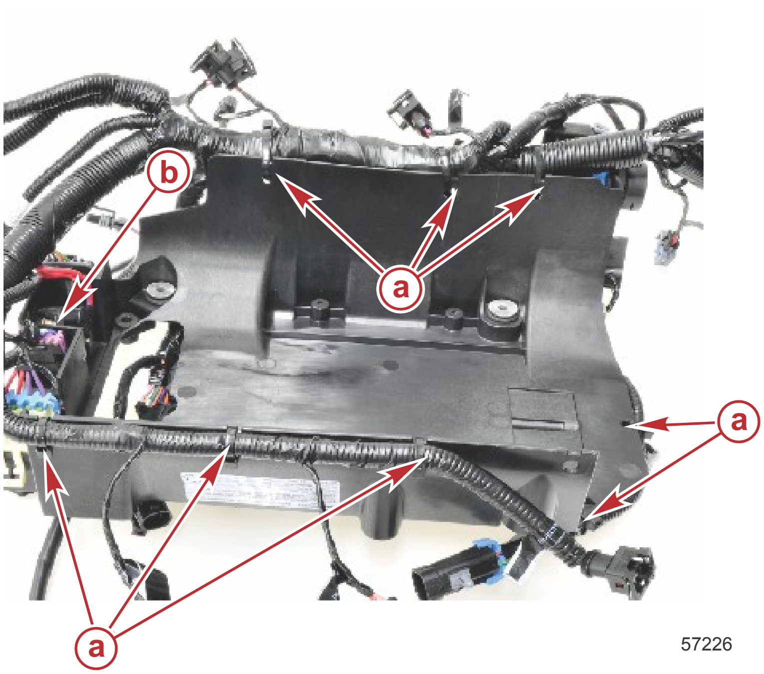


a - Cable ties
b - Circuit breaker

Harness Installation

> **⚠ WARNING**
>
> Damaged wires can cause electrical problems, resulting in system failure. In some cases, this can affect boat operation, leading to personal injury. Use conduit, hose clamps, grommets, or other appropriate measures to protect all electrical wires. Do not overtighten clamps and keep harnesses away from heat sources during installation.

1. Attach the harness to the PCM relay bracket using cable ties. Attach the circuit breaker to the PCM relay bracket.

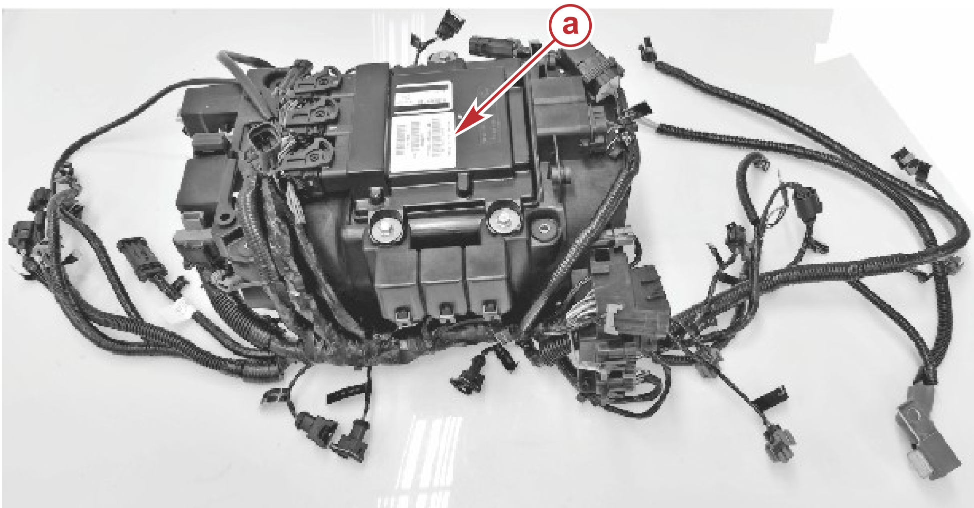


PCM relay bracket upside down to show the cable ties

a - Cable ties
b - Circuit breaker

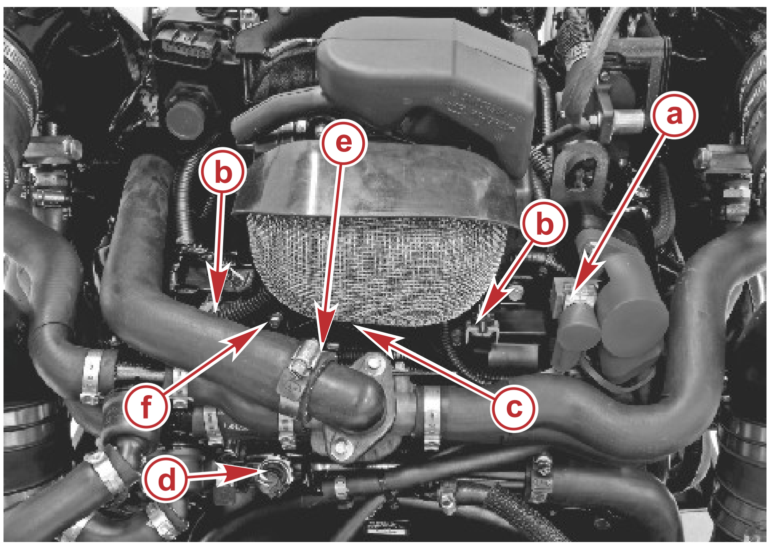
2. Attach the relays and fuses to the PCM relay bracket.

3. Set the PCM relay bracket with harness on top of the engine. Connect the harness as indicated.



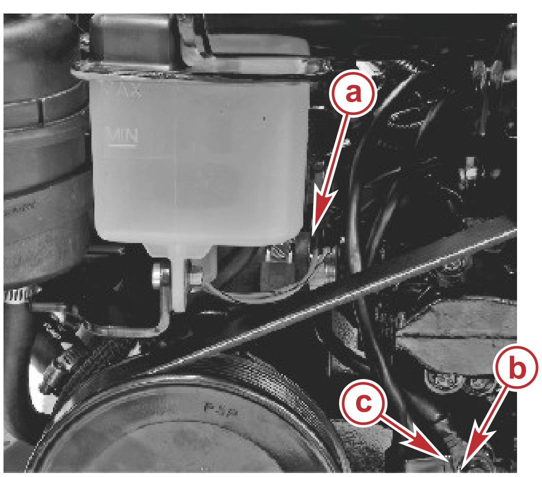
a - PCM relay bracket with harness

4. Connect the fused connector and the coils.



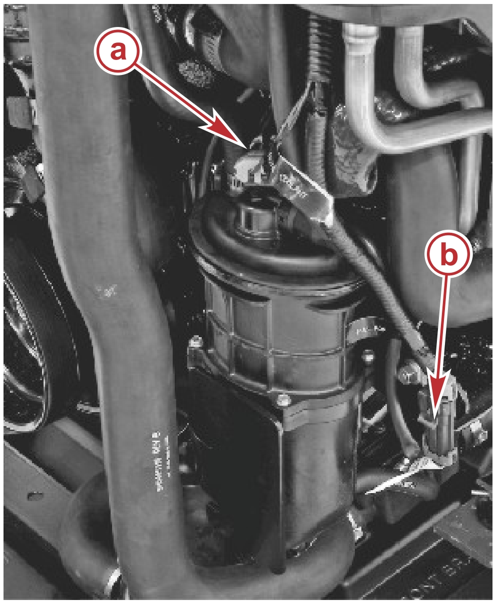
a - Fused connector
b - Coils
c - Throttle body
d - Temperature sensor
e - Oil pressure sensor
f - Ground stud

5. Connect the throttle body, temperature sensor, and oil pressure sensor.
6. Connect the ground wires to the ground stud.
7. Connect the drive lube connector, ground harness, crank sensor connector, and J-clip.



a - Drive lube connector
b - Ground harness
c - Crank sensor connector

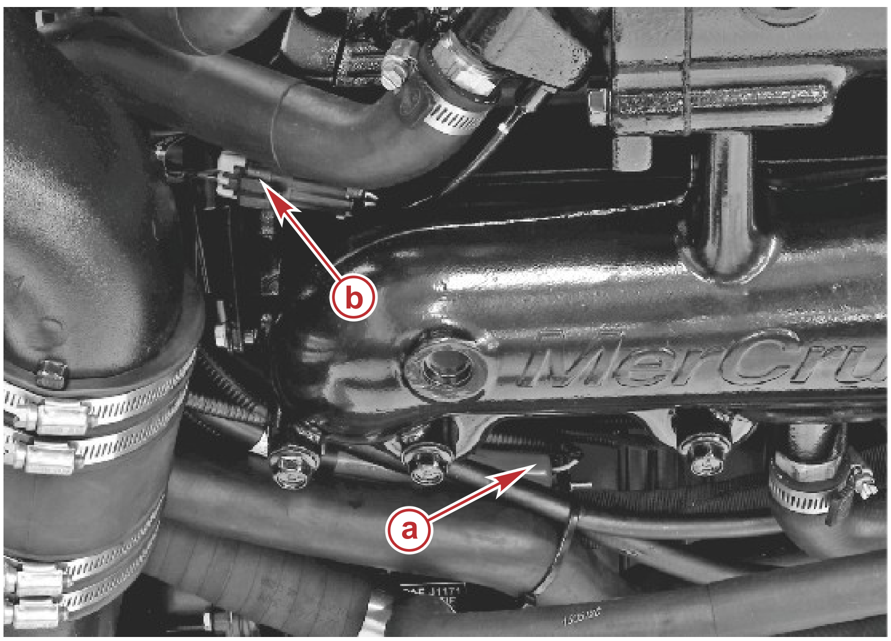
8. Connect the coolant sensor connector and the fuel pump connector.



59364

a - Coolant sensor connector
b - Fuel pump connector

9. Connect the wires at the starter.

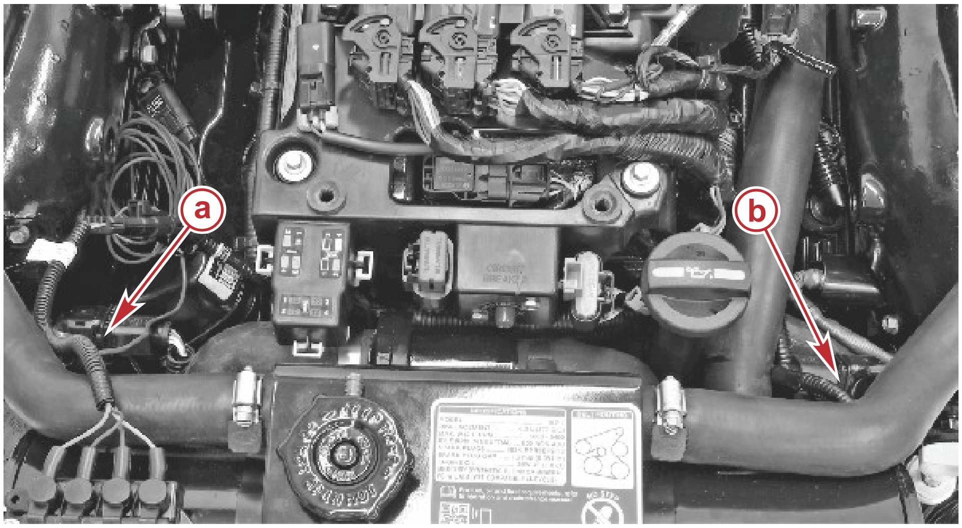


59363

a - Starter connection
b - Starboard exhaust temperature sensor

10. Connect the starboard and port exhaust temperature sensors.

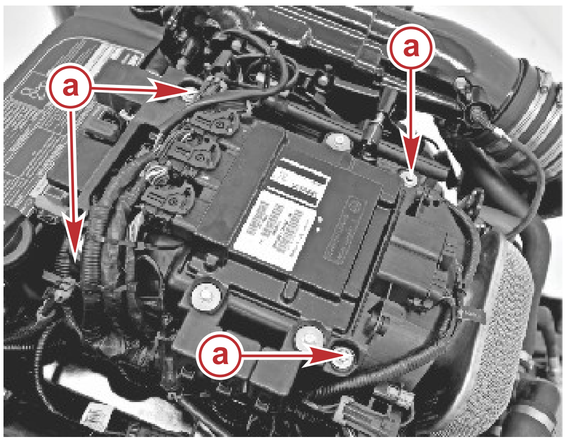
11. Connect the port and starboard precatalyst oxygen sensors.



59362

- a - Starboard precatalyst oxygen sensor
- b - Port precatalyst oxygen sensor

12. Install the PCM relay bracket screws.



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- a - Mounting screws

Electrical System

Section 4A - Starting System

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4
A

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Electrical connections	92- 25711 3

Wire Color Code Abbreviations

Wire Color Abbreviations					
BLK	Black			BLU	Blue
BRN	Brown			GRY	Gray
GRN	Green			ORN or ORG	Orange
PNK	Pink			PPL or PUR	Purple
RED	Red			TAN	Tan
WHT	White			YEL	Yellow
LT or LIT	Light			DK or DRK	Dark

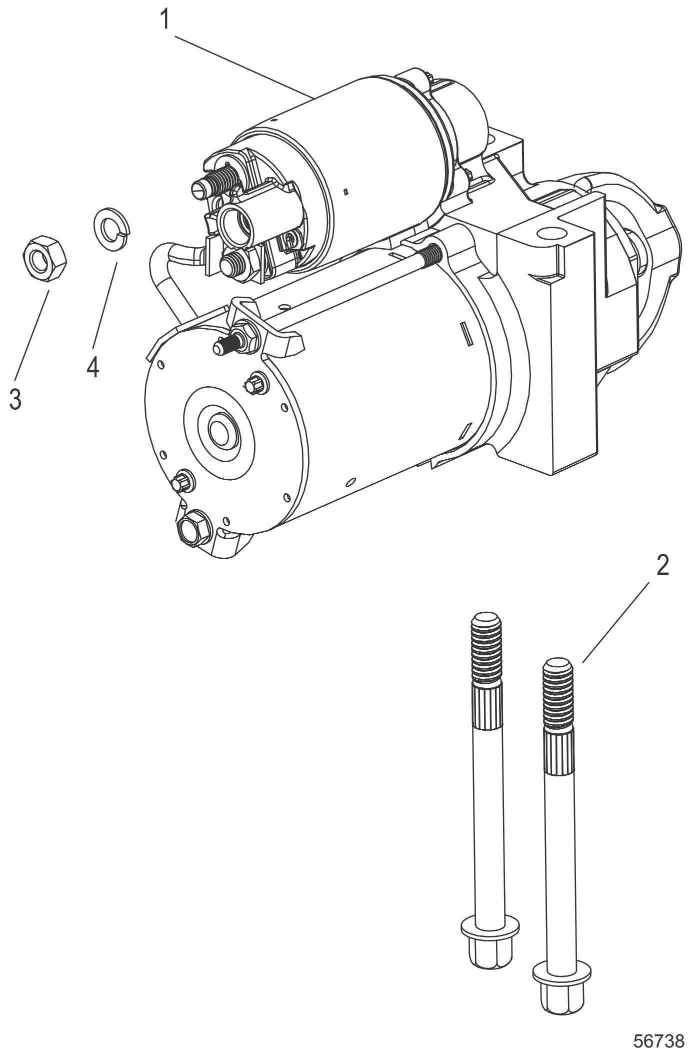
Starter Specifications

The permanent-magnet gear-reduction starter motor features small permanent magnets mounted inside its field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. A 4:1 ratio internal gear reduction results in armature speeds in the 7000 RPM range. The armature and driveshaft are mounted on roller or ball bearings in the place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

Delco Starter Specifications

Model	Delco ID Number	Engine Rotation	Voltage	No Load Test			
				Minimum Current Draw	Maximum Current Draw	Minimum RPM	Maximum RPM
PG260G	8000669	LH	12.0 V	35 A	85 A	2550	4150

Starter Motor Exploded View



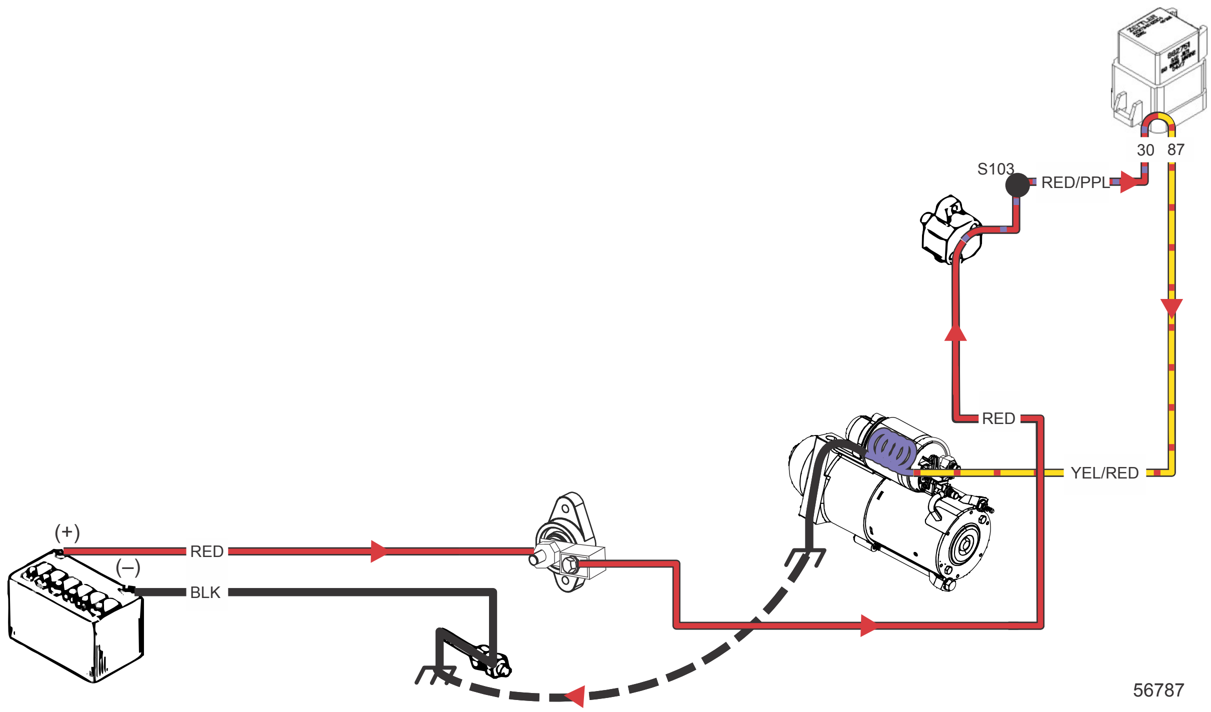
Starter Motor Exploded View

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Starter motor assembly			
2	1	Bolt (M10 x 1.5)	47.5	–	35
3	1	Nut (M8 x 1.5)	9.5	84	–
4	1	Lockwasher			

Starting System Electrical Diagrams

Starter Solenoid Circuit

For parts identification and further information, refer to the **PCM 112 Service Manual**.



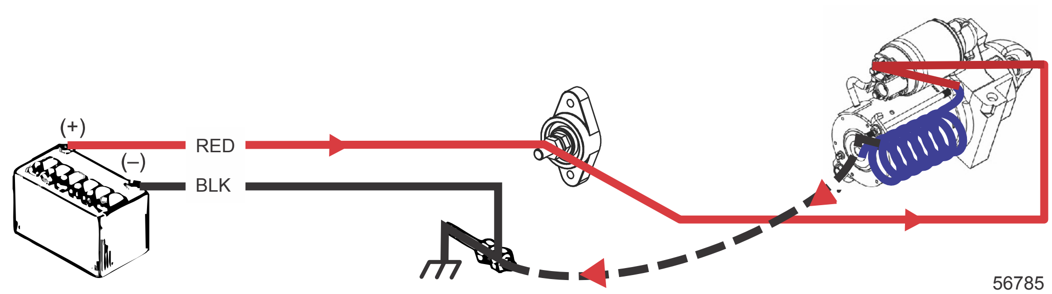
Refer to the diagram above. Once the starter relay is engaged, the current needed to engage the solenoid mounted on the starter motor flows:

1. From the battery positive (+) post to the engine-mounted hot stud (red battery cable)
2. From the hot stud through the 90-amp fuse located on the hot stud
3. From the 90-amp fuse to the 50-amp circuit breaker (red)
4. Through the circuit breaker, through a splice, and to the starter relay terminal 30 (red/purple)
5. Across the closed relay contact to terminal 87
6. From terminal 87 to the "S" connector on the starter-mounted solenoid (yellow/red)
7. From the solenoid "S" connector across the starter solenoid coil

   *NOTE: When the starter solenoid coil is energized, it closes contacts that allow current to flow to the starter motor. Refer to **Starter Motor Circuit** for details.*

8. From the solenoid coil, through the starter mounting bolts to the engine ground
9. From the engine ground to the negative (–) post of the battery (black battery cable)

Starter Motor Circuit



Refer to the diagram above. Once the starter-mounted solenoid is engaged, the high current needed to run the starter motor flows:

1. From the battery positive (+) post to the engine-mounted hot stud (red battery cable)
2. From the hot stud to the starter-mounted solenoid (red battery cable)

3. Across the closed solenoid contacts to the starter motor windings

   NOTE: With the starter motor windings energized, its attached gears engage with the flywheel, cranking the engine.
4. From the starter motor windings to the starter casing; and then through the starter motor mounting bolts to engine ground
5. From the engine ground to the negative (–) post of the battery (black battery cable)

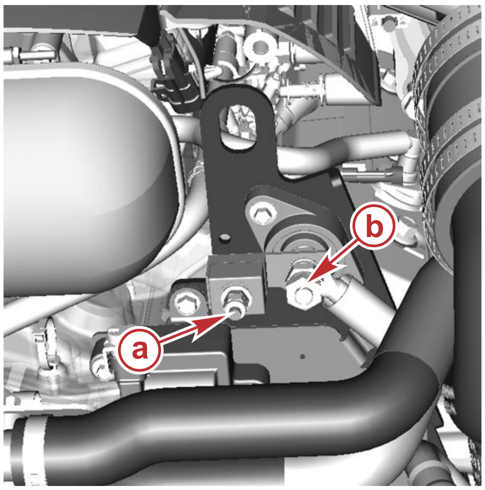
Starter Relay

The starter relay is located on the port side of the engine, next to the PCM. For details on removing and testing the starter relay, refer to **PCM 112 Service Manual—Section 3A** - **Component Testing**.

Starting Circuit Overload Protection

Two devices provide circuit protection for the starting circuits.

1. The 50-amp circuit breaker located on top of the engine on the PCM relay bracket. This circuit breaker protects the components and wiring in the starter solenoid circuit.
2. A 90-amp fuse, located next to the hot stud on the back side of the engine, which protects the engine wiring harness.



55252

a - 90-amp fuse
b - Hot stud

For additional details, refer to **Section 4E** - **Electrical System Overload Protection**.

Battery Cables for MerCruiser Models

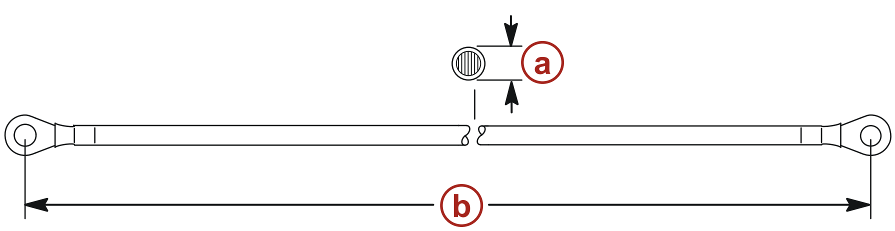
IMPORTANT: The OEM or designer of the vessel is responsible for selecting the proper battery cable size to replace the minimum size listed in the Circuit Length and Cable Size table, if the cables are used for electrical loads in addition to cranking the engine.

IMPORTANT: Use only copper battery cables. Do not use aluminum cables for marine installations.

IMPORTANT: Terminals must be soldered to the cable ends to ensure good electrical contact. Use only electrical-grade (rosin flux) solder. Do not use acid flux solder, as it may cause corrosion and a subsequent failure.

NOTE: Engine starting batteries should be located as close to the engine as possible.

See the following figure for correctly sizing cables. If longer battery cables are required, the cable size (gauge) must increase.



2758

a - Wire size by cross-sectional area (gauge)
b - Battery cable length

Circuit length is calculated by adding the total length of the positive (+) cranking circuit to that of the negative (–) cranking circuit (positive battery post to negative battery post).

Use the same cable size for both positive and negative cables.

Circuit Length and Cable Size

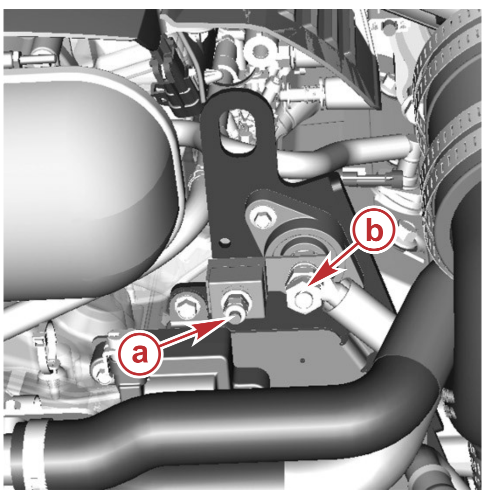
Circuit Length	Minimum Cable Size (see notes)
Less than or equal to 2.7 m (9 ft)	13.3 mm^2 (6 AWG)
2.7–4.6 m (9–15 ft)	21.2 mm^2 (4 AWG)
4.6–7.6 m (15–25 ft)	33.6 mm^2 (2 AWG)
7.6–9.5 m (25–31 ft)	42.4 mm^2 (1 AWG)
9.5–11.9 m (31–39 ft)	53.5 mm^2 (0 AWG)
11.9–15.2 m (39–50 ft)	67.7 mm^2 (00 AWG)
15.2–19.2 m (50–63 ft)	85.2 mm^2 (000 AWG)
19.2–24.4 m (63–80 ft)	107 mm^2 (0000 AWG)

NOTE: Consider the following information before choosing your cables:

1. *Two numbers are provided for minimum cable size. The second number (in parentheses) is the American Wire Gauge (AWG) cable recommended by MerCruiser for the indicated cranking circuit length. The first number is an approximate cross-sectional area equivalent to the AWG number, expressed in square millimeters (mm^2). This equivalent is to be used as the minimum cable size when selecting cables not denoted in gauge, such as ISO sizes. Always round up.*
2. *All listed cables are sized for* ***engine cranking only****.*

Hot Stud

The hot stud is located at the rear of the engine. It is normally covered by a protective boot. It is also located next to the 90-amp fuse. The hot stud provides a ready connection point for the positive battery cable. A second thick gauge cable is used to connect the hot stud to the starter. Both the cable from the battery to the hot stud and the cable from the hot stud to the starter are considered battery cables, and must be included in the total length used to calculate wire gauge.



55252

Shown with protective boot removed

a - 90-amp fuse

b - Hot stud

Starter

Inspection

The starter motor and the solenoid are completely enclosed in the drive housing to prevent contamination by moisture and dirt. Periodically:

1. Inspect the terminals for corrosion and loose connections. Reseal any exposed electrical connections with Liquid Neoprene.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Electrical connections	92- 25711 3

2. Inspect the wiring for frayed or worn insulation.
3. Ensure that the starter mounting bolts are tight.

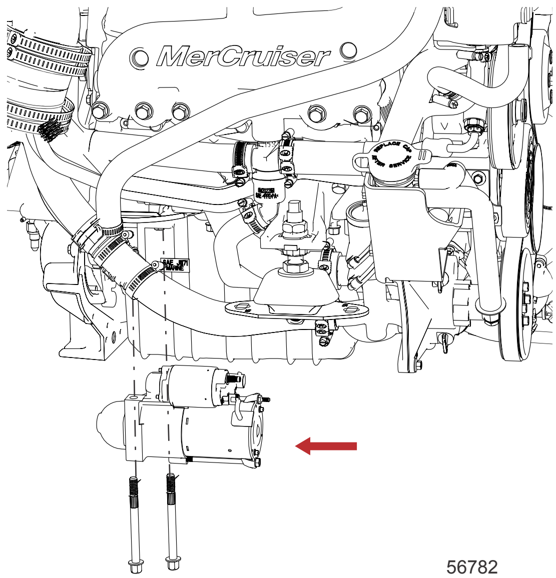
Description	Nm	lb-in.	lb-ft
Starter mounting bolts	47.5	–	35

Starter Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect the battery cables from the battery. Remove the negative (–) cable first.
2. Disconnect the wires from the solenoid terminals.
3. Remove the starter mounting bolts.
4. Pull the starter assembly away from the flywheel and remove it from the engine.



Water and Corrosion Inspection

Remove the two short screws from the starter motor end cap and inspect the threads.

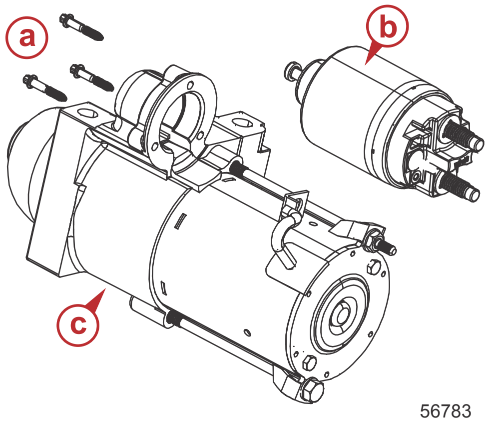
- If they are clean and gold in color, the starter motor has not had water inside of it.
- If they are dirty and discolored the starter motor may have water contamination and should be replaced.
  IMPORTANT: Starter damage caused by water contamination is not covered by the Mercury MerCruiser warranty.

Starter Solenoid

Removal

1. Disconnect the jumper between the starter motor and solenoid by removing the nut on the lower solenoid stud.

2. Using an E5 Torx® socket, remove the screws retaining the solenoid to the starter.



a - E5 Torx screws (3)
b - Starter solenoid
c - Starter motor

3. Remove the solenoid from the drive housing.

Installation

1. Set the solenoid in position on top of the starter housing.
2. Insert the E5 Torx screws into the mounting holes and tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Starter solenoid mounting screws, E5 Torx	4.25	37.5	–

3. Attach the jumper wire from the drive housing to the lower stud on the solenoid. Secure it with the previously removed nut.

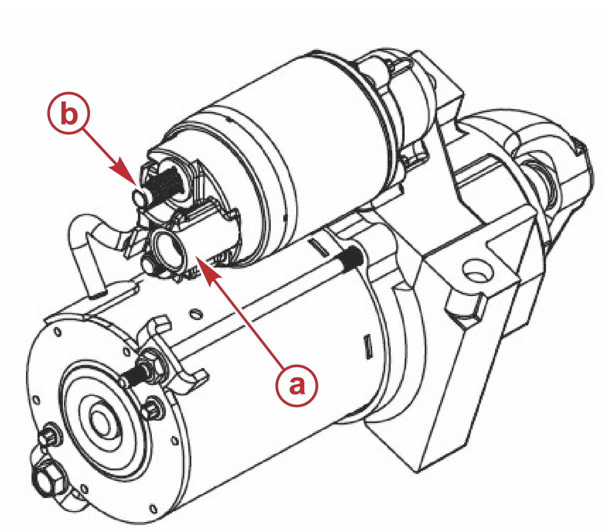
Starter Installation

IMPORTANT: The special mounting shim (if equipped) installed between the starter motor and the engine block must be reused.

1. Place the starter motor into position and install the mounting bolts. Tighten the starter mounting bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Starter mounting bolts	47.5	–	35

2. Connect the yellow/red wire connector to the solenoid "S" terminal.



Starter electrical connections

a - Solenoid "S" terminal
b - Positive (+) battery terminal

3. Connect the positive (+) battery cable to the positive (+) battery terminal. Tighten the terminal nut to the specified torque.

NOTE: The positive battery cable should be connected from the battery to the hot stud, and then to the starter.

Description	Nm	lb-in.	lb-ft
Battery terminal nut	9.5	84	–

4. Coat all terminals with Liquid Neoprene.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Electrical connections	92- 25711 3

5. Install the battery cable boot, if equipped.
6. Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.
7. Connect the negative (–) battery cable to the negative (–) battery terminal and tighten the clamp.

Starting System Tests

Low power-supply voltage and water contamination are the primary causes of most starter motor failures. Low power-supply voltage causes excessive heat to build up in the starter motor. It can also cause starter motor solenoid contact problems.

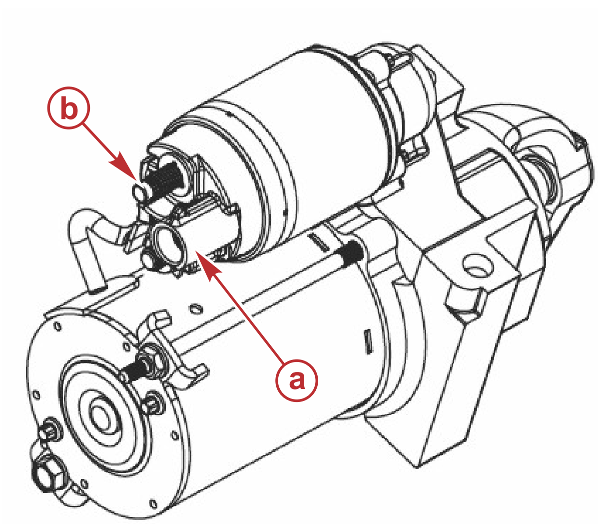
IMPORTANT: Perform these tests before removing the starter from the engine.
Use a digital multimeter to conduct the tests. Analog meters can be damaged by voltage spikes generated in the starter motor windings.

Low Voltage Tests

If the engine does not crank, or cranks slowly, use a digital multimeter to verify that at least 9.5 volts are available to the starter motor.

1. Ensure that the battery is fully charged.

   NOTE: The voltage measured at the posts of a fully charged battery will typically read around 12.7 volts.
2. Disable the ignition to prevent the engine from starting.
3. Remove the fuse from the fuel pump circuit to prevent fuel from flooding the cylinders, which could result in mechanical damage or damage to the catalyst.
4. Set the multimeter to VDC and connect the positive (+) meter lead directly to the starter's positive (+) battery terminal.



56784

Starter electrical connections
a - Solenoid "S" terminal
b - Positive (+) battery terminal

5. Connect the negative (–) meter lead directly to an unpainted metal surface on the starter housing.
6. Crank the engine over with the key switch for 10–15 seconds while observing the voltmeter.
   - A reading of 9.5 volts or more indicates that the battery is supplying sufficient voltage to the starter to operate properly. If the starter does not function properly, the starter or the engine are malfunctioning. Remove the spark plugs and try turning the engine over by hand to rule out an engine problem.
   - A reading below 9.5 volts indicates too much voltage loss between the battery and the starter motor. Check all components between the starter motor and the battery for damage, wear, and proper application. If no obvious defects are spotted, complete the **Voltage Drop Test**.

Verify that at least 9.5 volts are available to the solenoid at terminal "S," during cranking. Low voltage at the starter solenoid can cause intermittent operation of the solenoid contacts and shorten the life of the solenoid.

1. Connect the positive (+) voltmeter lead to terminal "S" on the starter solenoid (yellow/red wire from the starter relay).
2. Connect the negative (–) voltmeter lead to an unpainted surface of the starter housing.
3. Crank the engine over and observe the voltmeter. If the reading is less than 9.5 volts, there could be an issue with the starter relay, the yellow/red wire that connects the relay to the solenoid, or the circuit that supplies the voltage to terminal 87 of the relay (refer to **Starting System Electrical Diagrams** for circuit details).

Voltage Drop Test

The voltage drop test is used to identify areas of high resistance within the battery circuit. High resistance can result from loose connections, undersized cables, corrosion, or other imperfections in the starting circuit. Each area of high resistance acts as a small load on the starting circuit, reducing the voltage intended for energizing the starter motor. The net result is a sluggish starter.

As you perform this test, remember that voltage drops are additive. Identify and correct the worst areas, seeking to reduce the cumulative voltage drop to the point where 9.5 volts (or more) are available to the starter motor.

1. **Test the battery positive (+) cable first:**
   a. Connect the voltmeter positive (+) lead directly to the positive (+) post of the battery. Do not use the battery cable terminal. Connect the voltmeter negative (–) lead directly to the large, threaded starter motor positive (+) terminal to which the battery positive (+) cable is connected.
   b. Crank the engine over while observing the voltmeter. The voltage displayed on the meter is the voltage drop. It will normally be 0.3 volts or less; if it is higher, the battery cable might be undersized. If the drop is excessive, test the connections at the ends of the cable:
      - To find the point where the resistance is highest (as indicated by the highest voltage drop), leave the voltmeter positive (+) lead on the battery post and move the voltmeter negative (–) lead to the battery positive (+) cable ring terminal, which is on the threaded starter terminal. Crank the engine while observing the voltmeter.
      - Move the voltmeter negative (–) lead to the battery cable itself, which is inside the crimped battery cable ring terminal. Crank the engine while observing the voltmeter.
      - Continue to test each battery cable connection back to the battery positive (+) post.
   c. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.
2. **Check for voltage drop across the solenoid contacts:**
   a. Connect the positive (+) voltmeter lead to the large, threaded starter motor positive (+) terminal to which the battery positive (+) cable is connected. Connect the negative (–) meter lead to the lower stud on the solenoid.
   b. Crank the engine over while observing the voltmeter. The voltage drop should be 0.2 volts or less; if it is higher, the contacts are likely dirty or damaged.
3. **Check for voltage drop from the starter mounting bolt to the engine ground stud:**
   a. Connect the positive (+) voltmeter lead to a starter mounting bolt. Connect the negative (–) meter lead to the engine ground stud.
   b. Crank the engine over while observing the voltmeter. The voltage drop should be 0.2 volts or less; if it is higher, remove the starter and clean the mating surface. Reinstall the starter and retest.
4. **Check for voltage drop on the battery negative (–) cable:**
   a. Connect the voltmeter negative (–) lead directly to the battery negative (–) post, not the battery cable ring terminal. Connect the voltmeter positive (+) lead to an unpainted surface of the starter housing.
   b. Crank the engine over while observing the voltmeter.
      IMPORTANT: The maximum allowed drop is 0.3 volts.
   c. To find the point where the resistance is highest, leave the voltmeter negative (–) lead on the battery negative (–) post and move the voltmeter positive (+) lead to the ground stud where the battery negative (–) cable is connected.
   d. Move the voltmeter negative (–) lead to the battery negative (–) cable ring terminal that is on the ground stud.
   e. Move the voltmeter positive (+) lead to the battery cable itself, which is inside the crimped battery cable ring terminal.
   f. Test each battery cable connection in this manner back to the battery post.

Electrical System

Section 4B - Waste Spark System

Table of Contents

4
B

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

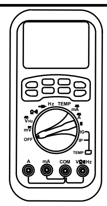
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Special Tools

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Waste Spark System Specifications

Waste spark system is an ignition system used with some two- and four-stroke cycle internal combustion engines. In a wasted spark system, the spark plugs fire in pairs even though one is on its compression stroke and one is on its exhaust stroke. The extra spark on the exhaust stroke has no effect and is thus "wasted." This design has the number of components in a typical ignition system, while the extra spark, against much reduced dielectric resistance, barely impacts on the lifespan of modern ignition components. In a typical engine, it requires only about 2–3 kV to fire the cylinder on the exhaust strokes. The remaining coil energy is available to fire the spark plug under compression (typically about 8–12 kV). PCM 112 ignition system uses double-ended driverless ignition coils. Each coil is a double-ended waste spark, so one coil will fire two cylinders. One cylinder will be on the compression stroke and the other cylinder will be on the exhaust stroke.

Coil

Description	Specification
Primary coil resistance	0.30–0.50 Ω
Secondary coil resistance	7,200–8,800 Ω

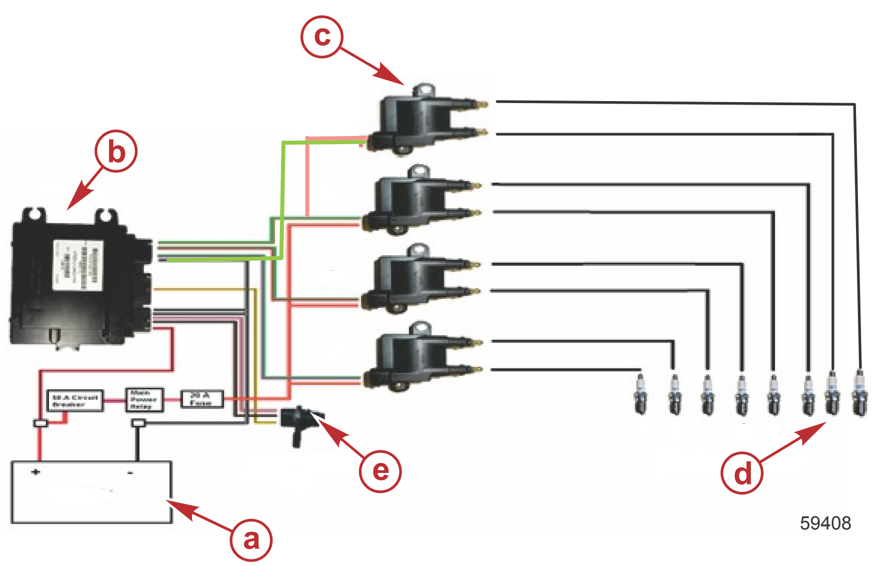
Spark Plugs

Engine	OEM Spark Plug	Gap
6.2L	NGK BPR5EFS-13	1.30 mm (0.051 in.)

Firing Order and Ignition Timing

Description	Specification
Firing order	1-8-4-3-6-5-7-2
Ignition timing	PCM

Ignition Components



59408

- a - Battery
- b - PCM
- c - Ignition coils
- d - Spark plugs
- e - Crankshaft position sensor

For diagnostics also refer to the **PCM 112 Diagnostic Manual**.

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Spark Plug Removal, Inspection, and Installation

NOTE: Refer to the specifications presented earlier in this section for spark plug part numbers and gap information.

Removal

1. Disconnect the spark plug wires from the spark plugs.

   NOTE: Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot, not the wire.
2. Remove the spark plugs.

   NOTE: A thin-walled spark plug socket may be required.

Inspection

1. Examine each spark plug. All plugs must be from the same manufacturer and have the same spark plug number.
2. Inspect each plug for worn electrodes and for glazed, broken, or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace as necessary.

Installation

1. Clean the cylinder head spark plug seat.
2. Adjust the spark plug gap with the appropriately sized, round-tipped feeler gauge.
   IMPORTANT: In the absence of a torque wrench or if limited access prevents the use of a torque wrench, hand-tighten the spark plugs until they seat in the cylinder head and then securely tighten with the appropriate ratchet and socket.
3. Install the spark plugs and tighten them to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	30	–	22.1
Spark plugs (used cylinder head)	14	123.9	–

4. Install the spark plug wires in the proper order. Refer to **Spark Plug Wires** for details.

Spark Plug Wires

Inspection

NOTE: Use care when removing the spark plug wires and the boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot to remove the wire.

1. Inspect the spark plug wires, the plug wire boots, and the coil wire for damage.
2. Check the spark plug wires and the coil wire for continuity using a multimeter.
   IMPORTANT: The spark plug wires must have the correct resistance to prevent radio frequency interference (RFI) and still deliver full spark. Nonresistor spark plug wires are not acceptable. The resistance for each 30 cm (1 ft) of wire length must not be more than 8,000 ohms and not less than 2,000 ohms. Replace any wires that are not as specified.
3. Replace any damaged wires.
4. Check for correct routing. Keep the spark plug wires as far away as possible from the engine wiring harness.

Installation

IMPORTANT: Use only Mercury marine-grade spark plug wires. Use of aftermarket spark plug wires may result in performance issues not covered by the Mercury limited warranty.

NOTE: Replace one spark plug wire at a time to reduce the risk of a routing error.

1. Disconnect each spark plug wire as it is to be replaced.

2. Install the replacement spark plug wires in the proper order. Observe the following:
   a. Reinstall the wires in the spark plug wire retainers.
   b. Attach the plug wires to the appropriate spark plug and terminal on the coil. Each end should fit securely.
      NOTE: *Ensure that the high-tension wire boot does not come loose when pushing the wire into the terminal.*

Ignition Coil

Ignition Coil Voltage Test

The ignition coils can be tested with the CDS G3 diagnostic interface tool with harness.

CDS G3 Diagnostic Interface Tool With Harness	8M0046124

⚠ WARNING
High voltage is present any time the key is turned on, especially when starting or operating the engine. Do not touch ignition components or metal test probes and stay clear of spark plug leads when performing live tests.

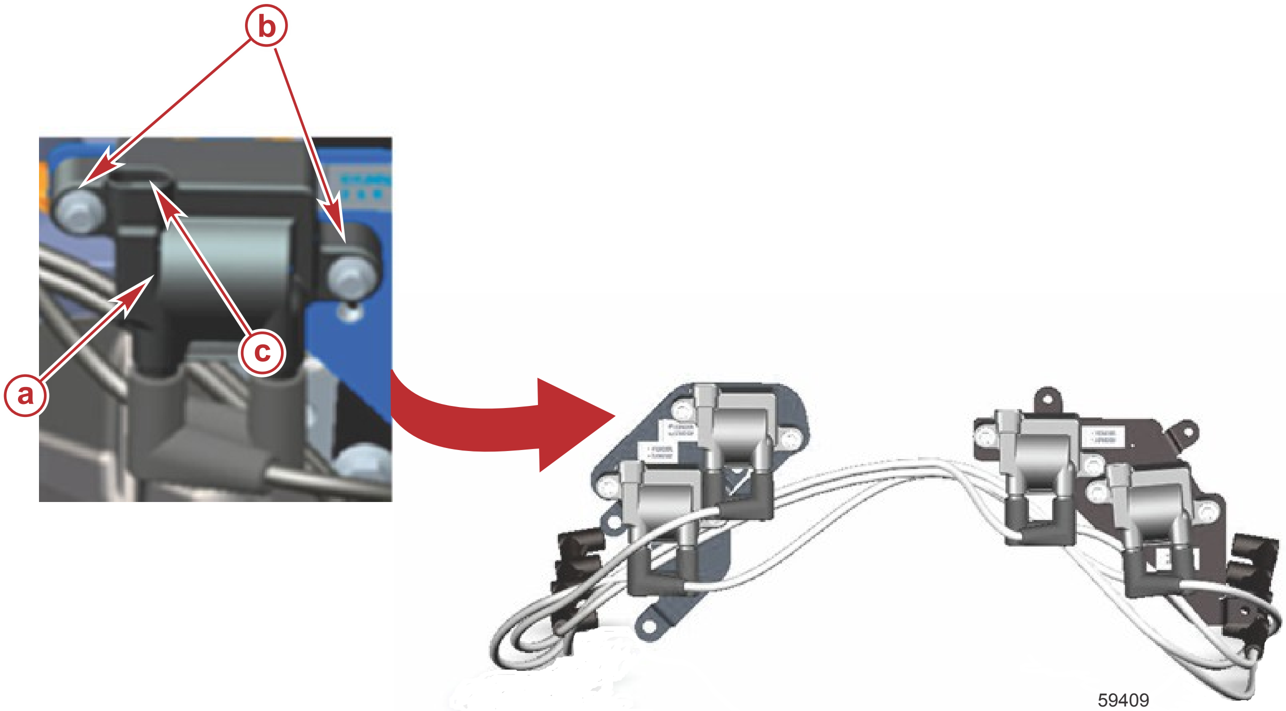
1. Disconnect the connector from all of the coils.
2. Perform a visual inspection of the pins at the coil and the wires coming to the connector. Look for broken, bent, and corroded pins at the coil; and loose, broken, or corroded wires at the connector.
3. Use the DMT 2004 digital multimeter to perform a voltage check of the wiring between the ignition coil connector and the ECM connector. Set the meter to DC volts.
4. Turn the ignition key to the "ON" position. Battery voltage will only be available when the main power relay is active.

DMT 2004 Digital Multimeter	91-892647A01

   NOTE: *All 12 VDC power wires for the coils are spliced together. Unless all the coils have failed, the most likely failure would be at the splice point, connector, or between the connector and the splice point.*
5. If battery voltage is not present on the red/yellow wire to the engine ground, there is an open circuit between the splice point and the red/yellow wire connector.

Removal

1. Disconnect the wire harness connectors at the ignition coil.



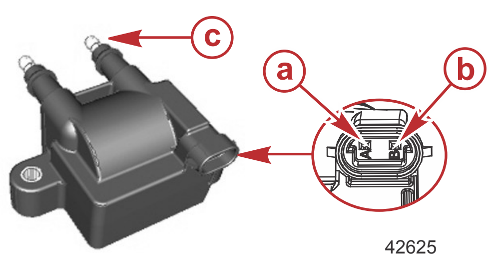
Coils

- **a -** Ignition coil
- **b -** Screws
- **c -** Wiring harness connector

2. Remove the high-tension coil lead.
3. Remove the coil mounting screws.
4. Remove the ignition coil.

Ignition Coil Resistance Test

1. Remove the spark plug lead from the ignition coil. Twist the ignition coil boot slightly while removing.
2. Use a DMT 2004 digital multimeter and perform the following test.



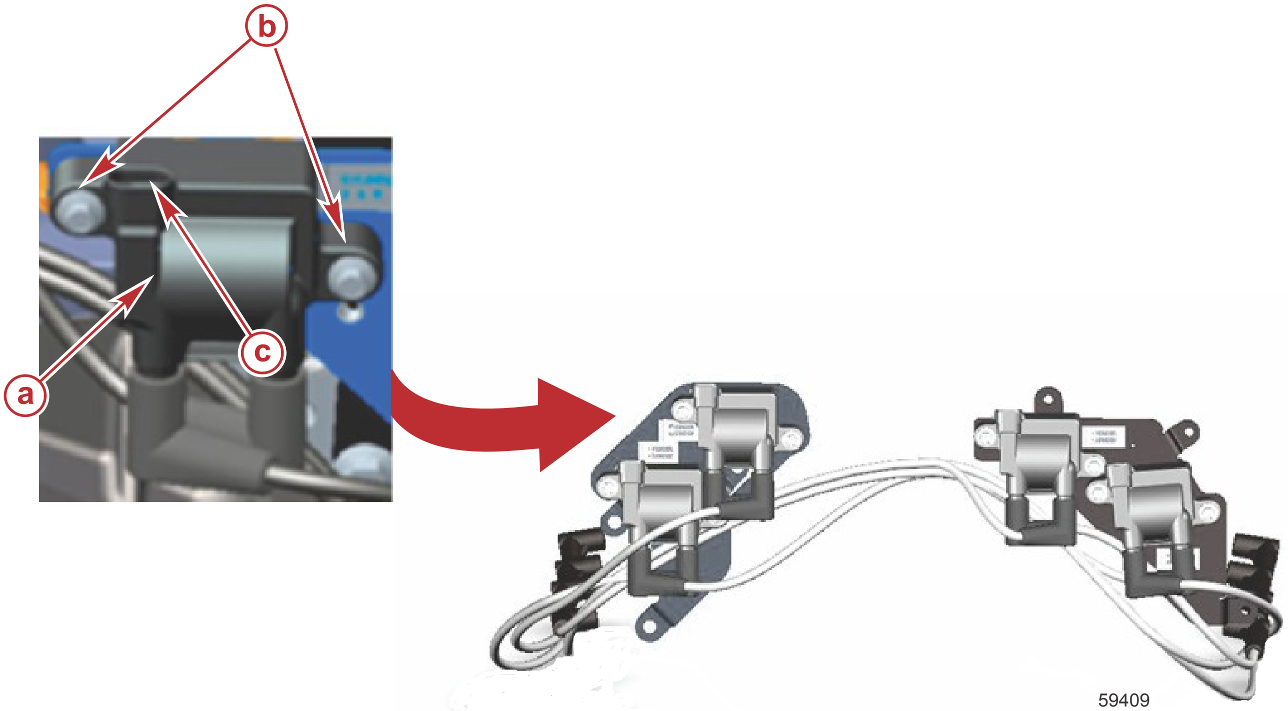
- **a -** Pin A
- **b -** Pin B
- **c -** Coil towers

Ignition Coil Resistance Test (Ω)	
Between coil towers	7200–8800
Between pin A and B	0.3–0.5

DMT 2004 Digital Multimeter	91-892647A01

Installation

1. Install the ignition coil onto the engine using two screws.



a - Ignition coil
b - Screws
c - Wiring harness connector

2. Connect the high-tension coil lead.
3. Connect the wire harness connector.

Notes:

Electrical System

Section 4C - Charging System

Table of Contents

4
C

Precautions

⚠ WARNING

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⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

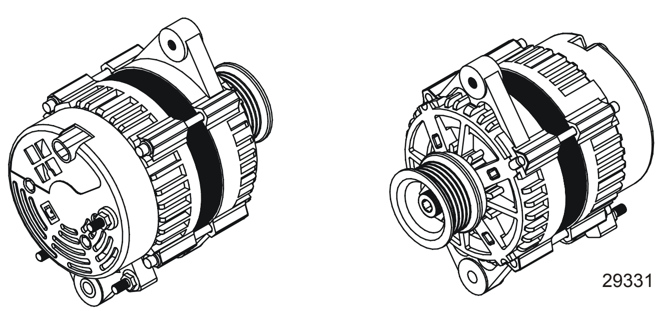
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Specifications



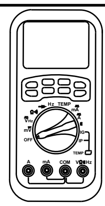
Typical Delco Alternator

Description	Specification
Excitation circuit	1.3 to 2.5 V

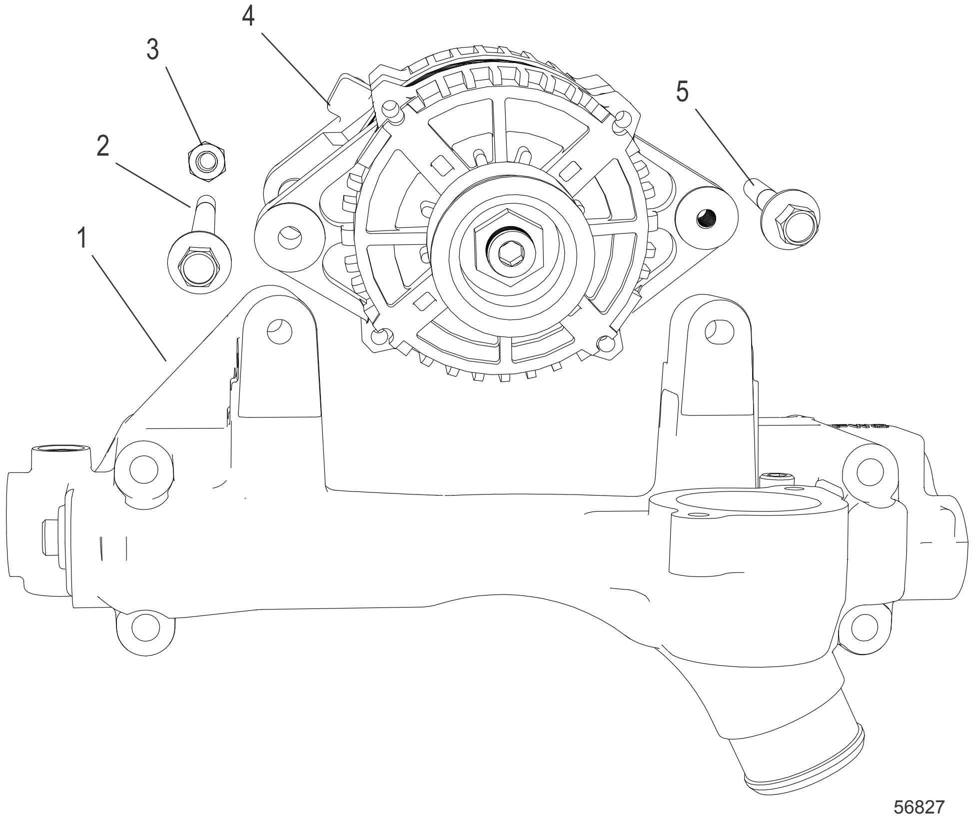
Description	Specification
Current output	60 amp minimum
Voltage output	13.9 to 14.7 V
Minimum brush length	6 mm (1/4 in.)

Special Tools

Belt Tension Gauge	SPX BT-33-73-F
 39451	Measures serpentine belt deflection.

DMT 2004 Digital Multimeter	91-892647A01
 **4516**	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Alternator and Brackets Exploded View



Alternator and Brackets Exploded View

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Coolant crossover and alternator bracket			
2	1	Hex head bolt (M8 x 110)	34	–	25.1
3	1	Nut			
4	2	Alternator assembly			
5	2	Hex head screw (M6 x 1.0)	34	–	25.1

Periodic Maintenance

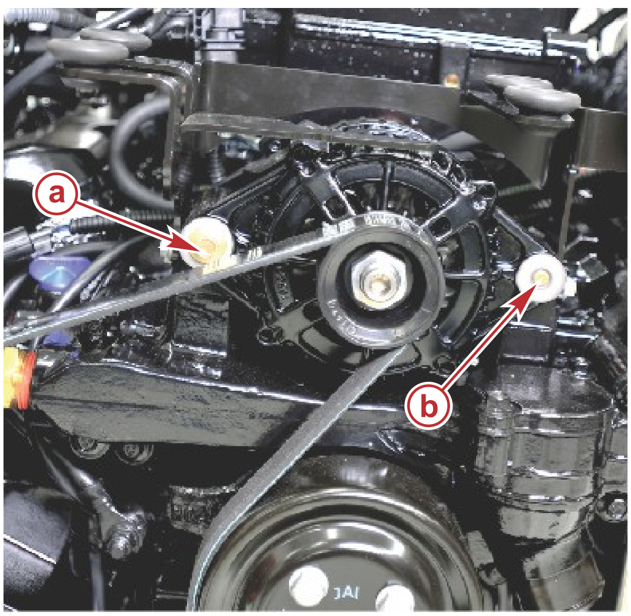
1. Inspect the entire charging system for loose, damaged, or corroded connectors.
2. Inspect the charging system wiring for damaged insulation.
3. Check the alternator drive belt tension and drive belt tensioner for proper operation.
4. Inspect the alternator drive belt for excess wear and damage.
5. Check all alternator mounting hardware for proper torque.

Alternator Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect both battery cables from the battery, being certain to disconnect the negative (–) cable first.
2. Disconnect the alternator lead and ground wires.
3. Disconnect the alternator excitation wire.
4. Remove the drive belt.
5. Remove the alternator mounting screws, washers, and nuts.



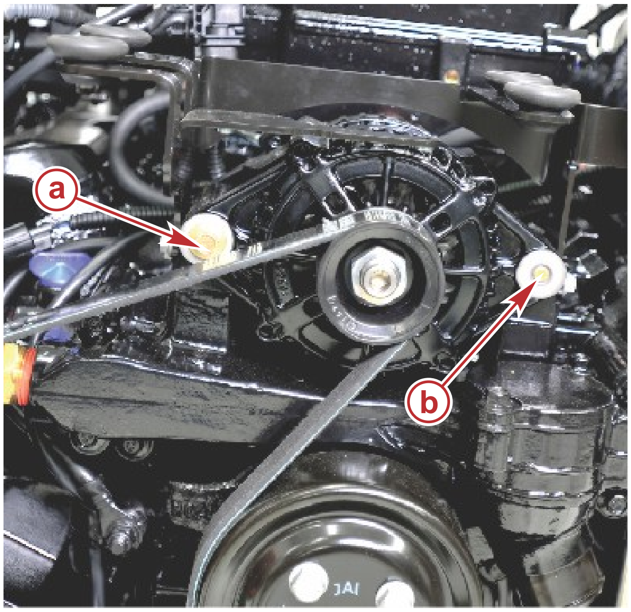
56572

a - Hex flange bolt, washer, and nut
b - Screw

6. Remove the alternator.

Alternator Installation

1. Position the alternator in the mounting bracket.



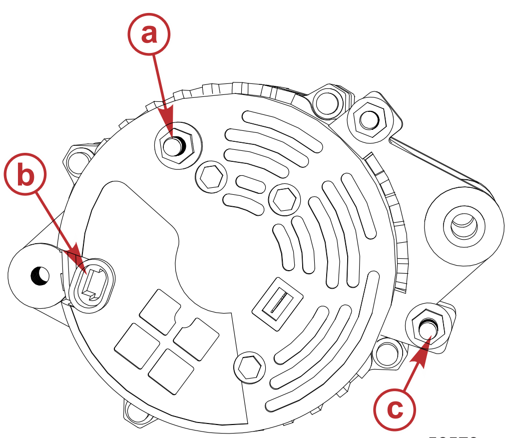
56572

a - Hex flange bolt, washer, and nut
b - Screw

2. Install the mounting hardware and tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Alternator mounting hardware	27	–	20

3. Install the drive belt and adjust the tension. Refer to **Maintenance–1C**.
4. Reconnect the alternator wiring.



56579

a - Orange battery lead
b - Harness connector
c - Ground

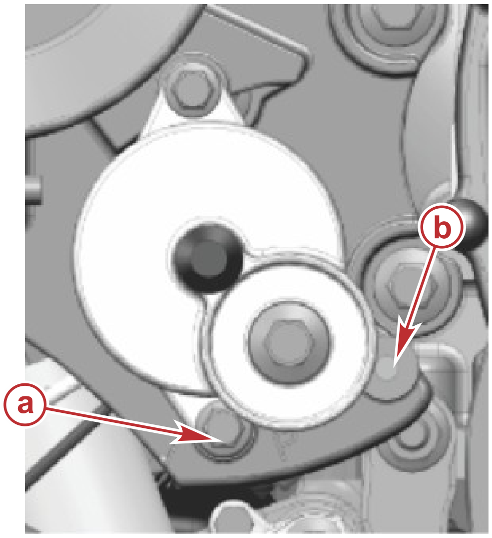
5. Reconnect both battery cables, being certain to connect the negative (–) cable last.

Serpentine Drive Belt

⚠ WARNING
Inspecting the belts with the engine running may cause serious injury or death. Turn off the engine and remove the ignition key before adjusting tension or inspecting belts.

IMPORTANT: The brackets and washers on the idler pulleys must be in a certain order or the serpentine belt will come off. All pulleys are referenced as though you were standing in front of the engine looking at the belt.

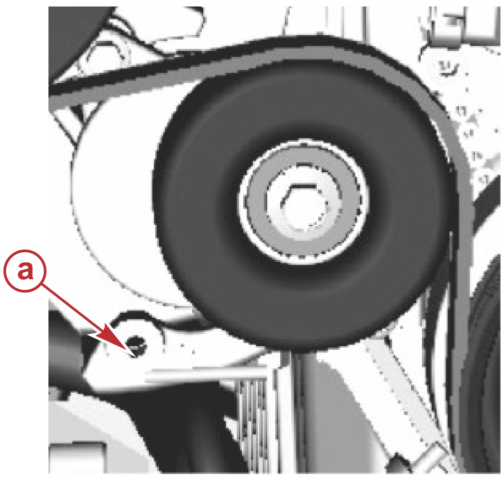
NOTE: The same belt tensioner is used with or without a seawater pump, but is used in a different position.



57442

With a seawater pump

a - Hole used with seawater pump
b - Hole used without seawater pump

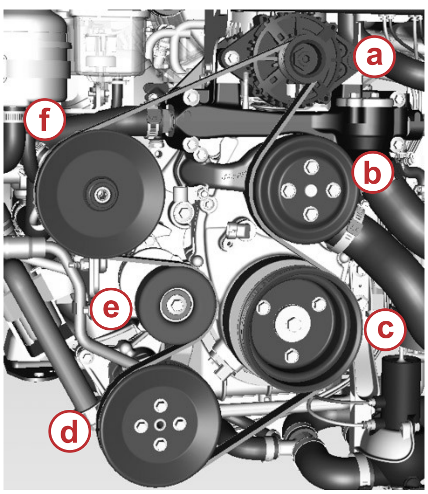


57443

Without a seawater pump

a - Hole not used

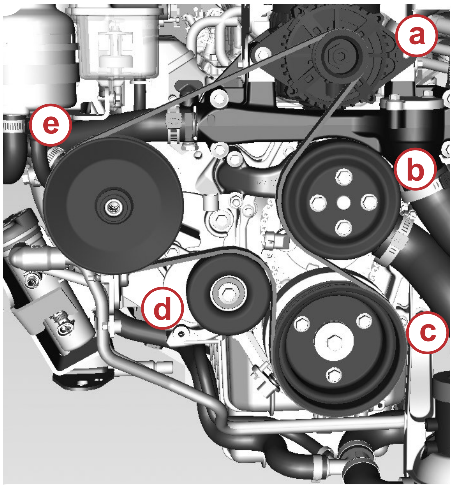
Sterndrive Models



55041

With a seawater pump

a - Alternator pulley
b - Water circulating pump pulley
c - Crankshaft pulley
d - Seawater pump pulley
e - Belt tensioner
f - Power steering pump pulley



55045

Without a seawater pump

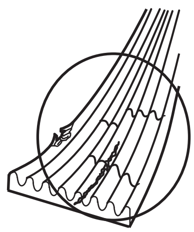
- a - Alternator pulley
- b - Water circulating pump pulley
- c - Crankshaft pulley
- d - Belt tensioner
- e - Power steering pump pulley

Checking

Inspect the drive belt for the following:

- Excessive wear
- Cracks

  NOTE: *Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in the direction of belt length) that join transverse cracks are NOT acceptable.*


mc75130-1

- Fraying
- Glazed surfaces
- Proper tension—13 mm (1/2 in.) deflection, with moderate thumb pressure, on the belt at the location that has the longest distance between two pulleys

Belt Tension Gauge	SPX BT-33-73-F

Replacing

IMPORTANT: If the belt is removed and is found to be in acceptable condition to use, you must install it in the same direction of rotation as before.

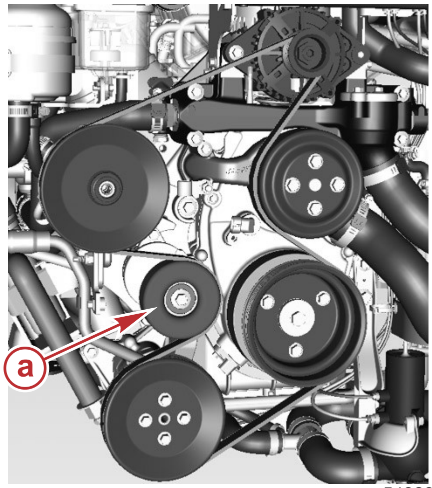
NOTE: *All power packages have a decal on the front of the engine. The decal shows the serpentine belt routing. Refer to the decal when installing the serpentine belt.*

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops. See your authorized MerCruiser dealer for service if these conditions exist.

⚠ CAUTION
Rapid release of the belt tensioner, or allowing the tensioner to snap back quickly, could cause injury or product damage. Relieve the spring tension slowly.

1. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner counterclockwise away from the belt until it stops.

2. Remove the belt from the idler pulley and slowly relieve the tension on the belt on the breaker bar.



Standard cooling shown, closed cooling similar

a - Belt tensioner

3. Inspect the belt for damage and replace as necessary.
4. Route the belt according to the diagram on the decal.
5. Carefully release the tensioner and ensure that the belt stays positioned properly.
6. Check the belt tension.

   NOTE: Proper tension is a measurement of deflection with moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

Description	
Deflection	13 mm (½ in.)

Troubleshooting

Before You Begin

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

IMPORTANT: The charging system may be damaged by:

- Reversed battery cables
- Running the engine with the battery cables disconnected
- An open circuit, such as a broken wire or loose connection

Before proceeding with the tests in this section, perform the following checks to eliminate possible problem areas.

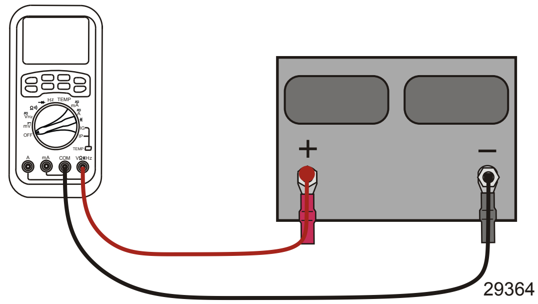
1. Check the charge and physical condition of the battery and battery cables. The battery must be at least 75 percent (1.230 specific gravity) charged to obtain valid test results. Ensure that the battery is fully charged before testing the system.

   NOTE: An undercharged battery can result from excessive current draw from excessive accessory power loads or by extended operation at low speeds.
2. Inspect the charging system wiring for damage or corrosion. Ensure that all connections are secure and clean.
3. Check the alternator drive belt for proper tension, excessive wear, cracks, fraying or glazed surfaces. Replace if necessary.

Charging Output Tests

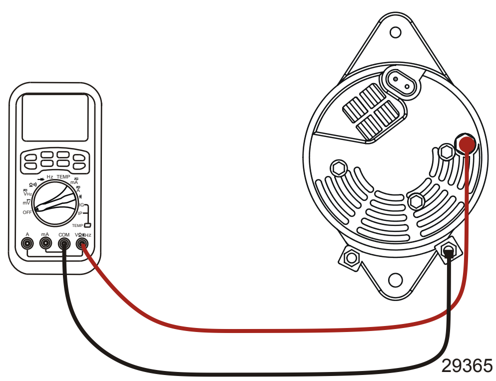
1. Check the drive belt condition and tension.
2. Check battery charge and condition.
3. Connect the digital multi-tester (DMT) leads directly to the battery posts.

DMT 2004 Digital Multimeter	91-892647A01



DMT connection

4. Supply cooling water to the power package.
5. Start the engine and operate at 1300-1500 RPM. Read the DMT in the VDC position. Most systems will read between 13.8 and 14.8 volts.
6. If the reading is between 13.5 and 14.8 volts, switch the DMT to the VAC position and observe. A reading of 0.25 VAC or less indicates that the alternator diodes are fully functional. A reading above 0.25 VAC indicates that the diodes are faulty and the alternator must be replaced.
7. If the reading is below 13.5 volts:
   a. Connect the positive (+) voltmeter lead to the alternator output post.
   b. Connect the negative (-) lead to the ground post on the alternator.



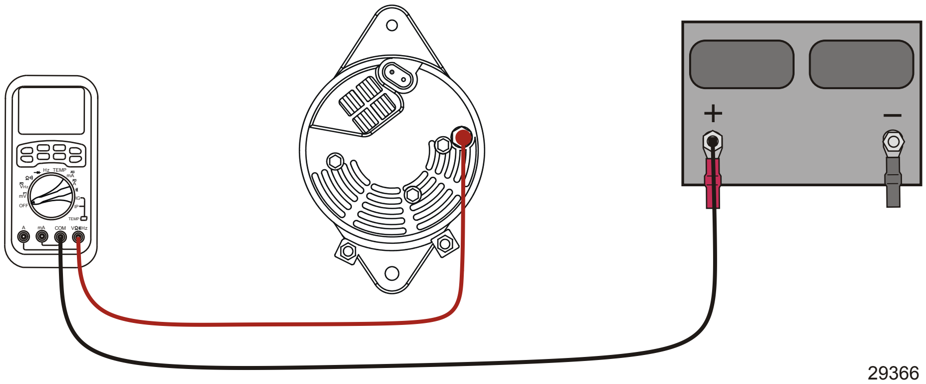
DMT alternator connections

   c. Manipulate the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, refer to **Voltage Drop Test (Alternator Circuit)**.
   d. If the reading is above 15 volts, the alternator is overcharging and must be replaced.
   e. If the voltmeter reading is now between 13.8 and 14.8 volts, there is too much resistance between the alternator and the battery.
   f. If the reading is, or drops below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

Voltage Drop Test (Alternator Circuit)

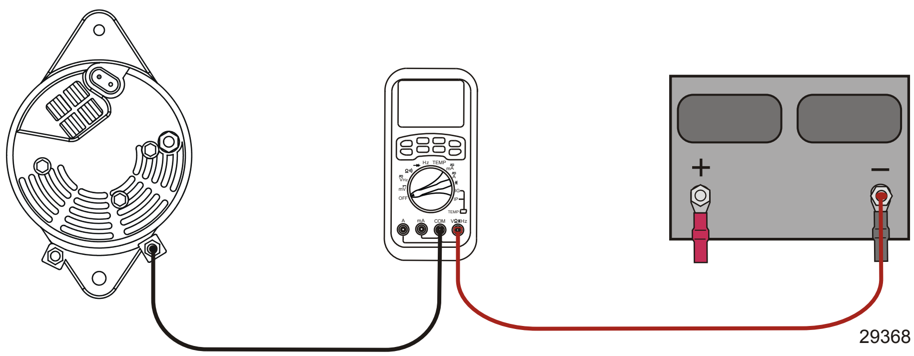
1. Supply cooling water to the power package.
2. Disconnect the coil wire so that the engine does not start.
3. Remove the fuel injector fuse or otherwise disable the injectors.
4. Crank the engine for 15 seconds to slightly discharge the battery.
5. Reconnect the coil wire, insert the fuel injector fuse, and verify that all accessories are off.
6. Connect the DMT positive (+) lead to the alternator output terminal. Connect the DMT negative (–) lead to the battery positive (+) post.

DMT 2004 Digital Multimeter	91-892647A01



DMT connections

7. Start the engine and operate at 1300-1500 RPM. A DMT reading of more than 0.5 volts indicates excessive resistance in the wiring.
8. Connect the DMT negative (–) lead to the alternator ground terminal. Connect the DMT positive (+) lead to the battery negative (–) post.



DMT connections

9. Start the engine and operate at 1300–1500 RPM. A DMT reading of more than 0.5 volts indicates excessive resistance in the wiring.

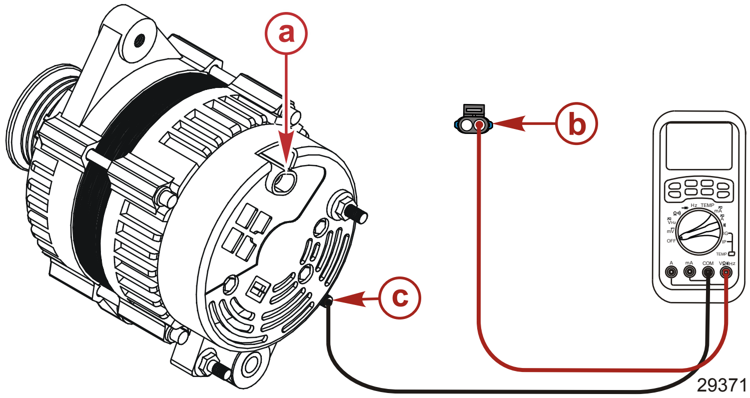
Sensing and Excitation Circuits

Perform the following tests to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

1. Unplug the purple and red/pink connector from the alternator.
2. Connect the positive (+) digital multi-tester (DMT) lead to the red/pink lead and the negative (–) DMT lead to the ground terminal.

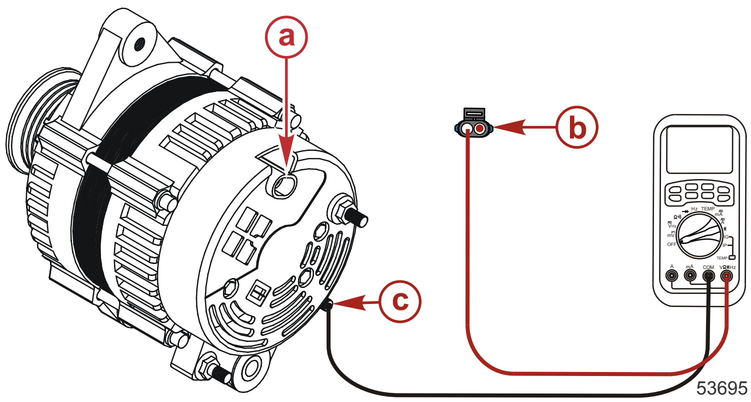
DMT 2004 Digital Multimeter	91-892647A01

3. The DMT should indicate battery voltage. If battery voltage is not present, check the circuit breaker and battery power interface for a loose or dirty connection or damaged wiring.



a - Connector location
b - Purple and red/pink connector
c - Ground terminal

4. Connect the positive (+) DMT lead to the purple lead and the negative (–) DMT lead to the ground terminal.
5. Turn the ignition switch to the "ON" position.
6. The DMT should indicate battery voltage. If battery voltage is not present, check the ignition circuit (purple lead) for a loose or dirty connection or damaged wiring.

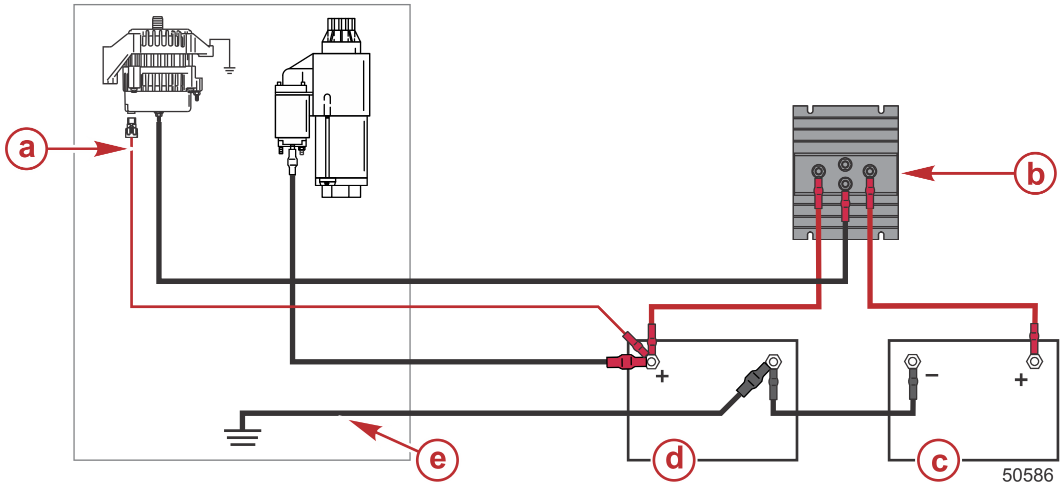


a - Connector location
b - Purple and red/pink connector
c - Ground terminal

Battery Will Not Recharge

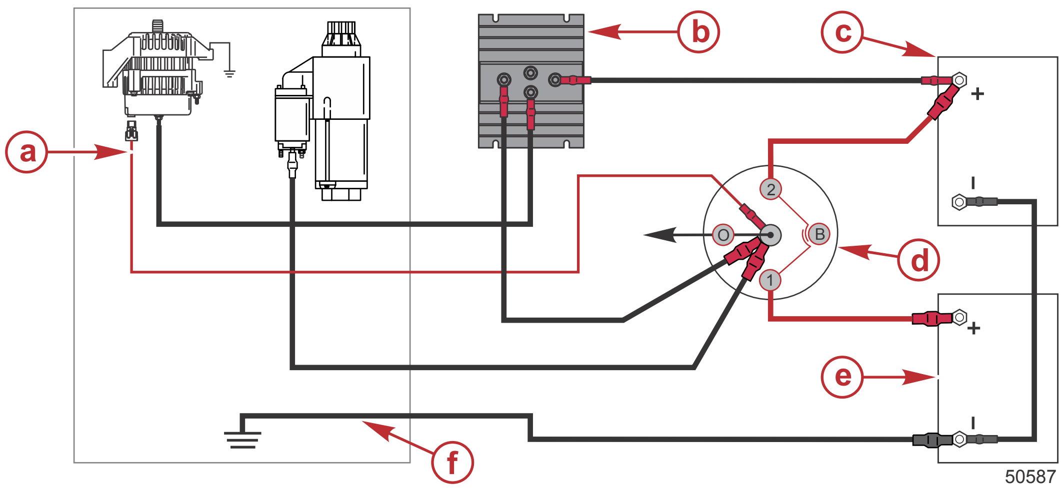
Possible Cause	Remedy
Excessive current draw from battery.	Turn off non-essential accessories.
Alternator drive belt loose or in poor condition.	Replace or adjust.
Unacceptable battery condition.	Test battery, replace if necessary.
Loose or dirty electrical connections or damaged wiring.	Check all associated electrical connections and wires (especially battery cables). Clean and tighten faulty connections. Repair or replace damaged wiring.
Faulty alternator	Test alternator output, replace if necessary.

Battery Isolator Diagrams



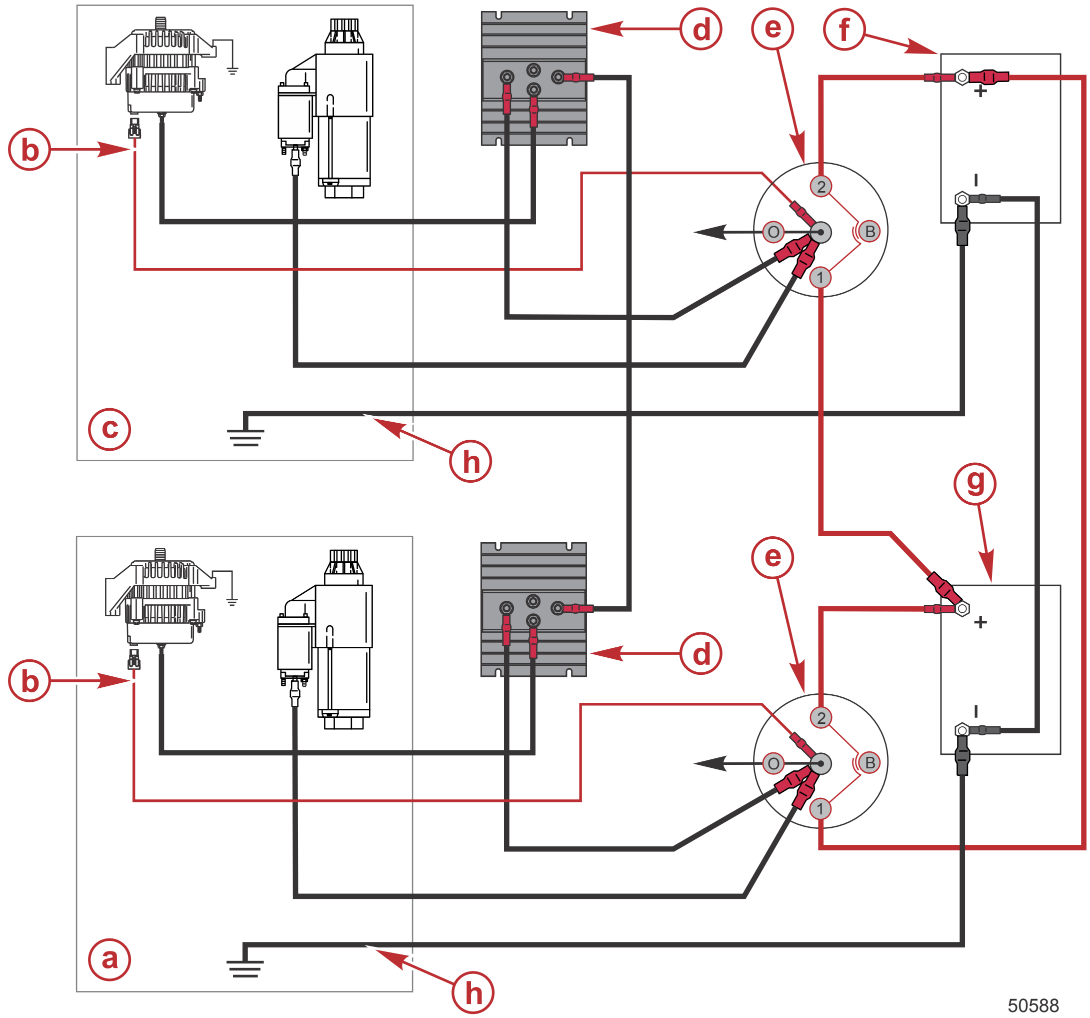
Typical single-engine battery isolator wiring

- a - Alternator sense wire
- b - Battery isolator
- c - Auxiliary battery
- d - Cranking battery
- e - Engine ground



Typical battery isolator with disconnect switch

- a - Alternator sense wire
- b - Battery isolator
- c - Auxiliary battery
- d - Battery disconnect switch
- e - Cranking battery
- f - Engine ground



Typical dual-engine application

- a - Starboard engine
- b - Alternator sense wire
- c - Port engine
- d - Battery isolator
- e - Battery disconnect switch
- f - Port engine cranking battery
- g - Starboard engine cranking battery
- h - Engine ground

Notes:

Electrical System

Section 4D - Instrumentation and Controls

Table of Contents

4
D

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

IMPORTANT: To avoid damaging the electrical system, follow these precautions:

- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

General Information

IMPORTANT: If all instruments are inoperative an electrical overload may have blown a fuse or tripped a circuit breaker. The cause of the overload must be corrected before returning the boat to service.

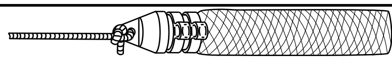
The initial investigation into instrumentation malfunctions should begin with the following:

- Confirm that the battery is fully charged.
- Check all fuses and circuit breakers.
- Inspect for wiring damage and loose or broken connectors.
- Ensure that all wiring connectors are properly connected and free of corrosion.

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Electrical terminals and connections	92- 25711 3

Special Tools

Data Cable Puller	91-888462A1
 4618	Attaches to end of DTS data harness to aid in pulling harness through boat. Prevents damage to DTS data harness.

Configuring the PCM Tachometer Signal (Non-DTS)

IMPORTANT: The engine propulsion control module (PCM) tachometer factory default is set to analog. This allows the operation of one analog tachometer. The PCM can be configured for digital output for applications utilizing an analog gauge interface (AGI) or digital gauges.

Use the Computer Diagnostic System (CDS) G3 to configure PCM tachometer output.

Gauge Configuration	Analog	Digital
Analog Tachometer Only	**X**	
System Link gauges used with VesselView, System Monitor, or System Tach	*leave at factory setting*	
System Link gauges used in conjunction with System Link adapter harness and command module harness without the use of VesselView, System Monitor, or System Tach		**X**
AGI used with or without VesselView, System Monitor or System Tachometer, to run analog and System Link gauges		**X**

Cleaning the Gauges

Clean the gauge by washing the face of the gauge and the trim ring with fresh water to remove sand and salt deposits. Wipe off the gauge face and trim ring with a soft cloth moistened with water. The gauge can be scored or damaged if wiped with abrasive material (for example, sand, saline, or detergent compounds) or washed with solvents such as trichloroethylene or turpentine.

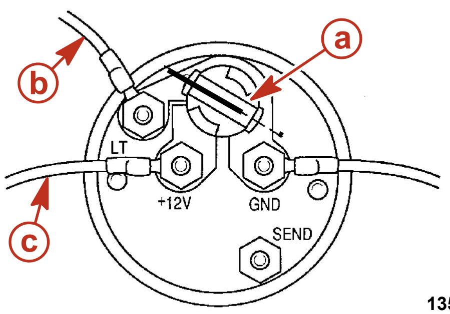
Analog Gauges

Gauge Lighting Options

Some gauges (Admiral and Flagship series) are equipped with two bulb socket settings for optional lighting configurations. The light bulb socket can be removed and the contacts can be aligned to be used with an ignition switch lighting circuit (+12 V) or a separate instrumentation lighting circuit (LT).

The standard position is instrumentation lighting circuit (LT) for use with the separate panel lights and audio test switch.

IMPORTANT: To adjust the lighting option to the desired setting, you must remove the light socket from the gauge and then turn it. Turning the socket while it is installed in the gauge could result in damage to the gauge or socket.



13553

a - Light socket
b - +12 V power supply from the panel lights and audio test switch
c - +12 V power supply from the ignition switch

Removal

1. Disconnect the battery cables. Remove the negative (–) cable first.
2. Remove the wires from the back of the gauge.
3. Disconnect the light socket wiring, if separate.
4. Remove the holding strap or unscrew the mounting ring around the gauge, and remove the gauge.

Installation

1. Position the gauge assembly in the appropriate mounting hole.
   IMPORTANT: Do not distort the case or bracket by overtightening.

2. On models with a holding strap: install the holding strap and nuts. Tighten the nuts evenly and securely.
3. On models with a mounting ring: install the mounting ring. Tighten the mounting ring securely. Do not overtighten.
4. Connect the other wires to the gauge as appropriate.
5. Install the gauge light socket.
6. Coat all exposed terminals with liquid neoprene.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Electrical terminals and connections	92- 25711 3

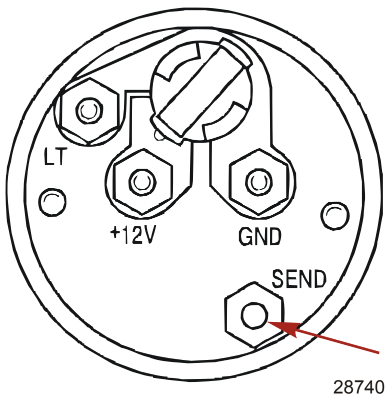
7. Reconnect the battery cables to the battery.

Analog Gauge Testing

Oil Pressure, Fuel Level, and Coolant Temperature Gauges

IMPORTANT: A defective gauge must be replaced. Repair is not available.

1. Turn the ignition switch (key switch) to the "OFF" or "0" position, whichever applies to the switch.
2. Remove the signal wire from terminal SEND ("S") or "G" (gauge), whichever applies to the gauge.



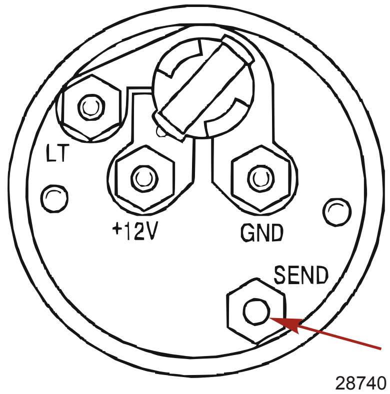
SEND ("S") terminal

3. Turn the ignition switch to the "RUN" or "1" position, whichever applies to the key switch style. The needle of the gauge must be in the indicated position.

Typical gauge

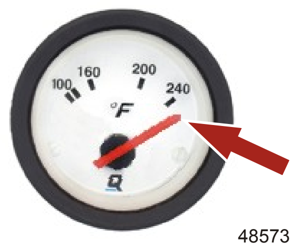
4. Turn the ignition switch to the "OFF" or "0" position, whichever applies to the key switch.

5. **On Flagship and Admiral gauges**: Connect a jumper wire from terminal G (GND) to terminal SEND ("S").



SEND ("S") terminal

6. **On VDO gauges**: Connect a jumper wire from terminal "–" (negative, or ground) to terminal "G" (gauge).
7. Turn the key switch to the "RUN" or "1" position, whichever applies to the key switch. The needle of the gauge must be in the indicated position.



Typical gauge

8. If the gauge does not respond as indicated it is defective and must be replaced.

Battery or Voltage Gauge

In-the-Boat Testing

1. Connect a digital multimeter (DMM) to the terminals on the back of the gauge.
2. Set the DMM to VDC.
3. Turn the keyswitch to the "ON" or "RUN" position.
4. The voltage indicated by the gauge should match the voltage measured by the DMM. If the values do not match, replace the gauge.

Bench Testing

If the gauge is disconnected from the boat's wiring, the gauge may be checked with any known good voltage source that is at least 9 vdc but no greater than 15 vdc.

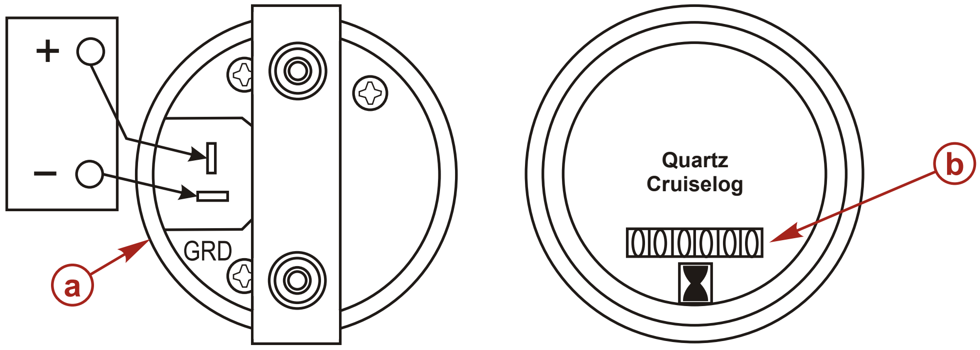
IMPORTANT: Connecting the gauge with the incorrect polarity could damage the gauge.

1. Connect the gauge's negative (–) terminal to the negative (–) terminal of the known good voltage source.
2. Connect the gauge's positive (+) terminal to the positive (+) terminal of the known good voltage source.
3. Check the position of the gauge needle. If it does not indicate the voltage of the source, replace the gauge.

Cruiselog (Engine Hour Meter)

1. Remove the battery cables and fully charge the battery.
2. Remove the wires from the rear of the gauge.

3. Connect a positive (+) jumper lead from the battery to gauge terminal + (12 V).



a - Electrical connections
b - Display

4. Connect a negative (–) jumper lead from the battery to gauge terminal "GND" (ground) or "–" (negative, or ground).
5. If the indicator display is not turning, the gauge is inoperable. Replace the gauge.

Tachometer

IMPORTANT: Ensure that the pulses per revolution selector on the back of the tachometer is set to 4.

1. Connect a service tachometer to the engine and compare readings between the service tachometer and the helm tachometer.
2. If the gauge is not accurate, make sure that the switch on the rear of the tachometer is set properly. Refer to the manufacturer's instructions that accompanied the gauge for an explanation of selections.
3. If the gauge does not meet the specifications, replace the gauge.

Tachometer Type	Allowable Range
5000 RPM maximum	± 100 RPM
6000 RPM maximum	± 150 RPM

Speedometer

IMPORTANT: When testing the speedometer for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure.

1. Supply the specified air pressure to the speedometer gauge pitot tube and compare the gauge readings to the specification. Lightly tap the pressure gauge during the accuracy check.
2. If the gauge readings are not within specifications, replace the gauge.

Air pressure	Speedometer display
36.5 kPa (5.3 psi)	32 km/h ± 1.6 km/h (20 mph ± 1 mph)
192 kPa (27.8 psi)	72 km/h ± 1.6 km/h (45 mph ± 1 mph)

SmartCraft Instrumentation

SmartCraft Compatibility

IMPORTANT: Digital gauges are available for use on Mercury MerCruiser engines equipped with the ECM 555 or later model controllers.

All System Series instruments are compatible with MerCruiser products.

- SC1000 System Monitor
- SC1000 System Tachometer and Speedometer
- SC100 System Link Gauges

Refer to the **Mercury SmartCraft Operation Manual** for information on the setup and operation of the System Monitor, System Tachometer, and System Speedometer.

SmartCraft System Rules

Controller area network (CAN) data bus wiring rules are the same for all SmartCraft compatible products.

- There are two termination resistors per CAN.
- Termination resistors define the ends of the CAN bus trunk.
- The maximum allowable CAN bus trunk cable length is 36.6 m (120 ft).
- Drops from the trunk should not exceed 1.8 m (6.0 ft).

- The maximum allowable distance between any two modules is 40.2 m (132 ft) (36.6 m [120 ft] trunk plus 1.8 m [6.0 ft] on each end).
- The CAN bus will support a maximum of 20 devices.

On dual engine applications, instrument harness part number 84-892323Txx (or equivalent for triples and quads) allows activation of all gauges from any key switch.

When installing a blue CAN data or System Tach/Speed harness, the end of the harness with multiple connectors must be connected to the SC1000 gauge. The System Link signals come from the SC1000 gauge. If the harness is reversed, there is no path for the System Link signals to transfer from the SC1000 gauge to the System Link gauges.

CAN Bus Overview

The wires required for three controller area network (CAN) buses can be found within the 14-pin harness that connects the engine to the helm. These buses carry communications between the various controllers used by the engines and helms. Each CAN bus consists of a twisted pair of wires—twisting the pair helps prevent electrical interference. If either wire develops an open or short, that CAN bus will stop communicating.

Only one CAN is used on the engines covered by this manual. This CAN is known as CAN P. The CAN P (propulsion) circuit (blue and white wires) connects together the engine modules, helm modules, and SmartCraft gauges and displays. Its primary purpose is to provide a path for data (such as temperatures, pressures, depth, boat speed, tank levels, and engine speed) to the SmartCraft gauges and displays. It is also used by diagnostic tools, such as CDS G3. There is one CAN P bus per boat, regardless of the number of engines or helms.

Termination Resistors

Termination resistors are CAN line signal conditioners. The resistor places a known load on the CAN line to ensure proper system communication. All CAN bus termination resistors are 120 ohms. Each CAN bus has two termination resistors installed, one at each of the furthest ends of the bus' running length. With all modules and gauges disconnected from the bus, the resistance between the two data communication wires of the CAN bus should be approximately 60 ohms. Incorrect CAN bus termination, usually caused by too few or too many installed termination resistors, will result in communication errors or complete failure of that CAN bus.


17168

Yellow 10-pin termination resistor


29610

Blue 2-pin termination resistor

Boat Harnesses and Installation Connections

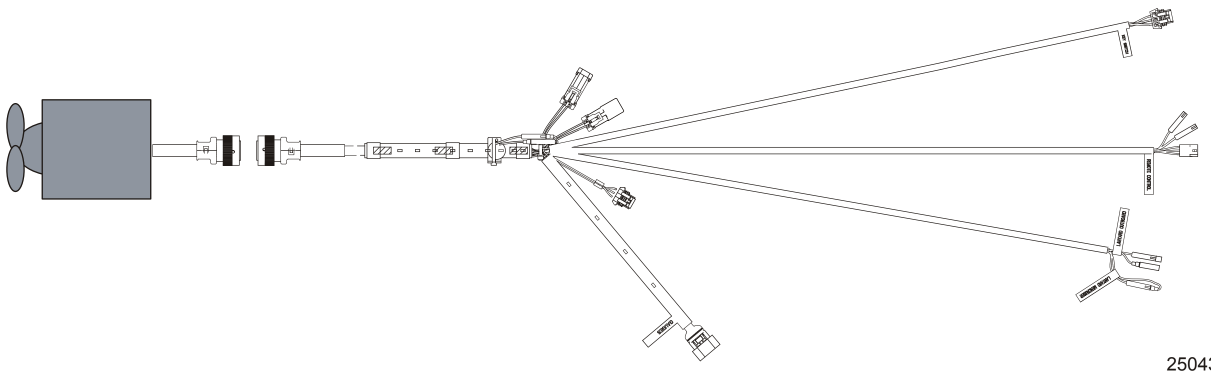
Engine Harness and Accessory Power Supply

If the engine harness is used to supply power for boat accessories (lights, blower, pumps, stereo, or any other electrical device using the engine wiring harness for power), the maximum accessory power available on the 14-pin wiring harness is 15 amps. Relay kits are available to provide additional accessory power at the helm. This maximum is fuse-protected and must be observed. If the fuse opens, the engine will stop and will not restart until the fuse is corrected.

Boat Wiring

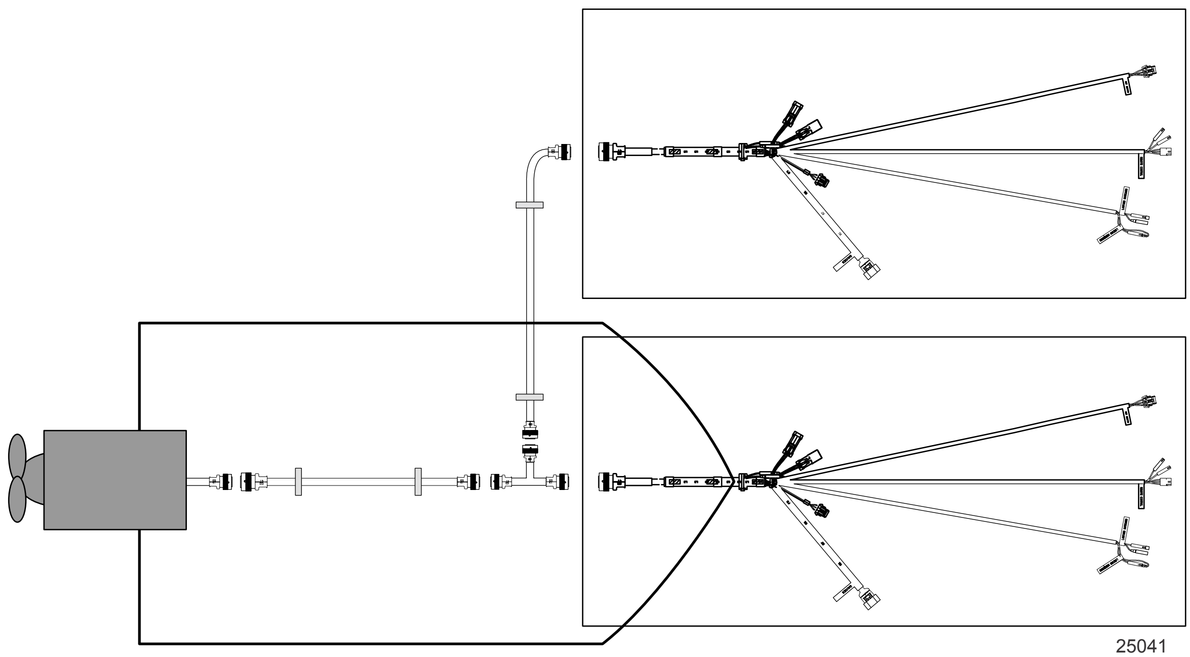
NOTE: *Twin engines are treated as two single engines in the same boat. No twin engine disconnect is required.*

Single Station



25043

Dual Station



25041

- On dual helm installations, use the extension harness from the engine to the lower station.
- Use the Y-adapter to connect the upper and lower stations.
- Use the proper length harness from the Y to the lower station.
- Use the proper length harness from the Y to the upper station.

25132

Y-adapter for dual helm installations

Boat Harness Installation Guidelines—MPI Sterndrive

Boat Harness Connector to Engine

Select the boat harness by length.

Boat Harness		
Length of the Boat Harness	Boat Harness and Key Switch Three Position (off/run/start)	Boat Harness (key switch is not included)
61 cm (2 ft)	84-896537 K02	84-896537 A02
4.6 m (15 ft)	84-896537 K15	84-896537 A15
6.0 m (20 ft)	84-896537 K20	84-896537 A20
7.3 m (24 ft)	84-896537 K24	84-896537 A24
8.8 m (29 ft)	84-896537 K29	84-896537 A29
12.2 m (40 ft)	84-896537 K40	84-896537 A40

NOTE: Extension harnesses are available if longer length is needed.

Key Switch Connector

- A mounting bezel is not available for the three position key switch.

  NOTE: Decal and washer kit 899203A01 is available for the three position key switch if needed.

Typical three position key switch (off/run/start)

- The four position key switch is available with mounting hardware.

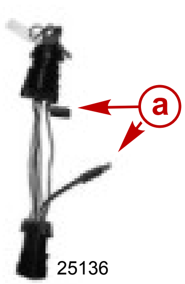
Typical four position key switch (off/accessory/run/start)

NOTE: When installing the key switch, verify that the drain hole in the barrel of the key switch is positioned downward for proper drainage.

- **For non-DTS applications:** For dual helm installation, a key switch is used at the upper and lower station. The key switches must operate independently.
- **For DTS applications:** For dual helm installation, a start and stop switch is used at the upper station. The lower station can use either a key switch at the helm, or a key switch at the main panel and a start and stop switch at the lower helm.

  IMPORTANT: For dual helm installation, both key switches used must be modified to operate independently.

  IMPORTANT: Cutting the black/yellow stripe wire disconnects the E-stop circuit incorporated in the key switch. Do not alter key switches on DTS applications.
- To modify the non-DTS key switches, cut the black/yellow stripe wire at each key switch and cover both open wire ends with heat shrink tubing.

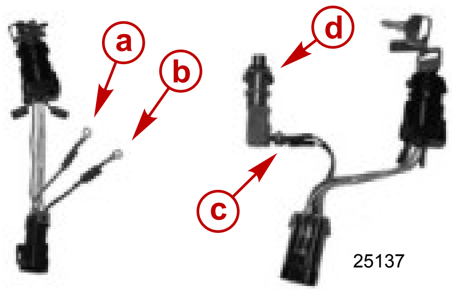


Typical key switch

a - Black/yellow stripe wire

IMPORTANT: The key switch at the station being used should be the only key switch in the run position. If both station key switches are in the run position the engine cannot be turned off with the key switch and the lanyard stop switches will not function.

- If a momentary stop switch is added, the stop switch will override the key switch and the engine will shut off when the stop switch is activated.
- If a stop button is desired on a dual helm installation, the black wire and black/yellow stripe wire can be clipped at the key switch and connected to a normally open momentary button switch. Any marine momentary push button, rocker style switch or toggle switch could be utilized to create the stop switch. Label the switch on the dash after installation.
- To install a momentary stop switch:
  a. Cut the black wire at the key switch and cover the cut wire at the key switch with heat shrink tubing.
  b. Install an eye terminal on the black wire from the connector side. Cover cut wire ends with heat shrink tubing.
  c. Install an eye terminal on the black/yellow stripe wire from the connector side. Cover cut wire ends with heat shrink tubing.
  d. Connect the black wire and the black/yellow stripe wire eye terminals to a momentary switch.



Typical key switch with momentary stop switch for MPI models

a - Black wire with eye terminals
b - Black/yellow stripe wire with eye terminals
c - Eye terminals connected to momentary switch
d - Momentary switch

Trim Switch

The trim switch connection on the helm harness is only used on Mercury outboard remote controls.

MerCruiser models require a separate trim harness from the trim control to the power trim pump connection. A Y-harness is available with adapters to connect the dual helm power trim harnesses together to connect to the transom harness. DTS models do not need the separate trim harness.

Use the power trim adapter harness for the single helm harness connection on the remote control to the power trim pump.

Power trim adapter harness

For dual helm installation, use a power trim extension harness from the upper and lower helm to a Y-harness.

An adapter harness connects the Y-harness to the power trim pump.

Neutral Safety Switch

Quicksilver remote controls for mechanical shift (cable) models are equipped with a microswitch to prevent accidental starting in gear. Do not remove this switch from the remote control.

Lanyard Stop Switch

Purple and purple/white wires are connected together through a normally closed stop switch only with MerCruiser remote control.

When the lanyard is pulled and the switch is tripped, the circuit is opened and the power to the engine, ECM, or ignition system is interrupted and the engine is shut off on MerCruiser remote control equipped boats.

If a lanyard stop switch is not used, or an E-stop switch is used, these two wires must be plugged together for the engine to run.

Optional E-Stop

The E-stop lanyard switch connection is used on Mercury outboards and can be used on MerCruiser MPI engines.

The black and black/yellow wires are connected together through a lanyard switch that is normally open. When the lanyard is pulled and the switch is tripped, the circuit will close and ground the ECM to shut the engine off.

When this connection is not used, the wires should be kept separate and capped.

Warning Horn

The audio warning horn and connections are included with the Mercury harness assemblies. (Another horn is also supplied with the engine for those using custom wiring systems.)

Accessory Relay Connection

The 14-pin wiring system is able to provide up to 15 amps of accessory power to the helm through the purple wire (key controlled) or the red wire (constant on) circuit. This harness is fuse protected on the engine with a 15-amp fuse on the engine. If the fuse is blown, the engine will not start or continue to run.

An accessory relay kit connected to this location can provide up to 40 amps of accessory power. The key switch will power-up the relay in the "accessory" position and "run" position.

Relay with power harness

Additional Relay Kit

An additional 40-amp relay kit can be installed and connected to a junction box at the dash gauge connection location. This location will power-up with the key in the "run" position only.

The use of both relay kits will result in a maximum of 80 amps of key controlled power at the helm. This multiplies out on dual engine and dual helm applications as long as the power wires to the helm are adequate to carry the total current demand.

Accessory relay harness

CAN P (CAN 1) Connections

CAN P (CAN 1) data bus—Connection with a terminator resistor in place:

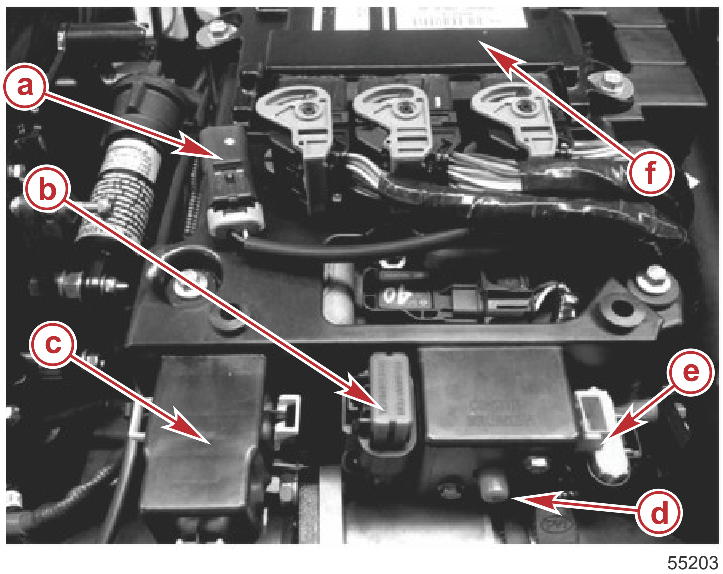
- The CAN P (CAN 1) data bus is terminated at each engine. Terminator resistors must be removed from the helm harness or junction box and a jumper harness must be installed at the helm to connect the port and starboard CAN P (CAN 1) lines together.

- If the boat is dual engine and dual helm, the terminator resistor at the lower helm is removed from the connector. The 2-pin link harness is installed at the upper station.

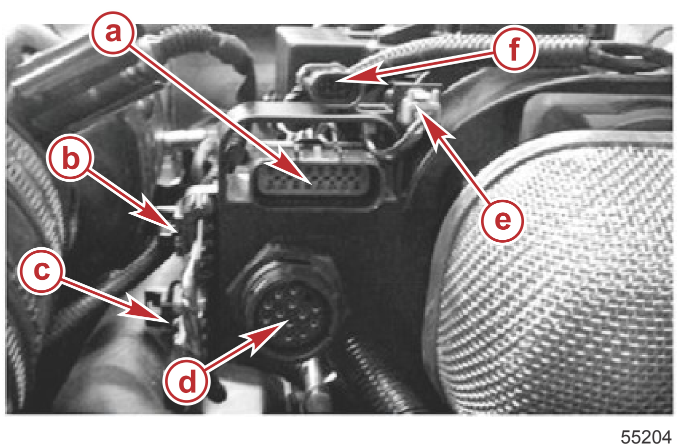
2-pin link harness—CAN

General Repower Information

- A 6-pin fuel paddle boat harness is required.



- a - Can X terminator DTS only
- b - 10-pin diagnostics
- c - Fuses
- d - Circuit breaker
- e - J1939 diagnostic connection
- f - PCM 112



- a - 16-pin transom harness
- b - Depth/RS-485
- c - Boat harness (tanks)
- d - 14-pin data harness
- e - OBD-M MIL light
- f - 7A clean power

Description	Part Number
Fuel tank, auxiliary tank, and paddle wheel harness	84-859743T03

Transom Harness—DTS/Mechanical Shift

This transom harness is designed so that connections can be made after the transom is installed in the boat but before the engine is installed. Connections made before the engine is installed are:

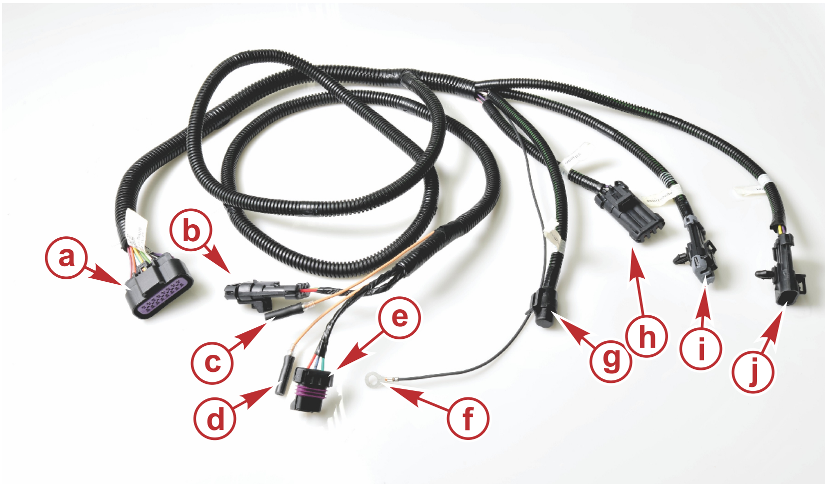
- MerCathode connection
- Trim connections

- Ground connection
- SmartCraft sensor connections

Secure the wiring and position the engine connector out of the way until the engine is installed.

After the engine is in place, make the single connection between the transom and the engine.

DTS engines are shipped with an adapter to connect the transom harness to the power trim pump.



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Transom harness—DTS
- a - 16-pin connector to engine harness
- b - Trim from helm
- c - Trim bypass
- d - Trim bypass
- e - Trim pump
- f - Ground
- g - Pitot
- h - Digital trim
- i - MerCathode
- j - Steering

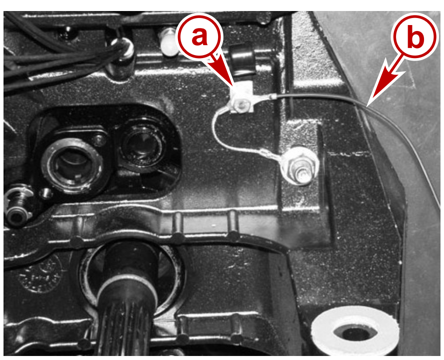
Transom Ground Connection

The ground wire for the transom is incorporated into the transom harness included with the engine.

Connect the ground wire in the transom harness under the bonding strap screw on the transom. Do not connect any other ground wires here.

Use the ground studs on the flywheel housing for other grounding needs.

NOTE: In some cases, a ground wire to connect to the flywheel housing may be attached to the bonding screw on the transom. This ground wire is not needed with the transom harness, but can be connected to the flywheel housing or removed. In any case the grounding wire in the transom harness must be connected to the bonding strap screw.



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Ground wire from the transom harness to the transom bonding strap screw
- a - Bonding strap screw
- b - Ground wire from transom harness

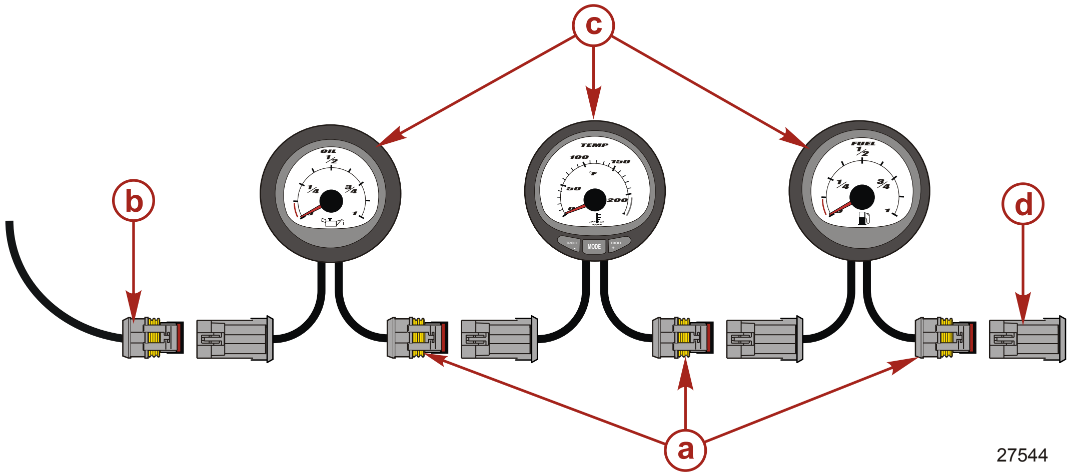
Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

System Link Gauges

System Link Gauge Connections

System Link gauges receive their data signal from a System gauge (System Monitor, System Tachometer, or VesselView) or from a System Link adapter harness. This enables the use of System Link gauges in a variety of situations and configurations. System Link gauges connect in series. Protect the System Link connector of the final gauge in a series with a weather cap.



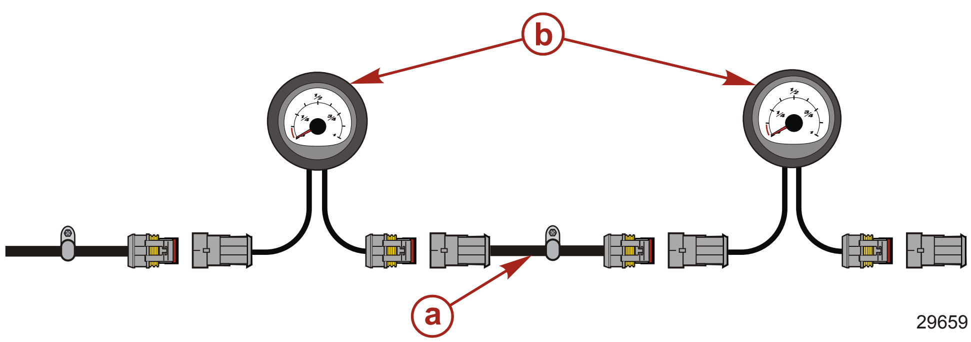
Example System Link gauge setup

a - System Link connectors in series
b - System Link connector to master gauge
c - System Link gauges
d - Weather cap

Each set of System Link gauges monitors one engine. In multiple-engine applications, install a System Link gauge set for each engine. In all cases, the System Link gauges connect to a master gauge or System Link adapter harness, which is connected to each engine's helm harness. For multiple-helm applications, the secondary helm instrumentation connects to the secondary helm harness in the same manner.

System Link Gauge Extension Harness Installation

The System Link gauge extension harness comes in five lengths, ranging from 15 cm to 9.1 m (6 in. to 30 ft). Install an extension harness anywhere in the System Link gauge series if you require additional gauge spacing or an alternative gauge mounting location. SmartCraft technology supports a System Link gauge series that does not exceed 9.1 m (30 ft) in overall length. SmartCraft supports one and two-helm installations with up to ten gauges per helm.



a - System Link gauge extension harness
b - System Link gauge

Warning System

Service Engine Light and OBD-M MIL Kit

Boats powered by emissions control technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash-mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash-mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

SC 1000 gauge and service engine light

Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL will remain illuminated for four seconds if the visual indication system is functioning correctly.

Audio Warning System

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

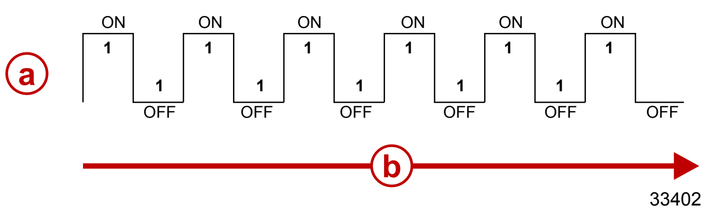
There are two warning horn states:

- Caution
- Critical

There is also an alarm that sounds if the helm has not been properly configured using the G3 service tool.

Caution

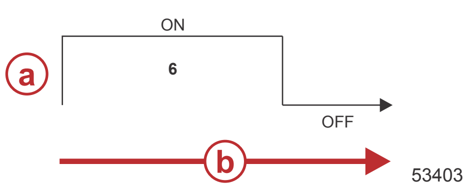
If a caution state is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

Critical

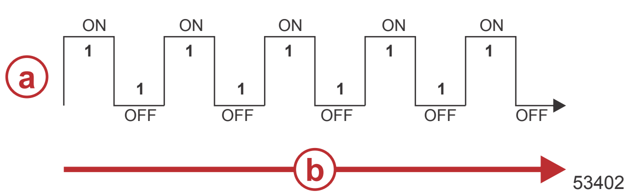
If a critical state is detected, the audio warning system sounds for six seconds and then turns off.



a - Horn (on or off)
b - Time (in seconds)

Nonconfigured Alarm–DTS Only

If the helm has not been properly configured using the G3 service tool, the audio warning system will sound for five one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

Testing the Audio Warning System

1. Turn the key switch to the on position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Guardian Strategy

The MerCruiser Engine Guardian system reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Below are some examples of what Engine Guardian monitors:

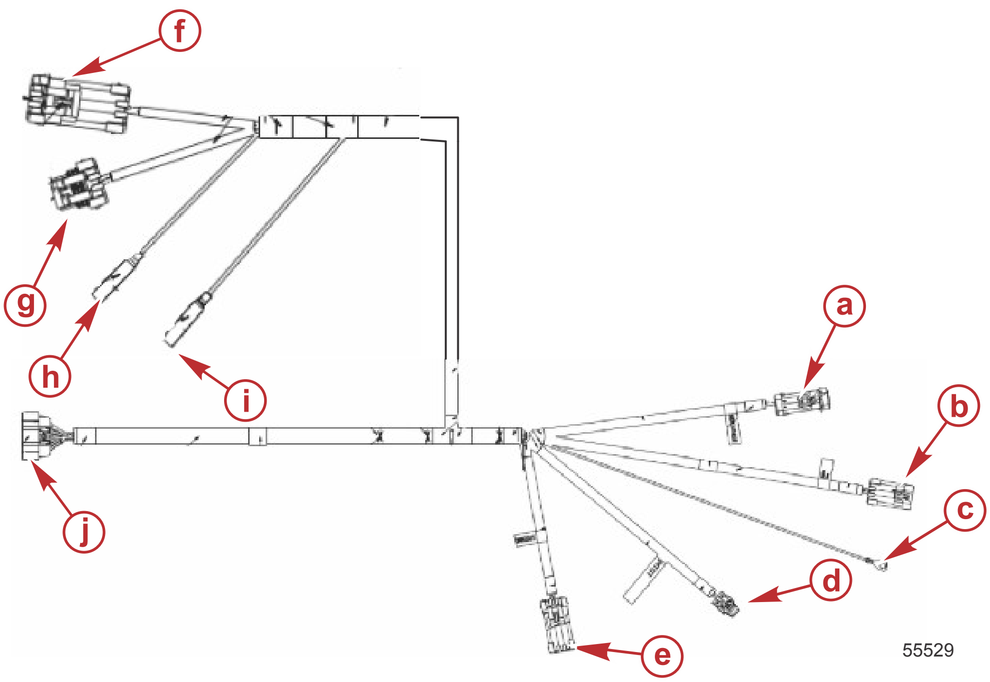
- Oil pressure
- Engine overspeed
- Exhaust manifold temperature

IMPORTANT: Engine Guardian can reduce power anywhere from 100% to idle, depending on the severity of the problem. If forced to idle, boat speed might not respond to throttle operation.

The PCM stores the fault for diagnostics. For example, if the water inlet becomes partially blocked, Engine Guardian reduces the available power level of the engine to help prevent damage from decreased water flow to the engine. If the debris passes through, and full water flow is restored, Engine Guardian restores engine power to normal.

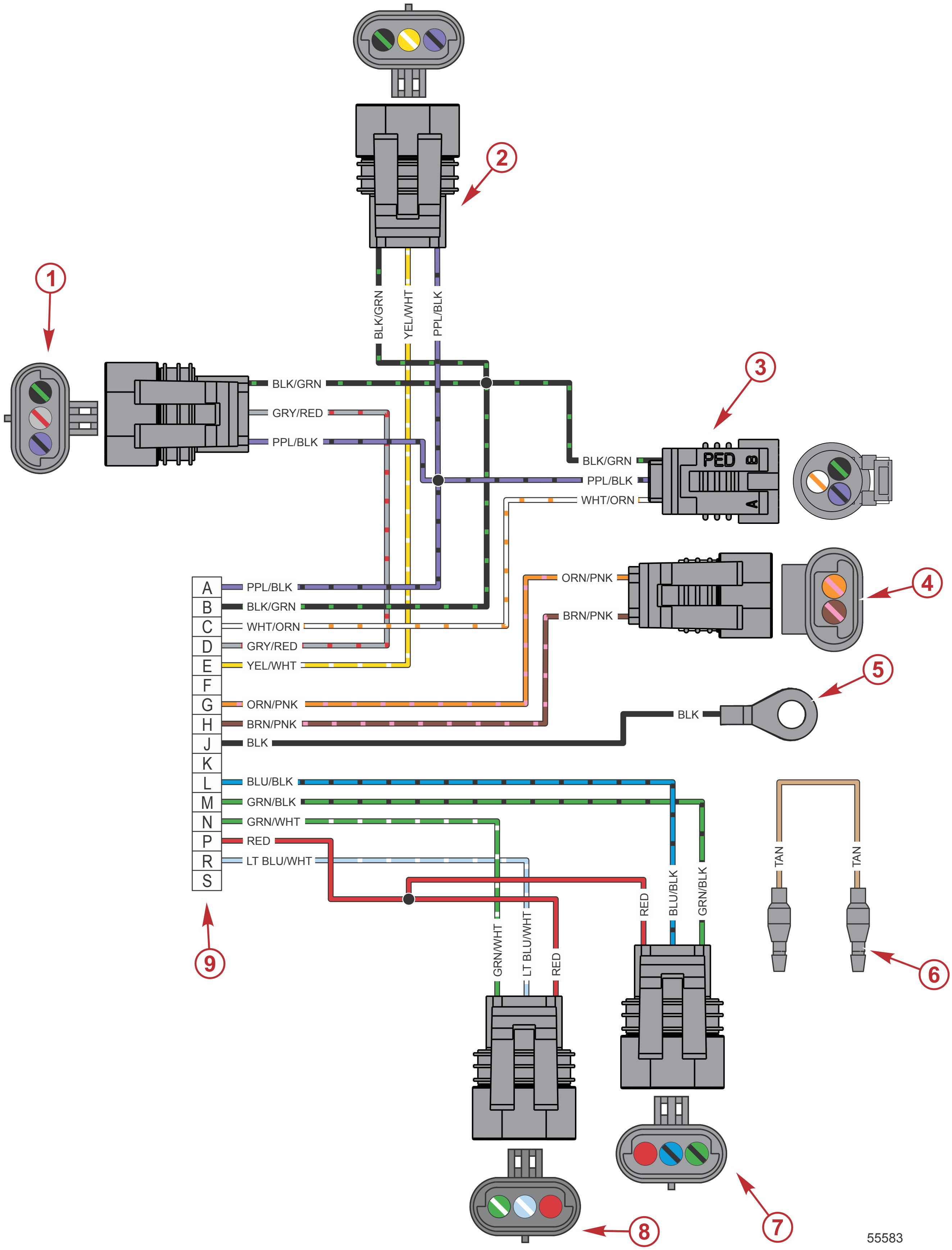
Wiring Diagrams

Transom Harness—MPI



a - MerCathode
b - Digital trim sensor
c - Ground to transom
d - Pitot sensor
e - Steering sensor
f - MerCruiser control (not needed if use Outboard control)
g - To trim pump
h - MerCruiser control (not needed if use Outboard control)
i - MerCruiser control (not needed if use Outboard control)
j - Engine

Notes:

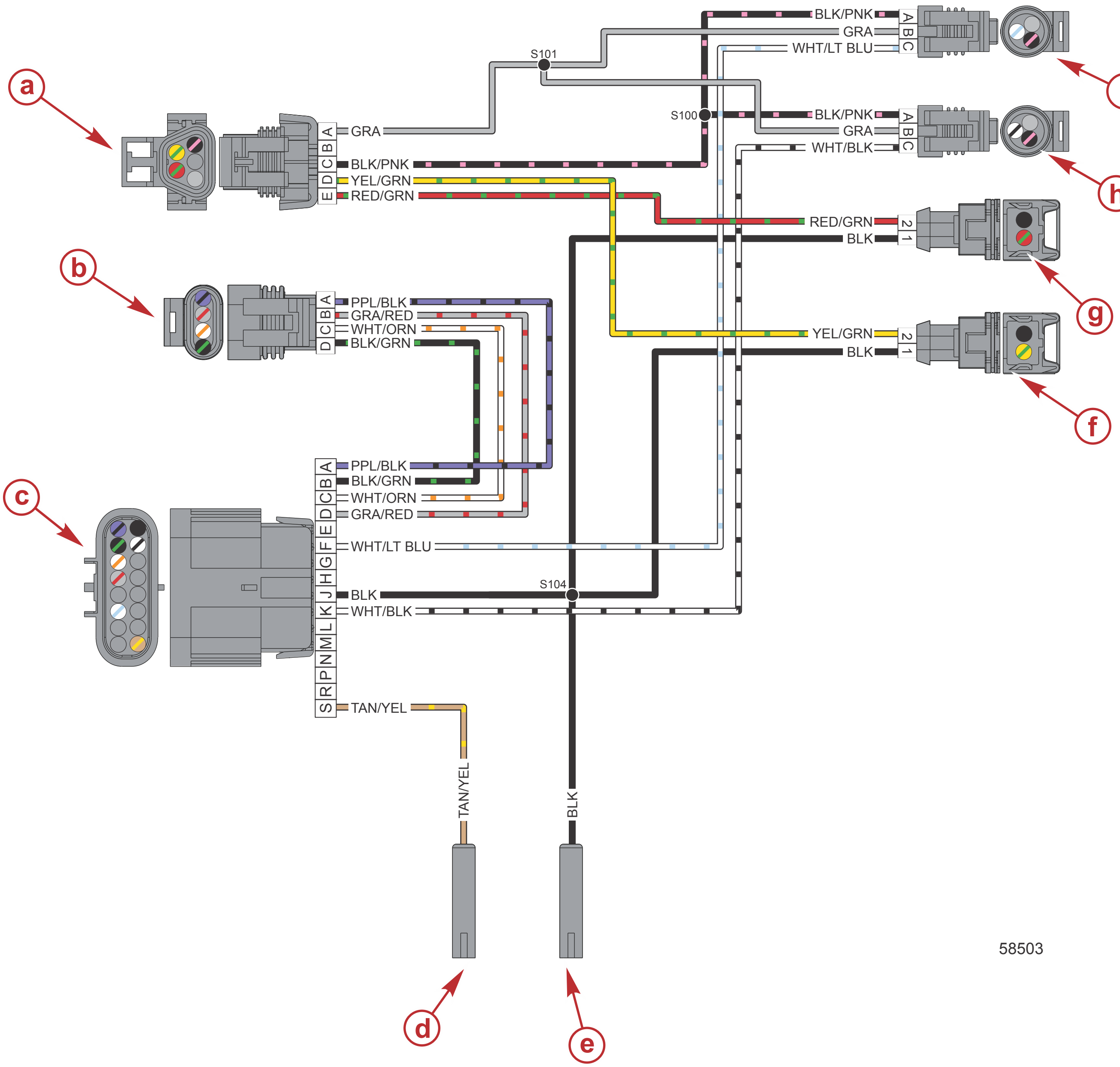


1
2
3
4
5
6
7
8
9
BLK/GRN
YEL/WHT
PPL/BLK
BLK/GRN
GRY/RED
PPL/BLK
BLK/GRN
PPL/BLK
WHT/ORN
PED
B
A
ORN/PNK
BRN/PNK
BLK
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
PPL/BLK
BLK/GRN
WHT/ORN
GRY/RED
YEL/WHT
ORN/PNK
BRN/PNK
BLK
BLU/BLK
GRN/BLK
GRN/WHT
RED
LT BLU/WHT
TAN
TAN
RED
BLU/BLK
GRN/BLK
GRN/WHT
LT BLU/WHT
RED
55583

Transom harness

1 - Steering
2 - Digital trim
3 - Pitot
4 - MerCathode
5 - Ground
6 - Trim bypass
7 - Trim from helm
8 - Trim pump
9 - 16-pin connector

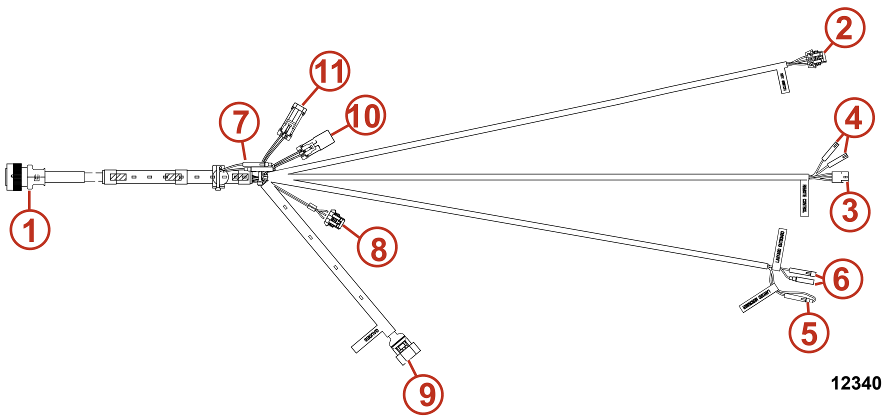
Transom Harness Wiring Diagram (TowSport, Inboard)



a - Transmission shift sensor
b - Steering/pitot sensor
c - 16-pin transom harness connector
d - Transmission over-temperature sensor
e - Trim/transmission over-temperature sensor ground
f - Shift solenoid B
g - Shift solenoid A
h - Reverse pressure sensor
i - Forward pressure sensor

Helm Mechanical

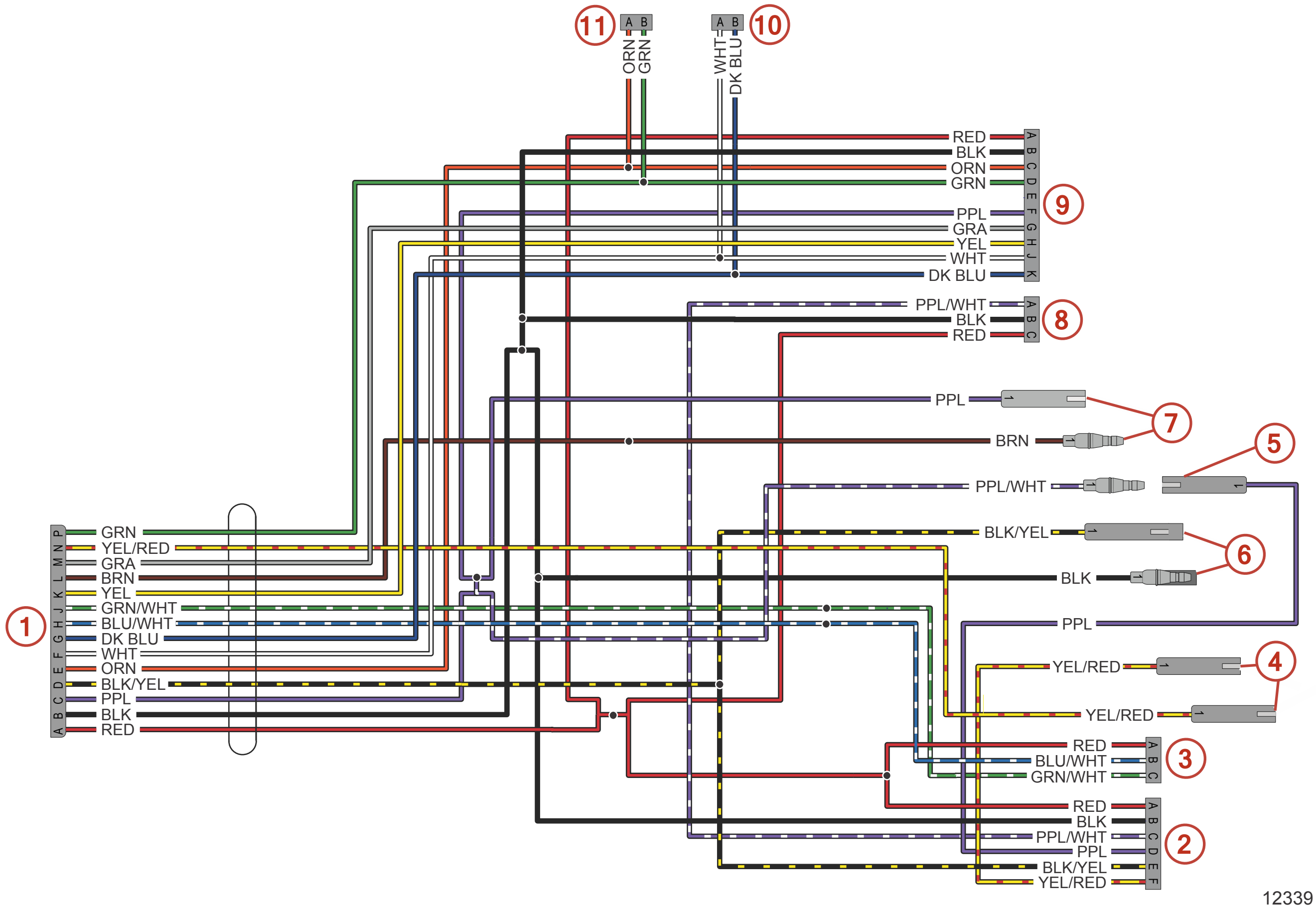
Drawing



14-pin Non-DTS

1 - 14-pin Deutsch connector
2 - Key switch connector
3 - Trim switch (outboard control)
4 - Neutral switch
5 - Lanyard switch (MerCruiser control) or key switch + connection
6 - Lanyard (outboard control) E-stop connection
7 - Warning horn
8 - Accessory relay connection (15 amp)
9 - Gauge connector/CAN connector for SmartCraft
10 - CAN P (CAN 1) with resistor cap
11 - CAN V (CAN 3) with weather cap

Diagram



1 - 14-pin Deutsch connector
2 - Key switch connector
3 - Trim switch (outboard only control)
4 - Neutral switch
5 - Lanyard switch (MerCruiser control) or key switch + connection
6 - Lanyard (outboard control) or E-stop connection
7 - Warning horn
8 - Accessory relay connection (15 amp)
9 - Gauge connector
10 - CAN P (CAN 1) with resistor cap
11 - CAN V (CAN 3) with weather cap

NOTE: Dual engines are treated as two singles in the same boat and are not connected together.

NOTE: The lanyard stop switch on MerCruiser control (purple and purple/white wires) breaks power to the ECM or ignition to stop the engine. The switch is normally ***closed*** *until activated. Therefore the purple and purple/white wires must be connected together if lanyard stop switch is not used, or if the E-stop switch is used.*

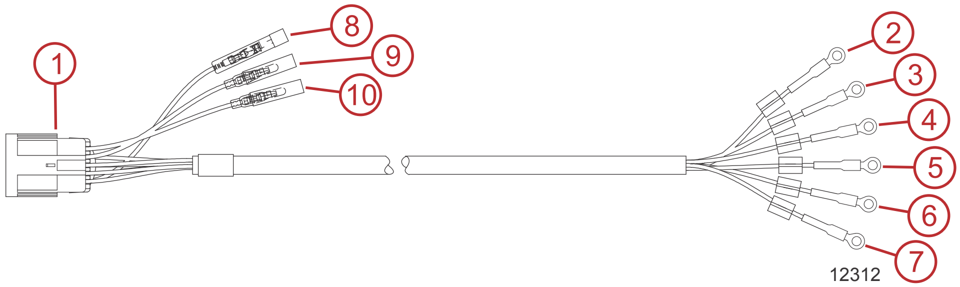
NOTE: Outboard control E-stop switch (black and black/yellow wires) connects ground to ECM to stop engine. The switch is normally ***open****; the circuit closes when the switch is activated. Wires must be separate unless connected through E-stop switch.*

Up to 15 amps total accessory power can be provided; on purple wire (switched) and the red wire (continuous power).

An accessory relay kit can be used for loads up to 40 amps. Refer to the **MerCruiser Parts and Accessory Guide or MerCruiser Rigging Guide.**

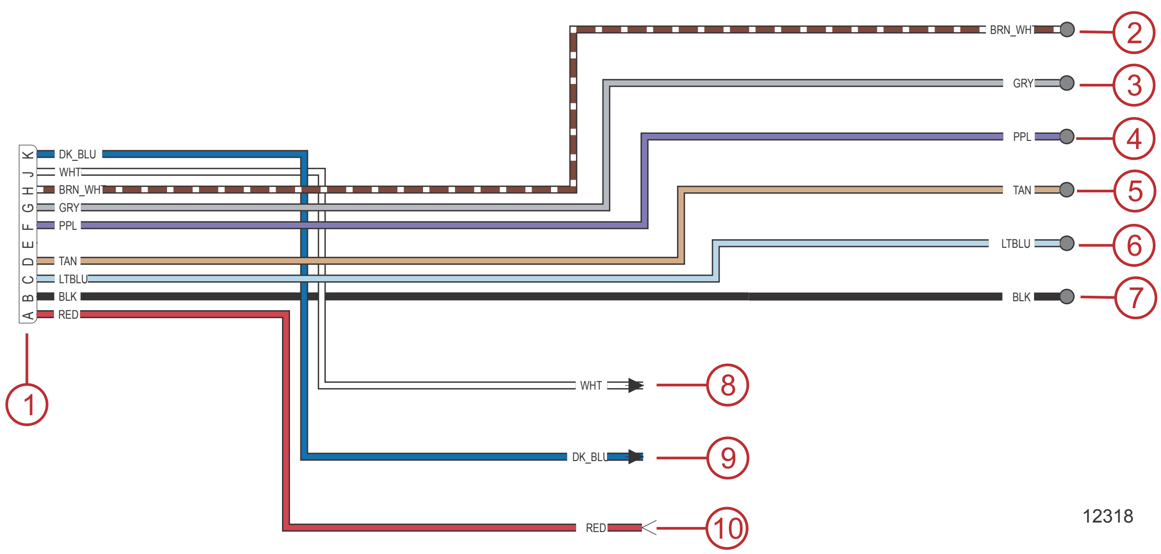
Analog Gauge Harness

Drawing



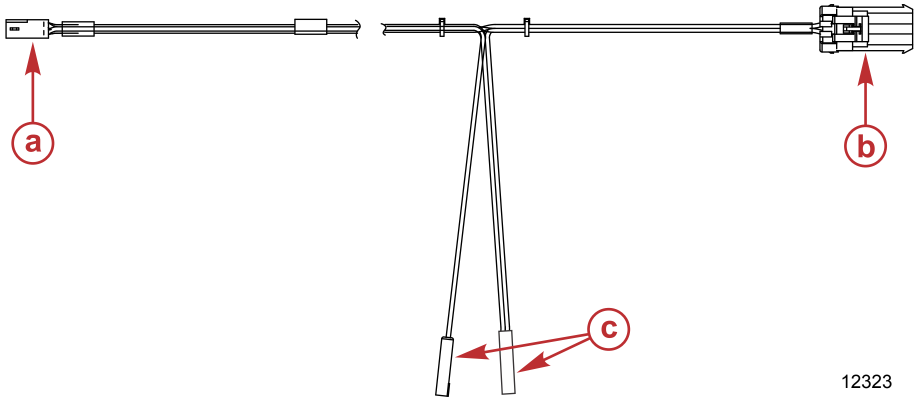
1 - Connector to boat harness
2 - Trim
3 - Tach
4 - Key on (+)
5 - Temp
6 - Oil
7 - Ground (–)
8 - CAN (+) or spare
9 - CAN (–) or spare
10 - 12V (+)

Diagram

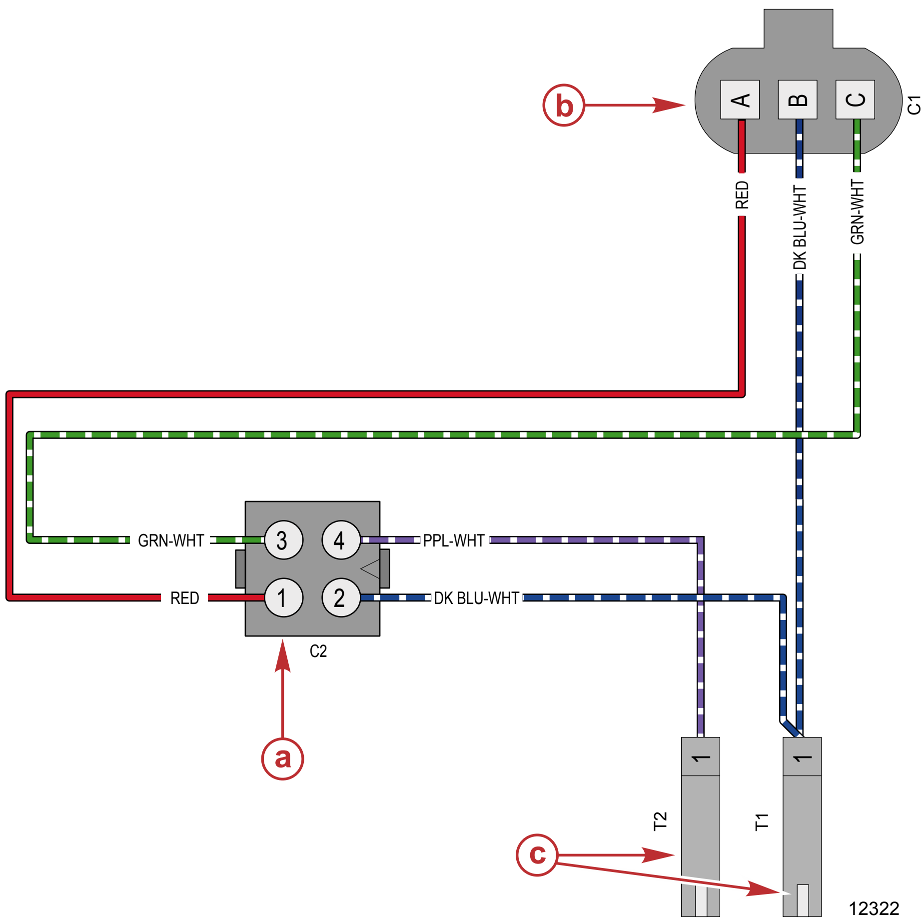


1 - Connector to boat harness
2 - Trim
3 - Tach
4 - Key on (+)
5 - Temp
6 - Oil
7 - Ground (–)
8 - CAN (+) or spare
9 - CAN (–) or spare
10 - 12V (+)

MerCruiser Remote Control Only to the Harness Assembly (Control Harness Assembly)

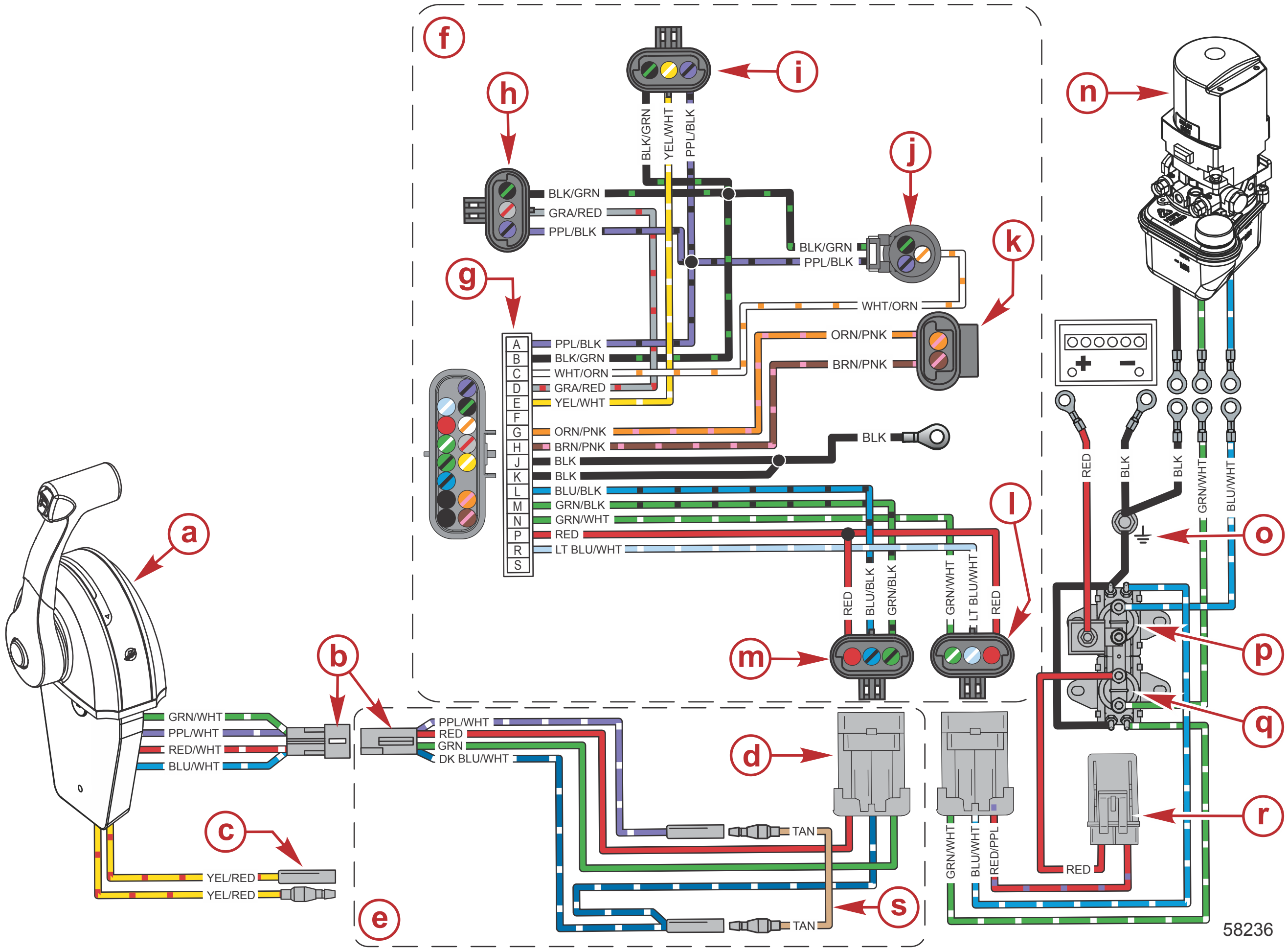


- a - Connection to control box helm control
- b - Connection to transom harness
- c - Connections to trim limit switch



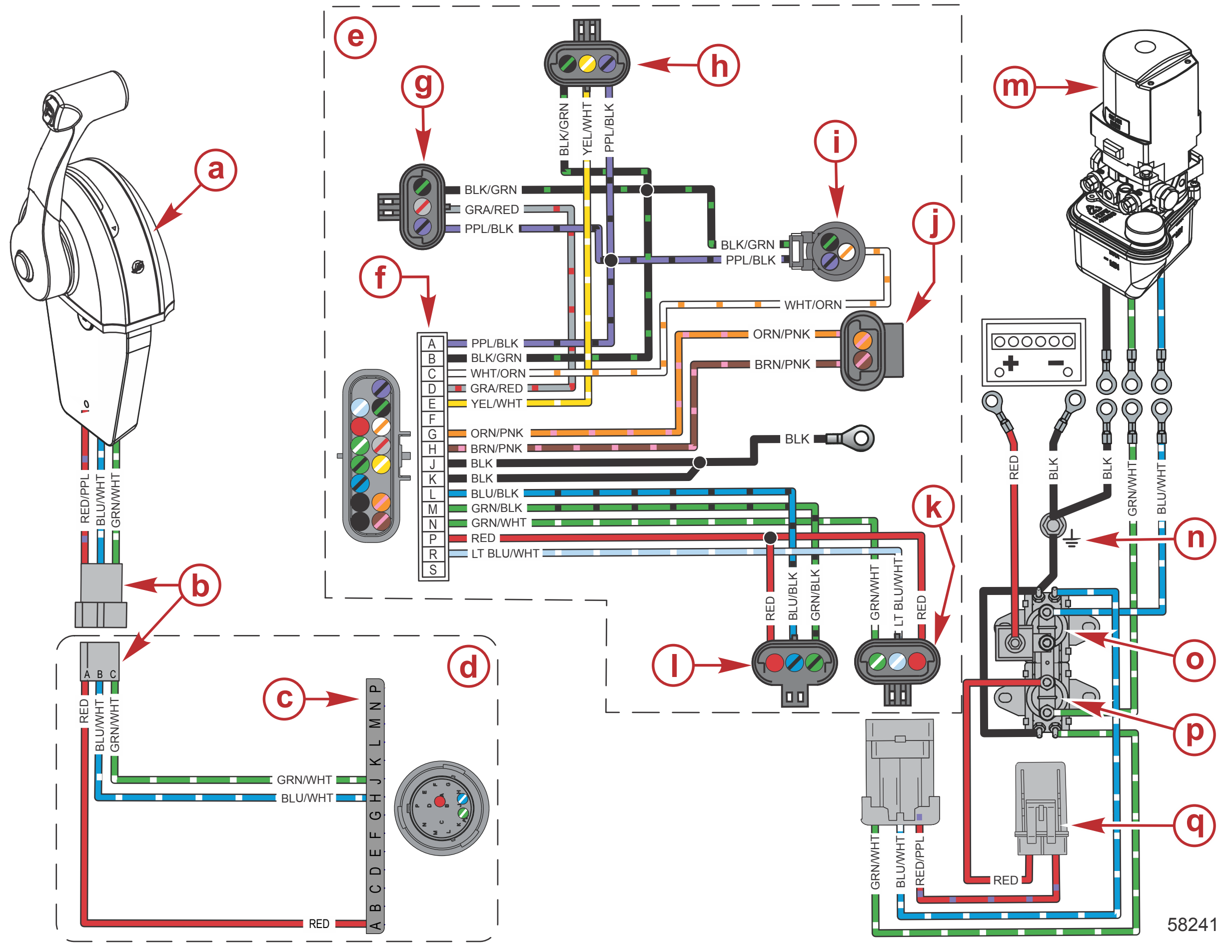
- a - Connection to control box
- b - Connection to transom harness
- c - Connections to trim limit switch

Power Trim System with a MerCruiser Remote Control



- **a -** MerCruiser remote control
- **b -** 4-pin Molex connector
- **c -** To ignition switch harness
- **d -** 3-pin connector
- **e -** Power trim extension harness
- **f -** Transom harness
- **g -** 16-pin connector to engine harness
- **h -** Steering
- **i -** Digital trim
- **j -** Pitot
- **k -** MerCathode
- **l -** Trim pump connection
- **m -** Helm trim switch
- **n -** Trim pump
- **o -** Ground
- **p -** Up solenoid
- **q -** Down solenoid
- **r -** 20-amp fuse
- **s -** Trim bypass (from transom harness)

Power Trim System with an Outboard Remote Control



- **a -** Outboard remote control
- **b -** 3-pin Molex connector
- **c -** 14-pin connector to engine harness
- **d -** Outboard ignition harness
- **e -** Transom harness
- **f -** 16-pin connector to engine harness
- **g -** Steering
- **h -** Digital trim
- **i -** Pitot
- **j -** MerCathode
- **k -** Trim pump connection
- **l -** Not used with the outboard remote control
- **m -** Trim pump
- **n -** Ground
- **o -** Up solenoid
- **p -** Down solenoid
- **q -** 20-amp fuse

14-Pin Engine Harness Connector

Mechanical 14-Pin Connector Pin-Out		
Pin	Wire Color	Function
A	Red/black	Clean power
B	Black	Clean ground
C	Purple	Wake
D	Black/yellow	E-stop
E	Blue/yellow	Oil pressure
F	White	CAN 1+
G	Blue	CAN 1–
H	Blue/black	Trim up
J	Green/black	Trim down
K	Orange/green	Trim gauge
L	Tan/Lt blue	Audio warning horn
M	Gray	Tachometer
N	Yellow/red	Crank
P	Brown	Temperature gauge

Axius Helm Installation (if Equipped)

If installing Axius, turn to Section 1 in the **Axius Installation Manual** and complete the appropriate procedures. Return here when finished and complete any other appropriate procedures in this section.

DTS Information and Installation

Special Tools - DTS Installation

Data Cable Puller	91-888462A1

Configuring the PCM Using the CDS

The computer diagnostic system (CDS) can communicate with the DTS command module. However, the CDS will not communicate with the PCM112 controller at this time. Refer to the following information when configuring the vessel or the engine using the CDS tool.

Configuring the PCM

The computer diagnostic system (CDS) will not configure the following, which require communication through the propulsion control module:

- Trailer and trim limit
- Engine location
- AutoSync-Enable/Disable
- Use CDS G3 for configuring above

Configuring the DTS Command Module

The CDS G3 can configure the DTS command module. Refer to the appropriate procedures to configure the following:

- Vessel configuration
- Handle adaptation
- CAN-based trackpad locations

Installation Guidelines for DTS System Components

⚠ WARNING
Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control. To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system.

Data Harness

⚠ WARNING

Prevent serious injury or death from a loss of boat control. Pulling on or flexing connectors can loosen terminals and cause open or intermittent electrical connections, which will interrupt control of throttle and shifting. Do not pull on cable connectors when pulling cables through the boat. Do not allow cables to flex at connection points. Fasten all electrical harnesses within 25 cm (10 in.) of any connection.

Connectors

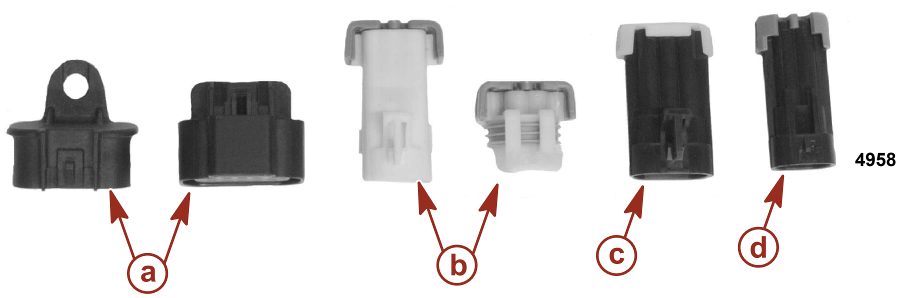
IMPORTANT: Connectors should never have to be forced into the receptacle. Ensure that connectors are free of any lubricant or dielectric grease before installation. When the connector is properly aligned, it will only take a small amount of pressure to insert it into the receptacle. Rotate the locking collar to secure the electrical connection.

NOTE: Connect only one data harness of the required length between the engine and helm. If a data harness is too short, do not connect multiple harnesses together to make up the required length. For installations requiring a data harness length longer than 12.2 m (40 ft), contact Mercury Marine for more information.

Weather Caps

Weather caps are to be used whenever there are any unused connectors on a harness. Verify all connections are tight to prevent moisture or corrosion occurring inside the connections.

Typical weather caps are as follows:



a - 10 pin cap
b - 5 pin cap
c - 3 pin cap
d - 2 pin cap

DTS Battery Specifications

IMPORTANT: Do not use deep cycle batteries for the main engine starting battery.
IMPORTANT: Boating industry standards (BIA, ABYC, etc.), federal standards and Coast Guard regulations must be adhered to when installing the battery. Ensure that battery cable installation meets the pull test requirements and that positive battery terminal is properly insulated in accordance with regulations.
IMPORTANT: It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.

Minimum SAE Starting Battery Requirements - BCI GRP 24	
MCA	1000
CCA	800
Ah	180 (International Rating)

NOTE: Due to the wide variety of battery manufacturers throughout the world, ratings and physical battery sizes will vary. Check with the manufacturer for a starting battery with a MCA, CCA, or Ah specification that will be equal to or greater than the SAE Standard J537 specified previously.

IMPORTANT: For DTS products, each engine must be equipped with its own starting battery. If your boat application requires additional battery loads for boat accessories or marine electronics, it is recommended that an auxiliary battery or batteries be installed.

⚠ WARNING

Failure to properly secure the battery leads can result in a loss of power to the Digital Throttle and Shift (DTS) system, leading to serious injury or death due to loss of boat control. Secure the battery leads to the battery posts with hex nuts to avoid loose connections.

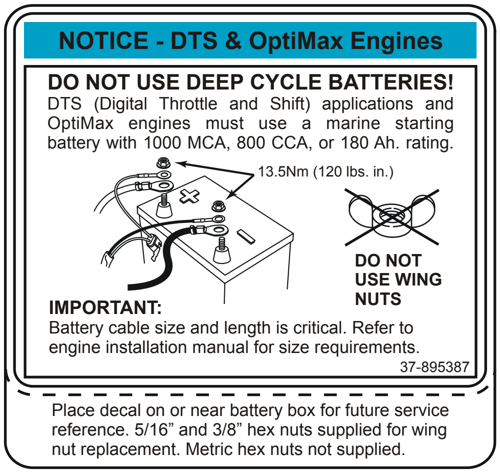
When connecting engine battery, hex nuts must be used to secure battery leads to battery posts. Torque nuts to specifications.

Description	Nm	lb. in.	lb. ft.
Hex nuts	13.5	120	

IMPORTANT: Battery cable size and length is critical. Refer to Battery Cable Size tables or engine installation manual for size requirements.

Spray terminals with a battery connection sealant to help retard corrosion.

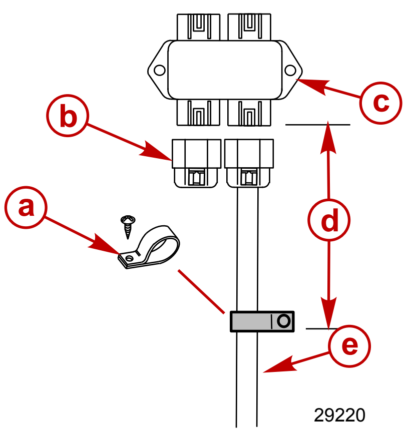
Decal needs to be placed on or near battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut are supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



3486

Junction Box (If Equipped)

- Although the junction box connections are watertight, it is recommended the junction box be mounted in an area that stays relatively dry.
- Mount in an area where the wiring connection will not get stepped on or disturbed.
- Mount in an area that is accessible for troubleshooting and servicing the system.
- Ensure the DTS command module harness will reach all the connection points.
- Fasten all junction box connections within 25.4 cm (10 in.) of the junction box.
- Seal all unused connections with weather caps.



a - Clamp
b - Weather cap (859318T 2)
c - Junction box
d - 25.4 cm (10 in.)
e - DTS command module harness

Electrical System

Section 4E - Electrical Components

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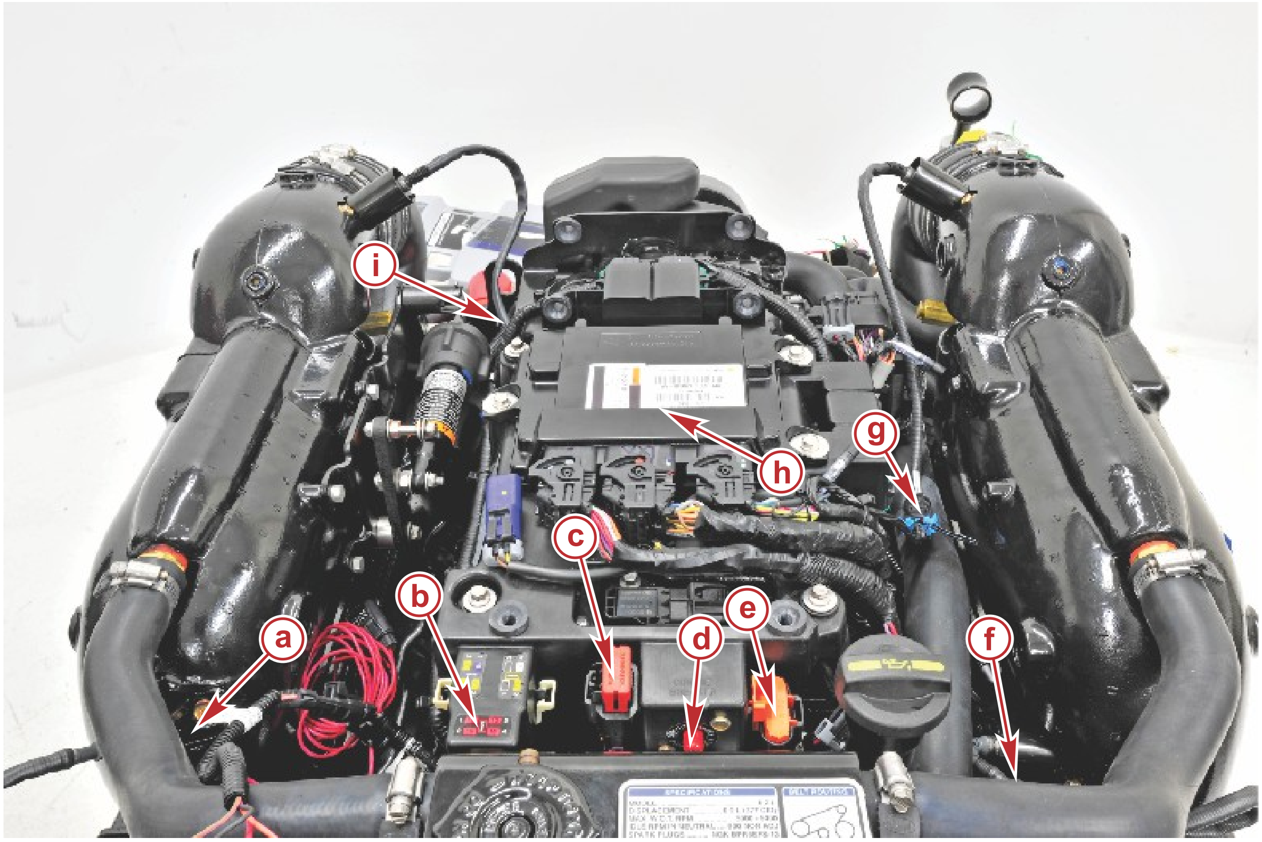
E

Engine Control and Sensor Locations

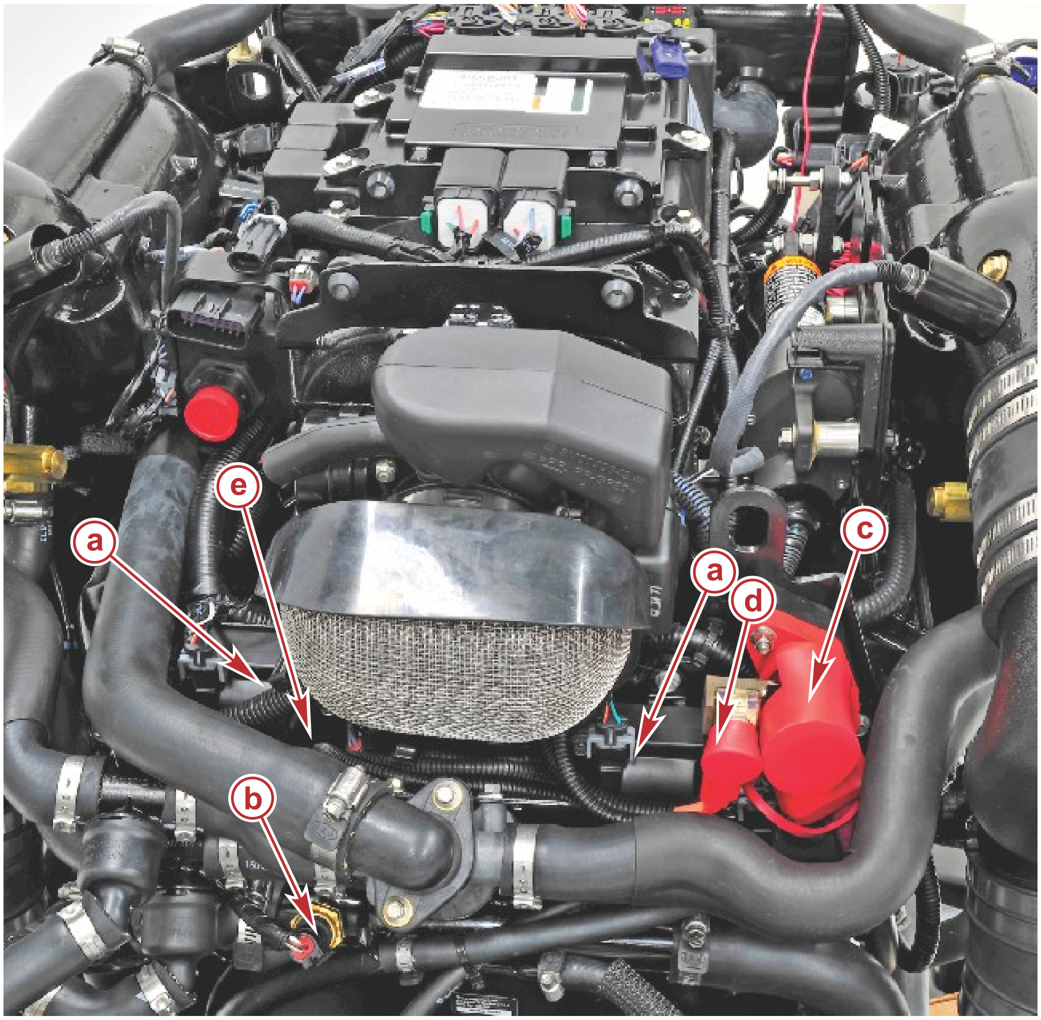
Front View



59412

a - Starboard precatalyst oxygen sensor connection
b - Fuses
c - 10-pin diagnostics
d - 50-amp circuit breaker
e - J1939 diagnostic connection
f - Port precatalyst oxygen sensor connection
g - Port postcatalyst oxygen sensor connection
h - PCM 112
i - Starboard postcatalyst oxygen sensor

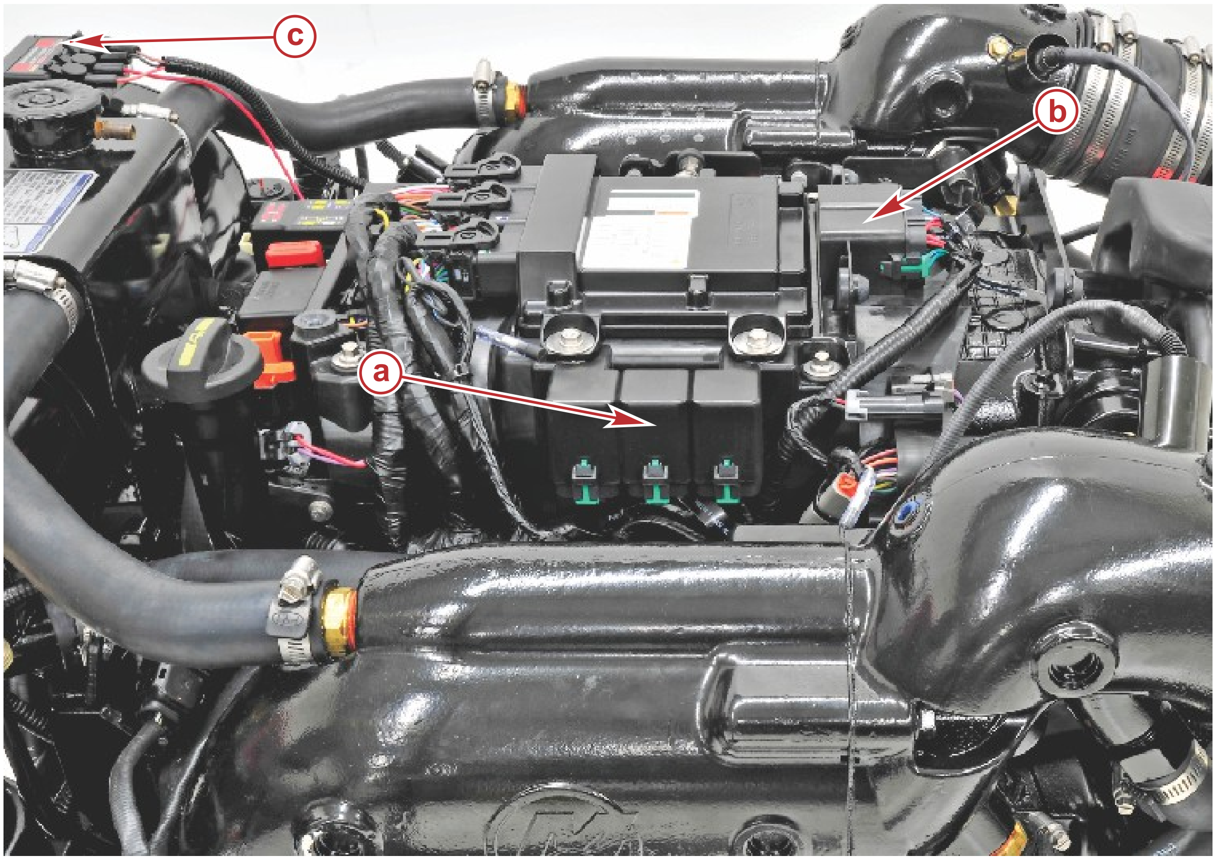
Rear View



59413

- **a -** Ignition coils (4)
- **b -** Seawater pump pressure sensor
- **c -** Hot stud
- **d -** 90-amp fuse
- **e -** Oil pressure sensor

Port Side View

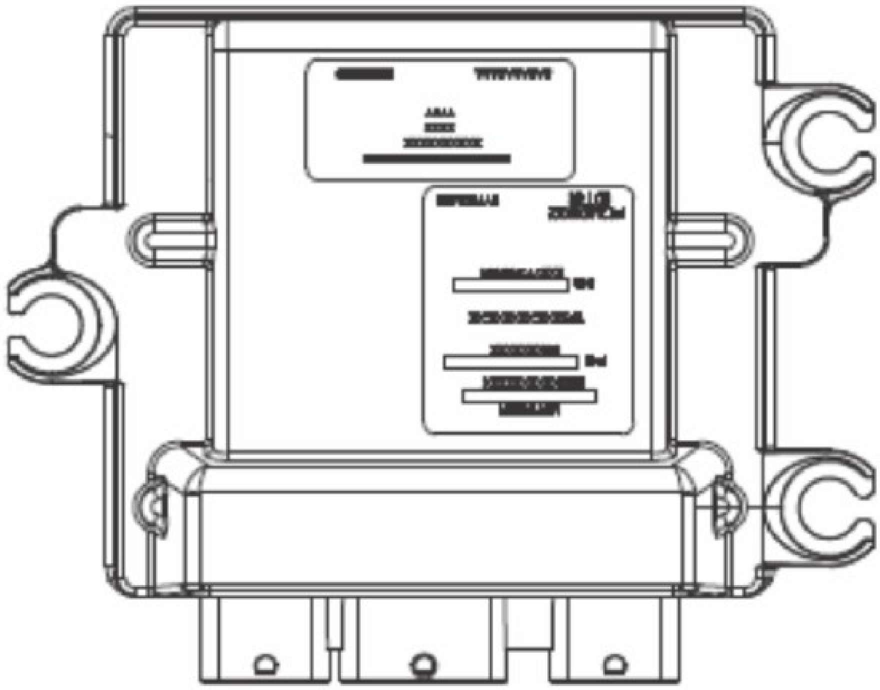


59414

- a - Fuel pump relays, starter relay, and main power relay
- b - Trim relays
- c - MerCathode

Propulsion Control Module (PCM)

PCM 112 Controller



56833

All engine models with or without emission control have a 112-pin propulsion control module (PCM) to manage closed-loop engine operation based on oxygen sensor feedback. The battery power requirements of the new PCM requires the use of a separate PCM power harness for clean power. This new PCM allows fault maintenance that conforms to the onboard diagnostics - marine (OBD-M) requirements mandated by California Air Resource Board (CARB) regulations.

The PCM 112 ignition system consists of a battery, PCM 112 controller, main power relay (MPR), fuse, crankshaft position sensor (CPS), ignition coil harnesses, ignition coils, spark plug wires, and spark plugs.

The PCM 112 controls all ignition system functions, and constantly adjusts dwell and spark timing. It uses engine speed and position information from the crankshaft to control the sequence, dwell, and timing of the spark. The PCM 112 also monitors information from various sensor inputs that include the following:

- The throttle position sensor (TPS)
- The engine coolant temperature (ECT) sensor
- The manifold air temperature (MAT) sensor
- The manifold absolute pressure (MAP) sensor

The ignition coil driver controls the ignition coils. The PCM 112 sends a signal to the ignition coil driver to complete the ground path for the coil primary winding 12-volt power source. After the proper dwell time has been reached, the PCM 112 signal is removed from the driver and the ground path for the coil primary winding is opened, causing the ignition coils to fire.

PCM Removal and Installation

⚠ WARNING
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

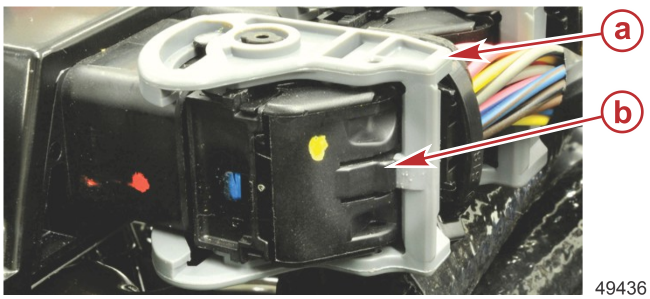
⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

IMPORTANT: The PCM is a sensitive electronic device that is subject to damage from electrostatic discharge. Do not touch the connector pins when removing or installing the module.

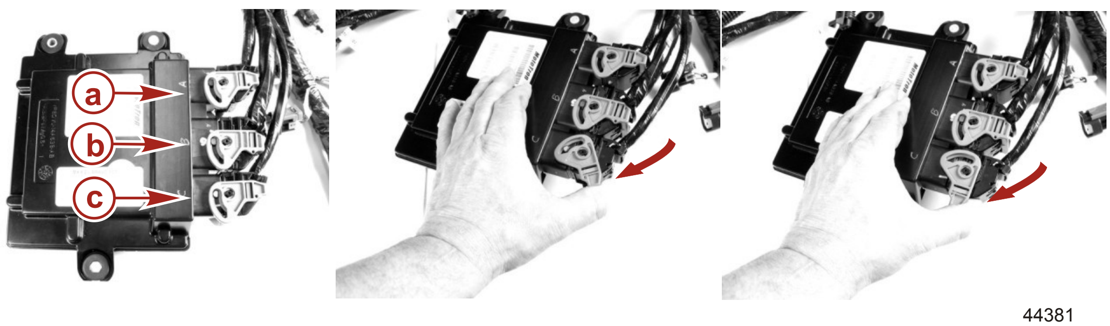
PCM Removal

1. Ensure that the battery cables are disconnected.
2. Remove the engine cover to gain access to the PCM.
3. Disconnect the PCM from the harness:
   a. Push in the tab on the side of PCM connector C and rotate the locking lever 90°, or until it clicks. Remove the connector from the PCM.



a - PCM connector locking lever
b - Locking lever tab

NOTE: When reinstalling the connectors, you will hear two clicks: once as you engage the locking mechanism on the harness connector to the pin on the PCM connector, and a second time as you rotate the lock to a full 90° to secure the connector.

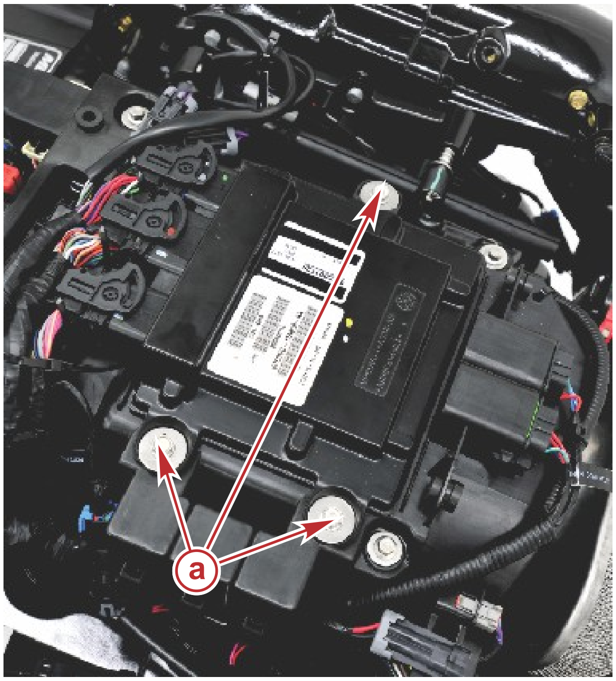


a - Connector A
b - Connector B
c - Connector C

   b. Remove connector B in the same manner.
   c. Remove connector A in the same manner.

NOTE: When installing the PCM, attach the connectors in the reverse order: connector A first, followed by connector B, and finally, connector C.

4. Remove the three screws that secure the PCM to the PCM bracket.



56835

a - PCM mounting screws

5. Remove the PCM from the engine.

PCM Cleaning and Inspection

NOTE: The PCM is a sealed electrical component. If it is defective, replace the PCM.

1. Clean the exterior of the PCM with a dry cloth. Do not touch the connector pins.
2. Inspect the outer surface for any obvious damage.
3. Visually inspect the electrical pins at both ends of the PCM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

PCM Installation

1. Mount the PCM to the bracket using the bushings, grommets, washers, and screws. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
PCM mounting screws	5	44.3	–

2. Connect and lock the electrical connectors to the PCM. Do not touch the connector pins.

PCM Diagnostics

Refer to **PCM 112 manual**.

Electrical System Overload Protection

If an electrical overload occurs, a fuse will blow or the circuit breaker will trip open. The cause must be found and corrected before replacing the fuse or resetting the circuit breaker.

50-Amp Main Circuit Breaker

The main circuit breaker is located at the front of the engine next to the engine oil fill port, beneath the engine cover. It provides overload protection for the engine wiring harness and the instrumentation power lead.

If the circuit breaker is of the push-button style, the circuit breaker can be reset by pushing in on the red button.

56869

Push-button style circuit breaker

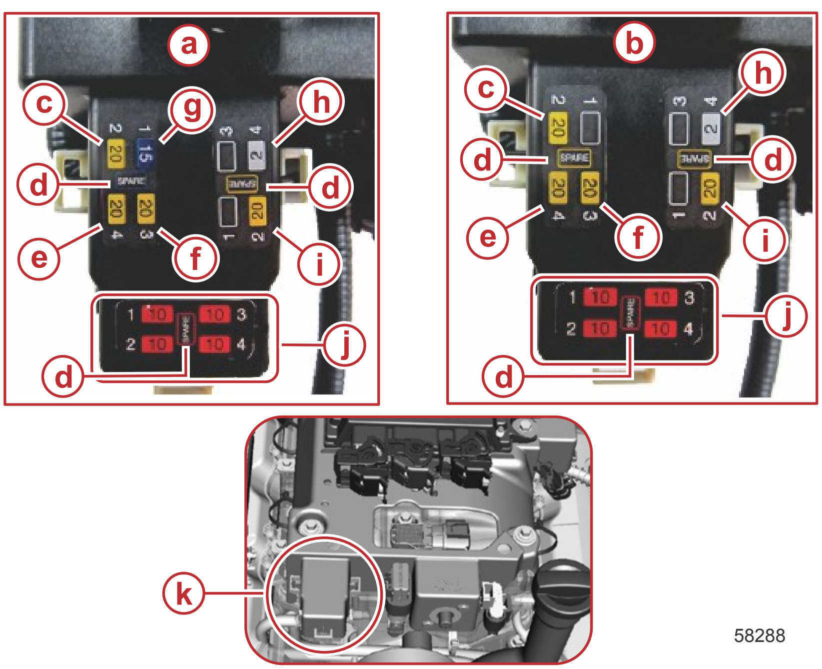
Fuses

IMPORTANT: When replacing fuses, always use the same style and current rating as the fuse being replaced.

- Fuses of a different style may not operate correctly, providing insufficient circuit protection.
- Fuses with a lower current rating will result in nuisance open circuits.
- Fuses with a higher current rating will not protect the circuit and components from overload.

Engine and Oxygen Sensor Fuses

All of the engine protection fuses are located at the front of the engine. To access the fuses, disengage the fuse holders from the electrical plate assembly.

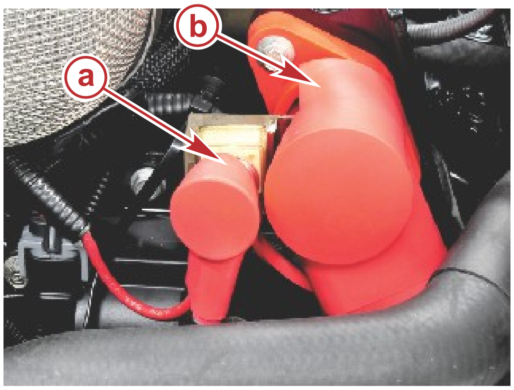


a - DTS engine
b - Mechanical engine
c - Engine and trim relays
d - Spare fuse
e - Alternator and fuel pump relay
f - Fuel injectors
g - DTS helm power
h - Malfunction indicator lamp (MIL)
i - Ignition coils
j - Oxygen sensor fuses (4)
k - Fuse holder location

58288

90-Amp Fuse

A 90-amp fuse, located next to the hot stud at the rear of the engine by the flame arrestor, protects the engine wiring harness from an electrical overload.

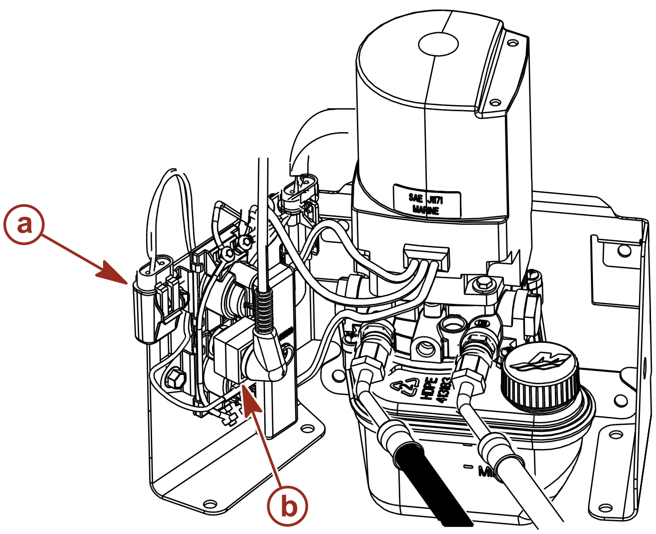


56871

- a - 90-amp fuse
- b - Hot stud

Power Trim Fuses

The power trim system is protected from overload by both a 110-amp fuse and a 20-amp spade fuse on the power trim pump. The trim pump may also have an in-line circuit protection device in the power trim positive lead near the battery switch or battery connection.



9208

- a - 20-amp spade fuse
- b - 110-amp fuse

Clean Power Fuse

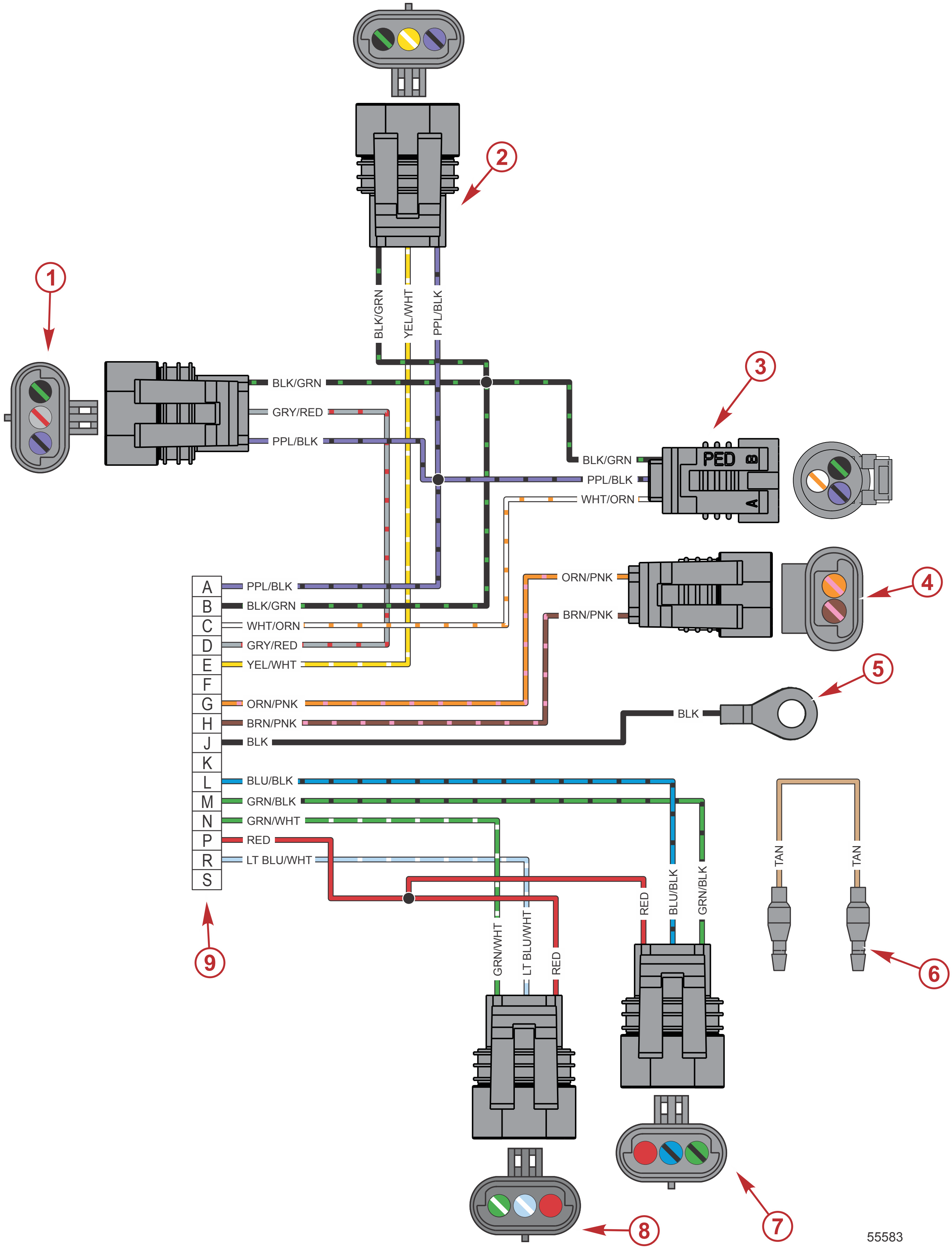
A power harness, connected to the engine starting battery, minimizes voltage drop to the electrical system. This harness is protected by a 5-amp fuse, located at the battery end of the harness.

MerCathode Fuse

For circuit protection, the MerCathode system has a 5-amp blade fuse connected into the controller's positive (+) lead. If the fuse is open, the system will not operate and will not protect against corrosion. Replace an open fuse with the same style and rating as that which is removed.

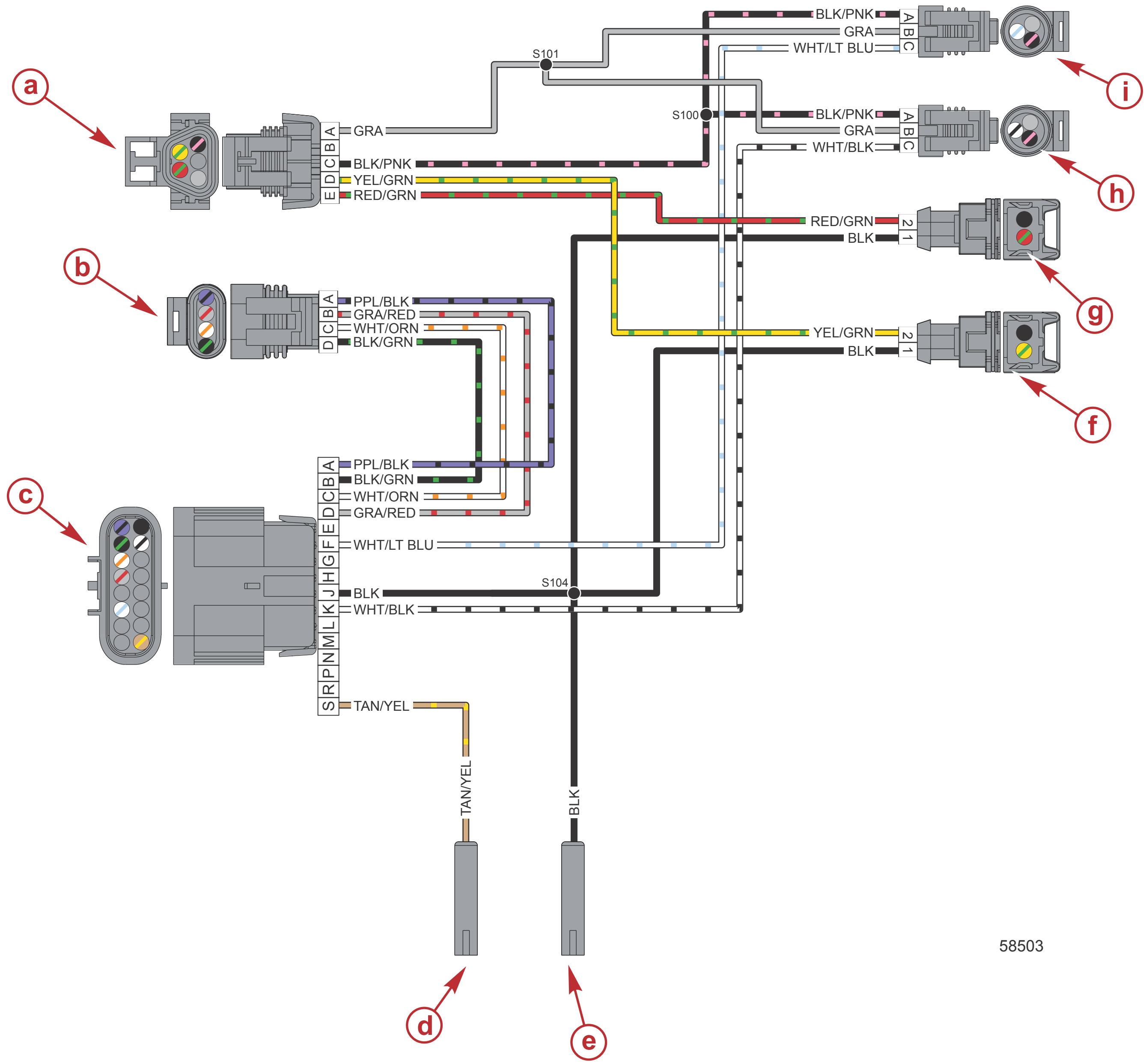
Transom Harness

Transom Harness Wiring Diagram (Sterndrive)



1 - Steering
2 - Digital trim
3 - Pitot
4 - MerCathode
5 - Ground
6 - Trim bypass
7 - Trim from helm
8 - Trim pump
9 - 16-pin connector

Transom Harness Wiring Diagram (TowSport, Inboard)



a - Transmission shift sensor
b - Steering/pitot sensor
c - 16-pin transom harness connector
d - Transmission over-temperature sensor
e - Trim/transmission over-temperature sensor ground
f - Shift solenoid B
g - Shift solenoid A
h - Reverse pressure sensor
i - Forward pressure sensor

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Fuel System

Section 5A - MPI ECT Fuel System

Table of Contents

Precautions

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

⚠ WARNING

Neglect or improper maintenance, repairs, or inspections of the power package can result in product damage or serious injury or death. Perform all procedures as described in this manual. If you are not familiar with proper maintenance or service procedures, consign the work to an authorized Mercury Marine dealer.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Explosive fumes contained in the engine compartment can cause serious injury or death from fire or explosion. Before starting the engine, operate the bilge blower or vent the engine compartment for at least five minutes.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

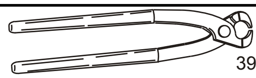
IMPORTANT: To avoid damaging the electrical system, follow these precautions:

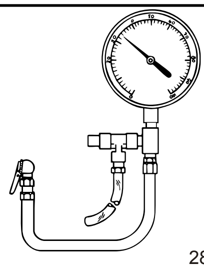
- Do not tap accessories into the engine harness.
- Do not puncture wires for testing (probing).
- Do not reverse the battery leads.
- Do not splice wires into the harness.
- Do not attempt diagnostics without the proper, approved service tools.

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	The threads of the barbed hose fitting	92-809822
66	Loctite 242 Threadlocker	Threads of the throttle body mounting screws	92-809821
95	2-4-C with PTFE	O-rings Seal grommet Fuel pressure regulator O-rings O-rings and seal grommets	92-802859A 1

Special Tools

Clamp Tool	91-803146T
 39648	Used to clamp high pressure (Oetiker ®) hose clamps. Part of Clamp Tool Kit (91-803146A4).

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS).

Fuel Pressure Specifications

Conditions	Reading on Fuel Pressure Gauge
Approximate fuel pressure at idle	280–310 kPa (40.6–45.0 psi)
Approximate fuel pressure engine not running	340–370 kPa (49.3–53.7 psi)

Fuel Requirements

NOTICE
Running out of fuel can damage catalyst components. Do not allow the fuel tanks to become empty during operation.

IMPORTANT: Use of improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine and will not be covered under the limited warranty.

Fuel Ratings

Mercury MerCruiser engines will operate satisfactorily with any major brand of unleaded gasoline that meets the following specifications:

USA and Canada - A posted pump octane rating of 87 (R+M)/2, minimum, for all models. Premium gasoline 91 (R+M)/2 octane is also acceptable for all models. **Do not** use leaded gasoline.

Outside USA and Canada - A posted pump octane rating of 91 RON, minimum, for all models. Premium gasoline (95 RON) is also acceptable for all models. **Do not** use leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and is acceptable for use in your Mercury Marine engine. The only oxygenate currently in use in the USA is alcohol (ethanol, methanol, or butanol).

Gasoline Containing Alcohol

Bu16 Butanol Fuel Blends

Fuel blends of up to 16.1% butanol (Bu16) that meet the published Mercury Marine fuel rating requirements are an acceptable substitute for unleaded gasoline. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Methanol and Ethanol Fuel Blends

IMPORTANT: The fuel system components on your Mercury Marine engine will withstand up to 10% alcohol (methanol or ethanol) content in the gasoline. Your boat's fuel system may not be capable of withstanding the same percentage of alcohol. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing methanol or ethanol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Likelihood of phase separation (water and alcohol separating from the gasoline in the fuel tank)

⚠ WARNING
Fuel leakage is a fire or explosion hazard, which can cause serious injury or death. Periodically inspect all fuel system components for leaks, softening, hardening, swelling, or corrosion, particularly after storage. Any sign of leakage or deterioration requires replacement before further engine operation.

IMPORTANT: If you use gasoline that contains or might contain methanol or ethanol, you must increase the frequency of inspection for leaks and abnormalities.

IMPORTANT: When operating a Mercury Marine engine on gasoline containing methanol or ethanol, do not store the gasoline in the fuel tank for long periods. Cars normally consume these blended fuels before they can absorb enough moisture to cause trouble; boats often sit idle long enough for phase separation to take place. Internal corrosion may occur during storage if alcohol has washed protective oil films from internal components.

Priming the Fuel System

IMPORTANT: Use a portable fuel tank with a primer bulb fuel line.

⚠ WARNING
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

1. Disconnect the fuel line from the fuel tank to the fuel inlet fitting and plug the line, if attached to the engine.
2. Attach portable fuel tank to the fitting and secure tightly.
3. Squeeze the primer bulb until the bulb becomes firm.
4. Turn the ignition switch to the "RUN" position for 3 seconds and then turn OFF.

   NOTE: Do not turn the key switch to the "START" position during the priming.
5. Repeat Step 3. and Step 4. three more times.

   IMPORTANT: Before disconnecting the fuel line primer bulb, ensure that the bulb is soft and does not still have fuel in it to prevent spilling fuel.
6. Disconnect the primer bulb fuel line from the fuel inlet fitting.
7. Remove the plug from the fuel tank fuel line.
8. Attach the fuel line from the fuel tank to the fuel inlet and tighten securely.

Alternate Priming Procedure for Fuel System

Fabricating a Pressure-Relief Collection Tool

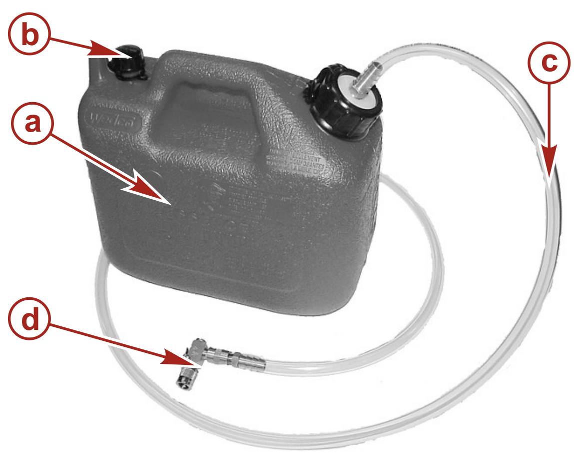
In order to take advantage of the alternative Priming Procedure a new pressure relief collection tool will need to be fabricated.

A 1.5 m (5 ft) length of hose will work for most applications. A longer or shorter length of hose may be used to meet your specific needs. **Example:** To ensure the hose is visible from the helm of a cruiser would require a much longer hose than would be required for a runabout. The smaller diameter hose works best when using a long hose to reduce the amount of time and fuel needed to become visible in the hose.

IMPORTANT: All components must be fuel rated and must be inspected regularly to ensure the tool is in safe working condition.

Supplies needed:

- One-gallon fuel can (collection tank) with separate vent.
- Clear hose (the hose can be from 3 mm to 9 mm [1/8 in. to 3/8 in.] diameter). The smaller diameter hose works best when using a long hose to reduce the amount of time and fuel needed to become visible in the hose.
- Appropriate sized barbed hose fitting.
- Fuel pressure adapter (90-803135) from Mercury or other equivalent adapter.



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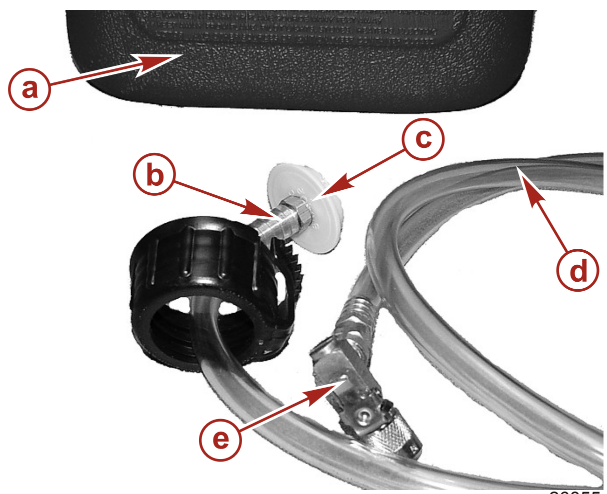
Pressure relief collection tool

a - One-gallon fuel can (collection tank)
b - Separate fuel can vent
c - Clear hose
d - Fuel pressure adapter (90-803135)

In the following example a hole was drilled through the cap. The cap was tapped according to the size of the barbed hose fitting being used. Sealant was applied to the threads of the barbed hose fitting and the fitting was threaded into the cap. The clear hose was connected to the barbed hose fitting and the fuel pressure adapter attached to the other end of the clear hose.



26855

a - One-gallon fuel can (collection tank)
b - Barbed hose fitting
c - Cap
d - Clear hose
e - Fuel pressure adapter

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	The threads of the barbed hose fitting	92-809822

Priming the Fuel System

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

Using Fuel from the Boat Tank

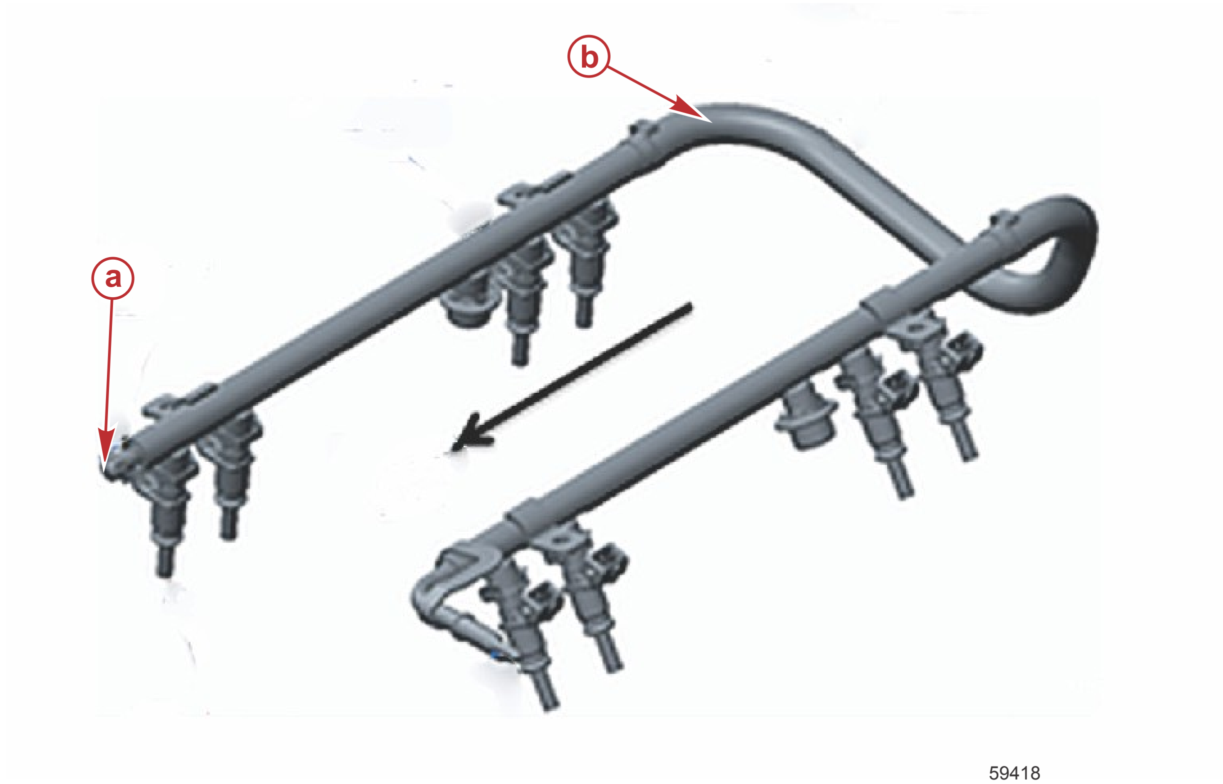
The fuel system is connected to the fuel tank on the boat and fuel is in the tank. This method does not require the use of a portable fuel tank.

Using Fuel from a Portable Tank

A portable fuel tank is connected to the engine and no fuel is in the boat fuel tank. After test running the engine connect the fuel line from the boat fuel tank to the fuel system. Follow the precautions in the appropriate **Mercury MerCruiser Installation Manual** for disconnecting the portable fuel tank and reconnecting the fuel line from the boat fuel tank to the boat fuel system.

The following procedure is the alternative method for priming the fuel system on all MPI models.

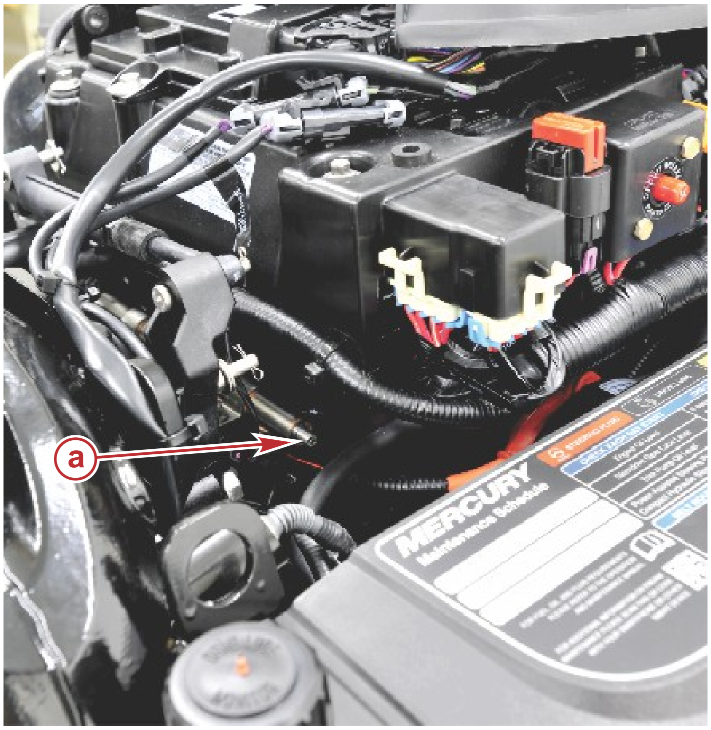
1. Remove the cap from the fuel pressure test port.



a - Fuel pressure test port
b - Fuel rail

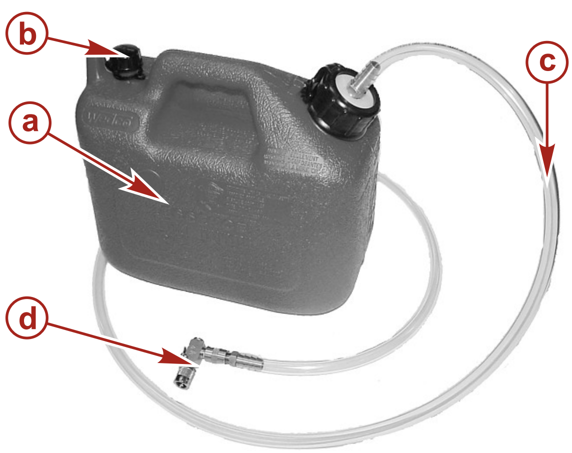
2. Open the vent on the pressure relief collection tank and connect the pressure relief tool to the fuel pressure test port.
3. Place the collection tank in a convenient location to ensure the clear hose is viewable from the helm.
4. Turn the ignition key to the on position. Do not turn the ignition key to the start position.
5. When the fuel pump stops running, turn the key off.
6. Again, turn the key back to the on position. Do not turn the ignition key to the start position.

7. Repeat this cycle until fuel is visible in the clear hose. Fuel does not have to reach the collection tank. Once fuel is visible in the clear line, the air has been evacuated and the system is primed.



56000

a - Fuel pressure test port on fuel rail



26854

Pressure relief collection tool

a - One-gallon fuel can (collection tank)
b - Separate fuel can vent
c - Clear hose
d - Fuel pressure adapter (90-803135)

8. Remove the pressure relief tool from the fuel pressure test port and install the cap.
9. Wipe up any fuel that may have spilled.
10. Ventilate the engine compartment.
11. After priming the fuel system, continue the engine preparation. Refer to the appropriate **Mercury MerCruiser Installation Manual**. All other procedures in the installation manual remain the same.

Important Information

Low Permeation Fuel Lines

Beginning in 2007 all spark-ignition marine inboard and sterndrive engines sold in California must use low permeation fuel supply and return lines to comply with applicable California Air Resources Board (CARB) regulatory standards.

Fuel Supply Connections

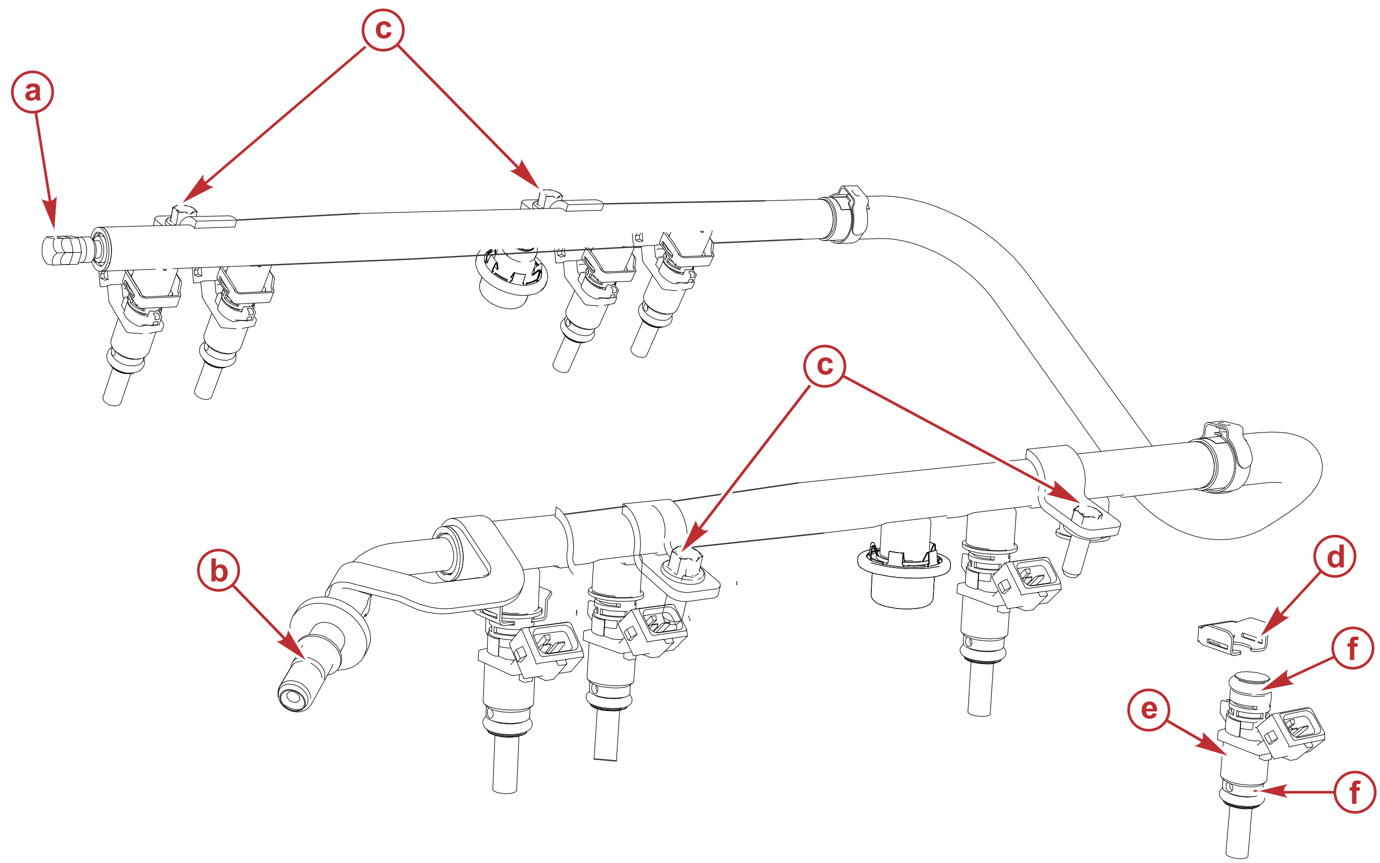
⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

- Use Loctite 567 Pipe Sealant on the threads of fuel inlet fittings or plugs. **Do not use PTFE tape.**
- Fuel inlet fittings or plugs should first be threaded into the fuel pump or fuel filter base until they are finger-tight.
- Fuel inlet fittings or plugs should then be tightened an additional 1-3/4 to 2-1/4 turns using a wrench. Do not overtighten.
- To prevent fitting damage or overtightening when installing a fuel line, the fittings should be held with a suitable wrench as the fuel line connectors are tightened securely.

Exploded Views

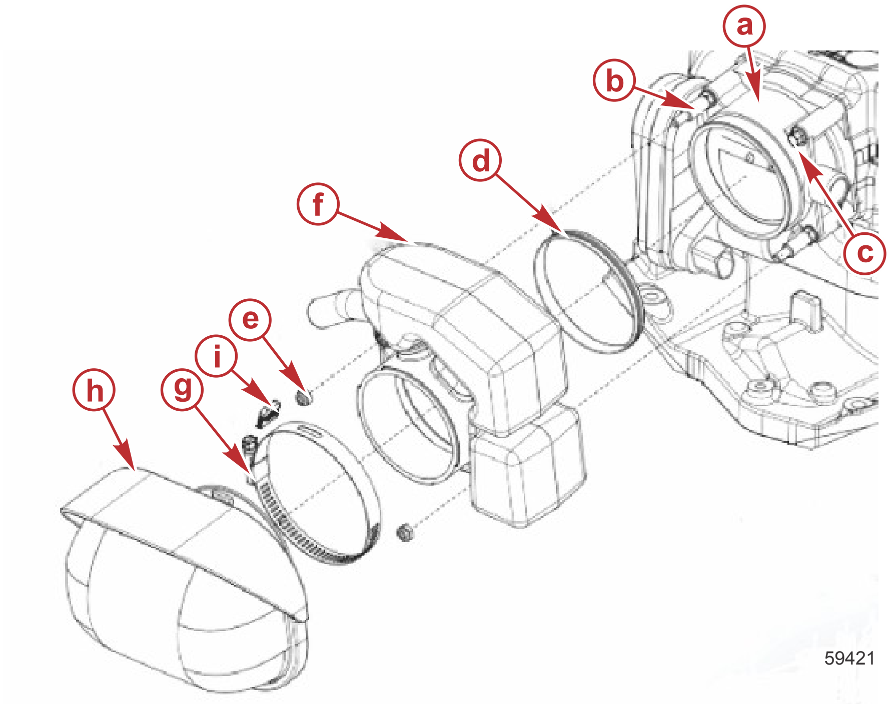
Fuel Rail Exploded View



59419

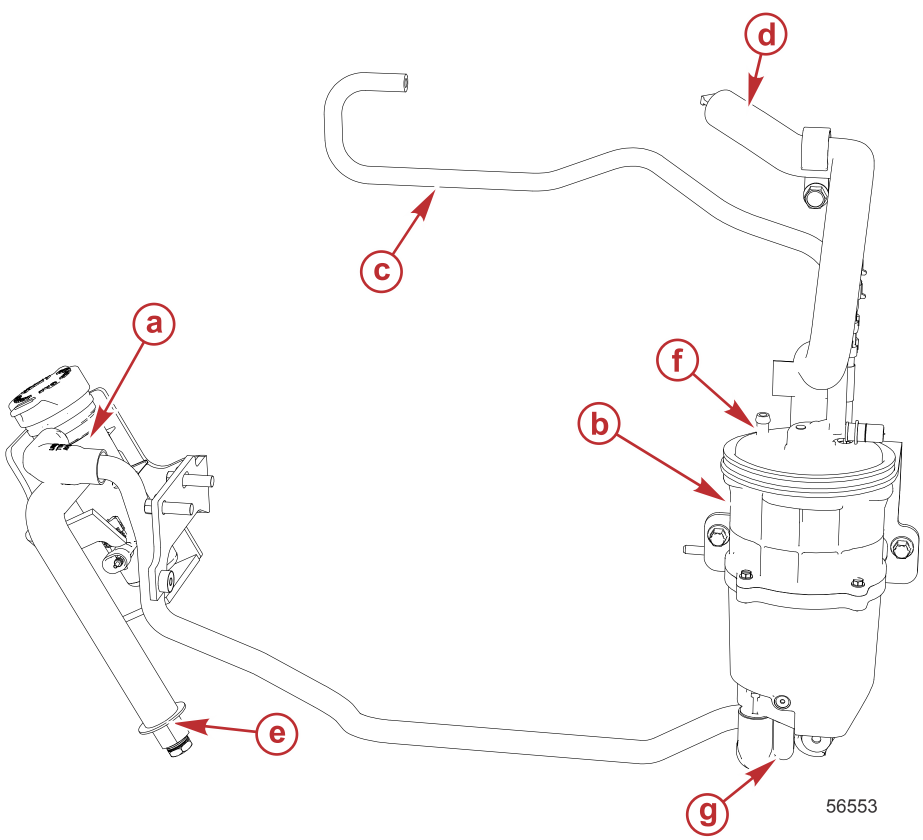
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
a	1	Schrader valve			
b	1	Fuel connection			
c	4	Fuel rail mounting screws	12.2	108	–
d	6	Fuel injector retainer			
e	6	Fuel injector			
f	12	O-ring			

Throttle Body



a - Throttle body
b - Stud (2)
c - Screw (2)
d - Seal
e - Nut (2)
f - Resonator
g - Clamp
h - Flame arrestor
i - Clamp cover

Fuel System Module



a - Water-separating fuel filter
b - Fuel supply module
c - Manifold hose
d - Hose to fuel rail
e - Supply hose
f - Cooling hose
g - Hose to strainer assembly

Fuel System

Fuel Delivery System

⚠ WARNING

Failure to comply with the required boating standards can result in serious injury or death. Always adhere to all applicable Marine Regulations (United States Coast Guard [USCG], European Union - Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) when installing the fuel delivery system.

IMPORTANT: Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

- An anti-siphon valve is required by the US Coast Guard.
- All spark-ignition marine inboard and sterndrive engines sold in California must use low permeation fuel supply and return lines to comply with applicable California Air Resources Board regulatory standards. Low permeation fuel line hose is defined as not exceeding 15 g/m²/24 h with CE10 fuel at 23° C as specified in SAE J 1527–marine fuel hoses.
- Flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.
- Fuel lines and fittings must be Coast Guard approved (USCG type A1), and not be smaller than 10 mm (3/8 in.) I.D.
- Multiple engine installations: It is best to use a fuel pickup and supply line for each engine. If a single pickup and supply line is used, fittings and line must not be smaller than 13 mm (1/2 in.) I.D.
- Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
- The tank breather pipe must have an inner diameter of at least 13 mm (1/2 in.) and must be fitted with a swan neck to prevent water from entering the tank.
- The filler pipe outer diameter should be at least 50 mm (2 in.).
- All connections should be on the upper side of the tank.
- A drain plug at the lowest point on the tank will permit removal of water and sediment.
- Establish the exact route and length of the fuel lines at the first installation of the engine to prevent problems later in connecting them to the engine.
- To prevent chafing, holes where the lines run through the bulkheads should be rounded off or protected with rubber grommets and fuel lines must be well secured.
- The fuel pickup should be at least 25 mm (1 in.) from the fuel tank bottom to prevent picking up impurities.
- The maximum measured vacuum at the engine's fuel inlet must not exceed 2 in. Hg or 6.9 kPa (1 psi) at idle, 3000 RPM, and full throttle RPM.

Special Information About Electric Fuel Pumps

IMPORTANT: The electric fuel pump and factory installed water-separating fuel filter have been carefully designed to function properly together. Do not install additional water-separating fuel filters between the fuel tank and the engine. Use the Mercury in-line fuel filter with the boost pump.

The installation of additional filters may cause:

- Vapor lock
- Difficult warm-starting
- Piston detonation due to lean fuel mixture
- Poor driveability

Anti-Siphon Valve

U.S. boating standards and regulations specify that an anti-siphon valve be used on any application where any portion of the fuel line falls below the top of the fuel tank. This valve serves to minimize the amount of fuel that could leak into the bilge of the boat in the event of a fuel system leak. A mechanical anti-siphon valve or an electrically operated fuel shut off valve is acceptable for this purpose and should be installed in accordance with industry standards and the manufacturer's instructions. The mechanical valve must be carefully sized to the fuel pressure head produced in a given application (a function of the fuel level height between the lowest and highest point in the system). The valve must check the flow of fuel when the engine is not running, yet avoid excessive restriction when the engine is operating. An overall fuel system pressure drop of 6.9 kPa (1 psi) or less is desirable but may not be achievable in all cases.

Fuel Supply Module (FSM)

FSM Removal

1. Release the fuel pressure on the fuel rail. Refer to **Fuel Rail Removal**.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

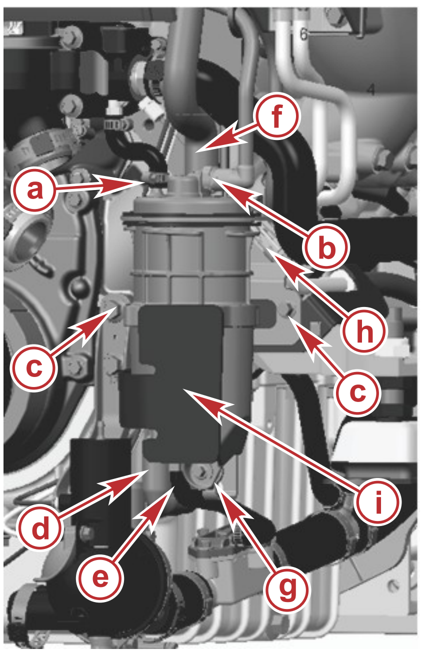
IMPORTANT: The FSM does not have a drain port incorporated into the upper or lower housing. If the FSM requires disassembly, the extraction of fuel in the FSM can be accomplished with the following method. Disconnect the fuel supply hose on the FSM. Attach a fuel pressure gauge to the fuel rail test port. Drain the fuel with the pressure gauge into an appropriate container by turning the key switch "ON" several times while holding the purge valve open, or use the CDS G3 diagnostic interface tool to energize the fuel pumps.

2. Disconnect all batteries from the engine and disconnect the FSM electrical connector.

⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

3. Loosen the clamp on the water hose to crossover and remove the hose.



56557

- a - Water hose to crossover
- b - To intake manifold vacuum line
- c - Bracket mount screws (2)
- d - Line to fuel filter
- e - Hose to strainer
- f - Hose to injector rail
- g - FSM mount screw
- h - FSM electrical connector
- i - Bracket

4. Push the blue release button of hose to injector rail at the rail.
5. Push the blue release button intake manifold vacuum line and remove the line.
6. Remove line to fuel filter by pushing the blue release button.
7. Remove hose to strainer at the stainer by removing the worm drive clamp.
8. Remove the two bracket mounting screws and remove the FSM and bracket assembly.
9. Remove one FSM mount screw and remove FSM from the bracket.
10. Remove Oetiker® clamp from hose to strainer and remove the hose.

FSM Disassembly

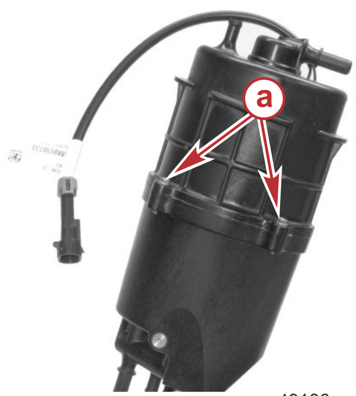
NOTE: *The FSM cannot be completely drained of fuel prior to disassembly. Use appropriate containers to capture fuel during the disassembly process. Wipe up fuel spills immediately and dispose of in an appropriate container.*

1. Place the FSM in an appropriate container to capture any fuel that will spill.

2. Remove the metal hose clamp securing the high-pressure hose to the FSM upper housing and remove the hose.

57375

3. Remove the four screws securing the upper housing to the lower housing.



49136

a - Screws (4)

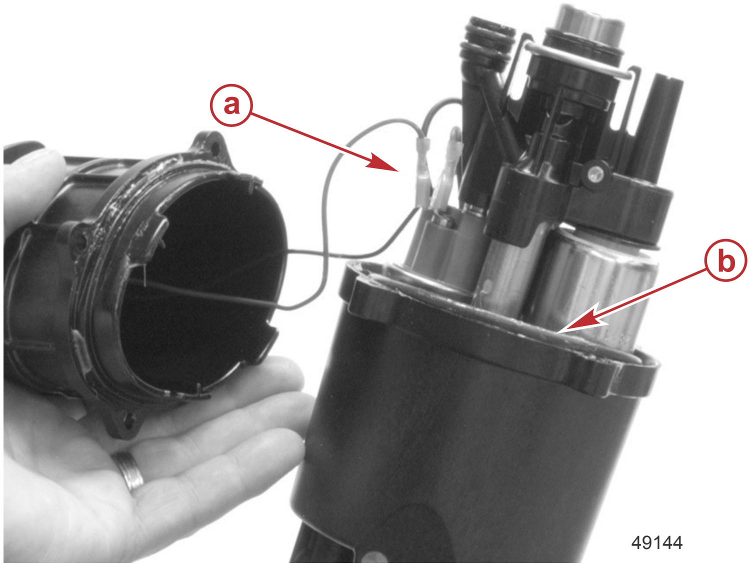
4. Grasp the lower housing and the upper housing and pull the upper housing slightly to partially separate the upper housing from the lower housing.
5. Insert two pry tools between the upper and lower housing and carefully separate the housing.

   NOTE: *Use caution when separating the housing. The lower housing may be completely filled with fuel.*

49141

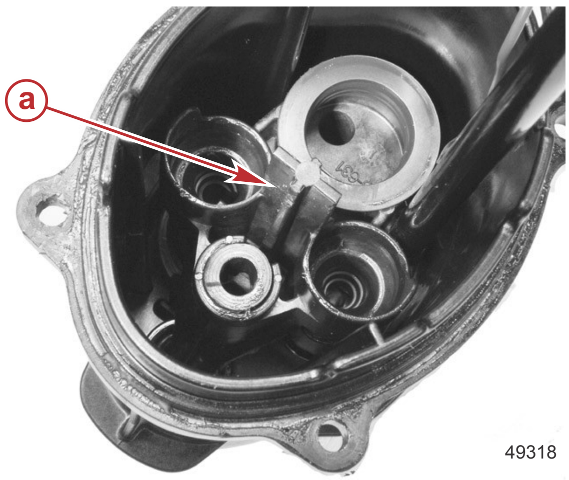
6. Carefully lift the upper housing to access the power wire connections.

7. Disconnect the upper housing power wires from the fuel pump connectors and remove the O-ring.



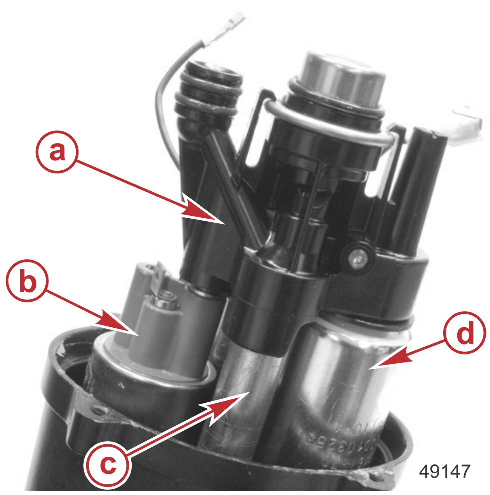
a - Power wires
b - O-ring

NOTE: Some of the internal components may be adhering to the upper housing when separated. Remove the fuel pumps with an appropriate tool. Use caution not to twist the fuel pumps when removing them. Use a vice grip tool to clamp onto the manifold webbing and pull the manifold out of the upper housing.



a - Manifold webbing

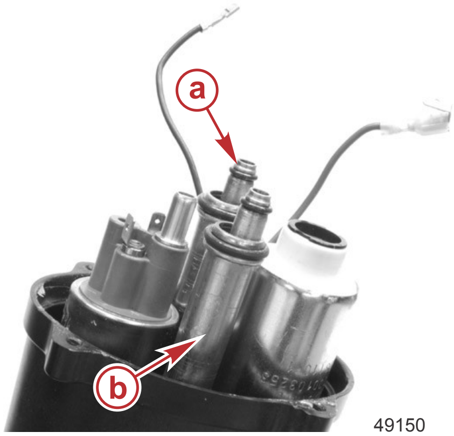
8. Remove the manifold from the tubes and fuel pumps.



a - Manifold
b - Fuel lift pump
c - Tubes (4)
d - High-pressure fuel pump

9. Remove the tubes and fuel pumps from the lower housing.

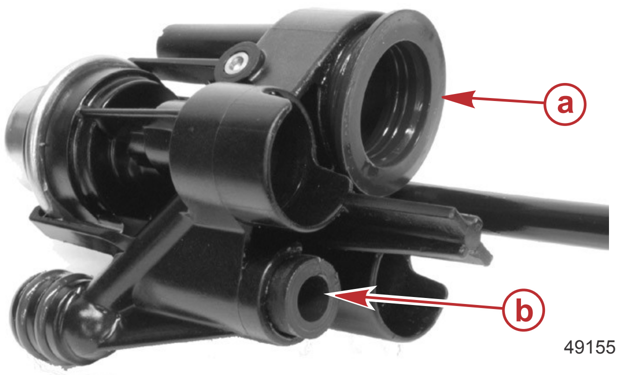
IMPORTANT: If the fuel pumps are difficult to remove, use an appropriate tool to extract them. Use caution not to twist the fuel pumps when removing.



49150

a - Fuel tube (2)
b - Water tube (2)

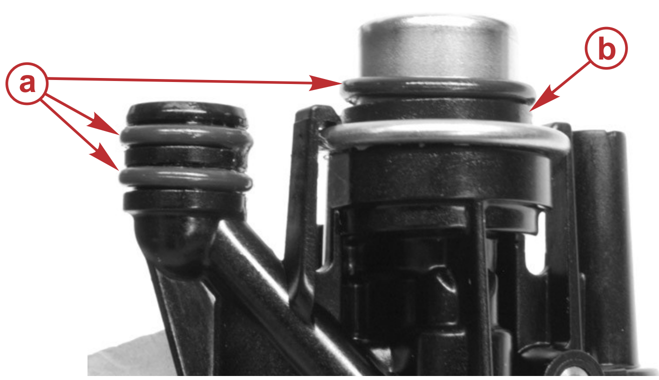
10. Remove the seal grommets from the manifold.



49155

a - High-pressure fuel pump seal grommet
b - Fuel lift pump seal grommet

11. Remove three O-rings and a spacer from the manifold.

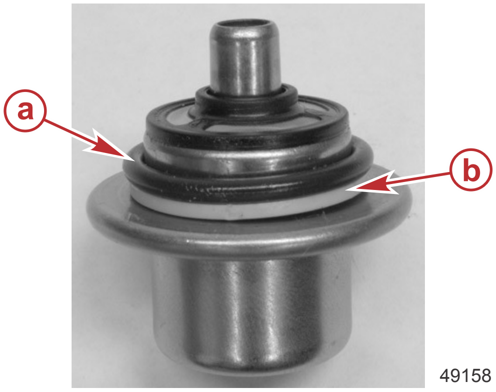


49156

a - O-rings
b - Spacer on fuel pressure regulator

12. Carefully spread the retainers and remove the fuel pressure regulator.
    IMPORTANT: Use extreme care not to spread the retainers excessively. Spreading the retainers excessively will cause the retainer to break off the manifold.

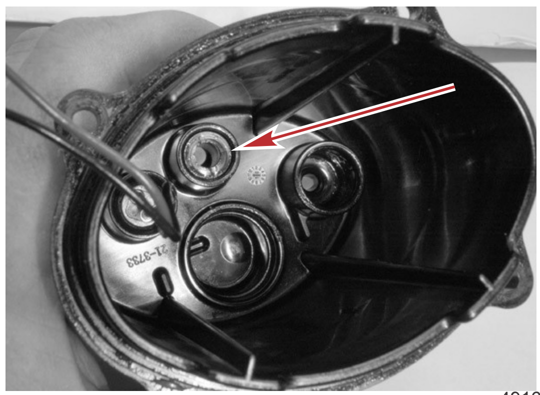
13. Remove the O-ring and spacer from the fuel pressure regulator.



49158

a - O-ring
b - Spacer

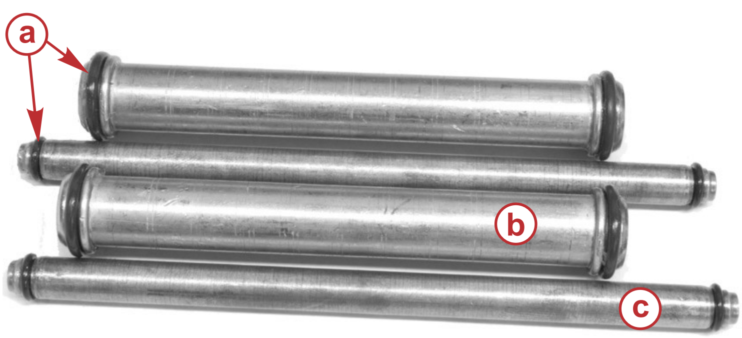
14. Inspect the inside of the upper and lower housings for seal grommets and remove them.


49162

15. Remove the fuel pump wire harness seal grommet from the upper housing by pushing on the seal grommet from the outside of the upper housing with a blunt tool.

FSM Assembly

1. Install the O-rings onto the water tubes and fuel tubes.
2. Lubricate the O-rings on the tubes with 2-4-C with PTFE.

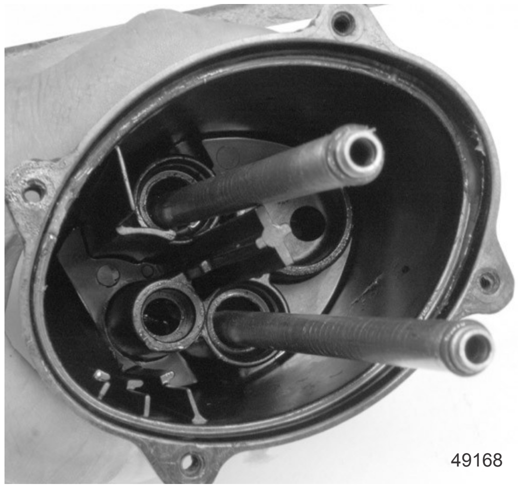


49167

a - O-rings
b - Water tube
c - Fuel tube

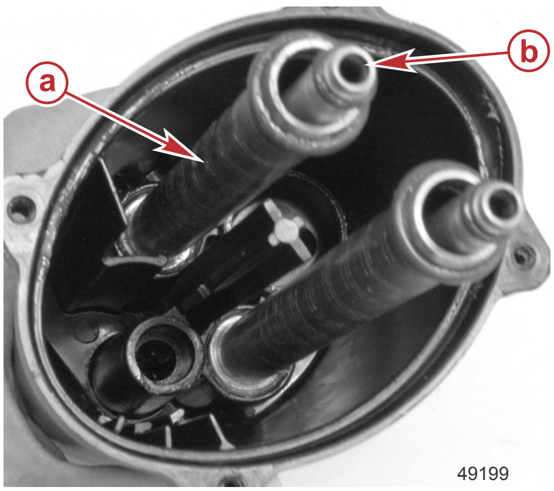
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-rings	92-802859A 1

3. Install the fuel tubes into the lower housing.



49168

4. Install the water tubes.



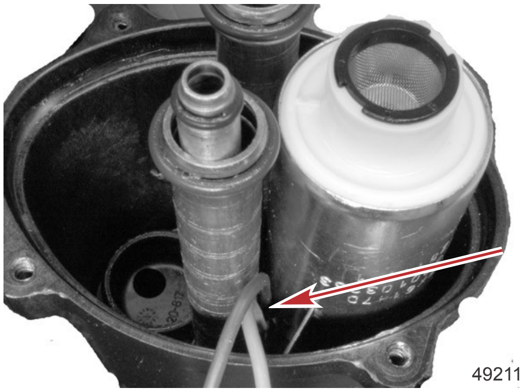
49199

a - Water tube
b - Fuel tube

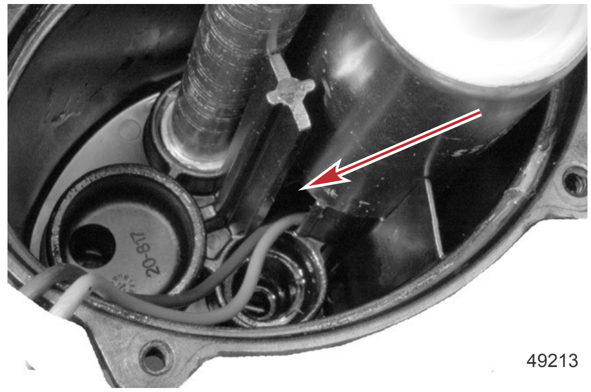
5. Install the seal grommet halfway onto the high-pressure fuel pump outlet.

49206

6. Lubricate the seal grommet with 2-4-C with PTFE and install the high-pressure fuel pump into the lower housing so the wires are between the webbing and the water tube.



Wires between webbing



Close up view without tube installed

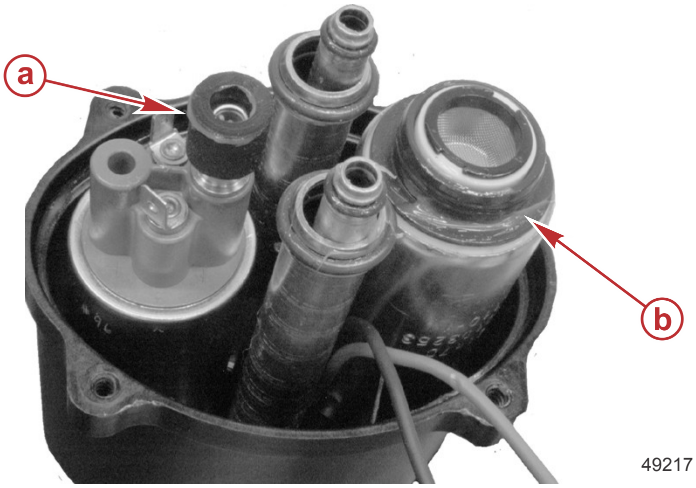
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Seal grommet	92-802859A 1

7. Install the seal grommet onto the fuel lift pump and lubricate with 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Seal grommet	92-802859A 1

8. Install the fuel lift pump into the lower housing so the outlet port of the pump faces towards the center of the FSM.
9. Install the seal grommet halfway onto the outlet port of the fuel lift pump.
10. Install the seal grommet onto the high-pressure fuel pump.

11. Lubricate both seal grommets with 2-4-C with PTFE.

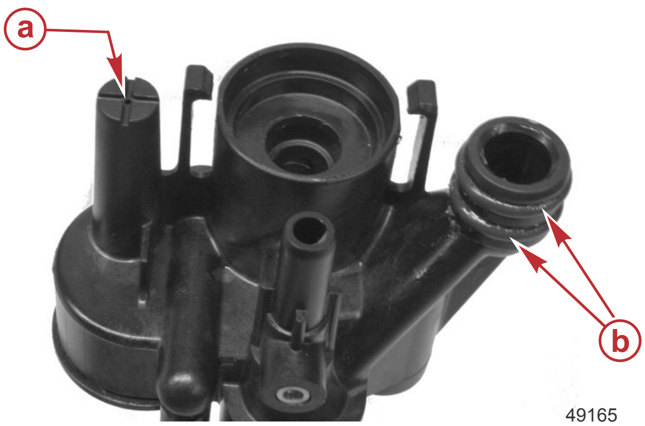


49217

a - Fuel lift pump seal grommet
b - High-pressure fuel pump seal grommet

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Seal grommet	92-802859A 1

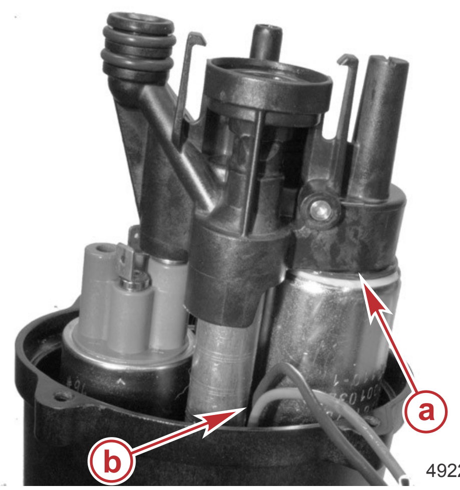
12. Install two O-rings onto the manifold.
13. Verify the hole in the manifold is open and that no debris partially blocks the hole.
    IMPORTANT: Use only appropriate solvents and compressed air to remove debris which may be blocking the hole. Do not use wire or any ridged device that may damage the hole.



49165

a - Hole in manifold
b - O-rings

14. Carefully install the manifold while aligning the fuel pumps and tubes. Verify the manifold is seated on the fuel pumps. Ensure the fuel pump wires are not binding between the water tube and the fuel pump.



49223

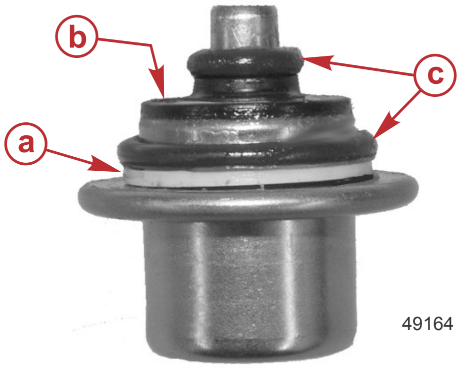
a - Manifold seated on fuel pump
b - Wires are not binding

15. Verify the spacer is installed onto the fuel pressure regulator.

16. Verify the fuel pressure regulator filter is clear of debris.

    NOTE: *The fuel pressure regulator filter is not a serviceable part, but can be cleared of debris with a mild solvent and low-pressure compressed air.*

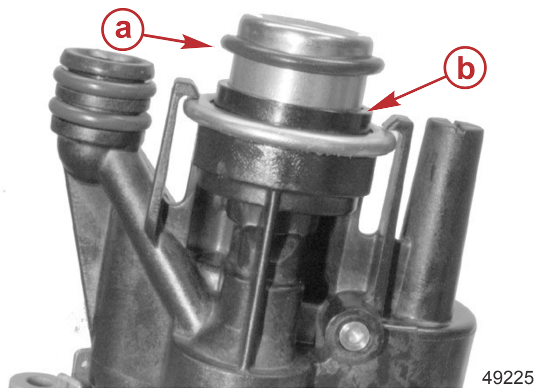
17. Install the O-rings onto the fuel pressure regulator and lubricate them with 2-4-C with PTFE.



a - Spacer
b - Filter
c - O-rings

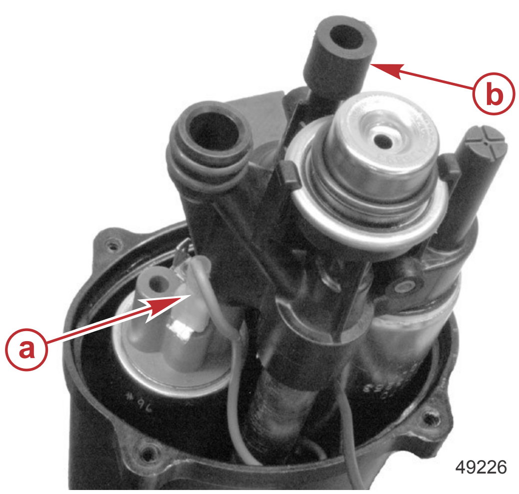
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Fuel pressure regulator O-rings	92-802859A 1

18. Install the fuel pressure regulator onto the manifold.
19. Install the spacer and O-ring onto the fuel pressure regulator.



a - O-ring
b - Spacer

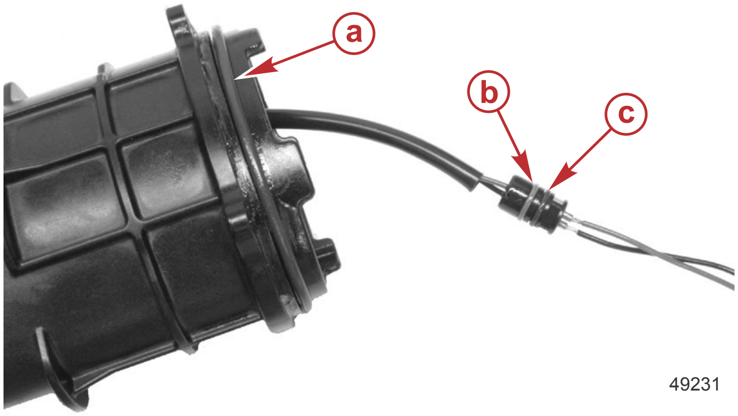
20. Install the seal grommet halfway onto the manifold.
21. Insert the red wire harness connector onto the fuel lift pump positive terminal.



a - Red wire
b - Seal grommet

22. Install the O-ring onto the upper housing.
23. Install new O-rings onto the fuel pump wire harness seal grommet. Verify the blue O-ring is installed on the upper groove of the seal grommet. Lubricate the O-rings with 2-4-C with PTFE.

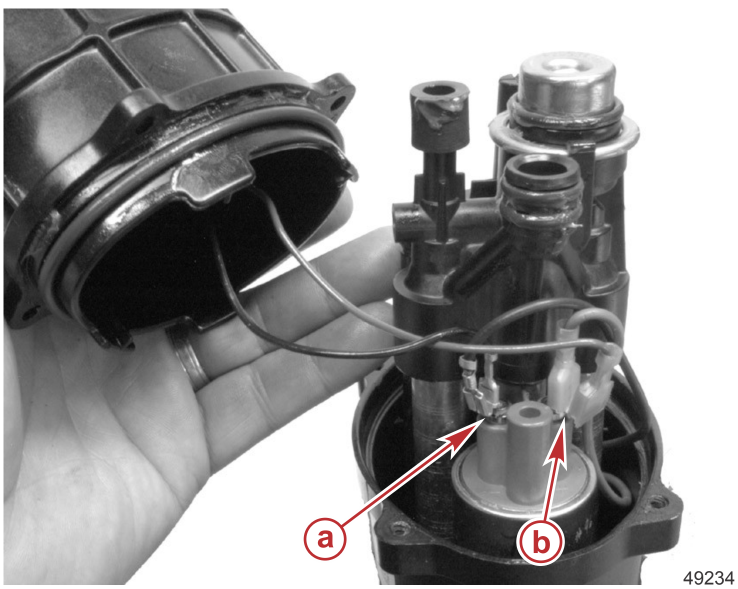
24. Pull on the wire harness to seat the seal grommet into the upper housing. A gentle push on the seal grommet on the inside of the housing with a blunt tool will ensure it is properly seated.



a - Upper housing O-ring
b - Blue O-ring
c - Second O-ring on seal grommet

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-rings	92-802859A 1

25. Connect the red wire from the upper housing to the positive terminal on the fuel lift pump.
26. Connect the black wire from the upper housing to the negative terminal on the fuel lift pump.
27. Connect the high-pressure fuel pump black wire to the terminal on the fuel lift pump.
28. Lubricate all the visible O-rings and seal grommets with 2-4-C with PTFE.



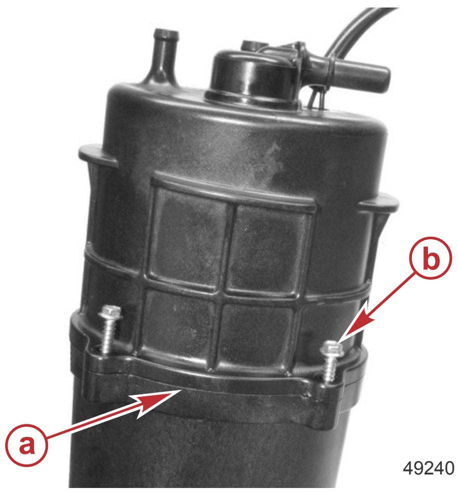
a - Black wires
b - Red wires

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-rings and seal grommets	92-802859A 1

29. Verify the wires will not become pinched and install the upper housing.

49237

30. Carefully push the upper housing into the lower housing until there is no gap between the upper and lower housing.
    IMPORTANT: If the gap between the upper and lower housing cannot be closed, the wires may be pinched or a seal grommet is not properly aligned.
31. Install the screws and tighten the screws to the specified torque.



49240

a - No gap
b - Screw (4)

Description	Nm	lb-in.	lb-ft
Screw	10	88.5	

32. Install a 16.2 mm metal hose clamp onto the high-pressure hose and install the hose onto the FSM upper housing. Use the hose clamp tool to secure the hose to the FSM.

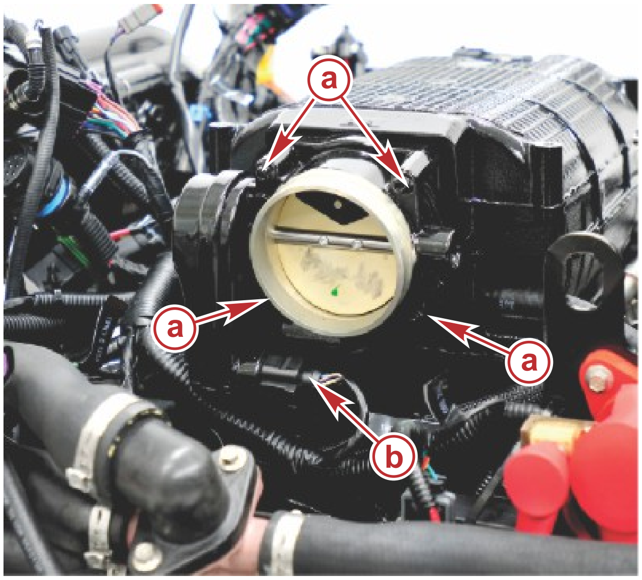
57375

Clamp Tool	91-803146T

Throttle Body

Throttle Body Removal

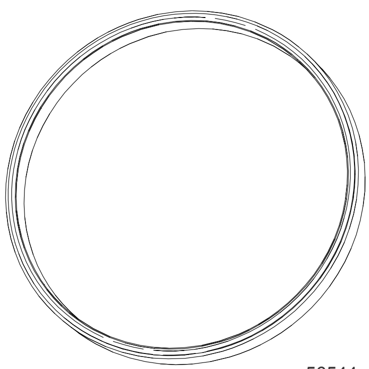
1. Remove the engine cover.
2. Remove the flame arrestor. Refer to the appropriate procedure in **Section 1C** - **Maintenance** for details.



56540

a - Throttle body mounting screws
b - Electronic throttle control (ETC) connector

3. Remove the ETC connector.
4. Remove the four throttle body mounting screws.
5. Remove the throttle body.
6. Remove and discard the throttle body gasket.



56544

Throttle body gasket

IMPORTANT: Insert a clean shop towel into the opening of the intake manifold to prevent foreign material from entering the engine.

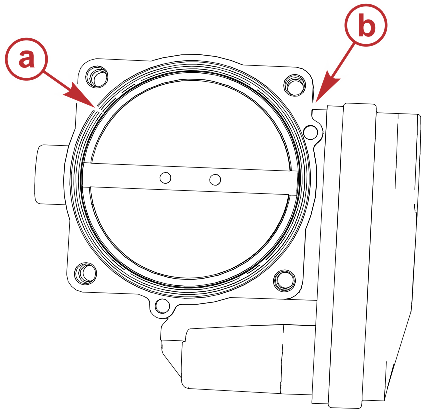
Throttle Body Cleaning and Inspection

IMPORTANT: Do not use cleaners containing methyl ethyl ketone.
IMPORTANT: Do not damage the adapter or throttle body when removing gasket material.

1. Carefully remove the gasket material from the intake manifold adapter and throttle body.
2. Thoroughly clean all parts of the throttle body. Ensure that all passages are free of debris and burrs.
3. Inspect the gasket mating surfaces for damage that could affect sealing.
4. Inspect the throttle body casting for cracks.
5. Inspect the throttle plates, linkage, return springs, and other components for damage, wear, and foreign material.

Throttle Body Installation

1. Install any components that were removed during the inspection and cleaning process.
2. Install a new throttle body gasket into the groove in the bottom throttle body plate.



56545

a - Gasket
b - Throttle body

3. Align the dowels and install the throttle body onto the intake manifold.
4. If reusing the fasteners, apply Loctite 242 Threadlocker to the threads of the throttle body mounting screws.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Threads of the throttle body mounting screws	92-809821

5. Install the two throttle body mounting screws. Tighten the screws to the specified torque. Install two throttle body nuts.

Description	Nm	lb-in.	lb-ft
Throttle body mounting screws and nuts	10	88.5	–

6. Install the flame arrestor and the engine cover. Tighten the clamp to the specified torque.

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	4	35.4	–

Fuel Rail

Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

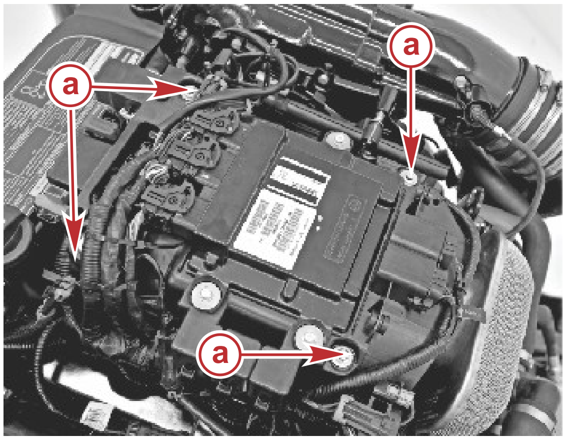
1. Disconnect the battery, removing the negative (–) battery lead first.
2. Remove the engine cover.

⚠ CAUTION

Using compressed air can cause serious injury. Always wear eye protection when working with compressed air to prevent injury from ruptured hoses or flying debris.

3. Use compressed air to remove dirt and debris from the fuel rail and injector area before removing the rail and injectors.
4. Remove the PCM relay bracket as follows.

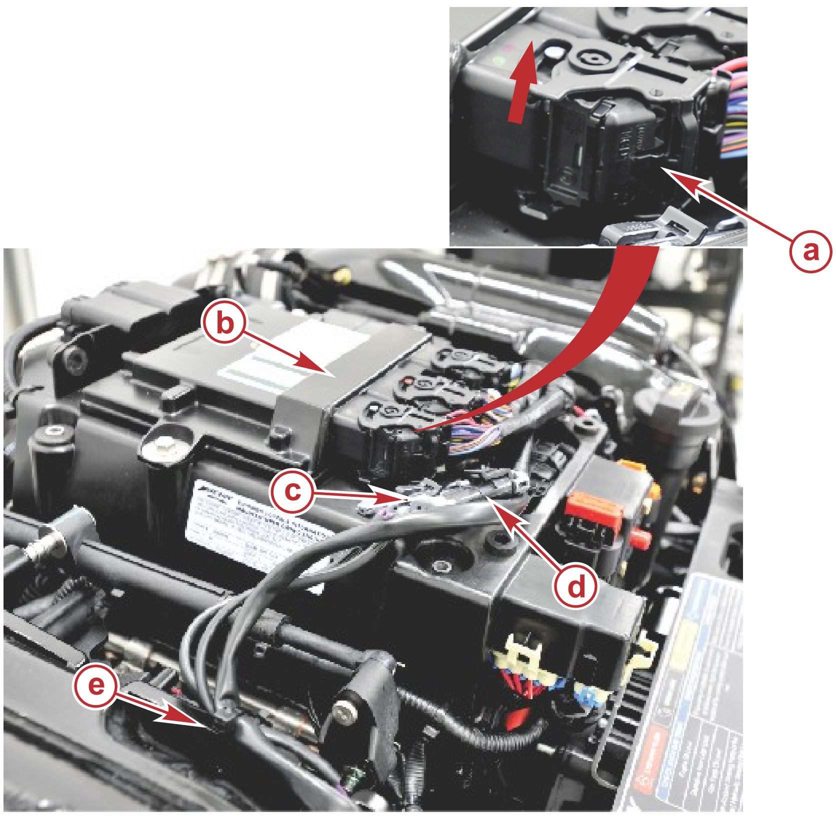
a. Remove the four mounting screws, holding the PCM relay bracket to the manifold.



a - Mounting screws

56506

b. Disconnect the three PCM connectors. To release the connector, push the locking tab and rotate the lock as shown.

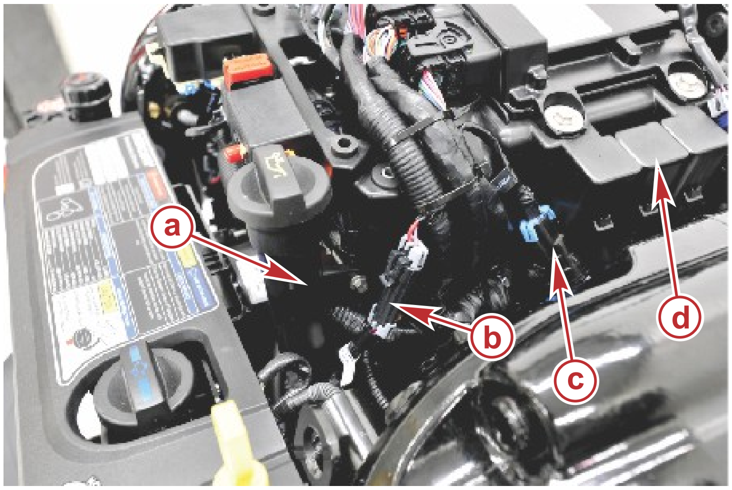


a - Locking tab
b - ECM
c - Shift anticipate connector (not used 6.2L)
d - Neutral switch connector
e - Demand sensor harness

56514

c. Disconnect the neutral switch connector, and the demand sensor harness.

d. Disconnect the starboard fuel injector connectors.

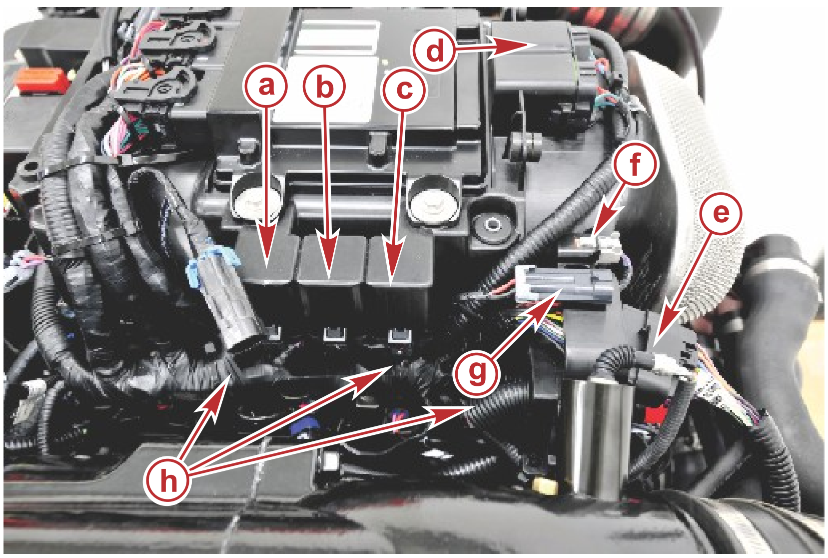


a - Oil fill tube
b - Alternator sense connector
c - Port post O2 sensor connector
d - Relays

56515

e. Remove the two screws securing the oil fill tube and remove the tube.

f. Disconnect the alternator sense connector, port side post O2 sensor connector and relays.



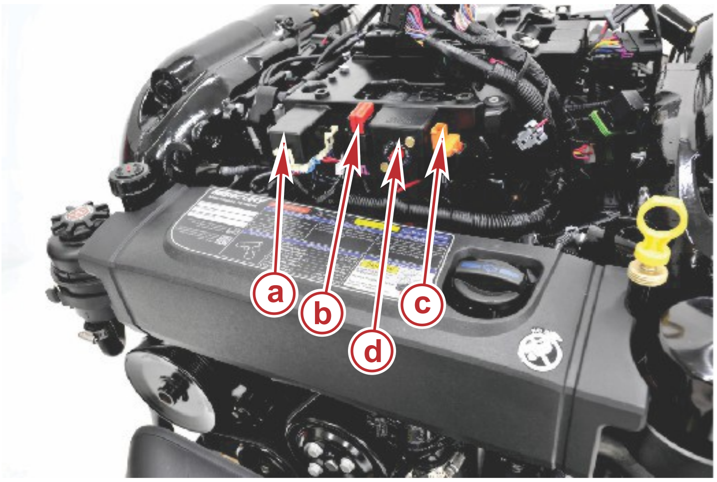
a - Fuel pump relay
b - Starter relay
c - Main power relay
d - Trim relays
e - Transom harness
f - OBD-M MIL light
g - Clean power connector
h - Cable ties

56516

g. Remove the remaining relays and the transom harness connector.

h. Remove the clean power connector and the OBD-M MIL light connector.

i. Remove the three cable ties holding the harness to the PCM relay bracket.

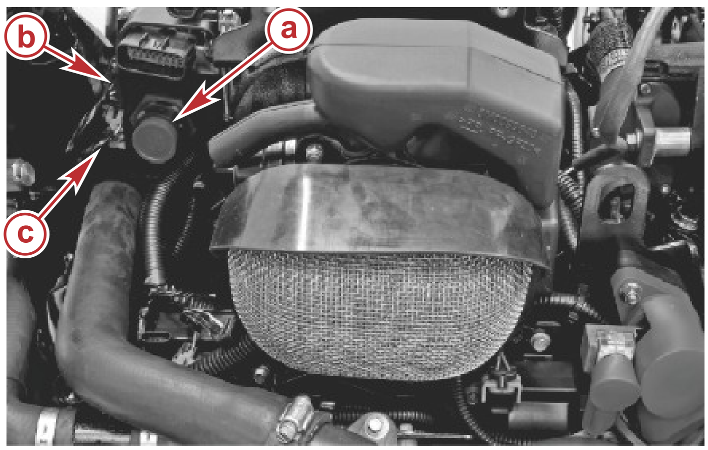


56518

- a - Fuses
- b - 10-pin diagnostics
- c - J1939 diagnostic connection
- d - Circuit breaker

j. Remove the fuses, 10-pin diagnostics connector, and the J1939 diagnostic connection from the PCM relay bracket.

k. Remove the circuit breaker.



59422

- a - 14-pin data harness
- b - Depth/RS-485
- c - Boat harness (tanks)

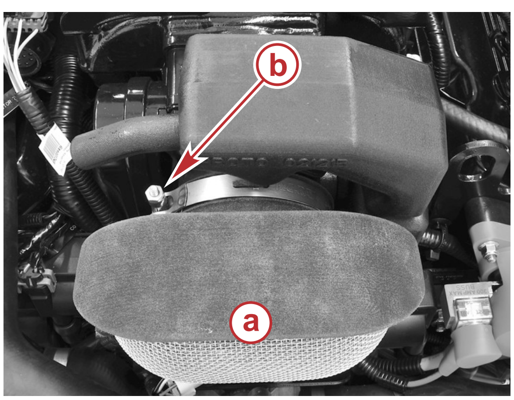
l. Remove the depth/RS-485 and the boat harness (tanks) connectors.

m. Remove the nut on the 14-pin data harness connector and remove the connector.

NOTE: The 14-pin data harness connector may have to be rotated slightly after removing the retaining nut to remove it from the mounting hole. This is due to the flat in the mounting hole.

n. Disconnect the manifold absolute pressure (MAP) sensor and lift it off the PCM relay bracket.

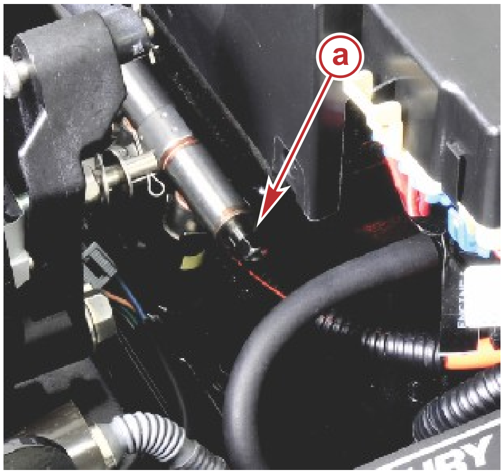
5. Loosen the clamp and remove the flame arrestor.



58395

- a - Flame arrestor
- b - Clamp securing the flame arrestor

6. Remove the throttle body. Refer to **Throttle Body Removal**.



a - Schrader valve

57140

7. Use a fuel pressure gauge to relieve pressure at the Schrader valve. Drain the fuel into a suitable container and dispose of the fuel according to local regulations.

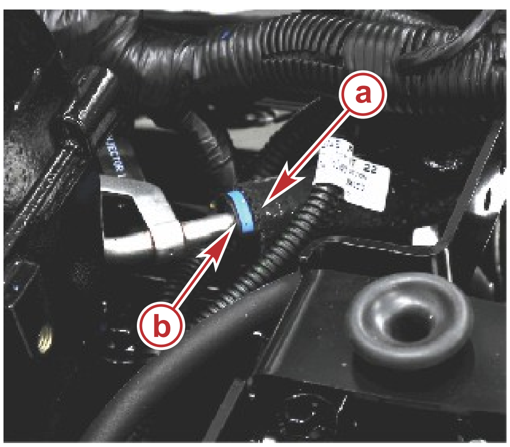
Fuel Pressure Gauge Kit	91-881833A03

8. Disconnect the fuel feed line to the injector rail.

CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

NOTE: To release the fuel feed line, push the blue release and pull off the fuel feed line.



a - Fuel feed line
b - Release

56530

9. Disconnect the remaining wiring harness from the injectors.
10. Remove the four fuel rail retaining screws.
11. Carefully remove the fuel rail and fuel injectors from the intake manifold.

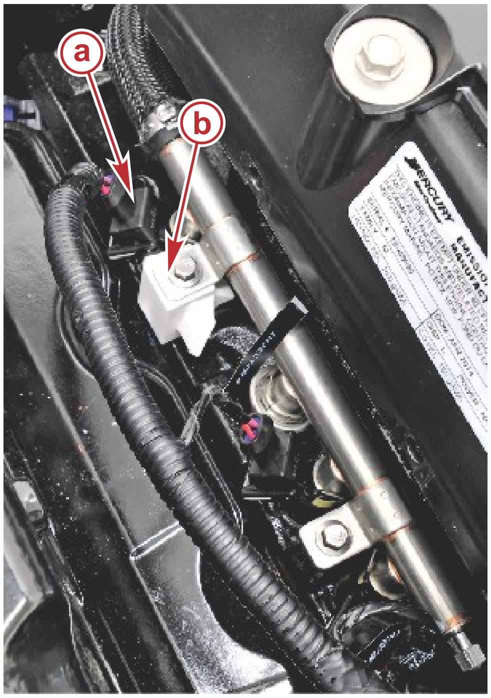
NOTE: Once the assembly has been removed from the intake manifold, the injectors can be removed from the rail. Be certain to take note of the injector location for reinstallation.

Installation

NOTE: Refer to the illustrations in the ***Removal*** *procedure as necessary.*

1. Inspect the fuel injector seals for damage. Replace if necessary.
2. Attach the injectors to the fuel rails.

3. On DTS engines install a spacer on the #6 injector to control the clocking on the injector.



a - #6 injector
b - Spacer

59101

4. Install the fuel rail, ensuring that all injectors seat correctly.
5. Install the fuel rail retaining screws and tighten them to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel rail retaining screws	12.2	108	–

6. Connect the fuel supply line to the fuel rail.
7. Connect the injectors to the engine harness.
8. Install the flame arrestor. Tighten the nut securely.
9. Install the PCM relay bracket as listed.
   a. Connect the MAP sensor.
   b. Install the 14-pin data harness connector and retaining nut.
   c. Install the depth/RS-485 and the boat harness (tanks) connectors.
   d. Install the circuit breaker.
   e. Install the fuses, 10-pin diagnostics connector, and the J1939 diagnostic connection.
   f. Attach the wire harness to the PCM relay bracket with three cable ties.
   g. Install the clean power connection and OBD-M MIL light connector.
   h. Install the remaining relays and the transom harness connector.
   i. Install the alternator sense connector, port side post O2 sensor connector and relays.
   j. Install the oil fill tube.
   k. Install the starboard injector connectors.
   l. Connect the three PCM connectors.
   m. Install the four mounting screws, holding the PCM relay bracket to manifold.
   n. Connect the neutral switch connector, and the demand sensor harness.
10. Install the engine cover.
11. Connect the battery, installing the positive (+) battery lead first.

Fuel Rail Pressure Damper

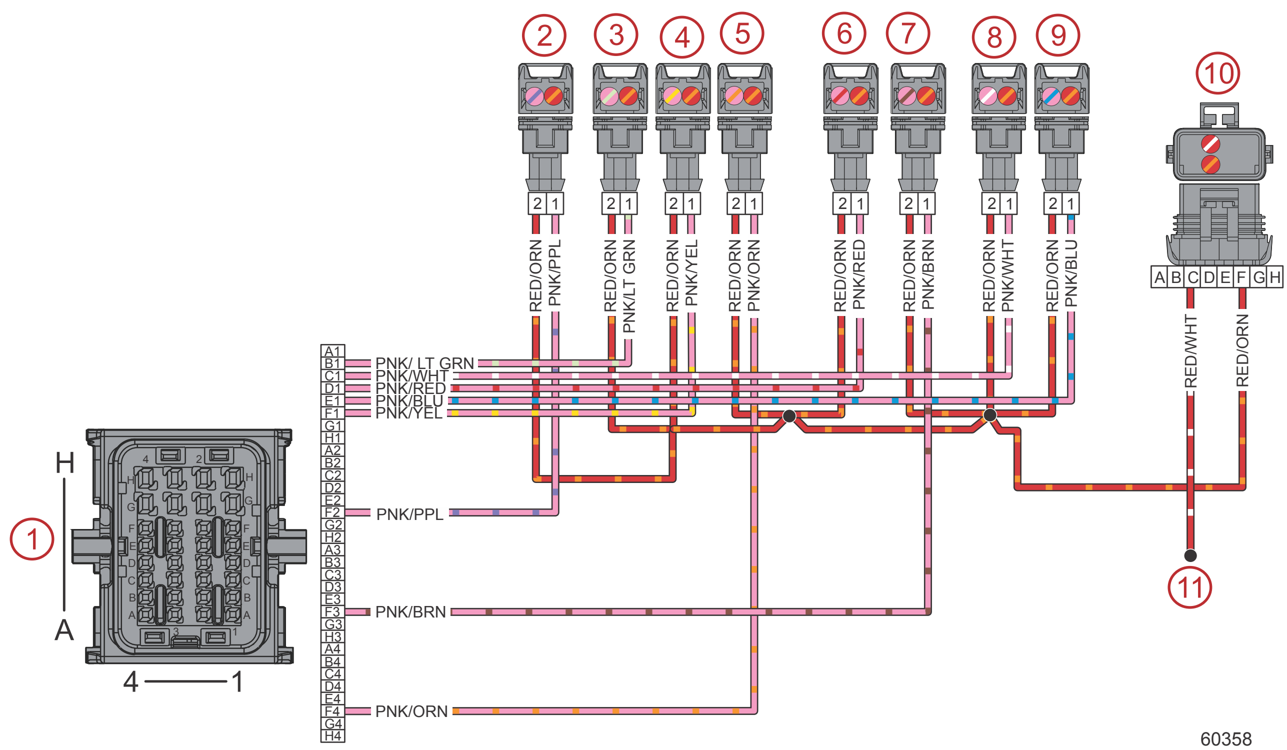
Two fuel rail pressure dampers are located on the fuel rail assembly. They are designed to reduce fuel pressure changes caused by pulses generated by the fuel injectors opening and closing. The fuel rail pressure damper contains a spring on the dry side of the diaphragm. This spring positions the diaphragm against the diaphragm seat when the engine is not running and there is no fuel pressure present.

NOTE: The fuel rail pressure dampers are replaced with the fuel rail as a assembly.

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Fuel Injector Wiring Diagram



1 - PCM connector A
2 - Injector 6
3 - Injector 8
4 - Injector 4
5 - Injector 3
6 - Injector 2
7 - Injector 1
8 - Injector 7
9 - Injector 5
10 - Engine fuses
11 - From main power relay terminal 87

Troubleshooting

Fuel Pressure Gauge Setup and Use

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

Installation

IMPORTANT: Wipe up spilled fuel immediately.

1. Remove the Schrader valve cap.
   IMPORTANT: Disconnecting the fuel pump does not ensure that the engine will not start. Be prepared for the possibility of the engine starting.
2. **Preferred method:** Disconnect the fuel pump and crank the engine to bleed off fuel pressure.
3. **Optional method:** Activate the Schrader valve located on the fuel rail to relieve pressure.
4. Using a proper adapter, attach the fuel pressure gauge to the Schrader valve.

Fuel Pressure Gauge Kit	91-881833A03
Digital Pressure Meter	91-892651A01

5. Turn the key switch on to purge all of the air from the fuel pressure gauge line.

NOTE: Turn the key switch on and off several times to purge the air from the line.

Test

1. Ensure that the fuel pump is connected.
2. Remove the reference line.
3. Turn the key switch on.
4. Observe the reading on the gauge. The reading should be within specification.

Fuel Pressure	Reading on Fuel Pressure Gauge
With reference line removed	358 kPa ± 14 kPa (52 psi ± 2 psi)
At idle, with reference line connected	296 kPa ± 14 kPa (43 psi ± 2 psi)

5. Correct the problem if the reading is out of specification.
6. Reattach the reference line.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. Provide cooling water to the engine.
8. Start the engine.
9. Check the fuel pressure; it should be *lower than* the previous specification.
10. Remove the reference line.
11. Observe the reading on the gauge. The fuel pressure should return to full pressure (the same reading as with the engine not running).
12. Reattach the reference line. The pressure should drop back to the initial pressure with the engine running.
13. Stop the engine.
14. Turn off the cooling water.
15. Correct the problem, if the system is out of specification.

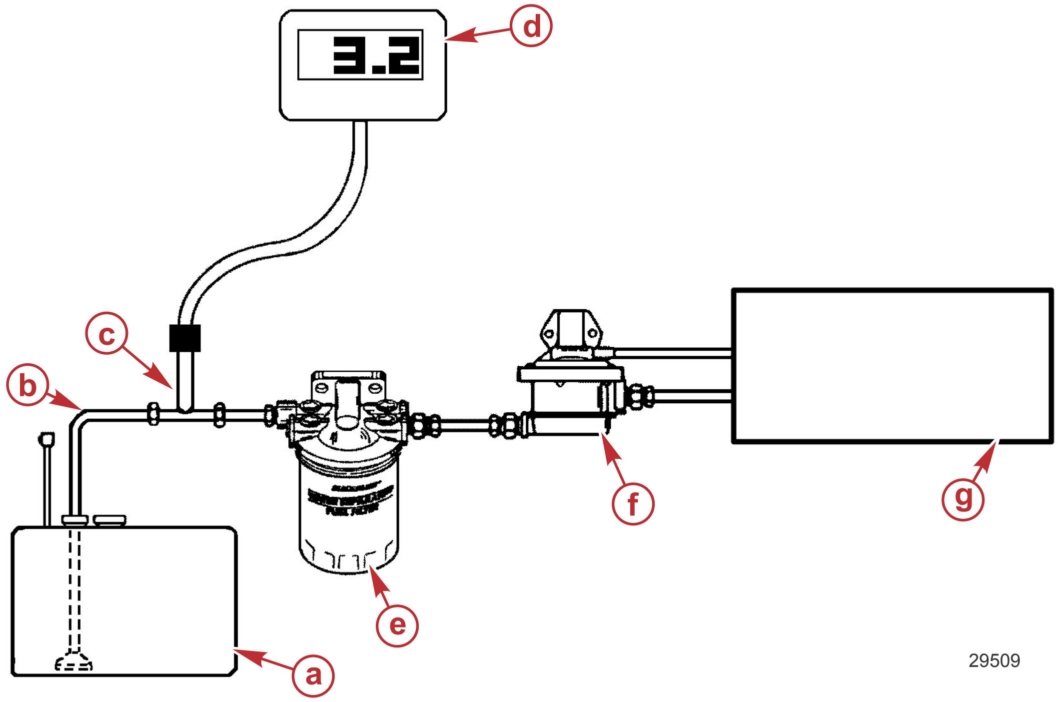
Removal

IMPORTANT: Follow the recommendations of the fuel pressure gauge manufacturer for the correct procedure for relieving pressure from the system.

1. Relieve the pressure from the fuel system.
2. Remove the fuel pressure gauge from the engine.
3. Install the Schrader valve cap.

Checking for Restrictions/Vapor Lock Problems in Fuel Delivery Systems

If there are any restrictions in the fuel delivery system the engine may experience vapor lock and other driveability problems. Fuel supply problems can be checked by using a vacuum gauge on a water-separating fuel filter fitting port. Installing it on the inlet side will check the fuel tank to filter supply line and hardware (anti-siphon valve, fuel fittings, etc.). Installing it on the outlet side will check the supply line, hardware, and the filter. If the outlet vacuum reading is higher than the inlet reading, the filter is clogged. If both readings are high then inspect the fuel tank, supply line, and hardware. Check for debris in the tank (blocking the pickup), clogged fuel filter screens on the end of pickup tubes in the tank, clogged in-line fuel filters, blocked off fuel tank vent, bent pickup tube, dirt and debris in the fuel fittings, wrong size fuel fittings (undersize connector fittings, undersize fuel shut-off valve passages, etc.), undersize fuel line, or a malfunctioning anti-siphon valve.



a - Fuel tank
b - Clear hose can be used to check for air bubbles
c - T-fitting
d - Digital vacuum gauge
e - Water-separating fuel filter
f - Fuel pump (mechanical or electric - depending on fuel system)
g - EFI fuel system

There is a MerCruiser specification for allowable vacuum, when measured at the inlet side of the engine-mounted MerCruiser water-separating fuel filter or if there is none mounted on the engine, at the inlet side of a fuel pump. Use a digital vacuum gauge (an analog gauge may not give accurate enough readings at these low levels) that reads in either kPa (kilopascals) or in. Hg (inches of mercury).

The specification is: 7 kPa (2 in. Hg) maximum at: idle, 3000 RPM, full throttle and then back at idle RPM (check at each point).

Any anti-siphon valve or restriction that causes a higher reading can contribute to vapor locking and other driveability problems. In hot weather, if you see 0 vacuum on the gauge and the engine is still running poorly, check the inlet fuel line to ensure that a good solid flow of fuel is in the line, instead of a mixture of fuel and vapors. If the vacuum is too high, try a less restrictive anti-siphon valve. Restrictive anti-siphon valves can cause vapor locking conditions.

Going to the next larger inside diameter (ID) fuel lines and fittings can help lower the vacuum also. This larger diameter ID can also help correct vapor locking conditions. An example is shown below.

8 mm (5/16 in.) fuel line ID	17.8 kPa (5.5 in. Hg)	Too high
9.5 mm (3/8 in.) fuel line ID	8.2 kPa (2.5 in. Hg)	Too high
12.5 mm (1/2 in.) fuel line ID	2.7 kPa (0.8 in. Hg)	Good

See MerCruiser Service Bulletin 99-7 (Rev. 1/01) for information on gasoline engine vapor locking.

Equipment Used to Test Fuel RVP, Fuel Temperature, or Fuel System Vacuum

The following information is contained in Mercury MerCruiser Service Bulletin 99-7 (Revised October 2000).

Testing fuel RVP:

SPX OTC sells a test kit, Gasoline Quality Testing Kit - P/N 7670.

Testing fuel temperature or vacuum:

Fittings required to make connections between engine fuel inlet and the boat fuel line and fitting.

(1) Pipe fitting - 1/4 in. pipe thread at both ends, 38 mm (1-1/2 in.) long

(1) T- fitting -1/4 in. female pipe thread

(1) Schrader valve - P/N 22-805408

(1) Cap, Schrader valve - P/N 22-805515

Tools required to measure fuel vacuum at fuel inlet of the engine.

(1) Digital compound gauge (–101 kPa to 689 kPa [–30 in. Hg to 99.9 psi]), that has an accuracy of within 2% of the reading. Cole-Parmer - P/N P-68950-00. (Note 1)

(1) Gauge guard (–101 kPa to 103 kPa [–30 in. Hg to 15 psi]). Cole-Parmer P/N U-07359-02. (Note 1)

(1) Gauge guard liquid 118 cc (4 fl oz). Cole-Parmer P/N U-07359-50. (Note 2)

(1) Hose connected to digital gauge with adapter to connect to the Schrader valve. Can use hose and Schrader valve connector from Fuel Pressure Kit, P/N 91-88183303.

Tools required to measure fuel temperature at fuel inlet of the engine.

(1) DMT 2000 meter - P/N 91-854009A3, or DMT 2004 Meter - P/N 91-892647A01.

(1) Reducer bushing - 1/4 in. male to 1/8 in. female pipe thread - P/N 22-48556.

(1) Temp probe compression fitting - 1/8 in. pipe thread. Cole-Parmer - P/N H-08539-04.

(1) Temp probe - 4 in. long with K connector. Cole-Parmer - P/N P-08117-45.

(1) Temp probe extension cable - 10 ft long with K connector. Cole-Parmer - P/N H-08516-30.

Cole-Parmer Instrument Company

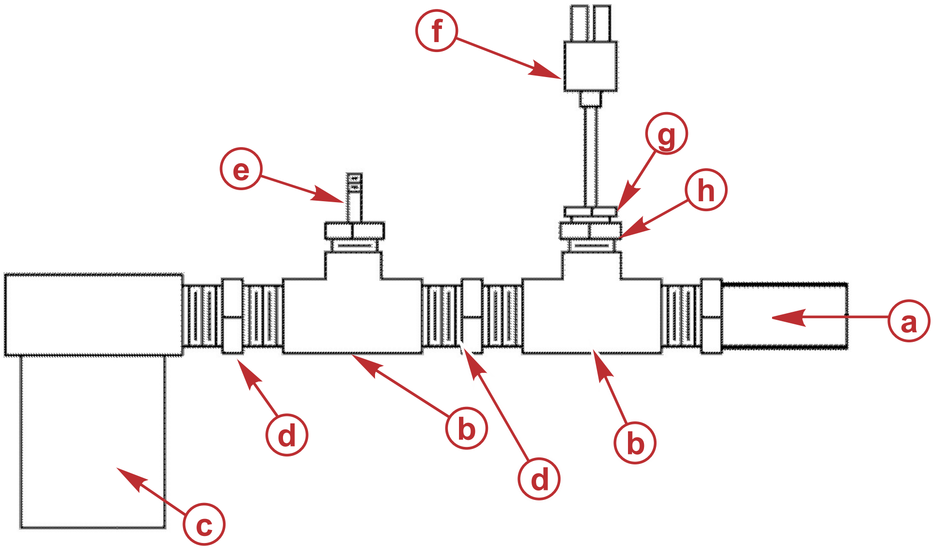
Phone: 847-549-7600 or 800-323-4340.

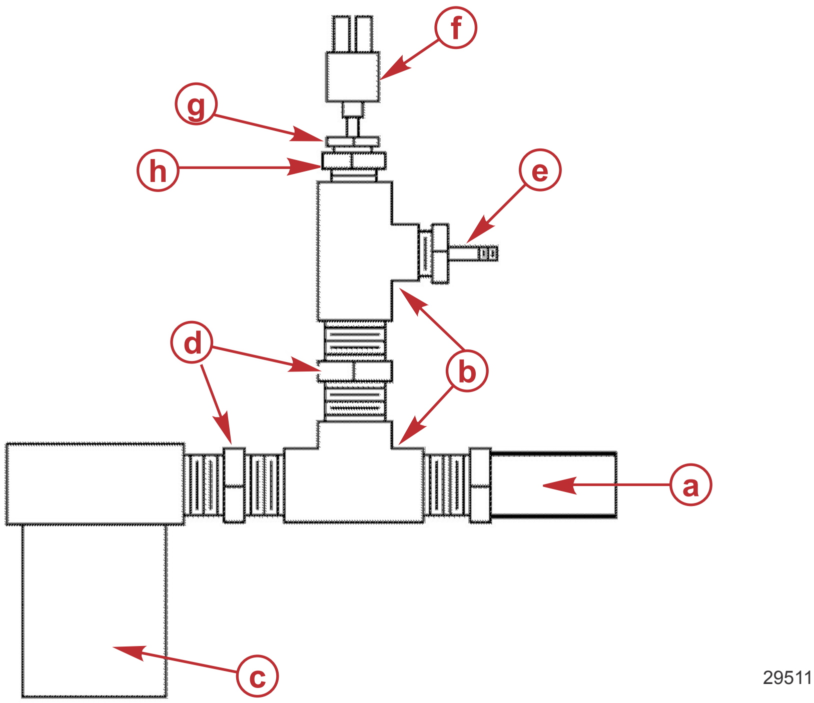
Fax: 847-247-2929

International Fax: 847-549-1700.

NOTE: 1 The gauge guard has to be used with the gauge listed to protect it from liquid gasoline or vapors. Failure to use the gauge guard will damage the gauge. When using the guard, the maximum range that can be applied to this guard installed on the gauge is –101 kPa to 103 kPa (–30 in. Hg to 15 psi).

NOTE: *2 The gauge guard liquid has to be filled under a vacuum. You have to pull a vacuum through the diaphragm seal with a vacuum pump and fill the guard through fill port on the side. Failure to do this will cause an incorrect gauge reading.*





Fittings used to measure fuel temperature or Vacuum

- a - From fuel supply
- b - T-fitting 6.35 mm (1/4 in.)
- c - Water-separating fuel filter
- d - Pipe fitting 6.35 mm x 38 mm (1/4 in. x 11/2 in.)
- e - Schrader valve
- f - Temperature probe
- g - Compression fitting
- h - Reducer bushing

Notes:

Cooling System

Section 6A - All Models

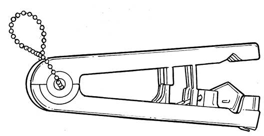
Table of Contents

6
A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Water circulating pump gaskets and the threads of the attaching fasteners	92-34227Q02
66	Loctite 242 Threadlocker	Seawater pump cover screw threads	92-809821
68	Loctite 609	Outer diameter of the lip seal	Obtain Locally
95	2-4-C with PTFE	Bearing shaft next to the rear shaft bearing	92-802859A 1

Special Tools

Air Line Cutter	91-883502
 24887	Cuts water drain system air lines without collapsing them.

Seawater Inlet Specifications

Seawater Inlet Specifications	
Seawater inlet hose	32 mm (1-1/4 in.) I.D. (wire-reinforced)
Seawater pickup	Low restriction with 32 mm (1-1/4 in.) connections
Seacock (ABYC requirement)	
Seawater strainer (optional)	

General Cooling System Information

Mercury MerCruiser engines come equipped with either standard cooling or closed cooling. On engines with standard cooling, the engine is cooled entirely by seawater (the water in which the boat is being operated). Closed-cooling systems use two cooling circuits, one of which uses seawater similarly to standard cooing. The second circuit uses a mixture of freshwater and coolant/antifreeze.

The cooling system must receive a sufficient amount of seawater under all operating conditions. The design and installation of the seawater supply system is the boat manufacturer's responsibility.

NOTICE
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Seawater Inlet Hose

- Use a 32 mm (1-1/4 in.) I.D. wire-reinforced hose that is capable of supporting 10 in. Hg vacuum to prevent the seawater inlet hose from collapsing from the seawater pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible with minimal bends to maximize flow.
- All connections must be secured with hose clamps.
- Fasten the hoses to maintain proper routing and to prevent chafing or contact with other moving parts.

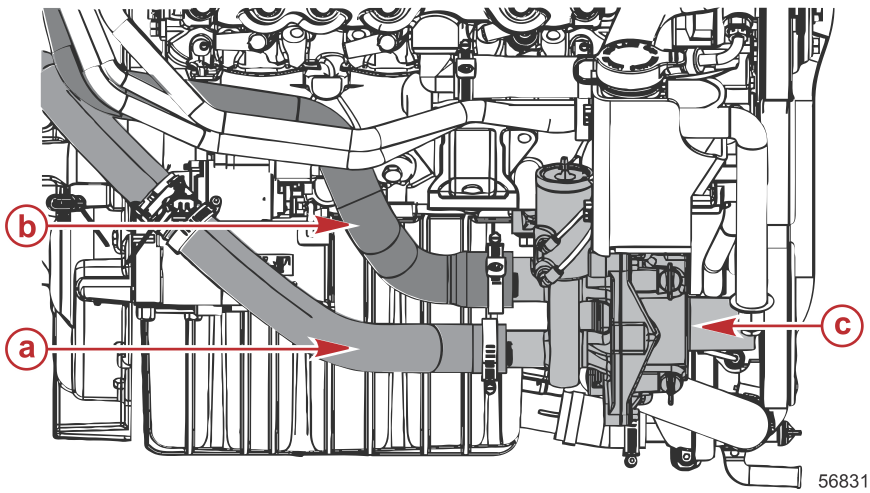
Seawater Pump Output Test

IMPORTANT: Note the following:

- The boat must be in the water for this test. This test cannot be performed with a flush-test device and water hose.
- Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.
- Perform this test accurately or problems may not be detected. An error in setting the engine RPM, timing the test, or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results:
    - Use a shop tachometer with an error rate of less than 5%. Do not use the boat tachometer as it may not have the necessary precision.
    - Use a stop watch to time the duration of the test to help ensure that accuracy is maintained.
    - Use a 9.5 L (10 US qt) or larger capacity container to measure the water output.

If the engine overheats, use this test to determine if a sufficient amount of water is being supplied to cool the engine:

1. **Models with engine-mounted seawater pumps:** Remove the seawater outlet hose, and replace it with another hose of the same diameter but approximately 1 m (3 ft) longer. The hose should have adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the pump outlet only. Do not clamp the hose at the engine cooler end.



a - Seawater inlet hose
b - Seawater outlet hose
c - Seawater pump

2. Place a 9.5 L (10 US qt) or larger container near the unclamped end of the hose.
3. With the assistance of another person, start the engine and adjust the speed to exactly 1000 RPM while holding the unclamped end of the hose on the connection on the engine. Remove the hose from the connection on the engine and direct the water flow into the container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return the engine to idle and stop the engine. Reconnect the hose to the engine.
4. Measure the quantity of water discharged into the container and compare with the specifications given in the following chart.

   NOTE: Values listed are minimum discharge quantities. Typical values at 1000 RPM are approximately 1.4 times those listed.

Engine-Mounted Seawater Pump Output for a 15-Second Period at 1000 RPM	
Model	Minimum Quantity
Bravo model with standard cooling	8.8 L (9.3 US qt)
Bravo model with closed cooling and an external water pickup	11.0 L (11.6 US qt)

5. Repeat the test four times to confirm the results.

Water Heater Installation

IMPORTANT: When connecting a cabin heater or water heater:

- The supply hose—from the engine to the heater, and return hose—from the heater to the engine, must not exceed 16 mm (5/8 in.) inside diameter (ID).
- Using the water heater fitting kit, make the heater connections only at the locations shown. Refer to the **Mercury Precision Parts Accessories Guide**, for kit details.
- Refer to the manufacturers' instructions for complete installation information and procedures.
- Do not reposition the engine temperature switch.

NOTICE

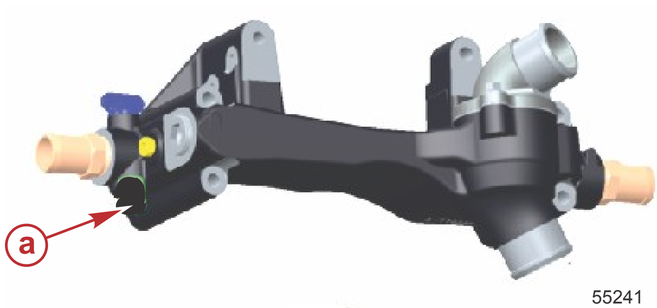
Blocking the coolant flow at the heater can cause reduced engine performance or overheating. Check for continuous coolant flow from the engine to the water circulating pump.

NOTICE

Prevent engine damage from overheating. In models equipped with closed cooling, low coolant levels may allow an air pocket to form when the hot water heater or cabin heater is mounted higher than the fill cap on the heat exchanger. Mount the heater lower than the fill cap of the heat exchanger and maintain the recommended coolant level.

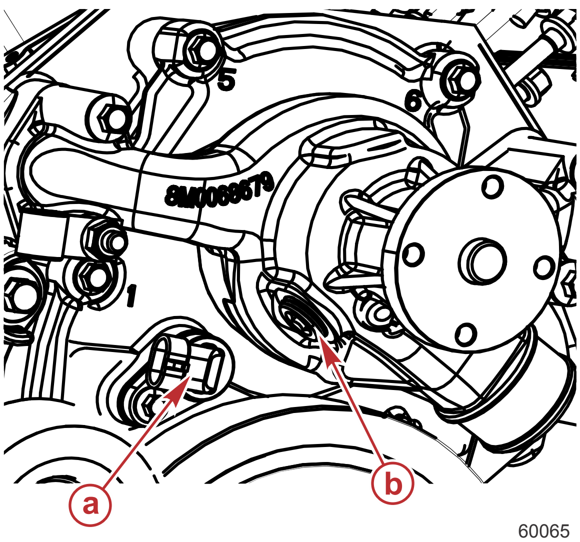
Supply Hose Connection

IMPORTANT: For models with closed cooling, the connections at the engine are to the glycol circuit, not to the seawater circuit.



a - Location for the water supply—to the heater

Return Hose Connection



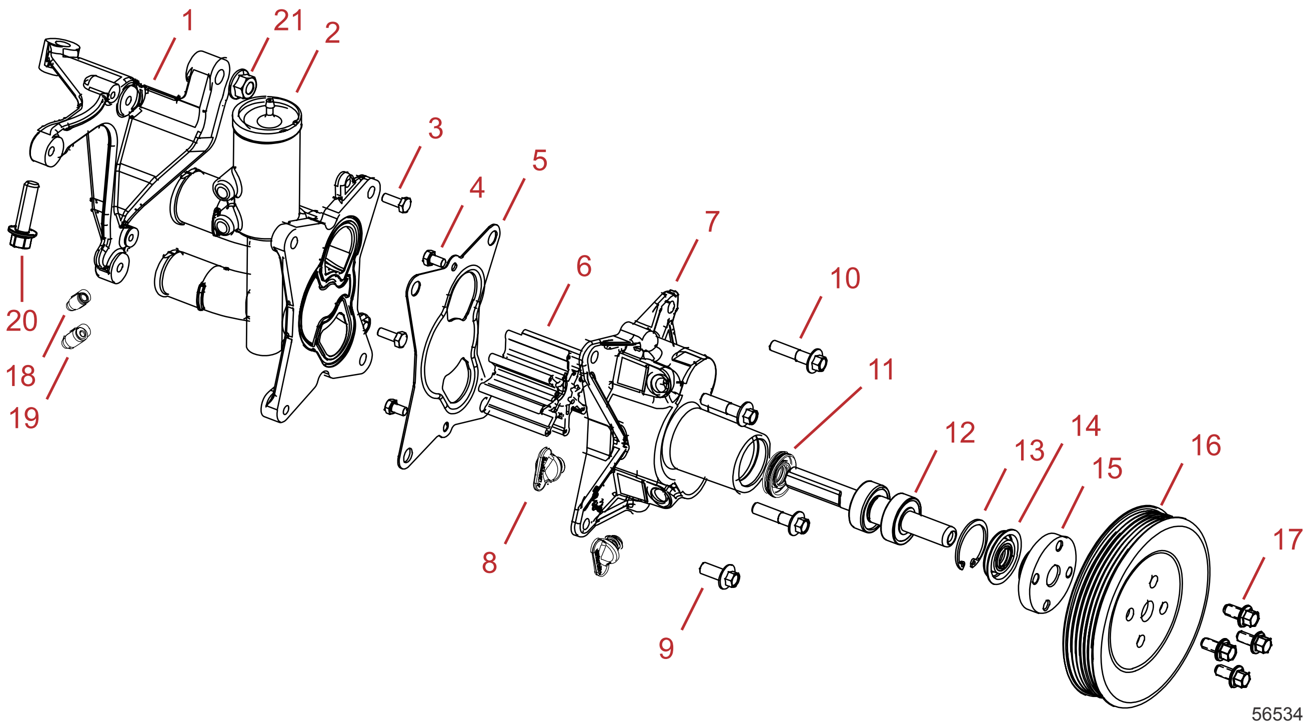
All models—water circulating pump housing

a - Cam sensor, remove connector

b - Location for the hot water return—from the heater, use 3/8 hex socket to remove

Seawater Pump (If Equipped)

Seawater Pump—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Seawater pump bracket			
2	1	Seawater pump cover (with air fittings)			
3	2	M6 x 16 hex head cap screw	10	88.5	–
4	2	M6 x 10 hex head cap screw	10	88.5	–
5	1	Housing seal with integrated rear wear plate			
6	1	Impeller			
7	1	Impeller housing			
8	2	Blue drain plug (with O-ring)	Hand tight		
9	1	M8 x 20 hex head flange screw	24	–	17.7
10	3	M8 x 35 hex head flange screw	24	–	17.7
11	1	Rear oil seal			
12	1	Bearing shaft assembly			
13	1	Retaining ring			
14	1	Lip seal			
15	1	Hub			
16	1	Pulley			
17	4	Pulley screw	24	–	17.7
18	1	90° 5/32 in. air fitting	4	35.4	–
19	1	90° 3/16 in. air fitting	4	35.4	–
20	1	M10 x 35 hex flange screw	40.7	–	30
21	1	M10 hex flange nut	67.8	–	50

Seawater Pump Replacement

NOTE: *The seawater pump does not need to be removed for servicing the impeller or wear plate.*

Removal

IMPORTANT: Make sure that the seacock is closed or remove the boat from the water before disconnecting any hoses.

This procedure is for removal of the entire seawater pump from the engine. Note that it is not necessary to remove the seawater pump to service the impeller or the wear plate.

1. Drain the seawater section of the cooling system.
2. Remove both of the hoses from the aft side of the seawater pump.
3. Disconnect the air hoses from the seawater pump cover with air fittings by pushing in and holding the plastic ring around the air hose and pulling the air hose out of the fitting.
   IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.
4. Remove the serpentine drive belt. Refer to **Section 4C** - **Serpentine Drive Belt**.
5. Remove the one M10 x 35 hex flange screw and the one M10 hex flange nut that secure the seawater pump and bracket to the engine, and remove the seawater pump.

Installation

1. Fasten the seawater pump and bracket to the engine. Tighten the M10 x 35 hex flange screw and the M10 hex flange nut to the specified torque.

Description	Nm	lb-in.	lb-ft
M10 x 35 hex flange screw	40.7	–	30
M10 hex flange nut	67.8	–	50

2. Install the seawater inlet and outlet hoses. Tighten the hose clamps securely.
   NOTE: The air lines for the air-actuated drain valve are two different sizes.
3. Install the appropriate air lines into the appropriate fittings on the air-actuated drain valve by fully inserting the air lines into the fittings. Pull on the air lines to ensure that they are properly installed.
   IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.
4. Install the serpentine drive belt. Refer to **Section 4C** - **Serpentine Drive Belt**.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

5. Supply cooling water to the engine.
6. Start the engine and check for leaks.

Seawater Pump Disassembly

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

To service the wear plate or impeller:

1. If the seawater pump is still mounted to the engine:
   a. Drain the seawater section of the cooling system.
      IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.
   b. Mark the direction of belt rotation, and remove the serpentine drive belt.
2. Remove the four screws (three long, one short) that secure the impeller housing assembly to the rear cover and bracket. Remove the impeller housing assembly.
3. Remove the two screws that secure the housing seal with integrated wear plate to the impeller housing.
4. Remove the impeller.

To service the bearing shaft assembly, including the lip seal and rear oil seal, continue with disassembly:

1. Remove the four screws that retain the seawater pump pulley.
2. Using an appropriate puller, remove the hub from the bearing shaft assembly.
3. Remove the lip seal from the front of the seawater pump housing.
4. Remove the snap ring.
5. Press the bearing shaft assembly out of the housing from the impeller side.

6. Remove the rear oil seal.

Cleaning and Inspection

⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

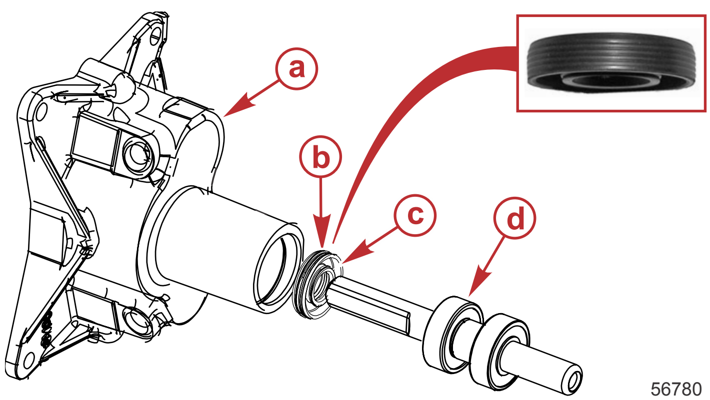
1. Clean the metal parts in solvent and dry with compressed air.
2. Clean the gasket material and sealant from the sealing surfaces.
3. Inspect the bearing housing. Examine the surfaces where the bearings contact the housing for evidence of the bearing outer races turning in the housing.
4. Inspect the seals in the bearing housing for signs of damage or leaks.
5. Rotate the bearing shaft in the bearing housing. Replace the bearing shaft assembly if the bearings feel rough or if either end of the shaft wobbles.
6. Inspect the impeller housing surfaces where the impeller rides. Replace the impeller housing if significant grooves exist.
7. Inspect the wear plate for grooves and replace as necessary.
8. Inspect the pump impeller and replace it if any of the following conditions exist:
   - Wear on the ends and tips of the blades
   - Cracks in the area where the blades flex
   - Cracks in the impeller hub
   - Blade set (blades remain curved)
9. Inspect the pump pulley for bends or cracks.
10. Inspect the serpentine belt for excessive wear.

Seawater Pump Assembly

Installing the Bearing Shaft and Seals

If the bearing shaft and seals were removed from the impeller housing:

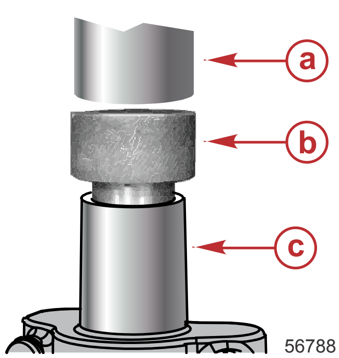
1. Orient the front of the rear seal toward the impeller housing.



Orientation of the rear oil seal

a - Seawater pump impeller housing
b - Grooved outside diameter of the rear oil seal
c - Back of the rear oil seal (spring side)
d - Shaft bearing

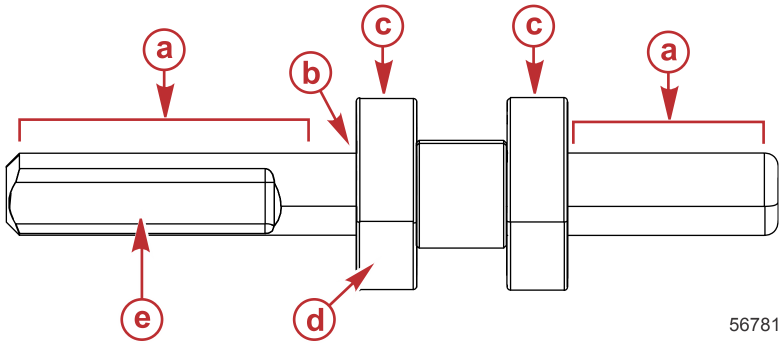
2. Using a suitable mandrel, press the seal to seat it in the housing.



a - Press
b - Suitable mandrel
c - Housing

3. Use 2-4-C with PTFE to lubricate the bearing shaft next to the rear shaft bearing, so that the lubricant is between the rear oil seal and the rear shaft bearing when the shaft is installed.

4. Lubricate the bearing shaft and the outer diameter of the bearings with clean engine oil.

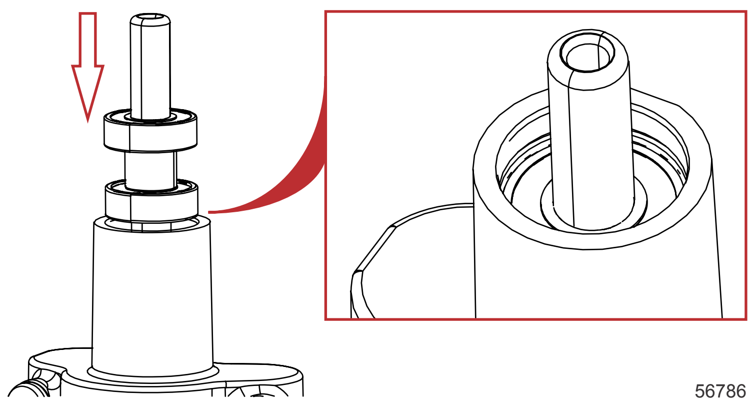


- **a -** Lubricate bearing shaft with clean engine oil
- **b -** Lubricate with 2-4-C with PTFE
- **c -** Lubricate outer diameter of bearings with clean engine oil
- **d -** Rear bearing
- **e -** Flat surface

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Bearing shaft next to the rear shaft bearing	92-802859A 1

IMPORTANT: The bearing shaft assembly should slip easily into the bearing housing using only minimal force.

5. Install the bearing shaft assembly into the impeller housing. The end of the shaft with flat surfaces should extend into the impeller cavity. Clean any assembly lube or oil from the forward end of the impeller housing.

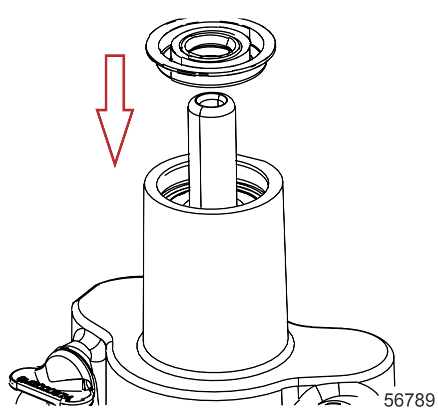


Bearing shaft assembly

6. Insert the snap ring into the snap ring groove in the impeller housing.
7. Apply Loctite 609 to the outer diameter of the lip seal. Do not allow adhesive to contact the seal portion or the bearing shaft assembly.

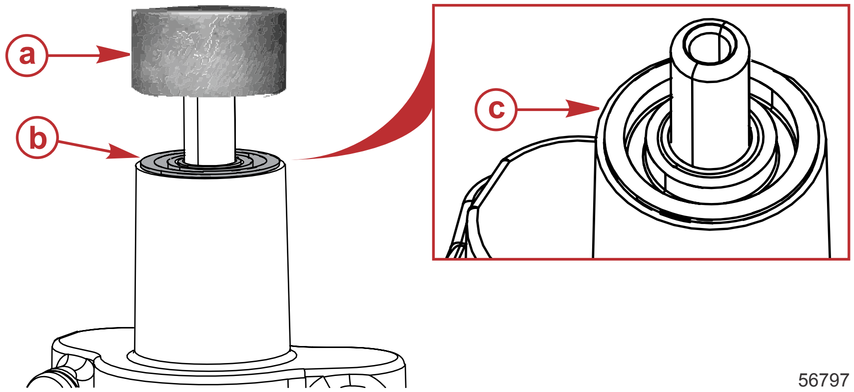
Tube Ref No.	Description	Where Used	Part No.
68	Loctite 609	Outer diameter of the lip seal	Obtain Locally

8. Install the lip seal onto the bearing shaft assembly and slide it down until it contacts the end of the impeller housing.



Lip seal

9. Use a suitable mandrel that will press the lip seal without contacting the bearing shaft. Press the lip seal into place. Wipe away excess adhesive.



a - Hollow mandrel on press
b - Lip seal
c - Lip seal seated

IMPORTANT: Support the bearing shaft while pressing the hub onto the shaft, to prevent overloading the bearings.

10. Ensure that the bearing shaft is adequately supported. Using a suitable tool, press the hub onto the end of the bearing shaft until it is 5.5 mm ± 0.4 mm (0.217 in. ± 0.016 in.) from the front face of the shaft.
11. Attach the pulley to the hub with four screws. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Pulley screw	24	–	17.7

Installing the Impeller, Wear Plate, and Impeller Housing Assembly

1. Install the impeller onto the bearing shaft.
2. Align and attach the housing seal with integrated rear wear plate to the impeller housing with two hex head cap screws. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Hex head cap screw	10	88.5	–

3. Install the blue drain plugs in the impeller housing, if removed.
4. Align and install the impeller housing assembly onto the seawater pump cover.
5. Apply Loctite 242 Threadlocker to the threads of the seawater pump cover screws.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Seawater pump cover screw threads	92-809821

6. Install the four seawater pump cover screws and tighten them to the specified torque.

NOTE: The three long screws reach into the seawater pump bracket.

Description	Nm	lb-in.	lb-ft
Seawater pump cover screws	24	–	17.7

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

7. Install the serpentine drive belt.

Water Circulating Pump

Removal

1. Allow the engine to cool.
2. Drain the seawater or closed-cooling section of the engine.
3. Remove the hose attached to the water circulating pump.
4. With the drive belt installed to prevent rotation, loosen the water circulating pump pulley screws.
IMPORTANT: If a belt is to be reused, it must be installed in the same direction of rotation as before.
5. Mark the direction of belt rotation and remove the serpentine drive belt.
6. Remove the water circulating pump pulley screws and pulley.
7. Remove the water circulating pump fasteners (three screws and one stud) and the water circulating pump.

Cleaning and Inspection

1. Clean all gasket material and sealant from the sealing surfaces.
2. Check the bearing for excessive play.
3. Check the bearing for abnormal noise when turning the shaft.
4. Check the pump body for cracks.
5. Check the seal for signs of leaking.

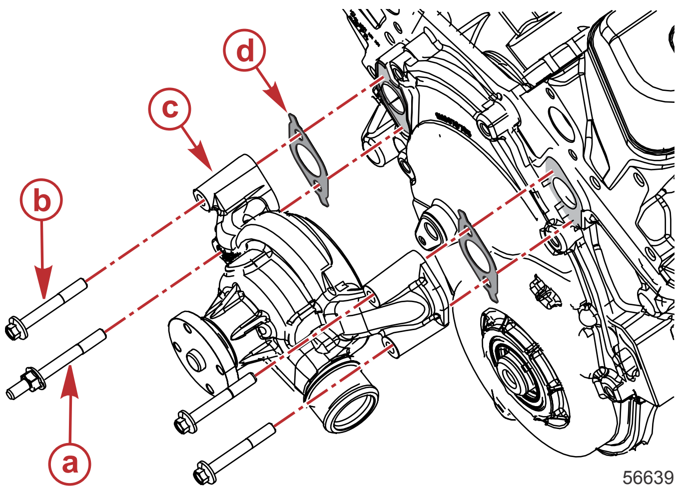
Installation

1. Coat both sides of the water circulating pump gaskets and the threads of the attaching fasteners with Perfect Seal.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Water circulating pump gaskets and the threads of the attaching fasteners	92-34227Q02

2. Install the new water circulating pump gaskets onto the cylinder block.
3. Install the water circulating pump. Tighten the fasteners (three screws and one stud) to the specified torque.

Description	Nm	lb-in.	lb-ft
Water circulating pump fasteners	29	–	21.4



a - Stud
b - Screws (3)
c - Water circulating pump
d - Gaskets (2)

4. Install the water circulating pump pulley onto the water circulating pump, and hand-tighten the screws.
5. Reconnect the hose to the water circulating pump. Tighten the hose clamps securely.
   IMPORTANT: If a belt is to be reused, it must be installed in the same direction of rotation as before.
6. Install the serpentine drive belt and adjust the belt tension. Refer to **Section 4C** - **Serpentine Drive Belt**.
7. Tighten the water circulating pump pulley screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Water circulating pump pulley screws	26.4	–	19.5

8. Fill the closed-cooling system, if equipped.

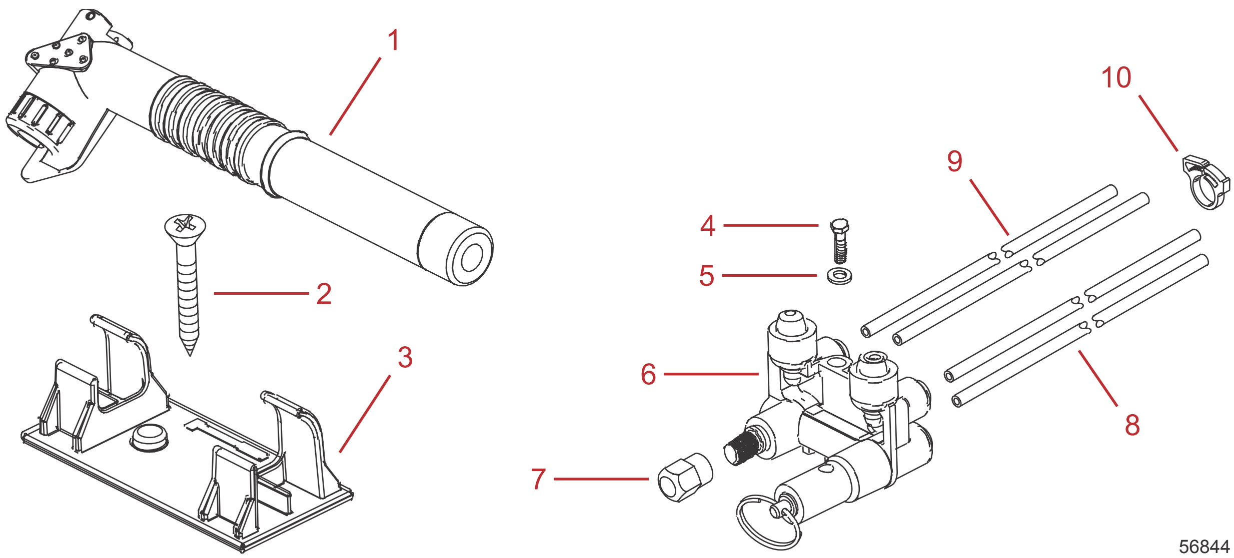
NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

9. Supply cooling water to the engine.
10. Start the engine and check for leaks.

Air-Actuated Drain System

Air Manifold and Air Pump—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Air pump			
2	2	Screw (for remote mounting)			
3	1	Air pump bracket			
4	2	M5 screw	2.3	20.3	–
5	2	Washer			
6	1	Air manifold assembly			
7	1	Service point cap			
8	2	Gray air hose			
9	2	Black air hose			
10	1	Nylon clamp			

General Information

The air-actuated drain system uses compressed air to move a piston that pulls a plug out of a drain port or moves a drain tube to expose a hole to a water passage allowing water to drain into the engine compartment. All of the drain locations are arranged to allow any debris to be continually flushed away from the drains during normal engine operation. A feedback mechanism provides positive indication of proper piston movement. When each piston moves far enough in its cylinder, a port is uncovered that allows compressed air to flow back to the air manifold and cause the green indicator to extend. The drains are closed by opening the manual release valve that releases the compressed air from the system. The manual release valve also functions as an automatic pressure relief valve that opens at approximately 482.7 kPa (70 psi), thereby protecting the compressed air circuit from damage due to excess pressure.

Testing

⚠ CAUTION

Water can enter the bilge when the drain system is open, damaging the engine or causing the boat to sink. Remove the boat from the water or close the seacock, disconnect and plug the seawater inlet hose, and ensure the bilge pump is operational before draining. Do not operate the engine with the drain system open.

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

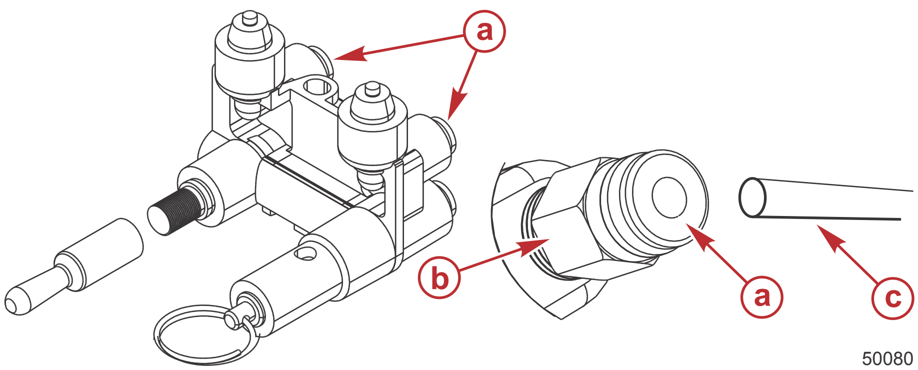
1. Remove the boat from the water.
2. Using the hand pump or other air source, pump air into the system until both of the green indicators extend and the manual release valve opens to relieve excess pressure. If one or both of the green indicators have not extended when the relief valve opens, the corresponding air-actuated drain valve has not opened and may be seized.
3. Release the compressed air from the air circuit by pulling up on the manual release valve ring.
4. Ensure both of the air-actuated drain valves have closed by verifying that water is no longer draining from either valve. If water continues to drain from an air-actuated drain valve after the air pressure has been released, the valve is seized and must be replaced.

Air Manifold

Removal

1. Remove the air manifold assembly from the air manifold bracket. Retain the washers and screws.

   NOTE: The air lines are arranged in pairs of one gray and one black air line for each drain valve. To avoid reconnecting these hoses incorrectly, note which side of the air manifold each pair of air lines is connected to before removing them from the air manifold.
2. Disconnect the air lines from the air manifold. Push in and hold the plastic ring around the air line and pull the air line out of the fitting.



a - Plastic ring
b - Air line fitting
c - Air line

Installation

1. Connect each pair of air lines to the proper side of the air manifold by fully inserting the air lines into the fittings on the air manifold.
2. Install the air manifold assembly onto the air manifold bracket using the washers and screws. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Air manifold assembly to bracket screw	2.3	20	–

3. Test the drain system for proper operation.

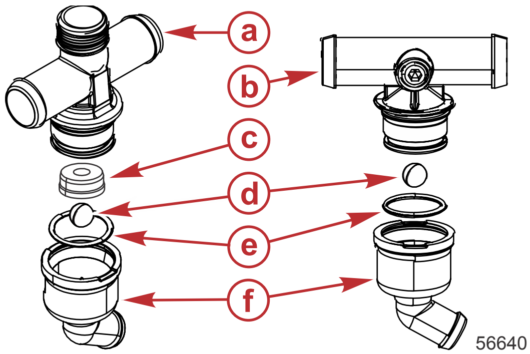
Drain Check Valve

General Information

Engines with standard cooling systems are equipped with drain check valves on the exhaust manifolds. Engines with closed-cooling systems are equipped with two drain check valves inline with the seawater hoses on the port side of the poppet valve assembly.

- The check ball within the valve is forced upward by water pressure from the seawater pump. This seals the drain fitting.
- When there is no water pressure from the seawater pump, such as when the engine is off, the check ball falls down into the grooved drain fitting. This allows water to drain from the exhaust manifold, elbow, and seawater hoses (depending on cooling system type).

Exploded View



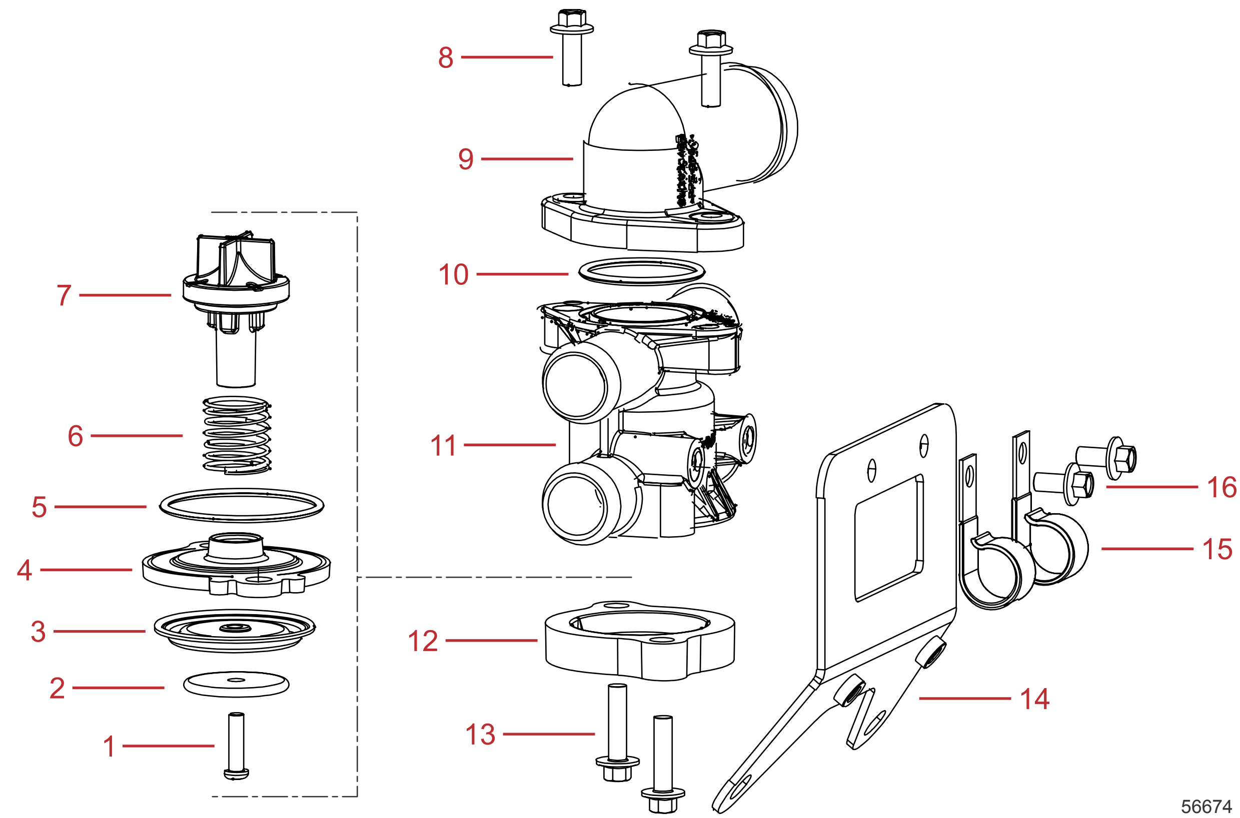
a - Exhaust manifold drain fitting - used on models with standard cooling
b - Inline T-fitting - used on models with closed cooling
c - Ball seat
d - Check ball
e - O-ring
f - Drain fitting (if removed, do not reuse)

Inspection and Cleaning

1. Drain the seawater system.
2. Remove the seawater hoses from the check valve assembly.
3. For models with standard cooling, remove the check valve assembly from the manifold.
4. Use a screwdriver to pry the drain fitting from the assembly. Discard the drain fitting.
5. Inspect the remaining parts for debris or damage. Clean or replace parts as necessary.
6. Use a new drain fitting for reassembly.

Poppet Valve

Poppet Valve Assembly—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
–	1	Poppet valve subassembly			
1	1	Pan head screw	2.5	22.1	–
2	1	Washer			
3	1	Diaphragm			
4	1	Relief valve plate			
5	1	O-ring			
6	1	Compression spring			
7	1	Poppet			
8	2	M6 x 18 hex head flange screw	8.5	75.2	–
9	1	Inlet fitting			
10	1	O-ring			
11	1	Poppet valve housing			
12	1	Cover			
13	2	M6 x 25 hex head flange screw	8.5	75.2	–
14	1	Poppet valve bracket			
15	2	J-clip			
16	2	M6 x 12 hex head flange screw	8.5	75.2	–

Poppet Valve Operation

A poppet valve is installed in the seawater portion of the cooling system of all emission controlled engines in order to control the flow of the cooling seawater. There are two major functions of the poppet valve.

1. The poppet valve controls the amount of seawater supplied to the exhaust system from idle to wide-open throttle.

2. The poppet valve prevents condensation at low speeds.

Poppet Valve Identification

The poppet valve assemblies are color coded to indicate the specific application. The different assemblies use different springs and have different size orifices. When replacing the poppet valve assembly, refer to the following chart.

Cooling System Type	Drive Type	Color
Standard cooling	Bravo	Green
Closed cooling	Bravo	Gray

Poppet Valve Springs

There are two specific spring pressures that are used to hold the poppet closed, depending on the cooling system type. When replacing a spring, be certain to order one with the proper spring pressure rating.

NOTE: While springs can be identified by their color when they are new, the color becomes difficult to interpret after the springs have been in service. Color alone is not a reliable means of identifying the spring pressure rating of a used spring.

Cooling System Type	Drive Type	Color	Wire Diameter	Part Number
Standard cooling	Bravo	Stainless steel	1.19 mm (0.047 in.)	90392
	Bravo	Black	1.57 mm (0.062 in.)	64878
Closed cooling	Bravo	Stainless steel	1.19 mm (0.047 in.)	90392

On all models, the poppet valve is connected to the seawater hoses at the top rear of the engine.

Poppet Valve Replacement

Removal

1. Drain the seawater portion of the cooling system.
2. Disconnect the five seawater hoses from the poppet valve assembly.
3. Remove the two screws that secure the poppet valve assembly to the poppet valve bracket. Be certain to retain the J-clips.

Cleaning and Inspection

NOTE: For parts reference, refer to the preceding exploded view.

1. Remove the two screws from the poppet housing cover to remove the poppet valve subassembly.
2. Carefully remove the pan head screw from the poppet subassembly to inspect the individual components. Inspect the poppet, spring, relief valve, diaphragm, and O-rings for debris or damage. Clean or replace parts as necessary.
3. Inspect the poppet valve plate for debris or damage.
4. Inspect the poppet valve housing and inlet fitting for debris or damage. Clean or replace parts as necessary.

   NOTE: Remove the two screws from the inlet fitting that hold the two pieces together, if further inspection is necessary.

Installation

NOTE: For parts reference, refer to the preceding exploded view.

1. If the inlet fitting was removed, ensure that the mating surfaces are clean and the O-ring is in position. Then loosely attach the two parts with two screws.

   IMPORTANT: Poppet valve springs are available in two spring ratings. Be certain to order a spring with the correct rating.
2. Assemble the pieces of the poppet subassembly (poppet, spring, relief valve, diaphragm, washer, and pan head screw). Tighten the pan head screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Pan head screw	2.5	22.1	–

3. Ensure that all mating surfaces are clean.
4. Place the O-ring in the groove on the poppet valve housing.
5. Slide the poppet subassembly into the poppet valve housing.
6. Use two screws to secure the housing cover to the poppet housing.
7. Tighten all screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Poppet assembly screws	8.5	75.2	–

IMPORTANT: Do not reuse pinch-type hose clamps. If pinch-type hose clamps were taken off during the removal procedure, use new worm-gear hose clamps during assembly.

8. Position the poppet valve assembly at the rear of the engine. Attach the five seawater hoses to the assembly, and secure them with hose clamps.
9. Attach the poppet valve assembly and two J-clips to the poppet valve bracket using two M6 x 12 screws. Tighten the screws to the specified torque.

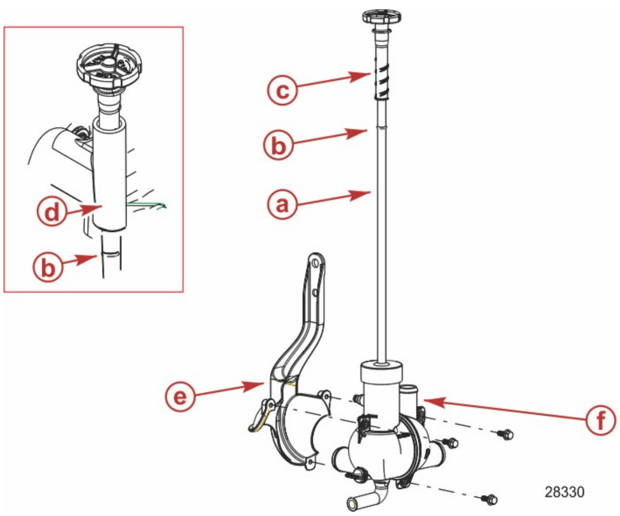
Description	Nm	lb-in.	lb-ft
M6 x 12 screws	8.5	75.2	–

10. After repairs are complete, pressurize the system (such as by starting the engine) and check for leaks.

Water Distribution Housing

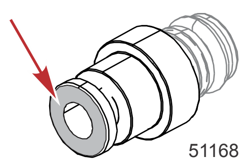
Removal

1. Drain the seawater section of the cooling system.
2. On an Alpha manual single-point drain, remove the drain rod from the water distribution housing.
   a. Remove the C-clip from the drain rod. Retain the C-clip.
   b. Turn the drain rod handle counterclockwise until the drain rod threads clear the alignment bracket. Pull the drain rod straight up to remove.



a - Drain rod with blue handle
b - C-clip
c - Drain rod threads
d - Drain rod alignment bracket
e - Bracket for the water distribution housing
f - Water distribution housing assembly

3. On an air-actuated single-point drain, remove each air line from the water distribution housing by pressing on the air valve fitting's release location and pulling the line out.



Release location on the air valve fitting

4. Disconnect the hoses from the water distribution housing.
5. Remove the bolt and nut attaching the water distribution housing and bracket to the engine.
6. Remove the bracket from the water distribution housing.

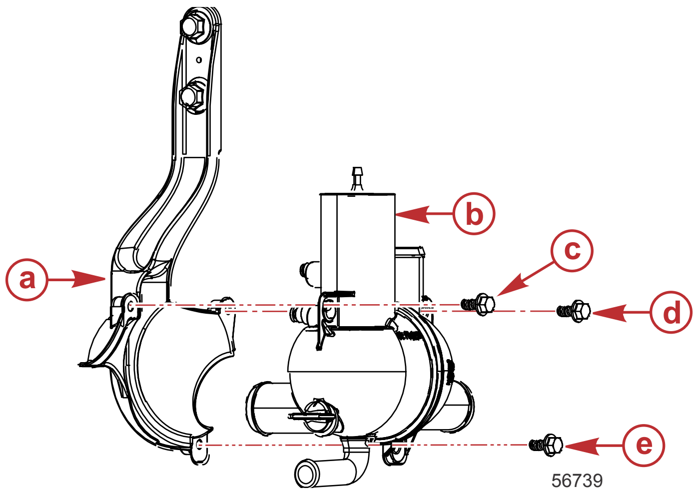
Cleaning and Inspection

1. Clean the water distribution housing with water and dry with a clean cloth or compressed air.
2. Inspect the housing for leaks, cracks, or corrosion damage. Replace, if necessary.

Water Distribution Housing Installation

1. Align the water distribution housing with the bracket.
2. Install and tighten the screws to the specified torque in the following order.
   a. Top right screw

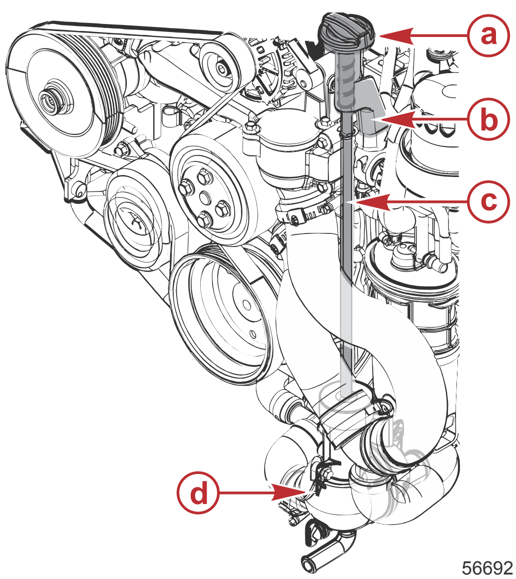
b. Top left screw
c. Bottom screw



a - Bracket for the water distribution housing
b - Water distribution housing assembly
c - Top left screw (tighten second)
d - Top right screw (tighten first)
e - Bottom screw (tighten last)

Description	Nm	lb-in.	lb-ft
Water distribution housing bracket screws	13	115	–

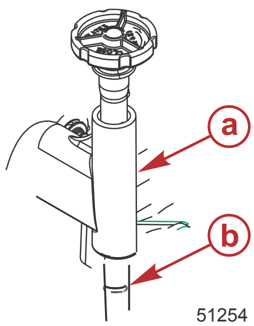
3. Install the bracket and water distribution housing to the engine. Do not tighten the bolt and nut at this time.
4. On a manual single-point drain:
   a. To obtain correct alignment, leave the hoses disconnected from the water distribution housing during installation.
   b. Position the water distribution housing assembly to align with the drain rod.
   c. Insert the drain rod into the water distribution housing to complete the alignment.



a - Drain rod handle
b - Drain rod bracket
c - Drain rod
d - Water distribution housing

   d. Ensure that the rod is correctly aligned. The rod must screw in and out of the water distribution housing easily and with minimal pressure.

e. Install the C-clip onto the drain rod.



a - Drain rod alignment bracket
b - C-clip

5. Tighten the two screws that secure the water distribution housing bracket to the engine to the specified torque.

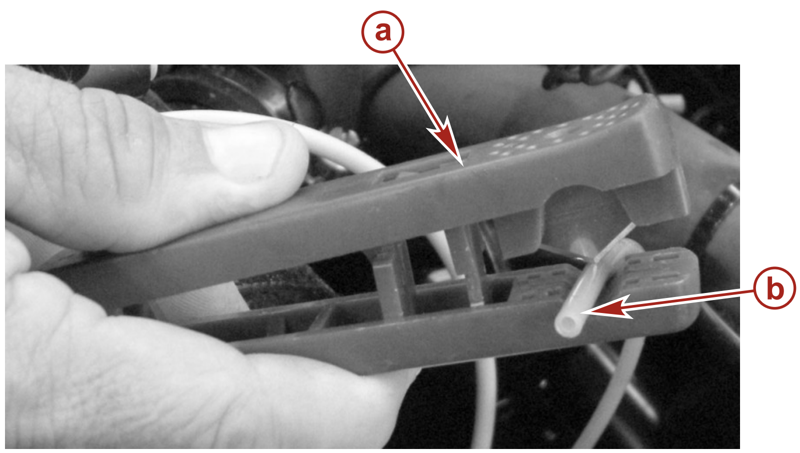
Description	Nm	lb–in.	lb–ft
Water distribution housing bracket screws	58	–	42.8

6. On an air-actuated drain system, connect the air lines to the water distribution housing and air manifold.

IMPORTANT: Ensure that the air lines are routed to avoid sharp bends and contact with moving parts.

NOTE: *The air line must remain cylindrical. The air line must not be distorted when cut. The end of the air line must be within 1 mm (0.04 in.) of square.*

a. Using an air line cutter, cut the bulk air line to the appropriate length.



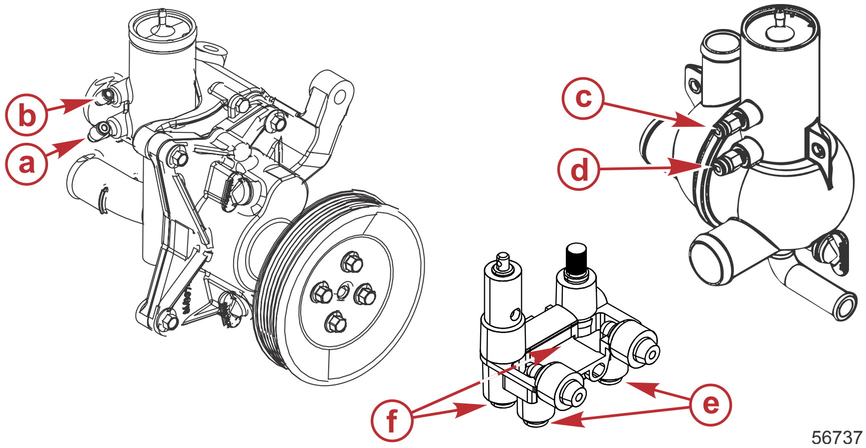
a - Air line cutter
b - Air line

Air Line Cutter	91-883502

b. Connect the air lines from the air manifold assembly to the seawater pump connectors and the water distribution housing connectors by inserting the end of the air lines approximately 6 mm (1/4 in.) onto the connectors.

c. Connect the 3/16 in. O.D. air lines into the lower connectors on the air manifold, the water distribution housing, and the seawater pump.

d. Connect the 5/32 in. O.D. air lines into the upper line connectors on the air manifold, the water distribution housing, and the seawater pump.



- **a -** Lower seawater pump air actuator air line connector (3/16 in.)
- **b -** Upper seawater pump air actuator air line connector (5/32 in.)
- **c -** Upper water distribution housing air actuator air line connector (5/32 in.)
- **d -** Lower water distribution housing air actuator air line connector (3/16 in.)
- **e -** Upper air manifold assembly air line connector (5/32 in.)
- **f -** Lower air manifold assembly air line connector (3/16 in.)

7. Pull on the lines to ensure that each air line is securely connected.
8. Secure the air lines with cable ties.
9. Connect the hoses to the water distribution housing. Securely tighten the hose clamps.

Notes:

Cooling System

Section 6B - Models with Standard Cooling

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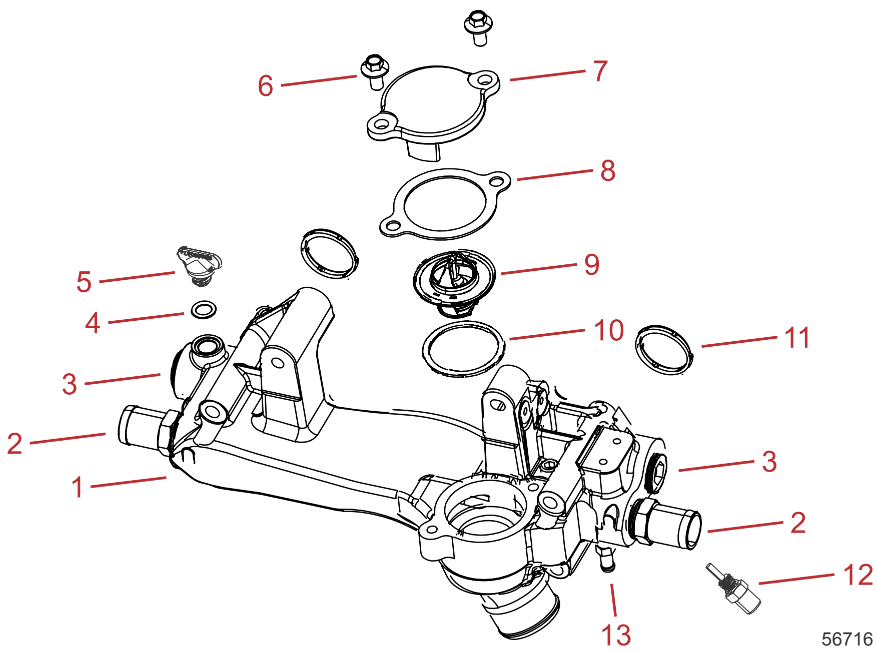
6
B

Specifications

Description	Specification
Thermostat operating temperature	60° C (140° F)

Crossover with Thermostat—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Crossover with fittings			
2	2	Barbed hose fitting	50.2	–	37
3	2	Plug	50.2	–	37
4	1	O-ring			
5	1	Blue drain plug	Hand tight		
6	2	Screw	27.1	–	20
7	1	Thermostat cap			
8	1	Thermostat cap gasket			
9	1	Thermostat (60° C [140° F])			
10	1	Thermostat housing gasket			
11	2	Crossover seal			
12	1	Temperature sensor	16.3	144.2	–
13	1	Barbed hose fitting	10.9	96.4	–

Thermostat Assembly

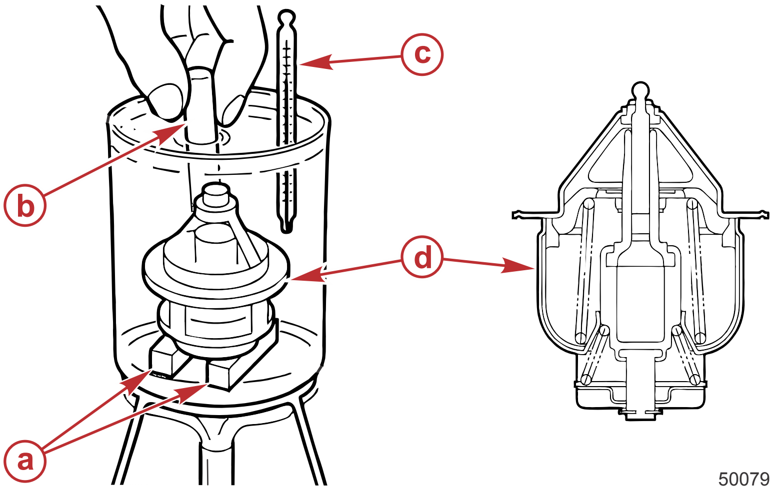
Thermostat Removal from the Crossover

1. Allow the engine to cool, and drain the seawater from the engine.
2. Remove the thermostat cap from the crossover assembly.
3. Remove the thermostat cap gasket, thermostat, and thermostat housing gasket from the crossover assembly.

Thermostat Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Add water to the container until it covers the thermostat.

4. Heat the water.
5. Stir the water constantly to avoid applying direct heat to the thermostat.



a - Wooden blocks
b - Stirring rod
c - Thermometer
d - Thermostat

6. Observe the thermostat and check the temperature when the thermostat fully opens. If the temperature is not within specifications, then replace the thermostat.

Thermostat Installation into the Crossover

NOTE: Refer to the exploded view for parts identification.

1. Clean the gasket surfaces on the crossover, thermostat cap, and thermostat.
2. Place a new thermostat housing gasket in the crossover. Ensure that it is positioned properly in the opening.
3. Place the thermostat in the opening in the crossover with the thermostatic element end toward the bottom.
4. Position a new thermostat cap gasket on the crossover.
5. Install the thermostat cap and tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Screws	27.1	–	20

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. Supply cooling water to the engine.
7. Start the engine and inspect for leaks.

Notes:

Cooling System

Section 6C - Models with Closed Cooling

Table of Contents

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825
122	Extended Life Antifreeze/ Coolant	Closed-cooling system	92-877770K1

Special Tools

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

Specifications

Seawater Inlet Recommendations

Description	Specification
Minimum flow	105 L/min (27.3 gal/min) at 4000 RPM
Minimum pressure at full flow (If restrictions are present, the reading could be inaccurate.)	110 kPa (16 psi) at 4000 RPM

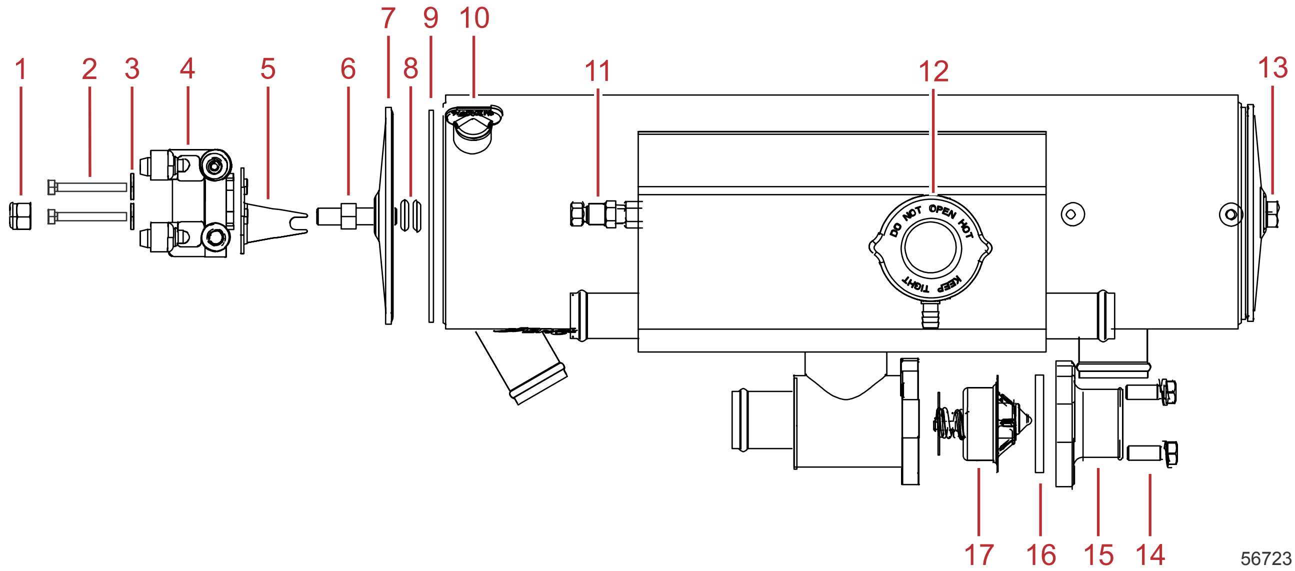
Closed-Cooling System

Description	Specification
Closed-cooling system capacity	14.3 L (15.1 US qt)
Thermostat operating temperature	77° C (170° F)
Pressure cap rating	110 kPa (16 psi)

Coolant Specification

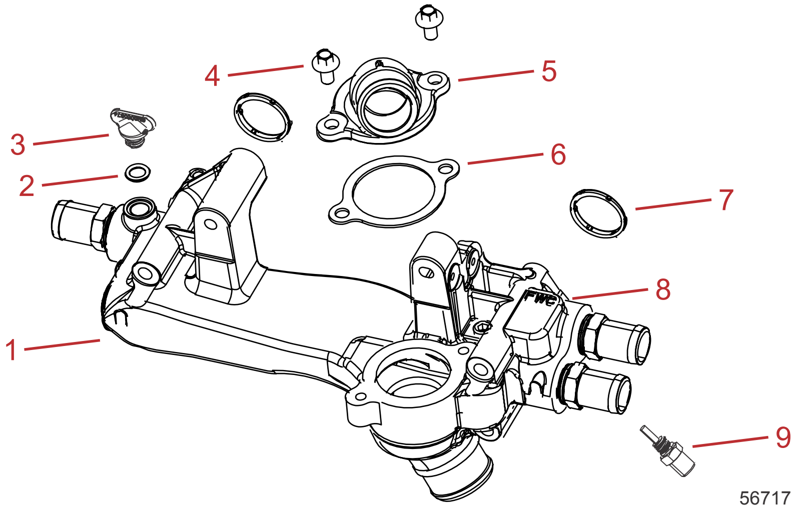
Description	Part Number
Extended Life Coolant (orange color)	92-877770K1

Heat Exchanger Assembly—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	End cap nut	14.9	131.8	–
2	2	Screw	2.3	20.3	–
3	2	Washer			
4	1	Air manifold			
5	1	Air manifold bracket			
6	1	Hex head stud	14.9	131.8	–
7	2	End cap			
8	4	O-ring			
9	2	Flat seal			
10	1	Blue vacuum release plug	Hand-tight		
11	1	Purge valve			
12	1	Pressure cap			
13	1	Hex head cap screw	14.9	131.8	–
14	2	Screw with captive lockwasher	6.8	60.1	–
15	1	Thermostat cover			
16	1	Thermostat seal			
17	1	Thermostat (77° C [170° F])			

Crossover for Closed Cooling—Exploded View



Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Crossover assembly			
2	1	O-ring			
3	1	Blue drain plug	Hand tight		
4	2	Screw	27.1	–	20
5	1	Crossover cap			
6	1	Crossover cap gasket			
7	2	Crossover seal			
8	–	Closed cooling identifying mark "FWC"			
9	1	Temperature sensor	16.3	144.2	–

Description

The cooling system is composed of two separate subsystems: the seawater system and the closed-cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed-cooling system as it passes through the heat exchanger. The closed-cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into the recovery bottle is approximately 230 ml (7.8 fl oz) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. While there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

Within the heat exchanger, the coolant (antifreeze) flows around the outside of the cooling tubes, while seawater flows through the inside of the cooling tubes.

Meeting the Minimum Seawater Flow Specifications

Bravo Models with Closed Cooling

Most Bravo models do not require a through-the-hull or through-the-transom seawater pickup to meet the minimum flow specifications. See the chart, **Seawater Pickups for Sterndrive Engine Models**.

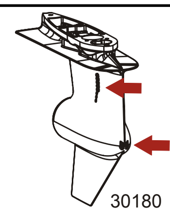
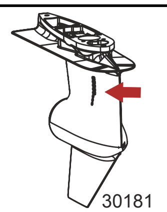
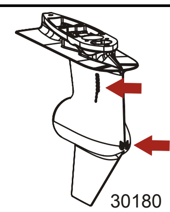
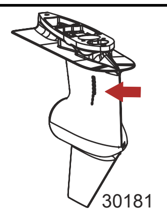
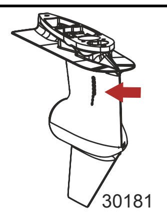
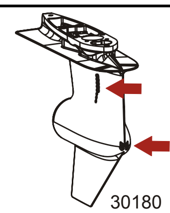
Bravo engine packages do not require the addition of a through-the-hull or through-the-transom seawater pickup if:

1. The sterndrive gearcase has dual water pickups.
2. The boat is capable of 64 km/h (40 mph) with the boat fully loaded and operated within the specified operating range.

Through-the-hull or through-the-transom seawater pickups are never required on Bravo models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere.

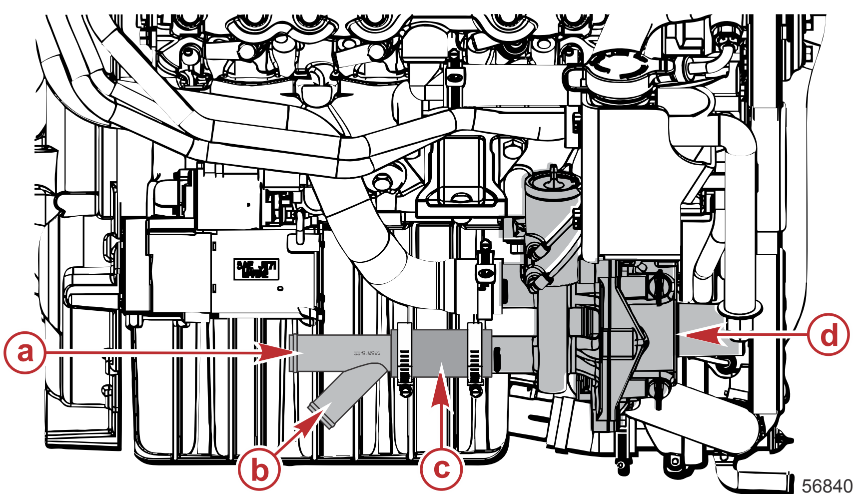
When additional water inlets are used, a Y-fitting is installed onto the seawater pump. Refer to **Installing the Y-Fitting**.

*NOTE: When not installing the through-the-hull or through-the-transom seawater pickup, refer to **Installing the Seawater Supply Hose**.*

Seawater Pickups for Sterndrive Engine Models			
Boat speed with the boat fully loaded and operated within the specified operating range	Bravo has side water pickup	Bravo has dual water pickup	Through-the-hull or through-the-transom seawater pickup
64 km/h (40 mph) or greater. Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere.		 30180	Not required. Refer to **Installing the Seawater Supply Hose**.
Less than 64 km/h (40 mph)	 30181	 30180	Required. Refer to **Installing the Y-Fitting**.
64 km/h (40 mph) or greater	 30181		Required. Refer to **Installing the Y-Fitting**.
Greater or less than 64 km/h (40 mph). Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere.	 30181	 30180	Not required. Refer to **Installing the Seawater Supply Hose**.

Installing the Y-Fitting

Engine models that require a through-the-hull or through-the-transom seawater pickup require a Y-fitting at the engine seawater pump inlet port. The Y-fitting directs the seawater from the sterndrive and through-the-hull or through-the-transom seawater pickup to the engine's seawater pump to meet the minimum flow specifications.



56840

- a - Y-fitting port to water inlet at transom
- b - Y-fitting port to through-the-hull or through-the-transom seawater pickup
- c - 10 cm (4 in.) hose, from seawater pump inlet to Y-fitting port
- d - Seawater pump

NOTE: For models not factory equipped with a Y-fitting, refer to ***Mercury Parts Catalog, Closed-Cooling Systems (Bravo)*** *to order the specified Y-fitting, seawater supply bulk hose, and hose clamps that meet MerCruiser specifications.*

1. Cut a 10 cm (4 in.) piece of the supply hose and connect it to the seawater pump inlet and the Y-fitting port.
2. Install a seawater supply hose onto the Y-fitting port and the sterndrive's water inlet at the transom. Cut off any excess hose.
3. Install a seawater supply hose onto the Y-fitting port and the through-the-hull or through-the-transom seawater pickup. Cut off any excess hose.
4. Properly secure all hoses to all fittings to prevent water leaking into the boat.

Installing the Seawater Supply Hose

For engine models not using a through-the-hull or through-the-transom seawater pickup:

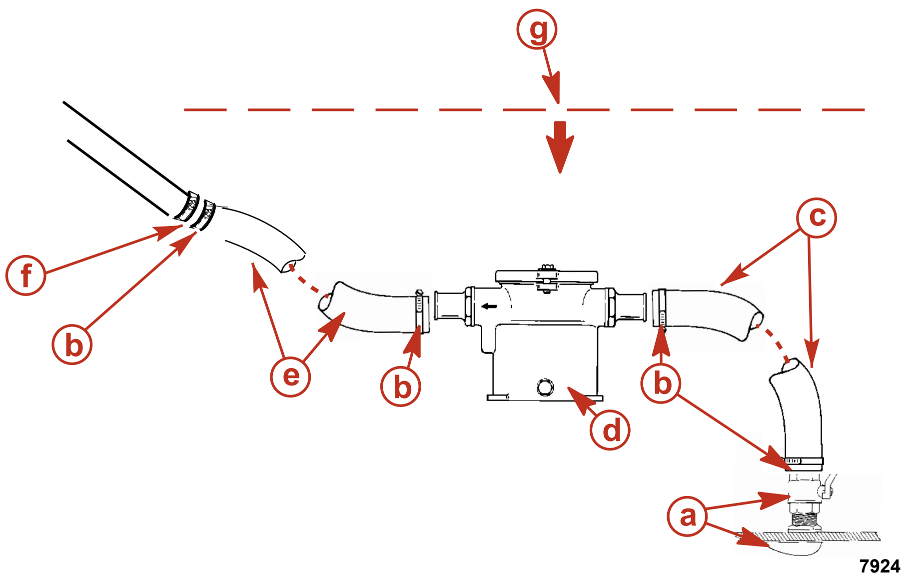
1. If applicable, remove the Y-fitting at the seawater pump inlet.
2. Install a seawater supply hose that meets MerCruiser specifications to the engine's seawater pump inlet.
3. Route the seawater supply hose directly to the seawater inlet fitting on the transom. Cut off any excess hose.
4. Properly secure the hose at both ends to prevent water leaking into the boat.

NOTE: For models not factory equipped with a seawater supply hose, refer to the ***Mercury Parts Catalog, Standard-Cooling Systems (Bravo)*** *to order the specified bulk hose, hose clamps, and quick-connect fittings that meet MerCruiser specifications.*

NOTE: For models with quick-connection fittings, refer to ***Bravo Seawater Inlet Fitting Connection*** *in* ***Section 2B****.*

Through-the-Hull Seawater Pickup System

IMPORTANT: Use a 32 mm (1-1/4 in.) ID wire-reinforced hose that is capable of supporting 34 kPa (10 in. Hg) vacuum when suction is created by the seawater pump impeller.



Typical installation shown with a through-the-hull seawater pickup

- a - Seawater pickup and seacock
- b - Hose clamp
- c - Seawater hose to seawater strainer
- d - Quicksilver seawater strainer
- e - Seawater hose to engine
- f - Seawater pump hose connector (if equipped)
- g - Below seawater pump level

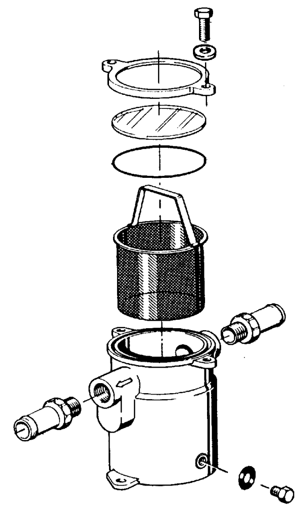
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slipstream. This will cause propeller ventilation and will adversely affect boat performance.

IMPORTANT: Make gradual bends in the seawater hoses to avoid kinks. Hoses must not come in contact with steering system components, engine coupler, or driveshaft.

- The seawater pickup must be large enough to permit sufficient seawater flow to engine seawater pump for adequate engine cooling.
- The seawater pickup also must supply a positive head while underway.
- The seawater pickup should be located as close to the seawater pump inlet as possible and in an area where an uninterrupted, solid stream of seawater will flow when the boat is underway.

Seawater Strainer

A seawater strainer is recommended if the boat is operated in an area with a high debris content. Use 32 mm (1-1/4 in.) I.D. wire-reinforced hoses on the inlet and outlet sides of the strainer fittings. The strainer must be sized to minimize restriction (refer to **Specifications**) and to provide a reasonable service interval. Locate the strainer in an area that is accessible for servicing. If the boat is not equipped with a seacock, the strainer should be located above the waterline to prevent seawater entry into the boat when servicing. The strainer must have a provision to allow draining in freezing temperatures.



Typical seawater strainer

Seawater Pickup

Either a through-transom or through-hull seawater pickup can be used. Select the pickup location to minimize the length of the 32 mm (1-1/4 in.) I.D. wire-reinforced seawater inlet hose, while providing an optimum location for seawater pickup. The location should be in an area that provides a solid, air-free flow of seawater under all operating conditions. Avoid areas with a disturbed seawater flow, such as those behind or in close proximity to the propeller. Locations that are too far forward or outboard should also be avoided as these are prone to aeration problems at high boat-trim angles and while turning.

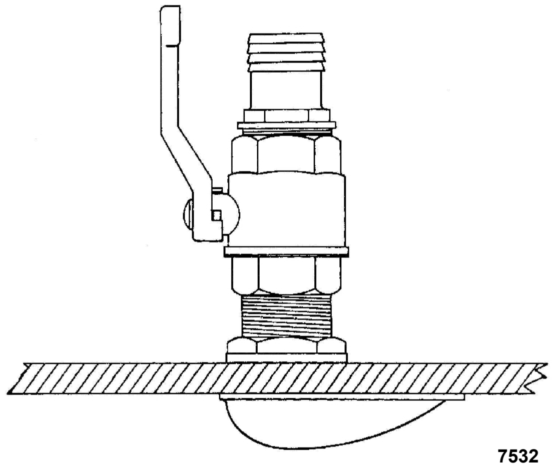
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slip-stream. This will cause propeller ventilation and will adversely affect boat performance.

Openings in seawater pickup should be a maximum of approximately 3 mm (1/8 in.) to prevent large debris from entering and clogging the cooling system.

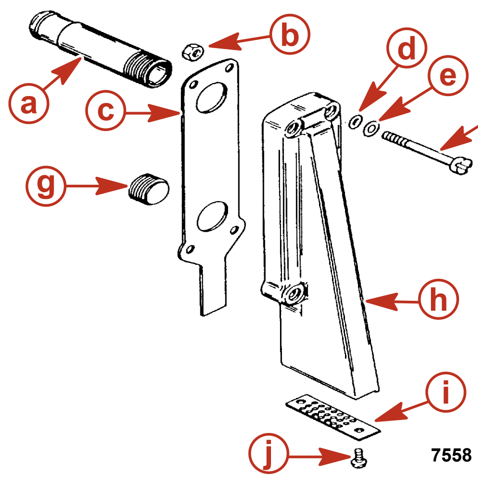
IMPORTANT: Use a seawater strainer if the seawater pickup openings exceed 3 mm (1/8 in.).

Some industry standards and regulations require that the pickup be connected into the boat's bonding system to minimize stray current corrosion. Refer to applicable standards and regulations for more details.

IMPORTANT: An external seawater pickup must have an integral seacock.



Seawater pickup with an integral seacock



Transom pickup

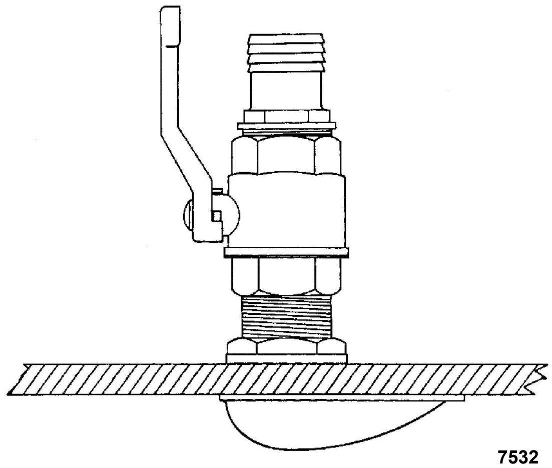
- a - Hose fitting - apply Loctite 567 to the threads
- b - Nut (4)
- c - Gasket
- d - O-ring (4)
- e - Washer (4)
- f - Screw (4)
- g - Plastic plug - apply Loctite 567 to the threads
- h - Pickup - apply RTV 587 to the sealing surfaces
- i - Screen
- j - Screw (2) - apply RTV 587 to the shaft

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Seacock

The American Boat and Yacht Council (ABYC) and other industry standards and regulations require the use of a seacock on certain types of applications to stop the entry of seawater in the event of a leak in the cooling system. Refer to applicable standards and regulations for specific requirements. The seacock also allows the seawater to be shut off when servicing the engine.

The seacock must provide minimum restriction to seawater flow (refer to **Specifications**). A ball valve or gate valve is recommended. The ball valve is most common and is typically equipped with a lever type handle that operates in a 90° arc. This design gives a clear indication of whether the valve is open or shut. Industry standards require that the seacock be rigidly attached to the hull at the seawater pickup. The seacock's location should be accessible for quick, easy operation.



Typical seacock

Seawater Strainer

Seawater Strainer Mounting Requirements

Use a properly sized strainer to maintain an adequate supply of water for cooling the engine.

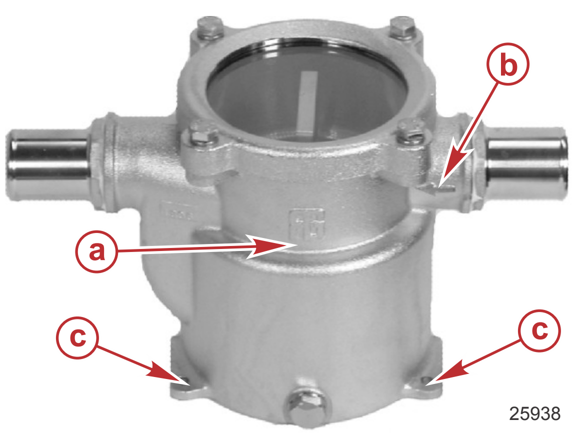
- Mount the seawater strainer in a location that will allow easy access for servicing, and maintenance.
- Mount the seawater strainer in a vibration free location.
- Do not mount the seawater strainer on the engine.
- If not equipped with a seacock, mount the seawater strainer above the seawater–line to prevent seawater entry into the boat when servicing.
- Use a 32 mm (1-1/4 in.) I.D. wire-reinforced hose.
- Do not allow hoses to contact hot or moving parts on the engine.

Seawater Strainer Installation

Refer to the manufacturer's instructions for detailed installation, operation, and maintenance.

IMPORTANT: Use the following guidelines when installing a Mercury seawater strainer.

1. Position the seawater strainer in an appropriate location, below the level of the seawater pump.
2. Ensure that the arrow that indicates the direction of seawater flow points toward the seawater pump.
3. Install the seawater strainer using flat washers and lag bolts.



a - Seawater strainer
b - Arrow indicating direction of water flow
c - Mounting bolt hole location (bolts not shown)

Cleaning the Seawater Strainer, if Equipped

NOTICE

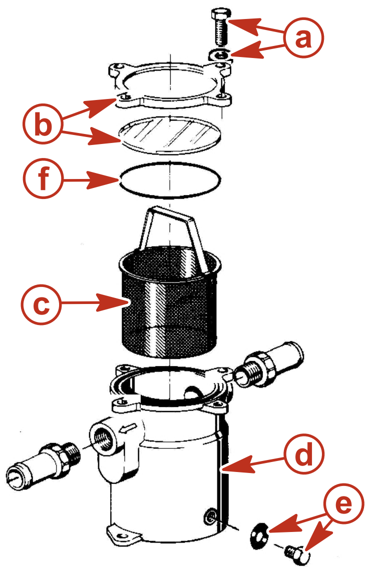
An open seawater strainer or seacock during some service or maintenance procedures can introduce water into the boat, causing damage or sinking the boat. Always close the water supply from the seawater pump, water inlet, or seacock when performing service or maintenance on the cooling system.

1. With the engine off, close the seacock, if equipped, or remove and plug the seawater inlet hose.
2. Remove the screws, washers, and cover.
3. Remove the strainer, drain plug, and sealing washer.
4. Clean all the debris from the strainer housing. Flush both the strainer and housing with clean water.
5. Check the cover gasket and replace when damaged or if it leaks.
6. Reinstall the strainer, drain plug, and sealing washer.

⚠ CAUTION

Seawater leaking from the seawater strainer could cause excess water in the bilge, damaging the engine or causing the boat to sink. Do not overtighten the cover screws, or the cover may warp and introduce seawater into the bilge.

7. Install the seal and cover using the screws and washers. Do not overtighten the cover screws.



a - Screws and washers
b - Cover with glass
c - Strainer
d - Housing
e - Drain plug and sealing washer
f - Seal

8. Open the seacock, if equipped, or remove the plug and reconnect the seawater inlet hose.
9. Upon first starting the engine, check for leaks or air in the system that would indicate an external leak.

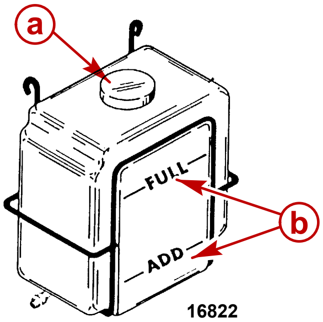
Coolant

Coolant Recommendations

IMPORTANT: Alcohol-based or Methanol-based antifreeze or plain water are not recommended for use in the closed-cooling section of the cooling system at any time.

NOTE: All factory installed closed-cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any top-off fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.
In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



Coolant recovery bottle

- a - Cap
- b - "ADD" and "FULL" marks

1. Before starting the engine, ensure that coolant is visible in the coolant recovery bottle.
2. If coolant is not visible:
   a. Check the closed-cooling system (including the coolant recovery system) for leaks.
   b. Make any necessary repairs.
   c. Refill the system with the recommended coolant solution.
3. If coolant is visible:
   a. Start the engine and operate it until it reaches its normal operating temperature.
   b. Check the coolant level in the coolant recovery bottle. The coolant level must be between the "ADD" and "FULL" marks on the front of the bottle.
   c. If the coolant level is low, remove the fill cap from the coolant recovery bottle and add the required amount of coolant solution. Refer to **Coolant Recommendations**.

⚠ CAUTION
A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

4. Occasionally, ensure that the coolant recovery system is functioning properly by removing the pressure cap from the heat exchanger and checking the level. The coolant level should be up to the bottom of the heat exchanger filler neck. If it is low, examine the entire closed-cooling section (especially the coolant recovery system) for leaks, and make any necessary repairs.
   IMPORTANT: When reinstalling the pressure cap, tighten it until it contacts the stops on the filler neck.

Pressure Cap Maintenance and Testing

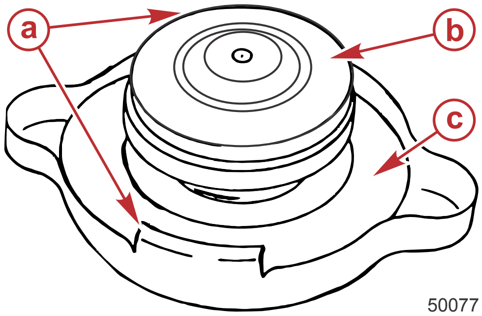
IMPORTANT: Replace the pressure cap if the engine overheats.

The pressure cap is designed to maintain a pressure of approximately its rated capacity once the engine has attained operating temperature. The cap should be cleaned, inspected and pressure-tested at regular intervals or whenever the cap is suspected of not maintaining the proper pressure.

⚠ CAUTION
A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

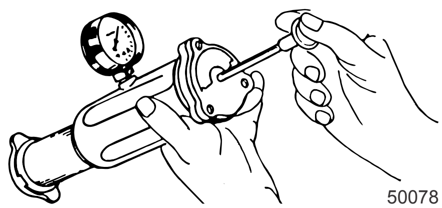
1. Carefully remove the pressure cap from the reservoir or the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the gasket (if used) and the rubber seal on the cap for tears, cuts, cracks, or other signs of deterioration. Replace the gasket, if damaged.
4. Replace the cap if the rubber seal is damaged.

5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.

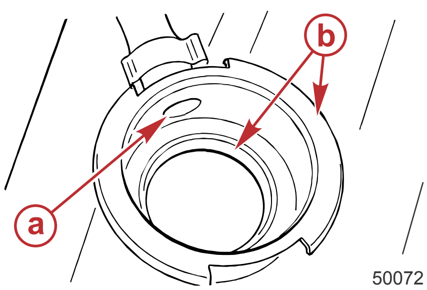


a - Locking tabs (one not shown)
b - Rubber seal
c - Gasket

6. Using a cooling system pressure tester, test the cap to ensure that it releases at the proper pressure and does not leak. Refer to the tester instructions. The cap must relieve pressure at 110 kPa (16 psi) and must hold the rated pressure for 30 seconds without going below 75.8 kPa (11 psi). Replace the cap if it fails to fall within these limits.



IMPORTANT: Before installing the cap, examine the lower inside sealing surface in the filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the cam lock flanges on the sides of the filler neck to ensure that they are not bent.



a - Coolant recovery passage
b - Sealing surfaces

7. Install the cap on the reservoir or the heat exchanger.

Testing the Closed-Cooling System

Testing Coolant for Alkalinity

⚠ CAUTION
A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

The coolant should be changed per the maintenance schedule (refer to **Section 1C** - **Maintenance**) and should be checked for alkalinity at least once between change intervals. To check the coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local source.
2. Allow the engine to cool, remove the pressure cap from the heat exchanger, and insert one end of the litmus paper into the coolant.
3. If the pink litmus paper turns blue, the coolant is alkaline and does not need to be replaced.
4. If the pink litmus paper remains pink, the coolant is not alkaline and must be replaced. Refer to **Changing Coolant**.

Pressure Testing the System

⚠ CAUTION
A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

If the coolant section of the closed-cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove the pressure cap from the heat exchanger or the reservoir.
2. Clean, inspect, and pressure test the pressure cap.
3. Clean the inside of the filler neck to remove any deposits or debris.
4. Examine the lower inside sealing surface for damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the cap.
5. Ensure that the locking cams on the sides of the filler neck are not bent or damaged.
6. Adjust the coolant level to 25 mm (1 in.) below the filler neck.
7. Attach an automotive-type cooling system pressure tester to the filler neck and pressurize the closed-cooling section to amount specified.

Pressure Cap Rating	Amount of Pressure Applied to Closed-Cooling System
110 kPa (16 psi)	138 kPa (20 psi)

8. Observe the gauge reading for approximately two minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until leakage is found.
9. While maintaining the specified pressure on the closed-cooling section, inspect the external portion of the cooling system (for example, hoses, gaskets, drain plugs, petcocks, core plugs, and circulating pump seal) for leakage. Also listen closely for bubbling or hissing.
10. Test the heat exchanger.

Seawater Pressure Test

IMPORTANT: This test applies only to models with closed cooling.
IMPORTANT: The boat must be in the water for this test.

1. Connect the G3 diagnostic tool.

CDS G3 Diagnostic Interface Tool With Harness	8M0046124

2. Start the engine. When the engine is at normal operating temperature, shift into forward gear.
3. Advance the throttle to 4000 RPM.
4. Check the seawater pressure with G3. If seawater pressure does not meet specification, further testing is required.

Description	Specification
Minimum pressure (models with closed cooling)	138 kPa (20 psi) at 4000 RPM

5. If no leakage could be found in the above steps, the engine is leaking internally. Leaking may be caused by one or more of the following:
   - Loose cylinder head bolts or damaged gasket
   - Loose intake manifold bolts or damaged gasket
   - Loose exhaust elbow or distribution block retaining nuts or damaged gasket
   - Cracked or porous cylinder head or block
   - Cracked or porous exhaust manifold

   Proceed as follows until the location of the internal leak is found.
   a. Start the engine.
   b. Pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, the compression or the combustion is leaking into the closed-cooling section from a leak in the combustion chamber.
   c. Stop the engine.
   d. Remove the spark plugs, examining each for the presence of coolant. A spark plug that is perfectly clean or has a milky appearance is an indication of an internal leak.
   e. Drain the oil from the engine and examine it for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove the engine from the boat and remove the oil pan. With the engine in the upright position, repressurize the closed-cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.
   f. If no leakage can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Testing for a Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

IMPORTANT: Operate the boat in the water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and the coolant recovery bottle. Use a 91 cm (3 ft) long hose for this test.
2. Route this hose so that a "U" is formed.
3. Put enough coolant into the hose to fill the center 127 mm (5 in.) of the U-shape.
4. Observe the U-shape while the engine is operating.
   - **During idle and warm-up:** Some coolant and air will leave the reservoir.
   - **At cruising speed (2500-3500 RPM):** Coolant and air leaving the reservoir should stop after approximately five minutes operating at a given RPM. A leaking head gasket will produce air bubbling through the U-shape, going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
   - **At higher speeds (4000+ RPM):** Normal operation is the same as described above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given RPM. A head gasket leak will not stop; the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Thermostat

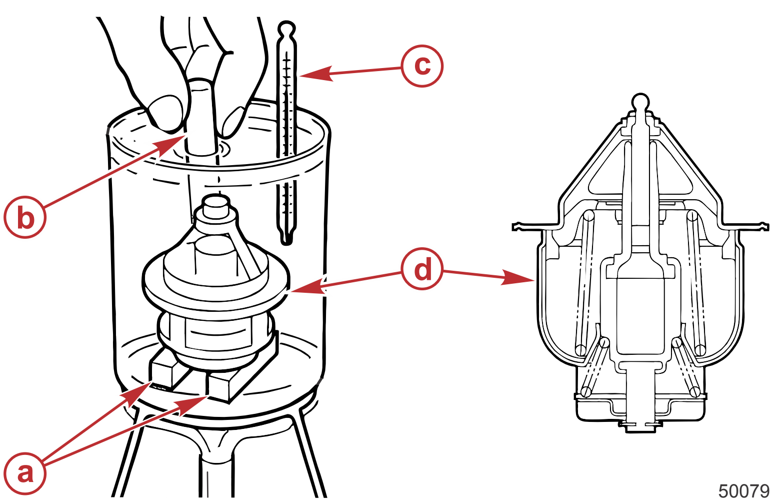
Thermostat Removal

Refer to the exploded view.

1. Drain the coolant from the engine.
2. Disconnect the hose from the thermostat housing cover.
3. Remove the thermostat housing cover bolts, the cover, and the seal.
4. Remove the thermostat from the thermostat housing.

Thermostat Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Add water to the container until it covers the thermostat.
4. Heat the water.
5. Stir the water constantly to avoid applying direct heat to the thermostat.

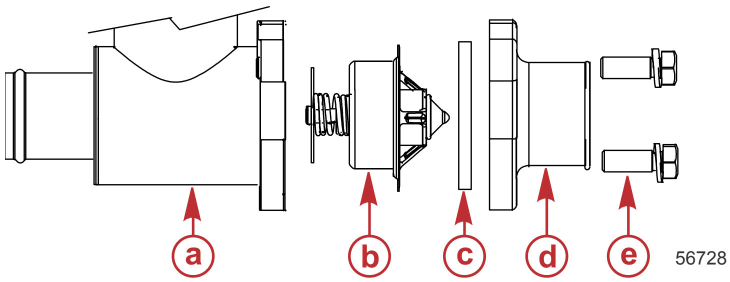


a - Wooden blocks
b - Stirring rod
c - Thermometer
d - Thermostat

6. Observe the thermostat and check the temperature when the thermostat fully opens. If the temperature is not within specifications, then replace the thermostat.

Thermostat Installation

1. Clean the surfaces on the thermostat housing and thermostat housing cover.
2. Install the thermostat seal onto the thermostat flange.
3. Install the thermostat into the thermostat housing.
4. Install the thermostat housing cover. Tighten the screws with captive lockwashers to the specified torque.



a - Thermostat housing (attached to heat exchanger)
b - Thermostat
c - Thermostat seal
d - Thermostat housing cover
e - Screw with captive lockwasher (2)

Description	Nm	lb-in.	lb-ft
Screw with captive lockwasher	6.8	60.1	–

5. Connect the hose to the thermostat housing cover. Tighten the hose clamp securely.
6. Connect any other hoses that were removed to gain access to the thermostat.
7. Fill the closed-cooling system.
8. Supply cooling water, start the engine, and inspect for leaks.

Changing Coolant

Closed-Cooling Section

The engine and exhaust sections of a closed-cooling system should remain filled year-round with the recommended coolant solution. Do not drain the closed-cooling section for storage, as this will promote rusting of internal surfaces. If the engine will be exposed to freezing temperatures, fill the closed-cooling section with Extended Life Coolant or an ethylene glycol antifreeze and water solution. Follow the manufacturer's recommended proportions to protect the engine to the lowest temperature to which it will be exposed. If necessary, change the coolant using the coolant specified in **Coolant Recommendations**.

Change Intervals

If the closed-cooling system is factory installed, drain and flush the coolant from the closed-cooling system at least every five years or 1000 hours of operation, whichever comes first. Change the coolant whenever exhaust gases have entered the system. If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

Draining the Closed Cooling System

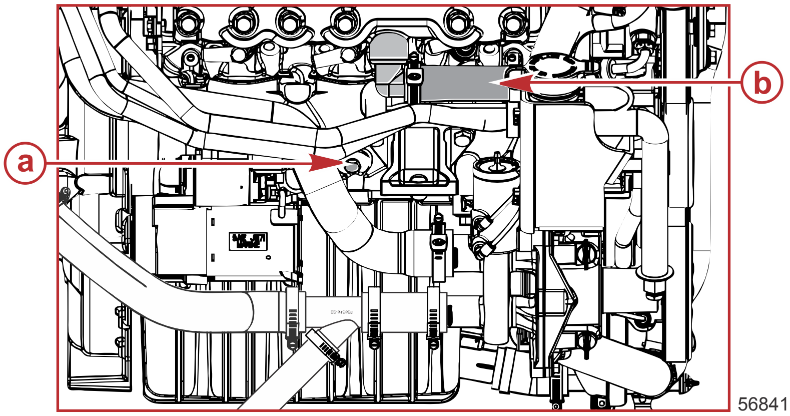
⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

IMPORTANT: A wire should be inserted into the drain holes to ensure that foreign material is not obstructing the drain holes.
IMPORTANT: The engine must be as level as possible to ensure the complete draining of the cooling system.
IMPORTANT: The closed-cooling section must be kept filled year-round with recommended coolant. If the engine will be exposed to freezing temperatures, ensure that the closed-cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect the engine to the lowest temperature to which it will be exposed.

1. Remove the pressure cap from the coolant tank.
2. On the port and starboard sides of the engine block, remove the block pipe plugs. Drain the coolant into a proper container.

3. On the port and starboard sides of the engine block, remove the coolant hoses from the bottom of the exhaust manifolds. Drain the coolant into a proper container.



Starboard shown, port similar

a - Engine block drain plug

b - Exhaust manifold coolant hose

4. Remove the hose from the heat exchanger to the water circulating pump at the pump connection. Drain the coolant into a proper container.
5. After the coolant has drained completely, reinstall the block pipe plug and hoses. Securely tighten the clamps.
6. Remove the coolant recovery bottle from the mounting bracket and drain the coolant into a proper container.

Cleaning the Cooling System

Closed-Cooling Section

Clean the closed-cooling section at least once every five years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale, or other foreign material. Always follow the manufacturer's instructions for the cleaner.

If the closed-cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in the opposite direction of the normal coolant flow to allow water to get behind deposits and force them out. Refer to the instructions that accompany the flushing device for the proper hookup and flushing procedure.

Seawater Section

The cooling efficiency of an engine with closed cooling is dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, or lime) collect on the inside of the tubes, reducing heat transfer and reducing the efficiency of the heat exchanger. It is recommended that the seawater section of the heat exchanger be cleaned as specified or whenever decreased cooling efficiency is suspected. Refer to **Heat Exchanger Assembly**.

Filling the Cooling System

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

NOTICE

Air trapped in the closed cooling system can cause the engine to overheat, resulting in engine damage. Minimize the possibility of trapping air when initially filling the closed cooling system by positioning the boat so that the front of the engine is higher than the rear of the engine.

IMPORTANT: The closed-cooling system should be filled with the engine cold, and should be rechecked once the engine has warmed to normal operating temperature.

⚠ CAUTION

A sudden loss of pressure can cause hot coolant to boil and discharge violently resulting in serious injury from burns. Allow the engine to cool down before removing the coolant pressure cap.

1. Remove the pressure cap from the heat exchanger.
2. Open the vent on the top of the thermostat housing to purge the air from the system.

3. Fill the heat exchanger with coolant until the air is purged from the thermostat housing.

Tube Ref No.	Description	Where Used	Part No.
122	Extended Life Antifreeze/ Coolant	Closed-cooling system	92-877770K1

4. When the air is purged, close the vent on top of the thermostat housing.
5. Continue to fill the heat exchanger with coolant until it is full to the bottom of the filler neck.
   IMPORTANT: When installing the pressure cap, be sure to tighten it until it seats on the filler neck.
6. Install the pressure cap onto the heat exchanger.
7. Add coolant to the recovery bottle to bring the level to the "FULL" line.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

8. Start the engine, and check for leaks while monitoring the temperature and coolant recovery bottle level.
9. Bring the engine to operating temperature. Allow the engine to run for five minutes at operating temperature.
10. Turn the engine off and let it cool.
11. Remove the fill cap from the coolant recovery bottle.
12. Fill the recovery bottle to the "FULL" line.
13. Install the fill cap onto the coolant recovery bottle.

Heat Exchanger Assembly

Testing—Internal Leaks

An internal leak will allow coolant to enter into the seawater circuit when the closed-cooling circuit is pressurized.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed-cooling circuit to 110-138 kPa (16-20 psi) with a radiator tester.
3. If seawater begins to flow from the seawater hose fitting of the heat exchanger, there is a leak.

Blockage

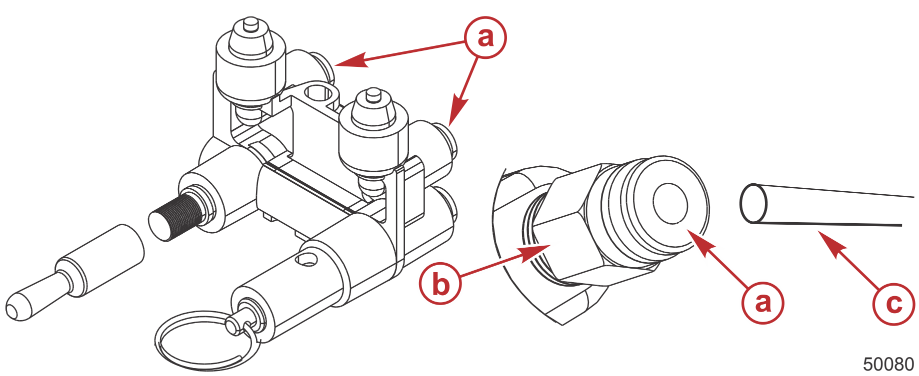
IMPORTANT: Seawater flows through the tubes in the exchanger. Coolant/antifreeze flows around the tubes.

1. Remove the end caps and inspect for any blockage in the seawater circuit, such as broken impeller blades or weeds.
2. Remove the closed-cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Heat Exchanger Removal

***NOTE:** The heat exchanger does not have to be removed for cleaning.*

1. Allow the engine to cool.
2. Drain the seawater from the engine.
3. Drain the coolant from the engine.
4. Remove the MerCathode controller, if equipped.
5. Remove each air line from the air manifold by pressing on the fitting and pulling the line out.



a - Release location
b - Air line fitting
c - Air line

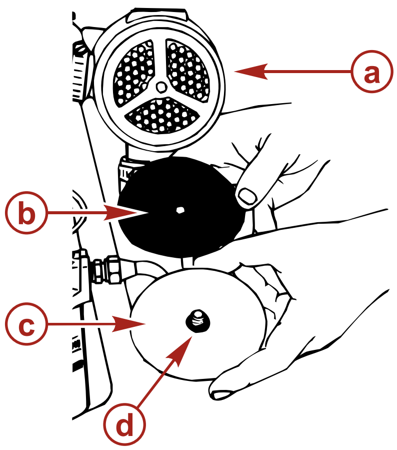
6. Remove the hoses from the heat exchanger.

7. Remove the two straps that fasten the heat exchanger to the engine.
8. Remove the heat exchanger.

Heat Exchanger Disassembly

IMPORTANT: Do not remove the air pump and air pump bracket if they are mounted to the engine compartment.

1. Remove the air manifold.
2. Remove the fasteners attaching the end caps to the heat exchanger.
3. Remove the end caps and gaskets.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - O-rings

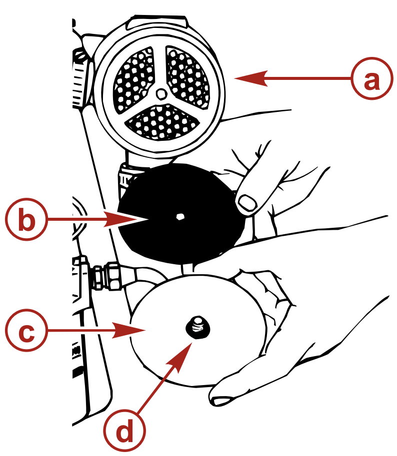
Cleaning and Inspection

1. Clean the old gasket material and sealant from the surfaces. Do not nick or gouge the surfaces.
2. Use a long rod and wire brush to clean out heat exchanger tubes.
3. Inspect each part for cracks or other damage. Replace as necessary.
4. Clean and paint the exterior surfaces as required to prevent corrosion.

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Do not melt the other joints during repair.

- Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in the cooling capacity. Do not close more than three tubes.
- Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - O-rings

After repairs are complete:

1. Assemble the heat exchanger. Tighten the heat exchanger end cap fasteners to the specified torque.

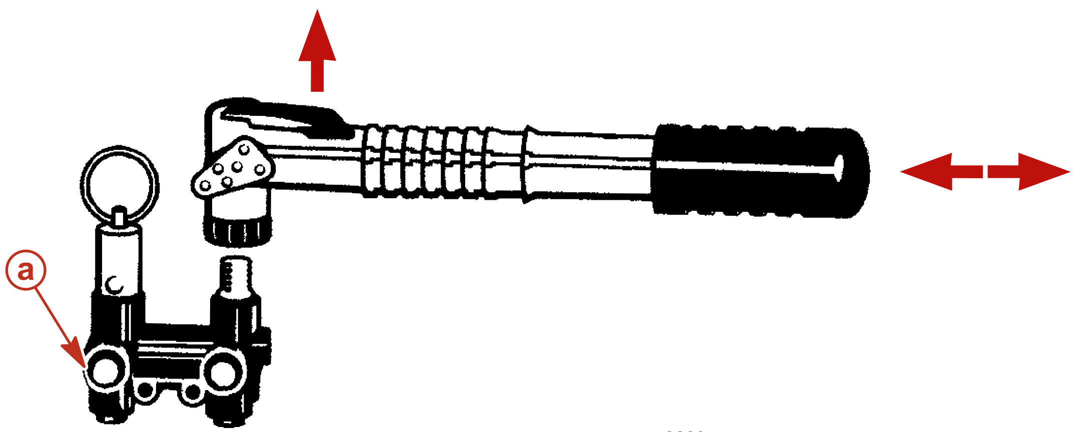
Description	Nm	lb-in.	lb-ft
Heat exchanger end cap fasteners	14.9	131.8	–

2. Fasten the air manifold and bracket to the heat exchanger. Tighten the nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Air manifold bracket nut	14.9	131.8	–

Heat Exchanger Installation

1. Lower the heat exchanger onto the brackets and simultaneously attach the water hoses.
2. Ensure that all hose ends are aligned and fully seated on the heat exchanger fittings. Tighten all hose clamps securely.
3. Attach the two straps that fasten the heat exchanger to the engine.
4. Attach the MerCathode controller, if equipped.
5. Connect the air lines to the air manifold by inserting the line into the fitting until a positive stop is encountered.
6. Ensure that the air lines are installed properly.
   a. Attach the air pump to the fitting on the air manifold.



8223

a - Green indicators

   b. Pull up on the air pump lever (vertical) to lock the pump onto the fitting.
   c. Pump air into the system until both green indicators extend. If the green indicators do not extend, the air lines are not attached properly.
7. Fill the closed-cooling system with the specified coolant.

Notes:

Cooling System

Section 6D - Water Flow Diagrams

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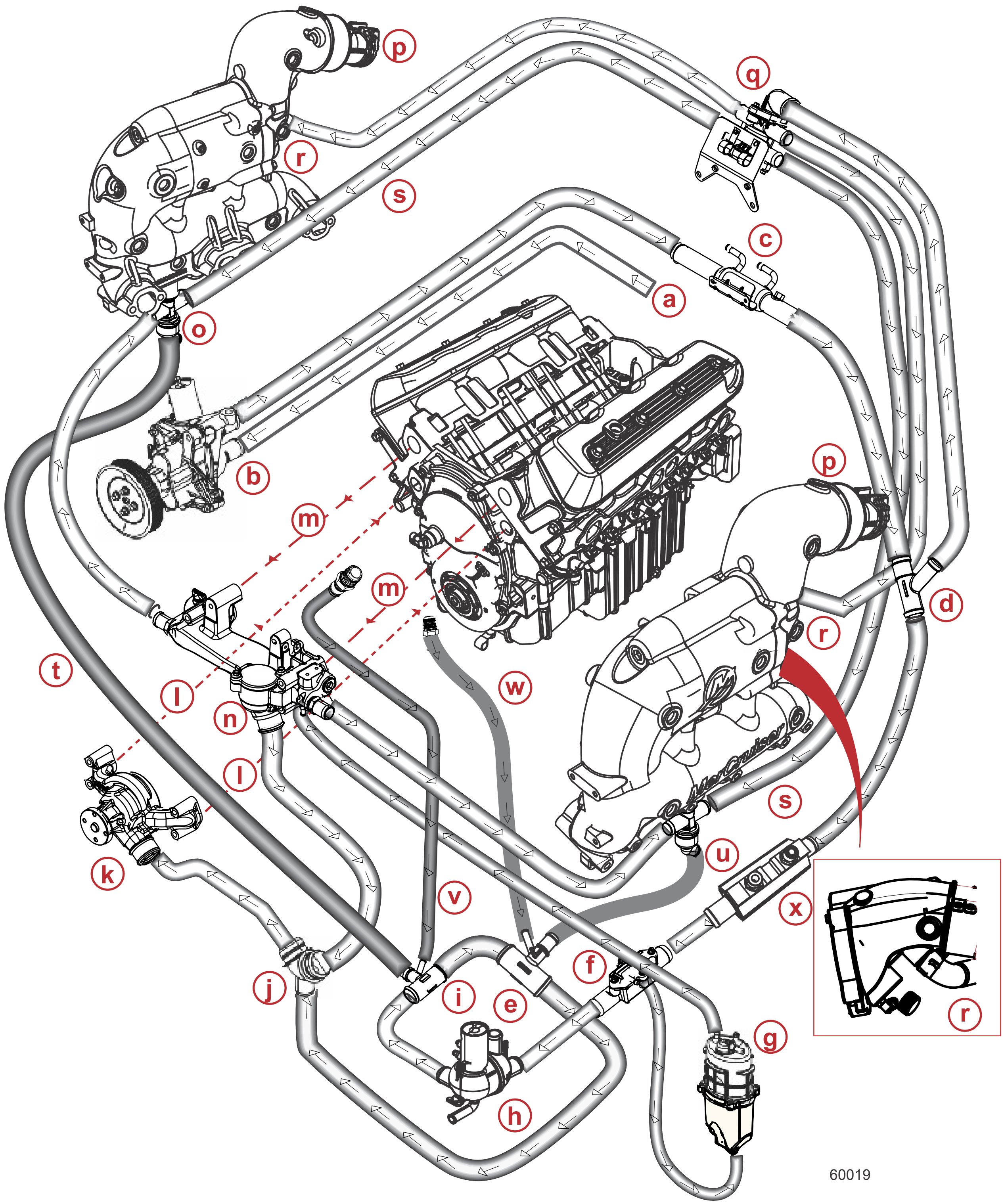
6
D

Models with Standard Cooling

Bravo with Air-Actuated Drain

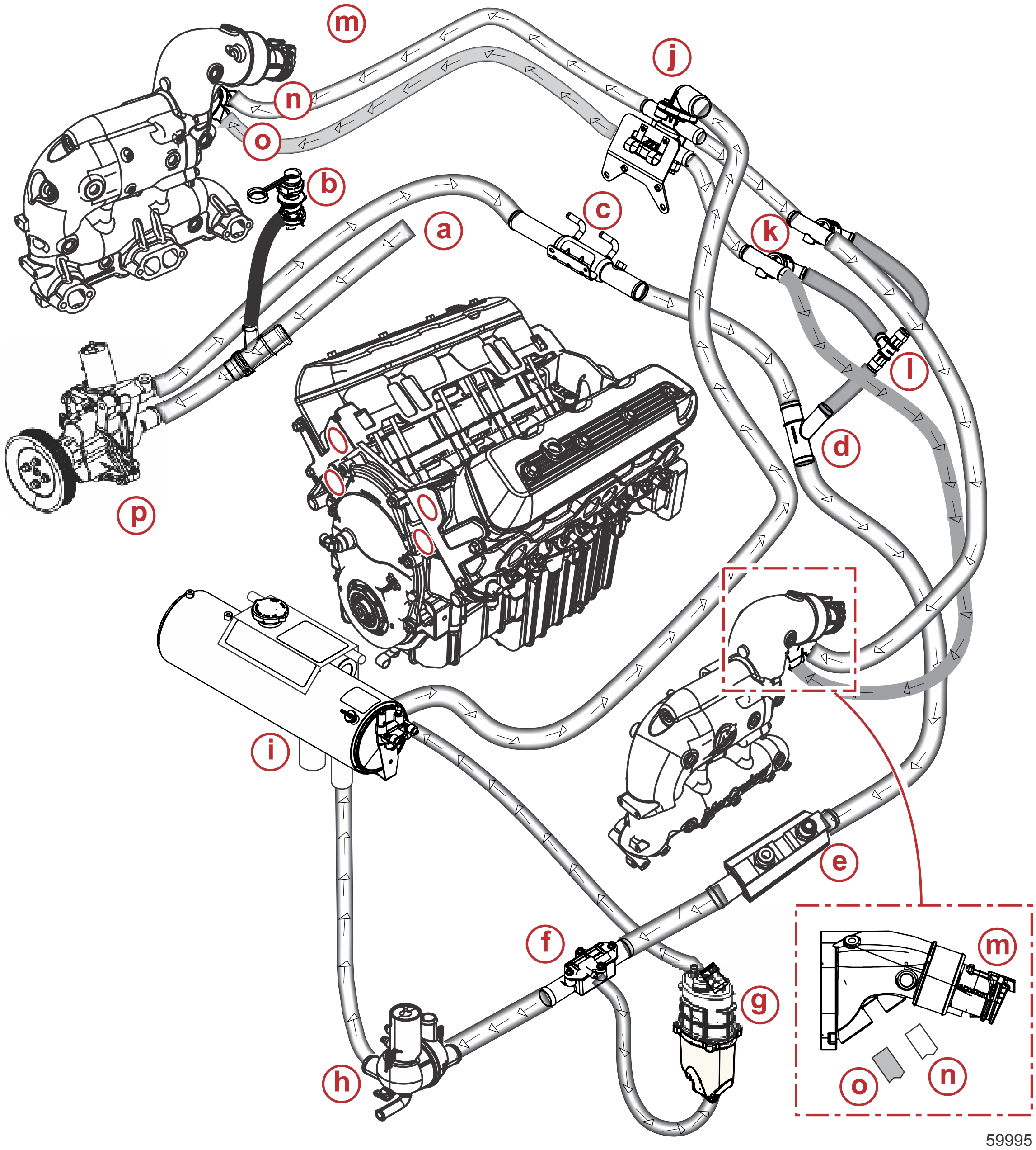


- a - Seawater inlet
- b - Seawater pump
- c - Power steering fluid cooler
- d - Y-fitting
- e - Drain fitting
- f - Fuel supply module water inlet strainer
- g - Fuel supply module
- h - Distribution housing
- i - Drain fitting
- j - Y-fitting
- k - Water circulating pump
- l - To engine block (from water circulating pump)
- m - To crossover (from engine block)
- n - Crossover with 60° C (140° F) thermostat
- o - Exhaust manifold seawater inlet and drain
- p - Exhaust and seawater outlet
- q - Poppet valve assembly (green)
- r - Exhaust elbow seawater inlet (poppet valve closed)
- s - Exhaust manifold seawater inlet (poppet valve open)
- t - Starboard exhaust manifold drain hose
- u - Port exhaust manifold drain hose
- v - Starboard engine block drain hose
- w - Port engine block drain hose
- x - Oil cooler

NOTE: When the poppet valve opens water will flow into (r and s)

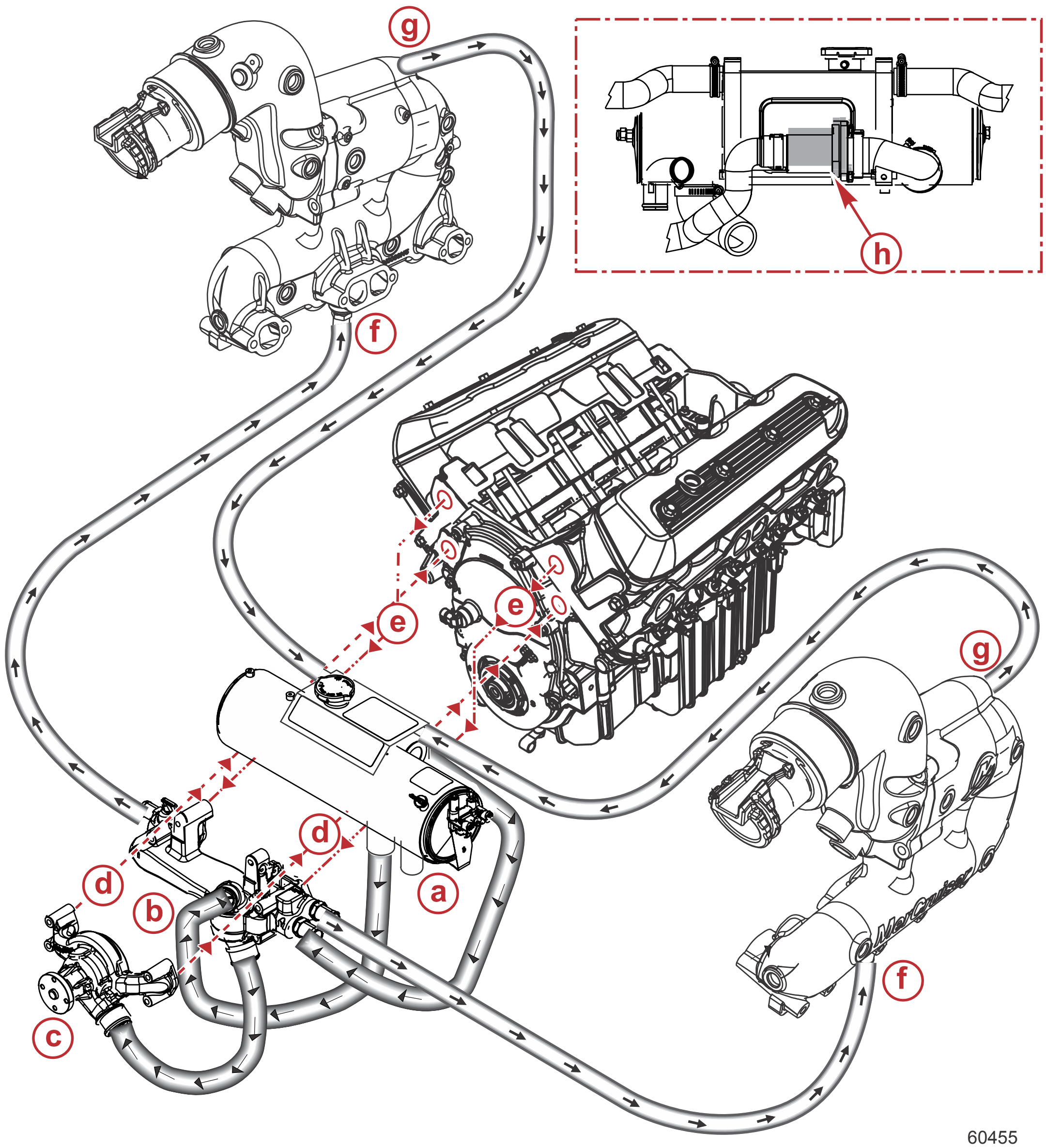
Models with Closed Cooling

Seawater Circuit (All Models with Closed Cooling)



- a - Seawater inlet
- b - Seawater flush hose and attachment
- c - Power steering fluid cooler
- d - Y-fitting
- e - Oil cooler
- f - Fuel supply module water inlet strainer
- g - Fuel supply module
- h - Distribution housing
- i - Heat exchanger
- j - Poppet valve assembly
- k - Check ball T-fitting
- l - Drain T-fitting
- m - Exhaust and seawater outlet
- n - Exhaust elbow seawater inlet—poppet valve closed
- o - Exhaust elbow seawater inlet—poppet valve open
- p - Seawater pump

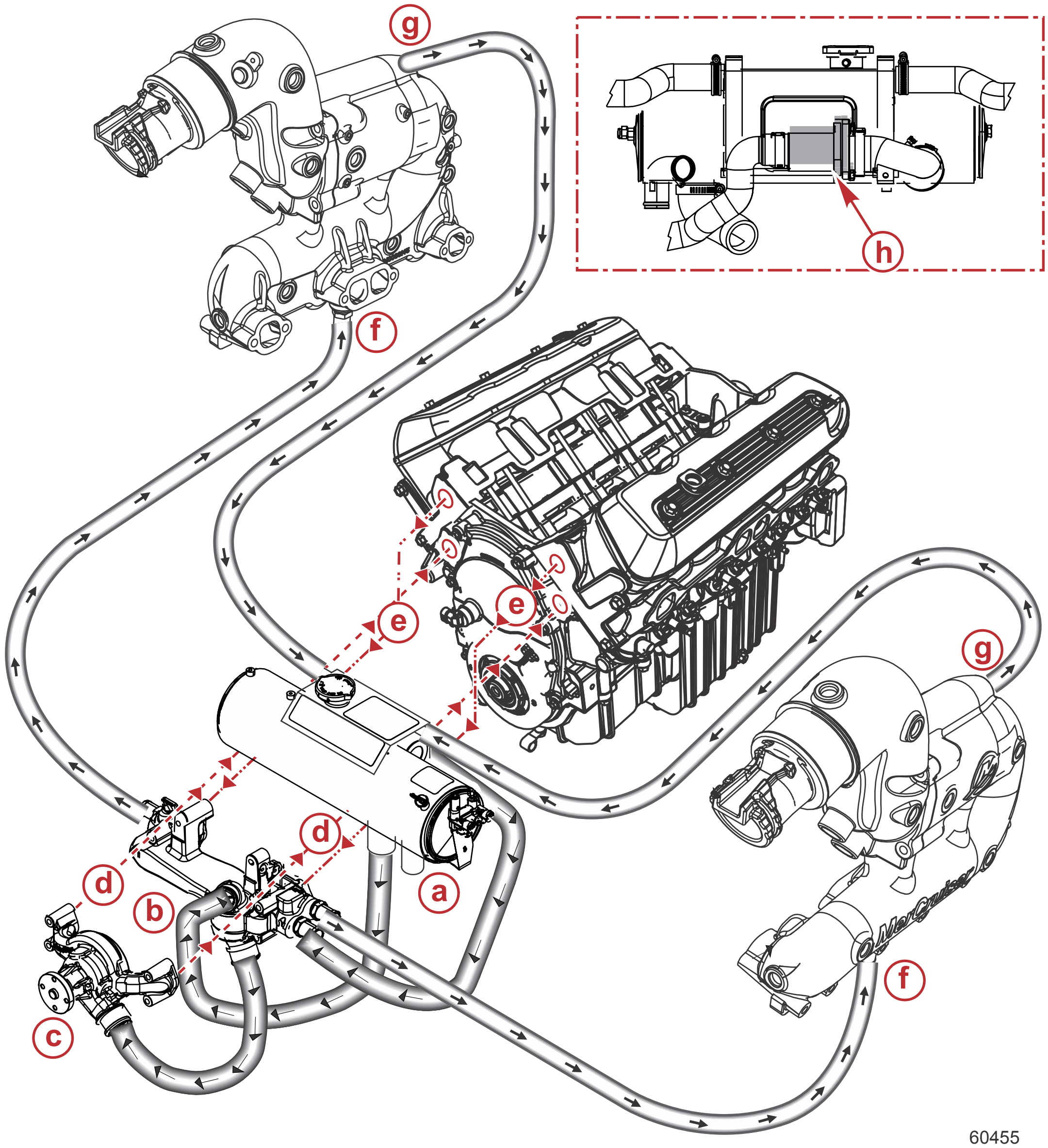
Glycol Circuit TowSport V-Drive



- a - Heat exchanger with attached thermostat housing
- b - Crossover
- c - Water circulating pump
- d - To engine block—from water circulating pump
- e - To crossover (from engine block)
- f - Exhaust manifold coolant inlet
- g - Exhaust manifold coolant outlet
- h - Detail of rear of heat exchanger, showing thermostat (shaded)

NOTE: Seawater hoses are not shown, for clarity.

Glycol Circuit Inboard V-Drive

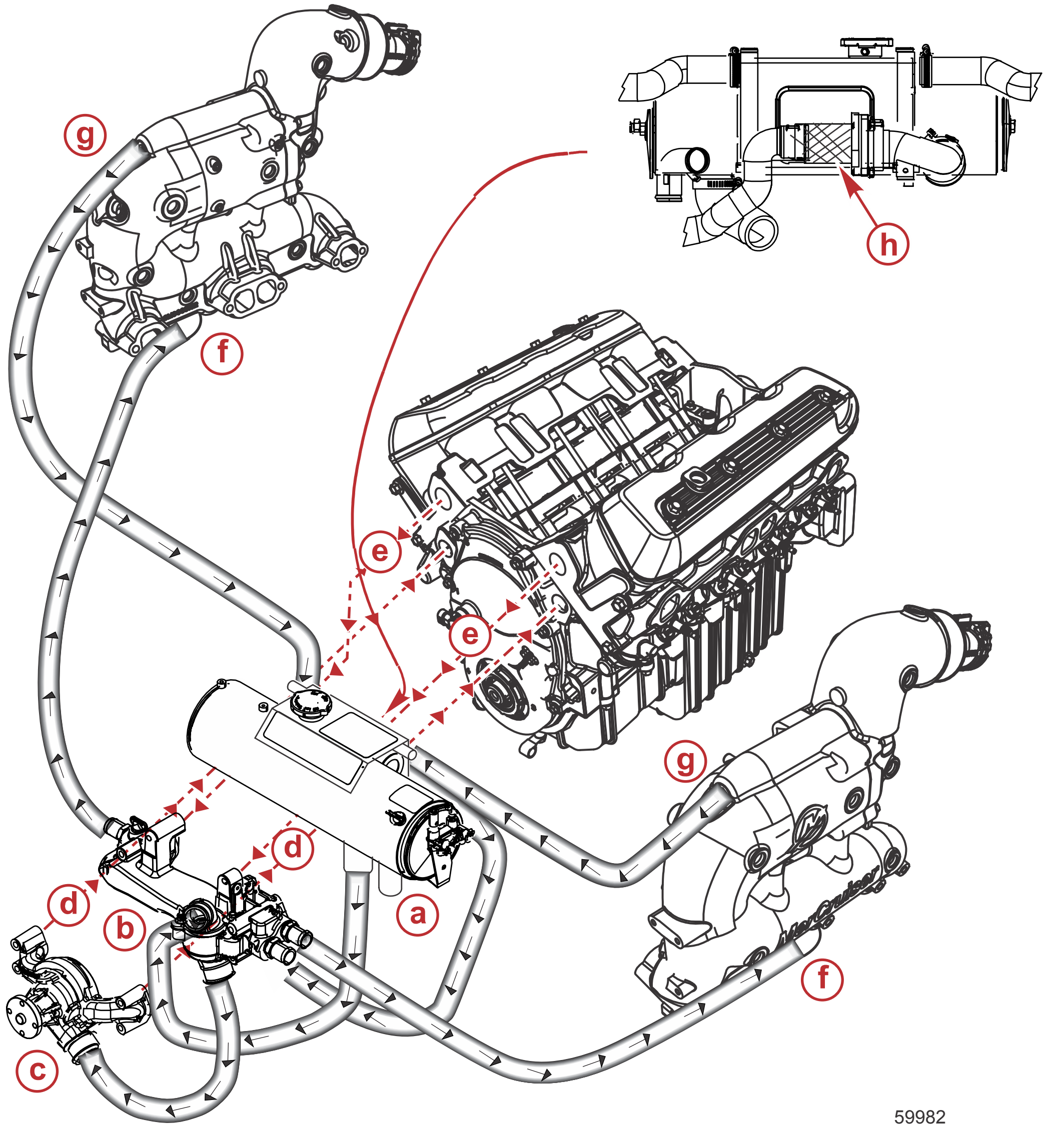


- a - Heat exchanger with attached thermostat housing
- b - Crossover
- c - Water circulating pump
- d - To engine block—from water circulating pump
- e - To crossover (from engine block)
- f - Exhaust manifold coolant inlet
- g - Exhaust manifold coolant outlet
- h - Detail of rear of heat exchanger, showing thermostat (shaded)

NOTE: Seawater hoses are not shown, for clarity.

NOTE: Inboard V-Drive is the same as TowSport V-Drive except on seawater side. No inlet hose to the sea pump on Inboard V-Drive and transmission cooler oil lines are different.

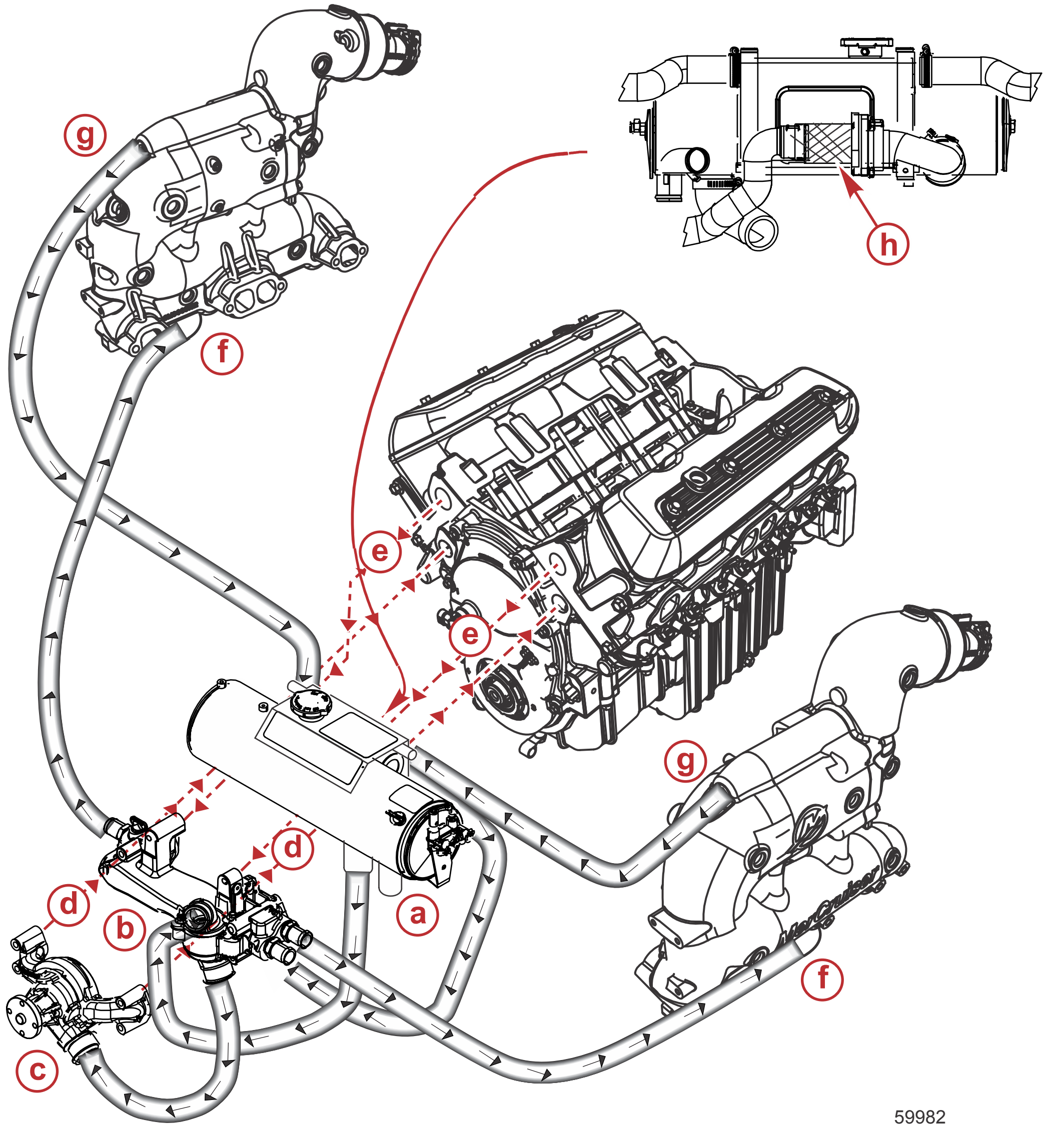
Glycol Circuit Inboard In-line



- a - Heat exchanger with attached thermostat housing
- b - Crossover
- c - Water circulating pump
- d - To engine block—from water circulating pump
- e - To crossover (from engine block)
- f - Exhaust manifold coolant inlet
- g - Exhaust manifold coolant outlet
- h - Detail of rear of heat exchanger, showing thermostat (shaded)

NOTE: Seawater hoses are not shown, for clarity.

Glycol Circuit TowSport Reverse V-Drive



- a - Heat exchanger with attached thermostat housing
- b - Crossover
- c - Water circulating pump
- d - To engine block—from water circulating pump
- e - To crossover (from engine block)
- f - Exhaust manifold coolant inlet
- g - Exhaust manifold coolant outlet
- h - Detail of rear of heat exchanger, showing thermostat (shaded)

NOTE: Seawater hoses are not shown, for clarity.

NOTE: TowSport reverse V-Drive FWC is the same as the Inboard In-line fresh water cooled (FWC) except on the seawater circuit. There is an inlet hose to the sea pump, and the transmission cooler oil lines are different.

Notes:

Exhaust System

Section 7A - Important Information

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7
A

Exhaust System Notice

NOTICE

Improperly designing, installing, or modifying the engine’s exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boatbuilder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

IMPORTANT: Through-the-hull exhaust is not allowed on 6.2L engines, through the propeller only.

Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boatbuilder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Preventing Contamination of the Emissions Control System

Catalyst and oxygen sensors can become contaminated, leading to component failure.

Phosphorus, found in some marine-grade oils, and other compounds will damage or destroy a catalyst's ability to clean the exhaust. Catalyst-friendly oil, such as Mercury MerCruiser Synthetic Blend Engine Oil, prevents this damage. Approved synthetic oils must be used in MerCruiser engines with Emissions Control Technology (ECT), except in special circumstances. Refer to **Section 1A** - **Engine Oil** for additional information.

NOTICE

Acetoxy silicone sealants and other compounds can damage oxygen sensors and catalysts. Use only compounds and sealants approved by Mercury Marine for use on catalyzed engines, such as Loctite 587 High Performance Blue.

Fiberglass is a silica-based material that can contaminate the catalyst and the oxygen sensors. To reduce the possibility that the engine will ingest harmful fiberglass and poison the emission control components, protect the engine from fiberglass dust and debris during construction and clean-up.

Fuel system and engine cleaners in the form of an aerosol sprayed near or into the intake of an operating engine can contaminate the catalyst and the oxygen sensors. The use of spray cleaners could cause irreversible damage to the catalytic converter leading to component failure.

NOTICE

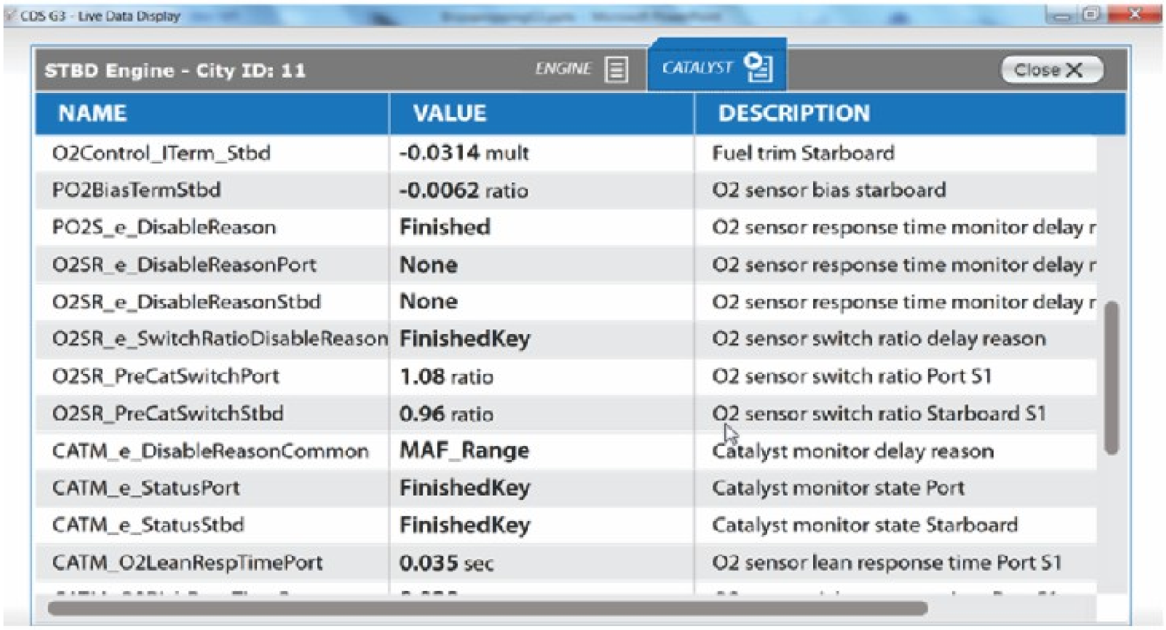
Aerosol fuel system and engine cleaners sprayed near or into the intake of an operating engine can damage the catalyst and the oxygen sensors. Do not spray aerosol cleaners near or into the intake of an operating engine. Use only approved fuel system additives.

The recommended method for fuel system and engine cleaning on an operational engine equipped with ECT is to use approved cleaners added to the fuel system. The cleaners approved by Mercury MerCruiser include Quickare, Quickleen, and Quickstor. Refer to the manufacturer's instructions for proper use.

Determining Catalyst Health

Catalyst health can be determined by observing onboard diagnostics - marine (OBD-M) catalyst monitor ratios with CDS G3. Remove the catalyst from the exhaust manifold for inspection only if live data indicates that a catalyst may be compromised.

Below is an example of a Live Data screen at completion of the catalyst monitor test. Actual values may differ. Note that the catalyst monitor ratios indicate that both catalysts may be damaged.



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CDS G3 Live Data screen

The equivalency ratio is defined as the actual air to fuel ratio divided by the desired air to fuel ratio. Actual/Desired= Equivalency Ratio. For fuel with no alcohol content the stoichiometric ratio is 14.7:1. For fuel with 10% alcohol, the air to fuel ratio is 14.1:1. The equivalency ratio eliminates the need to know the alcohol content of the fuel. An equivalency ratio of 1.00 is neither rich nor lean. Previously, we knew if we ran rich or lean. Now, the PCM 112 provides even more accurate closed-loop control because the new wide-band 02 sensors provide the magnitude of the error not just if it is above or below 1.00. The difference between target and actual air/fuel ratio is known as Equivalency Ratio error.

The new lambda-type wide-band 02 sensors provide temperature information by reading resistance in the circuit.

The new type produces a temperature control much more robust and accurate, resulting in more precise fueling. The sensor needs precise temperature control for accuracy.

Each sensor contains a heater controller and heater diagnostic chip.

Refer to **PCM 112 Diagnostics Service Manual** for information about catalyst monitor testing with CDS G3.

Measuring Engine Exhaust Elbow Height

General Information

The height of the exhaust elbows must be within the dimensions specified to prevent water intrusion. If needed, install exhaust elbow risers to obtain sufficient exhaust elbow height and exhaust angle. Risers must not exceed 152 mm (6 in.) (see the **Available Risers** chart for details). Take measurements with the boat in the water. To simulate maximum loading conditions likely to be encountered, refer to **Loading Requirements**.

IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boatbuilders must communicate any load distribution conditions that affect the exhaust system, such as maximum occupancy of the swim platform, to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Minimum Exhaust Elbow Height

Model	Specification
Sterndrive	27.9 cm (11 in.)
TowSport and inboard	33 cm (13 in.)

Available Risers

Model	Low	Medium	High
Sterndrive	51 mm (2.0 in.)	102 mm (4.0 in.)	152 mm (6.0 in.)
TowSport	Not available	Not available	Not available
Inboard	Not available	102 mm (4.0 in.)	152 mm (6.0 in.)

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 181.45 kg (400 lb) to the swim platform.
   c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity, must add 226.80 kg (500 lb) to the swim platform.

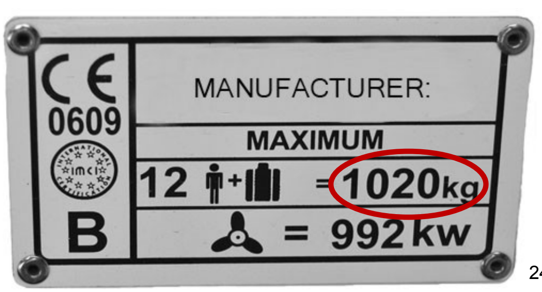
Loading the Boat (Boats with a Capacity Plate)

For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lbs, persons, gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb) per person. This gives the whole number and remainder of 74.84 kg (165 lb) persons to load onto the boat.
3. Put the remainder of a person in the next available seat. See the boat loading diagram.



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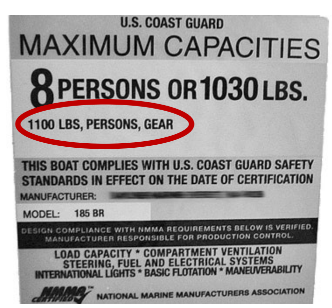
CE capacity plate



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USCG capacity plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.

NOTE: The following example is provided as a reference.

Example

NOTE: This example uses a boat that is less than 8.84 m (29 ft) long, not including a boat that is 8.84 m (29 ft) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 kg (400 lb) to the swim platform.

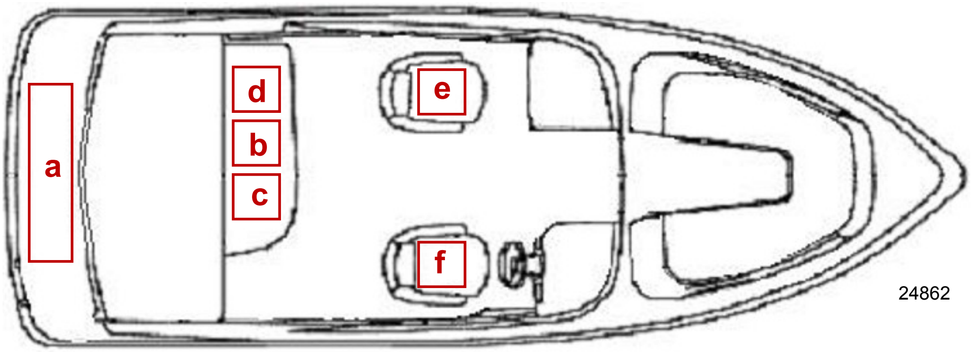
NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb – 400 lb = 700 lb
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat.
   - 700 lb ÷ 165 lb = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons.
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight.
   - 0.24 × 165 lb = 40 lb

   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
5. Using the totals in this example, load four 165-lb persons and one 40-lb person onto boat seating with 400 lb on the swim platform.

- 400 lb + 165 lb = 565 lb
- 565 lb + 165 lb = 730 lb
- 730 lb + 165 lb = 895 lb
- 895 lb + 165 lb = 1060 lb

- 1060 lb + 40 lb = 1100 lb



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 in. for an average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb (MerCruiser person weight) = XXXX lb maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb per person. This gives the number of 165-lb persons to load onto the boat. Round up to next whole number.
   IMPORTANT: To account for cargo, add a weight of 25 lb per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

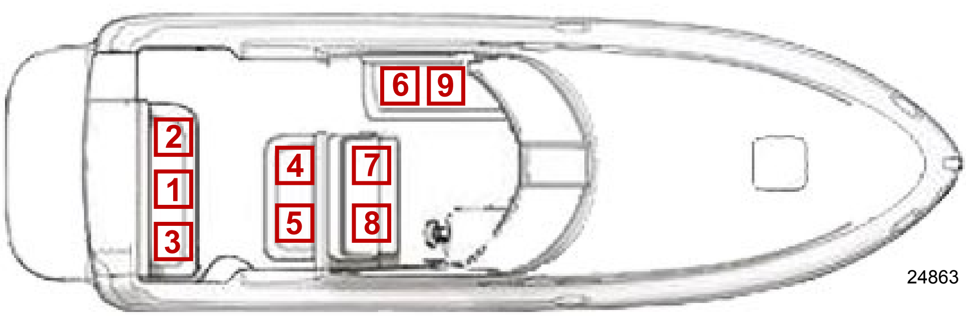
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: The following example is provided as a reference.
This example uses a boat that is 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 kg (500 lb) to the swim platform.

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



Designated seating diagram

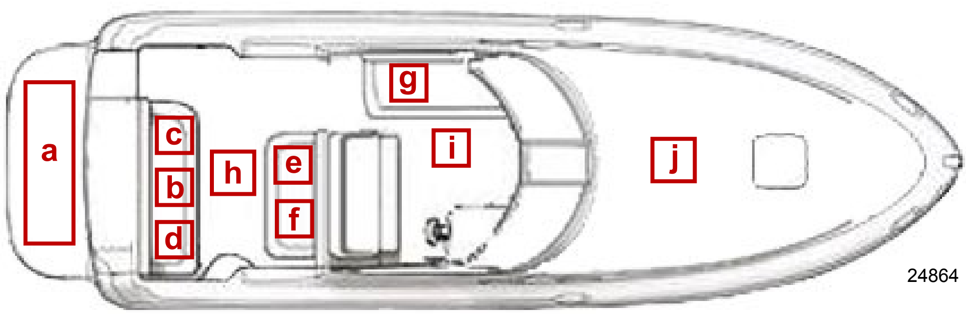
This example uses nine persons as the maximum passenger load.

NOTE: Use 0.50 lb as the break point to round up or down to obtain a whole pound.

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb = 225 lb
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%.
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%.
   a. 225 lb × 50% = 112.50 lb
   b. 112.50 lb rounded up = 113 lb
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%.
   - 225 lb × 25% = 56.25 lb
   - 56.25 lb rounded down = 56 lb
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb (MerCruiser person weight) to get a 1485 lb (total passenger load).
   - 9 passengers × 165 lb = 1485 lb
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb – 500 lb = 985 lb

7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb ÷ 165 lb = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb cargo in the aft storage, 113 lb cargo in the center storage, and 56 lb cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb passengers, onto the boat with 500 lb on the swim platform.

- 500 lb + 225 lb = 725 lb
- 725 lb + 165 lb = 890 lb
- 890 lb + 165 lb = 1055 lb
- 1055 lb + 165 lb = 1220 lb
- 1220 lb + 165 lb = 1385 lb
- 1385 lb + 165 lb = 1550 lb
- 1550 lb + 165 lb = 1715 lb

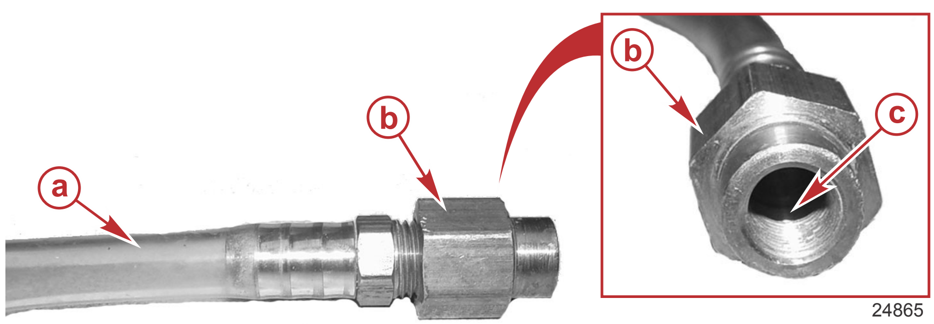


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

1. Obtain an 8–10 mm (5/16–3/8 in.) I.D. clear hose, approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.

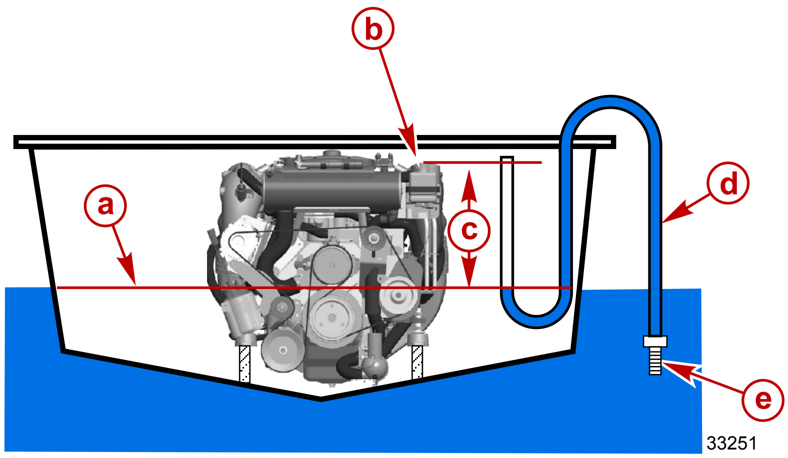


a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat that is sitting lower in the water.
3. Submerge the clear hose until it is completely filled with water.

4. Place a finger over the open end of the clear hose before removing the hose from the water.
5. Coil the excess clear hose into the boat bilge. Keep the coil of hose below the waterline.
6. Keeping the hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust elbow.
7. Slowly take your finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



Typical model with Emissions Control

a - Waterline
b - Top of exhaust elbow
c - Waterline to top of exhaust elbow measurement
d - Clear hose
e - Weight

Clear Hose Measurement Method from Seacock or Muffler Drain

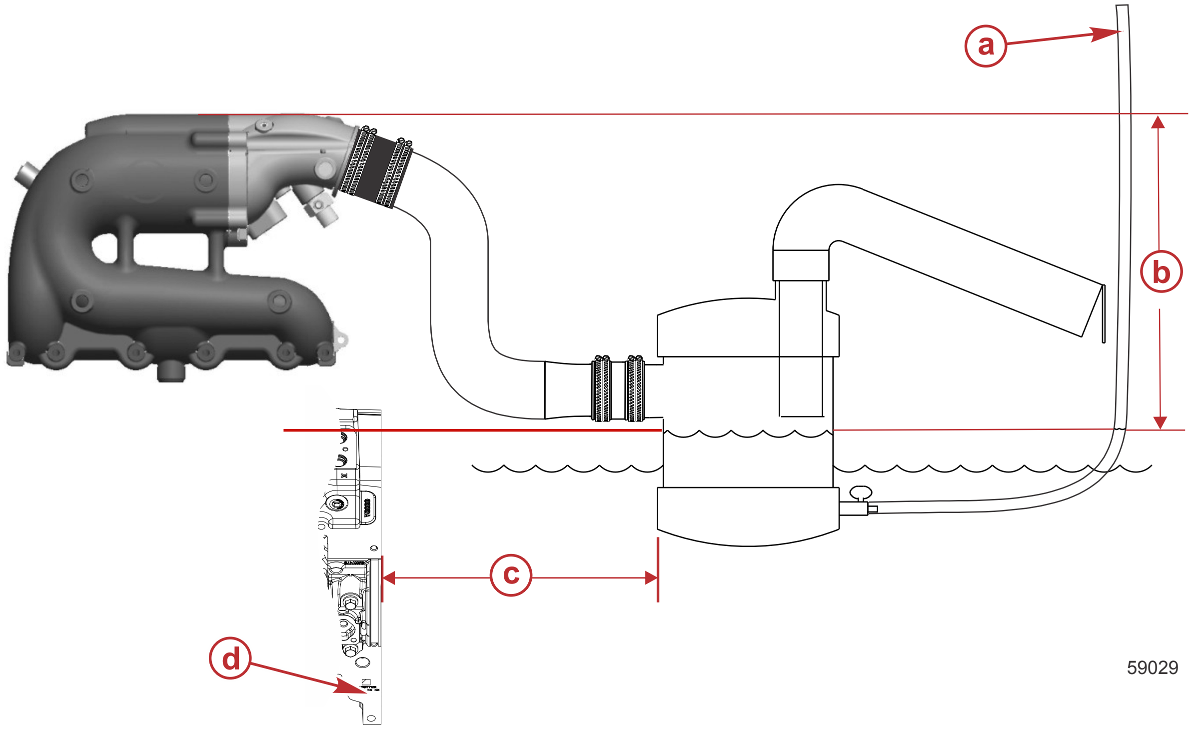
IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.

IMPORTANT: The engine must have been operated previously to fill the muffler with water.

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

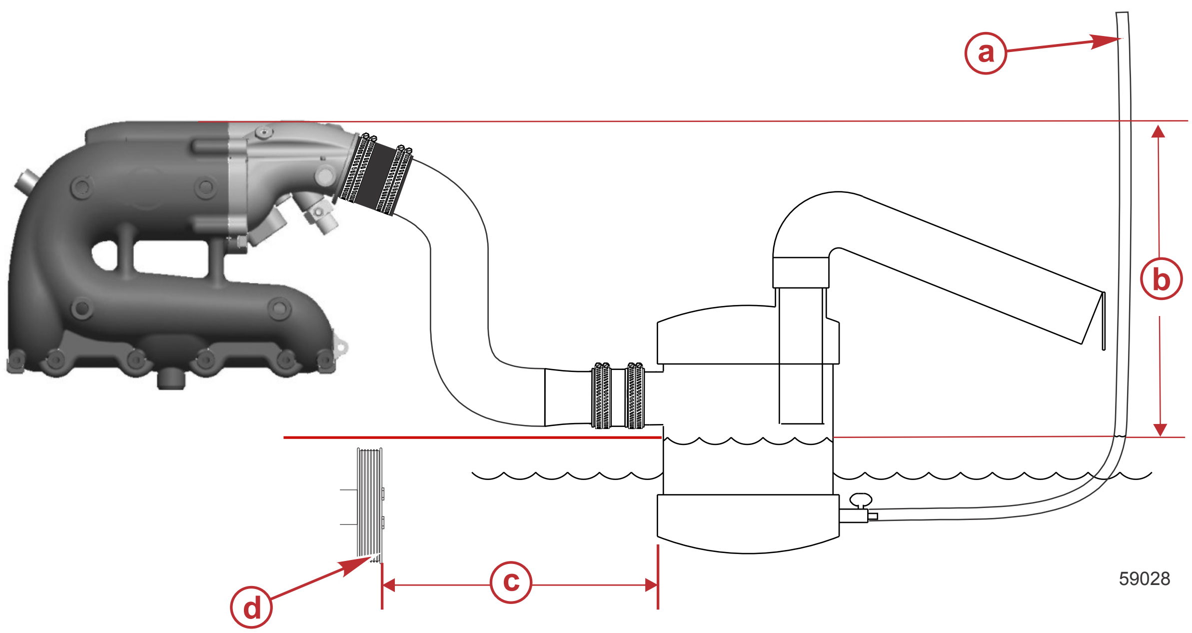
1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If hose is attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open-end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil any excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put your finger over the hose, and lift the open end until it is at the top of the exhaust elbow.
7. Slowly take your finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water in the muffler. Keep the hose close to the exhaust elbow and as vertical as possible.

8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height.



Typical vertical water lift muffler

a - Clear hose for measuring waterline
b - Minimum exhaust elbow height with maximum load
c - Exhaust distance flywheel housing to muffler 27.94 cm–73.66 (11in.–29in.)
d - Block machine surface for flywheel housing



V-Drive to sea pump pulley

a - Clear hose for measuring waterline
b - Minimum exhaust elbow height with maximum load
c - Exhaust distance sea pump to muffler 15.24 cm–60.96 cm (6 in.–24 in.)
d - Sea pump pulley

IMPORTANT: Horizontal waterlift mufflers are **NOT** permitted for use.

Notes:

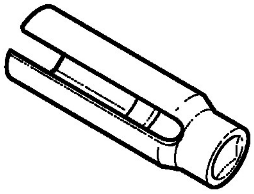
Exhaust System

Section 7B - Manifolds and Elbows

Table of Contents

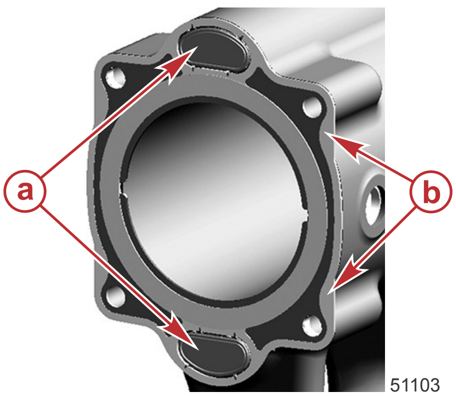
7
B

Special Tools

7/8 in. Oxygen Sensor Socket	obtain locally
 32314	SPX socket (or equivalent 7/8 in. automotive oxygen sensor socket) Aids in the removal and installation of oxygen sensors on products equipped with Emissions Control.

Elbow-to-Manifold Gaskets

There are two styles of elbow-to-manifold gaskets. Gaskets with open water ports are used in seawater-cooled systems. Gaskets with blocked water ports are used in closed-cooling systems. Indicator tabs around the perimeter of the gasket allow easy identification of the gasket style when the gaskets are installed.



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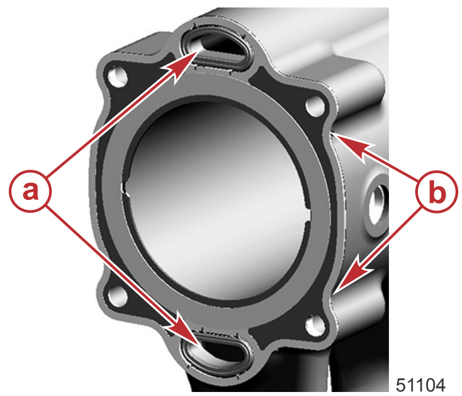
Models with closed cooling

a - Blocked water ports

b - Indicator tabs



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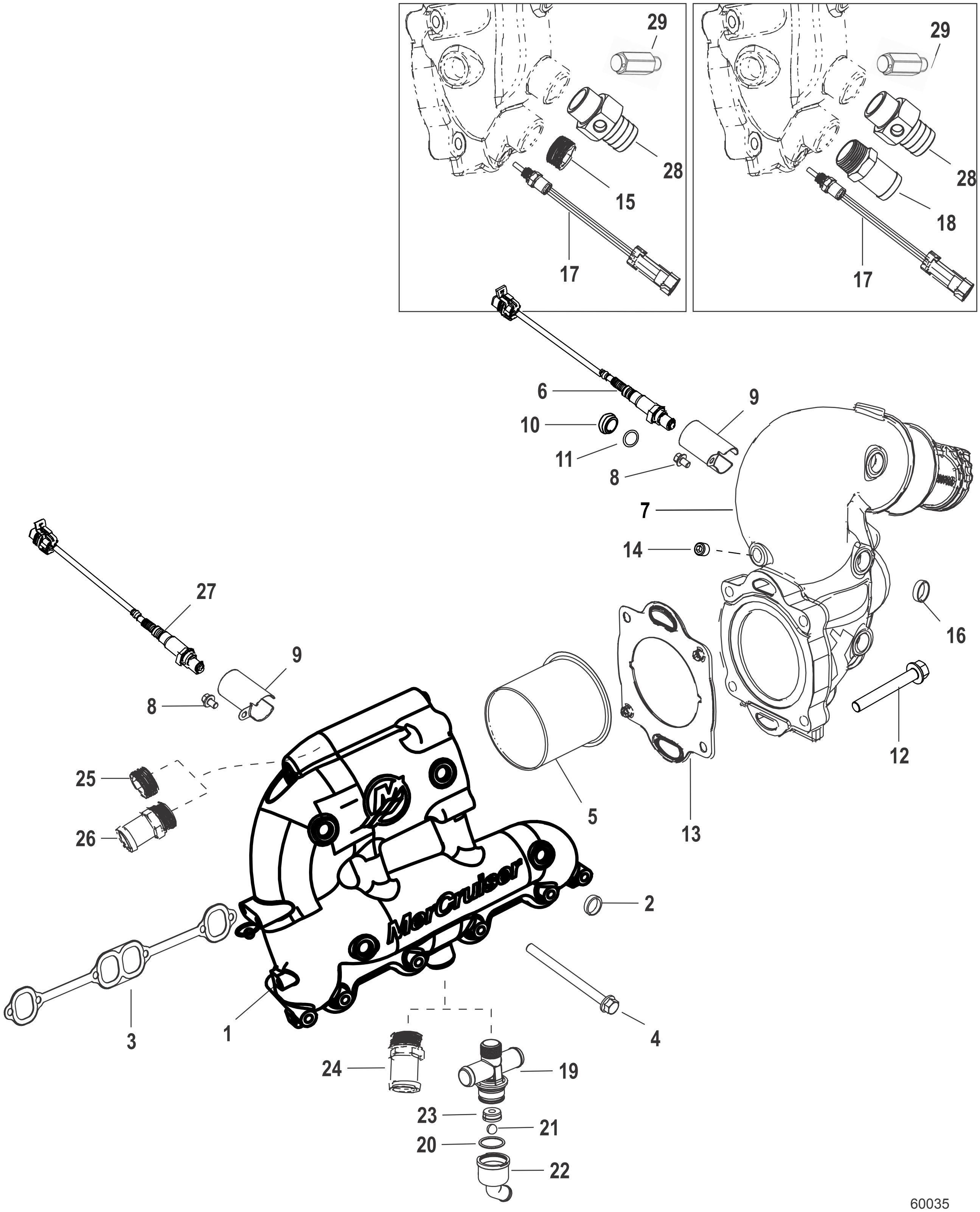
Seawater-cooled models

a - Open water ports

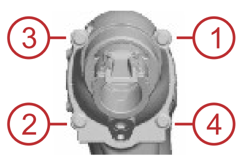
b - No indicator tabs

Notes:

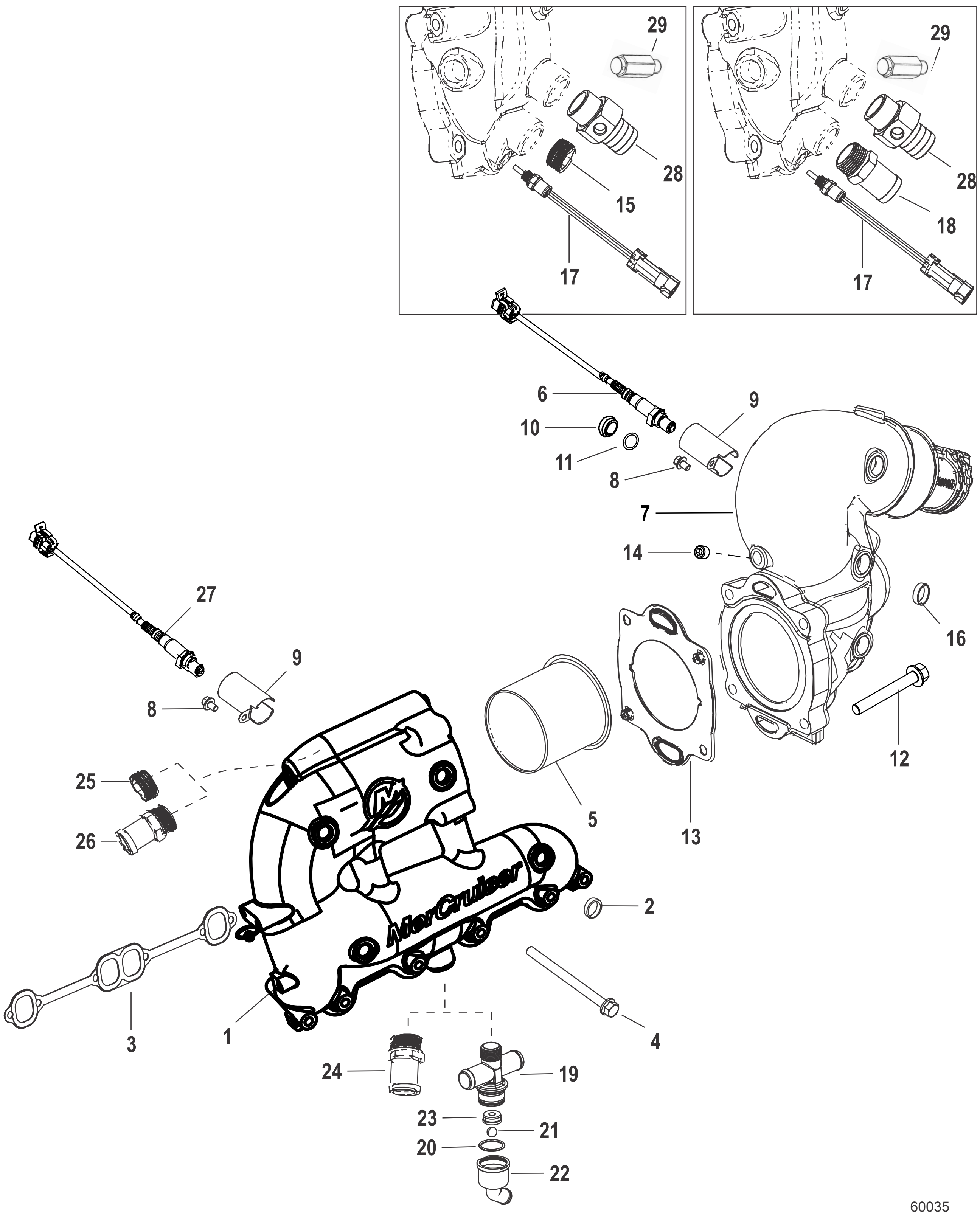
Exhaust Manifold and Elbow Exploded View



Exhaust Manifold and Elbow Exploded View

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Exhaust manifold assembly				
2	10	Expansion plug				
3	1	Gasket				
4	6	Screw (0.375-16 x 4.75)  59457	**First**	27	–	20
			Second	54	–	39.8
			Final	54	–	39.8
5	1	Catalyst (ECT only)				
6	1	Oxygen sensor—narrowband (ECT only)		50	–	36.8
7	1	Elbow assembly				
8	2	Screw (0.250-20 x 0.380 hex flange head) (ECT)		11.6	102.6	–
	1	Screw (0.250-20 x 0.380 hex flange head) (non-ECT)				
9	2	Cover bracket (ECT)				
	1	Cover bracket (non-ECT)				
10	1	Post O2 sensor plug (non-ECT)		50	–	36.8
11	1	Copper washer (non-ECT)				
12	4	Screw (0.375-16 x 2.5 hex flange head)  57899	**First**	46	–	34
			Final	46	–	34
13	1	Gasket, elbow to manifold with open water ports (seawater cooling)				
13	1	Gasket, elbow to manifold with blocked water ports (closed cooling)				
14	2	Brass pipe plug (0.25-8)				
15	1	Brass pipe fitting (seawater cooling) (0.750-4)		50	–	36.8
16	1	Expansion plug				
17	1	Exhaust manifold temperature sensor assembly		16	142	–
18	1	Seawater cooling uses #28		50	–	36.8
	2	Straight fitting (0.750-14) (closed cooling)				
19	1	Fitting assembly—seawater cooling		50	–	36.8
20	1	O-ring				
21	1	Ball				
22	1	Fitting				
23	1	Rubber ball seat		50	–	36.8
24	1	Straight fitting (0.750-14) (closed cooling)				
25	1	Brass plug		50	–	36.8
26	1	Straight fitting (0.750-14) (closed cooling)		50	–	36.8
27	2	Wideband oxygen sensor		50	–	36.8
28	1	Straight fitting with threaded hole (0.750-14 with 0.25-18 hole)		Hand-tight—plus two turns		
29	1	Check valve		16	142	–

Exhaust Manifold and Elbow Exploded View



Exhaust Elbows

Intermediate Exhaust Elbow Kit

IMPORTANT: Standard sterndrive applications with through-the-propeller exhaust require an intermediate exhaust elbow kit. See the following table for your specific application.

Riser	Exhaust Elbow Kit	Intermediate Exhaust Elbow Kit (Order Separately)
0 mm (0 in.)	879288A19 (port) 879288A21 (starboard)	879288A34
51 mm (2 in.)	8M0104209	879288A35
102 mm (4 in.)	8M0104210	879288A36
153 mm (6 in.)	8M0104211	879288A37

Riser Kits

NOTE: Some riser kits require additional hose kits.

51 mm (2.0 in.) Riser Kit for Emissions Control and Non-ECT Exhaust Manifolds (8M0104209)

Qty.	Description	Part Number
1	Exhaust elbow, port, 51 mm (2.0 in.)	8M8027593
1	Exhaust elbow, starboard, 51 mm (2.0 in.)	8M8027594
2	Elbow-to-manifold gasket—seawater cooling	27-8M2004414
2	Elbow-to-manifold gasket—closed cooling	27-8M2004606
2	Brass pipe plug (0.750-14)	22-428611
2	Plug O2 sensor (non-ECT)	8M0082363
2	Copper washer (non-ECT)	8M0097283

102 mm (4.0 in.) Riser Kit for Emissions Control and Non-ECT Exhaust Manifolds (8M0104210)

Qty.	Description	Part Number
1	Exhaust elbow, port, 102 mm (4.0 in.)	8M8027598
1	Exhaust elbow, starboard, 102 mm (4.0 in.)	8M8027599
2	Elbow-to-manifold gasket—seawater cooling	27-8M2004414
2	Elbow-to-manifold gasket—closed cooling	27-8M2004606
2	Brass pipe plug (0.750-14)	22-428611
2	Plug O2 sensor (non-ECT)	8M0082363
2	Copper washer (non-ECT)	8M0097283

153 mm (6.0 in.) Riser Kit for Emissions Control and Non-ECT Exhaust Manifolds (8M0104211)

Qty.	Description	Part Number
2	Exhaust elbow, 153 mm (6.0 in.)	8M8027595
2	Elbow-to-manifold gasket—seawater cooling	27-8M2004414
2	Elbow-to-manifold gasket—closed cooling	27-8M2004606
2	Brass pipe plug (0.750-14)	22-428611
2	Check ball fitting assembly (90°)	8M2012292
2	Cover bracket O2 sensor	8M2004597
2	Screw, 1/4-20 hex flange	8M2007128
2	Plug O2 sensor (non-ECT)	8M0082363
2	Copper washer (non-ECT)	8M0097283

Exhaust Elbow Removal

1. Turn the engine off and allow it to cool.

⚠ WARNING

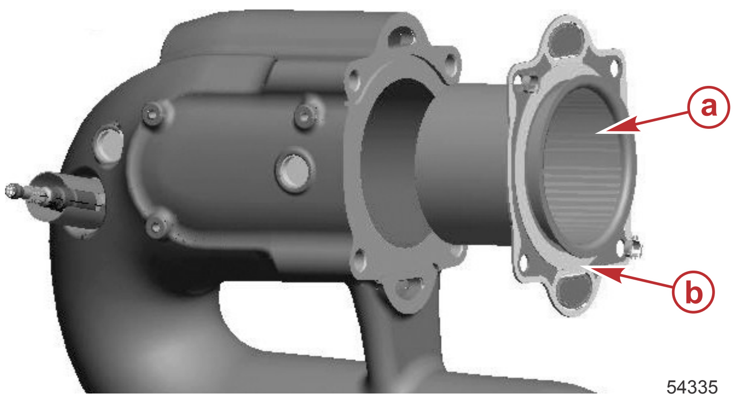
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

2. Disconnect the battery cables from the battery. Be certain to remove the negative (–) cable first.
3. Drain the engine coolant:
   - On models with seawater cooling, drain the seawater section of the engine. Refer to **Section 1C**.
   - On models with closed cooling, drain the coolant until the level is below the exhaust elbow joint area. Refer to the **Draining** procedure in **Section 6C**.
   - Note the locations and connections of the hoses for reassembly.
4. Disconnect the engine exhaust hoses. Retain the hose clamps.
5. Disconnect the seawater hoses from the elbow. Retain the hose clamps.
   - On models with seawater cooling, there is a single hose.
   - On models with closed cooling, there are two hoses.
6. Disconnect the oxygen sensor and the exhaust manifold coolant temperature sensor from the harness.
7. Remove and retain the four fasteners securing the exhaust elbow to the manifold.
   IMPORTANT: Remove the exhaust elbow carefully to ensure that the catalyst does not fall from the manifold.
8. Remove the exhaust elbow.

NOTICE

Exposing the catalyst to foreign materials such as silicone, oils, or fiberglass can chemically alter the precious metal coating of the catalyst and compromise its ability to convert exhaust gases. Handle catalyst components in a clean environment only.

9. Remove the catalyst and store it in a clean, dry place.
10. Remove and discard the old gasket. Clean the mating surface on the exhaust elbows and the exhaust manifolds.



a - Catalyst
b - Gasket

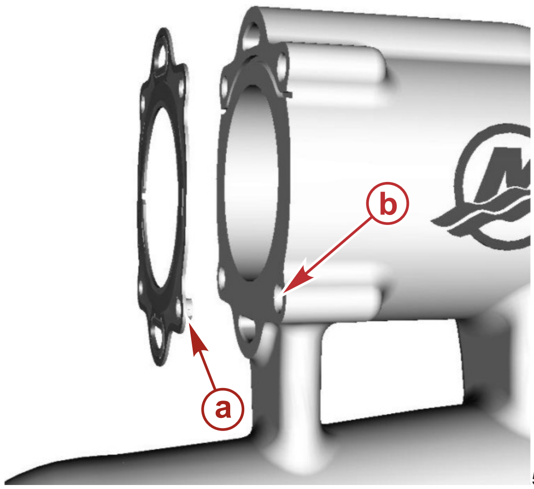
Exhaust Elbow Installation

IMPORTANT: Foreign material on hot catalysts can damage the catalysts. Prevent material from falling into the exhaust manifold. If material does fall into the exhaust manifold, remove the material carefully to avoid damage.

1. Select the appropriate elbow-to-manifold gasket for your cooling type. Refer to the table below.

Cooling Type	Gasket Ports	Part Number
Models with seawater cooling	Open water ports	8M2004414
Models with closed cooling	Blocked water ports	8M2004606

2. Insert the gasket dowels into the fastener holes on the exhaust manifold mating surface. With the dowels seated in the fastener holes, the water ports on the gasket align with the water ports on the exhaust manifold.

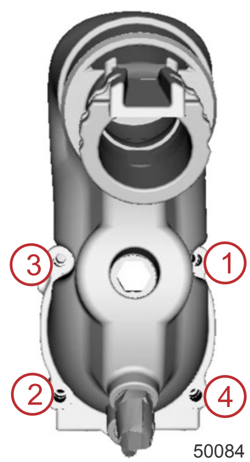


51105

a - Dowel
b - Fastener hole

NOTE: The gasket for systems with closed cooling blocks the water ports.

3. Insert the catalyst through the gasket into the exhaust manifold.
4. Align the appropriate port or starboard elbow with the fastener holes. On elbows with side-specific oxygen sensor holes, ensure that the oxygen sensor hole is on the side closest to the center of the engine. Install the four fasteners until hand-tight, starting with the top two.
5. Tighten the fasteners to the specified torque in the sequence shown below:



Elbow shown with components removed for clarity

6. On non-ECT models: Install the oxygen sensor plug into the oxygen sensor port. Tighten it to the specified torque.

Description		Nm	lb-in.	lb-ft
Screws (0.375-16 x 2.5 hex flange head)	1st Stage	46.1	–	34
	2nd Stage	46.1	–	34

7. Connect the oxygen sensor and the exhaust manifold coolant temperature (EMCT) sensor to the engine harness.

Description	Nm	lb-in.	lb-ft
Oxygen sensor plug	50	–	36.8

8. Connect the water hoses in the same location they were removed:
   a. On models with seawater cooling, connect the hose from the top fitting on the poppet valve to the fitting nearest to the exhaust outlet and tighten the hose clamp to the specified torque.
   b. On models with closed cooling:
      - Connect the hose from the top fitting on the poppet valve to the fitting nearest the exhaust outlet.
      - Connect the hose from the bottom fitting on the poppet valve to the fitting nearest the EMCT sensor.
      - Tighten both hose clamps to the specified torque.

Description	Nm	lb-in.	lb-ft
Hose clamps	3.2	28.3	–

9. Connect the engine exhaust hoses, using two hose clamps at each connection. Tighten the clamps to the specified torque.

Description	Nm	lb-in.	lb-ft
Hose clamps	3.2	28.3	–

10. Fill the closed-cooling system, if equipped, with the recommended antifreeze.
11. Connect both battery cables to the battery, being certain to connect the negative (–) cable last.
12. Upon starting the engine, inspect all exhaust and cooling hose connections for leaks.

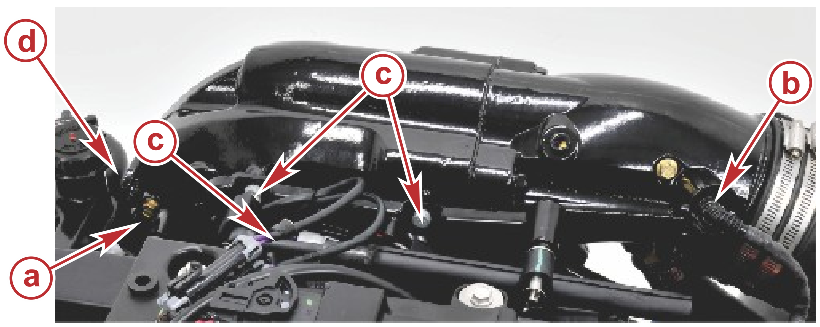
Exhaust Manifolds

Exhaust Manifold Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect both battery cables from the battery. Be certain to disconnect the negative (–) cable first.
2. If removing the starboard manifold, remove the shift plate and power steering reservoir bracket.



56904

a - Starboard precatalyst O2 sensor
b - Starboard postcatalyst O2 sensor
c - Mounting screws (two shown, one hidden)
d - Power steering reservoir bracket

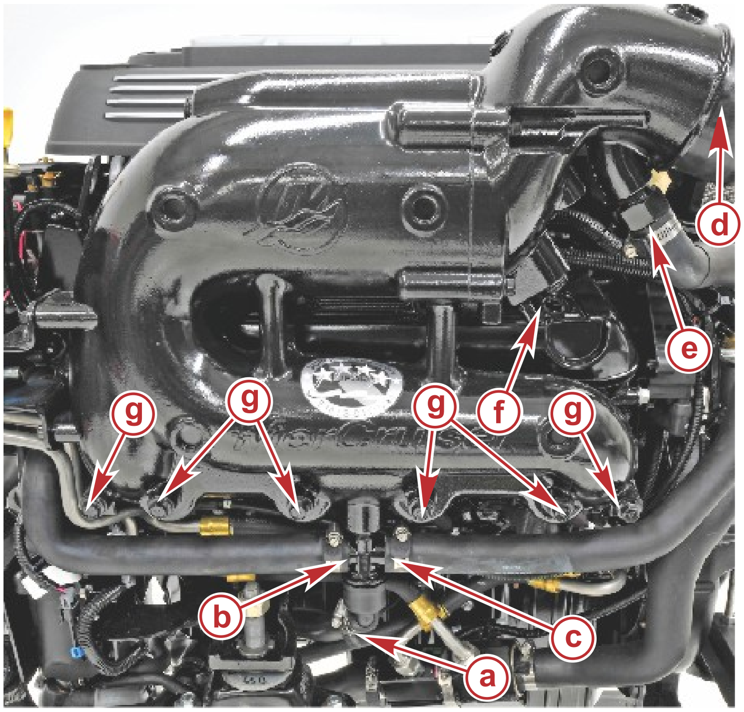
3. Drain the engine coolant:

56905

a - Port postcatalyst O2 sensor
b - Port precatalyst O2 sensor

   a. On models with seawater cooling, drain the seawater section of the engine. Refer to **Section 1C**.
   b. On models with closed cooling, drain the coolant until the level is below the exhaust elbow joint area. Refer to **Section 6C** - **Draining**.
   c. Note the locations and connections of the hoses for reassembly.

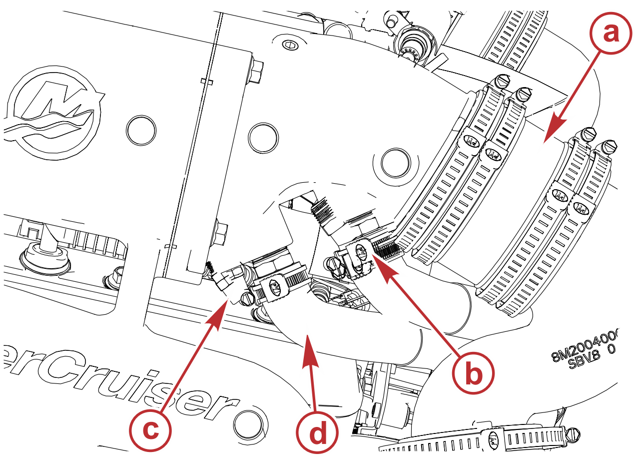
4. Disconnect the exhaust hoses and the cooling hoses from the exhaust manifold and elbow.



59455

Raw-water cooled

a - Seawater drain hose
b - Seawater cooling hose
c - Seawater cooling hose
d - Exhaust hose (shown attached to intermediate elbow, other models similar)
e - Seawater bypass hose
f - Exhaust manifold coolant temperature sensor
g - Exhaust manifold mounting screws (6)



56945

Freshwater cooled

a - Exhaust hose (shown attached to intermediate elbow, other models similar)
b - Seawater bypass hose
c - Exhaust manifold coolant temperature sensor
d - Seawater hose from poppet valve

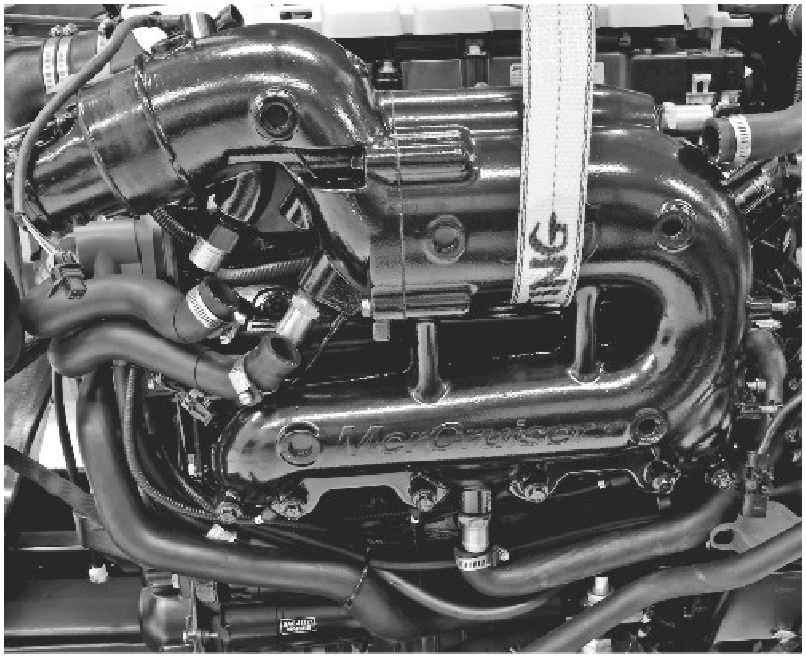
5. Remove the oil filter mounting bracket bolts.
6. Disconnect both oxygen sensors and the exhaust manifold coolant temperature sensor.

⚠ CAUTION

To avoid the possibility of injury or component damage, use caution when lifting heavy objects. Use an appropriate lifting device or seek assistance.

IMPORTANT: The exhaust manifold and elbow are heavy. The use of a hoist is highly recommended. If a hoist is not available, two people should be employed for manifold removal. It may be necessary to remove the elbow and the catalyst to reduce the weight of the assembly to an amount that is safe to lift without the use of a hoist.

7. Route a suitable lifting strap through the exhaust manifold as shown. Attach the strap to a suitable hoist and raise the hoist until all slack has been removed from the strap.



59600

Lifting strap

8. Remove the two outer screws that secure the exhaust manifold.
9. Hand-tighten two alignment pins (if available) in place of the removed screws.
10. Remove the four remaining screws.
    - If alignment pins are not used, exercise special caution when removing the last screw, as the position of the manifold may shift when the screw is removed.
    - The tension on the lifting strap may need to be adjusted to prevent the manifold from slipping and causing injury or damaging components (such as the spark plugs).
11. Remove the exhaust manifold and discard the gasket.

Manifold Cleaning and Inspection

IMPORTANT: This procedure is for the cleaning and inspection of the manifold only. To perform the leak check within this procedure, the elbow and catalyst must be removed. Refer to **Exhaust Elbow Removal**.
IMPORTANT: Exhaust gaskets are not reusable.

1. Clean any gasket material from all surfaces.
2. Check the water passages for foreign material. The passages must be clean for efficient cooling.
3. Inspect all parts for damage or wear. Repair or replace as necessary.
4. To test the exhaust manifold, use block-off plates, plugs, or short hoses with plugged ends. One block-off plate must have a threaded hole for attaching a compressed air hose. Use new gaskets when installing block-off plates. Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water. Air bubbles indicate a leak.
5. Inspect all sealing surfaces carefully. Machined surfaces must be clean and free of all marks and deep scratches or exhaust leaks may result.
6. Ensure that all mating surfaces are flat.

Description	Maximum overall difference
Surface flatness	0.07 mm (0.003 in.) with not more than a 0.02 mm (0.001 in.) difference within 25 mm (1.0 in.)

NOTE: The maximum material that can be removed is 0.25 mm (0.01 in.) to flatten a gasket surface.

7. Inspect the condition of the metal around the exhaust outlet in the casting. Inspect for damage caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser, if equipped. Replace all damaged parts.

Exhaust Manifold Installation

1. Ensure that the mating surfaces on the manifold and the cylinder head are clean and free from defects.

IMPORTANT: Always use a new gasket when installing the exhaust manifold.

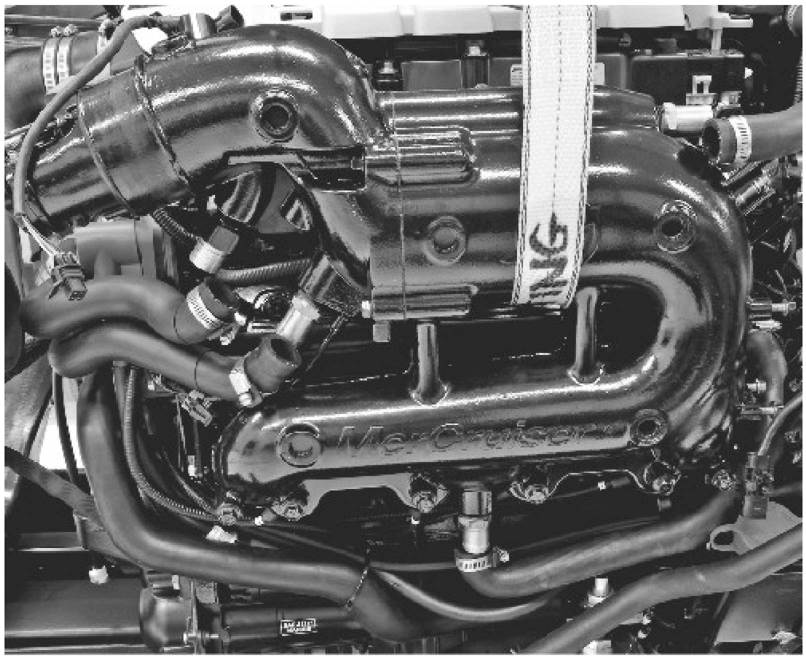
2. Hand-tighten two alignment pins (if available) through the appropriate holes in a new gasket and into the two outer mounting holes in the cylinder head.

⚠ CAUTION

To avoid the possibility of injury or component damage, use caution when lifting heavy objects. Use an appropriate lifting device or seek assistance.

IMPORTANT: The exhaust manifold and elbow are heavy. The use of a hoist is highly recommended. If a hoist is not available, two people should be employed for manifold installation. It may be necessary to remove the elbow and the catalyst to reduce the weight of the assembly to an amount that is safe to lift without the use of a hoist.

3. Route a suitable lifting strap through the exhaust manifold as shown. Attach the strap to a suitable hoist and move the manifold into position.

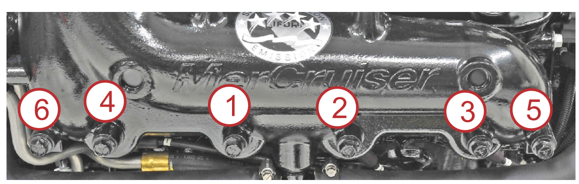


59600

4. Attach the exhaust manifold to the cylinder head using the six mounting screws.

   NOTE: Remove the alignment pins only after at least two mounting screws are in place.

5. Tighten the mounting screws to the specified torque, making three passes and following the sequence shown.



59457

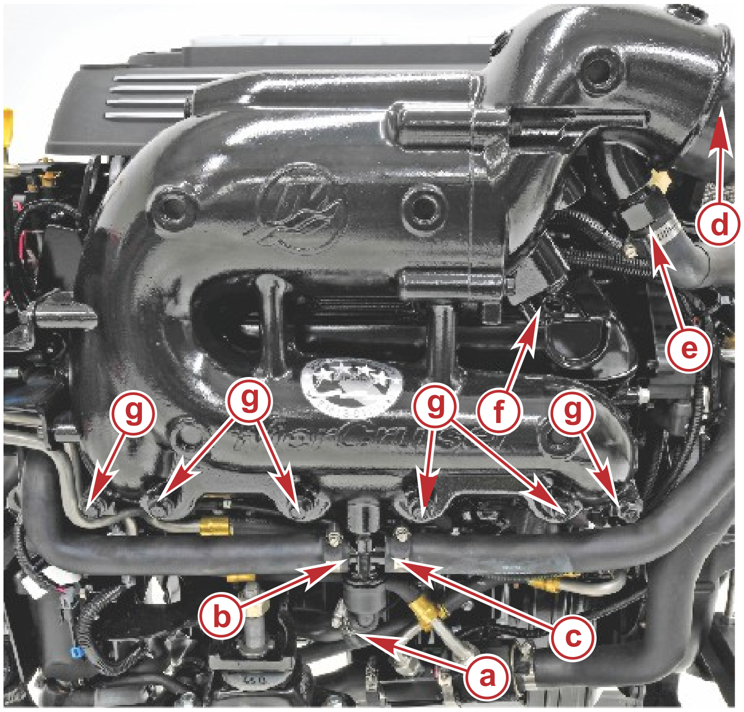
Exhaust manifold fastener torque sequence

Description		Nm	lb-in.	lb-ft
Manifold mounting screws	**First**	27	–	20
	Second	54	–	39.8
	Final	54	–	39.8

6. Install the catalyst and elbow, if they were removed. Refer to **Exhaust Elbow Installation**.
7. Attach all cooling hoses, securing them with hose clamps to the specified torque.
8. Connect the exhaust hoses, securing them with two hose clamps to the specified torque at each connection point.

Description	Nm	lb-in.	lb-ft
Hose clamps	3.2	28.3	–

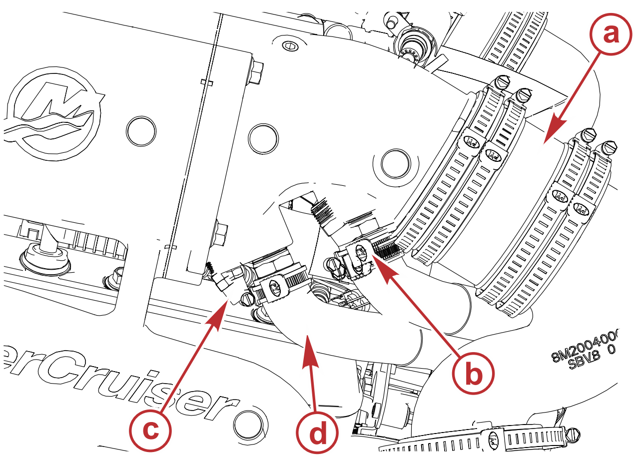
9. Connect the oxygen sensors and the exhaust manifold coolant temperature sensor.



59455

Raw-water cooled

a - Seawater drain hose
b - Seawater cooling hose
c - Seawater cooling hose
d - Exhaust hose (shown attached to intermediate elbow, other models similar)
e - Seawater bypass hose
f - Exhaust manifold coolant temperature sensor
g - Exhaust manifold mounting screws (6)



56945

Freshwater cooled

a - Exhaust hose (shown attached to intermediate elbow, other models similar)
b - Seawater bypass hose
c - Exhaust manifold coolant temperature sensor
d - Seawater hose from poppet valve

10. If installing the port exhaust manifold, install the O2 sensors.

56905

ECT model

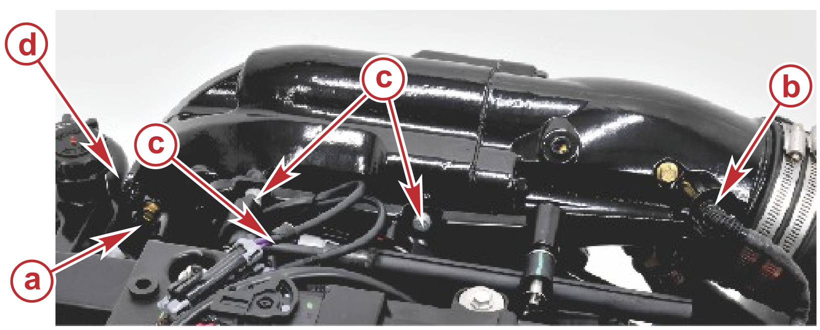
a - Port postcatalyst O2 sensor (ECT models only)

b - Port precatalyst O2 sensor (all models)

7/8 in. Oxygen Sensor Socket	obtain locally

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	36.8

11. If installing the starboard exhaust manifold, install the O2 sensors, and attach the shift plate, using the three mounting screws.



56904

ECT model

a - Starboard precatalyst O2 sensor (all models)

b - Starboard postcatalyst O2 sensor (ECT models only)

c - Mounting screws (two shown, one hidden)

d - Power steering reservoir bracket

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	36.8

12. Fill the closed-cooling system, if equipped, with the recommended coolant/antifreeze.
13. Connect both battery cables. Be certain to connect the negative (–) cable last.
14. Upon starting the engine, inspect all exhaust and cooling hose connections for leaks.

Oxygen Sensor

51233

NOTE: Refer to the appropriate exploded view for oxygen sensor location.

Removal

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the sensor from the engine harness.
2. Loosen the screw securing the oxygen sensor cover bracket, and remove the cover bracket.
3. Remove the oxygen sensors, as needed.

7/8 in. Oxygen Sensor Socket	obtain locally

Installation

1. Use the oxygen sensor tool to install the oxygen sensor. Tighten the sensor to the specified torque.

7/8 in. Oxygen Sensor Socket	obtain locally

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	36.8

2. Install the oxygen sensor cover bracket. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Oxygen sensor cover bracket screw	11.6	102.6	–

3. Connect the sensor to the engine harness.

Exhaust Manifold Coolant Temperature (EMCT) Sensor

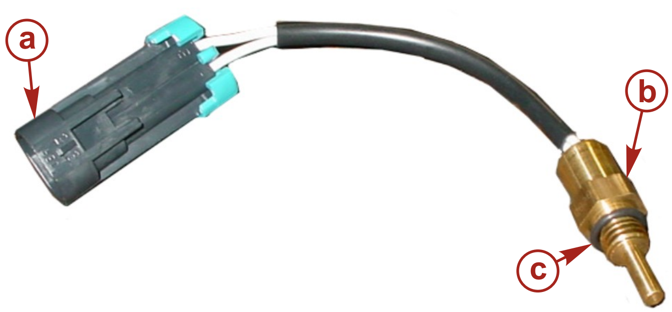
NOTE: The exhaust manifold coolant temperature (EMCT) sensor is a thermistor that is screwed into the exhaust elbow. Refer to the appropriate exploded view for EMCT sensor location.

Removal

1. Disconnect the EMCT sensor connector from the engine harness.
2. Remove the EMCT sensor from the exhaust elbow.

Installation

1. Verify that the O-ring is on the EMCT sensor.



48912

a - EMCT sensor connector
b - EMCT sensor
c - O-ring

2. Hand-start the EMCT sensor into the exhaust elbow.
3. Tighten the EMCT sensor to the specified torque.

Description	Nm	lb-in.	lb-ft
Sensor	16	142	–

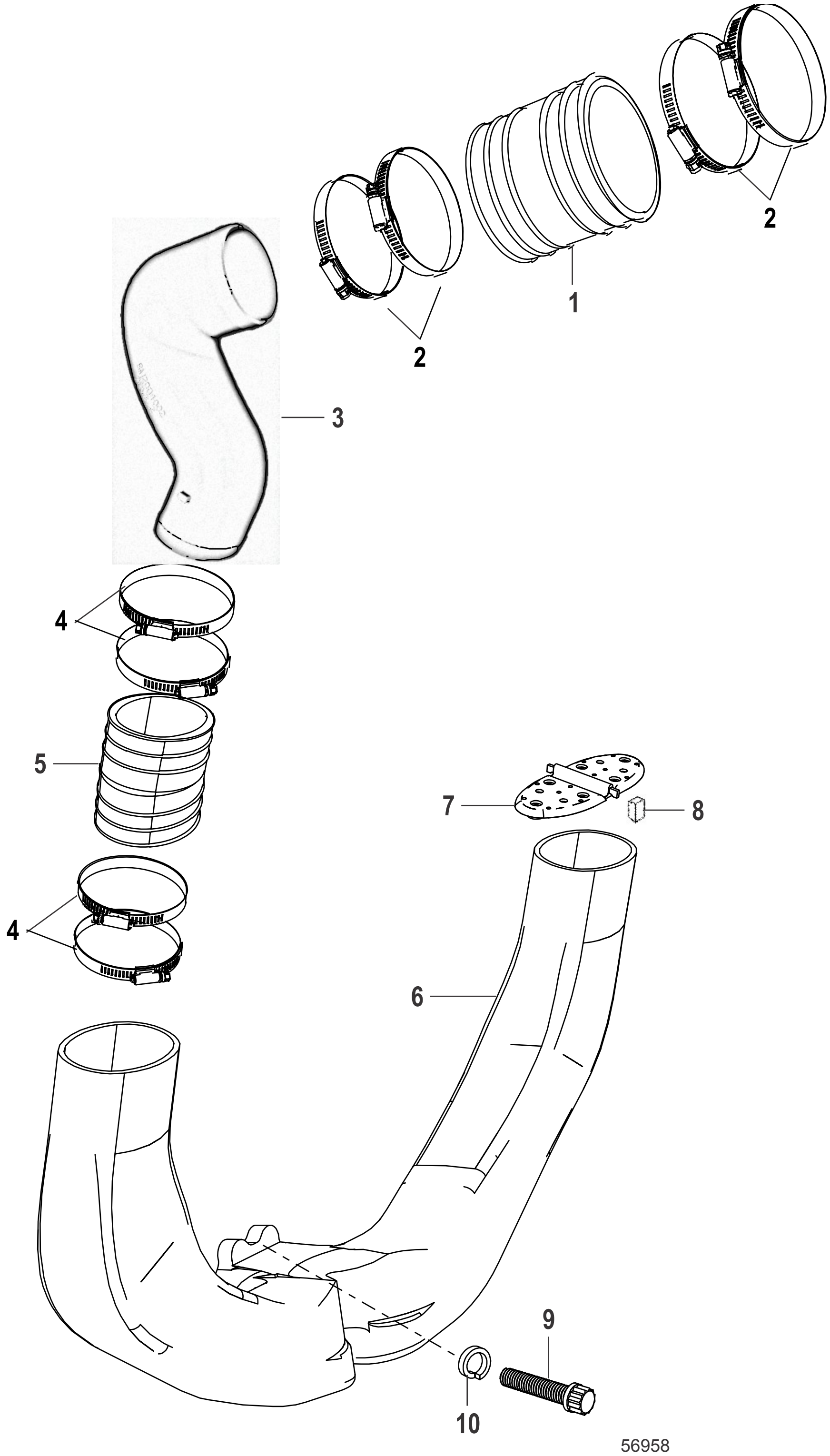
4. Connect the EMCT sensor connector to the engine harness.

Exhaust System

Section 7C - Exhaust Pipe and Through-the-Propeller Exhaust

Table of Contents

Exhaust System Components



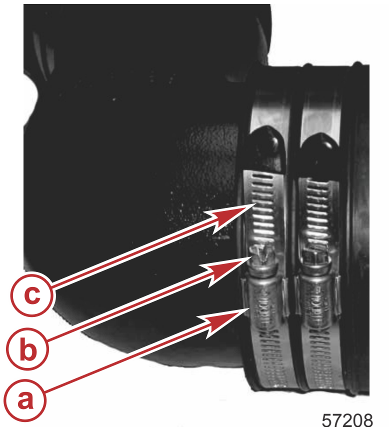
Exhaust System Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Exhaust tube			
2	8	Worm gear clamp, see Note	4–4.7	35.4–41.6	–
3	1	Intermediate elbow kit, non-riser			
	1	Intermediate elbow kit, 2-in. riser			
	1	Intermediate elbow kit, 4-in. riser			
	1	Intermediate elbow kit, 6-in. riser			
4	8	Worm gear clamp, see Note	4–4.7	35.4–41.6	–
5	2	Exhaust tube			
6	1	Exhaust pipe			
7	2	Water shutter assembly			
8	4	Grommet			
9	4	Screw	34	–	25.1
10	4	Lockwasher			

*NOTE: Torque values shown are for Tridon® hose clamps. Refer to **Hose Clamp Identification**.*

Hose Clamp Identification

IMPORTANT: Tridon types of hose clamps are used in various locations on Mercury MerCruiser power packages.



a - Tridon® hose clamp
b - Hex head screw (5/16 in.)
c - Slot cut through the band

Tridon® Hose Clamp

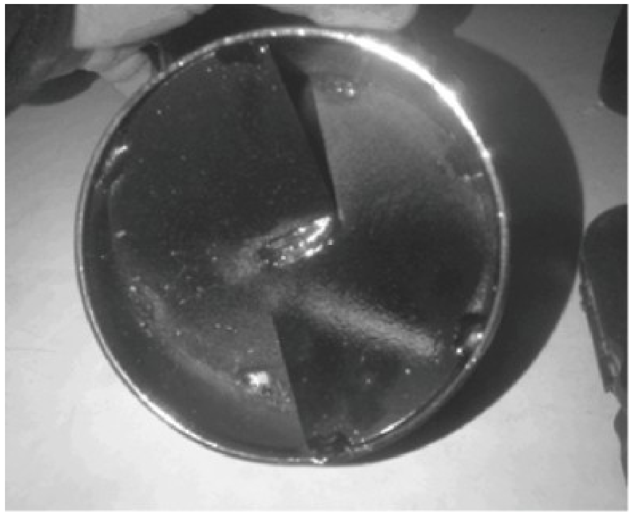
The Tridon® hose clamp uses a worm screw with 5/16 in. hex head to engage slots cut through the band.

Description	Nm	lb-in.	lb-ft
Tridon® hose clamp	4–4.7	35.4–41.6	–

6.2L Exhaust

- Exhaust system installation specifications
- Sterndrive models 11 in. elbow height—Static waterline height. Switchable allowed, Quick and Quiet baffles required for Corsa installation.
- Inboard and TowSport
  - 13 in. elbow height—Static waterline height.
  - Inboard exhaust systems requirement from Mercury. Mercury in-line shutters shipped with engine.
  - TowSport engine will ship with mufflers.
  - Factory risers:
    - 0" (not on inboard)
    - 2" (except TowSport and inboard)
    - 4" (except TowSport)
    - 6" (except TowSport)

Switchable Exhaust



59756

Corsa baffle

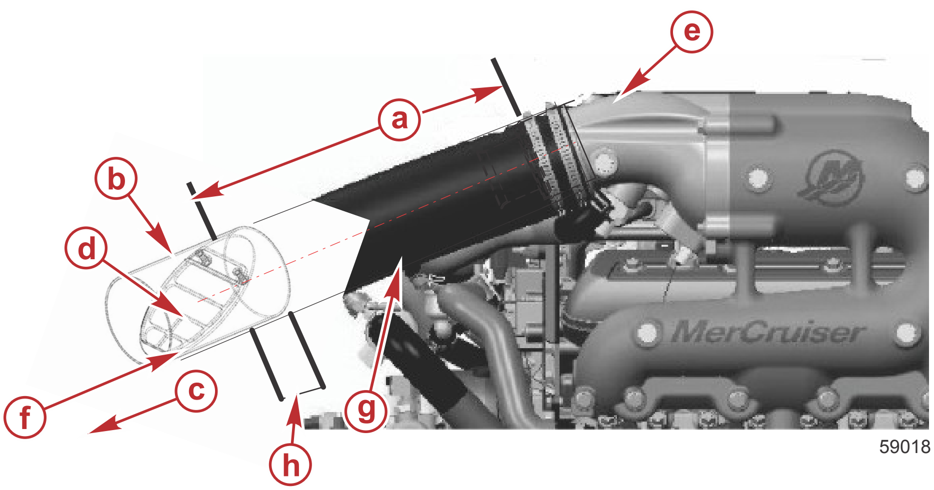
- If a switchable exhaust system is used, you must have a baffle in-line, either in the tip or on the side outlet.
- 6.2L Corsa switchable exhaust baffles are included with the engine.

6.2L MIE Exhaust Installation

An exhaust shutter is required to help prevent water intrusion.

Exhaust Shutter Installation

1. Install the exhaust shutter in the exhaust hose with the open end toward the engine. Position the shutter assembly so that the rubber shutter is facing down. Locate the shutter assembly no less than 66.04 cm (10 in.) after the elbow.

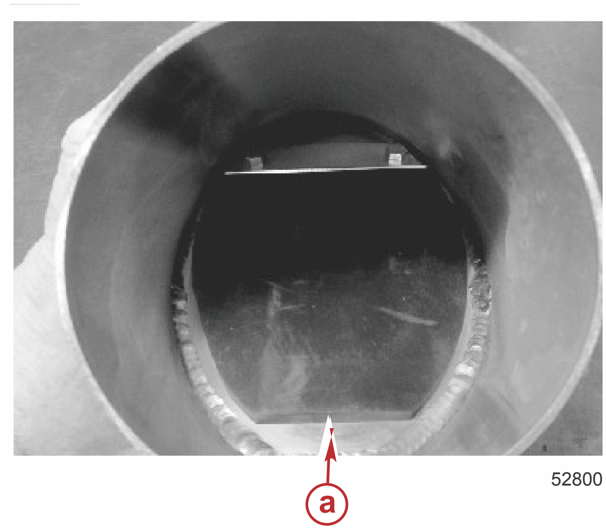


59018

- a - 25.4–66.04 cm (10–26 in.) after elbow
- b - Shutter assembly
- c - Flow
- d - Flapper down position
- e - Elbow
- f - Outlet
- g - Hose
- h - Minimum amount shutter assembly inserted into hose 50.8 mm (2 in.)

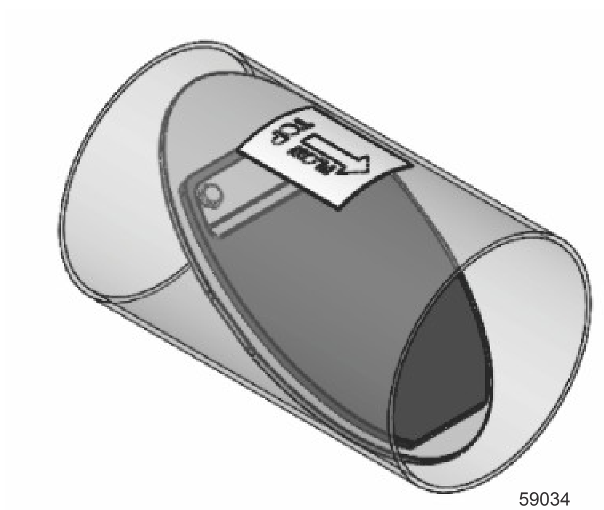
IMPORTANT: The shutter should be inserted in the hose a minimum 50.8 mm (2 in.).

2. Ensure that the horizontal support bar is perpendicular to the vertical axis of the exhaust tube, and that the rubber shutter rests on the bottom of the steel grate in the closed position, as indicated by decal on the shutter. The shutter must be able to gravitationally seal in order for it to be effective.



Shutter assembly outlet end

a - Bottom of steel grate



Decal indicating position and flow

⚠ WARNING

Improper boat design and construction may result in serious injury or death. Adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) when designing and constructing the boat and other components, such as the engine compartment, fuel delivery system, or exhaust system.

NOTICE

Hot spots in exhaust hoses can damage hoses and cause leaks. Ensure that discharge water from the exhaust elbow flows without restriction through all hoses and fittings.

IMPORTANT: All exhaust connections, including those at the exhaust elbow, must be secured with two hose clamps. ABYC standards also specify the use of stainless steel clamps with a minimum 13 mm (½ in.) bandwidth. Do not use spring tension clamps.

3. Every exhaust hose connection must be secured with at least two stainless steel hose clamps.

Qty.	Description	Part Number
4	Stainless steel clamps—101.60 mm (4 in.)	Obtain Locally

IMPORTANT: The shutter assembly must be installed no less than 10 in. after the elbow. It must be installed at a minimum 3° down angle.

TowSport Exhaust

TowSport exhaust shipped with mufflers:

- Tested and qualified mufflers shipping with engine
- OEM does not have to purchase separately
- Internal drain

General Information

The height of the exhaust elbows must be within the dimensions specified to prevent water intrusion problems. Exhaust elbow risers must be installed, if needed, to obtain the proper exhaust elbow height, and exhaust angle. Risers are limited to 152.4 mm (6 in.). Measurement must be taken with the boat in the water. It is important that the boat be loaded as outlined to simulate the maximum loading conditions likely to be encountered in normal operation.

IMPORTANT: Load distribution recommendations are the responsibility of the boat manufacturer. Any load distribution conditions that will affect the exhaust system must be clearly communicated to the operator in the owner's manual. For example, the number of people that can be located on the swim platform simultaneously should be included in the manual, if this could pose a problem.

Measurements under all loading conditions must be within the following specifications.

Minimum Exhaust Elbow Height	
Model	**Specification**
6.2L TowSport in-line models	33 cm (13 in.)
6.2L TowSport V-drive models	33 cm (13 in.)

Minimum Exhaust Hose Slope	
Model	**Specification**
6.2L TowSport	Within 406.4 mm (16 in.) of engine
	10°

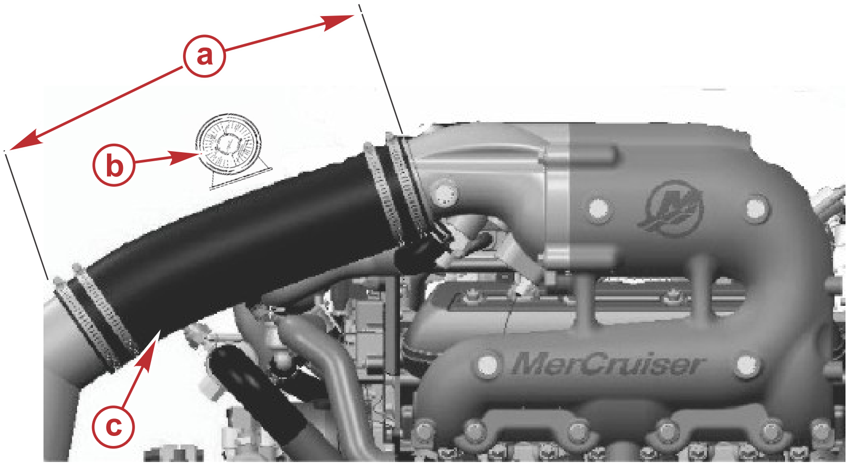
If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to the appropriate **Mercury Precision Parts and Accessory Guide** for part numbers.

The maximum exhaust riser height is specified in the table below.

Riser Options			
Model	**Low**	**Medium**	**High**
6.2L TowSport	51 mm (2 in.)	102 mm (4 in.)	152 mm (6 in.)

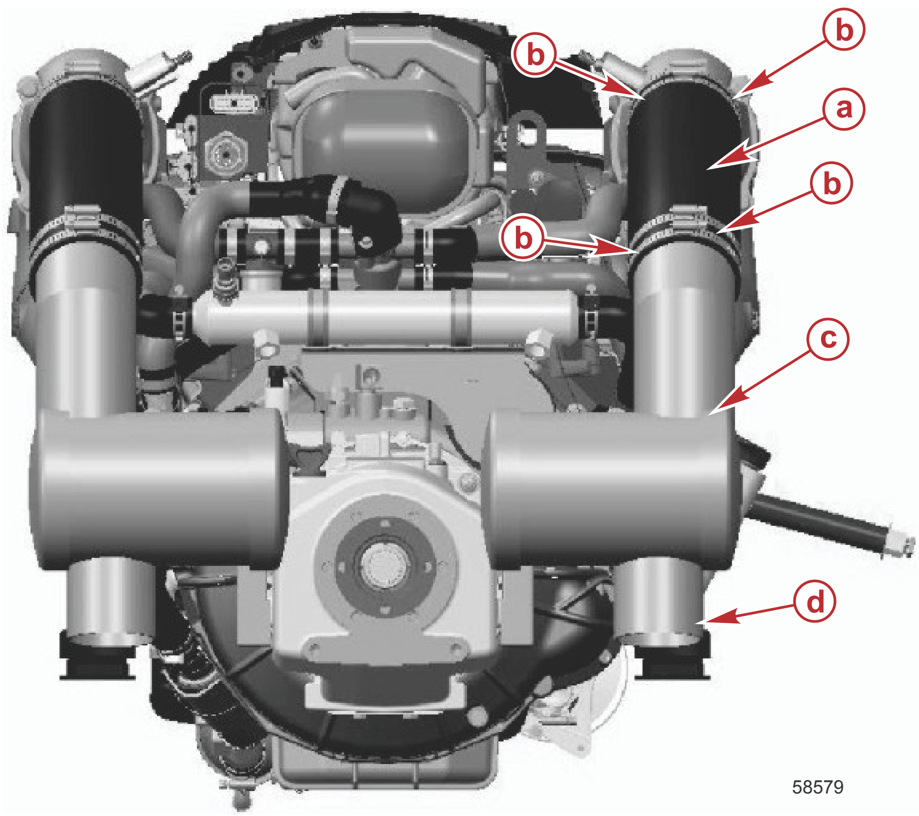
Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet continuing along each section to the exhaust exit point of the boat. All exhaust angle measurements must be performed with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. Refer to **Loading Requirements**.



58574

Typical exhaust
- a - Minimum 152.4 mm (6 in.), maximum 406.4 mm (16 in.)
- b - Inclinometer
- c - Exhaust hose or tube



58579

Typical muffler assembly
- a - Hose
- b - Hose clamps
- c - Muffler
- d - 88.9 mm (3.5 in.) outlet

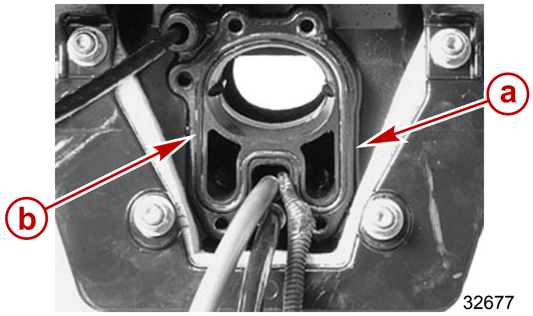
Component Replacement

Through-the-Propeller Exhaust

IMPORTANT: The exhaust pipe and the gimbal housing mating surface must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove or water may leak into the boat.

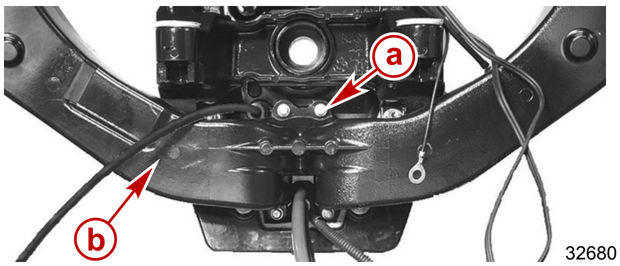
1. Inspect and clean the mating surfaces on the gimbal housing.

2. Inspect the O-ring. The O-ring must remain in the groove.



a - Mating surface
b - O-ring

3. Inspect and clean the mating surfaces on the exhaust pipe.
4. Install the exhaust pipe assembly using the four screws and lockwashers. Tighten the screws to the specified torque.



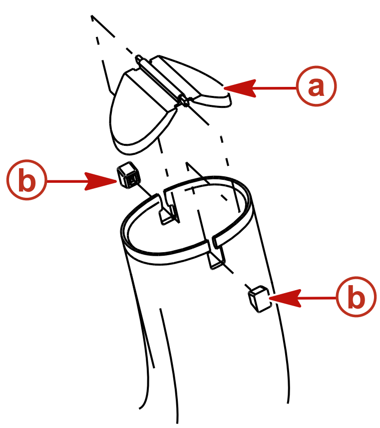
a - Exhaust Y-pipe screw (4)
b - Exhaust Y-pipe

Description	Nm	lb-in.	lb-ft
Exhaust Y-pipe screw	34	–	25.1

Water Shutter Replacement

IMPORTANT: Exhaust system connections to components other than those supplied by Mercury Marine must use two stainless steel clamps that are at least 13 mm (½ in.) wide at each joint.

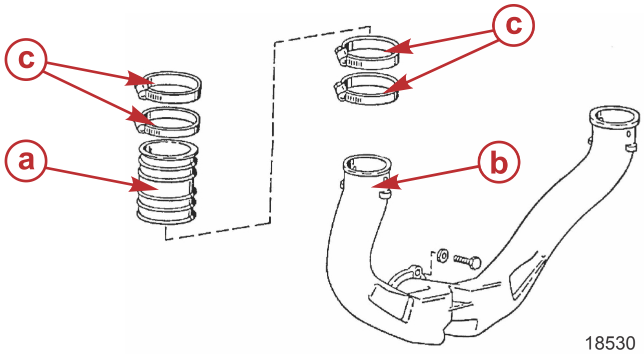
1. Remove and retain the intermediate exhaust pipe from the Y-pipe.
2. Remove and discard the water shutter and grommets from the Y-pipe.
3. Install the water shutter into the Y-pipe. Ensure that the water shutter is seated into the rubber grommets.



18483

a - Water shutter
b - Rubber grommet

4. Install the exhaust tube and the intermediate exhaust pipe onto the exhaust Y-pipe and secure with hose clamps. Tighten the hose clamps to the specified torque.



a - Exhaust tube
b - Exhaust Y-pipe
c - Hose clamps

Description	Nm	lb-in.	lb-ft
Tridon® hose clamp (exhaust tube)	4-4.7	35.4-41.6	–

Steering Systems

Section 8A - Power-Assisted Steering Pump and Related Components

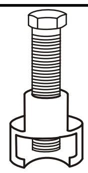
Table of Contents

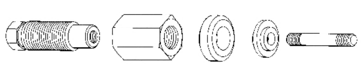
8
A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
28	Dexron III	Power steering system	Obtain Locally
114	Power Trim and Steering Fluid	Power-assisted steering pump shaft	92-858074K01
		Power-assisted steering system	
		Power steering system	

Special Tools

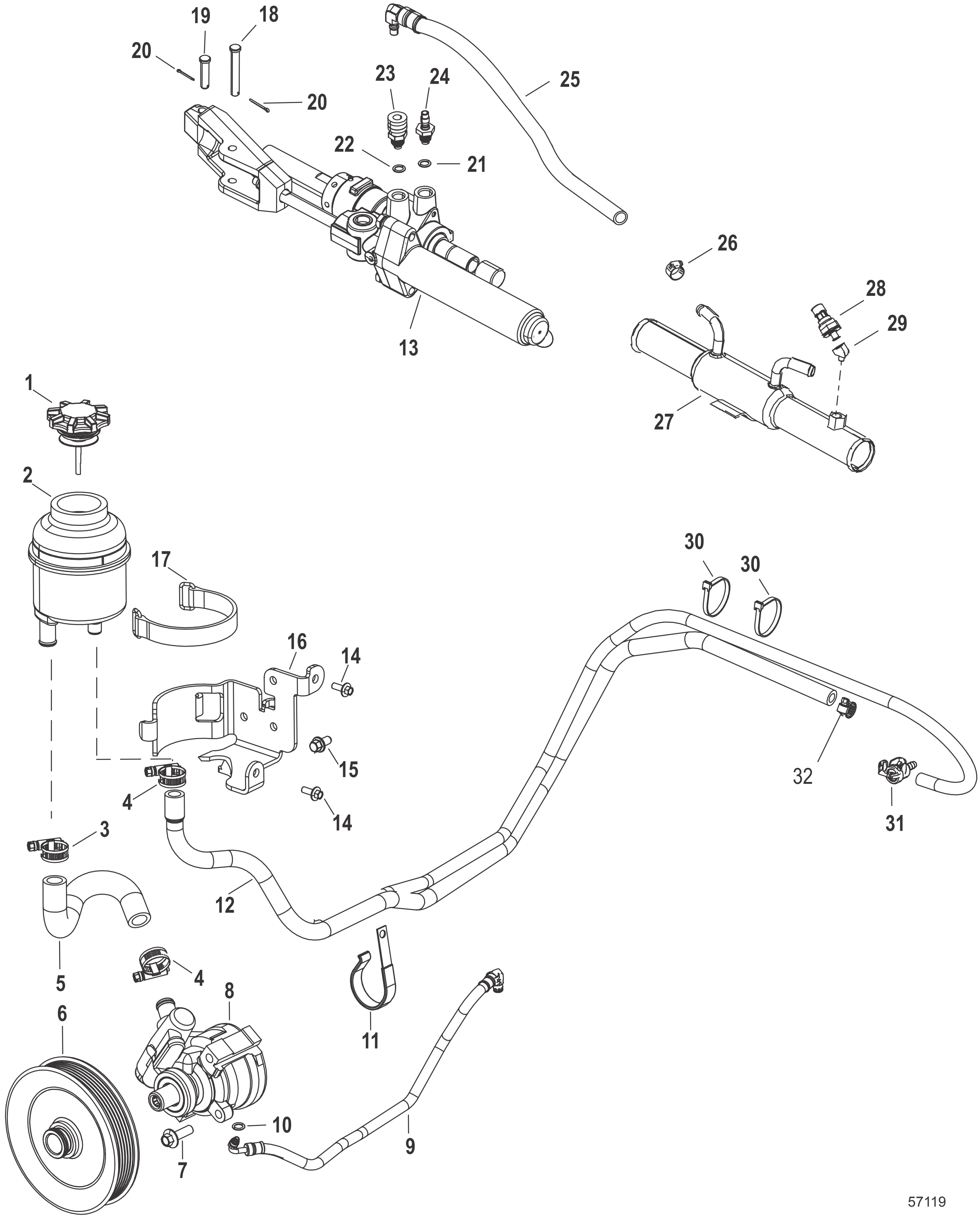
Power-Assisted Steering Pump Pulley Remover	Obtain locally
 18598	Removes the pulley on the power steering pump.

Pulley Pusher Installer	91- 93656A 1
 10047	Installs the pulley onto the power steering pump.

Power Steering Test Gauge Kit	91-38053A05
 10804	Tests the power steering system pressure.

Notes:

Power-Assisted Steering Components Exploded View

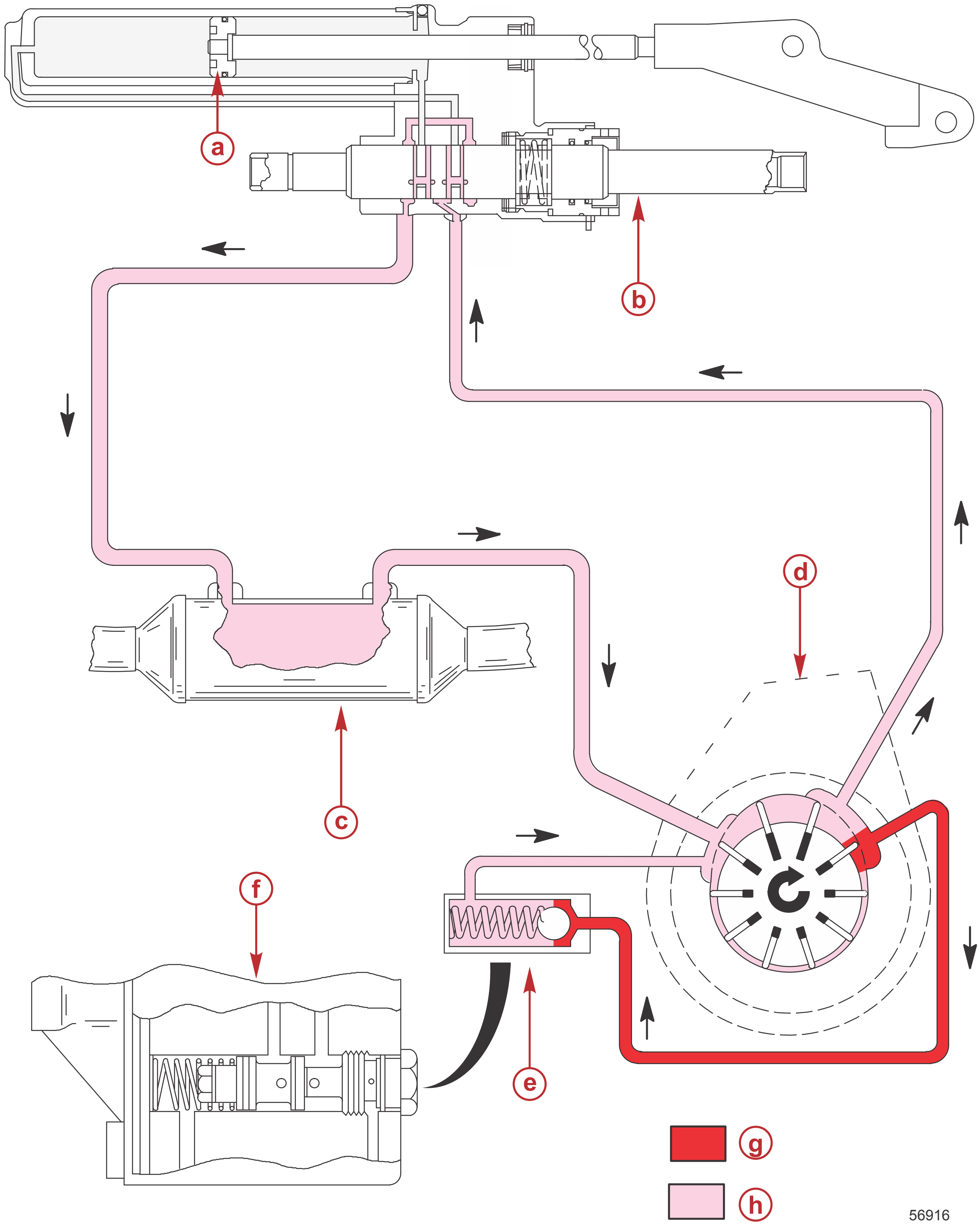


Power-Assisted Steering Components Exploded View

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cap and dipstick			
2	1	Power steering reservoir			
3	1	Clamp			
4	2	Clamp			
5	1	Oil pump to reservoir hose			
6	1	Pulley			
7	3	Screw			
8	1	Pump assembly			
9	1	Pump to cylinder hose	31	–	23
10	1	O-ring (0.301 x 0.064)			
11	1	Clip			
12	1	Reservoir to cooler hose			
13	1	Power steering cylinder			
14	2	Stainless steel screw			
15	3	Screw			
16	1	Bracket			
17	1	Strap			
18	1	Clevis pin			
19	1	Clevis pin			
20	2	Cotter pin			
21	1	O-ring			
22	1	O-ring			
23	1	Fitting			
24	1	Fitting			
25	1	Cylinder to cooler hose			
26	1	Clamp			
27	1	Power steering cooler			
28	1	Sensor			
29	2	Elbow (45°)			
30	2	Cable tie			
31	1	Fitting to the transom			
32	1	Clamp			

Hydraulic Diagrams

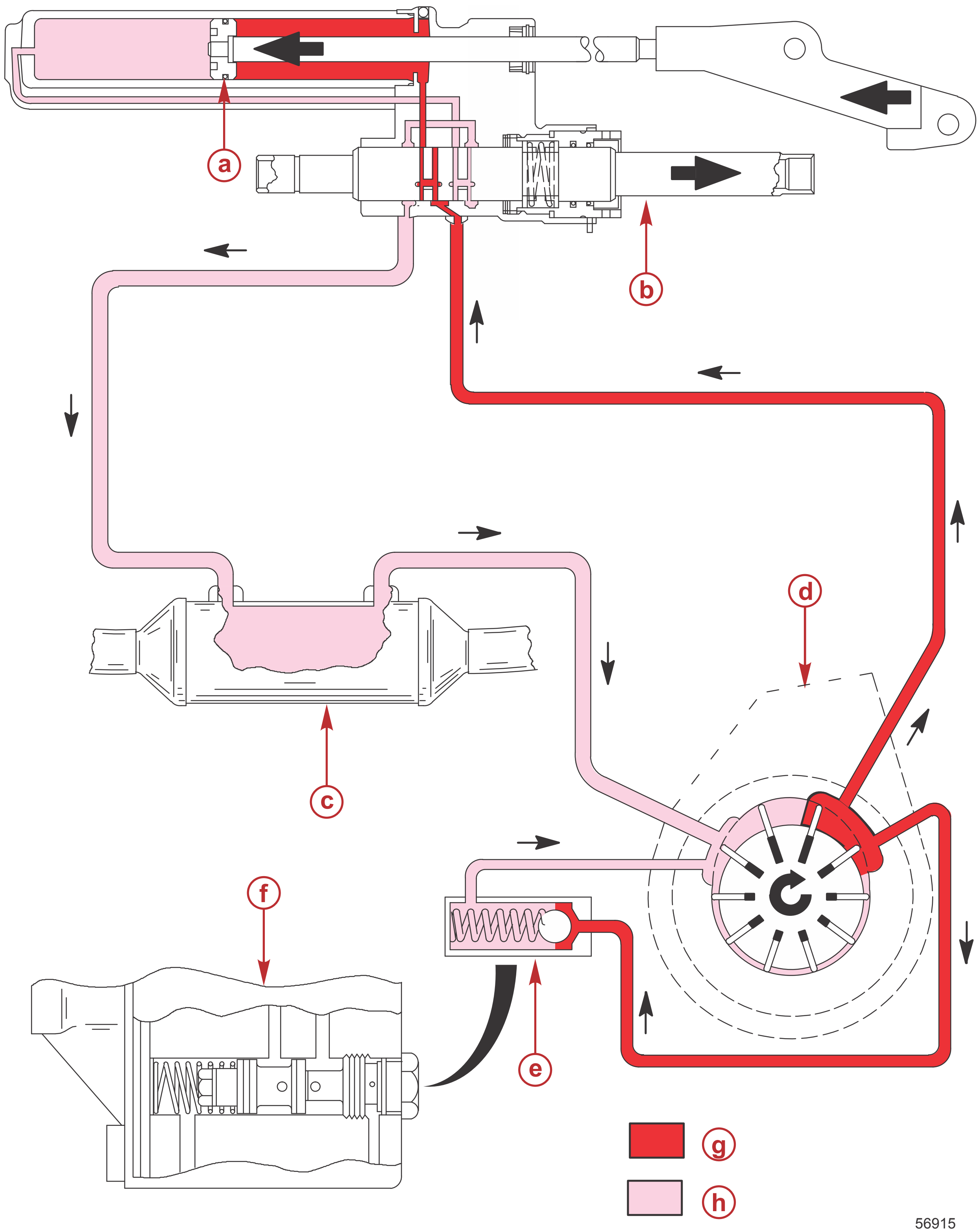
Neutral



The image represents the view from the inside of the boat looking at the transom

- a - Piston
- b - Control valve
- c - Power steering fluid cooler
- d - Pump
- e - Relief valve (inside of the pump housing)
- f - Pump housing
- g - High pressure
- h - Low pressure

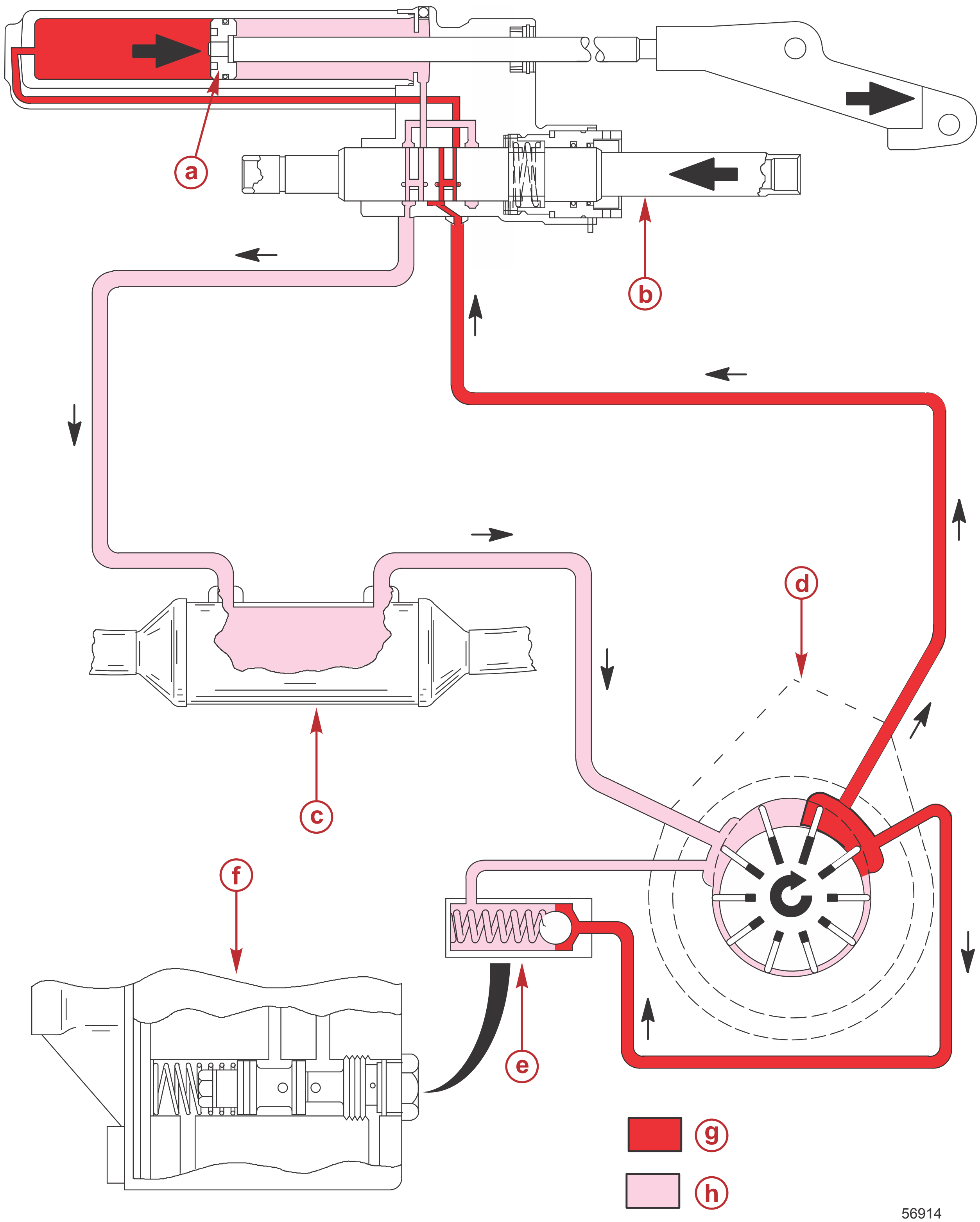
Left Turn



The image represents the view from the inside of the boat looking at the transom

- a - Piston
- b - Control valve
- c - Power steering fluid cooler
- d - Pump
- e - Relief valve (inside of the pump housing)
- f - Pump housing
- g - High pressure
- h - Low pressure

Right Turn



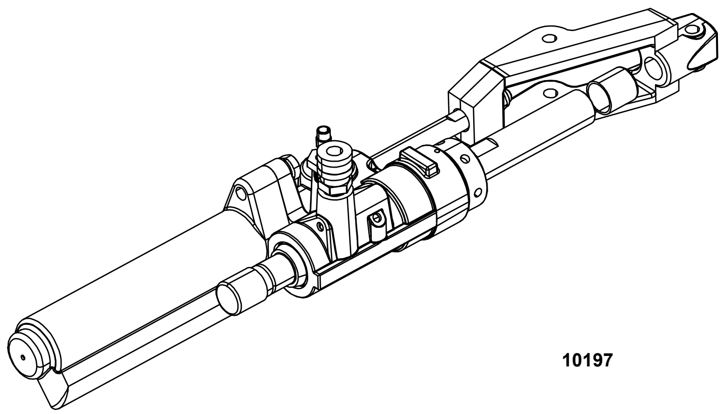
The image represents the view from the inside of the boat looking at the transom

- a - Piston
- b - Control valve
- c - Power steering fluid cooler
- d - Pump
- e - Relief valve (inside of the pump housing)
- f - Pump housing
- g - High pressure
- h - Low pressure

Description

Control Valve

The control valve is not serviceable and must be replaced as a complete assembly.



10197

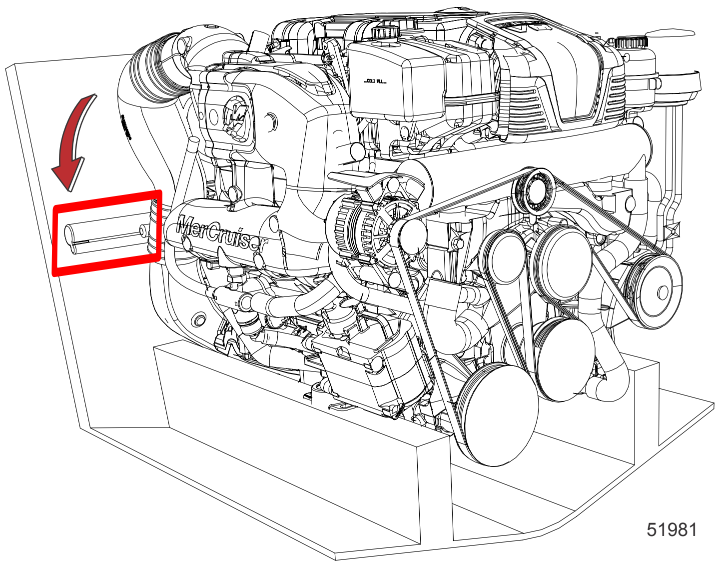
Axius Steering Cylinder Clearance

Provide 2.5 cm (1 in.) of clearance around and between the steering actuator and boat transom. This area must be free of protruding hull structures, through-the-hull fittings, harnesses, cables, wires, or any other obstructions between the TVM and transom to allow the steering cylinder a full range of motion.

Mercury recommends that only the shift cable be routed behind the steering cylinder. Vessel hoses and wiring routed behind the steering cylinder hinders service of the cylinder and may become damaged over time.

IMPORTANT: Refer to Mercury MerCruiser Service Bulletin 2012-09 for unique shift cable routing on all 8.2 ECT sterndrive single catalyst exhaust manifold models.

Do not route harnesses or install components on the inner transom that will interfere or obstruct the steering cylinder's movement. Ensure that a 2.54 cm (1 in.) space (clearance) exists behind the cylinder in all positions as the cylinder pivots during operation.



Required steering cylinder clearance

IMPORTANT: Steering components should not contact any part of exhaust during any degree of the components movement.

Power-Assisted Steering Pump

The power-assisted steering pump is not serviceable and must be replaced as a complete assembly.

Power-Assisted Steering Pump Pulley

Power-Assisted Steering Pump Pulley—Removal

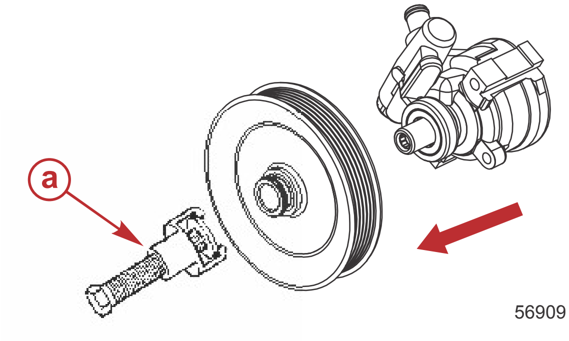
NOTE: The power-assisted steering pump pulley may be removed and installed while the power-assisted steering pump assembly remains mounted to the engine.

⚠ WARNING
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ CAUTION
Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

1. Disconnect both battery cables from the battery.
2. Be certain to disconnect the negative (–) cable first.
3. Remove the serpentine belt. Refer to **Section 1C** - **Replacing Belt**.

4. Install the pulley removal tool on the end of the power-assisted steering pulley and the shaft.



a - Typical pulley removal tool

Power-Assisted Steering Pump Pulley Remover	Obtain locally

5. While holding the pulley removal tool with a suitable wrench, turn the threaded bolt until the power-assisted steering pump pulley is removed.

Power-Assisted Steering Pump Pulley—Installation

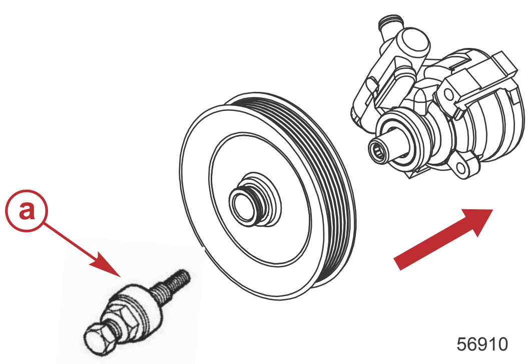
Install the power-assisted steering pump pulley using the pulley install tool.

Pulley Pusher Installer	91- 93656A 1

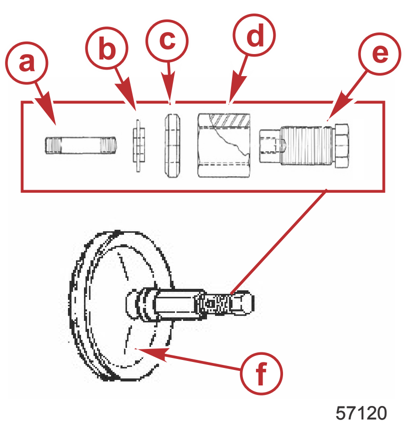
1. Lubricate the power-assisted steering pump shaft with Power Trim and Steering Fluid.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power-assisted steering pump shaft	92-858074K01

2. Start the pulley on the steering pump shaft.



a - Installer



a - Pulley pusher stud
b - Pulley pusher spacer
c - Pulley pusher bearing
d - Pulley pusher nut
e - Pulley pusher shaft
f - Power-assisted steering pump pulley

a. Thread the stud from the pulley pusher completely into the power-assisted steering pump shaft.
b. Place the spacer on the pulley.
c. Place the spacer and the bearing over the pulley pusher stud so that the spacer is against the pulley.

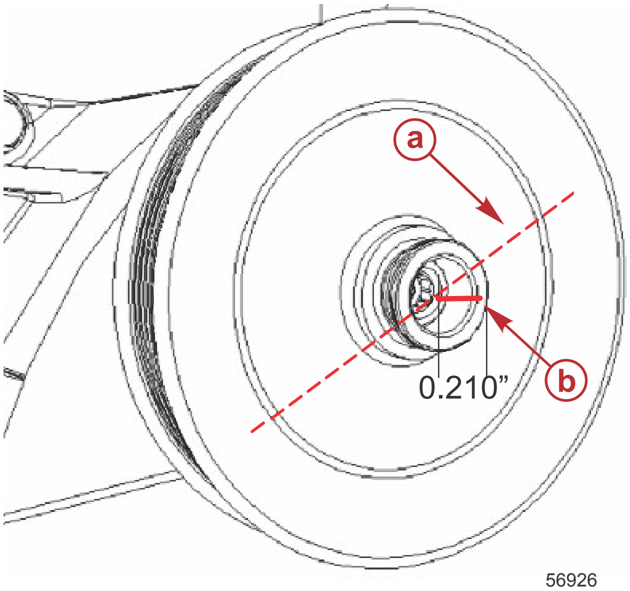
d. Thread the pulley pusher nut onto the pulley pusher shaft.

NOTE: The spacer is designed to keep the bearing centered on the tool.

e. Thread the pulley pusher shaft and nut onto the pulley pusher stud (threaded into the power-assisted steering pump shaft).

f. Turn the pulley pusher nut until the face of the power-assisted steering pulley is 0.210" from edge of shaft.

NOTE: Press the pulley as shown with the end of the shaft.



a - Pulley hub face (straightedge)
b - Pump shaft depth

3. Remove the tool and install the serpentine drive belt. Refer to **Section 1C** - **Serpentine Drive Belt**.

Power-Assisted Steering Pump Assembly

Steering Pump Assembly Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

⚠ CAUTION

Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last.

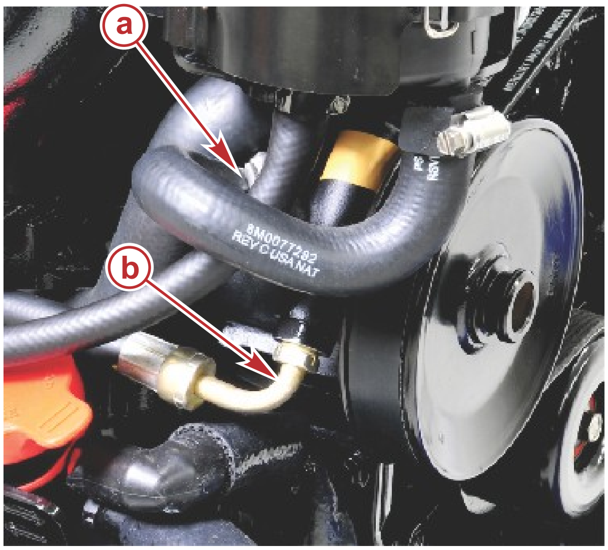
1. Disconnect both battery cables from the battery. Be certain to disconnect the negative (–) cable first.
2. Remove the steering pump pulley. Refer to **Power-Assisted Steering Pump Pulley—Removal**.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

3. Drain the fluid from the steering pump assembly:
   a. Allow the fluid to cool. Remove the power-assisted steering pump reservoir cap and dipstick.
   b. Remove the high-pressure hose and the return hose from the power-assisted steering pump.

c. Drain the fluid into a suitable container. Dispose of the fluid according to local regulations.



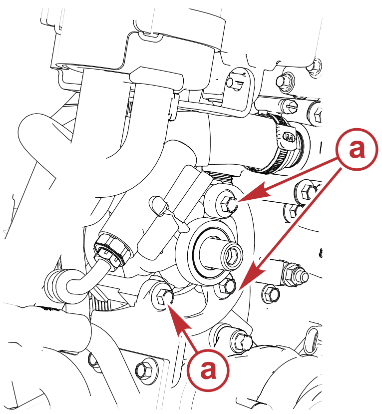
56918

Power-assisted steering pump assembly

a - Return hose

b - High-pressure hose

4. Remove the mounting screws from the power-assisted steering pump and mounting brackets.



56917

a - Pump mounting screws

5. Remove the power-assisted steering pump from the mounting brackets.

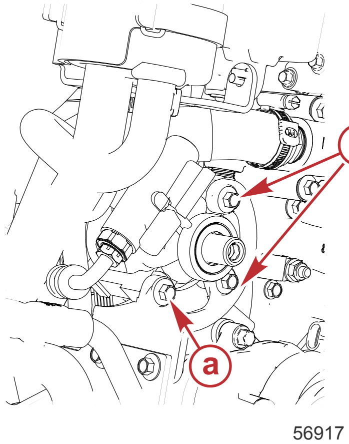
Steering Pump Assembly Installation

IMPORTANT: Do not cross-thread or overtighten the hose fittings.

1. Place the power-assisted steering pump onto the mounting brackets. Tighten the bracket to the specified torque.

Description	Nm	lb-in.	lb-ft
Power steering bracket to the block	35.2	–	26

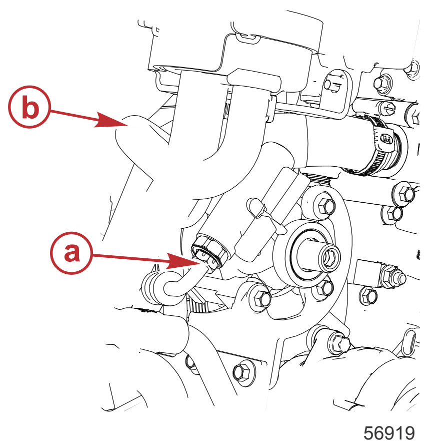
2. Install and tighten the pump mounting screws to the specified torque.



a - Pump mounting screws

Description	Nm	lb-in.	lb-ft
Power-assisted steering pump fasteners	17.6	155.7	–

3. Install the high-pressure hose fitting and new O-ring onto the steering pump assembly. Tighten the hose fitting to the specified torque.



a - High-pressure hose and fitting
b - Return hose

Description	Nm	lb-in.	lb-ft
Power-assisted steering hose fittings	31	–	23

4. Connect the return hose to the steering pump assembly and secure it with a hose clamp.
5. Install the pulley. Refer to **Power-Assisted Steering Pump Pulley—Installation**.

Replacing the Belt and Adjusting Tension

To replace the drive belt or to adjust the tension, refer to **Serpentine Drive Belt** in **Section 1C**.

Power-Assisted Steering Fluid

Filling and Bleeding

IMPORTANT: Fill the power-assisted steering system exactly as explained in the following procedure to ensure that all air is bled from the system. Failure to remove the air may cause foam during operation and discharge from the pump reservoir. Foamy fluid may cause the power-assisted steering system to become spongy, resulting in poor boat control.

1. Using the steering wheel, position the sterndrive so that it is in the straight ahead position.
2. Stop the engine.
3. Remove the cap and dipstick from the power-assisted steering pump.
4. Add approved fluid to bring the level up to the "FULL COLD" mark on the dipstick.
   IMPORTANT: Use only Power Trim and Steering Fluid in the power-assisted steering system.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power-assisted steering system	92-858074K01

5. Install the cap and dipstick. Tighten the cap securely.

NOTICE

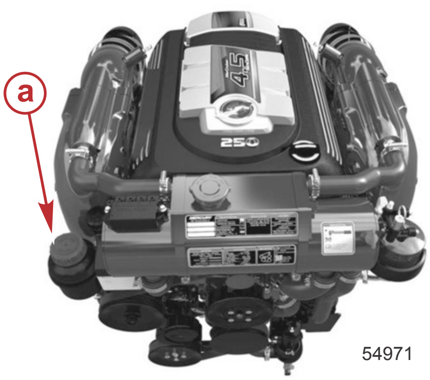
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. Start the engine and operate it at fast idle (1000–1500 RPM) until it reaches normal operating temperature. During this time, turn the steering wheel fully back and forth several times.
7. Using the steering wheel, position the sterndrive so that it is pointed straight ahead.
8. Stop the engine.
9. Remove the cap and dipstick from the reservoir.
10. Allow any foam in the pump reservoir to disperse.
    IMPORTANT: The sterndrive must be in the straight ahead position and steering fluid must be hot for an accurate reading of the fluid level.
11. Check the fluid level and add fluid as required to bring the level up to the "FULL HOT" mark on the dipstick. Do not overfill.
12. Reinstall the cap and dipstick. Tighten the cap securely.
13. If the fluid is still foamy, repeat steps 6 through 12 until the fluid does not foam and the level remains constant.

Power Steering Fluid

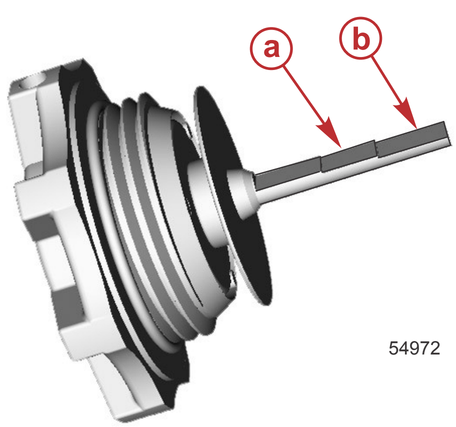
Checking

1. Stop the engine and center the sterndrive unit.
2. Remove the fill cap/dipstick and observe the level.



a - Fill cap/dipstick

   a. The proper fluid level with the engine at normal operating temperature should be within the warm range.
   b. The proper fluid level with the engine cold should be within the cold range.



a - Warm range
b - Cold range

IMPORTANT: If fluid is not visible in the reservoir, contact your authorized Mercury MerCruiser dealer.

Filling

1. Remove the fill cap/dipstick and observe the level.
2. Add the specified fluid to bring the fluid level up to the proper level.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power steering system	92-858074K01
28	Dexron III	Power steering system	Obtain Locally

3. Install the fill cap/dipstick.

Changing

Power steering fluid does not require changing unless it becomes contaminated with water or debris. Contact your authorized Mercury MerCruiser dealer.

Power-Assisted Steering Hoses

IMPORTANT: Make the hydraulic connections as quickly as possible to prevent fluid from leaking.
IMPORTANT: Do not cross-thread or overtighten the hose fittings.

High-Pressure Hose (Pump to Control Valve)

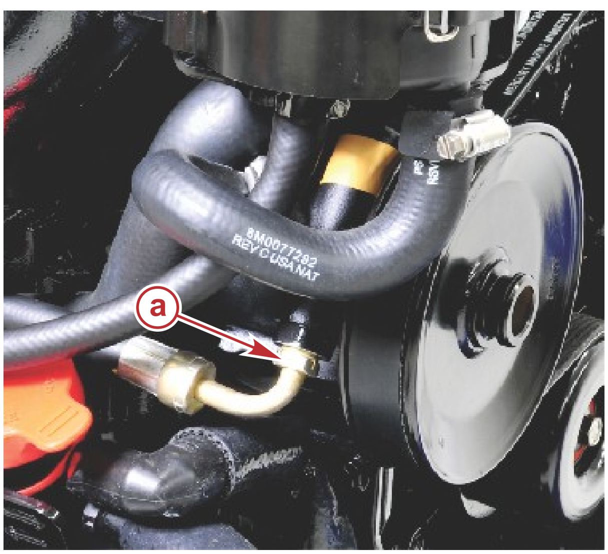
Removal

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Catch the fluid that drains from the pump and the hoses in a suitable container.

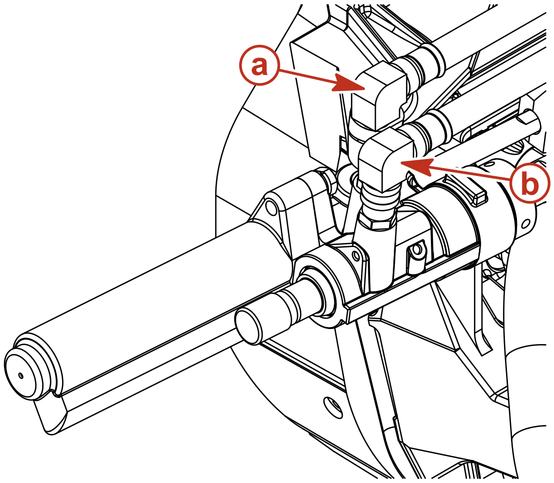
1. Note the position and the routing of the steering pressure hose before removal.
2. Remove the high-pressure hose and the O-ring from the power-assisted steering pump assembly.



56932

a - High-pressure hose (O-ring not shown)

3. Disconnect the high-pressure hose from the quick-connect fitting on the control valve at the transom.



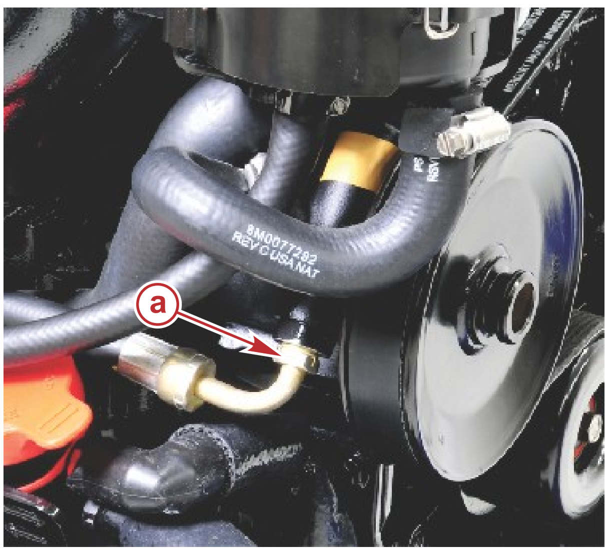
6686

a - High-pressure hose
b - Return hose

Installation

IMPORTANT: Route the hoses as shown below to prevent kinks, which can damage the hoses or fittings.
IMPORTANT: Do not cross-thread or overtighten the hose fittings.

1. Route the high-pressure hose into the same position as prior to removal.
2. Install a new O-ring in the high-pressure hose fitting, and install the fitting onto the power-assisted steering pump assembly. Tighten the fitting to the specified torque.



56932

a - High-pressure hose (O-ring not shown)

Description	Nm	lb-in.	lb-ft
High-pressure hose fitting	31	–	23

3. Route the high-pressure hose to the control valve at the transom in the same position as prior to removal.
4. Install the high-pressure hose onto the quick-connect fitting on the control valve at the transom. Ensure that the quick-connect fitting snaps into place.
5. Fill and bleed the system. Refer to **Filling and Bleeding**.

Return Hose (Pump Reservoir to Fluid Cooler)

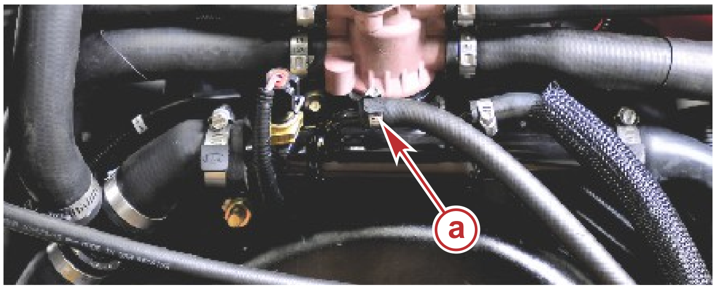
Removal

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Use a suitable container to catch the fluid that drains from the pump and hoses.

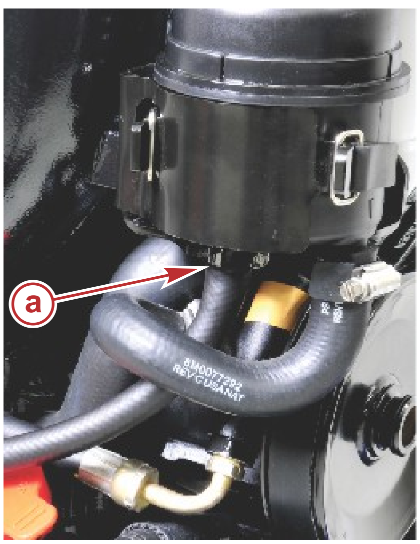
1. Note the routing of the return hose before removal.
2. Loosen the hose clamp and remove the return hose from the fluid cooler.



56933

a - Return hose

3. Loosen the hose clamp and remove the return hose from the power-assisted steering pump reservoir.



56934

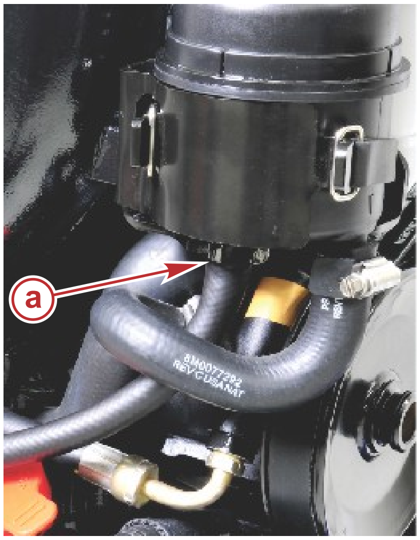
a - Return hose

Installation

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.

1. Route the return hose in the manner noted prior to removal.

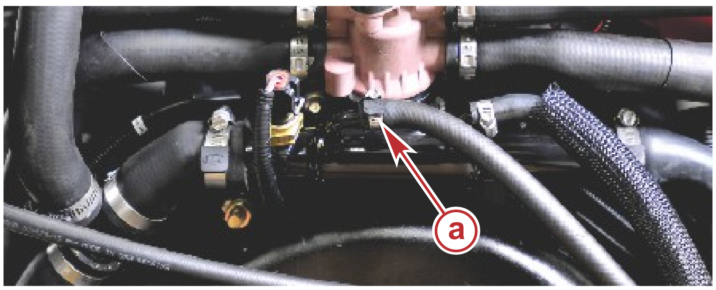
2. Install the return hose onto the power-assisted steering pump reservoir and secure it with hose clamps.



a - Return hose

56934

3. Install the return hose onto the fluid cooler and secure it with hose clamps.



a - Return hose

56933

4. Fill and bleed the system. Refer to **Filling and Bleeding**.

Return Hose (Control Valve to Fluid Cooler)

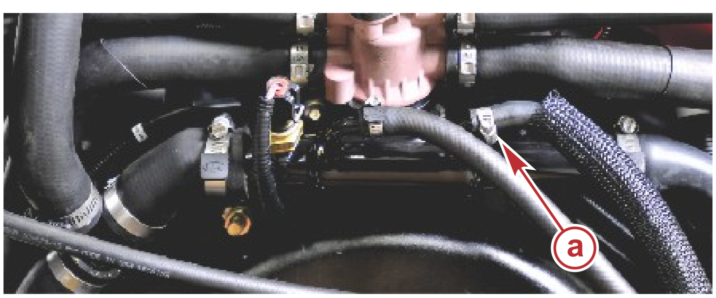
Removal

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: Use a suitable container to catch the fluid that drains from the pump and hoses.

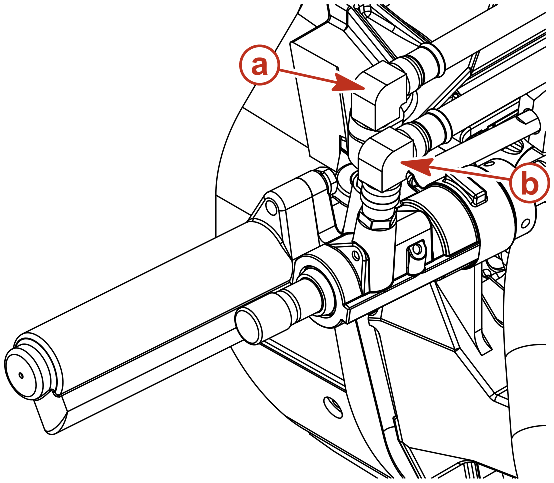
1. Note the position and routing of the return hose before removal.
2. Loosen the hose clamp and remove the return hose from the fluid cooler.



a - Return hose and hose clamp

56935

3. Disconnect the return hose from the control valve quick-connect fitting located at the transom.



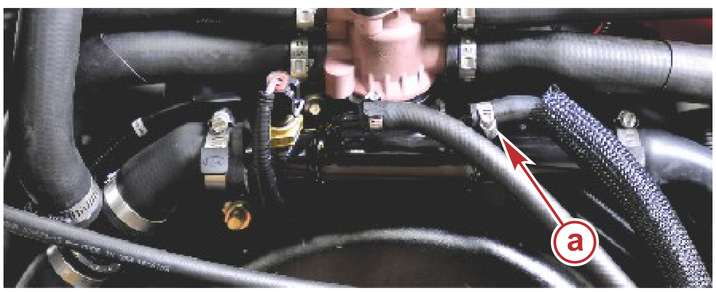
a - Pressure hose
b - Return hose

4. Remove the return hose.

Installation

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.
IMPORTANT: Do not cross-thread or overtighten the hose fittings.

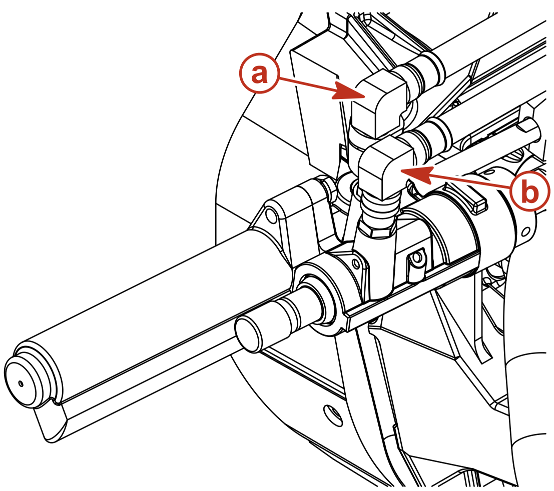
1. Route the return hose in the manner noted prior to removal.
2. Install the return hose onto the fluid cooler, and secure it with hose clamps.



56935

a - Return hose and hose clamp

3. Install the return hose onto the control valve quick-connect fitting located at the transom.



a - Pressure hose
b - Return hose

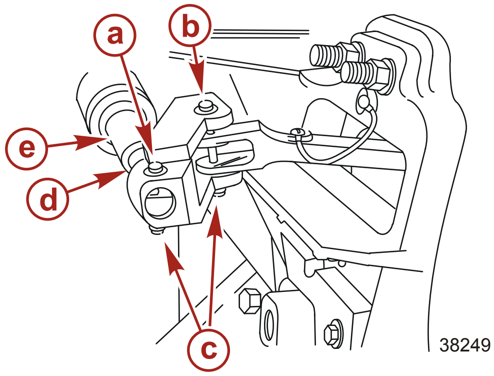
4. Fill and bleed the system. Refer to **Filling and Bleeding**.

Power-Assisted Steering System Tests

Power-Assisted Steering System Pressure Test

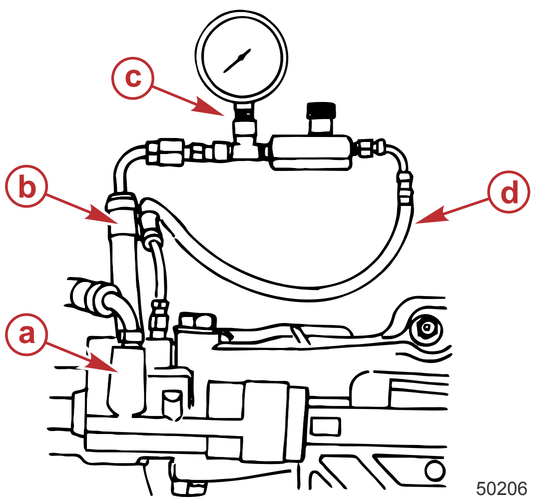
These test procedures are arranged so that a defective component can be detected through the process of elimination. Perform these tests in order.

1. Remove the cotter pin and remove the front clevis pin.
2. Remove the cotter pin and remove the rear clevis pin.
3. Retract the steering cable into the cable guide tube.



- a - Forward clevis pin
- b - Rear clevis pin
- c - Cotter pins
- d - Steering cable end
- e - Cable guide tube

4. Remove the high-pressure hose at the control valve, and install the test gauge between the hose and the control valve.



- a - Control valve
- b - Pressure hose
- c - Test gauge
- d - Gauge-to-control-valve hose

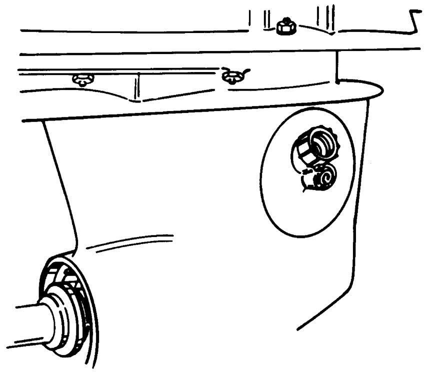
Power Steering Test Gauge Kit	91-38053A05

5. Completely open the valve on the power steering test gauge.

NOTICE
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

6. If the boat is out of the water, connect a flushing device to the sterndrive (refer to **Section 1C**). The cooling system is full when water is discharged through the propeller.

NOTE: For complete flush test device installation instructions, refer to ***Sterndrive Water Pickups*** *in* ***Section 1C****.*



Standard Bravo shown

7. Start the engine and operate it at 1000–1500 RPM until it reaches normal operating temperature.
8. With the engine at idle speed, the test gauge reading should be 483–862 kPa (70–125 psi). If not, proceed as follows:
   - If it is lower than 483 kPa (70 psi), refer to **Pump Pressure Test**.
   - If it is higher than 862 kPa (125 psi), check for hose restrictions in the power-assisted steering system.

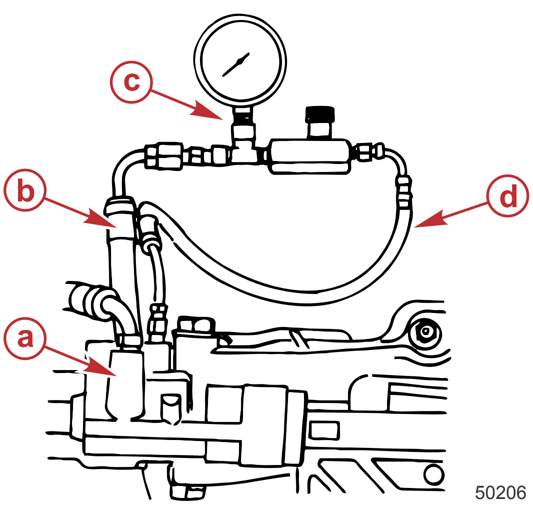
NOTICE
Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than 5 seconds.

9. Push in, then pull out on the steering cable. The gauge should show an instant increase in pressure when the block is pushed in both directions.
10. Push the steering cable in until the booster cylinder piston rod is fully retracted. With the piston rod in this position, push the steering cable in until a maximum pressure reading is obtained.
    - If the pressure is above 6897 kPa (1000 psi), the system pressure is good.
    - If the pressure is below 6897 kPa (1000 psi), conduct the **Pump Pressure Test**.

Pump Pressure Test

NOTICE
Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than 5 seconds.

1. Remove the high-pressure hose at the control valve, and install the test gauge between the hose and the control valve.



a - Control valve
b - High-pressure hose
c - Test gauge
d - Gauge-to-control-valve hose

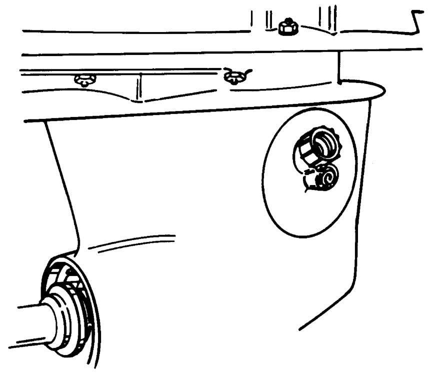
Power Steering Test Gauge Kit	91-38053A05

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

2. If the boat is out of the water, connect a flush test device to the sterndrive. Refer to **Seawater System** for proper seawater supply procedures. The cooling system is full when water is discharged through the propeller.

   NOTE: For complete flush test device installation instructions, refer to ***Sterndrive Water Pickups*** *in* ***Section 1C****.*



Bravo drive with flush test device

3. Start the engine and operate it at 1000–1500 RPM until it reaches normal operating temperature.
4. Close the test gauge valve briefly to obtain a maximum pressure reading.
5. Cycle the test gauge valve open and closed three times, and record the highest pressure reading attained during each cycle.
   a. If the pressure readings are 7932–8621 kPa (1150–1250 psi) and are within 345 kPa (50 psi) of each other, then the pump is within specifications. If the pump is within specifications, but system pressure was low (as tested under the **Power-Assisted Steering System Pressure Test**), refer to the appropriate Mercury MerCruiser sterndrive service manual for additional information.
   b. If the pressure readings are 7932–621 kPa (1150–1250 psi), but are not within 345 kPa (50 psi) of each other, then the steering pump flow control valve is sticking or the pump hydraulic system is dirty. Flush the pump with clean power steering fluid and recheck the pump pressure. If pump pressure is still not within specification, replace the power-assisted steering pump.
   c. If pressure readings are constant, but below 6897 kPa (1000 psi), replace the power-assisted steering pump.

Notes:

Steering Systems

Section 8B - Compact Hydraulic Steering

Table of Contents

8
B

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	90° fittings	92-809822
95	2-4-C with PTFE	Pivot bolt bushings and pivot bolt threads	92-802859A 1
		Clevis pin and clevis	
138	Synthetic Power Steering Fluid SAE 0W-30	Hydraulic hose end O-ring area	92-858077K01
		Power steering reservoir	

Approved Hydraulic Steering Fluids

Description	Where used	Part Number
Hydraulic Helm Steering Fluid	Hydraulic hose end O-ring area	92-862014Q1

Important Information About Through-the-Transom Exhaust

IMPORTANT: This compact hydraulic steering system is not designed for use with through-the-transom exhaust systems.

Introduction

The system has a pressure-relief valve to protect against internal fluid pressure becoming too high for the individual system components. This valve minimizes the possibility of a total loss of steering.

The steering cylinder is an unbalanced cylinder: in any position the port and starboard cylinder chambers will have different volumes. This is important when setting the hydraulic fluid level, as outlined later.

The steering unit may not function properly if dirt or contaminants are introduced into the system.

IMPORTANT: Due to a small amount of internal hydraulic fluid transfer (slip), a master spoke or centered steering wheel cannot be maintained with a hydraulic steering system. For best results, use an equal-distance spoke steering wheel.

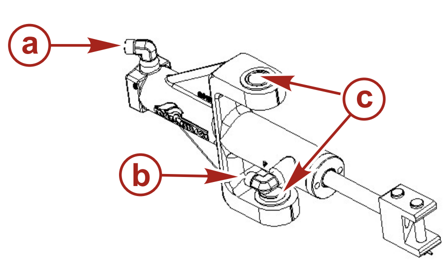
IMPORTANT: This section will not guide you through installation of the hydraulic power-assisted steering kits, refer to the installation instructions provided with these kits.

Installing the Steering Cylinder

1. Apply Loctite 567 PST Pipe Sealant to the threads (pipe threads only) of the two 90° elbow fittings and install them into the steering cylinder. Orient the fittings according to the application and the routing of the hydraulic hoses to the steering cylinder. Tighten the 90° fittings securely.
   IMPORTANT: Apply thread sealant to three threads all the way around the elbow fitting, leaving the first thread free of sealant. Tighten the fitting 1-3/4–2-1/2 turns after hand-tight.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	90° fittings	92-809822

2. Install the pivot bolt bushings into the steering cylinder pivot bolt holes.



42819

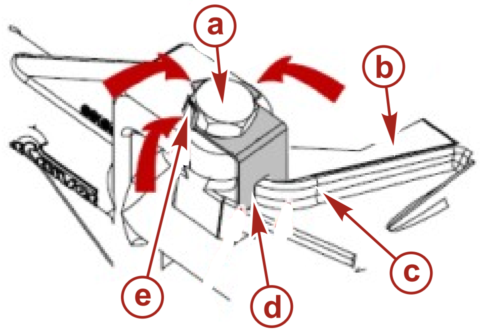
a - Starboard elbow fitting
b - Port elbow fitting
c - Cylinder pivot bolt bushings

3. Install the steering cylinder assembly as follows:
   a. Ensure that the pivot bolt bushings on the new steering cylinder are clean.
   b. Lubricate the pivot bolt bushings and pivot bolt threads.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Pivot bolt bushings and pivot bolt threads	92-802859A 1

c. Position the steering cylinder assembly so that the upper and lower pivot bolt holes are aligned with the pivot bolt holes in the transom plate.

d. Install the spacer, tab washer, and pivot bolt. Ensure that the tab washer tangs straddle the ridge on the transom plate.



a - Pivot bolt
b - Transom plate
c - Ridge on transom plate
d - Tab washer tangs (straddle ridge)
e - Tab (aligned with facets on pivot bolt)

43148

e. Hand-tighten the upper pivot bolt until completely seated. Repeat for the lower pivot bolt.

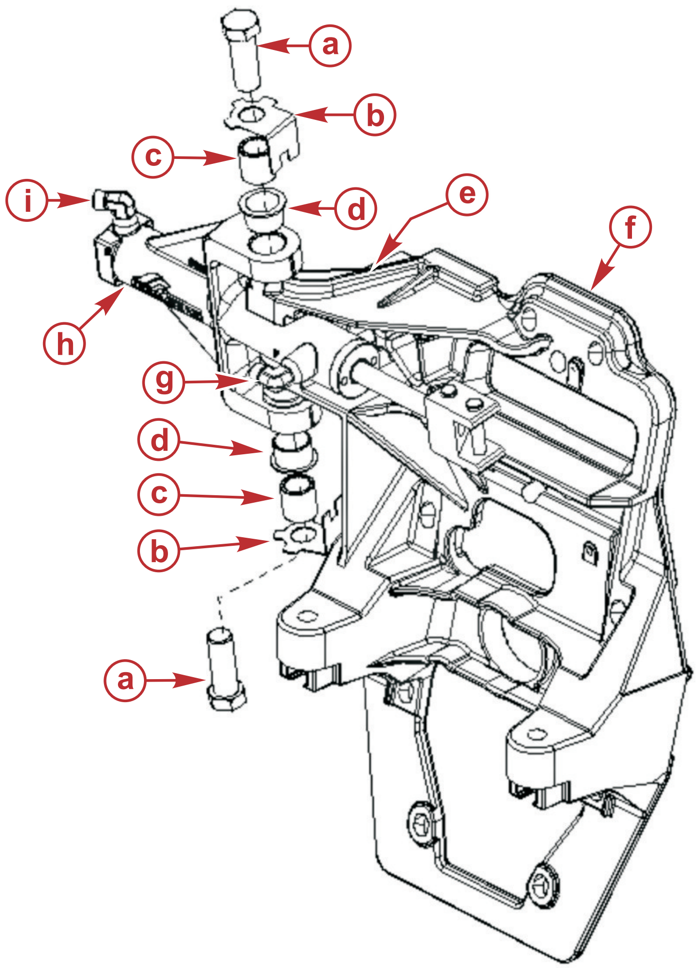
f. Ensure that the steering cylinder assembly pivots freely.

g. Tighten the pivot bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Pivot bolts	33	–	24

h. Bend the washer tabs against corresponding facets of the bolt heads.

IMPORTANT: It may be necessary to tighten the pivot bolts further to align the bolt facets with the tabs on the tab washer.



a - Pivot bolt (2)
b - Tab washer (2)
c - Spacer (2)
d - Pivot bolt bushing (2)
e - Ridge on transom plate
f - Transom plate
g - Port hydraulic elbow fitting
h - Steering cylinder assembly
i - Starboard hydraulic elbow fitting

57218

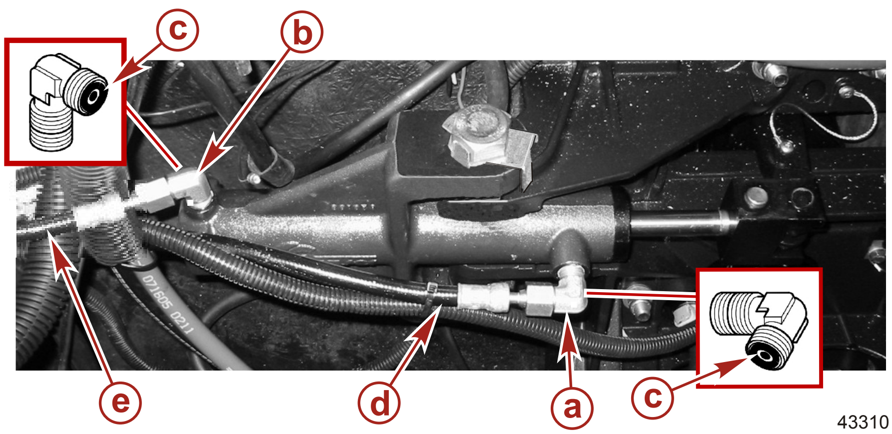
4. Connect the helm hoses to the steering cylinder as follows:

   NOTE: Do not use thread sealant on the hydraulic hose connections.

   a. Apply a small amount of clean lubricant to the hydraulic hose end O-ring area.

Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Hydraulic hose end O-ring area	92-858077K01

   b. Push the port and starboard hoses completely into the fittings.



a - Port 90° elbow fitting
b - Starboard 90° elbow fitting
c - 90° elbow fitting O-ring
d - Hose from the helm marked "L-PORT"
e - Hose from the helm marked "R-STARBOARD"

   c. Hand-tighten the hose fittings.

   d. Make the hose connections to the steering cylinder. Use a thin wrench to keep the cylinder fittings from turning while tightening the hoses securely. Do not overtighten the hose connections.

Initial Filling

IMPORTANT: Fill the power-assisted steering system exactly as explained in the following procedure to ensure that all air is bled from the system. Failure to remove the air may cause foam in the fluid during operation and discharge from the pump reservoir. Foamy fluid may cause the power-assisted steering system to become spongy, resulting in poor boat control.

1. Remove the cap and dipstick from the power-assisted steering pump.
2. Add approved fluid to bring the level up to the "FULL COLD" mark on the dipstick.

   IMPORTANT: Use only Synthetic Power Steering Fluid SAE 0W-30 in the power-assisted steering system.

Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Power steering reservoir	92-858077K01

3. Install the cap and dipstick. Tighten the cap securely.

NOTICE

Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

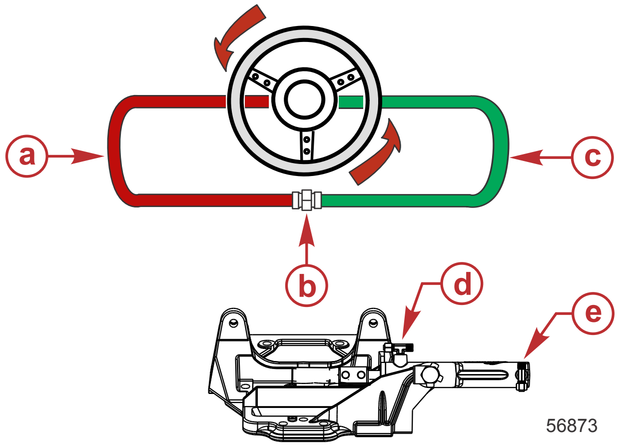
4. Start the engine and operate it for 10–15 seconds.
5. Stop the engine.
6. Remove the cap and dipstick from the reservoir.
7. Allow any foam in the pump reservoir to disperse.
8. Check the fluid level and add fluid as required to bring the level up to the "FULL COLD" mark on the dipstick. Do not overfill.
9. Install the cap and dipstick. Tighten the cap securely.
10. If the fluid is still foamy, repeat steps 1–9 until the fluid does not foam and the level remains constant.

NOTE: This initial fill procedure only fills the steering helm and the pressure and tank hoses.

Purging the Hydraulic Steering System

1. Disconnect the hydraulic hoses at the steering cylinder.
2. Connect the ends of the hoses to each other using the 892526 union fitting.

3. Check the fluid level in the steering pump reservoir.
4. Start the engine.
5. Turn the steering wheel five full turns in the counterclockwise direction.
6. Stop the engine.



a - Port steering hose
b - Union fitting 892526
c - Starboard steering hose
d - Port steering cylinder fitting
e - Starboard steering cylinder fitting

7. Remove the cap and dipstick from the reservoir.
8. Allow any foam in the pump reservoir to disperse.

   NOTE: It may take up to 20 minutes for the foam to dissipate.
9. Check the fluid level and add fluid as required to bring the level up to the "FULL COLD" mark on the dipstick. Do not overfill.
10. Repeat steps 4–9 until the reservoir is full and the fluid is clear. This should purge entrapped air from the steering system.
11. Disconnect the hose ends and remove the union fitting.
12. Connect the hydraulic hoses to the steering cylinder. Refer to **Connecting the Hydraulic Hoses to the Tilt Steering Helm**.

Checking Fluid Level After the Initial Fill

1. Start the engine and operate it at fast idle (1000–1500 RPM) until it reaches normal operating temperature. During this time, turn the steering wheel fully back and forth several times.
2. Using the steering wheel, position the sterndrive so that it is pointed straight ahead.
3. Stop the engine.
4. Remove the cap and dipstick from the reservoir.
5. Allow any foam in the pump reservoir to disperse.

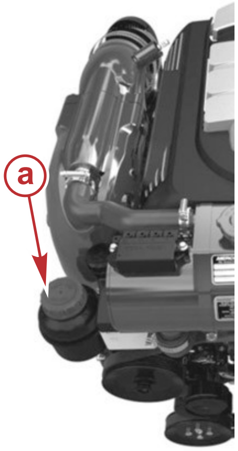
   IMPORTANT: The sterndrive must be in the straight ahead position and steering fluid must be hot for an accurate reading of the fluid level.
6. Check the fluid level and add fluid as required to bring the level up to the "FULL HOT" mark on the dipstick. Do not overfill.
7. Install the cap and dipstick. Tighten the cap securely.
8. If the fluid is still foamy, repeat steps 1–7 until the fluid does not foam and the level remains constant.

Checking Fluid Level

Engine Warm

1. Stop the engine. Center the sterndrive.

2. Remove the cap and dipstick from the power-assisted steering pump and note the fluid level.



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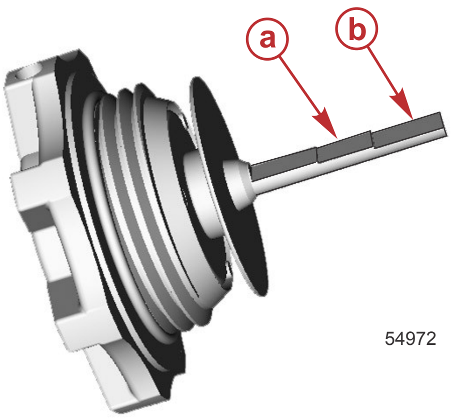
a - Fill cap/dipstick

3. The level should be between the "WARM" mark and the "COLD" mark on the dipstick.



54972

a - Warm range
b - Cold range

4. If the level is below the "COLD" mark, but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring the level up to the "WARM" mark on the dipstick. Do not overfill.

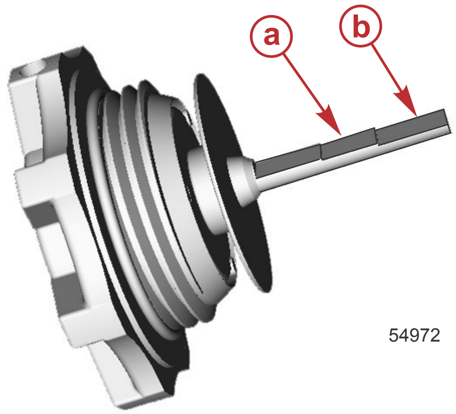
Tube Ref No.	Description	Where Used	Part No.
138	Synthetic Power Steering Fluid SAE 0W-30	Power steering reservoir	92-858077K01

5. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct it.

Engine Cold

1. With the engine stopped, center the sterndrive.
2. Remove the cap and dipstick from the power-assisted steering pump and note the fluid level.

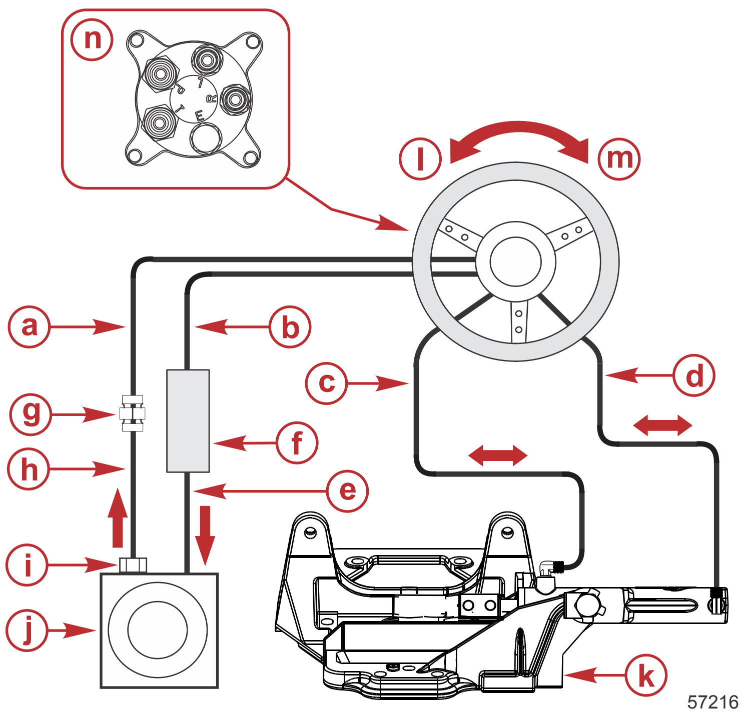
3. The level should be between the "COLD" mark and the bottom of the dipstick.



a - Warm range
b - Cold range

4. If the level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the "COLD" mark on the dipstick. Do not overfill.
5. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct it.

Steering Circuit Component Diagram



a - High-pressure hose - helm connection "P" to union fitting 892527
b - Return to cooler hose - helm connection "T"
c - Hose to steering cylinder - helm connection "L"
d - Hose to steering cylinder - helm connection "R"
e - Cooler to pump reservoir hose
f - Oil cooler
g - Union fitting 892527
h - High-pressure hose 8M2018435 - power steering pump to union fitting 892527
i - Orifice fitting (included in kit)
j - Power steering pump/reservoir
k - Steering cylinder
l - Port steering wheel direction
m - Starboard steering wheel direction
n - Helm connections

NOTE: Arrow denotes oil flow direction.

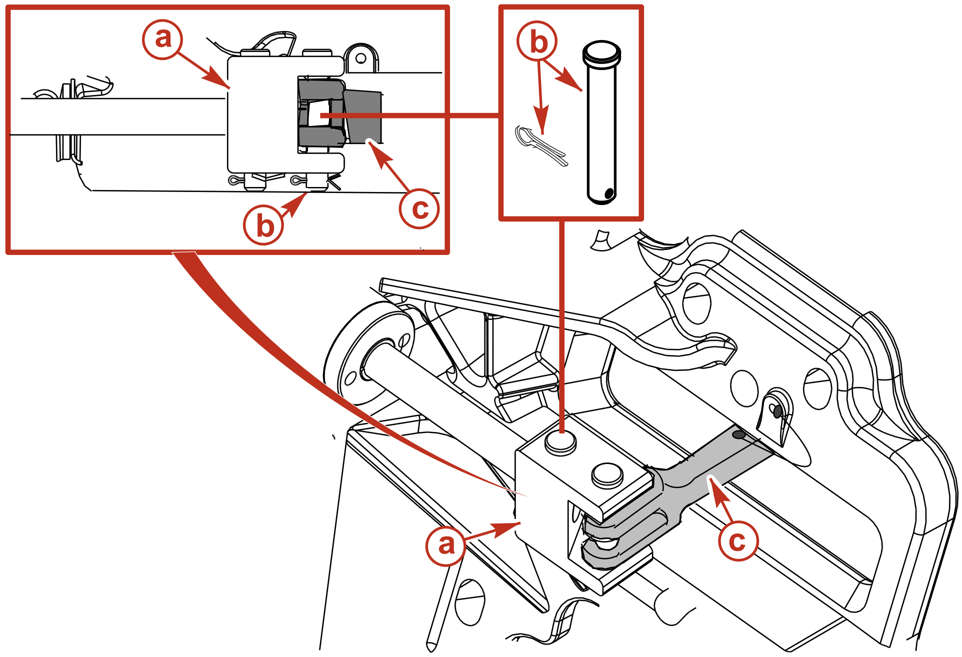
Connecting the Clevis

1. Lubricate the clevis pin and clevis using 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Clevis pin and clevis	92-802859A 1

2. Connect the clevis to the steering lever. Spread both ends of the cotter pin.

IMPORTANT: Ensure that the clevis is positioned as shown below. The angled notch in the clevis must face the rear.



10020

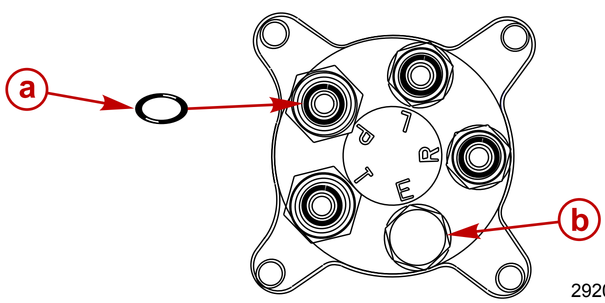
a - Clevis
b - Clevis pin and cotter pin
c - Steering lever

Connecting the Hydraulic Hoses to the Tilt Steering Helm

NOTE: *The hoses may be routed up through the steering helm opening in the dash and secured to the helm fittings prior to mounting the steering helm.*

1. Route the steering hoses through the standard backing plate on the internal side of the dashboard. Route the steering hoses through the drilled opening.
2. Remove and discard the shipping caps from ends of the four fittings on the steering helm. Ensure the O-ring seals did not lift off with the shipping caps.
3. Ensure the O-ring seals are in place on the end of the steering helm fittings.

   NOTE: *Do not use thread sealant on these hydraulic hose connections.*



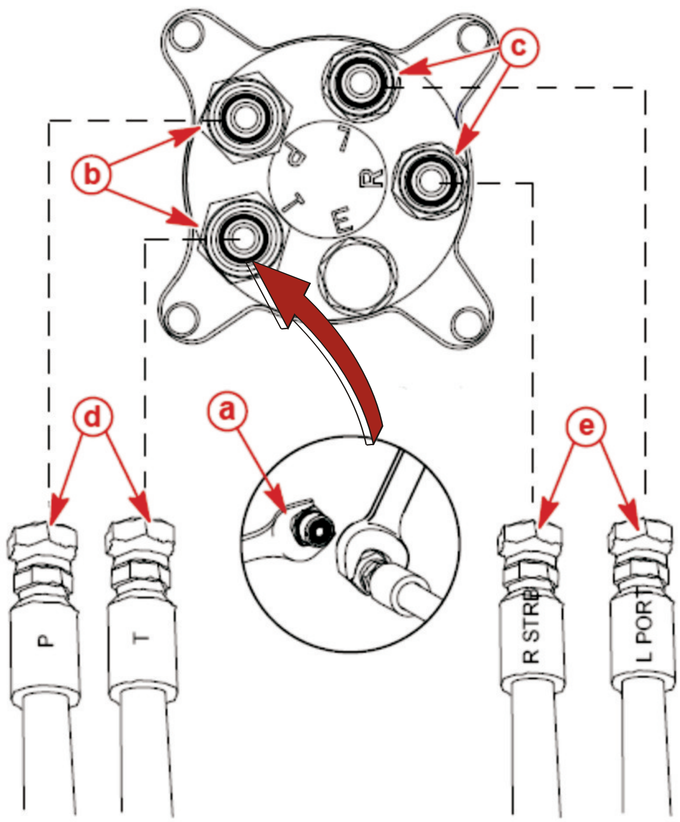
29203

a - O-ring seal (4)
b - Plug (not used)

4. Make the hose connections to the steering helm as shown. Use a thin wrench and keep the helm fittings from turning while tightening hoses to specification. Do not over-tighten the hose connections.

Helm Fitting ID Mark	Hose ID Mark	Nm	lb-in.	lb-ft
"P"	"P"	27	–	20
"T"	"T"	36	–	26.5
"R"	"R-STAR"	25	–	18
"L"	"L-PORT"	25	–	18

5. Helm and hose identification.



a - Thin wrench
b - Helm hex fitting "P & T"
c - Helm hex fitting "R & L"
d - Hydraulic hose hex fitting "P & T"
e - Hydraulic hose hex fitting "R STAR & L PORT"

Hydraulic Fluid Level

⚠ WARNING

Failure to fill the system properly can damage steering components, causing serious injury or death from loss of boat control. Completely retract the cylinder rod before checking or adding hydraulic fluid.

Setting Fluid Level

The system must be filled and purged as outlined previously before setting the fluid level.

1. Ensure that the cylinder rod is fully retracted.
2. With the filler tube screwed into the helm filler plug hole, fill the tube approximately half full of air-free hydraulic fluid.
3. Open the starboard bleeder valve and slowly turn the steering wheel clockwise until the fluid level in the filler tube is at the top of the plastic filler fitting. Continue turning steering wheel clockwise ¼ turn more, and then stop. Close the bleeder valve.
4. Remove the filler tube. The fluid level should be at the bottom of filler hole. Install the vent/fill plug.

Maintaining Fluid Level

To maintain proper fluid level, observe the following:

- Do not allow the fluid level to drop more than 6 mm (¼ in.) below the bottom of the filler hole.
- Check the fluid level periodically.

System Check

After filling, purging, and setting the fluid level the system must be checked for proper connections, possible leaks, and complete purging of air.

IMPORTANT: In the following procedure, turn the wheel with enough force to exceed the pressure relief valve in the helm. This action should not harm the helm or the system.

1. Turn the steering wheel (any wheel on a multi-steering station) very hard to port to pressurize the system.

2. While maintaining pressure, check all port fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before proceeding.
3. Turn steering wheel (any wheel on multi-steering station) very hard to starboard to pressurize system.
4. While maintaining system pressure, check all starboard fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before proceeding.

   NOTE: A significant drop in fluid level at the helm while performing the system check may indicate there is air in the system. Further filling and purging is required.
5. If no leaks are present, the system is ready for service.

Maintenance

⚠ WARNING

Proper installation and maintenance is essential for the steering system to function. Use only the recommended hardware when installing the steering system. Follow all installation specifications and recommended maintenance procedures.

IMPORTANT: Loss of hydraulic fluid or hydraulic pressure may cause the steering system to malfunction. Ensure that the steering system maintains the proper level of hydraulic fluid.

NOTE: A damaged cylinder shaft can cause seal failure and leaks. Replacing seals on a damaged cylinder assembly will not stop leaks. A damaged cylinder shaft must be replaced immediately.

Task	Interval
Check the hydraulic fluid level in the helm pump.	Two times per year, or at the first indication that the steering system is not operating correctly, whichever occurs first.
Check for leaks.	
Check mechanical linkages and connections. Tighten loose parts and replace badly worn parts.	
Check the cylinder shaft for nicks and scratches.	

Troubleshooting Guide

Important Information

When troubleshooting requires component removal from the vessel or the dismantling of steering system components, this work must be carried out by a qualified marine mechanic. The following is offered as a guide only, and neither Mercury MerCruiser nor the helm manufacturer are responsible for any consequences resulting from incorrect repairs.

Most faults occur when the installation instructions are not followed and usually show up immediately upon filling the system. The following troubleshooting chart provides the most common faults encountered and their likely cause and solution.

Sometimes when returning the steering wheel from a hard-over position, a slight resistance may be felt and a clicking noise may be heard. This should not be mistaken as a fault, as it is a completely normal situation caused by the releasing of the lockspool in the system.

⚠ WARNING

Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

Troubleshooting Chart

Symptom	Cause	Solution
1. During filling, the helm becomes completely jammed.	Blockage in the line between the helms and the cylinders.	Ensure that hoses were not kinked or pinched during installation. If so, the hose must be removed and replaced.
2. System is difficult to fill. Air escapes from the top of the helm even after the system appears full.	Air in system.	Review filling instructions.

Symptom	Cause	Solution
3. Steering is stiff and hard to turn, even when the vessel is not moving.	Steering cylinder pivot bushings are too tight or trunnion is bent, causing mechanical binding.	To test, disconnect the clevis from the steering lever and turn the steering wheel. If it does not turn easily, repair trunnion or loosen pivot bushings. Note that excessively loose connections to a steering cylinder or steering lever can also cause mechanical binding.
	Restrictions in hoses.	Find the restrictions and correct them.
	Air in hydraulic fluid.	Refer to the filling and purging instructions.
	The wrong hydraulic fluid has been used to fill steering system.	Drain the system and fill with approved hydraulic fluid.
4. The helm unit is bumpy and requires too many turns from port hard-over to starboard hard-over.	Dirt in inlet check valve of helm pump.	Replace the helm unit.
5. Steering is easy to turn while stationary, but becomes hard to turn when the vessel is underway.	Steering wheel is too small.	Fit a larger wheel, if possible. Refer to the installation instructions. If the problem cannot be rectified by changing the steering wheel, proceed with next cause and solution or consult the factory.
	Incorrect setting of trim tabs, if equipped.	Adjust tabs, if equipped.
6. Drive drifts to port or starboard while vessel is underway, even when the wheel is not being turned.	Dirt in check valves.	Remove the check valve plugs. These are the larger plugs on either side on rear of the helm. Clean the ball seats and balls, and reassemble. *NOTE: Be prepared to lose a certain amount of hydraulic fluid during this procedure. Have a small receptacle available. Refill the system when the check balls have been reassembled.*
7. Turning one steering wheel causes the second wheel to rotate.		
8. Seals will sometimes leak if steering system is not vented at uppermost helm.	The helm has a field-replaceable wheel shaft seal that can readily be replaced by removing the steering wheel and seal cover held in place by three small screws. Quad ring No. 210 is supplied in Seastar® Helm Seal Kit HS5151.	
9. Vent/fill plug leaks when turning to port.	Cylinder rod extended during filling.	Ensure that the cylinder rod is retracted during filling.

Notes:

Transmissions

Section 9A - ZF/45C, 45IV, 63A, 65IV Transmissions

Table of Contents

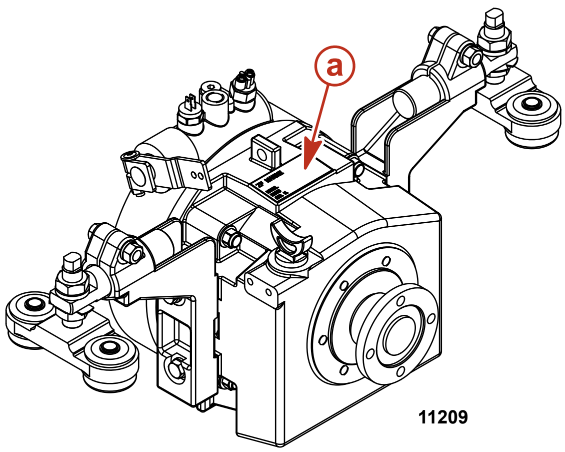
9
A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 703 Fast Cleaner	Filter element	Obtain Locally
9	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads	92-809822
25	Liquid Neoprene	Neutral start switch and temperature switch connections	92- 25711 3
		Exposed electrical terminals and connections	
28	Dexron III Automatic	ZF/45IV transmissions	Obtain Locally
		Breather valve	
		ZF/Hurth 45C and 63 transmissions	
		Transmission	
		63A and 63IV transmissions	
		Filter element O-rings	
91	Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	8M0071842

Identification

The transmission identification plate is located on the top rear of the transmission.



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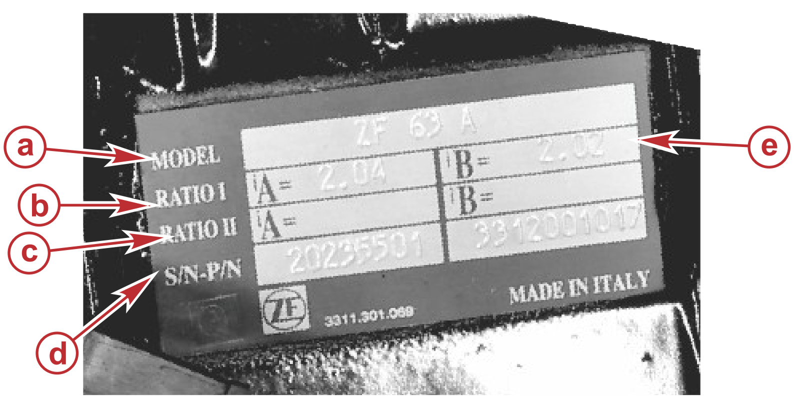
ZF Marine 45C

a - Identification plate



59763

Typical ZF Marine Transmission Identification Plate

a - Transmission type

b - Gear ratio with shifting position "A"

c - Gear ratio II with shifting position "A"

d - Serial number

e - Gear ratio with shifting position "B"

Specifications

Operating Specifications

Description	Specification	
	Model 45C/45IV	Model 63A/63
Shifting pressure	1400–2000 kPa (203–290 psi)	2150–2350 kPa (312–341 psi) at 2000 RPM
Operating temperature	54–79° C (130–175° F)	

Description		Specification	
		Model 45C/45IV	Model 63A/63
Temperature switch settings ± 5.6° C (10° F)	Open	87.8° C (190° F)	
	Closed	110° C (230° F)	

Ratios and Part Numbers

The ratio is shown on the identification plate. The ratio may be rounded off in some cases.

ZF Marine Model	Ratio	Mercury Marine Part Number
45C	1.0:1	864336A03
45IV	1.46:1	Not available
63A	1.5:1	863744T2
	2.1:1	863744T3
	2.5:1	863744T4
63IV	1.55:1	863745T2
	2.0:1	863745T3
	2.5:1	863745T4

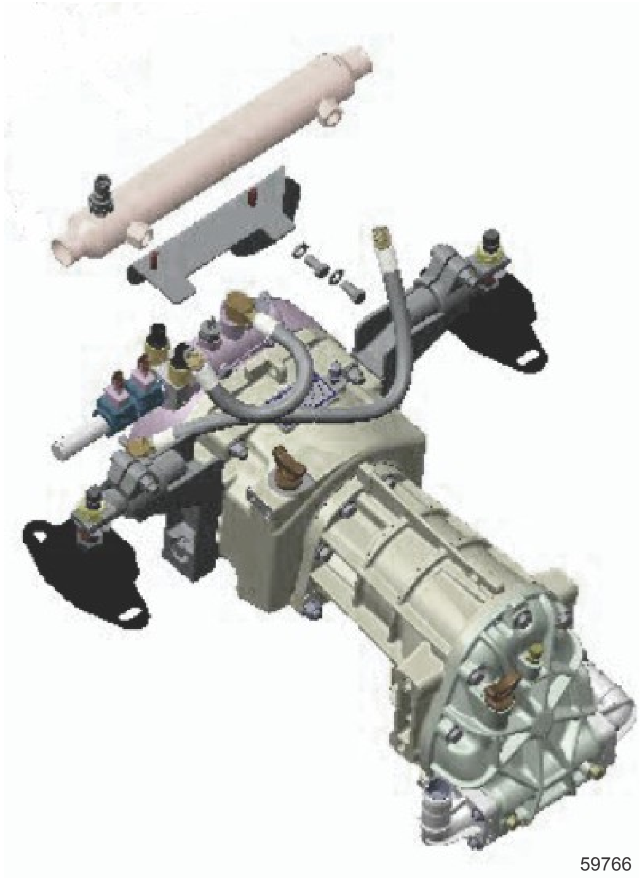
Fluid Specifications

Listed capacities are approximate. Always use the dipstick to determine the exact fluid level.

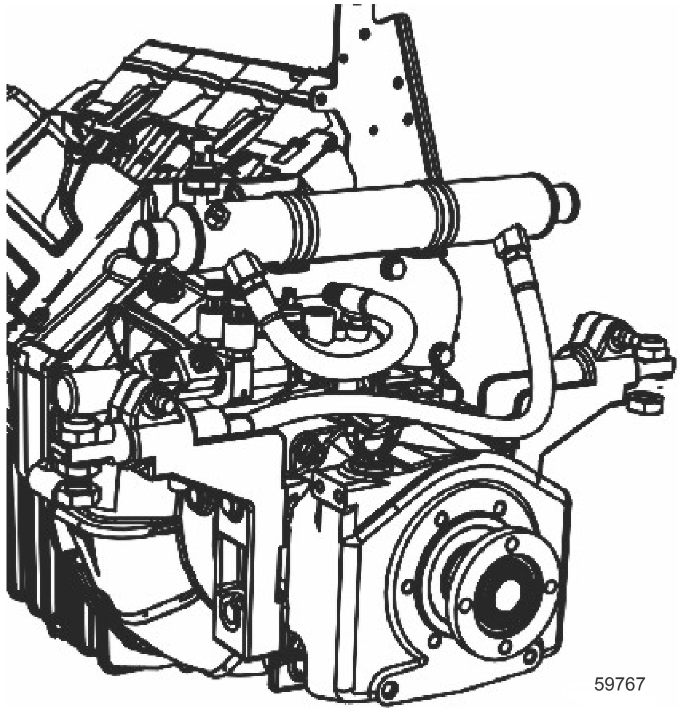
Model	Capacity	Fluid Type
45IV Reversing unit	2.4 L (2.5 US qt)	Dexron® IV Automatic Transmission Fluid
45IV V-Drive unit	1.0 L (1.0 US qt)	Dexron® III Automatic Transmission Fluid
63A	4.5 L (4.75 US qt)	Dexron® III Automatic Transmission Fluid
63IV	4.75 L (5.0 US qt)	

Transmission and Related Parts

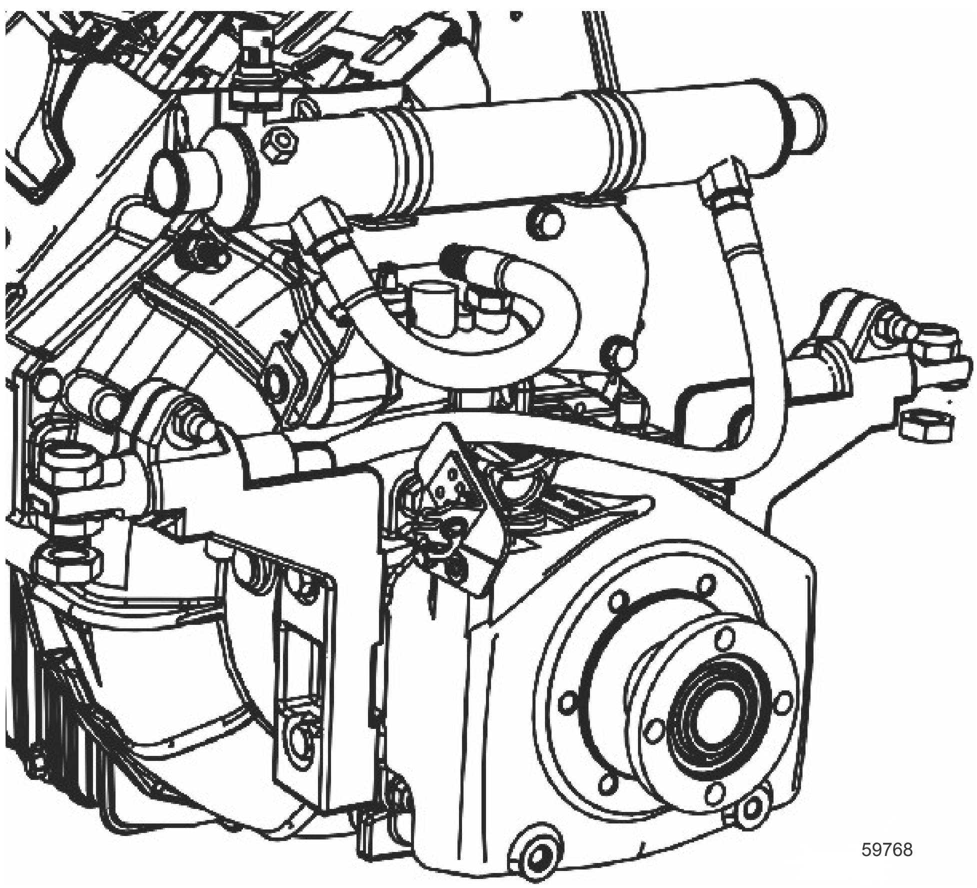
45IV



45C DTS and 45C Mechanical

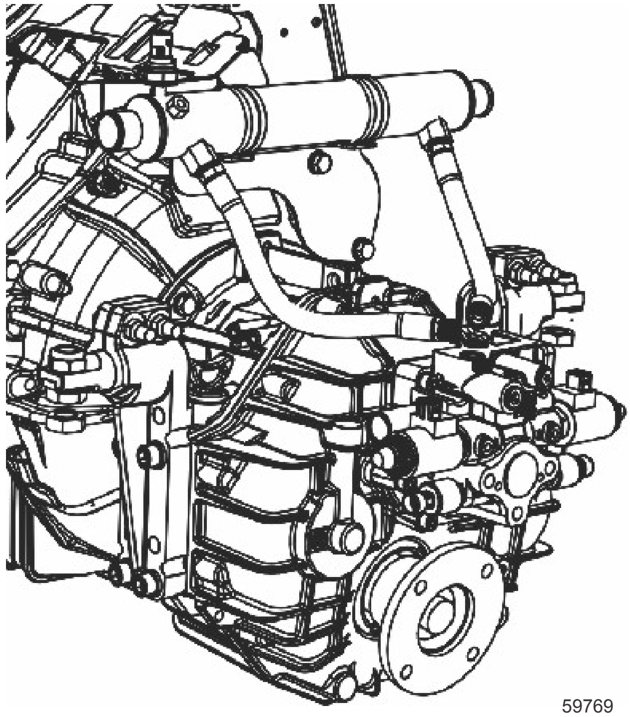


45C DTS



45C Mechanical

63A DTS



63A DTS

Important Information

Engine

All current production engines are left-hand rotation. Engine rotation is described as observed from the rear of the engine (transmission end) looking forward (water pump end). The installed angle of the transmission and the engine should not exceed 12° of the waterline.

Propeller

Propeller rotation is described as observed from the stern looking forward. The term left-hand (LH) refers to counterclockwise rotation. The term right-hand (RH) refers to clockwise rotation. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise.

Precautions

The transmission gear ratio is marked on the transmission identification plate, which is located on the top of the transmission. Transmission rotation is described as viewed from the rear of transmission.

- Do not start or crank the engine without fluid in the transmission.
- Except in an emergency, never shift the transmission at engine speeds above 1000 RPM.
- Freewheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission. However, freewheeling should be avoided above trolling speed. Ensure that the transmission fluid is at the proper level before freewheeling the propeller.
- Always replace the fluid cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage the transmission.
- Always use the specified fluid cooler, hoses, and fittings.

45C and 63 In-Line Transmissions

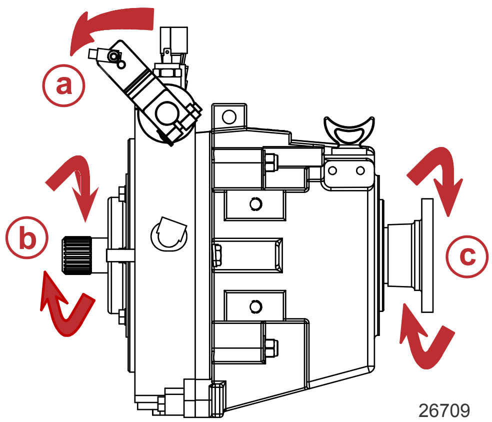
Transmission and Propeller Rotation

On MIE engines equipped with in-line transmissions having 1:1 gear ratio, the transmission output shaft rotation is the same as the engine rotation with the transmission in forward gear. Engine rotation is LH (CCW), so a LH propeller is required.

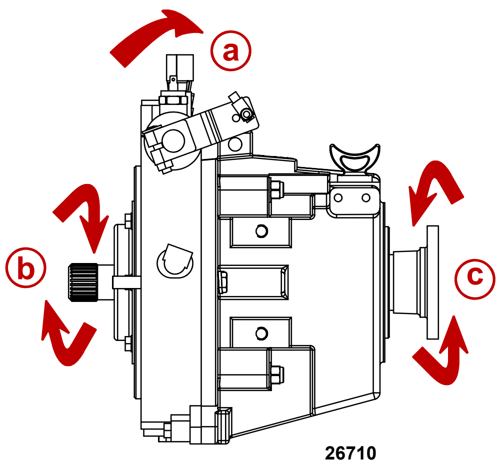
***NOTE:** 45C transmissions are not full power reversing.*

⚠ CAUTION

Using the reverse gear to propel the boat forward will damage the transmission. Install the shift cable so shifting the helm control forward engages the transmission's forward gear. Mercury Marine does not cover improperly installed components under warranty.



Forward
- a - Direction of shift lever engagement (toward flywheel)
- b - Engine/transmission input shaft shaft rotation direction (LH)
- c - Transmission output/propeller shaft rotation direction (LH)



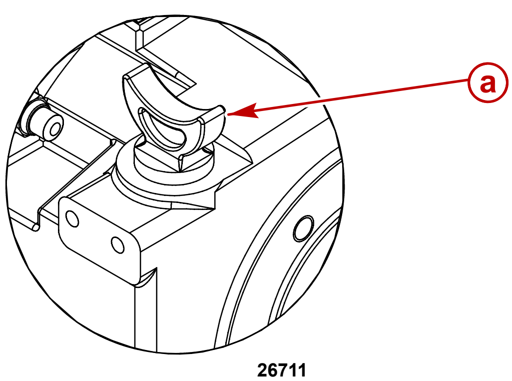
Reverse
- a - Direction of shift lever engagement (away from flywheel)
- b - Engine/transmission input shaft shaft rotation direction (LH)
- c - Transmission output/propeller shaft rotation direction (RH)

Transmission Fluid

Checking

IMPORTANT: Always check the fluid level before operating the transmission.

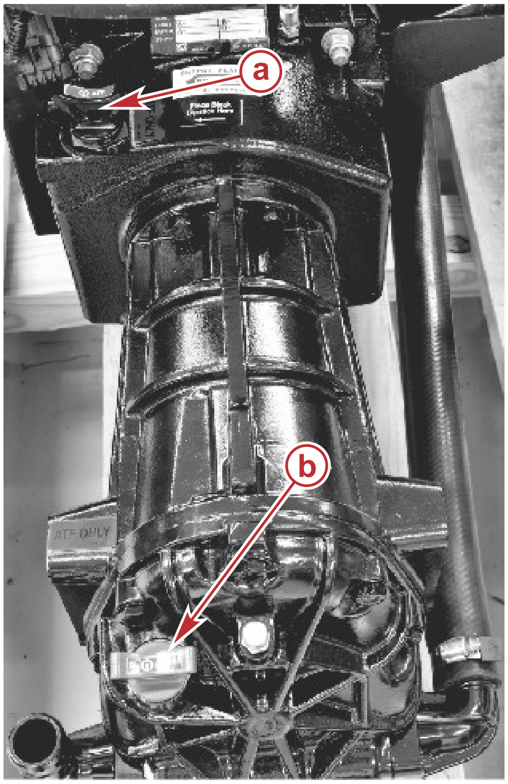
1. Loosen the dipstick by turning the T-handle counterclockwise.



- a - Dipstick handle

2. Remove the dipstick and wipe it clean.
   IMPORTANT: The dipstick requires an O-ring. Ensure that the O-ring remains in place.
3. Insert the dipstick into the transmission. Do not screw it in.
4. Remove the dipstick and check the fluid level.

5. If the fluid is below the full mark, add the specified fluid through the dipstick tube. Do not overfill. Install the dipstick with the cap seated.



60352

45IV

a - Black dipstick

b - Red dipstick

IMPORTANT: For 45IV models, the red dipstick is to be installed in the reversing unit and the black dipstick is to be installed in the V-drive unit.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	ZF/45IV transmissions	Obtain Locally

Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

Change the transmission fluid when servicing the transmission.

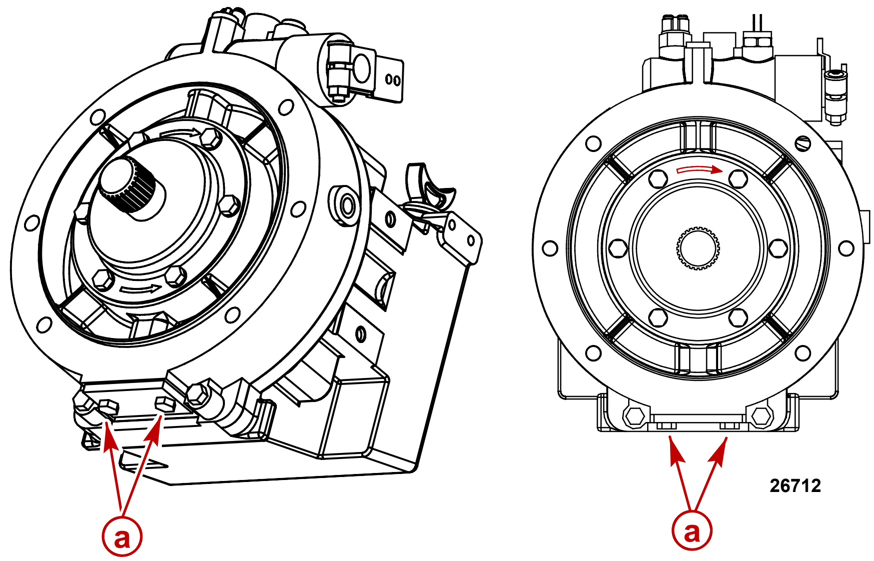
The transmission fluid change and filter service point is located on the bottom side of the transmission toward the engine flywheel. The transmission has to be raised high enough that the filter service point is accessible.

1. Remove the breather valve, fluid dipstick, and O-ring.
2. Clean the breather valve, allow it to dry, and coat it with automatic transmission fluid.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron® III Automatic	Breather valve	Obtain Locally

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.



a - Filter plate bolt and washer

3. Place a suitable container under the filter plate to catch the fluid.
4. Remove the two bolts, two washers, filter plate, seal, and filter element.
5. Completely drain the fluid from the transmission.
6. Check the fluid for:
   - **Metal particles**: A few small particles are normal. Larger metal chips are an early sign of transmission failure, which may mean the transmission should be disassembled and inspected for internal damage.
   - **Rubber particles**: Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.
7. Inspect the seal for wear and replace it if necessary.
8. Clean the filter element with Loctite 703 Fast Cleaner or equivalent.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 703 Fast Cleaner	Filter element	Obtain Locally

9. Install the filter element, seal, and filter plate.
10. Install the bolts and washers. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Filter plate bolt	18	159	–

11. Apply Loctite 574 Surface Seal to the threads of the breather valve and install the valve into the transmission. Hand-tighten.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 574 Surface Seal	Breather valve threads	Obtain Locally

12. Fill the transmission with the specified fluid through the dipstick hole. Refer to **Specifications**.
13. Install the dipstick and O-ring.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	ZF/45IV transmissions	Obtain Locally

Filling

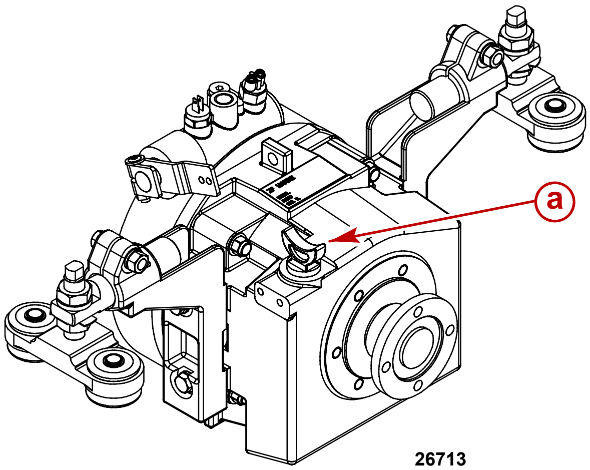
IMPORTANT: Use only the specified transmission fluid.

IMPORTANT: The fluid level is checked with the dipstick inserted—not screwed into the housing.

1. Remove the dipstick.
2. Fill the transmission with fluid through the dipstick hole to bring the level up to the full mark.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	ZF/Hurth 45C and 63 transmissions	Obtain Locally

3. Replace the dipstick.



a - Dipstick

IMPORTANT: Do not start or crank the engine without fluid in the transmission.
IMPORTANT: To accurately check the fluid level, operate the engine at 1500 RPM for two minutes immediately prior to checking the fluid level.

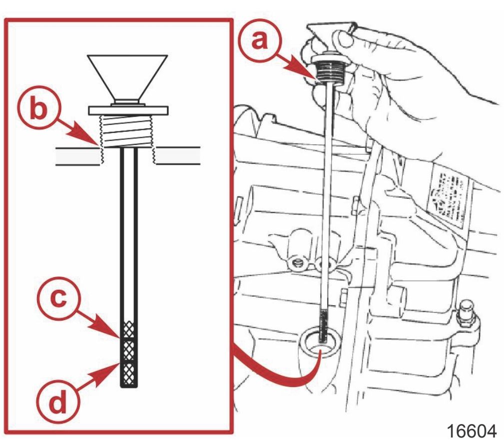
4. Start the engine and operate it at 1500 RPM for two minutes to fill all hydraulic circuits.
5. Stop the engine and quickly check the fluid level. Add transmission fluid, if necessary, to bring the level up to the full mark on the dipstick.

63A Down-Angle and 63IV V-Drive Transmissions

Transmission Fluid

Checking

1. Remove the dipstick.
   IMPORTANT: When checking the fluid level, rest the dipstick on top of the threaded housing hole. Do not screw the dipstick into the threaded housing hole.
2. Check the fluid level as indicated on the dipstick with the dipstick resting on top of the threaded hole.
   NOTE: *The fluid level may be somewhat over the maximum mark, as some of the fluid from the transmission fluid cooler and hoses may have drained back into the transmission.*
3. If the fluid level is low, add transmission fluid to bring the level up to the maximum mark on the dipstick.



a - Dipstick
b - Threaded hole
c - Maximum fluid level
d - Minimum fluid level

Tube Ref No.	Description	Where Used	Part No.
28	Dexron® III Automatic	Transmission	Obtain Locally

IMPORTANT: To accurately check the fluid level, the engine must be operated at 1500 RPM for two minutes immediately prior to checking the level.

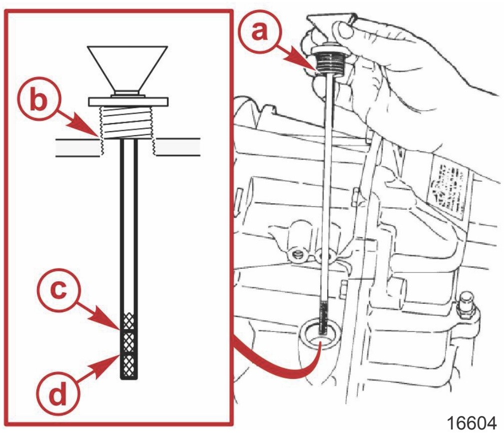
4. Start the engine and operate at 1500 RPM for two minutes to fill all the hydraulic circuits.
5. Stop the engine and immediately check the fluid level with the dipstick resting on the top of the threaded hole.
6. If the fluid level is low, add transmission fluid to bring the level up to the maximum mark on the dipstick.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron® III Automatic	Transmission	Obtain Locally

7. Install the dipstick.

Filling

1. If necessary, add the specified automatic transmission fluid through the dipstick threaded hole to bring the level up to the maximum mark on the dipstick.
   IMPORTANT: Use only the specified automatic transmission fluid.



a - Dipstick
b - Threaded hole
c - Maximum fluid level
d - Minimum fluid level

Tube Ref No.	Description	Where Used	Part No.
28	Dexron® III Automatic	63A and 63IV transmissions	Obtain Locally

2. Install the dipstick.
   IMPORTANT: To accurately check the fluid level, the engine must be operated at 1500 RPM for two minutes immediately prior to checking the level.
3. Refer to **Checking** and check the fluid level.

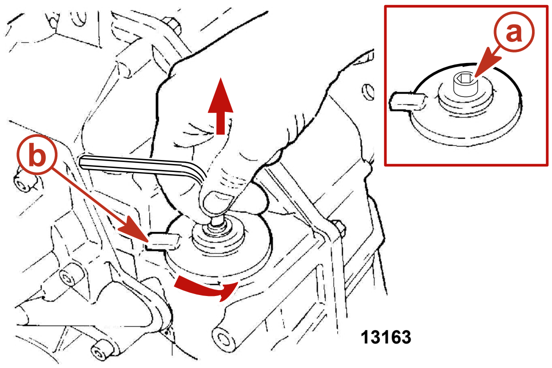
Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

NOTICE
Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

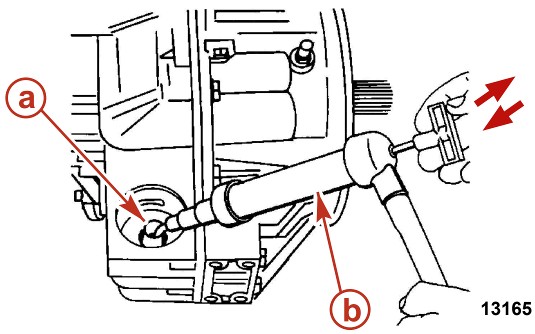
1. Clean the exterior of the transmission around the fluid filter assembly.

2. Use a 6-mm Allen wrench to remove the fluid filter assembly by turning the assembly nut counterclockwise and pulling at the same time.



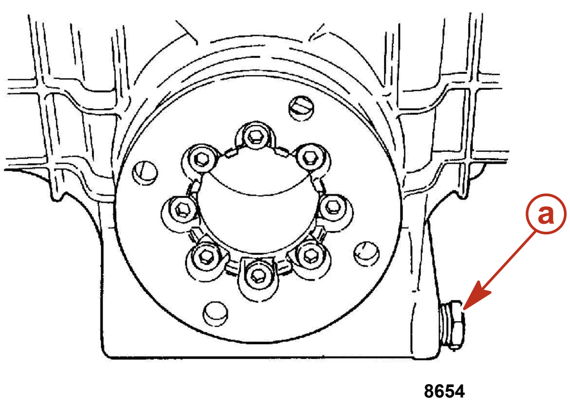
a - Fluid filter assembly
b - Assembly nut

3. **On 63A transmissions:**
   a. Push the hose of a suction pump through the suction pipe and down to the bottom of the housing.
   b. Pump the fluid from the housing into a suitable container. Dispose of the fluid according to local regulations.



a - Suction pipe
b - Suction pump

4. **On 63IV transmissions:**
   a. Remove the drain plug from the transmission and allow the fluid to drain.

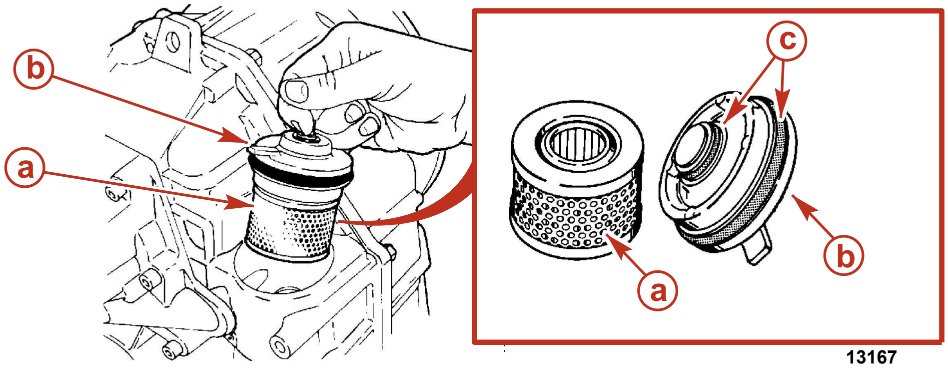


Typical 63IV transmission
a - Drain plug

   b. Install and securely tighten the drain plug after the transmission is drained.
5. Check the fluid for:
   - **Metal particles**: A few small particles are normal. Larger metal chips are an early sign of transmission failure, which may mean the transmission should be disassembled and inspected for internal damage.
   - **Rubber particles**: Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.
6. Remove and discard the filter element and O-rings.
7. Coat the new O-rings with new transmission fluid.

Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	Filter element O-rings	Obtain Locally

8. Install the new O-rings and filter element.

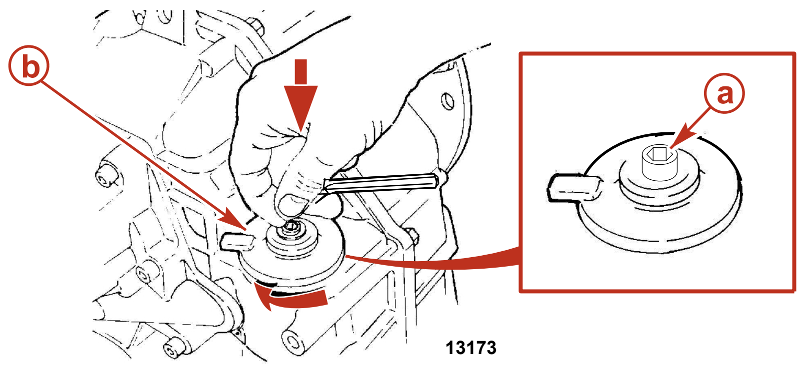


a - Filter element
b - Cover
c - O-rings

NOTICE

Improper installation of the transmission fluid filter assembly may cause the fluid to foam or leak out, resulting in decreased efficiency and damage to the transmission. Properly seat the transmission fluid filter during installation.

9. Install the fluid filter assembly in the transmission cavity by turning it clockwise and pushing at the same time.
10. Using a 6-mm Allen wrench, turn the filter assembly nut clockwise to tighten. Tighten the filter assembly nut to specification.



a - Fluid filter assembly
b - Assembly nut

Description	Nm	lb-in.	lb-ft
Filter assembly nut	5-8	48-72	

11. Fill the transmission to the proper level with the specified fluid. Refer to **Filling**.

Transmission Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

NOTICE

Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required.

NOTE: The following procedure describes the removal of the transmission without removing the engine. If the engine must be removed, refer to ***Section 2C****.*

1. Disconnect the battery cables from the battery. Be certain to disconnect the negative (–) cable first.
2. If required, drain the transmission fluid. Dispose of the fluid according to local regulations.
3. Disconnect the water hoses from the transmission fluid cooler.

   NOTE: The fluid cooler should be removed with the transmission.
4. On non-DTS transmissions:

a. Disconnect the shift cable from the transmission.

b. Disconnect the wires from the neutral start switch.

IMPORTANT: Make note of how the transmission harness is routed and connected for future reference.

5. On DTS transmissions, disconnect the transmission harness from the shift solenoids and pressure transducers.
6. Disconnect the wires from the transmission fluid temperature switch.
7. Loosen the trunnion clamping fasteners on the engine mounts (port and starboard).
8. Remove the nuts and bolts from the coupling, and separate the propeller shaft coupler from the transmission output flange.
9. Remove the four rear-engine-mount-to-engine-bed fasteners and hardware.
10. Support the rear of the engine using a suitable hoist, or put wooden blocks under the flywheel housing.
11. Support the transmission with a hoist or other suitable means through the lifting eye on the transmission case.
12. Remove the port and starboard rear mount brackets (with base and trunnion) from the transmission.

NOTICE

The weight of an unsupported transmission can bend the transmission input shaft or damage the engine coupler. Do not permit the splines of the input shaft or coupler to support the weight of the transmission. Completely support the transmission during removal, and until the attaching hardware is secured during installation.

13. Remove all hardware attaching the transmission to the flywheel housing.
14. Pull the transmission straight back and away from the engine to completely disengage the splines on the input shaft.
15. Carefully lift out the transmission.

Transmission Installation

1. Check the transmission output shaft rolling torque. Refer to the manufacturer's service manual for procedures, specifications, and corrective actions.
2. Apply Engine Coupler Spline Grease to the transmission input shaft splines and the engine drive plate splines.

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	8M0071842

3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Push the transmission into place and secure it to the flywheel housing. Tighten the fasteners to the specified torque.

Description	Nm	lb-in.	lb-ft
Transmission-to-flywheel-housing fasteners	61	–	45

5. Disconnect the hoist.
6. Attach the rear mount brackets to the transmission. Tighten the fasteners and hardware to the specified torque.

Description	Nm	lb-in.	lb-ft
Rear mount bracket fasteners	61	–	45

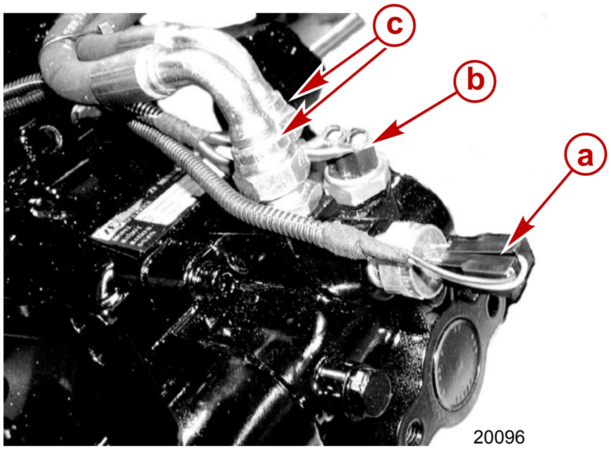
7. Using a hoist, raise the engine and transmission to remove blocks, if employed.
8. Lower the assembly to the engine bed.
9. Relieve hoist tension.
10. Securely tighten the four rear-engine-mount-to-bed fasteners and hardware.
11. Install the transmission fluid cooler hoses. Tighten the hose fittings at the transmission housing to the specified torque.

Description	Nm	lb-in.	lb-ft
Transmission fluid cooler hose fitting	34	–	25

12. For non-DTS transmissions:

    a. Connect the neutral start switch and fluid temperature switch wiring connectors.

b. Coat the neutral start switch and temperature switch connections with Liquid Neoprene.



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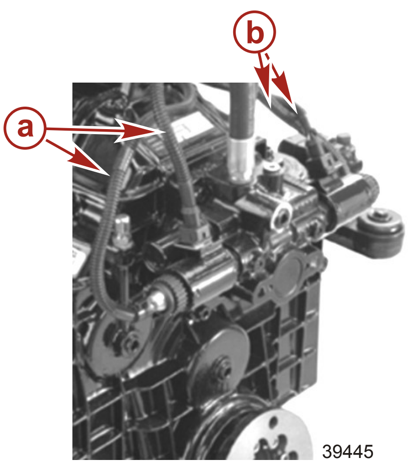
a - Fluid temperature switch
b - Neutral start switch
c - Transmission fluid cooler hose fitting

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Neutral start switch and temperature switch connections	92- 25711 3

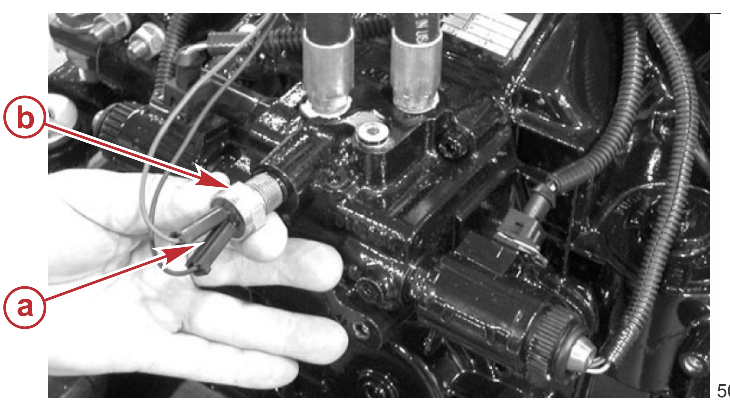
13. For DTS transmissions:
    a. Connect the transmission harness to the shift solenoids and pressure transducers. Connect and route the transmission harness as it was prior to removal.



39445

a - Harness connections for "A" side shift solenoid and pressure transducer
b - Harness connections for "B" side shift solenoid and pressure transducer

    b. Connect the transmission fluid temperature switch wiring connector.



50204

a - Wire connections
b - Fluid temperature switch

14. Check engine final alignment. Refer to **Section 2B** - **Final Engine Alignment**.
    IMPORTANT: All coupler bolts must be Metric Grade 10.9 (SAE Grade 8) or better, with a shoulder—grip length long enough to pass through the face mating plane of couplers.
15. After final engine and coupler alignment has been properly set—with the boat in the water, connect the propeller shaft coupler to the transmission output flange with bolts, lockwashers, and nuts. Tighten the bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller shaft coupler to transmission output flange bolt	68	–	50.2

IMPORTANT: Be certain to tighten the trunnion clamping fasteners on the engine mounts that were loosened during removal.

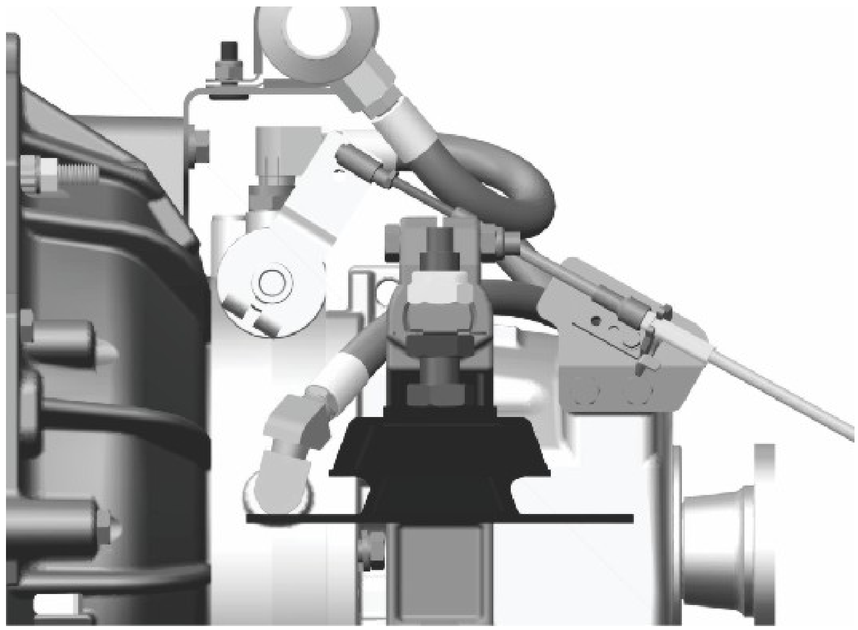
16. Tighten the trunnion clamping fasteners on the engine mounts that were loosened during removal to the specified torque.

Description	Nm	lb-in.	lb-ft
Trunnion clamping fasteners on the engine mounts	68	–	50.2

17. Refill the transmission with the specified fluid. Refer to **Filling**.
18. Connect and adjust the shift cables. Refer to **Shift Cable Installation and Adjustment**.
19. Connect the battery cables. Be certain to connect the negative (–) cable last.
20. Check for leaks and check the fluid level after the first engine start-up.

Shift Cable Installation and Adjustment

Shift Cable Installation



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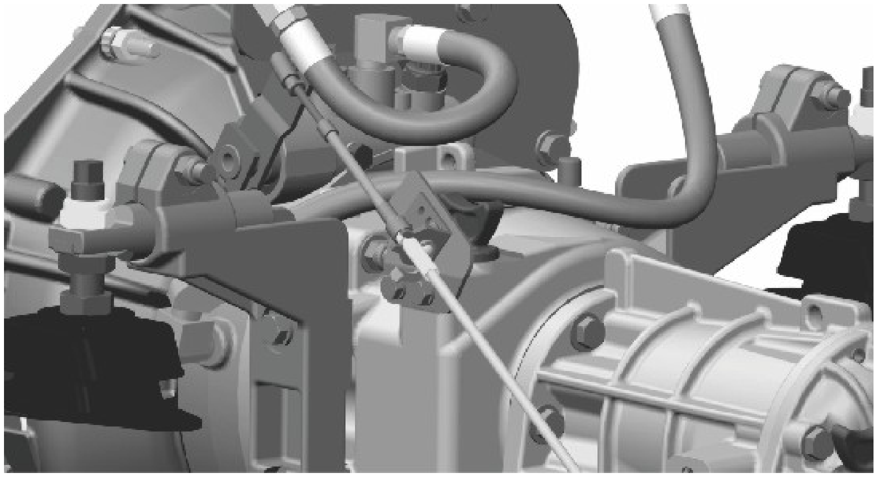
45C



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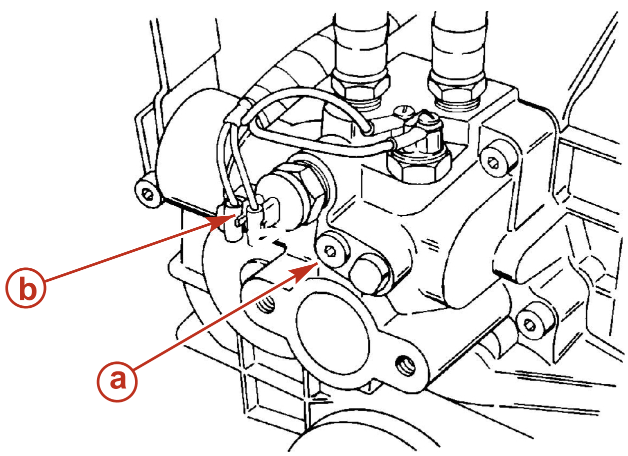
45IV

If factory cables are used, no adjustment should be needed. If other cables are used, then the manufacturer's specifications should be followed.

IMPORTANT: If not installed correctly, the customer will not be able to shift the transmission completely, or the cable will not be evenly loaded between forward and reverse, and the neutral position on the transmission will not match the location on the control box.

Pressure Test

1. Remove the pressure service port plug from port A.
2. Connect a suitable pressure gauge to port A.
3. Disconnect both wires and remove the fluid temperature switch from port B.
4. Install a thermocouple in port B.



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Typical ZF Marine transmission

a - Pressure service port plug—port A

b - Fluid temperature switch—port B

5. Operate the boat with a normal load onboard.
6. Ensure that the fluid temperature and shifting pressure are as specified.

Description	Specification	
Operating temperature	54–79° C (130–175° F)	
Shifting pressure	Position A	2150–2350 kPa (312–341 psi) at 2000 RPM
	Position B	

7. Repair or replace the transmission if measurements are not as specified.
8. Remove the pressure gauge and thermocouple.
9. Apply Loctite 567 PST Pipe Sealant to the fluid temperature switch threads.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads	92-809822

10. Install and securely tighten the fluid temperature switch.

    NOTE: The pressure service port is a metric face-seal design and requires special adapters.

Model	Pressure Service Port Special Adapter
63A and 63IV	Parker Hannifin M10-1/8F8OHG
45C	Parker Hannifin M14-1/8F8OHG

11. Install the pressure service port plug and tighten securely.
12. Connect the two fluid temperature switch wires. Apply Liquid Neoprene to the exposed electrical terminals and connections.

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Exposed electrical terminals and connections	92- 25711 3

13. Upon first operation, check for leaks.

Color Diagrams

Section 10A - Color Diagrams

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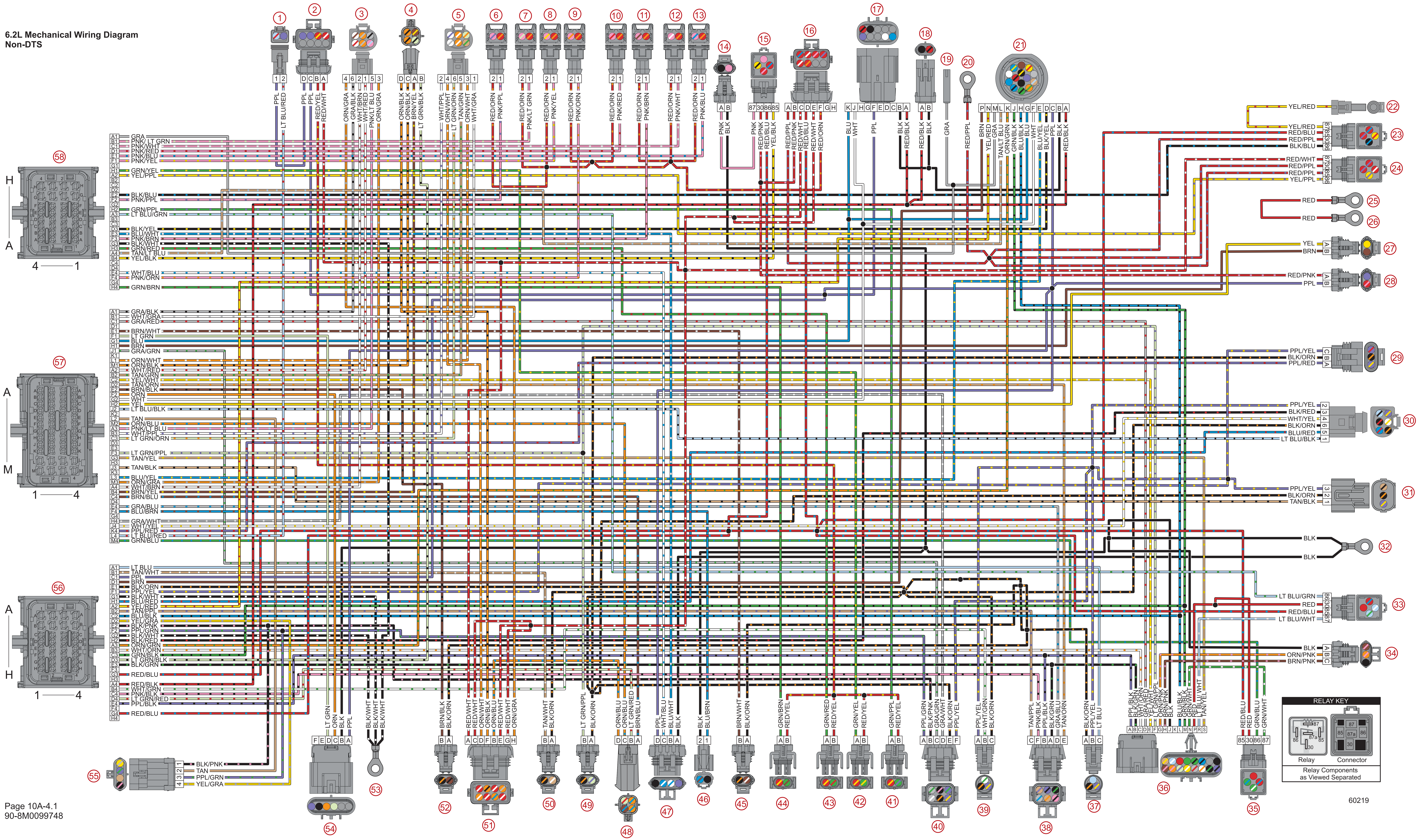
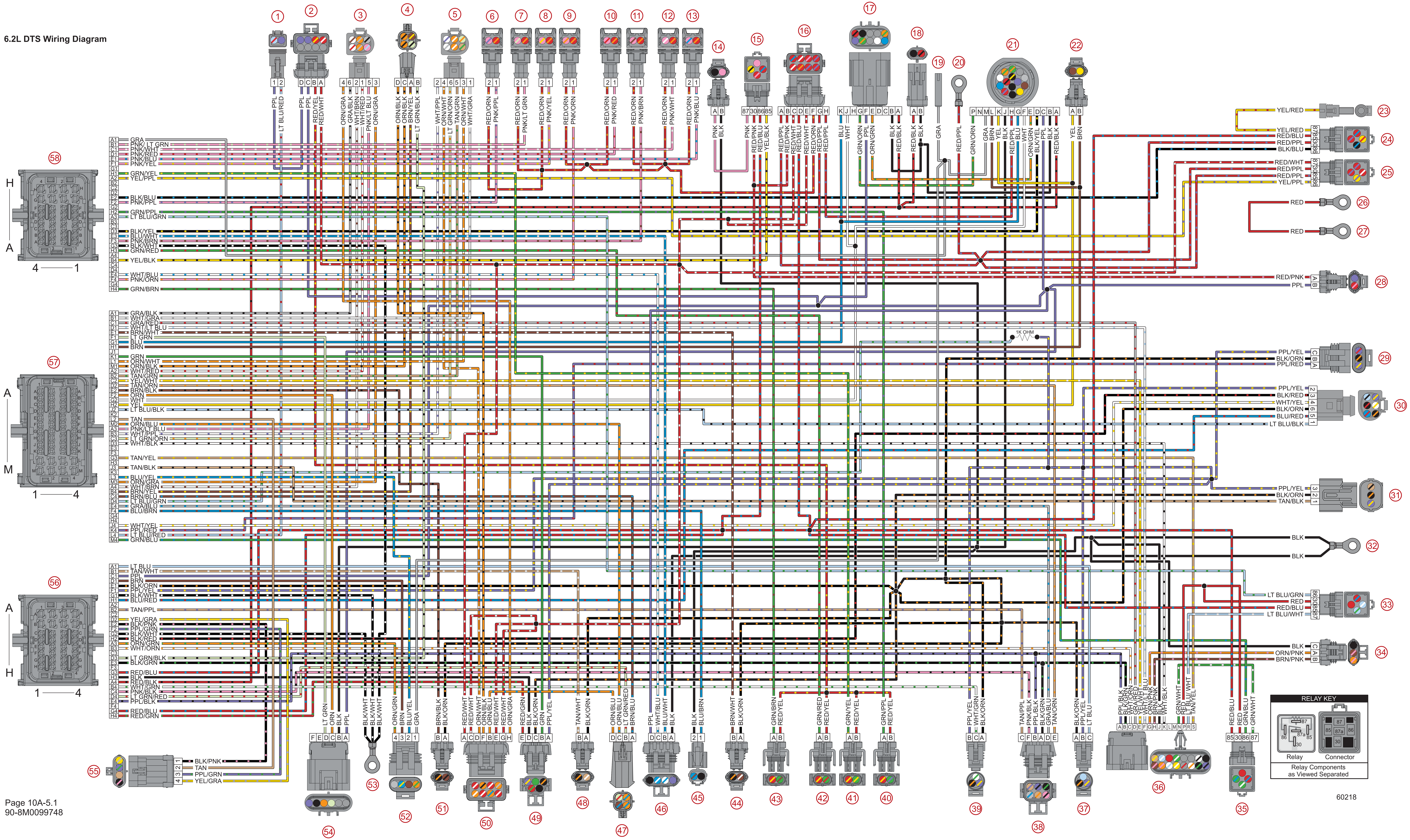
2 - OBD-M fuses—2-amp fuse across C and D, 20-amp fuse across A and B
3 - Starboard precatalyst wideband O2 sensor
4 - Starboard postcatalyst O2 sensor
5 - Port precatalyst wideband O2 sensor
6 - Fuel injector 6
7 - Fuel injector 8
8 - Fuel injector 4
9 - Fuel injector 3
10 - Fuel injector 2
11 - Fuel injector 1
12 - Fuel injector 7
13 - Fuel injector 5
14 - Fuel pump
15 - Fuel pump relay
16 - Engine fuses—20-amp fuse across A and B, C and D, and E and F—15-amp fuse across G and H, and in spare
17 - CAN P and CAN H resistors
18 - PCM clean power
19 - Analog tachometer signal
20 - To the 50-amp circuit breaker
21 - 14-pin connector
22 - Starter
23 - Starter relay
24 - Main relay
25 - Starter fuse
26 - Starter fuse to the 50-amp circuit breaker
27 - CAN resistor
28 - Alternator excite circuit
29 - Camshaft position sensor
30 - Electronic throttle control (ETC)
31 - Crankshaft position sensor
32 - Chassis ground
33 - Trim up relay
34 - MerCathode
35 - Trim down relay
36 - Transom harness
37 - Digital oil pressure
38 - Paddle wheel and fuel tanks
39 - Digital sea pump pressure
40 - Throttle demand
41 - Coil pack 3
42 - Coil pack 4
43 - Coil pack 2
44 - Coil pack 1
45 - Port water exhaust temperature
46 - Oil lube
47 - Diagnostic
48 - Port postcatalyst O2 sensor
49 - Neutral switch
50 - Electronic shift control (ESC)
51 - O2 sensor fuses—10-amp fuses in all
52 - Starboard exhaust temperature sensor
53 - PCM ground
54 - J1939 diagnostic
55 - Temperature and manifold absolute pressure (TMAP)
56 - PCM C
57 - PCM B
58 - PCM A

6.2L Mechanical Wiring Diagram
Non-DTS



6.2L DTS Wiring Diagram



6.2L DTS Wiring Diagram

1 - MIL light
2 - OBD-M fuses—2-amp fuse across C and D, 20-amp fuse across A and B
3 - Starboard precatalyst wideband O2 sensor
4 - Starboard postcatalyst O2 sensor
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6 - Fuel injector 6
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13 - Fuel injector 5
14 - Fuel pump
15 - Fuel pump relay
16 - Engine fuses—20-amp fuse across A and B, C and D, and E and F—15-amp fuse across G and H, and in spare
17 - CAN P and CAN H resistors
18 - PCM clean power
19 - Analog tachometer signal
20 - To the 50-amp circuit breaker
21 - 14-pin connector
22 - CAN 2 trim resistor
23 - Starter solenoid
24 - Starter relay
25 - Main power relay
26 - Starter fuse
27 - Starter fuse to the 50-amp circuit breaker
28 - Alternator excite circuit
29 - Camshaft position sensor
30 - Electronic throttle control (ETC)
31 - Crankshaft position sensor
32 - Chassis ground
33 - Trim up relay
34 - MerCathode
35 - Trim down relay
36 - Transom harness
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39 - Digital sea pump pressure
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41 - Coil pack 4
42 - Coil pack 2
43 - Coil pack 1
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45 - Oil lube
46 - Diagnostic
47 - Port postcatalyst O2 sensor
48 - Digital coolant sensor
49 - Electronic shift control (ESC)
50 - O2 sensor fuses—10-amp fuses in all
51 - Starboard exhaust temperature sensor
52 - Analog gauges
53 - PCM ground
54 - J1939 diagnostic
55 - Temperature and manifold absolute pressure (TMAP)
56 - PCM C
57 - PCM B
58 - PCM A

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

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