
Manual Outline

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Important Information

1

Removal and Installation

2

Engine

3

Electrical System

4

Fuel System

5

Cooling System

6

Exhaust System

7

Drives

8

Power-Assisted Steering System

9

Models Covered in this Manual

Sterndrive Model	Starting Serial Number
496 MAG HO	0M000000
496 MAG	
Inboard Model	Starting Serial Number
8.1S HO	0M000000
8.1 S Horizon	

Notice to Users of This Manual

Throughout this publication, Dangers, Warnings and Cautions (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.

DANGER

DANGER—indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

WARNING—indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

CAUTION—indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or property damage. It may also be used to alert against unsafe practices.

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.

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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, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be 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 which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, 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

Electrical, ignition and fuel system components on Mercury Marine Power Products are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Cleanliness and Care of Product

A Mercury Marine Power Product is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. Throughout this manual, 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 for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

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

Important Information

Section 1A - General Information

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A**

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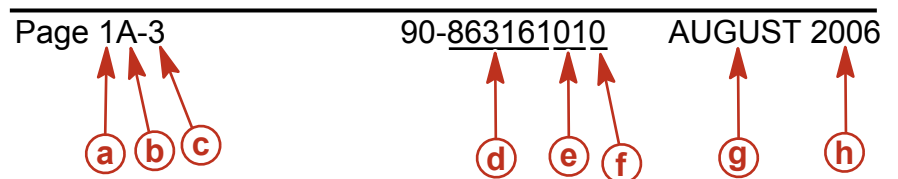
Before attempting repairs or tune-up, read through the procedure to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

See the Service Manual Outline following Models Covered in this manual for section titles.

Page Numbering

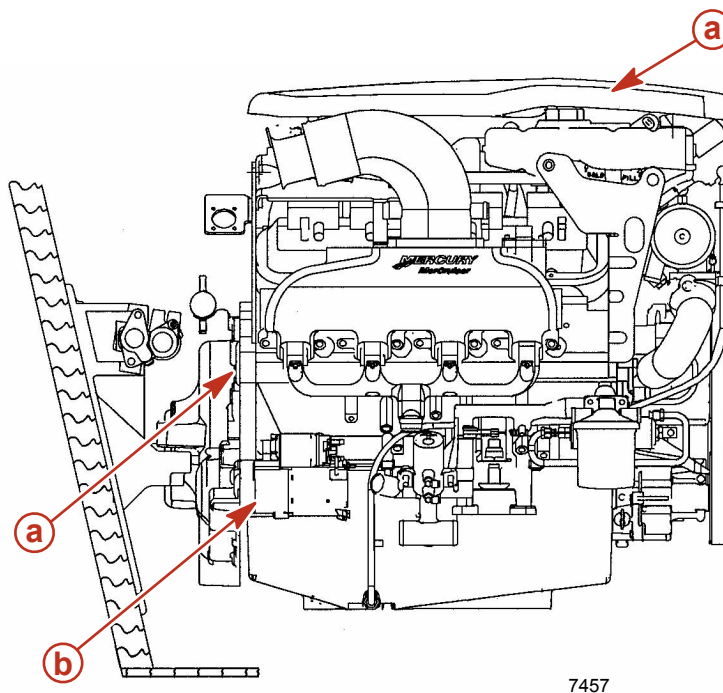
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| a - Section number | e - Volume number (two digits) |
| b - Section part | f - Revision number (one digit) |
| c - Page number | g - Month printed |
| d - Manual base number (six digits) | h - Year printed |

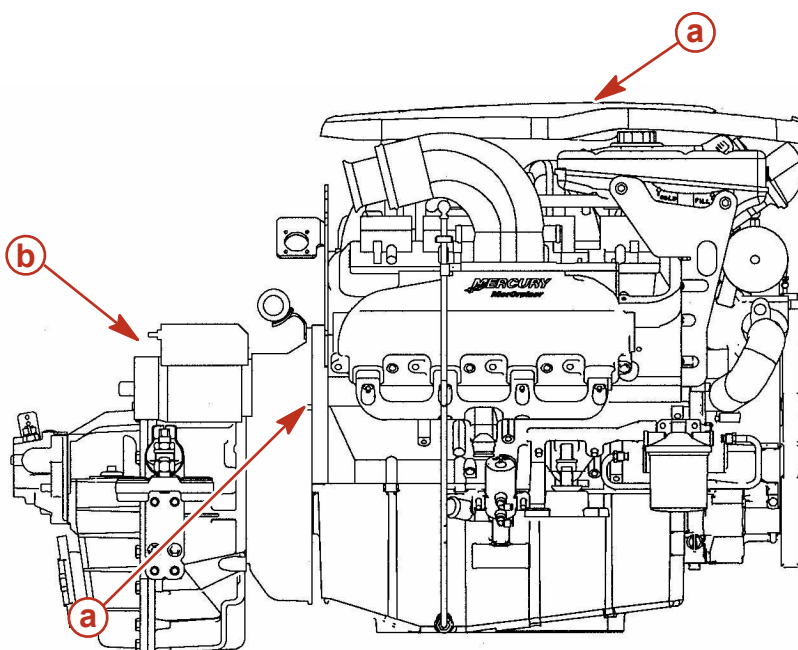
Engine Serial Number Locations



Sterndrive (MCM)

a - Serial number plate

b - Starter motor



Inboard (MIE)

a - Serial number plate

b - Starter motor

Notes:

Important Information

Section 1B - Maintenance

**1
B**

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Engine Specifications

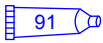
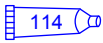
Sterndrive Engine Specifications

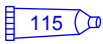
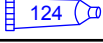
Models	496 MAG HO	496 MAG
Horsepower (Performance obtained and corrected in accordance with SAE J1228)	425	375
Kilowatts (Performance obtained and corrected in accordance with SAE J1228)	317	280
Displacement	8.1 L (496 cid)	
Specified WOT RPM range (Measured using an accurate service tachometer with the engine at normal operating temperatures)	4600–5000	4400–4800
Idle RPM in neutral (Measured using an accurate service tachometer with the engine at normal operating temperatures)	650 (Idle speed and timing on EFI models are not adjustable.)	
Minimum oil pressure @ idle (Oil pressure must be checked with the engine at normal operating temperature)	103 kPa (15 psi)	
Minimum oil pressure @ 2000 RPM (Oil pressure must be checked with the engine at normal operating temperature)	207 kPa (30 psi)	
Thermostat	71° C (160° F)	
Timing @ idle (Idle speed and timing on EFI models are not adjustable)	Not adjustable	
Firing order	1-8-7-2-6-5-4-3	
Electrical system	12-Volt negative (–) ground	
Alternator rating (hot operating amps)	65 amp	
Alternator rating (cold operating amps)	72 amp	
Recommended battery rating (minimum)	750 CCA, 950 MCA, or 180 Ah	
Recommended battery rating (DTS Models) (minimum)	800 CCA, 1000 MCA, or 190 Ah	
Spark plug type	AC Platinum (AC 41-983)	
Spark plug gap	1.5 mm (0.060 in.)	

Inboard Engine Specifications

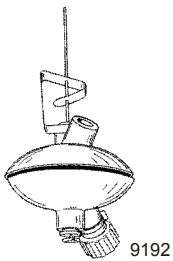
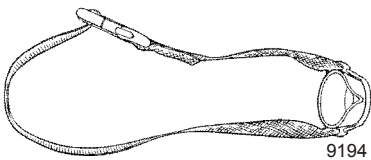
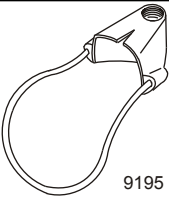
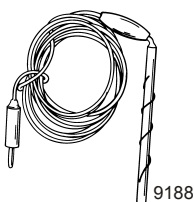
Models	8.1S HO	8.1S Horizon
Horsepower (Performance obtained and corrected in accordance with SAE J1228)	420	370
Kilowatts (Performance obtained and corrected in accordance with SAE J1228)	313	276
Displacement	8.1 L (496 cid)	
Specified WOT RPM range (Measured using an accurate service tachometer with the engine at normal operating temperatures)	4400–4800	4200–4600
Idle RPM in neutral (Measured using an accurate service tachometer with the engine at normal operating temperatures)	650 (Idle speed and timing on EFI models are not adjustable.)	
Minimum oil pressure @ idle (Oil pressure must be checked with the engine at normal operating temperature)	103 kPa (15 psi)	
Minimum oil pressure @ 2000 RPM (Oil pressure must be checked with the engine at normal operating temperature)	207 kPa (30 psi)	
Thermostat	71° C (160° F)	
Timing @ idle (Idle speed and timing on EFI models are not adjustable)	Not adjustable	
Firing order	1-8-7-2-6-5-4-3	
Electrical system	12-Volt negative (–) ground	
Alternator rating (hot operating amps)	65 AMP	
Alternator rating (cold operating amps)	72 AMP	
Recommended battery rating (minimum)	750 CCA, 950 MCA, or 180 Ah	
Recommended battery rating (DTS Models) (minimum)	800 CCA, 1000 MCA, or 190 Ah	
Spark plug type	AC Platinum (AC 41–983)	
Spark plug gap	1.5 mm (0.060 in.)	

Lubricant, Sealant, Adhesives

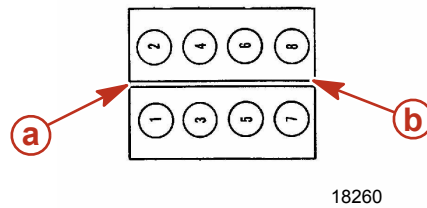
Tube Ref No.	Description	Where Used	Part No.
	Liquid soap	Flame arrestor	Obtain Locally
		Gray sterndrive U-joint cross bearings on Bravo X Sterndrives	
	Dexron III Automatic Transmission Fluid	Power steering system	Obtain Locally
	Special Lubricant 101	Steering cable	92-802865A1
		Pivot points	
	U-joint and Gimbal Bearing Grease	Gimbal bearing	92-802870A1
		Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	
	High Performance Gear Lube	Gear lube monitor	92-802854A1
	Engine Coupler Spline Grease	Driveshaft splines	92-802869A1
		Coupler	
	Power Trim and Steering Fluid	Power trim pump	92-858074K01
		Power steering system	

Tube Ref No.	Description	Where Used	Part No.
 115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-802824A1
 122	Extended Life Antifreeze/Coolant	Closed cooling system	92-877770K1
 124	Fuel System Treatment & Stabilizer	Fuel system	802875A1

Special Tools

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.
Flushing Kit	91-849996T 1
 9195	Use for flushing gearcases with low water inlets.
Reference Electrode	91-76675T 1
 9188	Senses and electrical current in the water when testing the MerCathode system. Use to check hull potential.

Firing Order



Left hand rotation - firing order 1-8-7-2-6-5-4-3

a - Water pump end

b - Flywheel end

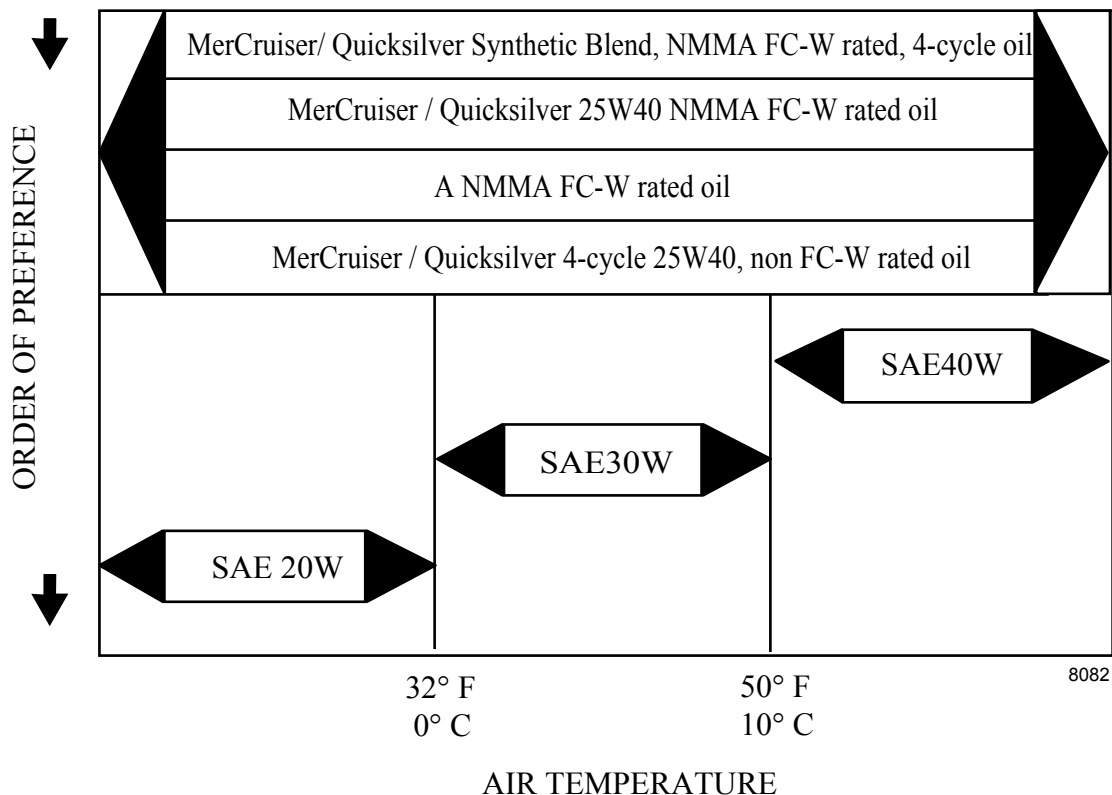
Approved Engine Oil

Engine Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of the following oils listed in the order of recommendation:

1. MerCruiser / Quicksilver Synthetic Blend, NMMA FC-W rated, 4 cycle oil.
2. MerCruiser / Quicksilver 25W40 NMMA FC-W rated oil.
3. A NMMA FC-W rated oil.
4. MerCruiser / Quicksilver 4-cycle 25W40, non FC-W rated oil.
5. A good grade straight weight detergent automotive oil per the operating chart below.

NOTE: The use of non-detergent oils, multi-viscosity oils (other than as specified), non FC-W rated synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.



Fluid Specifications and Capacities—Sterndrive

Sterndrives

NOTE: Oil capacity includes Drive 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	2972 ml (100-1/2 oz)	

Engine

IMPORTANT: All capacities are approximate fluid measures.

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

All Models	Capacity	Fluid Type
Engine Oil (with filter) (Always use the dipstick to determine the exact quantity of oil or fluid required.)	8.5 liters (9 U.S. qts)	MerCruiser/Quicksilver Synthetic Blend, NMMA FC-W rated, 4 cycle oil
Seawater Cooling System (Seawater Cooling System capacity information is for winterization use only.)	20 liters (21 U.S. qts)	Propylene Glycol and Purified Water
Closed Cooling System	18 liters (19 U.S. qts)	Mercury Extended Life Coolant/Antifreeze or Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with Purified Water

Fluid Specifications and Capacities—Inboard

Transmission

Model	Capacity	Fluid Type
5000A	2.84 L (3.00 qts)	Dexron III Automatic Transmission Fluid
5000V	3.30 L (3.5 qts)	
63A	4.00 L (4.5 qts)	
63V	4.00 L (4.5 qts)	
80A	5.50 L (6 qts)	

Engine

IMPORTANT: All capacities are approximate fluid measures.

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

All Models	Capacity	Fluid Type
Engine Oil (With Filter) (Always use the dipstick to determine the exact quantity of oil or fluid required.)	8.5 liters (9 U.S. qts)	MerCruiser / Quicksilver Synthetic Blend, NMMA FC-W rated, 4 cycle oil
Seawater Cooling System (Seawater Cooling System capacity information is for winterization use only.)	20 liters (21 U.S. qts)	Propylene Glycol and Purified Water

All Models	Capacity	Fluid Type
Closed Cooling System	18 liters (19 U.S. qts)	Mercury Extended Life Coolant/Antifreeze or Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with Purified Water

Maintenance Intervals

Maintenance intervals and the corresponding tasks, as shown in this or previous schedules, are based on average boating applications and environments. However, individual operating habits and personal maintenance preferences can impact the suggested intervals. In consideration of these factors, Mercury Mercruiser has adjusted some maintenance intervals and corresponding tasks. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer. Therefore, the boat owner and servicing dealer should discuss the current Maintenance Schedule and develop appropriate maintenance intervals.

Always disconnect battery cables from the battery before working around electrical system components to prevent injury to yourself and damage to the electrical system should a wire be accidentally shorted.

Maintenance Schedule—Sterndrive Models

Routine Maintenance

NOTE: Perform only the maintenance that applies to your particular power package

EACH DAY START

- Check the engine oil level. (This task interval can be extended based on operator experience with the product.)
- Check the coolant level.
- Check the power-assisted steering fluid level.
- Check the sterndrive gear lube level in the gear lube monitor.
- Check the trim pump fluid level.

EACH DAY END

- Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water.

WEEKLY

- Check the coolant level.
- Check the trim pump fluid level.
- Check the seawater inlets for debris or marine growth.
- Check and clean the seawater strainer.
- Inspect the sterndrive anodes and replace if 50% eroded.

EVERY TWO MONTHS OR 50 HOURS

- Check the battery connections and fluid level.
- Lubricate the propeller shaft and torque the propeller nut. (If operating in only freshwater, this maintenance may be extended to every four months.)
- Treat the engine surfaces with Corrosion Guard if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water.

- Ensure that the gauges and the wiring connections are secure. Clean the gauges. (Every two months or every 50 hours, whichever occurs first. If operating in saltwater, the interval is reduced to every 25 hours or 30 days whichever occurs first.)

Scheduled Maintenance

NOTE: *Perform only the maintenance that applies to your particular power package.*

AFTER FIRST 25 HOURS AND NOT TO EXCEED 30 HOURS

- Change the engine oil and filter.

ANNUALLY

- Touch up the power package with paint and spray with Corrosion Guard.

EVERY 100 HOURS OR ANNUALLY (WHICHEVER OCCURS FIRST)

- Change the engine oil and filter.
- Change the sterndrive gear lube.
- Torque the gimbal ring U-bolt locknuts.
- Replace the water-separating fuel filter element.
- 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 on Bravo Models.
- Clean the flame arrestor, IAC muffler, and the crankcase ventilation hoses. Inspect the PCV valve, if equipped.
- Driveshaft extension models: lubricate the driveshaft U-joints, transom end (tailstock) bearings, and engine end (output) bearings.

EVERY 200 HOURS OR 3 YEARS

- Inspect and lubricate the sterndrive U-joints and the splines. Inspect the bellows and check the clamps. (Gray sterndrive U-joint cross bearings have grease fittings and require lubrication at specified intervals. Black sterndrive U-joint cross bearings do not have grease fittings and do not require additional lubrication.)
- Check the engine alignment.
- Lubricate the gimbal bearing and the engine coupler. (Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time.)

EVERY 300 HOURS OR 3 YEARS

- Torque the engine mounts.
- 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, if equipped.
- Inspect the exhaust system components, and verify that the flapper valves are not missing or worn, if equipped.
- Inspect the condition and the tension of the belts.

EVERY 5 YEARS

- Replace the coolant (every two years if extended life antifreeze coolant is not being used).

Maintenance Schedule—Inboard Models

Routine Maintenance

NOTE: Perform only the maintenance that applies to your particular power package.

EACH DAY START

- Check the engine oil level. (This task interval can be extended based on operator experience with the product.)
- Check the coolant level.
- Check the transmission fluid level.

EACH DAY END

- Flushing is needed if engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water.

WEEKLY

- Check the coolant level.
- Check the transmission fluid.
- Check the water inlets for debris or marine growth.
- Check and clean the seawater strainer.

EVERY TWO MONTHS OR 50 HOURS

- Check the battery connections and the fluid level.
- Treat the engine surface with Corrosion Guard if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water.
- Ensure that the gauges and the wiring connections are secure. Clean the gauges. (If operating in only freshwater, this maintenance may be extended to every four months.)

Scheduled Maintenance

AFTER FIRST 25 HOURS AND NOT TO EXCEED 30 HOURS

NOTE: Perform only the maintenance that applies to your particular power package.

- Change the engine oil and filter.
- Change the transmission fluid.

ANNUALLY

- Touch up the power package with paint and spray with Corrosion Guard.

EVERY 100 HOURS OR ANNUALLY (WHICHEVER OCCURS FIRST)

- Change the engine oil and filter.
- Change the transmission fluid.
- Replace the water-separating fuel filter element.
- Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages.
- Clean the flame arrestor, IAC muffler (MPI engines), and the crankcase ventilation hoses. Inspect the PCV valve, if equipped.

EVERY 300 HOURS OR 3 YEARS

- Inspect the condition, and the tension of the belts.
- Torque the engine mounts.
- 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. Check the anodes and replace if 50% eroded.
- Clean, inspect, and test the pressure cap.
- Inspect the exhaust system components and verify that the flapper valves are not missing or worn, if equipped.

EVERY 5 YEARS

- Replace the coolant (every two years if extended life antifreeze coolant is not being used).

ACCORDING TO OEM

- Check the engine to propeller shaft alignment (Inboard and Tow Sports Models only)

Engine Oil

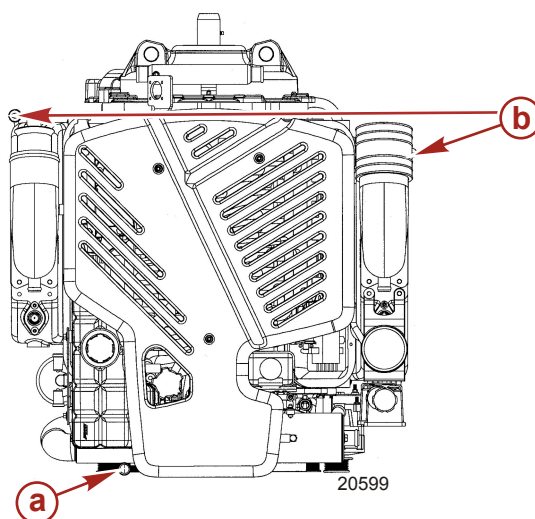
⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities.

Checking

1. Stop the engine. Allow approximately 5 minutes for the oil to drain into the oil pan. The boat must be at rest in the water.
2. Remove the dipstick. Wipe clean and reinstall fully into the dipstick tube. Wait 60 seconds to allow trapped air to vent.

NOTE: Ensure that the dipstick is installed with the oil level indication marks facing the rear of the engine (flywheel end).



a - Sterndrive models dipstick location

b - Inboard models dipstick location

IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the full or OK range mark on the dipstick.

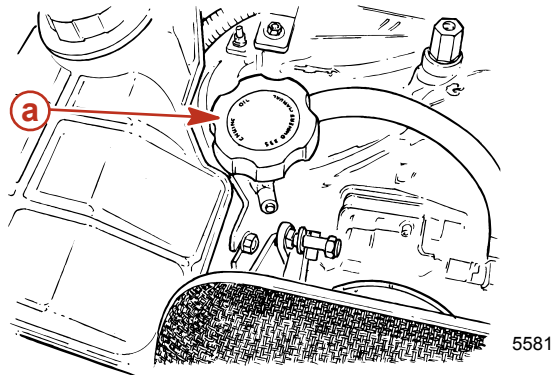
3. Remove the dipstick and observe the oil level. The oil level must be between the full or OK range mark and the add mark. Reinstall the dipstick into the dipstick tube.

Filling

IMPORTANT: Do not overfill the engine with oil.

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

1. Remove the oil fill cap.



a - Oil fill cap

IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the full or OK range mark on the dipstick.

2. Add the specified engine oil to bring the level up to, but not over, the full or OK range mark on the dipstick. Recheck the oil level.
3. Replace the fill cap.

All Models	Capacity	Fluid Type
Engine Oil (With Filter)	8.5 liters (9 U.S. Quart)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40

Changing Oil and Filter

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

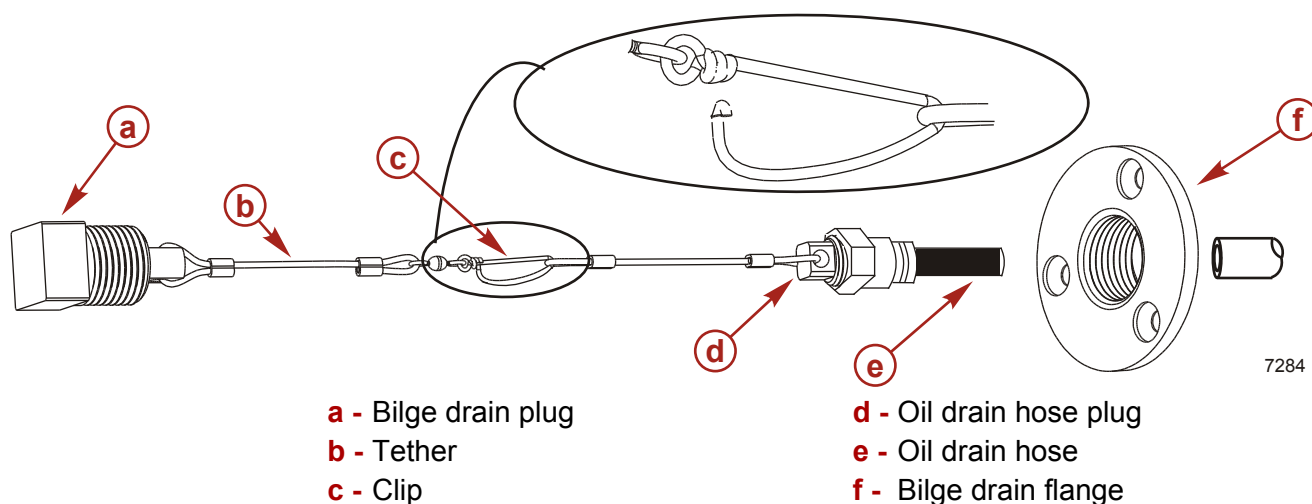
IMPORTANT: Change the engine oil when the engine is warm from operation. Warm oil flows more freely, carrying away more impurities. Use only the recommended engine oil (see Specifications and Capacities).

EASY ENGINE OIL DRAIN SYSTEM

NOTE: The boat must be out of the water to perform this procedure.

1. Loosen the oil filter to vent the system.
2. Remove the bilge drain plug.

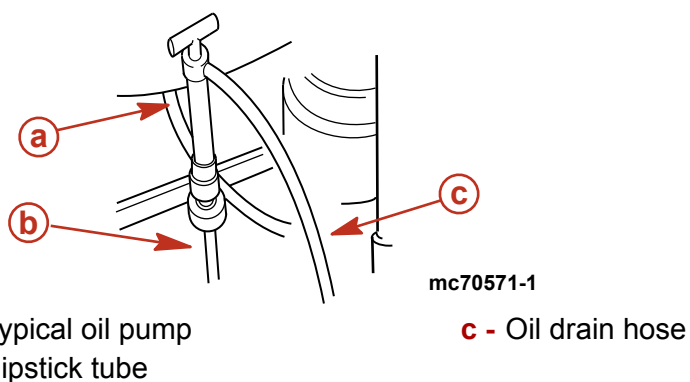
3. Pull the tether through the bilge drain.



4. Place the oil drain hose in a suitable container.
5. Remove the drain plug from the oil drain hose.
6. After the oil has drained completely, install the drain plug in the oil drain hose.
7. Push the oil drain hose through the bilge drain and install the bilge drain plug.

ENGINE OIL DRAIN PUMP

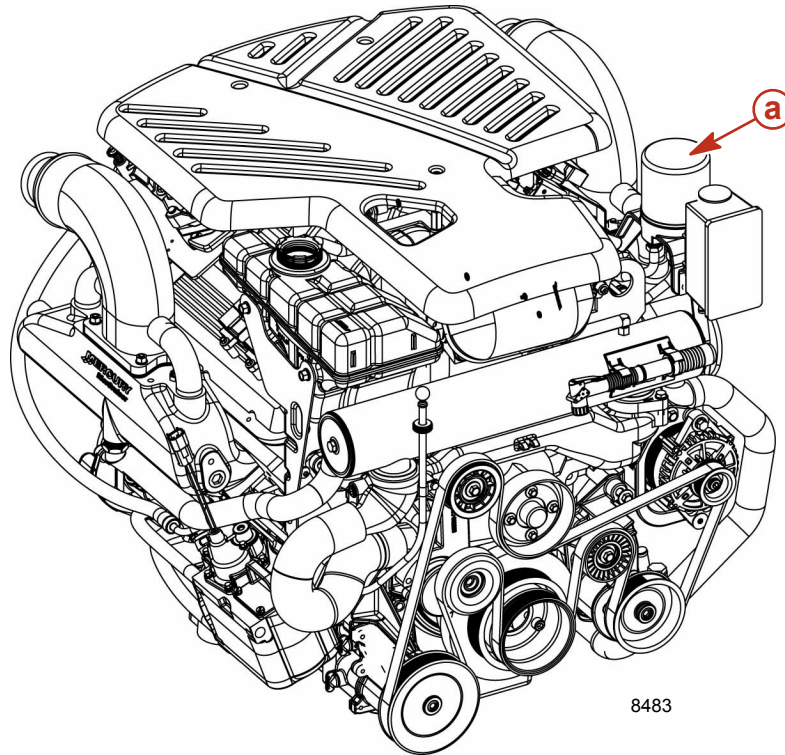
1. Loosen the oil filter to vent the system.
2. Remove the dipstick.
3. Install the oil pump onto the dipstick tube.



4. Insert the hose end of the oil pump onto an appropriate container and, using the handle, pump until the oil is removed.
5. Remove the pump.
6. Install the dipstick.

CHANGING FILTER

1. Remove and discard the oil filter.



a - Oil filter

2. Coat the sealing ring on the new filter with engine oil and install.
3. Tighten the oil filter securely (following the oil filter manufacturer's instructions). Do not overtighten.
4. Remove the oil fill cap.

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

5. Add the recommended engine oil to bring the engine oil level up to the bottom of the OK range on the dipstick.
6. With the boat at rest in the water, check the oil level and add the specified oil to bring the oil level up to, but not over, the full or OK range.

NOTE: Adding 0.95 liters (1 quart) of engine oil will raise the level from the add mark to the top of the OK range.

All Models	Capacity	Fluid Type
Engine Oil (With Filter)	8.5 liters (9 U.S. Quart)	Mercury/Quicksilver Synthetic Blend MerCruiser Engine Oil 25W-40

7. Start the engine, run the engine for 3 minutes, and check for leaks.
8. Stop the engine. Allow approximately 5 minutes for the oil to drain into the oil pan, then recheck the oil level. The boat must be at rest in the water.

Sterndrive Gear Lube

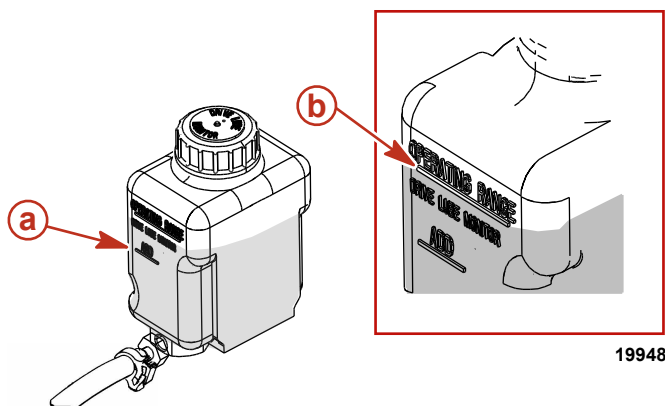
⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities.

Checking

NOTE: The gear lube level will fluctuate during operation. The gear lube level should be checked with the engine cold, before starting.

1. Check the gear lube monitor to determine the gear lube level. Keep the gear lube level within the recommended operating range. See **Filling**.



19948

Gear lube level shown is at the correct operating range

a - "ADD" mark

b - "OPERATING RANGE"

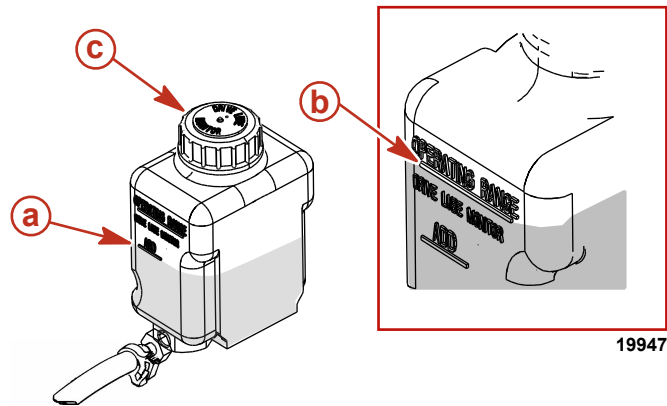
IMPORTANT: If any water is visible at the bottom of the gear lube monitor or appears at the fill and drain plug hole, or if the gear lube appears discolored, locate and repair the leak immediately. Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual.

Filling

IMPORTANT: If more than 59 ml (2 fl. oz.) of High Performance Gear Lube is required to fill the gear lube monitor, a seal may be leaking. Damage to the sterndrive unit may occur due to lack of lubrication. Locate and repair the leak immediately. Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual.

1. If the gear lube level is below or near the "ADD" mark, the specified gear lube must be added.
2. Remove the gear lube monitor cap.

- 3. Fill the gear lube monitor with the specified gear lube so that the gear lube level is in the operating range. Do not overfill.

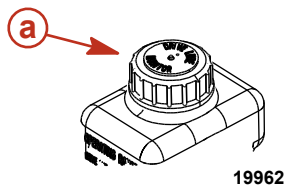


Gear lube monitor

- a - Gear lube level at the "ADD" mark
- b - Gear lube level at the "OPERATING RANGE"
- c - Cap

Tube Ref No.	Description	Where Used	Part No.
 87	High Performance Gear Lube	Gear lube monitor	92-802854A1

- 4. Ensure that the rubber gasket is inside the gear lube monitor cap and install the cap. Do not overtighten.



- a - Gear lube monitor cap

NOTE: When filling the entire sterndrive, refer to the appropriate Mercury MerCruiser Sterndrive Service Manual.

Changing

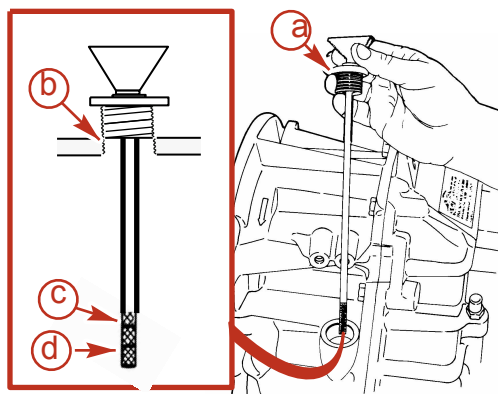
Refer to the appropriate Mercury MerCruisre Sterndrive Service Manual.

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 the 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.

- If the fluid level is low, add transmission fluid to bring the level up to the maximum mark on the dipstick.



16604

- | | |
|--------------------------|--------------------------------|
| a - Dipstick | c - Maximum fluid level |
| b - Threaded hole | d - Minimum fluid level |

IMPORTANT: To accurately check the fluid level, the engine must be operated at 1500 RPM for two minutes immediately before checking the level.

- Start the engine and operate at 1500 RPM for two minutes to fill all the hydraulic circuits.
- Stop the engine and quickly check the fluid level with the dipstick resting on the top of the threaded hole.
- If the fluid level is low, add transmission fluid to bring the level up to the maximum mark on the dipstick. See **Filling**.

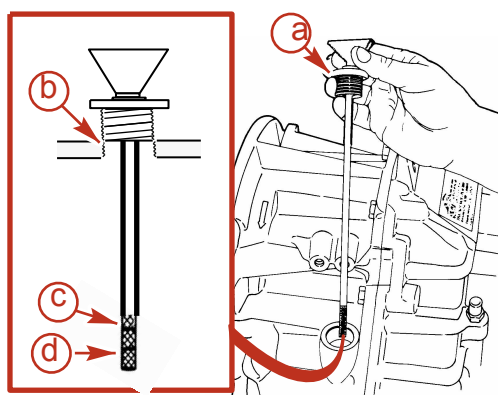
NOTE: If the transmission fluid level was extremely low, see **Troubleshooting**.

- Install the dipstick.

Filling

- If necessary, add specified automatic transmission fluid through the dipstick threaded hole to bring the level up to the maximum mark on the dipstick.

IMPORTANT: Use only specified automatic transmission fluid (ATF).



16604

- | | |
|--------------------------|--------------------------------|
| a - Dipstick | c - Maximum fluid level |
| b - Threaded hole | d - Minimum fluid level |

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

Model	Capacity	Fluid type	Part Number
ZF Marine 45A	3 liters (3 ¼ U.S. qts.)	Dexron III Automatic Transmission Fluid or Equivalent	Obtain Locally
ZF Marine 63A	4.5 liters (4 ¾ U.S. qts.)		
ZF Marine 63IV	4.9 liters (5 ¼ U.S. qts.)		

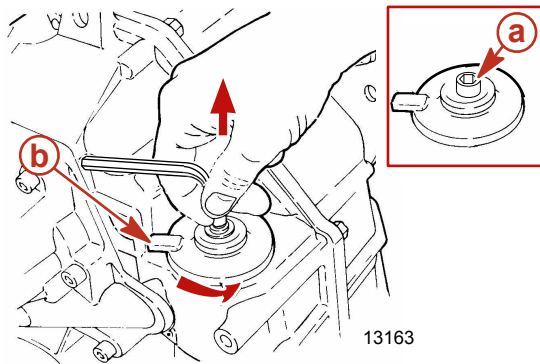
2. Install the dipstick.

IMPORTANT: To accurately check the fluid level, the engine must be run at 1500 RPM for 2 minutes immediately before checking the level.

3. Check the fluid level. See **Checking**.

Changing

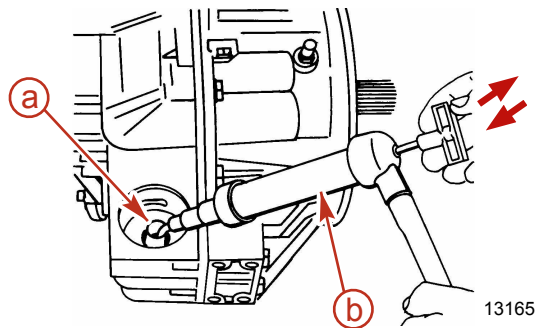
1. Clean the exterior of the transmission around the fluid filter assembly.
2. Use a 6 mm Allen wrench and remove the fluid filter assembly by turning the assembly nut counterclockwise and pulling at the same time.



a - Assembly nut

b - Fluid filter assembly

3. Push the hose of a suction pump through the suction pipe and down to the bottom of the housing.
4. Pump the fluid from the housing into a suitable container. Dispose of fluid properly.

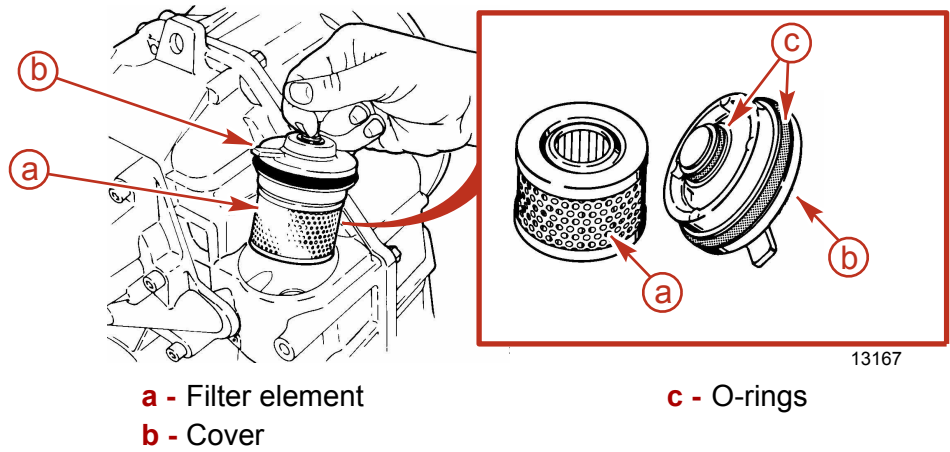


a - Suction pipe

b - Suction pump

5. Remove and discard the filter element and the O-rings.
6. Coat the new O-rings with transmission fluid.

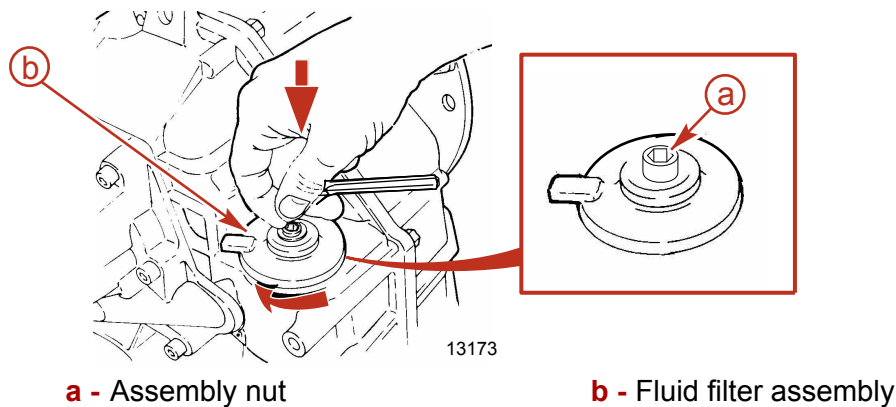
7. Install the new O-rings and filter element.



⚠ CAUTION

The transmission fluid filter assembly must be properly seated to avoid fluid foaming or loss of fluid resulting in decreased efficiency and damage to transmission.

8. Install the fluid filter assembly in the transmission cavity by turning clockwise and pushing at the same time.
9. Using a 6 mm Allen wrench turn the filter assembly nut clockwise to tighten. Torque the nut.



Description	Nm	lb. in.	lb. ft.
Filter assembly nut	5-8	48-72	

10. Fill the transmission to the proper level with the specified fluid. See **Filling**.

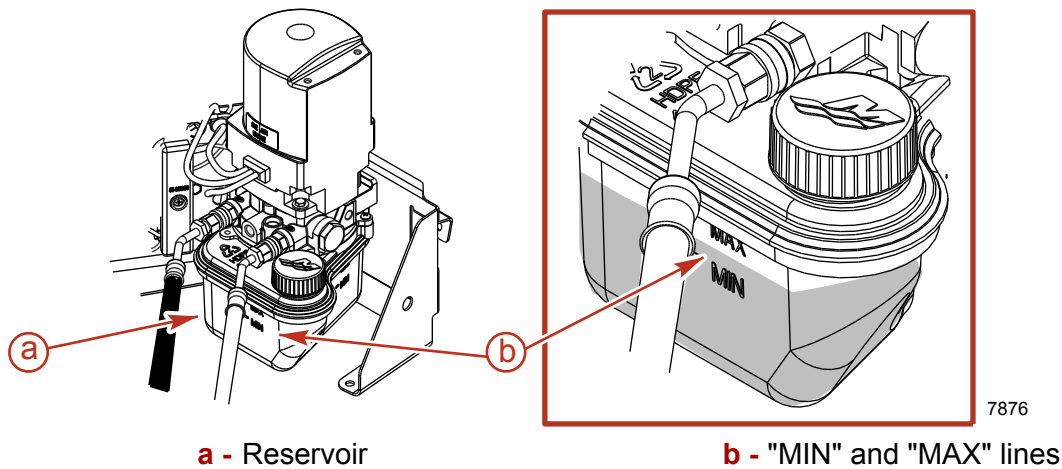
Power Trim Fluid

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.



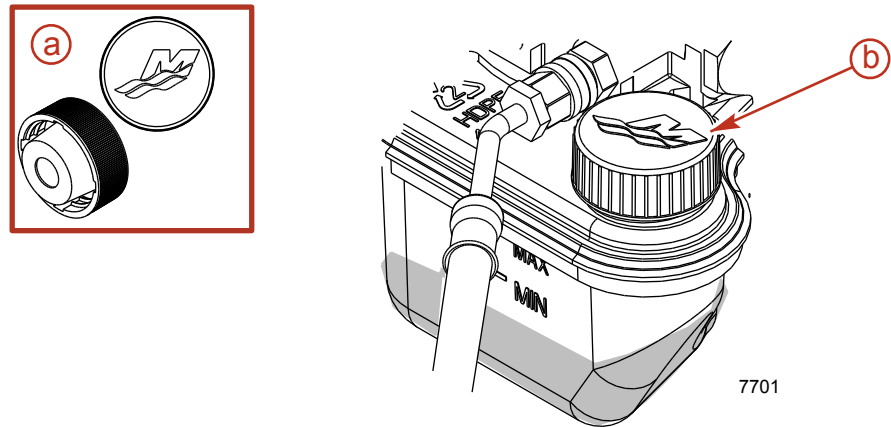
- 3. Fill as necessary with the specified fluid. See **Filling**.

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

Filling

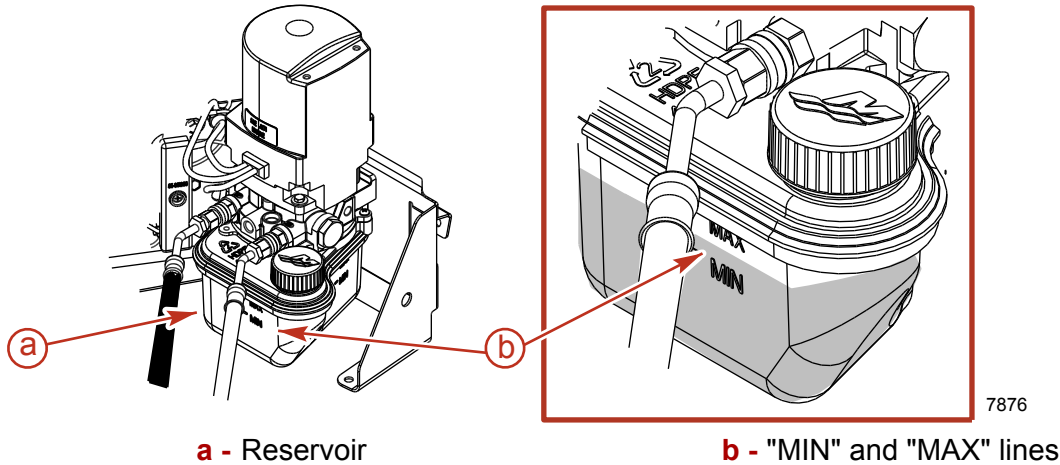
- 1. If the fluid level is below the "MIN" line, the specified fluid must be added.
- 2. Remove the fill cap from the reservoir.

NOTE: Fill cap is vented.



Power trim pump reservoir shows the oil level is below "MIN" line

3. Add the specified fluid to bring the fluid level to the within the "MIN" and "MAX" lines on the reservoir.



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.

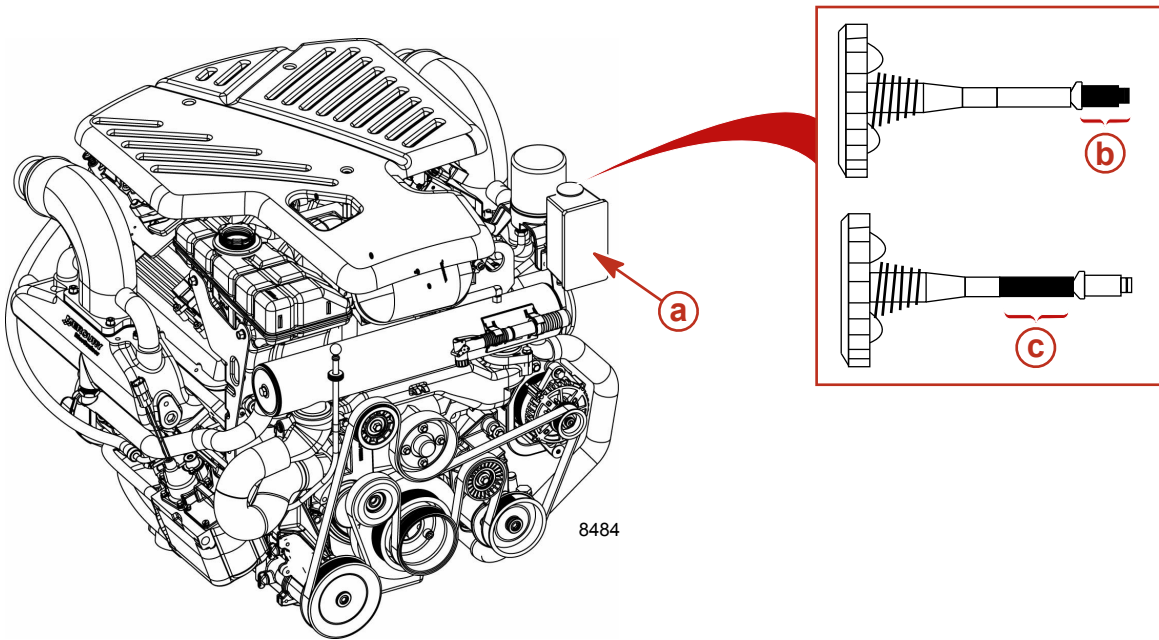
1. Remove the contaminated power trim fluid from the power trim pump reservoir.
2. Fill the power trim pump reservoir to the proper level with the appropriate power trim fluid. See **Filling**.
3. Raise and lower the sterndrive 6 to 10 times to cycle the power trim fluid, and to purge contaminants from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

Power Steering Fluid

Checking

1. Stop the engine and center the sterndrive.
2. Remove the fill cap/dipstick from the power steering fluid reservoir and observe the level.
 - a. The proper fluid level with the engine at normal operating temperature should be within the warm range.

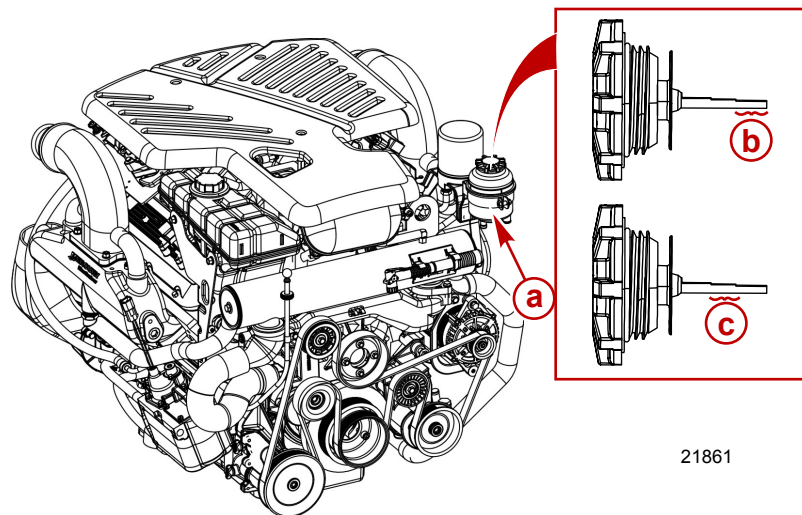
- b. The proper fluid level with the engine cold should be within the cold range.



Square reservoir

a - Reservoir
b - Cold range

c - Warm range



Round reservoir

a - Reservoir
b - Cold range

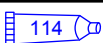
c - Warm range

3. Fill to the full line with the specified fluid.

IMPORTANT: If fluid is not visible in the fluid reservoir, locate and repair the leak.

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 range.

Tube Ref No.	Description	Where Used	Part No.
 28	Dexron III Automatic Transmission Fluid	Power steering system	Obtain Locally
 114	Power Trim and Steering Fluid	Power steering system	92-858074K01

3. Reinstall the fill cap/dipstick.

Changing

Power steering fluid does not require changing.

Closed Cooling System

Coolant Requirement

⚠ CAUTION

Propylene glycol, alcohol or methanol based antifreeze is not recommended for use in the closed cooling system.

Use *de-ionized* or *distilled* water to dilute the antifreeze if it is not pre-diluted.

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. The color of this antifreeze is orange. Any "top-off" fluid used must be *Extended Life Coolant*.

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

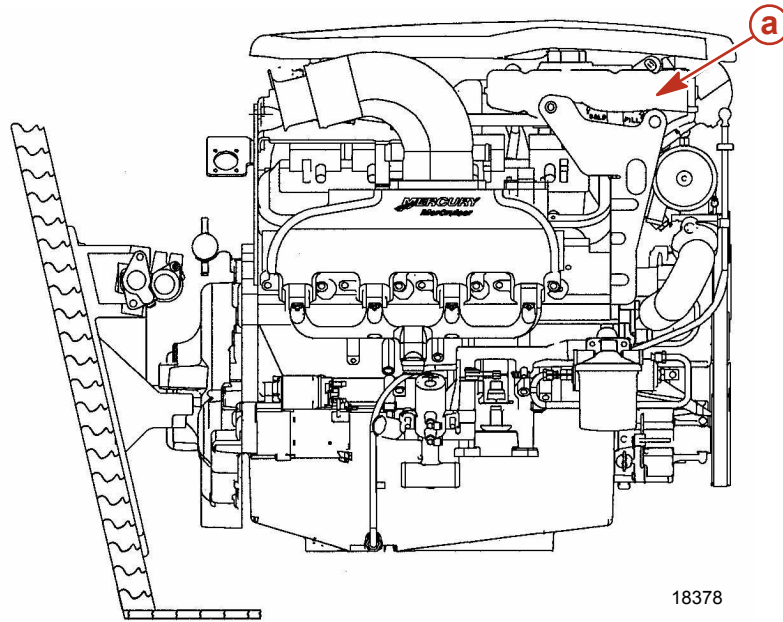
Checking Coolant Level

⚠ WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

IMPORTANT: When reinstalling the pressure cap, ensure that it is tightened securely.

1. The coolant level should be at the "FULL" mark on the coolant reservoir with the engine cold.



a - Coolant reservoir

Draining

IMPORTANT: The engine must be as level as possible to ensure complete draining of the cooling system.

IMPORTANT: The closed cooling section must be kept filled year-round with the recommended coolant. If the engine will be exposed to freezing temperatures, ensure that the closed cooling section is filled with a solution of Extended Life Coolant and distilled water properly mixed to protect the engine to the lowest temperature to which it will be exposed.

IMPORTANT: Observe the precautions previously outlined before proceeding.

WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

1. Remove the pressure cap from the coolant reservoir.
2. Remove both of the hex head drain plugs located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the engine coolant into a suitable container.
4. After the coolant has drained completely, reinstall the drain plugs. Tighten the drain plugs securely.

Cleaning the Closed-Cooling System

The closed-cooling section of closed-cooling system should be cleaned 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 manufacturer's instructions for the cleaner.

If the closed-cooling section is extremely dirty, use a pressure flushing device to flush out remaining deposits. Flushing should be done in the direction opposite normal coolant flow to allow water to get behind deposits and force them out. For proper hookup and flushing procedures refer to instructions which accompany the flushing device.

Filling the Closed Cooling System

IMPORTANT: The engine must be cooled to ambient temperature to correctly perform the following procedure.

CAUTION

Propylene glycol, alcohol or methanol based antifreeze is not recommended for use in the closed cooling system.

Use *de-ionized* or *distilled* water to dilute the antifreeze if it is not pre-diluted.

The coolant section of the closed cooling system must be filled with a 50/50 mixture of Extended Life Coolant and distilled water.

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

NOTE: Coolant section capacity is approximately 22 liters (23 U.S. qt.).

Model	8.1L (496 cid)
Closed cooling system	21.76 liters (23 qt.)

WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

IMPORTANT: When filling the coolant section after it has been completely drained, the engine should be level or slightly lower at the flywheel end.

1. Remove the pressure cap from the coolant reservoir.
2. Fill the reservoir to the "FULL" mark with the recommended coolant solution.
3. When refilling the coolant section after it has been completely drained, fill the reservoir to within 12 mm (0.50 in.) of top of reservoir neck before starting the engine.
4. Replace the pressure cap.

CAUTION

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

5. Supply cooling water to the engine.
6. With the engine running, check the hose connections, fittings, and gaskets for leaks. Also observe the engine temperature gauge to ensure that the engine operating temperature is normal. If the gauge indicates excessive temperature, stop the engine immediately and determine the cause.

⚠ WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

7. After the engine has cooled completely, recheck the coolant level and add coolant, if necessary.
8. If the reservoir was completely emptied of coolant, a significant amount of air remains in the cooling system. Refill the reservoir to the "FULL" mark, repeat the warm-up/cool-down cycle, and check the coolant level again.
9. Maintain the coolant level in the reservoir at or near the "FULL" mark with the engine cold.

Battery

NOTE: Refer to the manufacturer's instructions.

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

Changing the Water-Separating Fuel Filter—Gen II

⚠ WARNING

Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive. Be certain that the key switch is "OFF." Do not smoke or allow sparks or open flame near the area when changing the fuel filter. Wipe up any spilled fuel immediately.

Ensure that there are no fuel leaks in the engine compartment before closing the engine hatch.

⚠ CAUTION

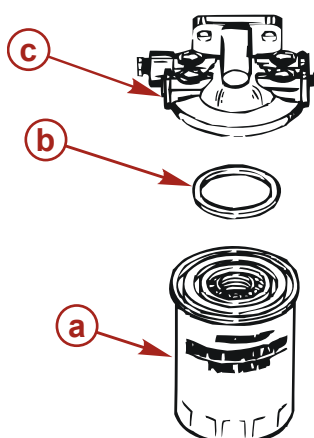
The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel vapor locking
- Difficult warm-starting
- Piston detonation due to lean fuel mixture
- Poor driveability

Removal

1. Remove the water-separating fuel filter and sealing ring from the filter base. Discard the filter and sealing ring.



6152

a - Fuel filter
b - Sealing ring

c - Filter base

Installation

1. Coat the sealing ring on the new water-separating fuel filter with new engine oil. Thread the water-separating fuel filter onto the filter base and tighten securely by hand. Do not use a filter wrench.
2. Start and operate the engine. Check the water-separating fuel filter connection for gasoline leaks. If leaks exist, stop the engine immediately and recheck the filter installation.

Changing the Water-Separating Fuel Filter Element—Gen III

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure.

⚠ WARNING

Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure the ignition key is "OFF". Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

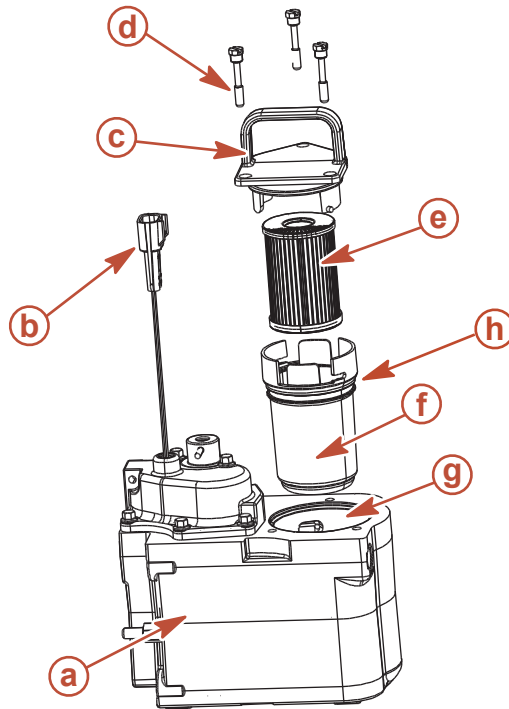
Ensure that no fuel leaks exist before closing the engine hatch.

1. Allow the engine to cool down.
2. Close the fuel supply valve, if equipped.

NOTE: Mercury MerCruiser recommends that the engine be shut off for 12 hours before filter removal.

3. Disconnect the Cool Fuel Module harness from the engine wiring harness.

4. Turn the key switch to the start position and allow the starter to operate for five seconds to relieve fuel system pressure.
5. Turn the key switch to the off position.
6. Loosen each of the filter assembly retaining screws until the screws are disengaged from the Cool Fuel Module. Do not remove the filter assembly retaining screws from the filter cap.
7. Unseat the filter assembly by grasping the filter assembly handle and pulling upward. Do not completely remove the filter assembly from the Cool Fuel Module at this time.



8837

- | | |
|--|--|
| a - Cool Fuel Module | e - Fuel filter element |
| b - Cool Fuel Module harness | f - Filter cup |
| c - Filter cap | g - Cool Fuel Module filter reservoir |
| d - Filter assembly retaining screw | h - Seal, Filter cup |

8. Allow any fuel that may be in the filter assembly to drain out through the bottom of the filter assembly and into the Cool Fuel Module filter reservoir.
9. Remove the filter cup from the filter cap by grasping the filter cap and rotating it clockwise while holding the filter cup stationary.
10. Remove the used water-separating fuel filter element from the filter cup; place it in a clean, approved container.
11. Dispose of any water or debris in the filter cup.
12. Install a new water-separating fuel filter element into the filter cup. Push the element into the cup until completely seated.
13. Install the new O-ring on the filter cup.
14. Attach the filter cap to the filter cup by grasping the filter cap and rotating it counterclockwise while holding the filter cup stationary until the filter cap locks securely into place.

15. Install the fuel filter assembly slowly into the Cool Fuel Module to prevent spilling fuel, and align the screws retained in the filter cap with the screw holes in the Cool Fuel Module. Tighten the filter assembly retaining screws until hand tight.
16. Ensure that the filter cap is firmly seated against the Cool Fuel Module and torque each filter assembly retaining screw.

Description	Nm	lb. in.	lb. ft.
Filter assembly retaining screw	6	53	

17. Open the fuel supply valve, if equipped.
18. Reconnect the Cool Fuel Module harness to the engine wiring harness.

WARNING

Avoid serious injury or death due to FIRE or EXPLOSION. Ensure that the engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

19. Properly ventilate the engine compartment.
20. Supply cooling water to the engine.
21. Run the engine and check for any leaks. Stop the engine immediately if any leak exists and correct before continuing.

Cleaning the Flame Arrestor

WARNING

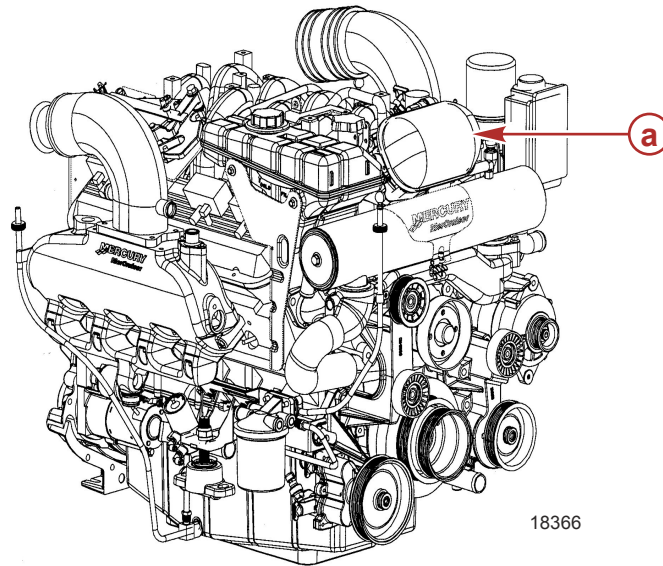
Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor; ensure that ignition is off. Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor.

1. Remove the engine cover.
2. Remove the flame arrestor.
3. Clean the flame arrestor with warm, soapy water.

Tube Ref No.	Description	Where Used	Part No.
	Liquid soap	Flame arrestor	Obtain Locally

4. Dry the flame arrestor with compressed air.

5. Reinstall the flame arrestor.



a - Flame arrestor

Seawater System

Cleaning the Seawater Strainer, If Equipped

⚠ CAUTION

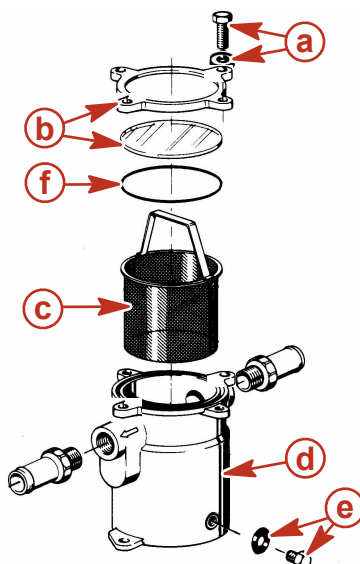
When cleaning the seawater strainer, close the seacock, if equipped. If the boat is not equipped with a seacock, remove and plug the seawater inlet hose to prevent siphoning, which would allow seawater to flow from the drain holes or removed hoses.

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. Excess water in the bilge can damage the engine or cause the boat to sink. Do not overtighten the cover screws or the cover will warp and leak seawater into the bilge.

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



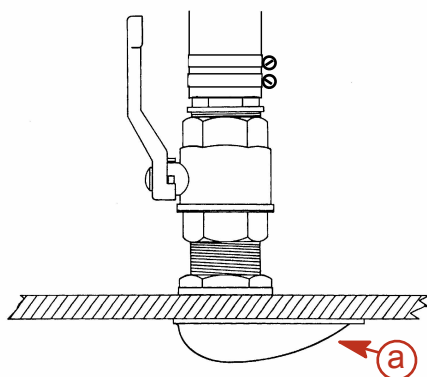
a - Screws and washers
b - Cover with glass
c - Strainer

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.

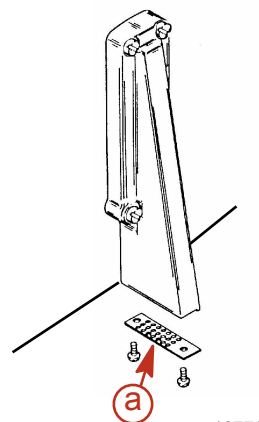
Checking the Seawater Pickups

1. Ensure that the water inlet holes for the seawater pickup are clean and not obstructed.



Typical through-the-hull seawater pickup

a - Water inlet holes



Typical through-the-transom seawater pickup

16776

Draining the Seawater System

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Ensure that the boat is out of the water, the seacock is closed (if equipped) or the seawater inlet hose is disconnected and plugged on both ends, and the bilge pump is operating before beginning the draining procedure.

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. When the drain system is open excess water can enter the bilge. Do not operate the engine with the drain system open.

IMPORTANT: Only drain the seawater section of the closed cooling system.

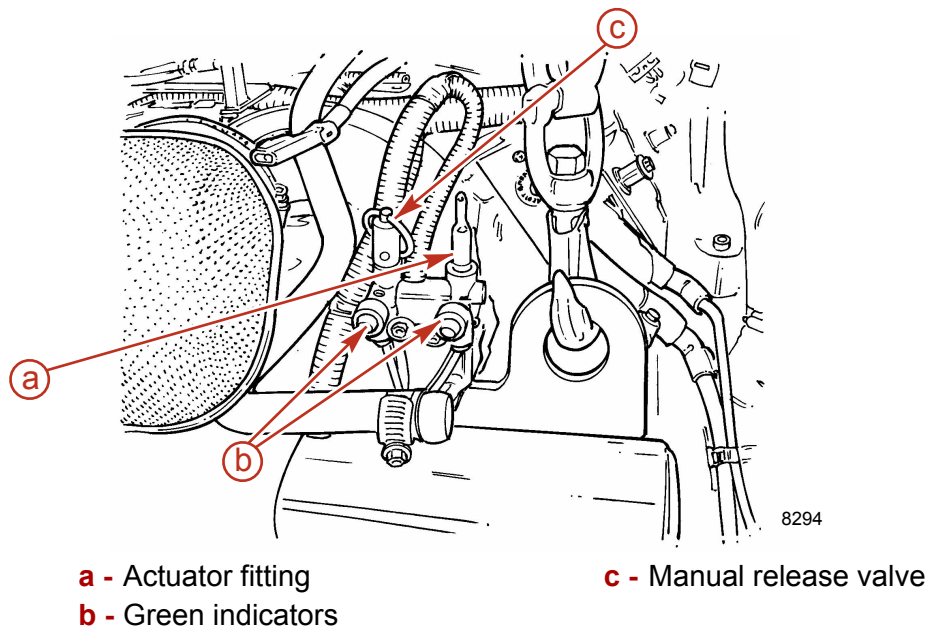
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

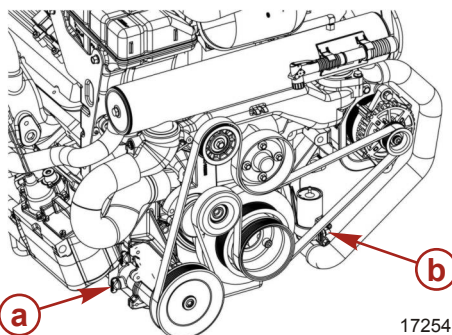
Your power package is equipped with a drain system. Refer to **Drain System Identification** to determine which instructions apply to your power package.

IMPORTANT: The engine must not be operating at any point during the draining procedure.

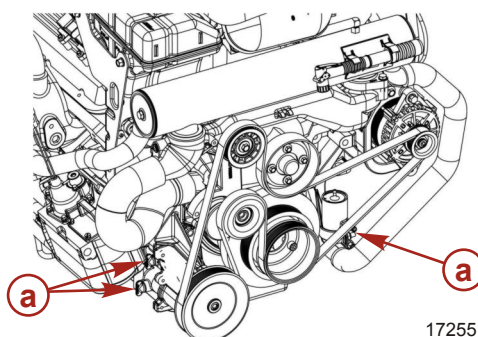
Drain System Identification

AIR ACTUATED SINGLE POINT DRAIN SYSTEM



**a** - Port side drain location**b** - Starboard side drain location

MANUAL DRAIN SYSTEM

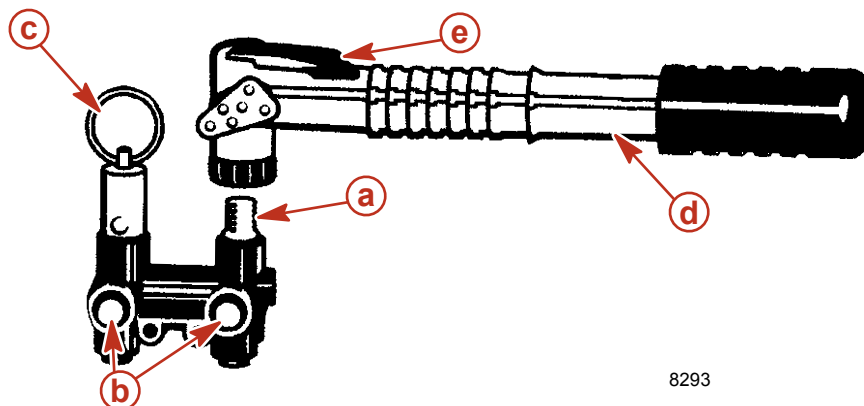
**a** - Blue drain plug locations

Air Actuated Single Point Drain System

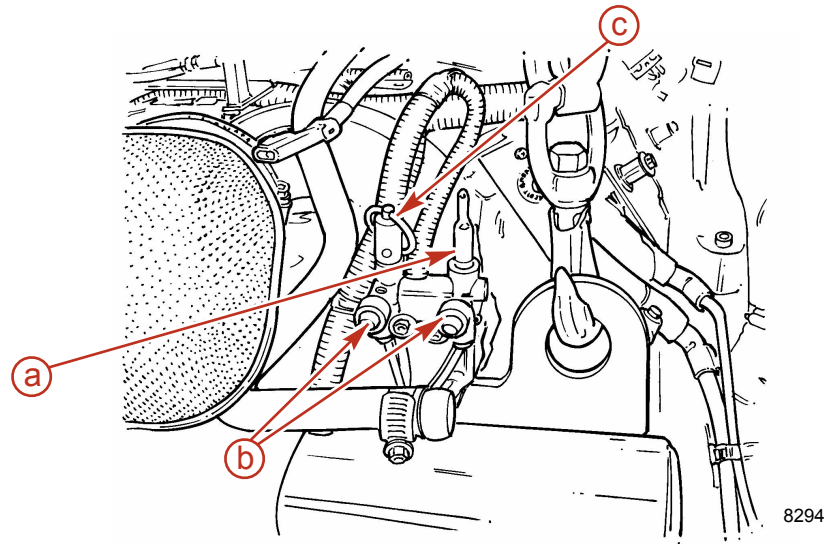
BOAT IN THE WATER

NOTE: This procedure is written for the air pump that is attached to the engine. However, any air source can be used.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the air pump from the engine.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the actuator fitting.
5. Pull lever on air pump (vertical) to lock pump on the fitting.

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

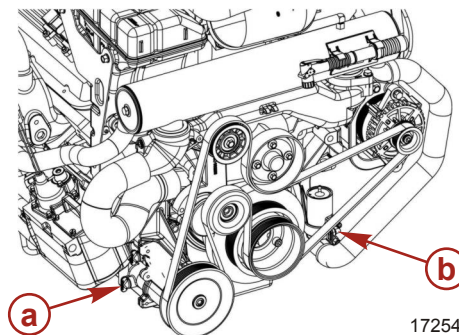
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



a - Actuator fitting
b - Green indicators

c - Manual release valve

7. Verify that water is draining from each opening. If not, use the **Manual Drain System** instructions.



a - Port side drain location

b - Starboard side drain location

8. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
9. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
10. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
11. Remove the air pump from the air manifold and return it to the mounting bracket.
12. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.

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



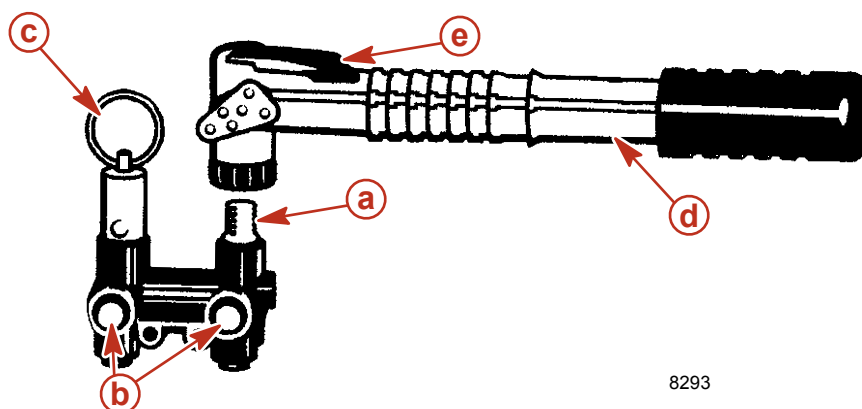
a - Green indicators

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

BOAT OUT OF THE WATER

NOTE: This procedure is written for the air pump that is attached to the engine. However, any air source can be used.

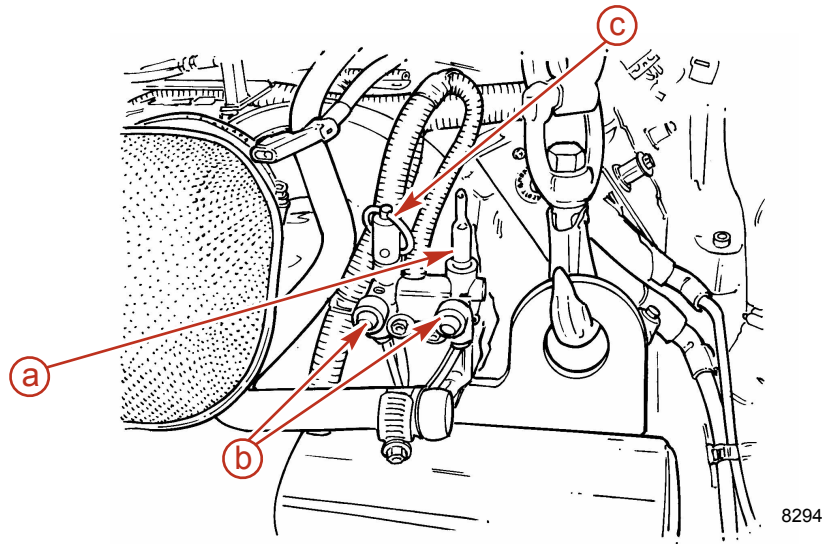
1. Place the boat on a level surface to ensure complete draining of system.
2. Remove the air pump from the engine.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the actuator fitting.
5. Pull lever on air pump (vertical) to lock pump on the fitting.



a - Actuator fitting
b - Green indicators
c - Manual release valve

d - Air pump
e - Lever (locking)

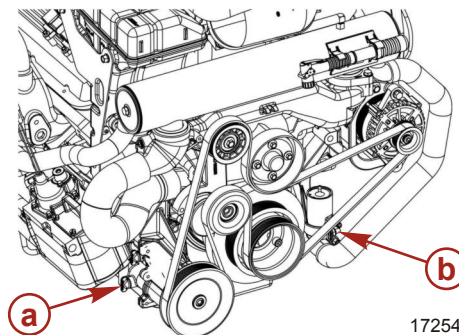
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



a - Actuator fitting
b - Green indicators

c - Manual release valve

7. Verify that water is draining from each opening. If not, use the **Manual Drain System** instructions.



a - Port side drain location

b - Starboard side drain location

8. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
9. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
10. Crank the engine over slightly with starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
11. Remove the air pump from the air manifold and return it to the mounting bracket.
12. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.

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



a - Green indicators

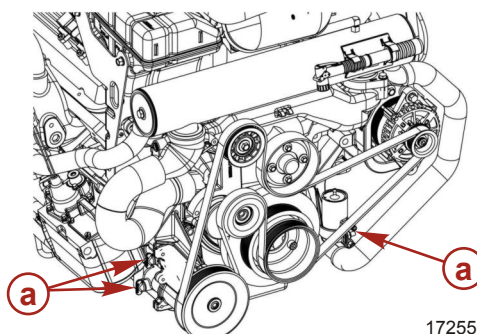
Manual Drain System

BOAT IN THE WATER

NOTE: Use this procedure if the air-actuated single-point drain system fails.

NOTE: It may be necessary to lift, bend, or lower hoses to allow water to completely drain when the hoses are disconnected.

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Remove the blue drain plug from the air-actuated water drain assembly (front port side).
3. Remove the two blue drain plugs from the seawater pickup pump (front starboard side).



a - Blue drain plug locations

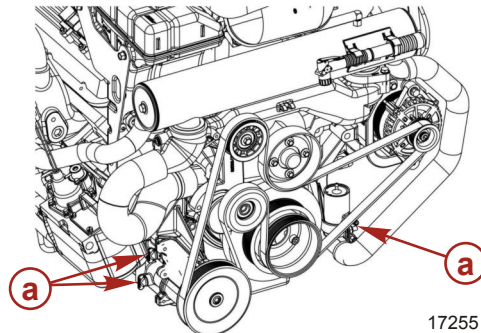
4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
6. Pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
7. Crank the engine over slightly with starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
8. Prior to launching the boat or starting the engine, close the drain system by installing the three blue drain plugs.
9. Open the seacock, if equipped, or unplug and reconnect the water inlet hose prior to operating the engine.

BOAT OUT OF THE WATER

NOTE: Use this procedure if the air-actuated single-point drain system fails.

NOTE: It may be necessary to lift, bend, or lower hoses to allow water to completely drain when hoses are disconnected.

1. Place the boat on a level surface to ensure complete draining of the system.
2. Remove the blue drain plug from the air-actuated water drain assembly (front port side).
3. Remove two blue drain plugs from the seawater pickup pump (front starboard side).



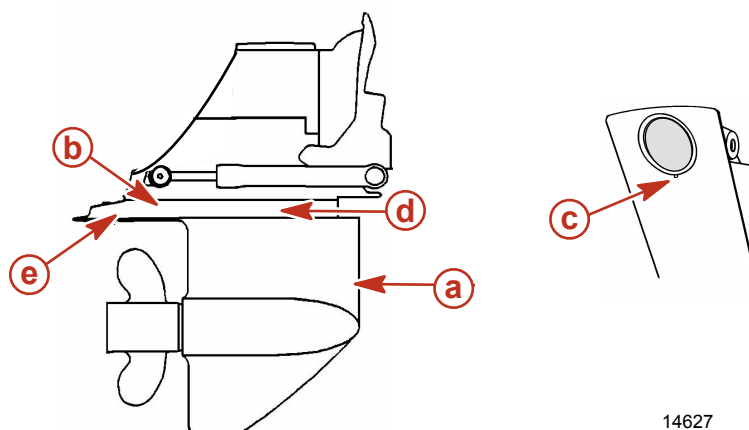
a - Blue drain plug locations

4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
6. Pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
7. Crank the engine over slightly with starter motor to purge any water trapped in the seawater pickup pump. Do not allow the engine to start.
8. Prior to launching the boat or starting the engine, close the drain system by installing the three blue drain plugs.

Draining the Sterndrive

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

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



Sterndrive Water Drain Holes

- | | |
|---------------------------------------|--|
| a - Speedometer pitot tube | d - Gear housing water drain hole (1 each port and starboard) |
| b - Anode cavity vent hole | e - Gear housing cavity vent hole (Bravo II only) |
| c - Anode cavity drain passage | |

⚠ CAUTION

Avoid damage to the sterndrive unit. Always store the sterndrive unit in the full down position. The universal joint bellows may develop a set if unit is stored in raised position and may fail when unit is returned to service.

2. Lower the sterndrive 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

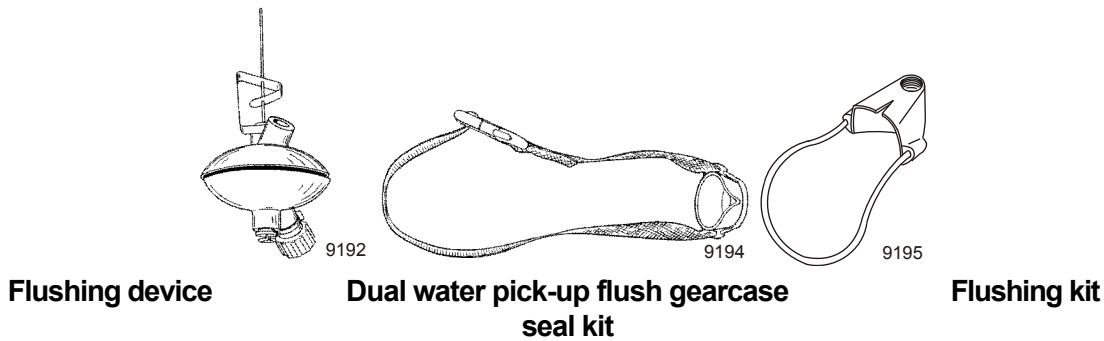
IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze, mixed to the manufacturers instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended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

Flushing the Seawater System—Sterndrive Models

General Information—Bravo Sterndrive

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

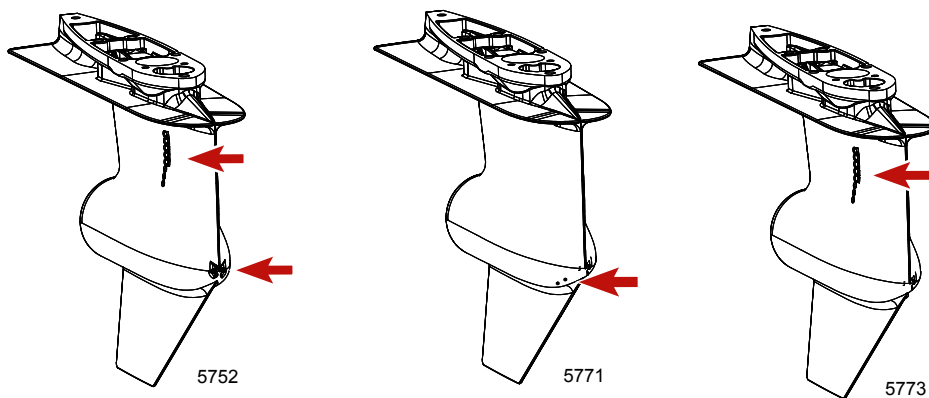
FLUSHING ATTACHMENTS



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

STERNDRIVE WATER PICKUPS

There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side pickups. Dual water pickups require the flushing attachment (44357Q 2) and the flush seal kit (881150K 1), low water pickups require the flushing attachment (849996T 1), and side pickups require the flushing attachment (44357Q 2).



The Boat out of the Water—Bravo Sterndrive

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results, flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to full down/in position.

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.

2. Remove the propeller. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.
3. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
4. Connect the water supply hose to the water source.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

8. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For power packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

13. Stop the engine.
14. Immediately shut off the supply water and remove the flushing attachment.
15. Install the propeller. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.

The Boat in the Water—Bravo Sterndrive

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results, flushing is recommended after each outing and before cold weather and extended storage.

1. Raise the sterndrive to the trailer position.
2. Install the appropriate flushing attachment over the water inlet holes in the gear housing.
3. Lower the sterndrive to the full down/in position.
4. Connect the water supply hose to the water source.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

8. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

13. Stop the engine.
14. Immediately shut off the supply water. Do not remove the flushing attachment from the sterndrive at this time.

⚠ CAUTION

Avoid engine damage due to inflow of seawater. If flushing with the boat in the water, close the water inlet after flushing the engine.

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Close the seacock before removing the seawater inlet hose.

15. Close the seacock, if equipped, then disconnect the seawater inlet hose to prevent water from siphoning into the engine or boat.

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Disconnect and immediately plug the seawater inlet hose to prevent water from siphoning into the engine or boat.

16. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump, and immediately plug the hose to prevent water from siphoning into the engine or boat.
17. Raise the sterndrive to the trailer position.
18. Remove the flushing attachment from the sterndrive.
19. Tag the ignition switch with an appropriate tag requiring the seacock to be opened or the seawater inlet hose to be reconnected before operating the engine.

The Boat out of the Water—Alternative Water Pickups

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to the full down/in position.

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.

2. Remove the propeller. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.
3. Close the seacock, if equipped.
4. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump.
5. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

6. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
7. Place the remote control in the neutral idle speed position.
8. Immediately start the engine.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

9. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

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 a minimum of 10 minutes.
12. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
13. Slowly return the throttle to the idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

14. Stop the engine.
15. Immediately shut off the supply water and remove the flushing attachment.
16. Install the water inlet hose to the seawater inlet of the seawater pump. Tighten the hose clamp securely.
17. Install the propeller. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.

The Boat in the Water—Alternative Water Pickups

IMPORTANT: Flushing the power package is most effective when performed with the boat and sterndrive out of the water.

IMPORTANT: Flushing is needed if the engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather and extended storage.

1. Lower the sterndrive to the full down/in position.

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Close the seacock before removing the seawater inlet hose.

2. Close the seacock, if equipped, then disconnect the seawater inlet hose to prevent water from siphoning into the engine or boat.

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Disconnect and immediately plug the seawater inlet hose to prevent water from siphoning into the engine or boat.

3. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump and immediately plug the hose to prevent water from siphoning into the engine or boat.
4. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

5. With the sterndrive in the normal operating position, completely open the water source to provide maximum water supply.
6. Place the remote control in the neutral idle speed position.
7. Immediately start the engine.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

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

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

9. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
10. Operate the engine with the sterndrive in neutral for a minimum of 10 minutes.
11. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

13. Stop the engine.
14. Immediately shut off the supply water and remove the flushing attachment.
15. Tag the ignition switch with an appropriate tag requiring the seacock to be opened or the seawater inlet hose to be reconnected before operating the engine.

Flushing the Seawater System—Inboard Models

The Boat out of the Water—Inboard Models

IMPORTANT: Flushing the power package is most effective when performed with the boat out of the water.

IMPORTANT: Flushing is needed if engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather or extended storage.

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.

1. Close the seacock, if equipped, then disconnect the seawater inlet hose from the seawater pump.
2. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump and immediately plug the hose.
3. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

4. Completely open the water source to provide maximum water supply.
5. Place the remote control in the neutral idle speed position.
6. Start the engine.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

8. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
9. Operate the engine with the transmission in neutral for a minimum of 10 minutes.
10. **For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water**, continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to the idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

12. Stop the engine.
13. Immediately shut off the supply water and remove the flushing attachment.

14. Install the water inlet hose to the seawater inlet of the seawater pump. Tighten the hose clamp securely.

The Boat in the Water—Inboard Models

IMPORTANT: Flushing the power package is most effective when performed with the boat out of the water.

IMPORTANT: Flushing is needed if engine package has been operated in saltwater, brackish water, mineral-laden water, or polluted water. For best results flushing is recommended after each outing and before cold weather or extended storage.

CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Close the seacock before removing the seawater inlet hose.

1. Close the seacock, if equipped, then disconnect the seawater inlet hose to prevent water from siphoning into the engine or boat.

CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. Disconnecting the seawater inlet hose will cause water to enter the bilge. Disconnect and immediately plug the seawater inlet hose to prevent water from siphoning into the engine or boat.

2. If not equipped with a seacock, disconnect the seawater inlet hose from the seawater pump, and immediately plug the hose to prevent water from siphoning into the engine or boat.
3. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

4. Completely open the water source to provide maximum water supply.
5. Place the remote control in the neutral idle speed position.
6. Immediately start the engine.

CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM ($\pm$ 100 RPM).

CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

8. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
9. Operate the engine with the transmission in neutral for a minimum of 10 minutes.

10. For engine packages operated in saltwater, brackish water, mineral-laden water, or polluted water, continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to the idle speed position.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

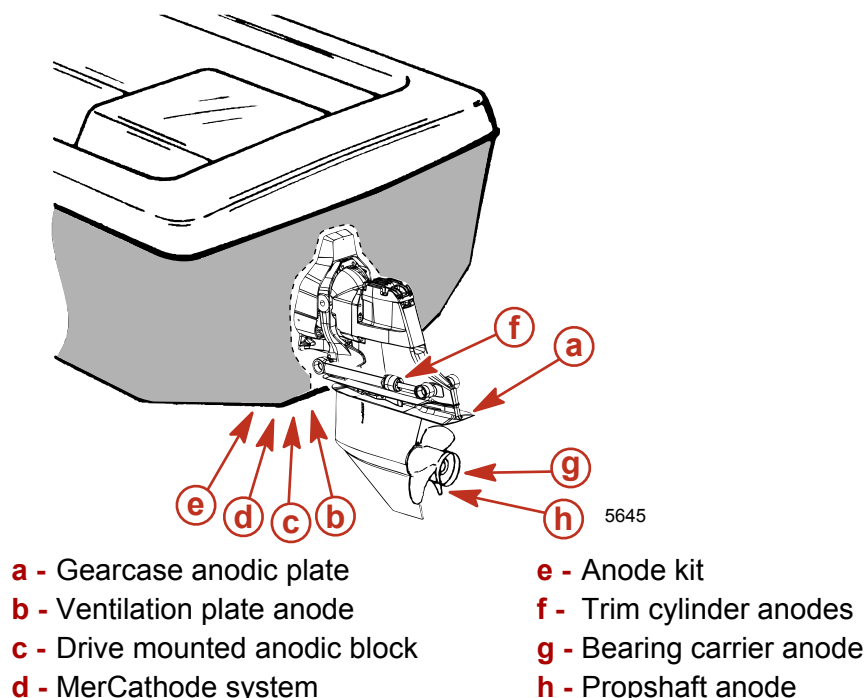
12. Stop the engine.
13. Immediately shut off the supply water and remove the flushing attachment.
14. Tag the ignition switch with an appropriate tag requiring the seacock to be opened or the seawater inlet hose to be reconnected prior to operating the engine.

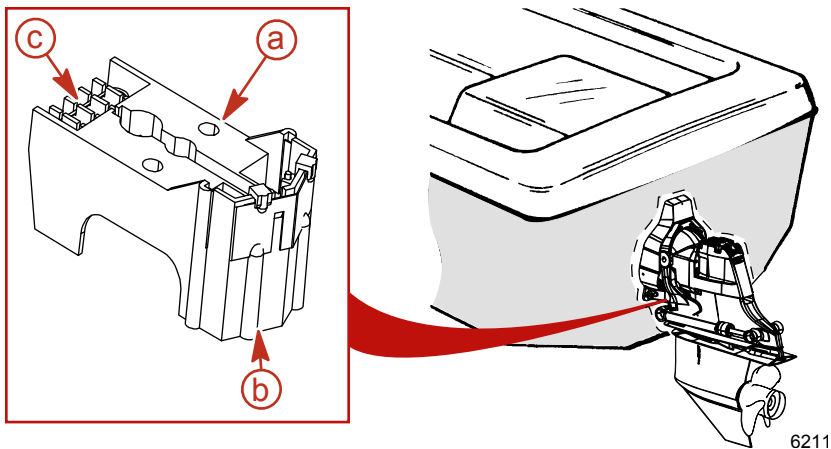
Corrosion Protection

⚠ CAUTION

Improper boat-cleaning procedures can cause product damage. Washing the MerCathode assembly, especially with a brush or high-pressure washer, will damage the MerCathode assembly making it unable to inhibit galvanic corrosion. When cleaning the boat, do not use a brush or a high-pressure washer to wash the MerCathode assembly found on the bottom of the transom assembly.

Whenever two or more dissimilar metals (like those found on the sterndrive) are submerged in a conductive solution, such as saltwater, polluted water, or water with a high mineral content, a chemical reaction takes place causing electrical current to flow between metals. The electrical current flow causes the metal that is most chemically active, or anodic, to erode. This is known as galvanic corrosion and, if not controlled, it will in time cause the need for replacement of power package components exposed to water. Refer to the **Marine Corrosion Protection Guide** (90-88181301).

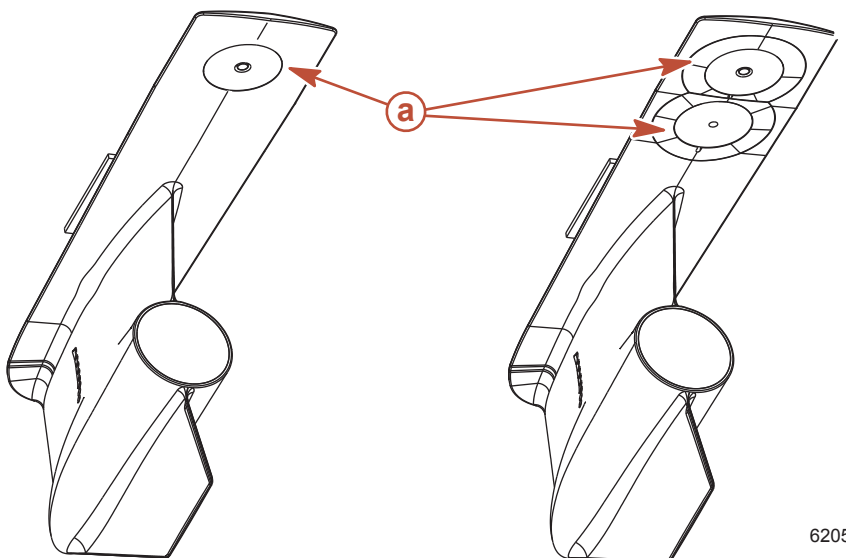




- a** - MerCathode reference electrode **c** - Do not pressure wash
b - Do not paint

IMPORTANT: Replace sacrificial anodes if eroded 50 percent or more.

Gearcase Anodic Plate. Mounted on the underside of the lower gearcase and serves as a sacrificial anode.

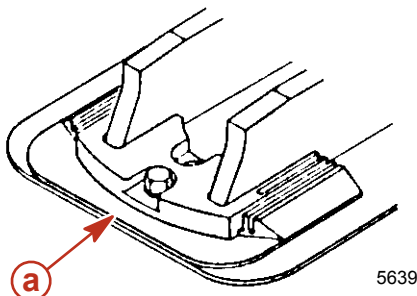


Bravo One, Bravo Two and Early Bravo Three Models

Later Bravo Three Models

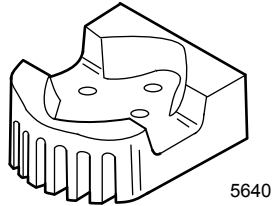
- a** - Anode

Ventilation Plate Anode. Mounted on the front of the gearcase and serves as a sacrificial anode.

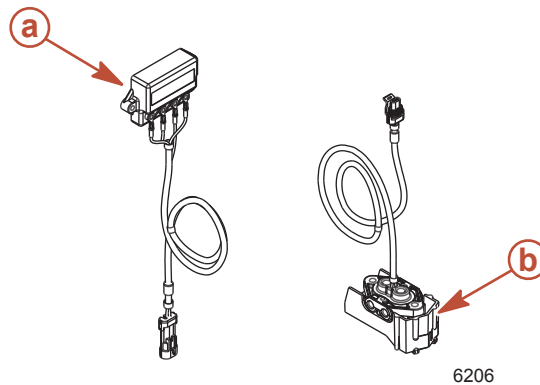


- a** - Anode

Drive-Mounted Anodic Block (if equipped). Mounted to the underside of the gimbal housing and serves as a sacrificial anode.



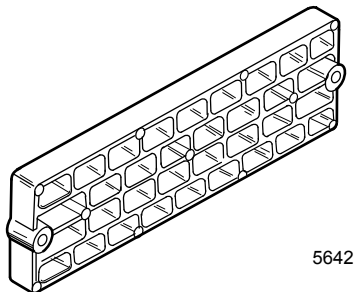
MerCathode System. An electrode assembly replaces the anodic block. The system should be tested to ensure adequate output. The test should be performed where the boat is moored, using the Quicksilver Reference Electrode and Test Meter. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.



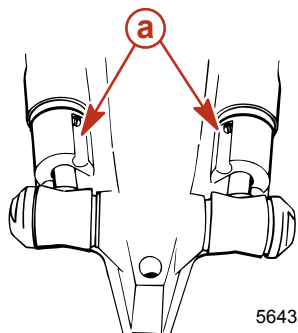
a - MerCathode controller

b - MerCathode Assembly

Anode Kit (if equipped). Mounted to boat transom. Acts as a sacrificial anode.

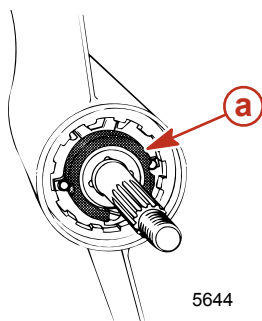


Trim Cylinder Anodes. Mounted on each trim cylinder.



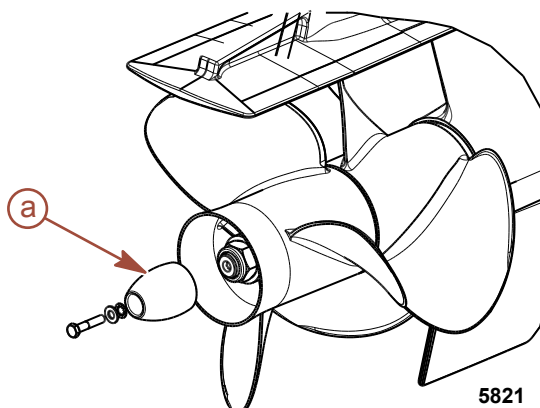
a - Trim cylinder anodes

Bearing Carrier Anode (Bravo One). Located in front of the propeller, between the front side of the propeller and the gear housing.



a - Bearing carrier anode

Propshaft Anode (Bravo Three with engine serial number 0M640000 and above). Located in front of the propeller, between the front side of the propeller and the gear housing.



a - Propshaft anode

In addition to the corrosion protection devices, follow these steps to inhibit corrosion:

1. Paint your power package, see **Painting Your Power Package**.
2. Spray power package components on the inside of the boat annually with Corrosion Guard to protect the finish from dulling and corrosion. External power package components may also be sprayed.
3. All lubrication points, especially the steering system, shift, and throttle linkages, should be kept well lubricated.
4. Flush the cooling system periodically, preferably after each use.

PAINTING YOUR POWER PACKAGE

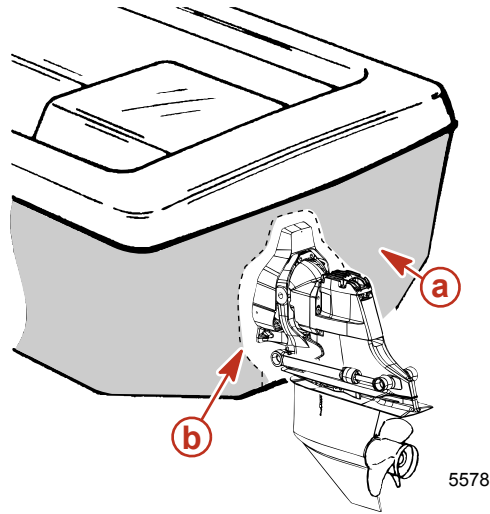
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

1. **Painting the Boat Hull or Boat Transom:** Anti-fouling paint may be applied to the boat hull and boat transom but you must observe the following:

IMPORTANT: Do NOT paint the anodes or the MerCathode system reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

IMPORTANT: If anti-fouling protection is required for the boat hull or boat transom, copper- or tin-based paints, if not prohibited by law, can be used. If using copper- or tin-based anti-fouling paints, observe the following:

- Allow a minimum of a 40 mm (1-1/2 in.)unpainted area on the transom of the boat around the sterndrive, anodic blocks, and the MerCathode System. Doing so prevents an electrical connection between these components and the paint.



a - Painted boat transom

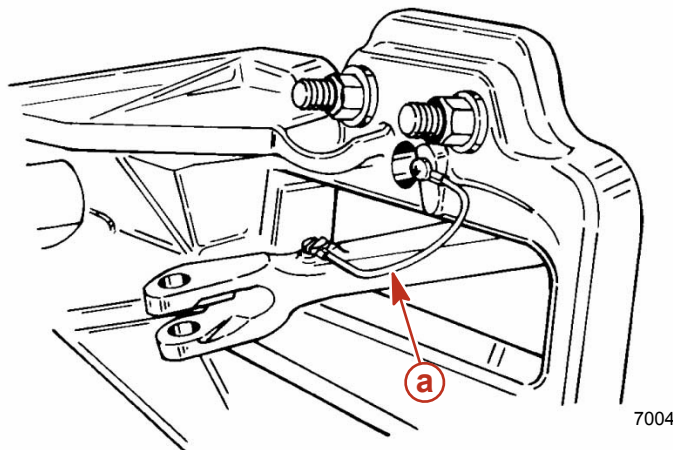
b - Unpainted Area on Transom

2. **Painting the Sterndrive or Transom Assembly:** The sterndrive and the transom assembly should be painted with a good quality marine paint or an anti-fouling paint that does not contain copper, tin, or any other material that could conduct electrical current. Do not paint drain holes, anodes, the MerCathode system, or items specified by the boat manufacturer.

Continuity Circuit: Bravo Sterndrive

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

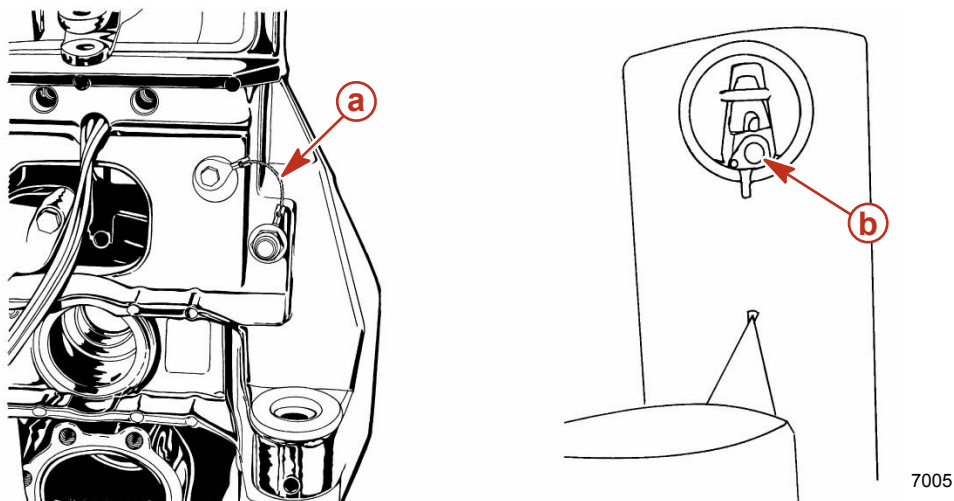
1. Inspect the steering lever ground wire for loose connections, broken connectors, or frayed wiring.



a - Steering lever ground wire

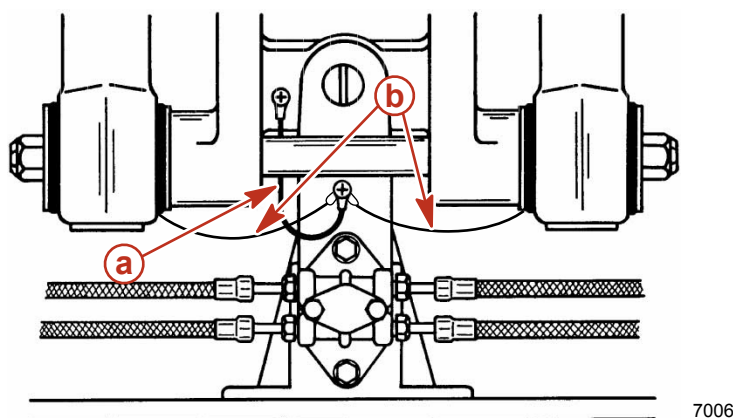
2. Inspect the inner transom plate ground wire for loose connections, broken connectors, or frayed wiring.

3. Inspect the driveshaft housing to gear housing ground plate inside the anode cavity for a loose or faulty connection.



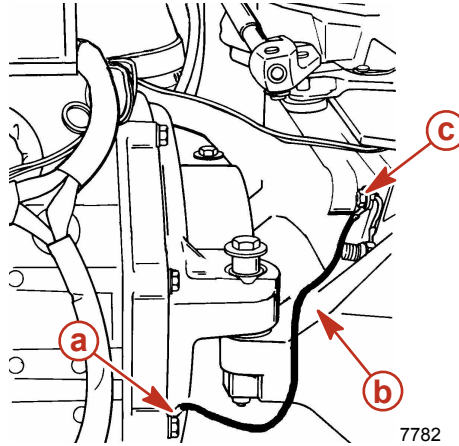
a - Inner transom plate ground wire **b** - Ground plate (inside anode cavity)

4. Inspect the gimbal housing ground wires for loose connections, broken connectors, or frayed wiring.



a - Gimbal housing to gimbal ring ground wire **b** - Gimbal housing to trim cylinder ground wires

5. Inspect the flywheel housing grounding stud, ground wire, and the inner transom plate grounding screw for loose connections, broken connectors, or frayed wiring.

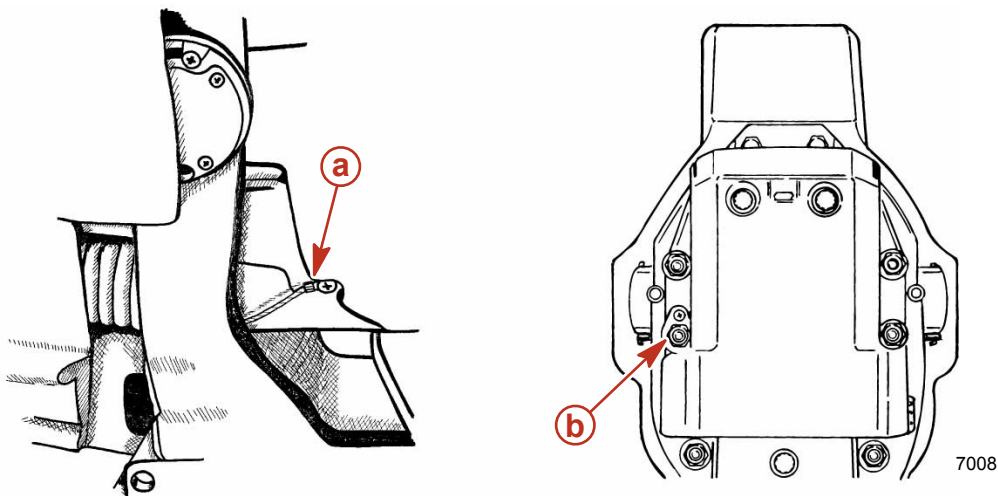


Typical

- a** - Flywheel housing screw or grounding stud
b - Continuity circuit (ground) wire

- c** - Inner transom plate grounding screw

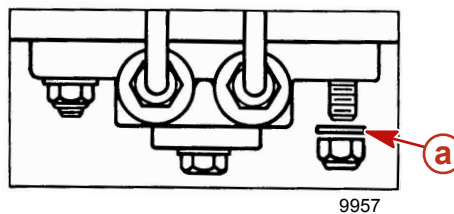
6. Inspect the gimbal ring ground wire and the sterndrive ground plate for loose connections, broken connectors, or frayed wiring.



- a** - Gimbal ring to bell housing ground wire

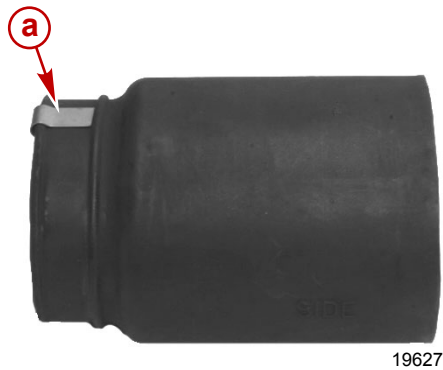
- b** - Sterndrive to bell housing ground plate

7. Inspect the continuity washers under the hydraulic manifold block fasteners (where the manifold block is mounted to the gimbal housing) for a loose or faulty connection.



- a** - Continuity washers

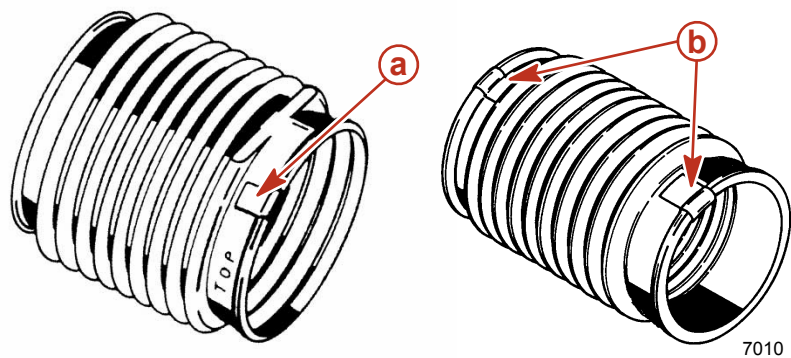
8. Inspect the sterndrive exhaust tube ground clip for a loose or faulty connection.



Exhaust tube ground clip

a - Exhaust tube ground clip

9. Inspect the sterndrive U-joint bellows and exhaust bellows ground clips for a loose or faulty connection.



a - U-joint bellows ground clip

b - Exhaust bellows ground clip

MerCathode

If the boat is equipped with a Quicksilver 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 where the boat is moored, using a Quicksilver Reference Electrode and Test Meter.

Reference Electrode	91-76675T 1
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Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for testing procedures.

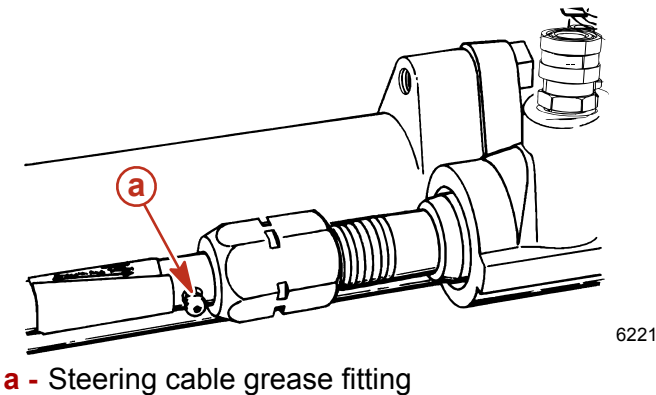
Lubrication

Steering System

⚠ CAUTION

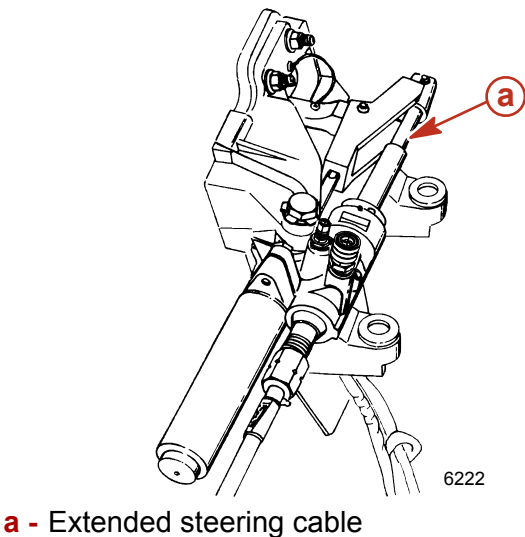
Do not grease the steering cable while its extended. Hydraulic lock could occur and cause loss of steering control.

- NOTE:** If steering cable does not have grease fitting, inner wire of cable cannot be greased.
- If Steering Cable Has Grease Fittings:** Turn steering wheel until steering cable is fully retracted into cable housing. Apply approximately 3 pumps of grease from a typical hand-operated grease gun.



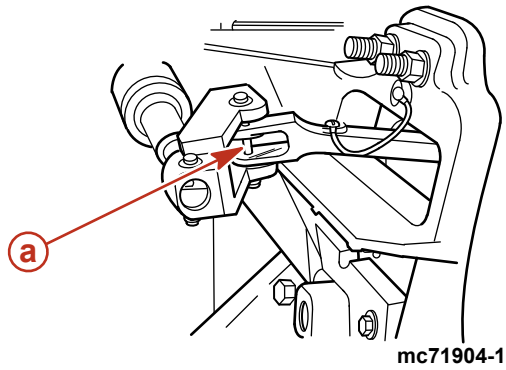
Tube Ref No.	Description	Where Used	Part No.
 34	Special Lubricant 101	Steering cable	92-802865A1

- Turn steering wheel until steering cable fully extended. Lightly lubricate the exposed part of cable.



Tube Ref No.	Description	Where Used	Part No.
 34	Special Lubricant 101	Steering cable	92-802865A1

3. Lubricate the steering system pivot points.



a - Steering system pivot points

Tube Ref No.	Description	Where Used	Part No.
 34	Special Lubricant 101	Pivot points	92-802865A1

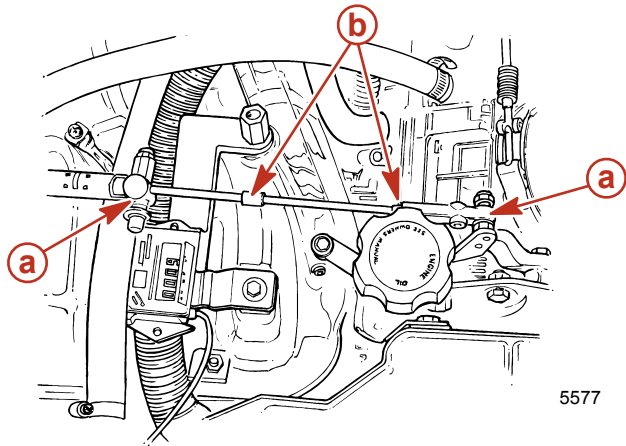
4. On dual engine boats: Lubricate the tie bar pivot points.

Tube Ref No.	Description	Where Used	Part No.
 34	Special Lubricant 101	Pivot points	92-802865A1

5. Upon first starting engine, turn steering wheel several times to starboard and then port to ensure that the steering system operates properly before getting underway.

Throttle Cable

1. Lubricate the pivot points and the guide contact surfaces.



a - Pivot points

b - Guide contact surfaces

Description	Where Used	Part No.
Mercury/Quicksilver Synthetic Blend, NMMA FC-W rated, 4-cycle oil	Pivot points, guide contact surfaces	92-883724K01

-
- A technical line drawing of a mechanical assembly, likely a valve or actuator. The drawing shows a complex arrangement of pipes, valves, and structural components. Two red callout boxes are present: one labeled 'a' with three arrows pointing to different locations on the lower part of the assembly, and another labeled 'b' with one arrow pointing to a specific component on the upper part of the assembly.

b - Guide contact surfaces

Gimbal Bearing

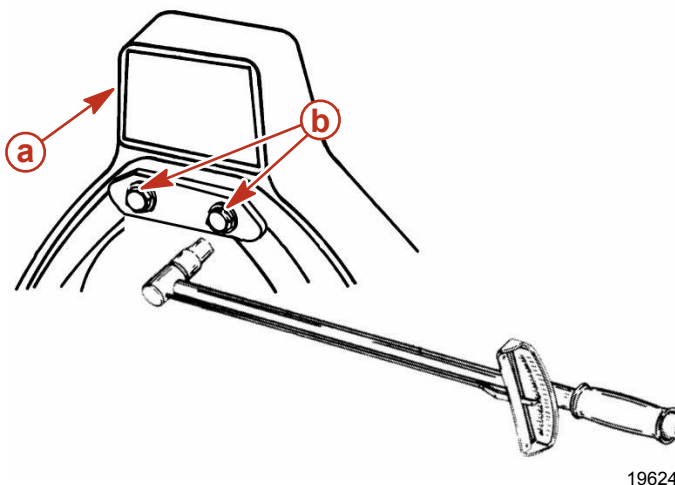
-

Tube Ref No.	Description	Where Used	Part No.
 42	U-joint and Gimbal Bearing Grease	Gimbal bearing	92-802870A1

Gimbal Ring to Steering Shaft Connection

- 90-863161010 AUGUST 2006

2. Retorque the gimbal ring locknuts for the steering shaft connection.



a - Gimbal ring

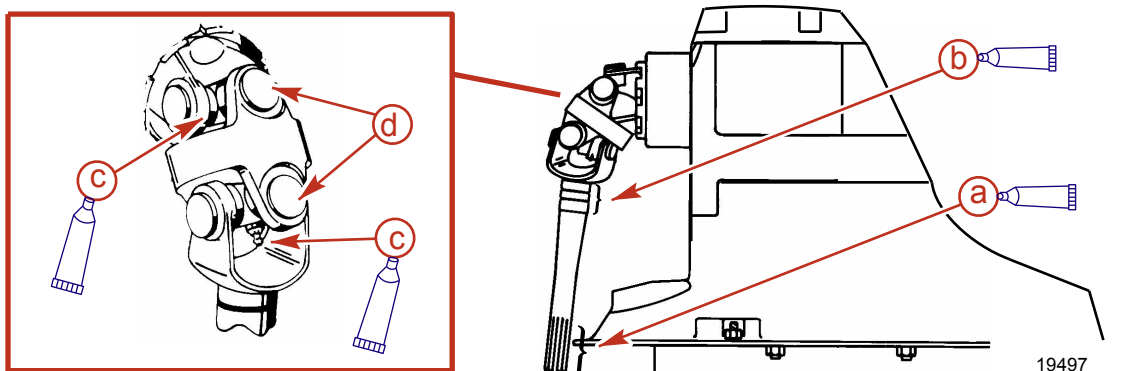
b - Gimbal ring locknut

Description	Nm	lb. in.	lb. ft.
Gimbal ring locknut	72		53

Sterndrive U-joint Cross Bearings and Shaft Splines (Sterndrive Removed)

NOTE: Gray sterndrive U-joint cross bearings have grease fittings and require lubrication at specified intervals. Black sterndrive U-joint cross bearings do not have grease fittings and do not require additional lubrication. The sterndrive must be removed to lubricate the gray U-joints.

1. Remove the sterndrive; refer to the appropriate Mercury MerCruiser sterndrive service manual for sterndrive removal and installation.
2. Lubricate the sterndrive U-joint cross bearings through the grease fittings, if equipped, by applying approximately 3-6 pumps of grease from a typical hand-operated grease gun.
3. Lubricate the U-joint shaft splines and the O-rings.



a - Driveshaft splines

b - U-joint O-rings

c - Grease fittings, if equipped

d - Cross bearing assemblies

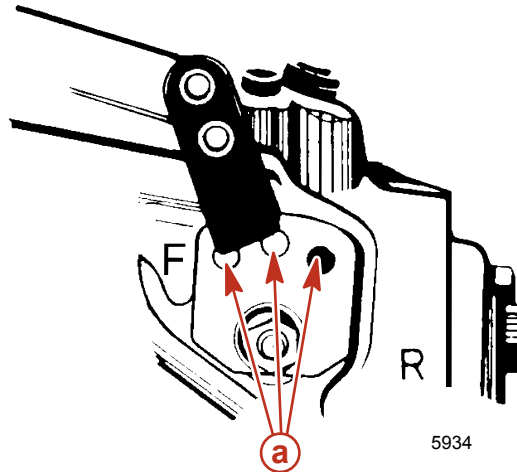
Tube Ref No.	Description	Where Used	Part No.
 91	Engine Coupler Spline Grease	Driveshaft splines	92-802869A1

Tube Ref No.	Description	Where Used	Part No.
	Exxon Unirex EP2 Grease	Gray sterndrive U-joint cross bearings on Bravo X Sterndrives	Obtain Locally

Typical Transmission Linkage

IMPORTANT: The poppet ball must be centered in detent hole for each F-N-R position.

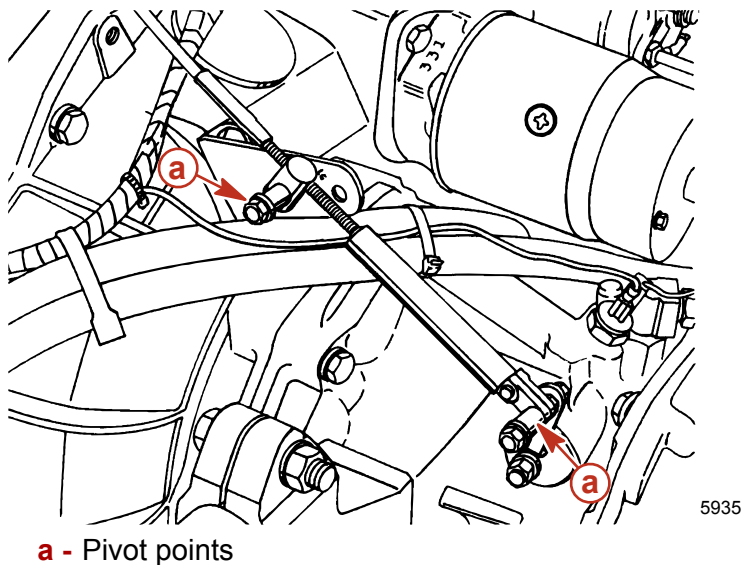
1. Lubricate the detent ball and the holes in the shift lever.



Typical In-Line Transmission

Description	Where Used	Part No.
Mercury/Quicksilver Synthetic Blend, NMMA FC-W rated, 4-cycle oil	Pivot points, guide contact surfaces	92-883724K01

2. Lubricate the shift cable pivot points.

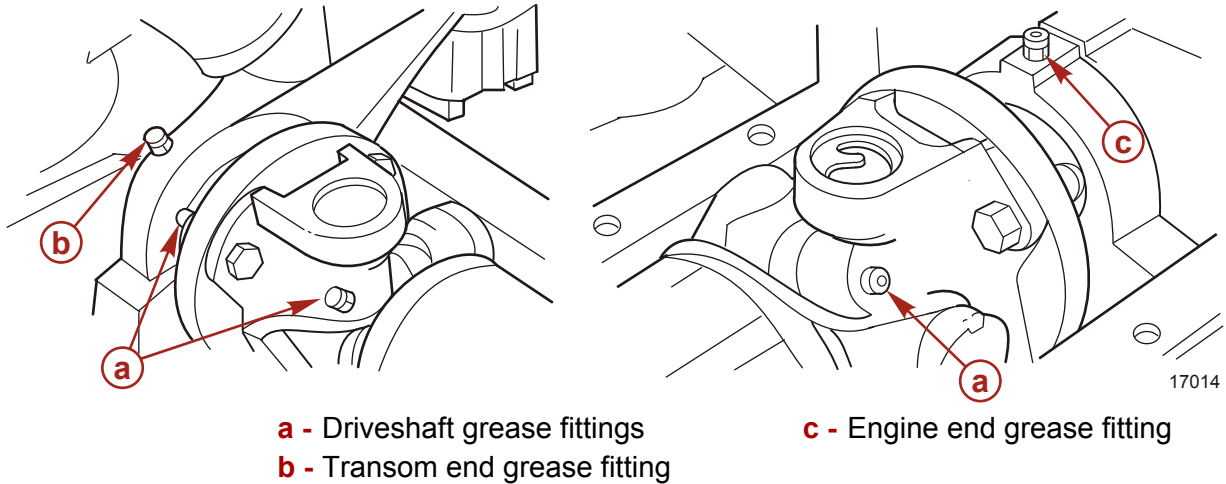


Description	Where Used	Part No.
Mercury/Quicksilver Synthetic Blend, NMMA FC-W rated, 4-cycle oil	Pivot points	92-883724K01

Driveshaft Extension Models

1. Lubricate the transom end grease fitting and engine end grease fitting by applying approximately 10 - 12 pumps of grease from a typical hand-operated grease gun.

2. Lubricate the driveshaft grease fittings by applying approximately 3 - 4 pumps of grease from a typical hand-operated grease gun.

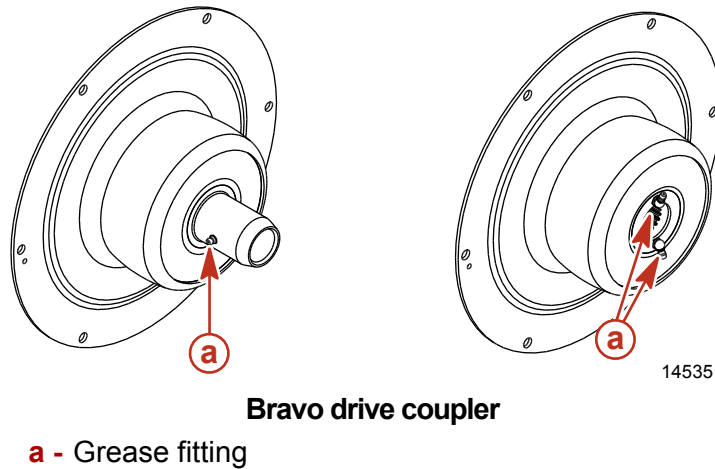


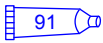
Tube Ref No.	Description	Where Used	Part No.
 42	U-joint and Gimbal Bearing Grease	Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	92-802870A1

Engine Coupler

1. Lubricate engine coupler splines through the grease fittings on the coupler by applying approximately 8–10 pumps of grease from a typical hand-operated grease gun.

NOTE: If the boat is operated at idle for prolonged periods of time, coupler should be lubricated every 50 hours

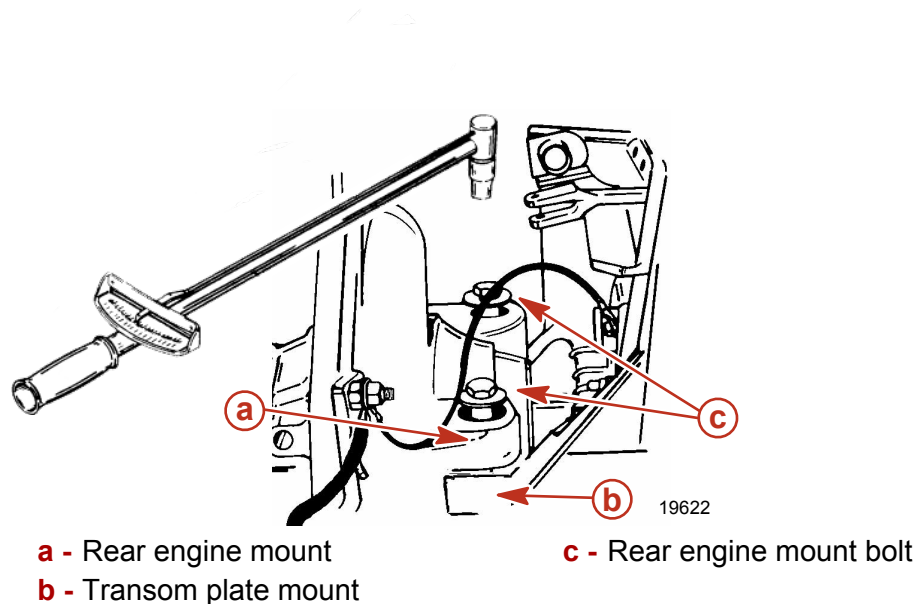


Tube Ref No.	Description	Where Used	Part No.
 91	Engine Coupler Spline Grease	Coupler	92-802869A1

NOTE: On Bravo models, the coupler and shaft splines can be lubricated without removing the sterndrive. Apply lubricant from a typical hand-operated grease gun until a small amount of grease begins to push out.

Engine Mounts

Loosen the rear engine mount bolts 1 to 1-1/2 turns. Retorque the rear engine mount bolts.



Description	Nm	lb. in.	lb. ft.
Rear engine mounts	51		38

Electrical System

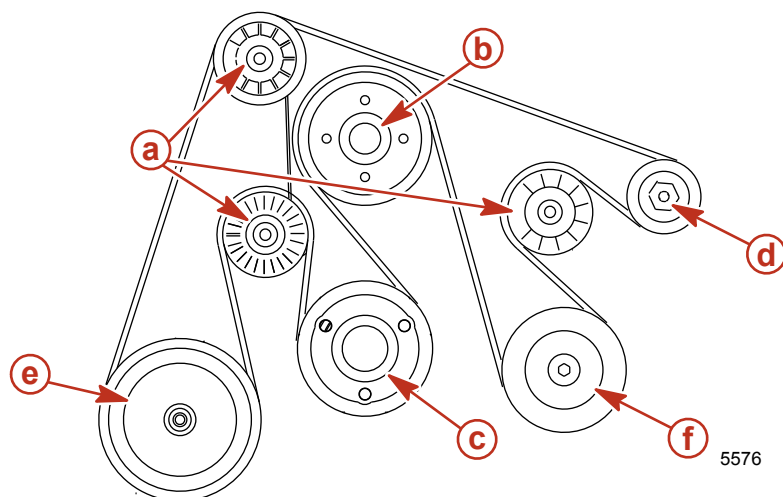
NOTE: Refer to **Section 4** for specific procedures.
Inspect the entire electrical system for loose, damaged or corroded fasteners.

Serpentine Drive Belt—Manual Tensioner

Component Location

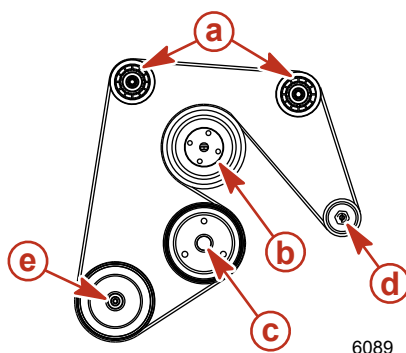
⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



Belt Routing Diagram—Sterndrive

- | | |
|------------------------------------|--|
| a - Idler pulley | d - Alternator pulley |
| b - Circulating pump pulley | e - Seawater pump pulley |
| c - Crankshaft pulley | f - Power assisted steering pump pulley |



Belt Routing Diagram—Inboard

- | | |
|------------------------------------|---------------------------------|
| a - Idler pulley | d - Alternator pulley |
| b - Circulating pump pulley | e - Seawater pump pulley |
| c - Crankshaft pulley | |

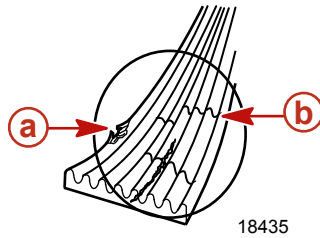
Checking

Inspect the drive belt for the following:

- Excessive wear
- 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)
- 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.

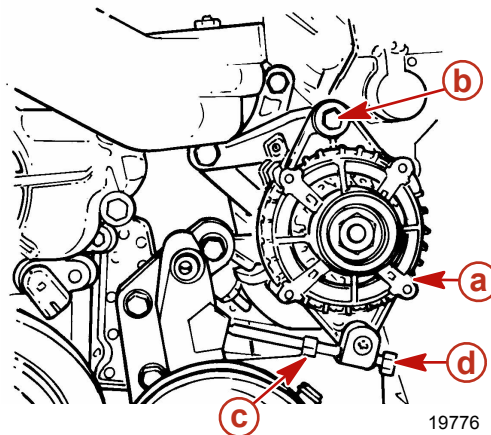


a - Fraying

b - Cracks

Removal

1. Loosen the alternator mounting bolt, and nut.
2. Loosen the tension bolt retainer nut.
3. Loosen the tension bolt.



a - Alternator

b - Alternator mounting bolt (nut not shown)

c - Retainer nut

d - Tension bolt

4. Move the alternator to relieve tension on the drive belt.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

5. If the belt is to be reused, mark the direction of the rotation.
6. Remove the belt.

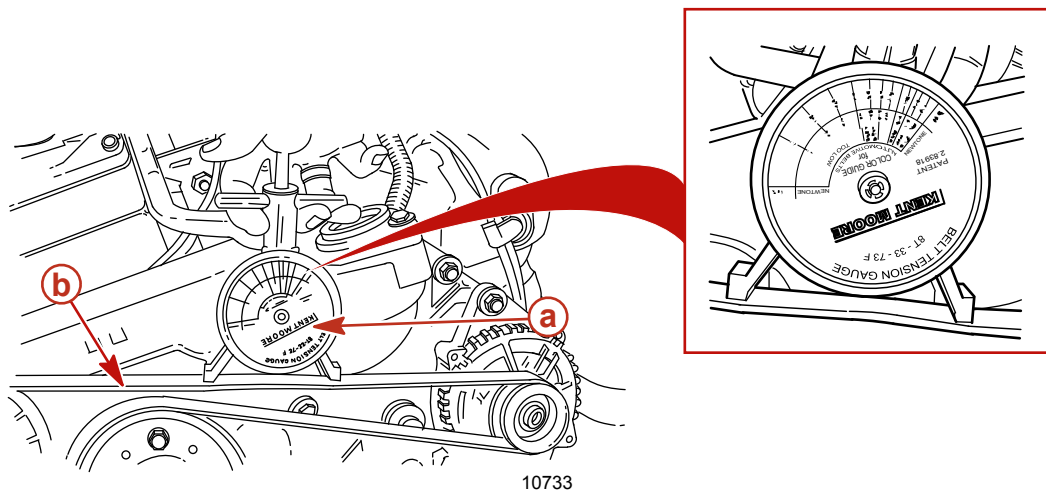
Installation and Adjustment

1. Install the drive belt onto the pulleys.
2. Position the tension bolt into the idler pulley bracket.
3. Tighten the tension bolt until the belt is taut.

NOTE: Measure belt deflection on the belt at the location that has the longest distance between the two pulleys.

4. Check the belt deflection between the upper idler pulley and the alternator pulley using one of the following methods.

- a. Attach a Kent Moore Belt Tension Gauge to the drive belt. The gauge has different ranges for new and used belts.



a - Kent Moore Tension Gauge

b - Serpentine belt

- b. If a belt tension gauge tool is not available, check the belt deflection by applying moderate downward pressure on the drive belt. Proper deflection is approximately 6 mm (1/4 in.).
5. Securely tighten the tension stud retainer nut.
6. Tighten the alternator attaching bolt and nut.
7. Supply cooling water to the engine.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

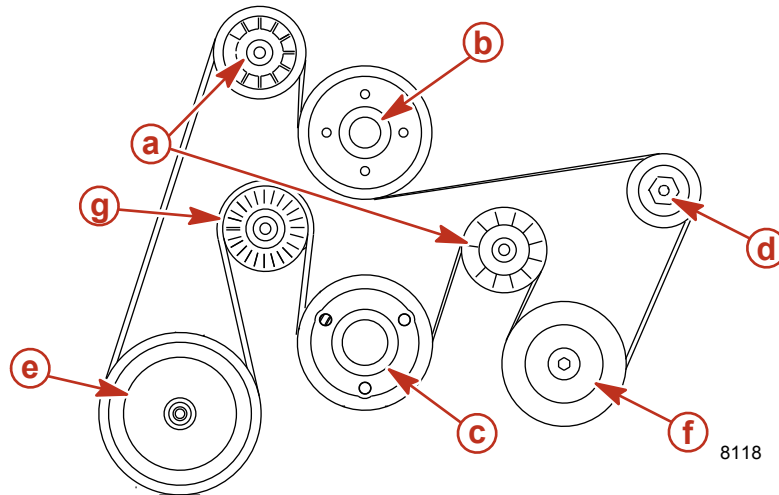
8. Operate the engine for a short period of time. Recheck the drive belt adjustment.

Serpentine Drive Belt—Automatic Tensioner

Serpentine Drive Belt—Sterndrive Models

⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



Belt Routing Diagram—Sterndrive

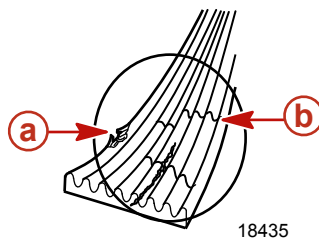
- | | |
|--|---------------------------------------|
| a - Idler pulley | e - Seawater pump pulley |
| b - Water circulating pump pulley | f - Power steering pump pulley |
| c - Crankshaft pulley | g - Tensioner pulley |
| d - Alternator pulley | |

CHECKING

Inspect the drive belt for the following:

- Excessive wear
- 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)
- 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.



a - Fraying

b - Cracks

REMOVAL

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

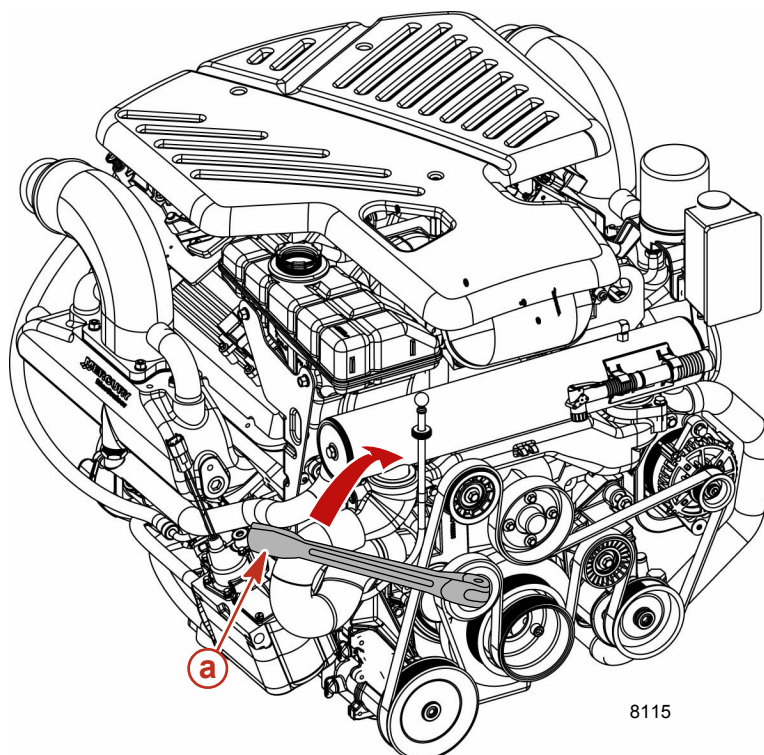
The belt tensioner is designed to operate within the limits of arm movement provided by the cast stops when the belt length and geometry are correct.

If the tensioner is contacting either of the limits 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 limits.

⚠ CAUTION

The belt tensioner assembly contains a high tension spring. Rapid release of the tensioner, or allowing the tensioner to snap back quickly, could injure the operator or cause product damage. Relieve the spring tension slowly to avoid injury or product damage.

1. Use a breaker bar and appropriate socket to hold back the tensioner and relieve the belt tension. Rotate the tensioner away from belt until it stops.
2. Remove the belt from the idler pulley and slowly relieve the tension on the breaker bar.



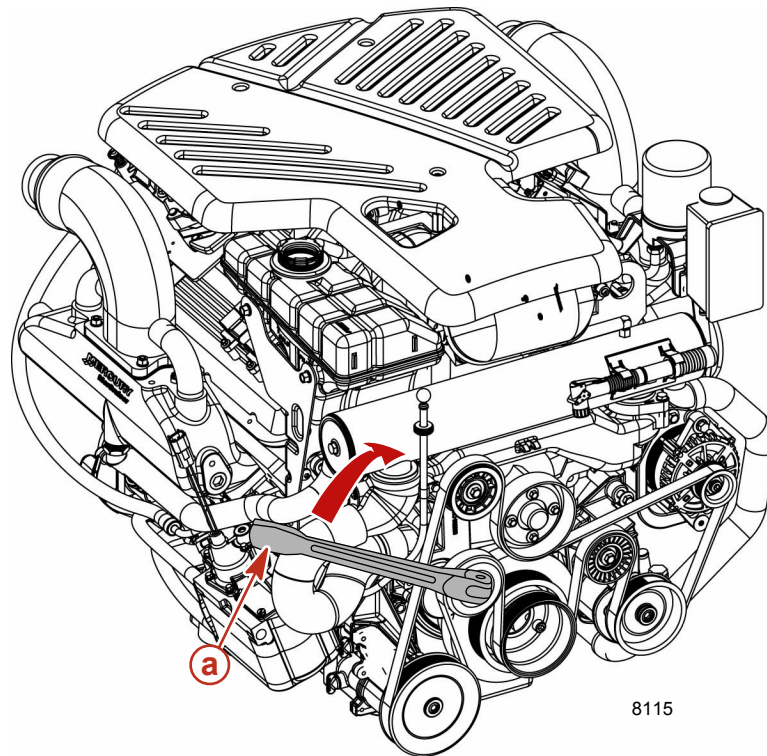
Breaker bar with arrow in direction of movement to relieve tension.

a - Breaker bar

INSTALLATION

1. Use a breaker bar and appropriate socket to position the tensioner back to the engine running location.

2. Install the the belt over the tensioner pulley. Slowly relieve the tensioner to the belt.



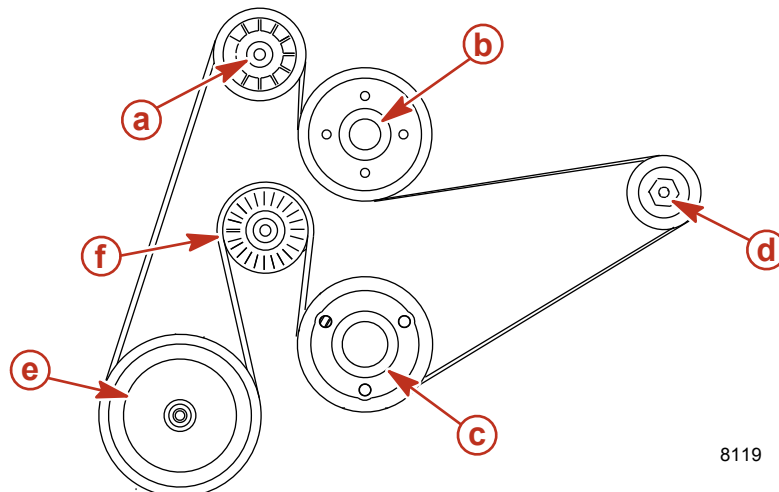
Breaker bar with arrow in direction of movement to reposition in tension.

a - Breaker bar

Serpentine Drive Belt—Inboard Models

⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



a - Idler pulley

b - Water circulating pump pulley

c - Crankshaft pulley

d - Alternator pulley

e - Seawater pump pulley

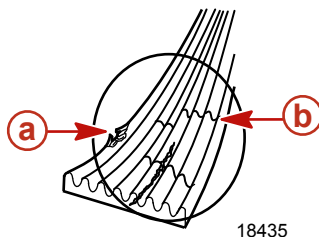
f - Tensioner pulley

CHECKING

Inspect the drive belt for the following:

- Excessive wear
- 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)
- 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.



a - Fraying

b - Cracks

REMOVAL

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

The belt tensioner is designed to operate within the limits of arm movement provided by the cast stops when the belt length and geometry are correct.

If the tensioner is contacting either of the limits 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 limits.

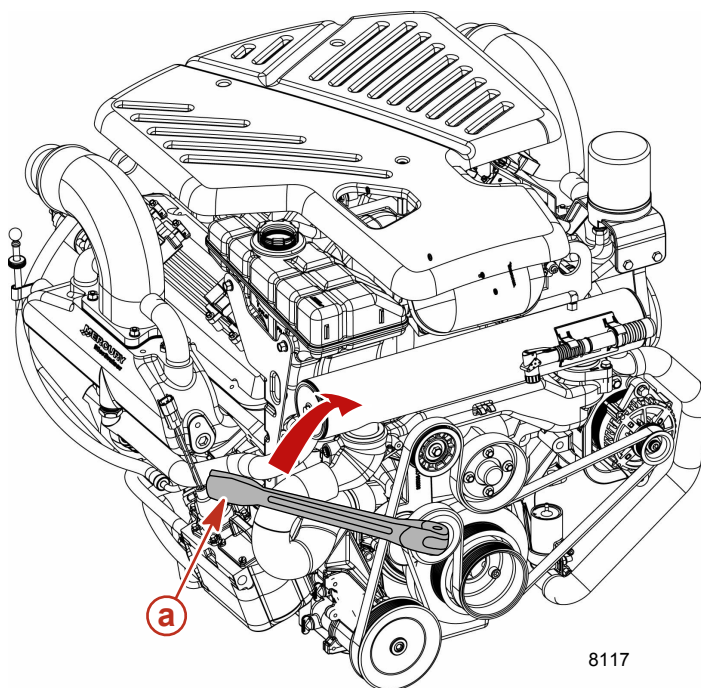
See your authorized MerCruiser dealer for service if these conditions exist.

CAUTION

The belt tensioner assembly contains a high tension spring. Rapid release of the tensioner, or allowing the tensioner to snap back quickly, could injure the operator or cause product damage. Relieve the spring tension slowly to avoid injury or product damage.

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

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

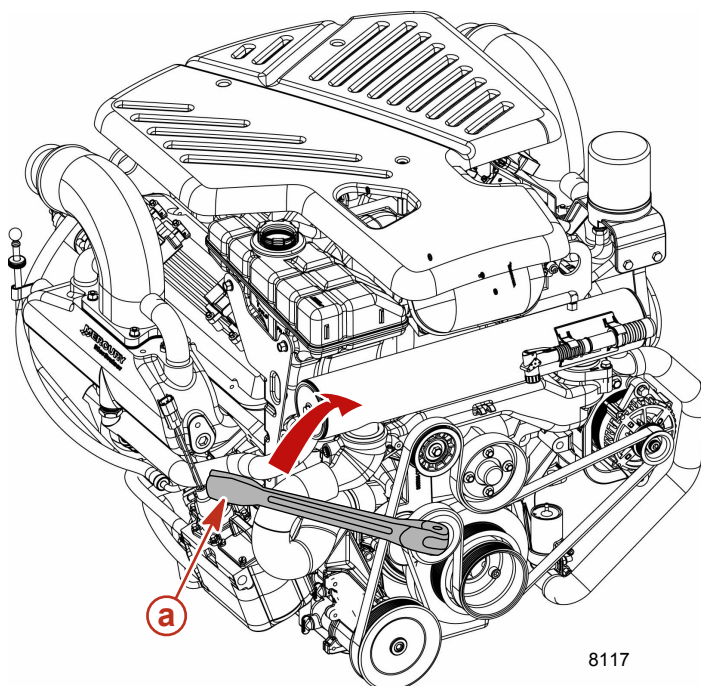


Breaker bar with arrow in direction of movement to relieve tension.

a - Breaker bar

INSTALLATION

1. Use a breaker bar and appropriate socket to position the tensioner back to the engine running location.
2. Install the belt over the tensioner pulley. Slowly relieve the tensioner to the belt.



Breaker bar with arrow in direction of movement to reposition in tension.

a - Breaker bar

Cold Weather or Extended Storage

Cold Weather Or Extended Storage

IMPORTANT: Mercury MerCruiser strongly recommends that this service should be performed by an authorized Mercury MerCruiser dealer. Damage caused by freezing IS NOT covered by the Mercury MerCruiser Limited Warranty.

CAUTION

Seawater section of cooling system must be completely drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine. Damage caused by freezing is not covered by the Mercury MerCruiser Limited Warranty.

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

Preparing Power Package For Storage

1. Fill the fuel tanks with fresh gasoline (that does not contain alcohol) and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat the gasoline. Follow instructions on the container.
2. **If the boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. See **Fuel Requirements** for additional information.
3. Flush the cooling system.
4. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off engine.
5. Change the oil and oil filter.
6. For additional assurance against freezing and rust, after draining the seawater section, fill the cooling system with a mixture of propylene glycol and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.

FUEL SYSTEM

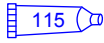
WARNING

The fuel injection system is pressurized. Avoid serious injury from an explosion. Use care when removing water separating fuel filter. Allow engine to cool down before removing the water separating fuel filter. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

1. In a 23 liter (6 U.S. gal.) remote fuel tank mix:
 - a. 19 liter (5 U.S. gal) regular unleaded 87 octane (90 RON) gasoline
 - b. 1.89 liter (2 U.S. qts.) Premium Plus 2-Cycle TC-W3 Outboard Oil
 - c. 150 ml (5 ounces) Fuel System Treatment and Stabilizer or 30 ml (1 ounce) Fuel System Treatment and Stabilizer Concentrate.

Tube Ref No.	Description	Where Used	Part No.
 115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-802824A1
 124	Fuel System Treatment & Stabilizer	Fuel system	802875A1

2. Allow the engine to cool down.

IMPORTANT: Immediately wipe up any fuel spills or sprays.

3. Close the fuel shut off valve, if equipped. Disconnect and plug the fuel inlet fitting if not equipped with a fuel shut off valve.
4. Connect the remote fuel tank (with the fogging mixture) to the fuel inlet fitting.

IMPORTANT: Supply cooling water to the engine.

5. Start and operate the engine at 1300 RPM for 5 minutes.
6. After specified operating time is complete, slowly return throttle to idle rpm and shut engine off.

IMPORTANT: Ensure that some fogging mixture remains in the engine. Do not allow the engine's fuel system to become completely dry.

7. Replace the water separating fuel filter element. See **Section 5** for proper procedure.

BATTERY

Follow the battery manufacturer's instructions for storage.

Power Package Recommissioning

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

CAUTION

Avoid electrical system damage. When installing the battery, be sure to connect the negative (-) battery cable to the negative (-) battery terminal and the positive (+) battery cable to the positive (+) battery terminal.

2. Install a fully-charged battery. Clean the battery cable clamps and terminals and reconnect cables (see CAUTION listed above). Tighten each cable clamp securely when connecting.
3. Coat the terminal connections with a battery terminal anti-corrosion agent.
4. Perform all the checks in the before starting column of the **Operations Chart**.

CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

5. Start the engine and closely observe 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.

Important Information

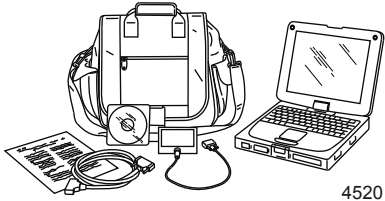
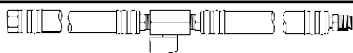
Section 1C - Troubleshooting

**1
C**

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Special Tools

Computer Diagnostic System (CDS)	Order through SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222
Fuel Shut Off Tool	91-805918A1
 7051	Tests fuel system pressure / vacuum

Finding Other Diagrams

NOTICE
Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

Precautions

⚠ WARNING Always disconnect battery cables from battery before working on fuel system to prevent fire or explosion.
⚠ WARNING Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor; ensure that ignition is off. Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor.
⚠ WARNING Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.
⚠ CAUTION Do not operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.
⚠ WARNING If engine is to be tested with boat out of water, the propeller must be removed to avoid injury.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

⚠ CAUTION

Avoid engine damage from overheating. If the engine is operated above 1400 RPM during flushing, suction created by the seawater pickup pump may collapse the flushing water hose, causing the engine to overheat.

⚠ CAUTION

Flush water will collect in the exhaust system when the engine is not operating, resulting in engine damage. Do not supply flush water for more than 15 seconds without the engine operating.

⚠ WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

Important Information

1. First, determine which engine system is causing the problem. To make an engine operate, three basic components—fuel, spark (ignition), and compression—are required. If all three components are present, the engine should operate. If any one of the three is missing, weak, or arriving at the wrong time, the engine will not operate.
2. Determine if any faults are present by using the CDS (Computer Diagnostic System), or a diagnostic tool. If faults are present, correct the fault before proceeding.

Computer Diagnostic System (CDS)	Order through SPX
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3. Determine if there is fuel present at the Schrader valve just behind the throttle body.
4. Remove the spark plugs and ensure that they are the correct type and heat range and are not fouled or burned.
5. Run a compression check on the engine to ensure that the engine is mechanically acceptable.

Poor Boat Performance and Poor Maneuverability

Symptom	Cause	Action
1. Bow too low.	1.0 Improper drive unit trim angle.	1.0 Trim the drive to the appropriate angle.
	1.1 Improper weight distribution.	1.1 Distribute the weight evenly.
	1.2 Improperly adjusted trim tabs or after planes.	1.2 Adjust the trim tabs or after planes
	1.3 Marine growth on boat bottom.	1.3 Clean the boat bottom.
	1.4 False bottom full of water.	1.4 Siphon the water from the false bottom. Determine the cause of the excess water.
	1.5 Permanent or power hook in the boat bottom.	1.5 Correct the boat bottom.

2. Bow too high.	2.0 Improper drive unit trim angle.	2.0 Trim the drive to the appropriate angle.
	2.1 Propeller pitch too high.	2.1 Replace with a lower pitch propeller.
	2.2 Marine growth on boat bottom.	2.2 Clean the boat bottom.
	2.3 Poorly operating engine.	2.3 Tune the engine.
	2.4 Improper weight distribution.	2.4 Distribute the weight evenly.
	2.5 Rocker in the boat bottom.	2.5 Correct the boat bottom.
	2.6 False bottom full of water.	2.6 Siphon the water from the false bottom. Determine the cause of the excess water.
	2.7 Improperly adjusted trim tabs or after planes.	2.7 Adjust the trim tabs or after planes.
3. Propeller ventilation.	3.0 Marine growth on boat bottom.	3.0 Clean the boat bottom.
	3.1 Damaged propeller, pitch too small, diameter too small.	3.1 Replace the propeller.
	3.2 Water pickup or through-hull fittings located too close to the propeller.	3.2 Remove the water pickup or the through-hull fittings. Repair the hull. Reinstall the water pickup or the through-hull fittings in the proper locations.
	3.3 Permanent or power hook in boat bottom.	3.3 Repair the boat bottom.
	3.4 Propeller plugged up with weeds.	3.4 Clean the propeller.
	3.5 Keel located too close to the propeller or too deep in the water.	3.5 Repair the hull.
	3.6 Drive unit installed too high on the transom.	3.6 Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position.

Improper Full Throttle Engine RPM

Symptom	Cause	Action
1. Full throttle engine RPM too high.	1.0 Propeller damaged, pitch too low, diameter too small, propeller hub slipping.	1.0 Replace the propeller.
	1.1 Water pickup or through-hull fittings located too close to the propeller.	1.1 Remove the water pickup or the through-hull fittings. Repair the hull. Reinstall the water pickup or the through-hull fittings in the proper locations.
	1.2 Improper drive unit trim angle.	1.2 Trim the drive unit to the appropriate angle.
	1.3 Keel located too close to the propeller or too deep in the water.	1.3 Repair the hull.
	1.4 Drive unit installed too high on the transom.	1.4 Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position.
	1.5 Wrong gear ratio drive unit.	1.5 Replace the drive unit with the appropriate gear ratio.

2. Full throttle engine RPM too low.	2.0 Improper drive unit trim angle.	2.0 Replace the propeller.
	2.1 Drive unit trimmed in too far.	2.1 Trim the drive unit to the appropriate angle.
	2.2 Marine growth on boat bottom.	2.2 Clean the boat bottom.
	2.3 Damaged boat bottom.	2.3 Repair the boat bottom.
	2.4 Permanent or power hook in the boat bottom.	2.4 Repair the boat bottom.
	2.5 False bottom full of water.	2.5 Siphon the water from the false bottom. Determine the cause of the excess water.
	2.6 Drive unit installed too low on the transom.	2.6 Remove the drive unit. Reglass the transom and recut the hole. Reinstall the drive unit in the proper position.
	2.7 Wrong gear ratio drive unit.	2.7 Replace the drive unit with the appropriate gear ratio.
	2.8 Wrong propeller selection.	2.8 Replace with the correct propeller for the specific application.

Engine Cranks Over but Will Not Start or Starts Hard

Symptom	Cause	Action
1. Engine cranks over but will not start or starts hard.	1.0 Fuel shut off valve closed.	1.0 Open the fuel shut off valve.
	1.1 Lanyard stop switch tripped.	1.1 Reset the lanyard stop switch.
	1.2 Blown fuse.	1.2 Check the fuses on the engine
	1.3 Water in the fuel.	1.3 Treat the contaminated fuel with appropriate fuel treatment. Replace the Gen II water separating fuel filter. Check the Gen III water separating fuel filter element. If the problem persists, drain the fuel tank and refill.
	1.4 Low grade or stale fuel.	1.4 Drain the fuel tank and refill.
	1.5 Faulty fuel pump relay.	1.5 Check the fuel pump relay.
	1.6 Slow cranking battery.	1.6 Check the battery and battery connections.
	1.7 Vapor lock.	1.7 See Vapor Lock Condition .

Engine Will Not Crank Over

Symptom	Cause	Action
1. Engine will not crank over.	1.0 Remote control lever not in NEUTRAL position.	1.0 Place the remote control lever in NEUTRAL and try the ignition again. If the problem persists, check the remote control lever NEUTRAL detent setting.
	1.1 Battery switch in the wrong position, battery charge low, damaged wiring, loose electrical connections, faulty main power relay.	1.1 Check the battery switch position, check the electrical connections at the starter. Check the battery cable connections. Check the battery charge and recharge if necessary, check the main power relay.
	1.2 Circuit breaker tripped.	1.2 Reset the circuit breaker.
	1.3 Blown fuse.	1.3 Replace the fuse.
	1.4 Ignition switch faulty.	1.4 Replace the ignition switch.
	1.5 Slave solenoid faulty.	1.5 Replace the slave solenoid.
	1.6 Faulty neutral start safety switch.	1.6 Replace the neutral start safety switch.
	1.7 Starter solenoid faulty.	1.7 Replace the starter solenoid.
	1.8 Starter motor faulty.	1.8 Replace the starter motor.
	1.9 Mechanical engine malfunction.	1.9 Determine the cause of the malfunction and repair.

Charging System Inoperative

Symptom	Cause	Action
1. Charging system inoperative.	1.0 Loose or broken drive belt.	1.0 Replace the serpentine drive belt.
	1.1 Engine RPM too low on initial start.	1.1 Accelerate the engine to 1500 RPM.
	1.2 Loose or corroded electrical connections.	1.2 Check the electrical connections.
	1.3 Faulty battery gauge.	1.3 Replace the gauge
	1.4 Battery will not accept charge.	1.4 Check the electrolyte level and fill if necessary. Replace the battery.
	1.5 Faulty alternator or regulator.	1.5 Test the alternator and replace if necessary.

Noisy Alternator

Symptom	Cause	Action
1. Noisy alternator.	1.0 Loose mounting bolts.	1.0 Tighten the mounting bolts.
	1.1 Loose or broken drive belt.	1.1 Replace the serpentine drive belt.
	1.2 Loose drive pulley.	1.2 Tighten the drive pulley.
	1.3 Worn or dirty bearings.	1.3 Replace the alternator.
	1.4 Faulty diode trio or stator.	1.4 Replace the alternator.

Instrumentation Malfunction

IMPORTANT: For information on SmartCraft Gauges, refer to the appropriate Mercury MerCruiser SmartCraft DTS (Digital Throttle and Shift) Service Manual.

Symptom	Cause	Action
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1. Instrumentation malfunction.	1.0 Faulty wiring, loose or corroded terminals.	1.0 Check the electrical connections.
	1.1 Faulty key switch.	1.1 Replace the key switch.
	1.2 Faulty gauge.	1.2 Replace the gauge.
	1.3 Faulty sender.	1.3 Replace the sender.
	1.4 Faulty analog gauge interface.	1.4 Check the analog gauge interface.
	1.5 Improper AGI (analog gauge interface) configuration.	1.5 Check the AGI configuration.

Radio Noise

Symptom	Cause	Action
1. A popping noise that increases with engine RPM. Noise stops as soon as engine is turned off.	1.0 Wrong spark plugs.	1.0 Change the spark plugs.
	1.1 Leaking spark plug wires.	1.1 Change the spark plug wires.
	1.2 Moisture on ignition components.	1.2 Check all ignition components for corrosion.
2. A high-pitched whine in the radio.	2.0 Alternator—poor brush contact on the slip rings.	2.0 Test the alternator. Replace if necessary.
	2.1 Wrong spark plugs.	2.1 Install the correct spark plugs.
3. A hissing or crackling noise when instruments are jarred with ignition on.	3.0 Instrumentation—loose connections or antennae wire routed too close to instruments.	3.0 Check the instrument harness connections. Check the antennae routing.
4. Varying unexplained noises.	4.0 Accessories—bilge pump, bilge blower, fish finder, depth locator, cabin heater motor, etc.	4.0 Disconnect the accessories one at a time until the noise disappears. Replace the faulty accessory.

Poor Fuel Economy

Symptom	Cause	Action
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1.0 Poor fuel economy.	1.0 Fuel leak.	1.0 Locate the leak and repair.
	1.1 Operator habits—Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution.	1.1 Educate the operator.
	1.2 Engine laboring—Bent, damaged or wrong propeller.	1.2 Water test the boat for proper operating RPM at WOT.
	1.3 Clogged flame arrestor.	1.3 Clean the flame arrestor.
	1.4 Engine compartment sealed too tight.	1.4 Vent the engine hatch appropriately.
	1.5 Boat bottom dirty (marine growth), hook, rocker.	1.5 Clean the boat bottom.
	1.6 Improper fuel.	1.6 Drain the fuel tank and refill with the correct fuel.
	1.7 Excessive fuel pressure.	1.7 Check the fuel pressure.
	1.8 Engine needs tune-up.	1.8 Perform the cylinder cut-out test. Change the spark plugs. Check the ignition coils for cracks or corrosion, change the spark plug wires, check all ignition components for corrosion.
	1.9 Engine running too cold or too hot.	1.9 Check the thermostat, check for kinked or restricted hoses, clean the cooling system.
	1.10 Plugged or restricted exhaust.	1.10 Clean the exhaust system.
	1.11 Low compression.	1.11 Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, the valves, or the pistons.

Engine Runs Poorly at Idle

Symptom	Cause	Action
1. Engine surges.	1.0 Leaking idle air control (IAC), intake manifold, throttle body gaskets, or carburetor gaskets.	1.0 Find and replace the leaking gaskets.
	1.1 Throttle valves worn or damaged.	1.1 Inspect the throttle valves. Replace the throttle body if necessary.
	1.2 Worn or leaking IAC hose or vacuum hose to the pressure regulator.	1.2 Find and replace the leaking hose.
3. Poor cold engine operation.	3.0 Engine is not reaching normal operating temperature.	3.0 Replace the thermostat or the thermostat housing gasket.
	3.1 Faulty engine temperature sensor (ECT).	3.1 Replace the ECT.
	3.2 Fuel pressure too high or too low.	3.2 Determine the cause and repair.
	3.3 Throttle valves worn or damaged.	3.3 Inspect the throttle valves. Replace the throttle body if necessary.
	3.4 Engine flooding (MPI).	3.4 Check the fuel pressure. If too high, find cause and correct. Clean the flame arrestor. Perform the cylinder balance test.

4. Engine stalls.	4.0 Idle RPM too low.	4.0 Clean the flame arrestor. Test the IAC to see if it opens and closes properly.
	4.1 Engine flooding (MPI).	4.1 Check the fuel pressure. If too high, find cause and correct. Inspect the fuel pressure regulator. Inspect the injectors.
	4.2 Leaking idle air control (IAC), intake manifold, throttle body gaskets or carburetor gaskets.	4.2 Find and replace the leaking gaskets.
5. Engine misses.	5.0 Fault in the ignition system.	5.0 Use the Computer Diagnostic System (CDS) to check the ignition system. Check the spark plugs. Check the spark plug wires. Check the ignition coil operation. Replace the faulty component.
6. Hard starting.	6.0 Engine starts hard.	6.0 See Engine Starts Hard .

Engine Runs Poorly at High RPM

Symptom	Cause	Action
1. Engine runs poorly at high RPM.	1.0 Crankcase overfilled with oil.	1.0 Check the oil level with the boat at rest in the water. Drain the oil if necessary to obtain the correct level.
	1.1 Anti-siphon valve restricting fuel supply.	1.1 Check the fuel flow rates and repair, replace or remove anti-siphon valve as necessary.
	1.2 Plugged fuel tank vent.	1.2 Clean the fuel tank vent.
	1.3 Improper fuel supply.	1.3 Inspect the fuel supply system. Repair or replace as necessary.
	1.4 Low grade or stale fuel.	1.4 Drain the fuel tank and refill.
	1.5 Water in the fuel.	1.5 Treat the contaminated fuel with appropriate fuel treatment. If the problem persists, drain the fuel tank and refill.
	1.6 Spark plugs fouled, burned, cracked porcelain, or incorrect heat range.	1.6 Inspect the spark plugs and service or replace.
	1.7 Spark plug wires broken or poorly insulated.	1.7 Replace the spark plug wires.
	1.8 Coil or coils damaged or malfunctioning.	1.8 Replace the coil or coils.
	1.9 Engine RPM too high.	1.9 Use CDS to determine if in overspeed.
	1.10 Engine overheating.	1.10 Check cooling water supply or coolant level.
	1.11 Low compression—worn valves, rings or seals.	1.11 Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, valves, or pistons.
	1.12 Plugged or restricted exhaust.	1.12 Clean the exhaust system.
	1.13 Clogged water separating fuel filter.	1.13 Change the water separating fuel filter.
	1.14 Excessive fuel restriction.	1.14 Perform the fuel pressure test.

Engine Acceleration Is Poor

Symptom	Cause	Action
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1. Engine acceleration is poor.	1.1 Vacuum leak.	1.1 Locate and repair the vacuum leak.
	1.2 Spark plugs fouled, burned, cracked porcelain, or incorrect heat range.	1.2 Inspect the spark plugs and service or replace.
	1.3 Low fuel pressure.	1.3 Perform the fuel pressure test.
	1.4 Excessive fuel restriction.	1.4 Perform the fuel pressure test.
	1.5 Low compression—worn valves, rings, or seals, one or more cylinders not firing.	1.5 Perform the cylinder cut-out test, perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, valves, or pistons.

Troubleshooting With Vacuum Gauge

Symptom	Cause	Action
1. Steady reading between 38.1 and 53.3 cm (15 and 21 in.) at idle RPM.	1.0 Normal.	1.0 No action necessary.
2. Extremely low reading, but steady at idle RPM.	2.0 Vacuum leak, underpowered boat, faulty boat bottom.	2.0 Determine the source of the vacuum leak and repair. Replace the propeller. If the problem persists, contact the manufacturer about the correct power package. Repair the boat bottom.
3. Fluctuates between high and low at idle RPM.	3.0 Blown cylinder head gasket between two adjacent cylinders.	3.0 Determine the cause and replace the cylinder head gasket.
4. Fluctuates 10.1–12.7 cm (4–5 in.) very slowly at idle RPM.	4.0 Spark plug gap too narrow.	4.0 Inspect the spark plugs and service or replace if necessary.
5. Fluctuates rapidly at idle, steadies as RPM is increased.	5.0 Valve guides are worn.	5.0 Ream the valve guides and install a valve with an oversized stem or replace the cylinder head.
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM.	6.0 Burned or leaking valve.	6.0 Replace the valve.

Engine Noise

Important Information

No definite rule or test will positively determine the source of engine noise. Use the following information as a general guide to diagnose engine noise.

1. Use a timing light to determine if the noise is timed with engine speed or 1/2 engine speed. Noises timed with engine speed are related to the crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to 1/2 engine speed are valve train related.
2. 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

3. If you believe the noise is confined to one particular cylinder, use the CDS to perform a cylinder cut-out test. If the noise lessens noticeably or disappears, it is isolated to that particular cylinder.

Computer Diagnostic System (CDS)	Order through SPX
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4. Try to isolate the noise to a location in the engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are the flywheel or coupler; the exhaust flappers rattling against exhaust pipe; the crankshaft striking the oil pan, oil pan baffle, or dipstick tube; the rocker arm striking the valve cover, or a loose flywheel cover. In many cases, if this is found to be the problem, a complete engine teardown is not necessary.
6. When the noise is isolated to a certain area and component, removal and inspection will be required. See the appropriate sections of the service manual for the information required for service.
7. If the noise cannot be distinguished between the engine and the drive unit, remove the drive from the boat. Supplying water directly to the engine, operate the engine without the drive to determine whether the noise still occurs.

Symptom	Action	Cause
1. Engine noise in the valve cover area, timed to 1/2 engine speed, noise can be confined to one cylinder or may be found in any number of cylinders.	1.0 Rocker arm striking cover.	1.0 Inspect the valve cover for damage. Replace if necessary.
	1.1 Rocker arm out of adjustment.	1.1 Adjust the rocker arm.
	1.2 Worn rocker arm.	1.2 Replace the rocker arm.
	1.3 Bent push rod.	1.3 Replace the push rods.
	1.4 Collapsed lifter.	1.4 Replace the lifter.
	1.5 Sticking valve.	1.5 Inspect the valves and repair or replace.
2. Engine noise in cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed.	2.0 Carbon build-up.	2.0 Inspect the internal engine components for carbon buildup. Clean or replace.
	2.1 Connecting rod installed wrong.	2.1 Remove the connecting rods and install properly.
	2.2 Bent connecting rod.	2.2 Replace the connecting rod.
	2.3 Piston damaged or broken.	2.3 Inspect the piston. Replace if necessary.
	2.4 Piston rings damaged or broken.	2.4 Inspect the piston rings. Replace if necessary.
	2.5 Piston pin damaged or broken.	2.5 Inspect the piston pin. Replace if necessary.
3. Engine noise in camshaft area, front of the engine, timed to 1/2 engine speed.	2.6 Worn cylinder.	2.6 Inspect the cylinder. Bore as necessary. Replace the cylinders if necessary.
	3.0 Crankshaft timing sprocket damaged.	3.0 Inspect the crankshaft timing sprocket. Replace if necessary.
	3.1 Timing chain damaged.	3.1 Inspect the timing chain. Replace if necessary.
	3.2 Valve lifter damaged.	3.2 Inspect the valve lifter. Replace if necessary.
	3.3 Camshaft bearings damaged.	3.3 Inspect the cam bearings. Replace if necessary.

4. Engine noise in camshaft area, center of the engine, timed to 1/2 engine speed.	4.0 Valve lifter damaged.	4.0 Inspect the valve lifter. Replace if necessary.
	4.1 Camshaft bearing damaged.	4.1 Inspect the camshaft bearings. Replace if necessary.
5. Engine noise in camshaft area, rear of the engine, timed to 1/2 engine speed.	5.0 Valve lifter damaged.	5.0 Inspect the valve lifter. Replace if necessary.
	5.1 Camshaft bearings damaged.	5.1 Inspect the camshaft bearings. Replace if necessary.
6. Engine noise in camshaft area, throughout the engine, timed to 1/2 engine speed.	6.0 Loss of oil pressure.	6.0 Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss. Check for leaks. Check the oil pressure gauge operation. Check the oil pump operation.
	6.1 Valve lifters damaged.	6.1 Inspect the valve lifters. Replace if necessary.
	6.2 Camshaft bearings damaged.	6.2 Inspect the camshaft bearings. Replace if necessary.
7. Engine noise in crankshaft area, front of the engine, timed to engine speed.	7.0 Crankshaft timing sprocket damaged.	7.0 Inspect the crankshaft timing sprocket. Replace if necessary.
	7.1 Timing chain damaged.	7.1 Inspect the timing chain. Replace if necessary.
	7.2 Main bearing damaged.	7.2 Inspect the main bearing. Replace if necessary.
	7.3 Rod bearing damaged.	7.3 Inspect the rod bearing. Replace if necessary.
8. Engine noise in crankshaft area, center of the engine, timed to engine speed.	8.0 Crankshaft striking the oil pan or the oil pan baffle.	8.0 Inspect the oil pan and the oil pan baffle. Repair or replace as necessary.
	8.1 Main bearing damaged.	8.1 Inspect the main bearing. Replace if necessary.
	8.2 Rod bearing damaged.	8.2 Inspect the rod bearing. Replace if necessary.
9. Engine noise in crankshaft area, rear of the engine, timed to engine speed.	9.0 Loose flywheel cover.	9.0 Tighten the flywheel cover fasteners.
	9.1 Loose coupler.	9.1 Tighten the coupler fasteners.
	9.2 Loose flywheel.	9.2 Tighten the flywheel fasteners.
	9.3 Main bearing damaged.	9.3 Inspect the main bearing. Replace if necessary.
	9.4 Rod bearing damaged.	9.4 Inspect the rod bearing. Replace if necessary.
10. Engine noise in the crankshaft area, throughout the engine, timed to engine speed.	10.0 Loss of oil pressure.	10.0 Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss. Check for leaks. Check the oil pressure gauge operation. Check the oil pump operation.
	10.1 Main bearings damaged.	10.1 Inspect the main bearing. Replace if necessary.
	10.2 Rod bearings damaged.	10.2 Inspect the rod bearing. Replace if necessary.
11. Engine spark knock.	11.0 Low grade or stale fuel.	11.0 Drain the fuel tank and refill.
	11.1 Engine overheating.	11.1 Check cooling water supply or coolant level.
	11.2 Carbon build-up.	11.2 Inspect the internal engine components for carbon buildup. Clean or replace.

12. Hissing.	12.0 Vacuum leak.	12.0 Locate and repair the vacuum leak.
	12.1 Leaking exhaust (manifolds or pipes).	12.1 Inspect the exhaust manifolds and elbows for cracks or porosity. Replace the gaskets.
	12.2 Loose cylinder heads.	12.2 Ensure that the cylinder head bolts are properly torqued. Replace the bolts if necessary.
	12.3 Blown cylinder head gasket.	12.3 Determine the cause of blown gasket and replace the gasket.
	12.4 Throttle body gasket installed wrong, or leaking.	12.4 Replace the throttle body gasket.
13. Throttle body whistle.	13.0 Vacuum leak.	13.0 Locate and repair the vacuum leak.
	13.1 Dry or tight bearing in an accessory.	13.1 Locate the bearing and lubricate or replace.
	13.2 IAC muffler misaligned or missing.	13.2 Install new muffler or realign.
14. Sparks jumping.	14.0 Cracked coil tower.	14.0 Replace the ignition coil.
15. Squeaks or squeals.	15.0 Drive belt slipping.	15.0 Replace the drive belt.
	15.1 Dry or tight bearing in an accessory.	15.1 Locate the bearing and lubricate or replace.
	15.2 Parts rubbing together.	15.2 Locate the parts and correct the cause.
16. Rattling in the exhaust pipe area.	16.0 Exhaust shutters damaged.	16.0 Inspect the exhaust shutters for damage. Replace if necessary.

Oil Pressure

Symptom	Cause	Action
1. Loss of engine RPM, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM.	1.0 Oil level in the crankcase above the "FULL" or "OK RANGE" mark.	1.0 Drain excess oil.
2. Low oil pressure, oil pressure gauge fluctuation, internal engine noise or damage.	2.0 Oil level in the crankcase below the "ADD" mark.	2.0 Add oil to the correct level. Determine if engine noise is still present and if so, diagnose internal engine damage.
3. Change in oil pressure.	3.0 This may be a normal condition. Oil pressure may be high in the cooler times of the day and when the engine is not up to operating temperature. As the air temperature warms up and the engine is operating at normal temperature, it is normal for oil pressure to drop.	3.0 Check oil level. If oil level is accurate and oil pump appears to be working, no further action is necessary.
4. Low engine oil pressure at idle.	4.0 With modern engines and engine oils, low oil pressure readings at idle do not necessarily indicate a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat.	4.0 Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.

5. Low engine oil pressure at idle after operating at a high RPM.	5.0 With modern engines and engine oils, low oil pressure readings at idle do not necessarily indicate a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat.	5.0 Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
6. Differences in oil pressure between engines on boats with dual engines.	6.0 It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, or other differences.	6.0 Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
7. Differences in oil pressure between stations on boats with dual stations.	7.0 It is not uncommon to see different oil pressure readings between the two stations, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, or other differences.	7.0 Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
8. Low oil pressure.	8.0 Low oil level in crankcase.	8.0 Check the oil level with the dipstick. Add oil as necessary.
	8.1 Defective oil pressure gauge and/or sender.	8.1 Verify with an automotive test gauge.
	8.2 Thin or diluted oil.	8.2 Change the oil, and oil filter.
	8.3 Faulty oil pump.	8.3 Ensure that the relief valve opens and closes properly. Check the pickup tube for restrictions. Rebuild or replace the oil pump.
	8.4 Internal or external oil leak.	8.4 Check for oil passage plugs leaking. Check the cylinder block for cracks.
	8.5 Excessive bearing clearance.	8.5 Inspect bearings and replace if necessary.
9. High oil pressure.	9.0 Oil too thick.	9.0 Change the oil.
	9.1 Defective oil pressure gauge and/or sender.	9.1 Verify with an automotive test gauge.
	9.2 Clogged or restricted oil passage.	9.2 Clean all oil passages.
	9.3 Oil pump relief valve stuck closed.	9.3 Repair or replace oil pump.

Excessive Oil Consumption

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

IMPORTANT: When excessive oil consumption is suspected, use the CDS to perform the cylinder cut-out test, and the cylinder compression test. See the following chart for other possible causes, and the suggested action.

Symptom	Cause	Action
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1. Excessive oil consumption.	1.0 Oil leaks.	1.0 Clean the bilge, place white paper on the floor of the bilge, and run the engine to locate oil leaks.
	1.1 Oil too thin.	1.1 Change the oil.
	1.2 Oil level too high.	1.2 Drain the oil and verify the cause of the excessive oil. Change the oil and recheck periodically.
	1.3 Drain holes in the cylinder head plugged, causing oil to flood the valves.	1.3 Clean the drain holes.
	1.4 Defective oil cooler.	1.4 Replace the oil cooler.
	1.5 Intake manifold gasket leaking.	1.5 Replace the intake manifold gasket.
	1.6 Worn valve stems or valve guides.	1.6 Replace the valves or valve guides.
	1.7 Defective valve seals.	1.7 Replace the valve seals.
	1.8 Defective piston rings.	1.8 Replace the piston rings.
	1.9 Excessive bearing clearance.	1.9 Replace the bearings.

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 Read Boat in the Water Procedure in the Operation, Maintenance and Warranty Manual .
	1.1 Spark plug misfiring.	1.1 Use the CDS to perform the cylinder cut-out test. Inspect and service the spark plugs. Replace if necessary.
	1.2 Water ingestion through the exhaust system.	1.2 Verify the exhaust elbow height. Repair the exhaust system.
	1.3 Improper engine or exhaust hose installation.	1.3 Check the engine installation specifications.
	1.4 Cracked exhaust manifold.	1.4 Replace the exhaust manifold.
	1.5 Corroded exhaust elbow.	1.5 Replace the exhaust elbow.
	1.6 Loose cylinder head bolts.	1.6 Tighten the cylinder head bolts.
	1.7 Blown cylinder head gasket.	1.7 Determine the cause of blown gasket and replace the gasket.
	1.8 Cracked valve seat.	1.8 Replace the valves.
2. Water in 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.

Engine Overheats

Mechanical

IMPORTANT: First check if the engine is actually overheating or if the temperature gauge or sender is faulty.

Symptom	Cause	Action
1. Engine overheats (mechanical).	1.0 Engine RPM below specifications at WOT (engine laboring).	1.0 Replace the propeller. Clean the boat bottom. Check the false bottom for water.
	1.1 Spark plug wires crossed (wrong firing order).	1.1 Install the spark plug wires correctly.
	1.2 Lean fuel mixture.	1.2 Drain the fuel tank and refill with the appropriate fuel.
	1.3 Wrong heat range spark plugs.	1.3 Replace the spark plugs.
	1.4 Exhaust restriction.	1.4 Inspect the exhaust system and repair.
	1.5 Valve timing incorrect.	1.5 Adjust the valves.
	1.6 Blown cylinder head gaskets.	1.6 If the engine overheats above 3000 RPM, replace the cylinder head gasket. On seawater cooled engines, install a clear plastic hose between the thermostat housing and the exhaust manifolds. If air bubbles are present at a higher RPM, replace the cylinder head gasket.
	1.7 Insufficient lubrication to the moving parts of the engine.	1.7 Check the oil level. add if necessary. Check the oil flow through the oil passages. Clean as necessary.

2. Engine overheats (cooling system).	2.0 Loose or broken drive belt.	2.0 Replace the serpentine drive belt.
	2.1 Seawater shut off valve partially or fully closed (if equipped).	2.1 Open the seawater shut off valve.
	2.2 Clogged or improperly installed seawater strainer.	2.2 Clean the seawater strainer. Reinstall the seawater strainer.
	2.3 Loose hose connections between the seawater pickup and seawater pump inlet.	2.3 Tighten all hose clamps.
	2.4 Seawater inlet hose kinked or collapsed.	2.4 Visually inspect the seawater inlet hose and shorten or replace as necessary.
	2.5 Seawater pickup clogged.	2.5 Clean the seawater pickup.
	2.6 Marine growth on boat bottom.	2.6 Clean the boat bottom.
	2.7 Defective thermostat.	2.7 Replace the thermostat.
	2.8 Exhaust elbow water outlet holes plugged.	2.8 Clean the water outlet holes.
	2.9 Insufficient seawater pump operation.	2.9 See Section 6 .
	2.10 Obstruction in cooling system such as casting flash, sand, rust, and salt.	2.10 Flush the cooling system.
	2.11 Engine water circulating pump defective.	2.11 Replace the water circulating pump.
	2.12 Low coolant level.	2.12 Fill the coolant reservoir.
	2.13 Antifreeze not mixed properly.	2.13 Drain and replace the coolant.
	2.14 Heat exchanger cores plugged.	2.14 Clean the heat exchanger.
	2.15 Water hoses reversed at the water distribution block.	2.15 Install the hoses properly.
	2.16 Worn or damaged seawater pump impeller.	2.16 Replace the seawater pump impeller.
3. Insufficient water flow from the belt driven seawater pump	3.0 Loose or broken drive belt.	3.0 Adjust belt tension, replace the serpentine drive belt.
	3.1 Seawater shut off valve partially or fully closed (if equipped).	3.1 Open the seawater shut off valve.
	3.2 Clogged or improperly installed seawater strainer.	3.2 Clean the seawater strainer. Reinstall the seawater strainer.
	3.3 Loose hose connections between the seawater pickup and seawater pump inlet.	3.3 Tighten all hose clamps.
	3.4 Seawater inlet hose kinked or collapsed.	3.4 Visually inspect the seawater inlet hose and shorten or replace as necessary.
	3.5 Seawater pickup clogged.	3.5 Clean the seawater pickup.
	3.6 Marine growth on boat bottom.	3.6 Clean the boat bottom.
	3.7 Faulty seawater pump.	3.7 Replace the seawater pump.
	3.8 Worn or damaged seawater pump impeller.	3.8 Replace the seawater pump impeller.

Power Assisted Steering

Symptom	Cause	Action
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1. Poor, erratic, or no assist.	1.0 Loose or broken drive belt.	1.0 Replace the drive belt.
	1.1 Fluid level low.	1.1 Fill the system.
	1.2 Air in the system.	1.2 Bleed the lines.
	1.3 Leaking hoses.	1.3 Bleed the lines.
	1.4 Steering cables and/or steering helm binding.	1.4 Clean the rust or the debris from the cable and the helm. Remove and reinstall the cable. Check the cable lubrication.
	1.5 Restriction in hydraulic hoses causing loss of pressure.	1.5 Inspect the hydraulic hoses for kinks.
	1.6 Control valve not properly positioned.	1.6 Position control valve properly.
	1.7 Mounting bracket adjusting screw loose.	1.7 Tighten the mounting nut.
	1.8 Faulty pump causing the flow control valve to stick.	1.8 Repair or replace the pump.
	1.9 Leaking valve body or loose fitting spool.	1.9 Tighten the fitting spool. Repair or replace the valve body.
2. Noisy pump.	2.0 Drive belt loose.	2.0 Replace the serpentine drive belt.
	2.1 Low fluid level.	2.1 Fill the power steering pump reservoir and bleed the lines.
	2.2 Air in fluid.	2.2 Drain the power steering system. Fill the power steering pump reservoir.
	2.3 Faulty pump.	2.3 Replace the pump.
	2.4 Wrong steering cables installed.	2.4 Install the appropriate cables.
3. Fluid leaks.	3.0 Loose hose connections.	3.0 Tighten all hose clamps. Bleed the system.
	3.1 Damaged hose.	3.1 Inspect and replace the damaged hose.
	3.2 Oil leaking from the top of the pump.	3.2 Drain excess oil.
	3.3 Cylinder piston rod seal leaks.	3.3 Install new seal kit.
	3.4 Faulty seals or O-rings in the pump.	3.4 Replace the seals or the O-rings in the pump.
	3.5 Cracked or porous metal parts.	3.5 Inspect all power steering components for leaks.

Transmission—Non DTS

NOTE: Refer to the transmission manufacturer's information for detailed troubleshooting. This information is meant as a guide only.

Symptom	Cause	Action
1. Transmission will not shift.	1.0 Shifting lever is loose and cannot be shifted.	1.0 Tighten clamping bolt on the shifting lever.
2. Delayed shift time.	2.0 Shift linkage not properly adjusted; not allowing full engagement.	2.0 Lift remote control off. If gear can be shifted by hand, correct remote control. If the transmission cannot be shifted correctly by hand, refer to the transmission service manual.
3. Clutch is slipping; propeller speed too low compared to engine speed.	3.0 Inadmissible fluid used.	3.0 Drain fluid. Refill with prescribed fluid. Flush transmission while engine runs in NEUTRAL position. Drain fluid. Refill transmission.

4. Transmission locked.		4.0 Replace the transmission.
5. Excessive fluid temperature.	5.0 Excessive fluid in the transmission.	5.0 Remove excessive fluid.
	5.1 Fluid cooler is dirty on the water side.	5.1 Detach coolant water lines and clean fluid cooler on water side.
6. Water in the fluid, fluid looks milky.	6.0 Fluid cooler faulty.	6.0 Repair leakage at cooler or replace cooler. Change transmission fluid.
	6.1 High water level in the engine compartment, water entering through the output shaft seal or breather.	6.1 Remedy cause for water level in engine compartment. Change transmission fluid.
7. Fluid leakage at breather.	7.0 Excessive fluid in the transmission.	7.0 Pump excessive fluid out with commercial hand pump.
8. Transmission noise becomes louder.	8.0 Fluid level too low so that pump sucks in air.	8.0 Fill to mark on dipstick with appropriate fluid.
	8.1 Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission.	8.1 Replace flexible coupling. Check alignment between engine and transmission.
9. Chattering transmission noise mainly at low engine speed.	9.0 Misaligned propeller shaft on output.	9.0 Mount and align propeller shaft strictly according to instructions issued by shaft manufacturer.

Transmission—DTS

For troubleshooting information on DTS transmissions, **refer to the appropriate Mercury MerCruiser SmartCraft DTS (Digital Throttle and Shift) Service Manual.**

Drain System Will Not Drain or Drains Slowly

Symptom	Cause	Action
1. Drain system will not drain or drains slowly.	1.1 Cooling system or drain holes plugged with debris.	1.1 Remove the blue drain plugs and inspect for blockage. Flush the cooling system and drain the engine.
	1.2 Air actuator malfunction.	1.2 Inspect the air lines from the air manifold and the drain actuator for kinks, damage and leaks. Inspect the air manifold and the fittings for cracks, leaks, damage, or corrosion.
	1.3 Boat sitting on an incline.	1.3 Boat must be at rest and level when draining the engine.
	1.4 Draining the engine while the boat is in the water.	1.4 Read Boat in the Water Procedure in the Operation, Maintenance and Warranty Manual.
	1.5 Water in the engine is frozen.	1.5 Thaw engine and inspect for freeze damage.
2. Drain system leaking at the orange drain seal.	2.0 Actuator piston not closed.	2.0 Activate pressure relief valve. Inspect and clean the water distribution housing and the seawater pump drain actuator. Replace if damaged.
3. Water leaking out of the pressure relief valve on the air manifold.	3.0 Seawater pump seal leaking.	3.0 Replace the drain portion of the seawater pump.
	3.1 Vents on the drain actuator are under the waterline.	3.1 Empty water from bilge.

Gen III Cool Fuel Module Diagnostics

Electrical

1. Disconnect the electrical connector at the Cool Fuel Module.
2. Connect a Digital Volt / Ohm Meter (DVOM) to the engine side of the electrical connector.
3. Turn the ignition switch to the run position.
4. Verify that there is 12 volt battery (+) power going to the Cool Fuel Module. If voltage is less than 11.5 vdc, find and correct the voltage drop or no voltage condition.

NOTE: The fuel pump relay will only remain active for 2-3 seconds while the key is in the RUN position.

Checking Fuel Pressure and Fuel Supply Vacuum

1. Connect a fuel pressure gauge to the schrader valve on the fuel rail.
2. Cycle key switch 2-3 times (OFF to RUN position) at 3 second intervals to reach maximum fuel pressure.
3. Verify that the pressure is within specification.
4. If fuel pressure exceeds 44 psi (303 kPa), replace the fuel pressure regulator.
5. If fuel pressure is less than 40 psi (276 kPa), but greater than 13 psi (90 kPa):
 - a. Relieve the fuel pressure in the fuel rail. Refer to section 2A for fuel pressure relief procedure.
 - b. Use a tee fitting and connect a vacuum gauge to the fuel inlet side of the Cool Fuel Module. Do not remove the fuel inlet fitting adapter.
 - c. Cycle the key switch 2-3 times (OFF to RUN position) at 3 second intervals to reach maximum pressure.
 - d. Verify that the vacuum from the fuel source is within specification. If the vacuum exceeds 2 in. Hg (7 kPa) , excessive fuel restriction exists. Correct the fuel restriction before proceeding.
 - e. With the vessel secured to the dock and the engine running in neutral, restrict the fuel supply with fuel shut-off tool and verify that the Cool Fuel Module has the ability to cause an inlet vacuum reading of 11 in. Hg (37 kPa) or greater. If the vacuum reading is less than 11 in. Hg (37 kPa) with the fuel supply restricted, but fuel pressure is within specification, replace the low-pressure pump.

Fuel Shut Off Tool	91-805918A1
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6. If fuel pressure is 13 psi (90 kPa) or less and inlet vacuum is less than 15 in. Hg (51 kPa), replace high-pressure pump and fuel pressure regulator.

In-Water Test

1. With a vacuum gauge and a fuel pressure gauge in place, operate the boat throughout the RPM range and record the pressure and vacuum readings.
2. If the fuel the supply vacuum reading is greater than 2 in. Hg (7 kPa) , find and correct the fuel supply restriction.
3. If fuel pressure is less than 40 psi (276 kPa), but greater than 13 psi (90 kPa):
 - a. Verify that the vacuum from the fuel source is within specification. If the vacuum exceeds 2 in. Hg (7 kPa) , excessive fuel restriction exists. Correct the fuel restriction before proceeding.
 - b. If no excessive fuel supply restriction exists, replace low-pressure fuel pump.

4. If fuel pressure is 13 psi (90 kPa) or less and no excessive fuel supply restriction exists, replace high-pressure pump and fuel pressure regulator.

IMPORTANT: It will be necessary to sea-trial the boat following repairs to be sure that the pressure and the fuel system vacuum remain within specification throughout the RPM range.

Notes:

Removal and Installation

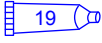
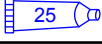
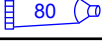
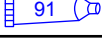
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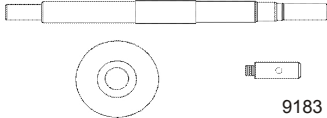
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System.....	2A-22		

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminal connections	Obtain Locally
	Perfect Seal	Engine mounting hardware threads and nuts	92-34227-1
	Liquid Neoprene	Exposed terminals and connections	92-25711-3
	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally
	Engine Coupler Spline Grease	Coupler splines	92-802869A1

Special Tools

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

Removal

⚠ WARNING

Avoid injury or death and power package damage from electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

IMPORTANT: The sterndrive must be removed prior to engine removal. Refer to the appropriate Mercury MerCruiser sterndrive service manual.

⚠ CAUTION

Engine compartment size may require the removal of additional components.

1. Remove the boat from the water.
2. Disconnect both of the battery cables from the battery.
3. Remove the sterndrive. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.
4. Remove the engine cover.
5. Disconnect the 10-pin or 14-pin instrument wiring harness from the engine harness.
6. Close the fuel shut-off valve, if equipped.

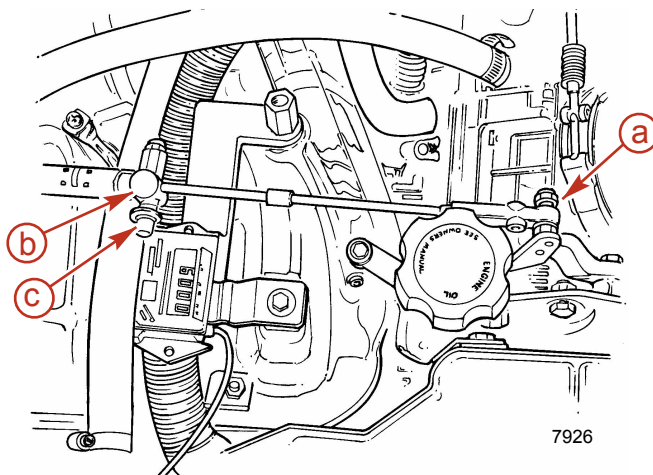
⚠ WARNING

Be careful when servicing fuel system components; gasoline is extremely flammable and highly explosive. Do not smoke or allow sources of spark or open flame near the work area. Wipe up any spilled fuel immediately.

The fuel pressure must be relieved before servicing the high pressure components in the fuel system.

7. Disconnect and plug fuel lines to prevent fuel from leaking into the bilge.

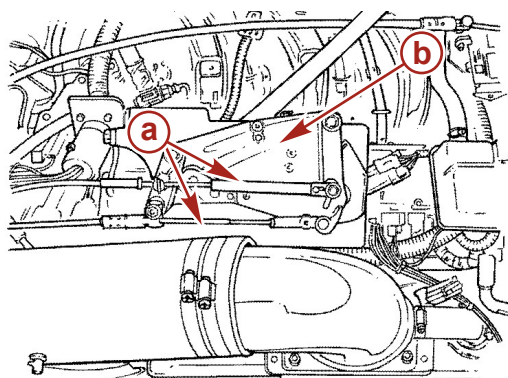
8. On non-DTS models, disconnect the throttle cable from the throttle body and retain the fasteners.



a - Flat washer and locknut
b - Cable barrel

c - Flat washer and locknut

9. Remove both of the shift cables from the shift plate (non DTS). Retain the locknuts and hardware.



a - Shift Cables

b - Shift Plate

10. Disconnect the power-assisted steering hydraulic hoses from the steering control valve. If equipped with standard connections, plug the hydraulic hose fittings. If equipped with quick-connect fittings, connect the hoses together to prevent leaking.
11. Remove the gear lube monitor and hose and place out of the way.
- NOTE:** After wires are disconnected, loosen them from any clamps or cable ties retaining them to the engine or hoses.
12. Disconnect the gear lube monitor hose.
13. Disconnect the trim sender wire connections from the engine harness.
14. Disconnect the transom harness.
15. Disconnect the CAN link harness, if equipped.
16. Disconnect the continuity circuit wire.
17. Disconnect the clean power harness, if equipped.
18. Disconnect the battery isolator wires, if equipped.
19. Disconnect any accessory wires connected to the engine.

20. Disconnect the wires from the MerCathode controller assembly and disconnect the MerCathode quick-connect fitting, if equipped.
21. Disconnect the seawater inlet hose.
22. Disconnect water heater lines, if equipped.
23. Disconnect the exhaust system hoses.
24. Remove and retain the boat drain plug.
25. Disconnect the oil drain hose lanyard from the boat drain plug.
26. Disconnect the continuity wires and accessories that are connected to the engine.

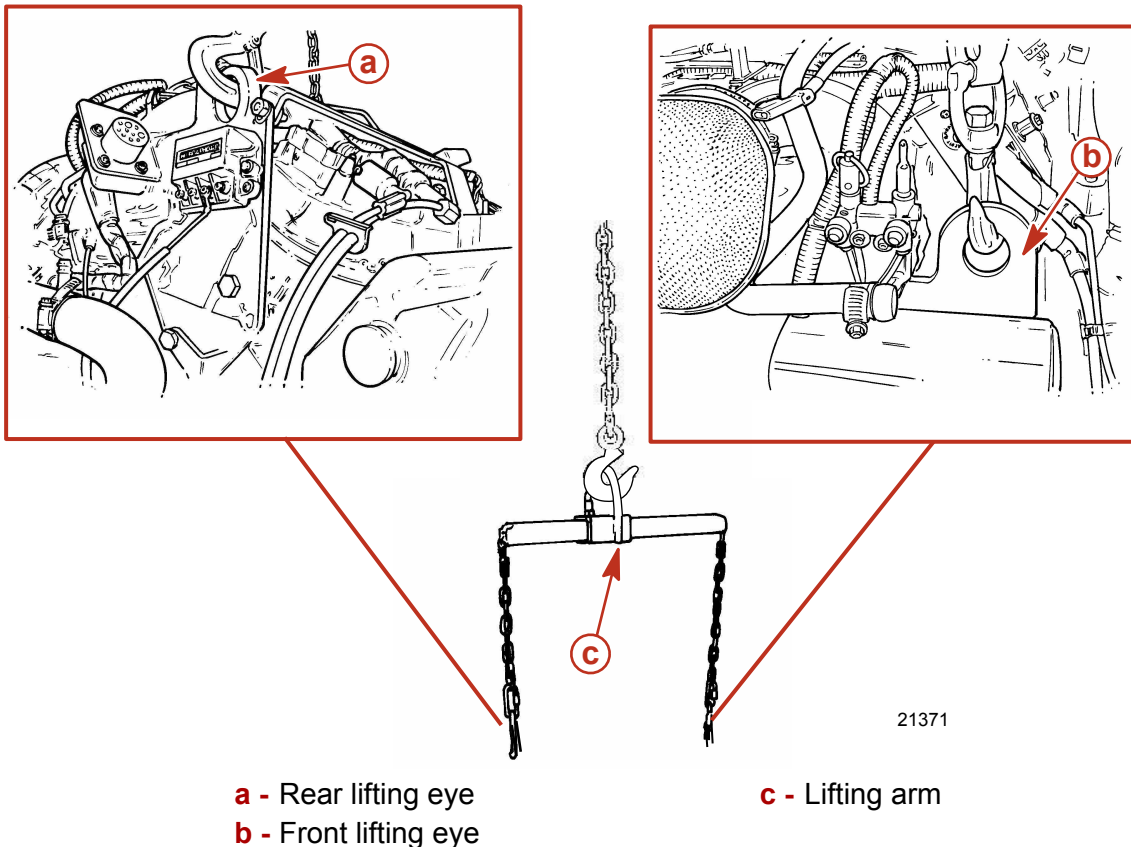
⚠ CAUTION

Engine components can be damaged by lifting the engine with an improperly attached sling or hoist. Use a proper lifting arm or similar device to avoid damaging the engine and components.

⚠ CAUTION

Avoid damage to engine components. You must use a hoist to lift the engine. Do not allow the lifting sling to catch on components that are attached to the engine.

27. Attach a suitable sling and lifting arm to the lifting eyes on the engine and adjust so that the engine is level when suspended.

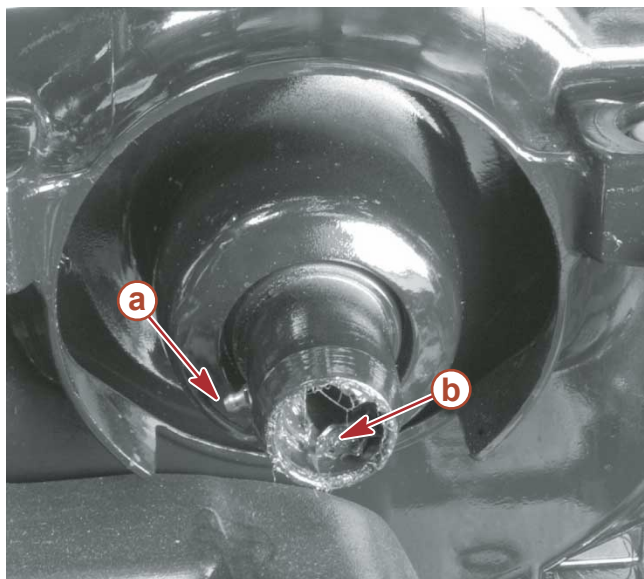


28. Remove and retain the front and rear engine mounting fasteners.
29. Using an overhead hoist, carefully remove the engine. Do not damage the power-assisted steering control valve.
30. Carefully remove the engine. Do not hit the control valve on the transom.

Engine Installation

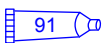
Engine Installation and Alignment

1. On engines where the engine mounts were disturbed, ensure that the front mount adjusting nuts are positioned midway on the studs so that adequate up and down adjustment exists for engine alignment.
2. Lubricate the coupler splines.



a - Grease fitting

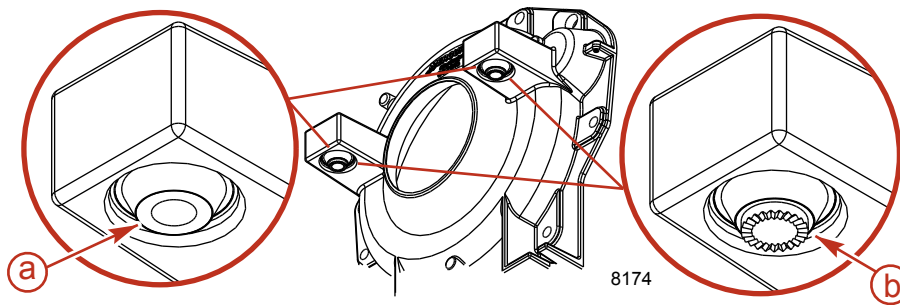
b - Coupler splines

Tube Ref No.	Description	Where Used	Part No.
 91	Engine Coupler Spline Grease	Coupler splines	92-802869A1

⚠ CAUTION

Avoid product damage caused by improper engine alignment. Improper engine alignment can be caused by mismatched flywheel housing mounts and inner transom plate mounting hardware. Ensure that the flywheel housing mounts and the inner transom plate mounting hardware, port and starboard, are the correct parts and match before installing the engine.

3. Determine the type of flywheel housing mounts installed. Early style flywheel housing mounts have a smooth bottom surface. New design mounts have a knurled bottom surface.



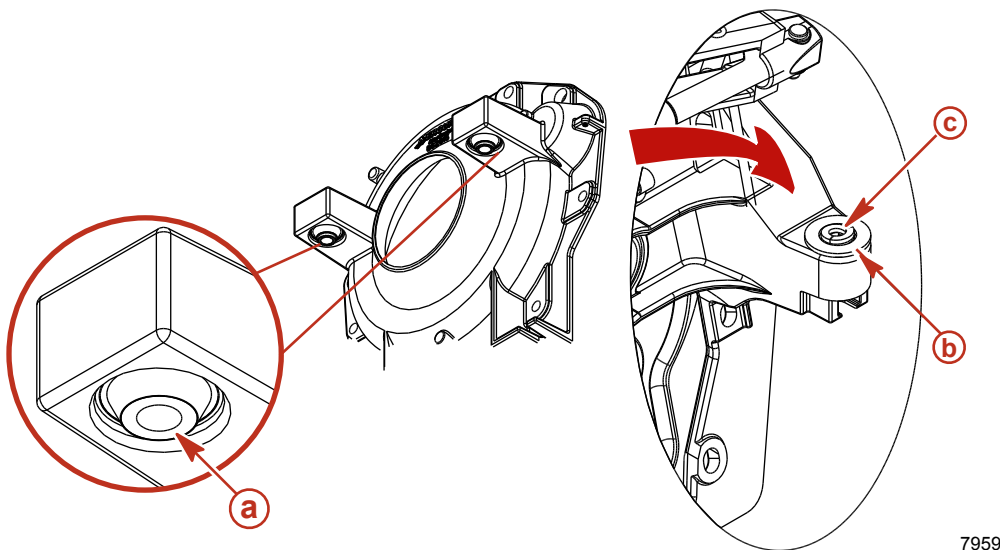
Typical flywheel housing

a - Early style mount (smooth surface)

b - New design mount (knurled surface)

IMPORTANT: Fiber washers are used on the inner transom plate with both the early style and new design mounts.

4. On models with early style mounts (smooth bottom surface), position the rear engine mount attaching hardware on the inner transom plate mounts as shown.



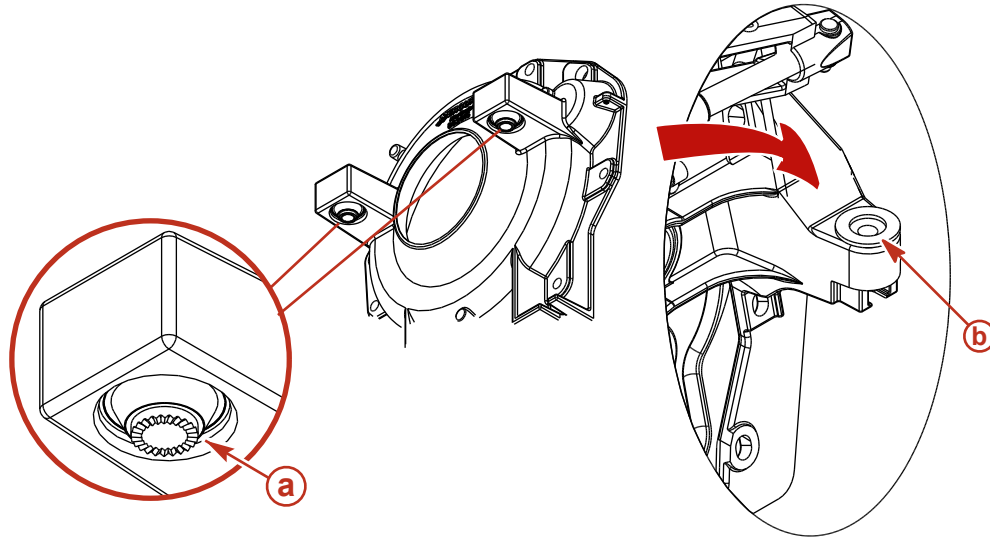
Starboard side shown, port side similar

a - Early style mount (smooth surface)

b - Fiber washer

c - Double-wound lockwasher

5. On models with new design mounts (knurled bottom surface), position the rear engine mount attaching hardware on the inner transom plate mounts as shown.



7960

Starboard side shown, port side similar

a - New design mount (knurled surface)

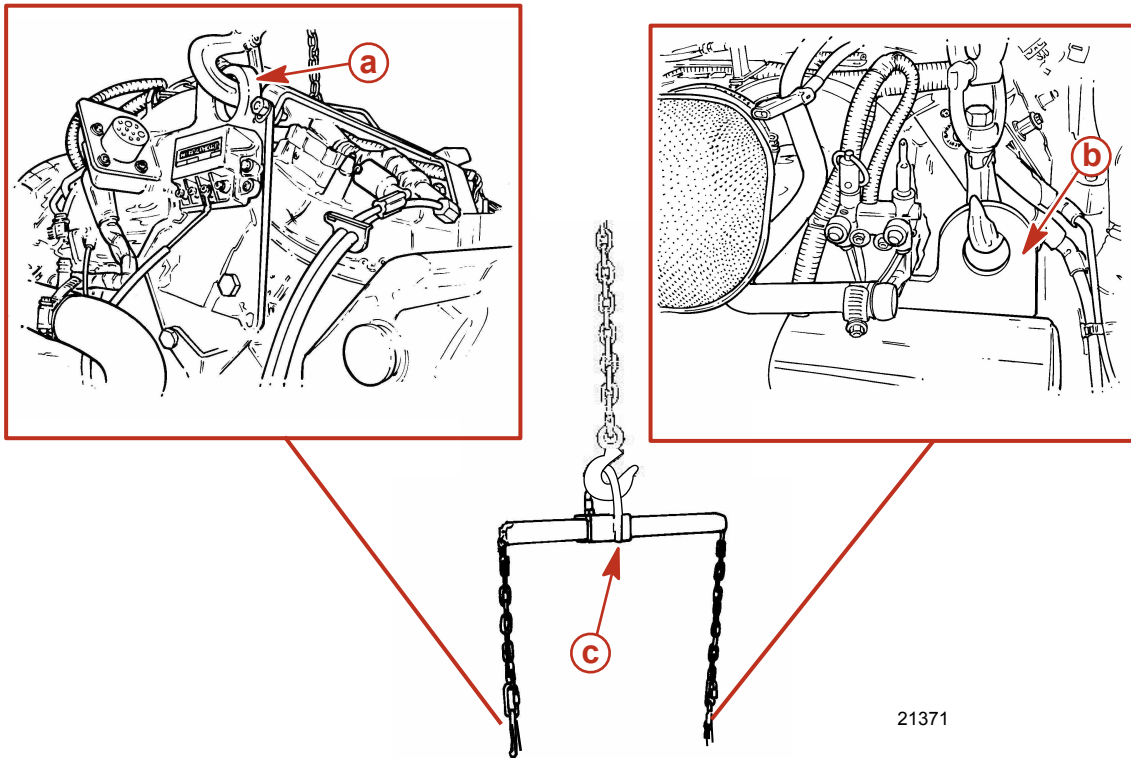
b - Fiber washer

⚠ CAUTION

Engine MUST be lifted with a lifting arm or damage to engine components could occur.

6. Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that engine is level when suspended.

7. Lift the engine into position in the boat using an overhead hoist.



Typical

a - Front engine lifting eye

b - Rear engine lifting eye

c - Suitable sling and lifting arm

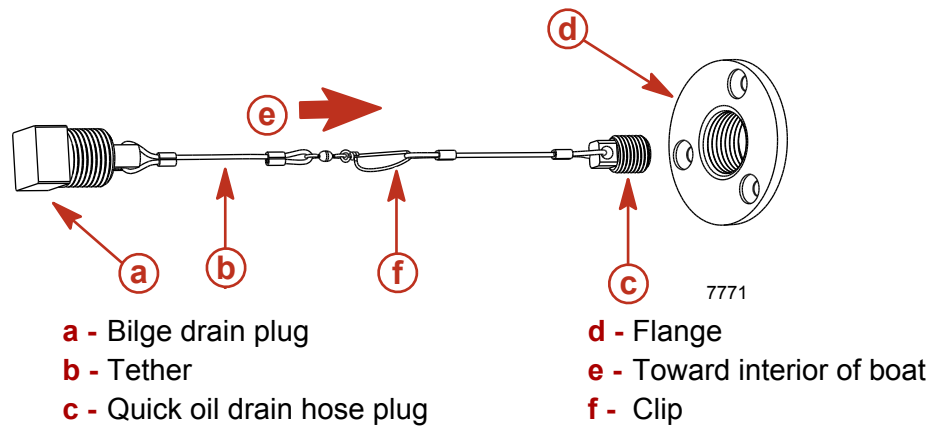
⚠ CAUTION

When lowering engine into position do not set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

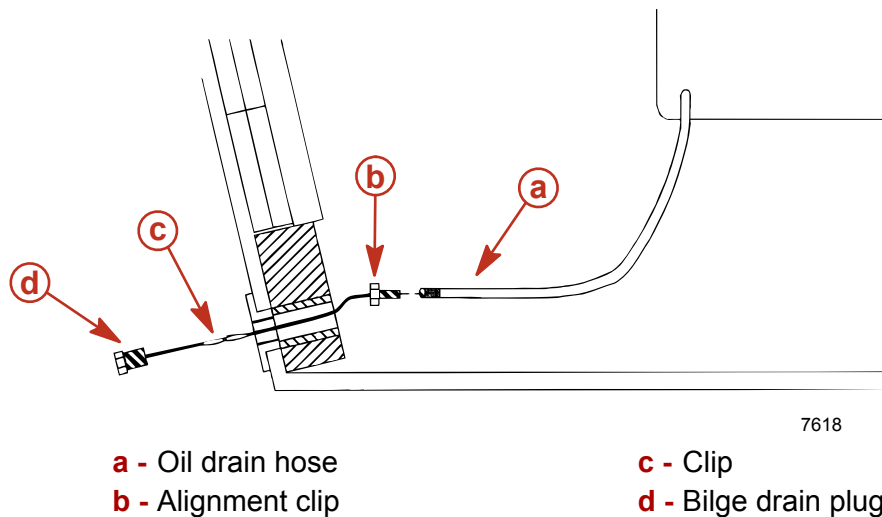
IMPORTANT: The quick drain oil fitting clearance must be greater than 13 mm (1/2 in.) from the engine compartment and boat bottom.

8. **If equipped with quick drain oil**, ensure that the quick drain oil fitting has a clearance of more than 13 mm (1/2 in.) from the engine compartment and boat bottom.
9. **If the clearance is 13 mm (1/2 in.) or less**, remove the quick drain oil fitting and install the oil drain plug from parts bag directly into the engine oil pan.

10. If the clearance is greater than 13 mm (1/2 in.):



- Push the end of the oil drain hose out of the boat hull through the flange.
- Pull the oil drain hose out until it is 30.48 cm (12 in.) from the flange.
- Move the alignment clip on the oil drain hose and squeeze to position it on the hose just inside of the boat hull against the flange.
- Connect the bilge drain plug to the oil drain hose plug using the clip.



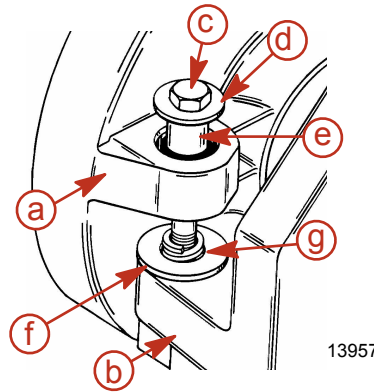
- Push the oil drain hose through the flange into the boat hull.
- Install the bilge drain plug in the hull.

11. On models with early style mounts (smooth bottom surface):

- Ensure that the fiber washers, double-wound lockwashers, and locknuts are on the inner transom plate mounts.
- Align the rear engine mounts with the inner transom plate mounts. Then, set the engine onto the inner transom plate mounts. Simultaneously align the exhaust elbow with the exhaust tube. Do not relieve the hoist tension.

IMPORTANT: Engine mounting hardware must be installed in the sequence shown.

- c. Install and torque both rear engine mounting bolts with hardware as shown.



Model with early style mounts (smooth bottom surface)

- | | |
|--------------------------------------|------------------------------------|
| a - Rear engine mount | e - Spacer |
| b - Inner transom plate mount | f - Fiber washer |
| c - Bolt | g - Double-wound lockwasher |
| d - Washer | |

Description	Nm	lb. in.	lb. ft.
Rear engine mounting bolts	51		38

IMPORTANT: The finished boat stringer must position the front engine mount so that a minimum of 6 mm (1/4 in.) up or down adjustment exists after the mount is adjusted to contact the stringer. This allows for future engine alignment or adjustments. Make proper alterations to the boat stringer (structure) height to obtain the 6 mm (1/4 in.) dimension.

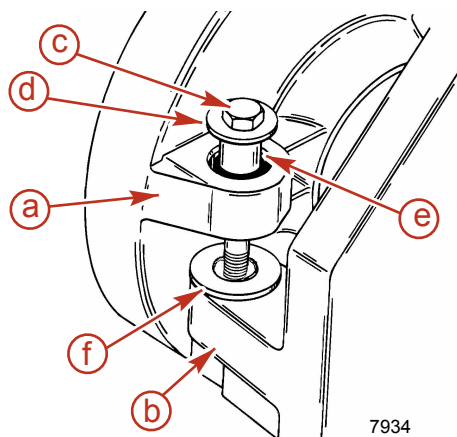
- Adjust the front engine mounts until they rest on the boat stringers.
- Set the engine on the boat stringers.
- Relieve the hoist tension.
- Disconnect the sling from the engine lifting eyes.

12. On models with new design mounts (knurled bottom surface):

- Ensure that the fiber washers and locknuts are on the inner transom plate mounts.
- Align the rear engine mounts with the inner transom plate mounts. Then, set the engine onto the inner transom plate mounts. Simultaneously align the exhaust elbow with the exhaust tube. Do not relieve the hoist tension.

IMPORTANT: Engine mounting hardware must be installed in sequence shown.

- c. Install and torque both rear engine mounting bolts with the hardware as shown.



Typical model with new design mounts (knurled bottom surface)

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

Description	Nm	lb. in.	lb. ft.
Rear engine mounting bolts	51		38

- d. Adjust the front engine mounts until they rest on the boat stringers.
- e. Set the engine on the boat stringers.
- f. Relieve the hoist tension entirely and fasten both mounts to the boat stringer using the appropriate hardware.
- g. Disconnect the sling from the engine lifting eyes.

⚠ CAUTION

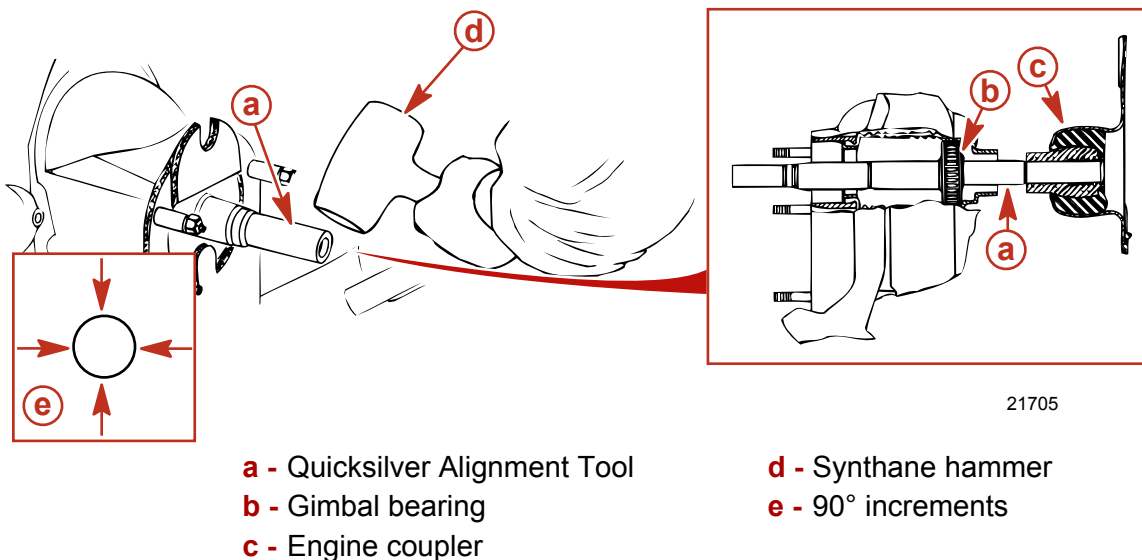
Alignment tools other than the Quicksilver Alignment Tool may cause improper alignment and damage to the gimbal bearing, the engine coupler, or both. Do not use an alignment tool from another manufacturer. Use only the Quicksilver Alignment Tool.

⚠ CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:
Do not attempt to force Quicksilver alignment tool.
Do not raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.
Do not raise engine mount bracket above top of engine mount stud.

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

14. 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.



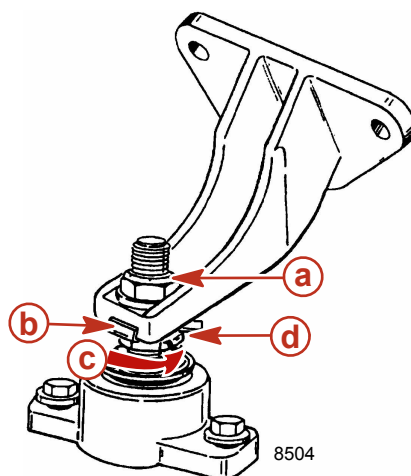
Alignment Tool Assembly	91-805475A 1
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15. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.

16. If the alignment tool does not fit, remove it and carefully adjust the 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 adjusting nuts as necessary. Tighten the locknuts.



Typical front mount

- a** - Locknut
b - Adjusting nut
c - Direction (counterclockwise) to raise the front of the engine
d - Tab washer

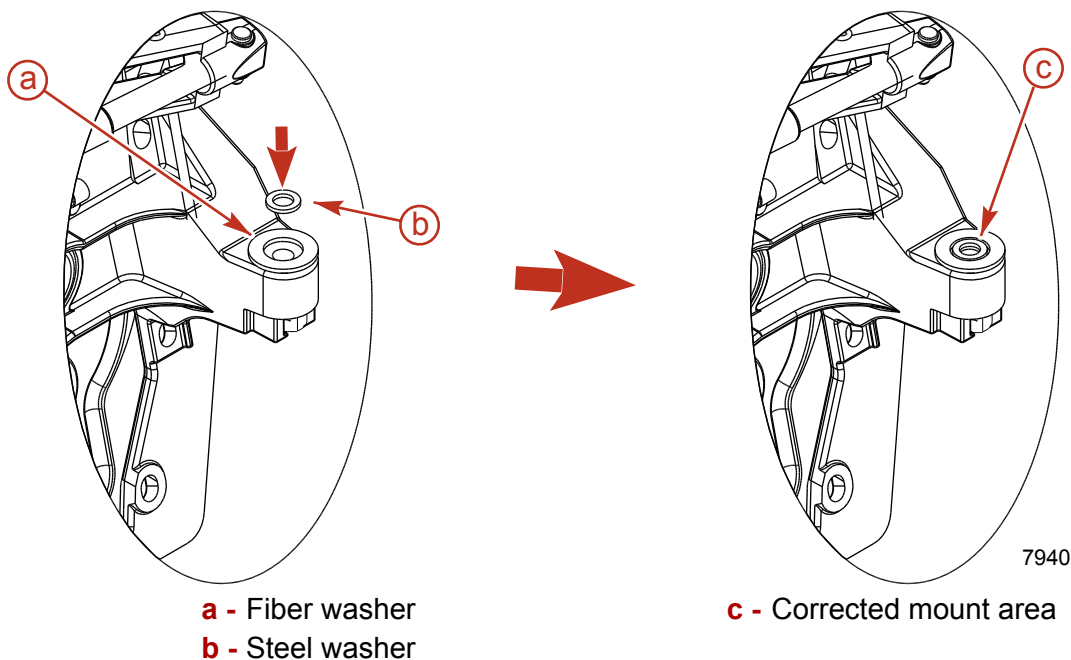
17. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.

NOTE: Spacer Kit (12-892619A01) is available to raise the rear on the engine. This would only be needed 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 washer kit can be installed in the rear mount to raise the rear of the engine.

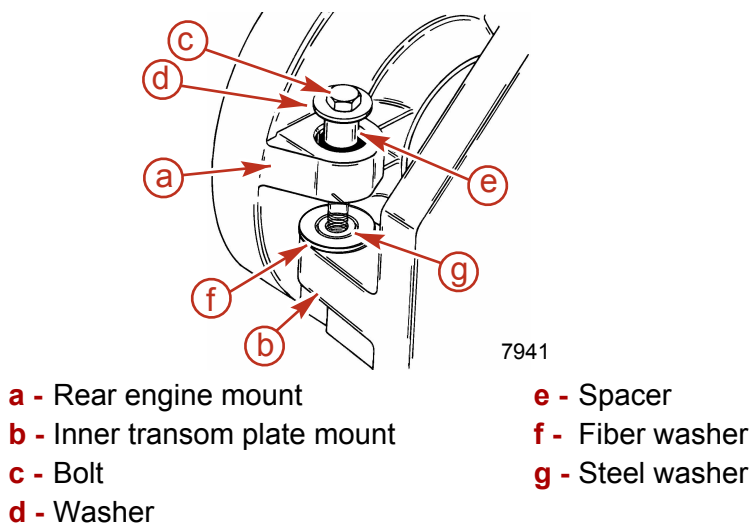
18. On models where the front engine mounts cannot be lowered enough to allow for proper engine alignment:

- Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that the engine is level when suspended.
- Remove the rear engine mounting bolts and hardware.
- 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.



- Install and torque both rear engine mounting bolts with appropriate hardware as shown.

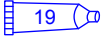


Description	Nm	lb. in.	lb. ft.
Rear engine mounting bolts	51		38

- 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 installs 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 (lag bolts or thru-bolts, and so on).
 22. Torque both front mount locking (jam) nuts.

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

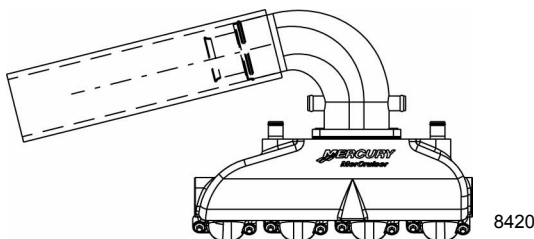
23. Recheck the alignment with the alignment tool. The tool must enter the coupler splines freely. If not, remove the alignment tool and readjust the front mounts.
24. Remove the alignment tool.
25. If operating in a saltwater environment, apply sealant to the threads and nuts of the engine mounting 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	92-34227-1

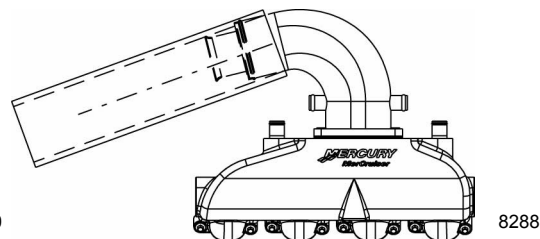
⚠ CAUTION

Avoid exhaust hose failure which could cause exhaust or discharge water to enter the boat. Discharge water from the exhaust elbow must flow without restriction around the entire inside diameter of the exhaust hose to avoid causing hot spots, which could eventually burn through the exhaust hose. Connect the exhaust hoses and tubes to the exhaust elbows so that they do not restrict the flow of discharge water from the exhaust elbows.

26. Align the exhaust tubes.



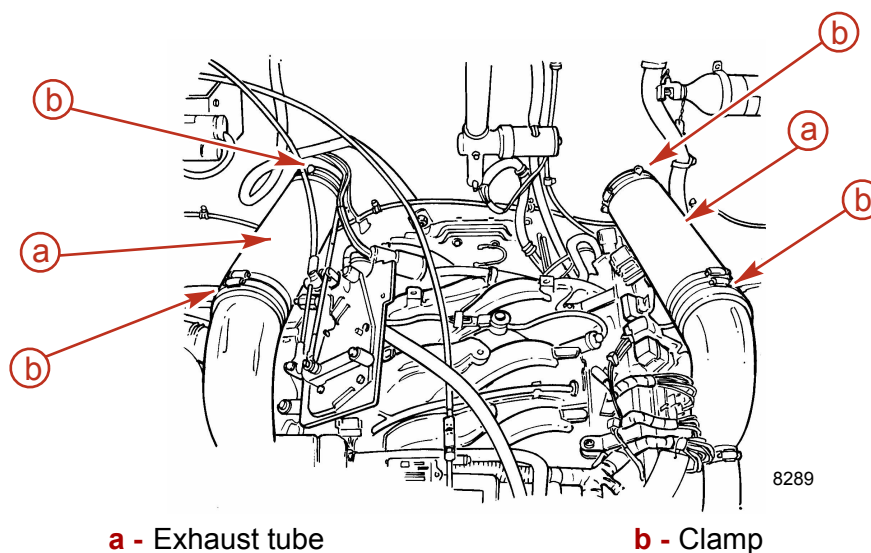
Correct alignment



Incorrect connection

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

27. Tighten all exhaust hose or exhaust tube clamps securely.



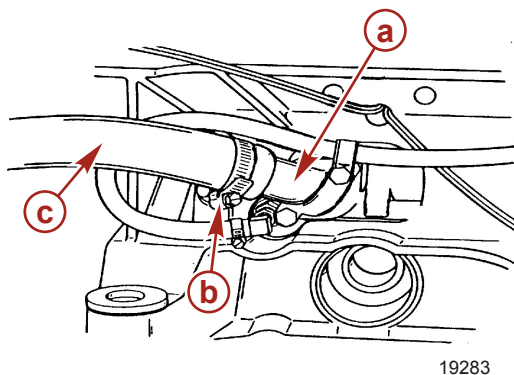
Fluid Connections

Bravo Sterndrive Transom Seawater Inlet—Standard Connection

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

1. Connect the seawater hose to the water tube at the gimbal housing with a hose clamp. Tighten clamp securely.

NOTE: For visual clarity, the engine is out of position in this step.



Bravo Sterndrive Transom Seawater Inlet—Quick-Connect

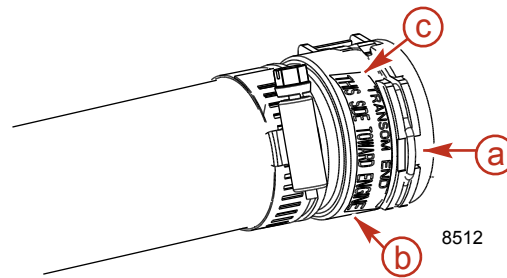
⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test.

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.



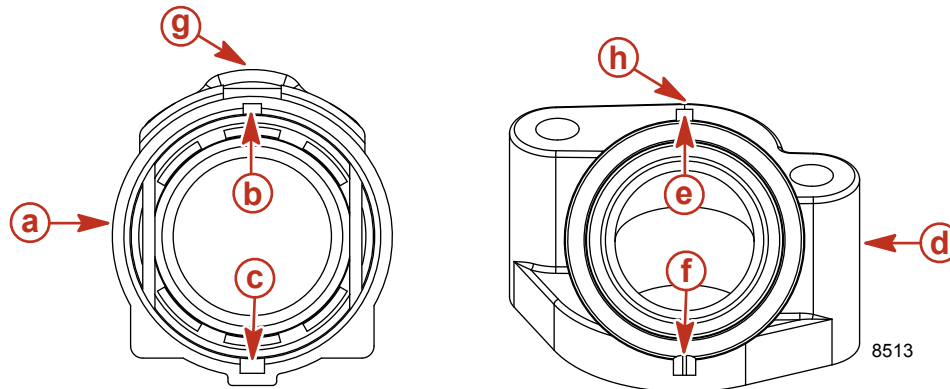
Seawater inlet hose assembly

- 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 only mate at the correct orientation. Mate the small tab with the small slot.

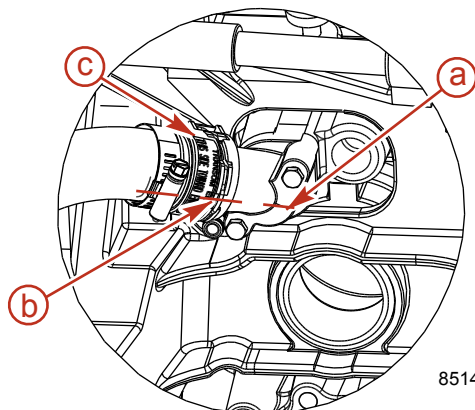
- c. Align the slots of the quick-connect fitting to the tabs of the water inlet fitting.



- 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 connected.

NOTE: The retainer clip snaps into place and resumes the closed position when properly connected.



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

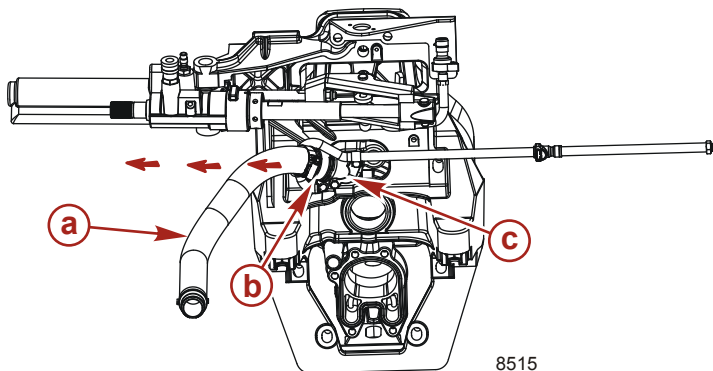
c - Hose decal

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test.

IMPORTANT: A pull test must be performed at the seawater inlet connection.

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 lb. ft.). 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.

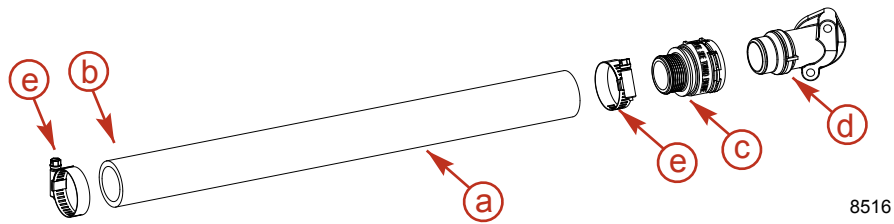


a - Seawater inlet hose
b - Quick-connect fitting

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.



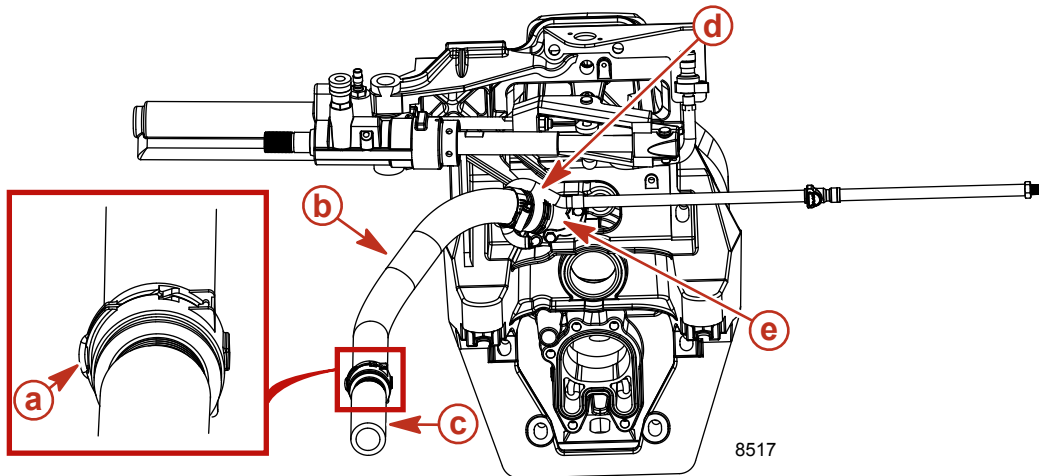
Seawater inlet hose assembly

- 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.



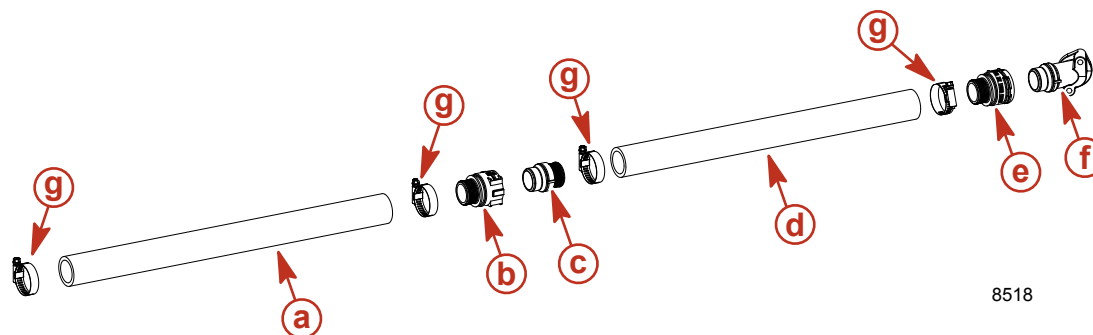
- a** - Retainer clip position (away from engine)
- b** - Seawater extension hose
- c** - Seawater inlet hose (to engine seawater pump)
- d** - Quick-connect fitting (to seawater inlet fitting)
- e** - Seawater inlet fitting (to transom)

⚠ CAUTION

Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test.

- b. Perform a pull test and ensure that the requirements for checking the integrity of the connection are met.

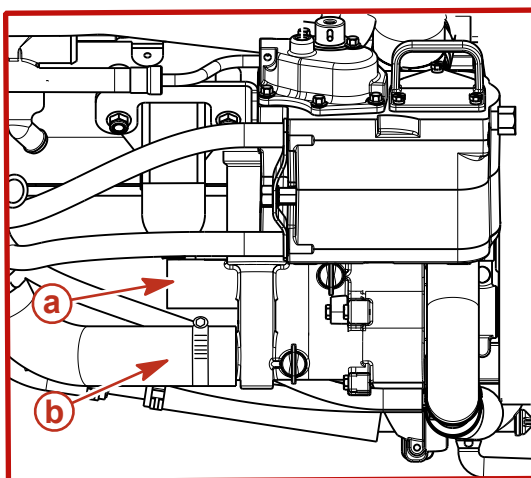
NOTE: The seawater extension hose assembly connects to the transom and the seawater inlet hose.



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

Seawater Pump Inlet Connection

1. Connect the seawater inlet hose to the seawater pump inlet fitting.



Seawater Pump Connections

- | | |
|--|--|
| a - Seawater inlet hose fitting | b - Seawater (out) hose to cooler |
|--|--|

Power-Assisted Steering—Standard Connections

⚠ CAUTION

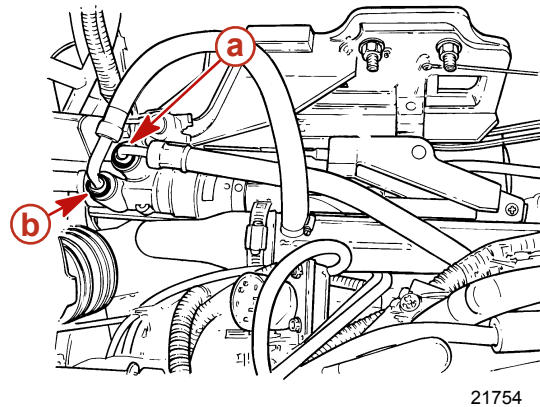
Extreme heat will lower burst pressure or melt steering system hydraulic hoses. Stress on the hose fittings or kinks in the hoses may cause hose failure. In any case, a loss of steering control may occur resulting in injury or property damage. Route the hydraulic hoses away from extreme heat, do not stress the hose fittings and do not kink the hoses.

1. Route the hoses to the control valve at the transom in the same position as prior to removal.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent oil leakage.

IMPORTANT: Be careful not to cross-thread or overtighten the hydraulic hose fittings.

2. Ensure that the O-ring is in position on the hoses at the fittings.
3. Install the threaded hose fittings into the control valves at the transom.
4. Torque both hydraulic hose fittings.



21754

a - Rear fitting (pressure hose)

b - Front fitting (return hose)

Description	Nm	lb. in.	lb. ft.
Power steering hose fitting	31		23

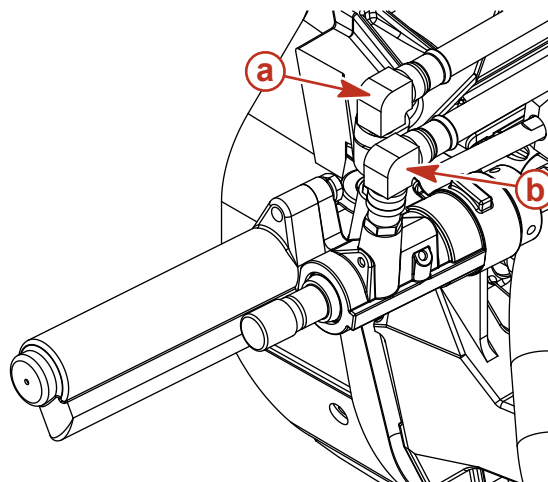
IMPORTANT: The hoses must not come in contact with steering system components, the engine coupler, U-joint shaft, or driveshaft.

5. Secure the hoses with a cable tie to avoid contact with hot or moving components.

Power-Assisted Steering—Quick-Connect Fitting

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

1. Disconnect the quick-connect fittings on the power steering hoses.
2. Connect the power steering hoses to the control valve. Ensure that the quick-connects snap into place.
3. Route hoses as appropriate to avoid contact with the steering system components.
4. Use extra hose clips to secure the hose to the transom.



6686

Models with one hose routed behind power steering control valve

a - Pressure hose

b - Return hose

NOTE: Power steering fluid can be added at this time if desired.

Gear Lube Monitor Connection

IMPORTANT: Avoid using excessive hose when routing it to gear lube monitor. Hose should be routed directly to oil reservoir in as straight a line as possible to avoid low spots (traps) in the system.

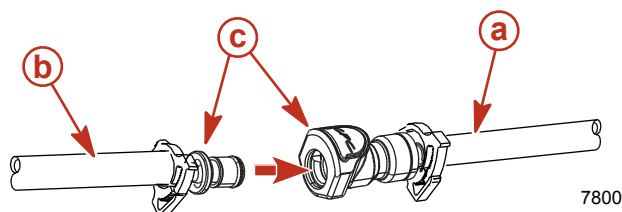
⚠ CAUTION

Ensure that hose is not kinked when connecting in the following step. If hose is kinked, gear lube monitor will not function properly and damage to sterndrive unit could occur.

1. Locate the gear lube monitor quick-connect at the rear of the engine.
2. Locate the gear lube monitor quick-connect at transom.

IMPORTANT: The hose must not come in contact with steering system components, engine coupler, U-joint shaft, or driveshaft.

3. Fasten the quick-connect.



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

Fuel Supply Connections—Gen II Cool Fuel System

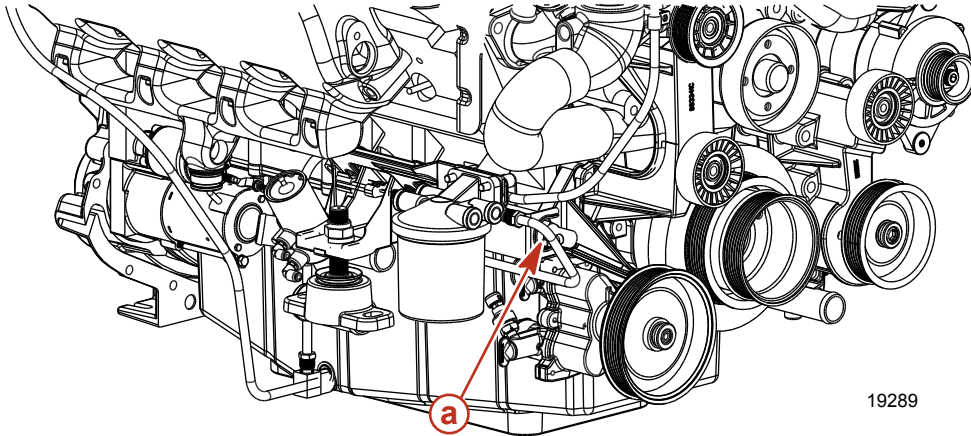
⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

A flexible fuel line must be used to connect the fuel line to the engine to absorb deflection when the engine is running.

IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel lines.

1. Connect the fuel line from the fuel tank to the boost pump inlet. Ensure that the connections are secure.



19289

a - Fuel inlet hose connection

2. Open the fuel shut-off valve, if equipped. Check for leaks.

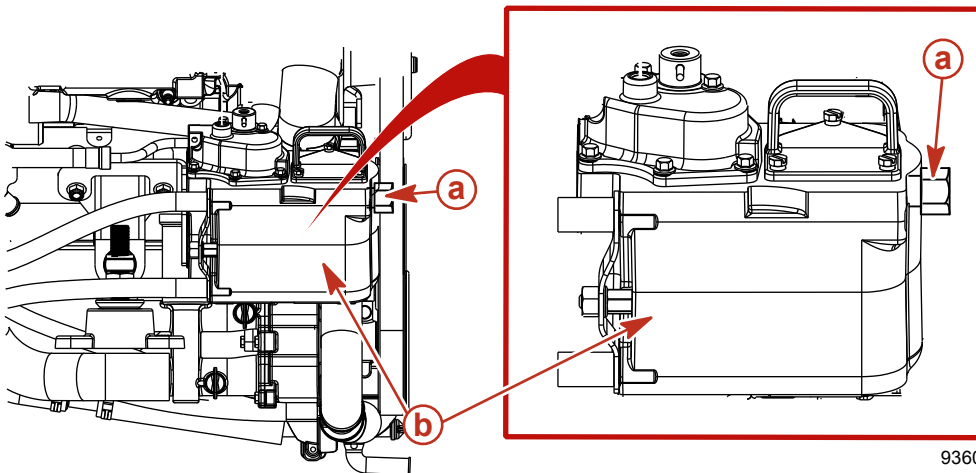
Fuel Supply Connection—Gen III Cool Fuel System

FUEL LINE CONNECTION

A flexible fuel line must be used to connect the fuel line to the engine to absorb deflection when the engine is running.

IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.

1. Connect the flexible fuel line to the Gen III Cool Fuel Module fitting.



9360

a - Fuel fitting

b - Gen III Cool Fuel Module

2. Open the fuel shut-off valve, if equipped. Check for leaks.

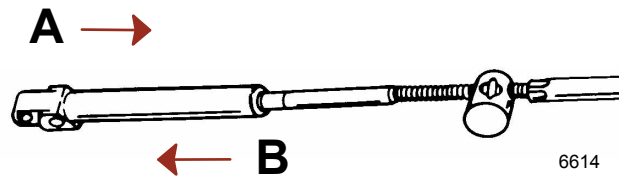
Bravo Model Shift and Throttle Cable Installation

Bravo Models Shift Cable Installation

NOTE: Bravo Models Only: Using Adjustment Tool (91-12427), shift cables can be adjusted without or with the sterndrive installed, using the following procedure.

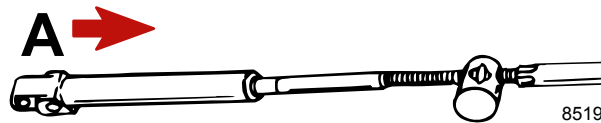
IMPORTANT: Sterndrive propeller rotation is determined by the shift cable installation in the remote control.

- Bravo One/Two - If shift cable end guide moves in direction A when control lever is placed in FORWARD, remote control is set up for RIGHT-HAND (RH) propeller rotation.
- Bravo One/Two - If shift cable end guide moves in direction B when control lever is placed in FORWARD, remote control is set up for LEFT-HAND (LH) propeller rotation.



Arrow indicates direction of motion

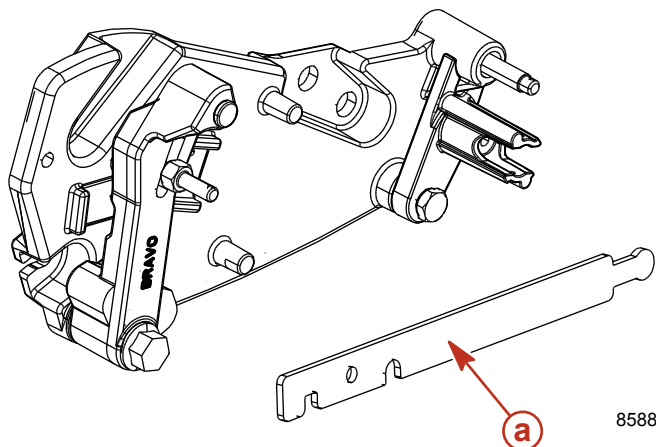
- Bravo Three - Front propeller on sterndrive is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction A, when control lever is placed in FORWARD gear position.



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

Bravo Models Shift Cable Adjustment

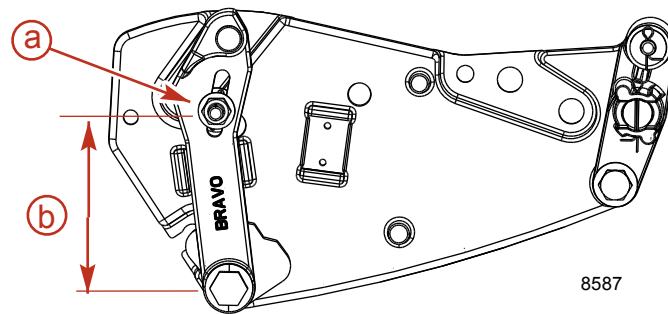
1. Remove the adjustment tool.



Typical Bravo shift bracket shown without switch

a - Adjustment tool

2. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud.

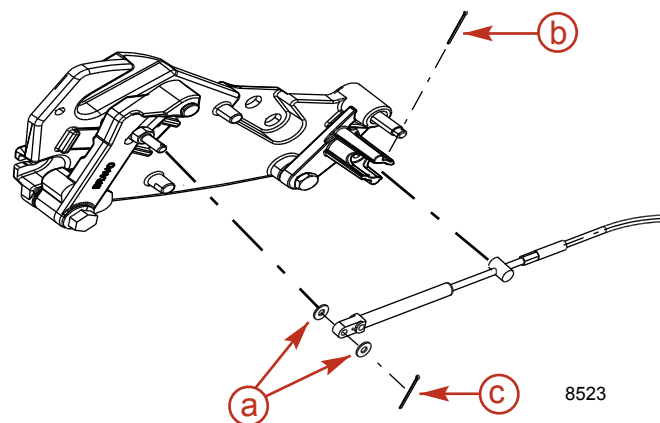


Typical Bravo shift bracket shown without switch

a - Adjustable stud

b - 76 mm (3 in.) (center of pivot bolt to center of stud)

3. Install sterndrive shift cable.
4. Install cotter pin.
5. Insert cotter pin from top and spread ends fully.



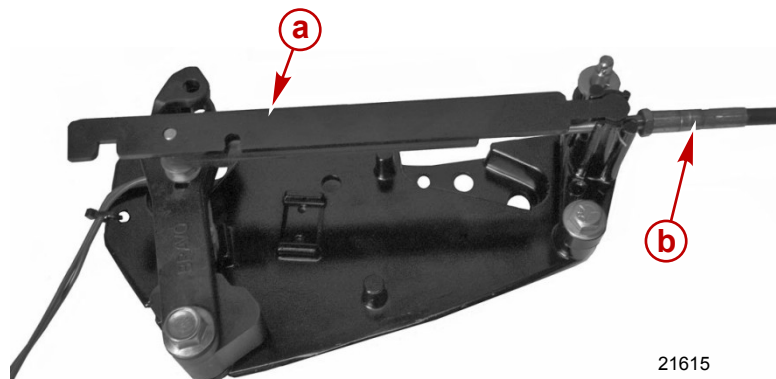
Typical Bravo shift bracket shown without switch

a - Washers (2)

b - Long cotter pin

c - Short cotter pin

6. Place adjustment tool over sterndrive shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer.



Typical Bravo shift bracket shown without switch

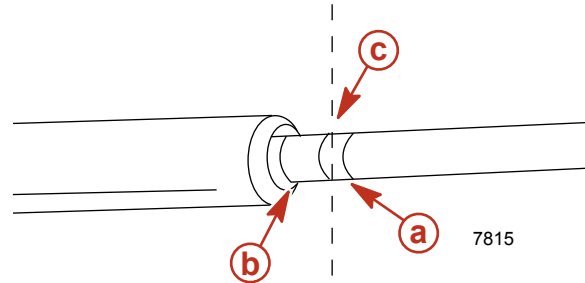
a - Adjustment tool

b - Sterndrive shift cable

7. Locate center of remote control and control cable play (backlash).

IMPORTANT: Keep center mark "c" aligned with control cable end guide edge when making the following adjustment.

- Shift remote control to NEUTRAL.
- Push in on control cable end with enough pressure to remove play and mark position "a" on tube.
- Pull out on control cable end with enough pressure to remove play and mark position "b" on tube.
- Measure distance between marks "a" and "b" and mark position "c" half-way between marks "a" and "b."

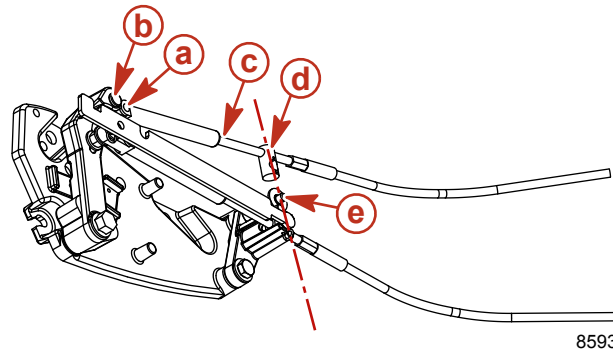


- Temporarily install control cable end guide into shift lever and insert anchor pin.
- Adjust control cable barrel so that hole in barrel centers with vertical center line of stud. Ensure that backlash center mark is aligned with edge of control cable end guide.

⚠ CAUTION

Do not attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur.

- Remove control cable end guide from shift lever by removing clevis pin.

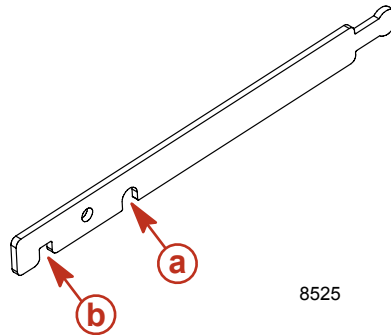


Typical Bravo shift bracket shown without switch

- | | |
|------------------------------------|---------------------------------|
| a - Control cable end guide | d - Control cable barrel |
| b - Clevis pin | e - Stud |
| c - Backlash center | |

- Install the control cable.
- Install the washer and cotter pin to secure the barrel.
- Install the clevis pin.
- Install the cotter pin into the clevis pin from the top and spread the ends.
- Remove the adjustment tool.

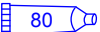
16. Shift remote control lever into FORWARD position. Place end of adjustment tool in barrel retainer. If slot does not fit over stud, loosen shift lever stud and slide stud up or down until slot in tool fits over stud. When adjustment is correct, retighten stud.
17. Lift the adjustment tool so that the slot is above the stud.
18. Shift the remote control into REVERSE and repeat the adjustment process.



a - RH rotation Bravo One, Two, Three FORWARD, LH rotation Bravo One and Two REVERSE slot

b - LH rotation Bravo One and Two FORWARD, RH rotation Bravo One, Two and Three REVERSE slot

19. Remove adjustment tool.
20. Ensure that all cotter pins are secure and that the ends of the cotter pins are spread to 180 degrees.
21. Lubricate shift cable pivot points.

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

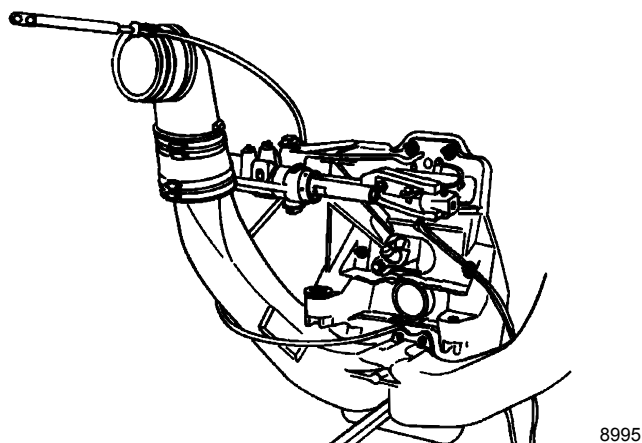
Shift Cable Installation For DTS System

IMPORTANT: Do not move the shift cable stud on the shift arm.

IMPORTANT: The shift cable barrel is preset and CANNOT be adjusted.

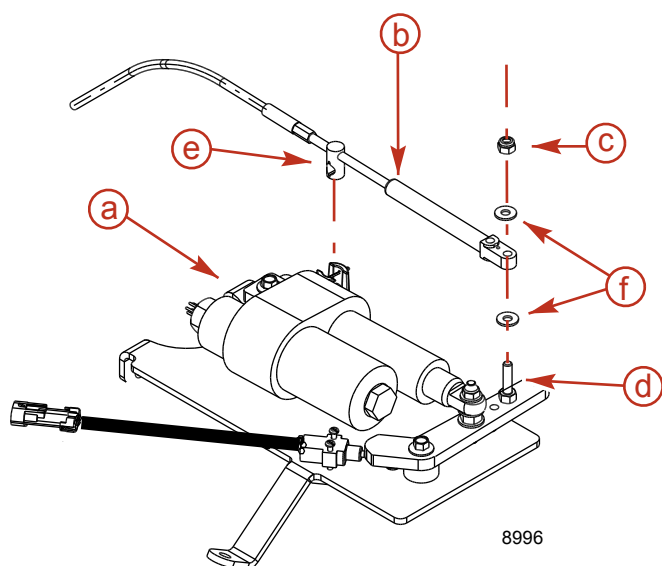
1. Route the intermediate shift cable from the transom assembly to the shift actuator as follows:
 - a. The cable should come through the transom, above the exhaust pipe and make a turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing.
 - b. The cable should then be routed under the starboard rear engine mount and turn toward the transom.
 - c. 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.



NOTE: A final check of the adjustments should be made with the boat in the water and engine running. If this cannot be done or is not done at your manufacturing facility, arrangement should be made with the dealer to do this as part of the pre-delivery inspection.

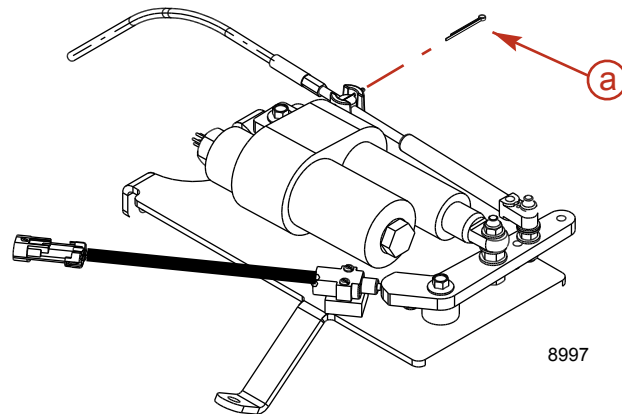
2. Install the intermediate shift cable to the shift actuator on the engine.
3. Tighten locknut until it contacts and then loosen 1/2 turn.



a - Shift actuator
b - Shift cable
c - Locknut

d - Shift cable stud
e - Shift cable barrel
f - Washers

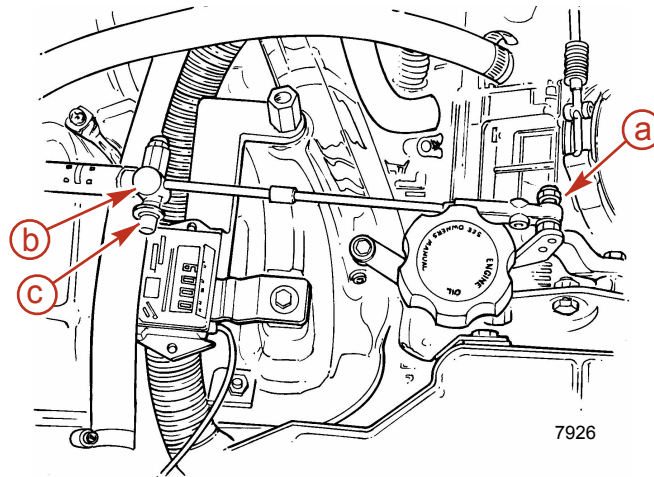
4. Insert cotter pin from top and spread ends.



a - Cotter pin

Throttle Cable Installation and Adjustment

1. Place the remote control handle in the neutral idle position.
2. Remove the engine cover.
IMPORTANT: Ensure that the throttle cable is routed to avoid sharp bends and contact with moving parts. Do not fasten any items to the throttle cable. The outer cable must be free to move when the cable is actuated.
3. Remove the flame arrestor.
4. Install the cable end guide on the throttle lever, then push the cable barrel end lightly toward the throttle lever end. (This will place a slight preload on the shift cable to avoid slack in the cable when moving the remote control lever).
5. Adjust the barrel on the throttle cable to align with the hole in the anchor plate. Ensure that the hole in the barrel positions the cable as shown.



a - Flat washer and locknut
b - Cable barrel
c - Flat washer and locknut

6. Secure the throttle cable with fasteners and tighten securely.
7. Place the remote control throttle lever in the WOT position. Ensure that the throttle plate is completely open.
8. Return the remote control throttle lever to the idle position and ensure that the throttle plate is completely closed.

9. Reinstall the flame arrestor and tighten the clamp securely.

IMPORTANT: Adjust the shift cables as outlined in the appropriate Mercury MerCruiser sterndrive service manual.

10. Install and adjust the drive unit and the remote control shift cables, using the hardware retained. Refer to the appropriate **Mercury MerCruiser sterndrive service manual**.

Electrical Connections

Finding Other Diagrams

NOTICE

Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

CAUTION

Avoid damage to the electrical system components caused by improper work or diagnostic practices. Observe the following precautions when working on or around an electrical harness, or when adding electrical accessories:

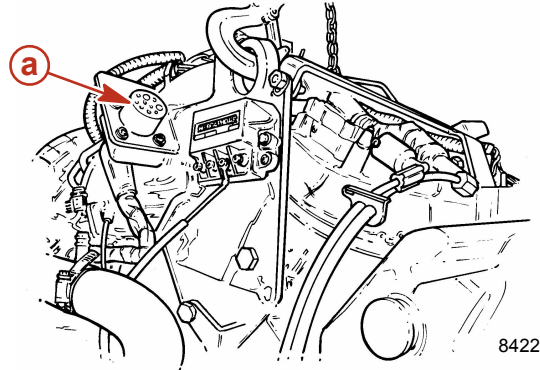
- Do not tap electrical accessories into the engine electrical harness.
- Do not puncture (probe) wires for testing.
- Do not reverse battery leads.
- Do not splice wires into the electrical harness.
- Do not attempt diagnostics without proper, approved service tools.

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

Engine Harness

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 boat at least every 45.7 cm (18 in.), using the appropriate fasteners.
3. **Models with 10-pin harness or SmartCraft Harness:**
 - a. Place the hose clamp over the instrumentation wiring harness.

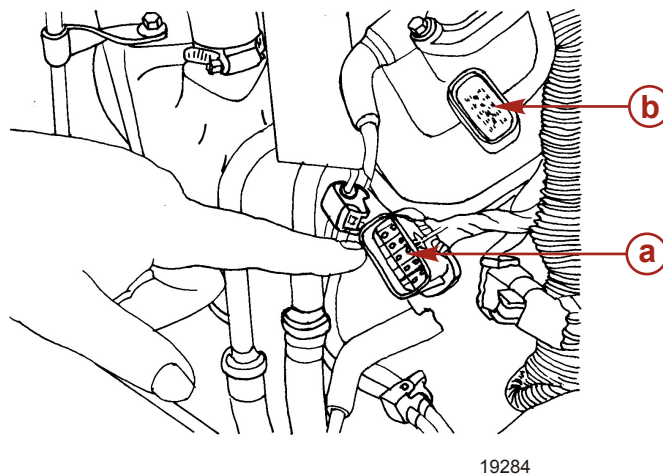
- b. Connect the instrumentation wiring harness to the engine harness plug. Secure the connection with a hose clamp.



Typical round 10-pin harness shown

a - Engine harness plug

- c. Tighten the hose clamp to secure the wiring harness to the engine harness plug.
- d. Connect the transom harness.
- e. Connect the CAN line.



a - Transom harness connection

b - CAN line connection

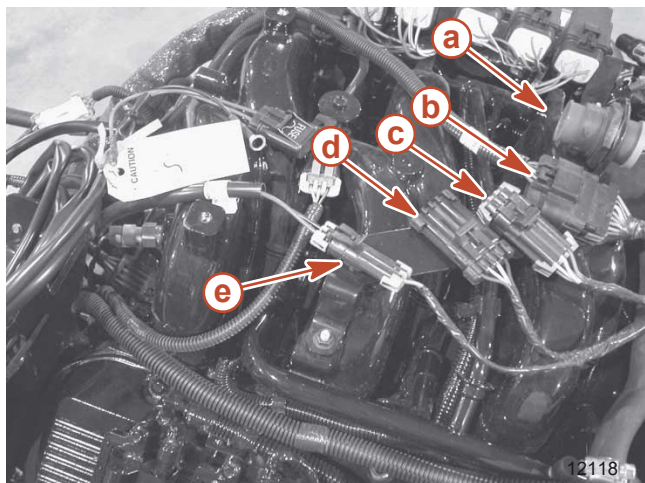
- f. Connect the trim position sender connection from the gimbal housing to the engine harness.

IMPORTANT: The 14-pin wiring harness cannot supply accessory power without a relay and harness kit.

4. Models with 14-pin harness:

- a. Connect the instrumentation wiring harness to the engine harness plug.
- b. Connect the transom harness.
- c. Connect the depth transducer connector to the DLC/Depth transducer connector on the engine harness.
- d. Connect the paddle wheel and tank level connector.

- e. Connect the power harness (Clean Power w/ 5-amp fuse) connector.



14-pin harness connections

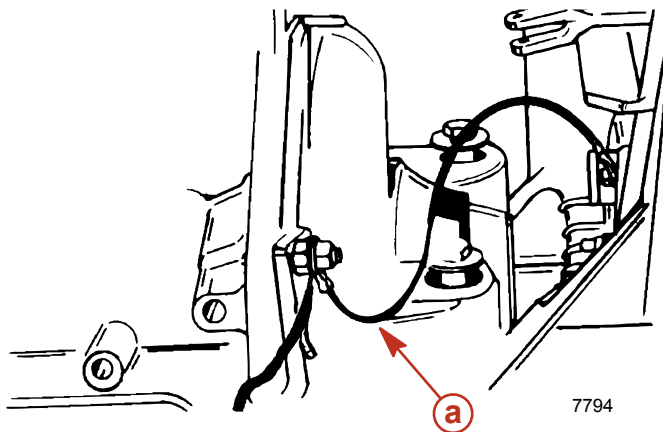
- | | |
|--|---|
| a - Engine harness connector | d - DLC/Depth transducer connector |
| b - Transom harness connector | e - Power harness connector/Clean Power w/ 5-amp fuse (DTS only) |
| c - Paddle wheel/Tank level connector | |

Continuity Wire Connection

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

IMPORTANT: Models equipped with only a 10-pin engine harness must connect the continuity circuit wire from the engine to the transom assembly.

1. For models equipped with only a 10-pin engine harness, connect the continuity circuit wire from the engine to the transom assembly.



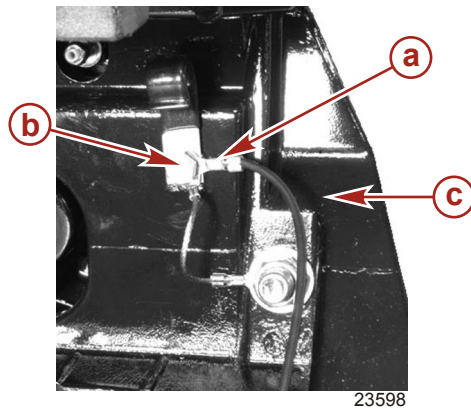
- a** - Continuity wire

IMPORTANT: Models equipped with a 14-pin engine wiring harness are equipped with a separate transom harness. Incorporated into the transom harness is a continuity circuit ground lead. Some models may also have the separate continuity circuit wire. Connect the transom harness continuity circuit ground lead to the transom plate, and connect the the continuity circuit wire between the transom plate and the flywheel housing ground stud. Proper ground connection between the transom and the engine is required to ensure proper operation of the corrosion protection system.

2. For 14-pin engine harness models equipped with a transom harness continuity circuit ground lead and a continuity circuit wire:
 - a. Connect the transom harness continuity circuit ground lead and the continuity circuit wire to the inner transom plate using the grounding screw on the upper port side of the inner transom plate. Tighten the screw securely.
 - b. Connect the continuity circuit wire to the engine.

IMPORTANT: Models equipped with a 14-pin engine harness have the continuity circuit incorporated into the engine and transom harnesses. The continuity circuit ground lead has been incorporated into the transom harness and must be connected to the inner transom plate to ensure proper operation of the corrosion protection system. A separate continuity circuit wire is not required for models equipped with a transom harness continuity circuit ground lead.

3. For models equipped with a 14-pin engine harness, secure the transom harness continuity circuit ground lead to the inner transom plate using the grounding screw on the upper port side of the inner transom plate. Tighten the screw securely.



a - Transom harness ground lead
b - Grounding screw

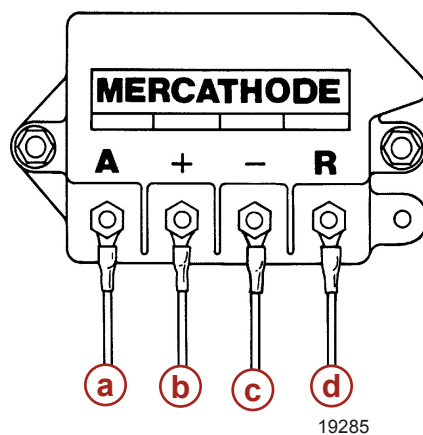
c - Inner transom plate

4. Connect any grounding wires or accessories that may have been disconnected.

Standard Connection MerCathode System

IMPORTANT: The opposite ends of the RED/PURPLE wire and the black wire must be connected directly to the battery terminals. Do not connect them to a switched circuit. The MerCathode system must function continuously for proper corrosion protection.

1. Connect the wires to the MerCathode controller assembly.



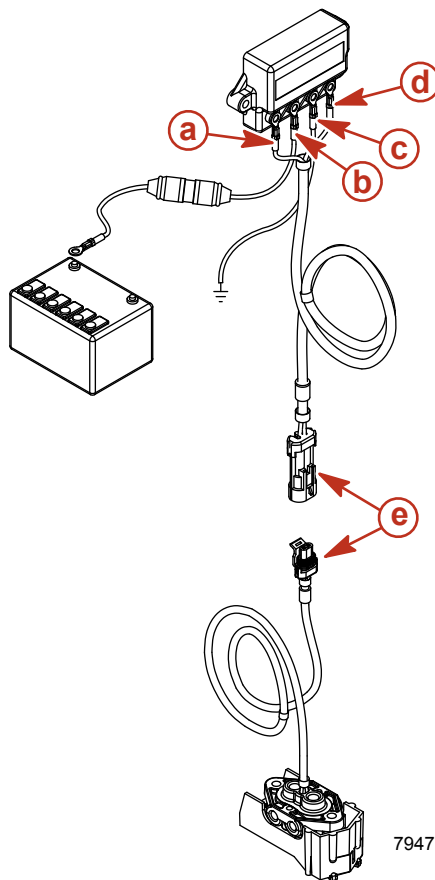
- a** - ORANGE wire—from electrode on transom assembly
- b** - RED/ PURPLE wire—to positive (+) battery terminal
- c** - BLACK wire—from engine harness
- d** - BROWN wire—from electrode on transom assembly

2. Apply a thin coat of sealant to all wire connections.

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

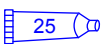
Quick-Connect MerCathode System

- 1. Connect the wires to the MerCathode controller assembly, if they are not already connected. Connect the male and female quick-connect terminals.



- a - Orange lead—from anode on transom assembly (through the quick-connect fitting)
- b - RED/PURPLE wire—to positive (+) battery terminal
- c - Black wire—from engine harness, if equipped, or to negative (–) battery terminal
- d - Brown wire—from electrode on transom assembly (through the quick-connect fitting)
- e - Male and female quick-connect terminals

- 2. Apply a thin coat of sealant to all wire connections.

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

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.

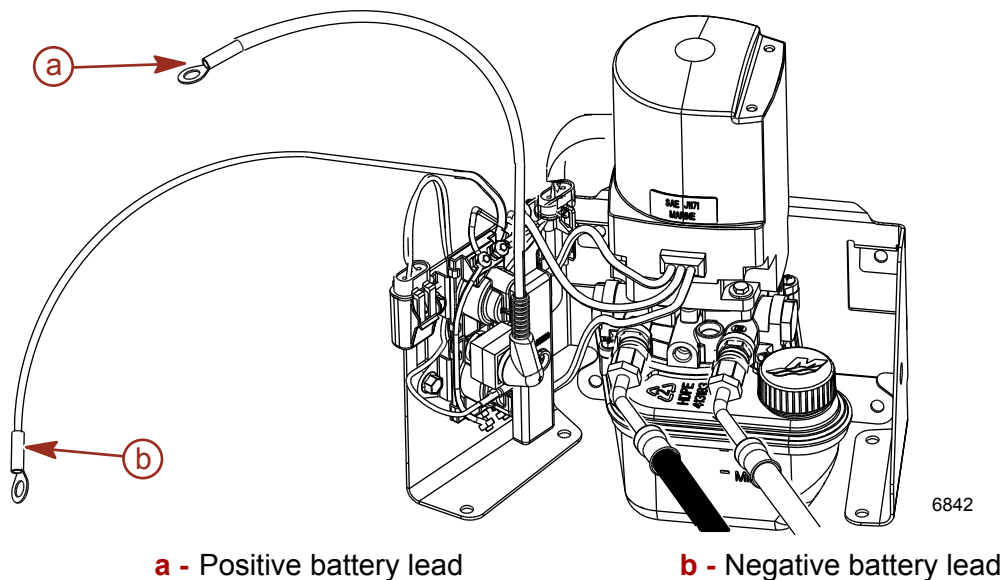
Tube Ref No.	Description	Where Used	Part No.
	Battery connection sealant	Battery terminal connections	Obtain Locally

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

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

Power Trim Pump

1. Connect the power trim pump BLACK (–) battery cable to the negative (–) battery terminal and the pump RED (+) battery cable to positive (+) battery terminal.



2. 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

Trim Limit and Trim Sender Harness

1. Connect the trim limit and trim sender to the transom harness.

Sterndrive Installation

Refer to the appropriate **Mercury MerCruiser Sterndrive Service Manual** and install and adjust the sterndrive unit and remote control shift cables using hardware retained during removal.

Notes:

Removal and Installation

Section 2B - MIE Models

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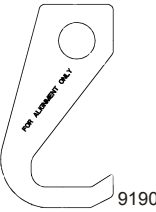
**2
B**

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Battery Connection Sealant	battery terminals	Obtain Locally
	Liquid Neoprene	Exposed terminals and electrical connections Exposed terminals and connections	92-25711-3

Special Tools

Alignment Hook	91-863375A 1
	Assists during engine alignment.

Removal

⚠ WARNING

Avoid injury or death and power package damage from electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ CAUTION

Engine compartment size may require the removal of additional components.

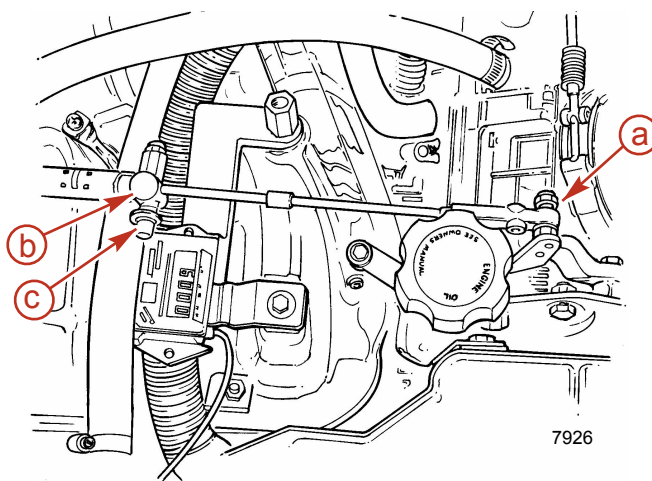
1. Remove the boat from the water.
2. Disconnect both of the battery cables from the battery.
3. Remove the engine cover.
4. Disconnect the 10-pin or 14-pin instrument wiring harness from the engine harness.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

5. Close the fuel shut-off, if equipped.
6. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.

7. Disconnect the throttle cable from the throttle body and retain the fasteners (non DTS).

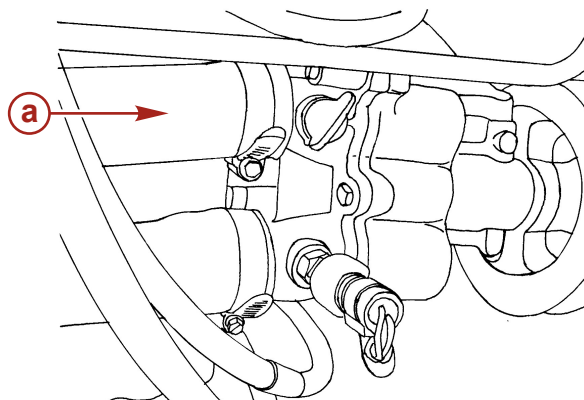


a - Flat washer and locknut

c - Flat washer and locknut

b - Cable barrel

8. Disconnect the shift cable from the transmission (non DTS).
9. Disconnect the seawater inlet hose.



a - Seawater inlet hose

10. Disconnect the shaft log seal hose from the hose fitting on the exhaust manifold.
11. Disconnect the exhaust system hoses.
12. Disconnect the continuity wires and accessories that are connected to the engine.
13. Disconnect the propeller shaft coupler from the transmission output flange.
14. On V-drive models, remove the propeller shaft flange from the propeller shaft and slide the propeller shaft away from the transmission to create suitable clearance.

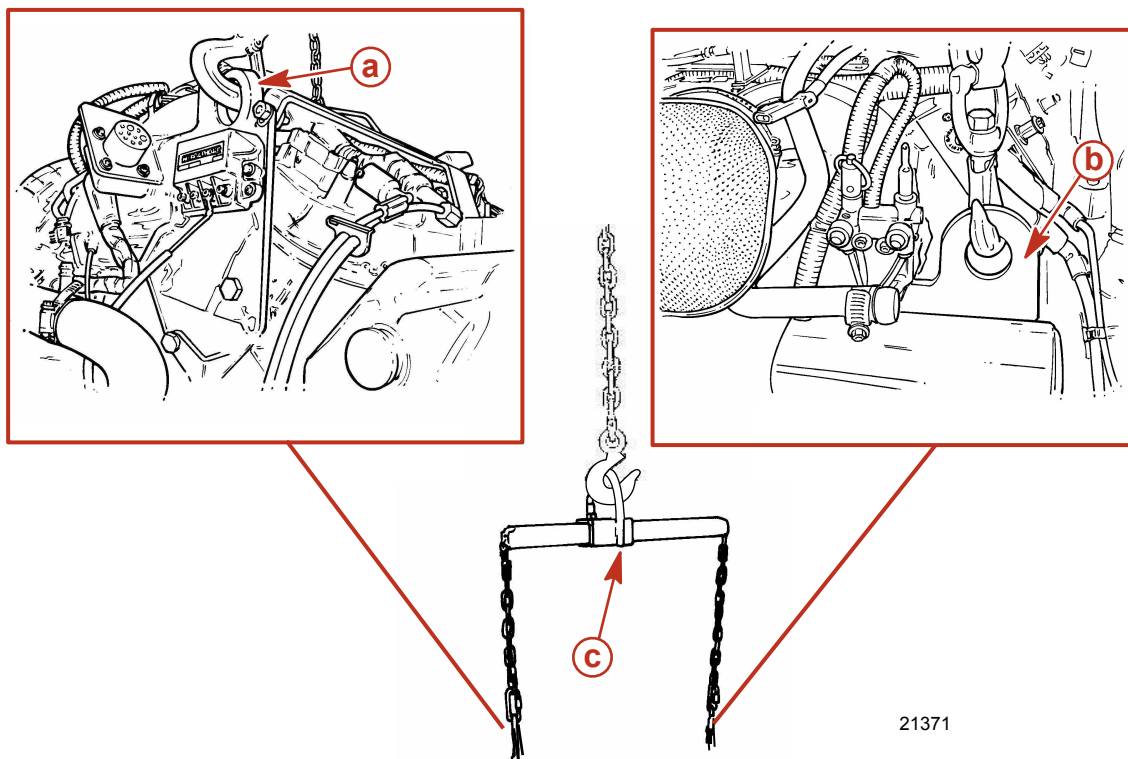
⚠ CAUTION

Engine MUST be lifted with a lifting arm or damage to engine components could occur.

⚠ CAUTION

Engine compartment size may require the removal of additional components.

15. Attach and adjust a suitable sling and lifting arm to the lifting eyes on the engine so that the engine is level when suspended.



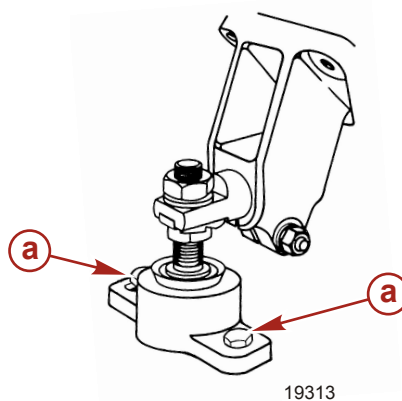
21371

Sterndrive Shown Inboard Similar

- a** - Rear lifting eye
b - Front lifting eye

- c** - Suitable sling and lifting arm

16. Remove the front and rear engine mounting bolts. Retain the hardware.

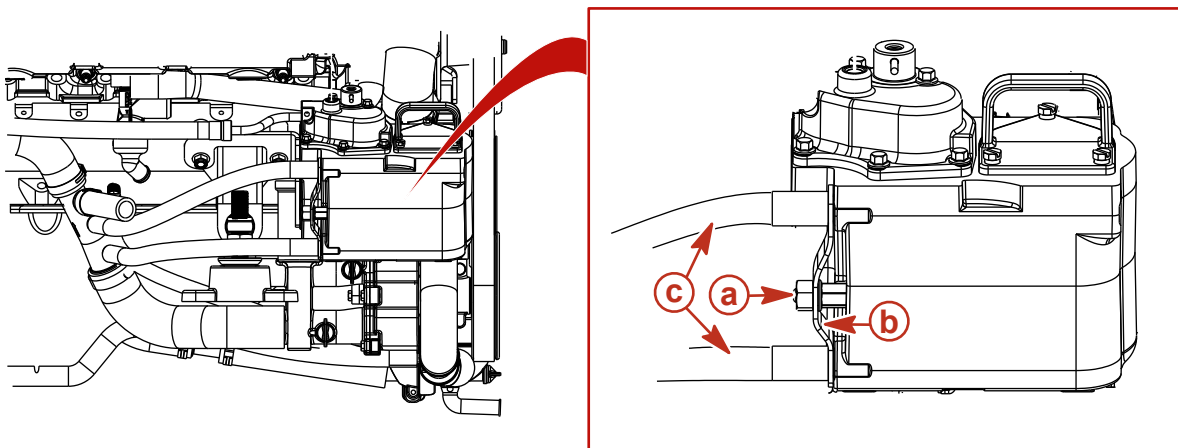


19313

- a** - Lag bolt (with washers)

17. On models with Gen III Cool Fuel system:

- a. To gain access to the starboard engine mount loosen the captured nut from the hose retainer bracket and remove the water hose from the Gen III Cool Fuel Module.



8208

a - Captured nut
b - Retainer bracket

c - Water hose

18. Carefully remove the engine.

Engine Installation

Engine Mount Pre-Adjustment

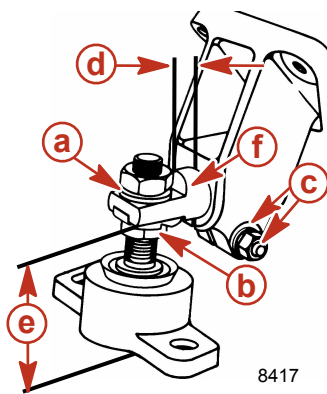
IMPORTANT: Engine mounts must be adjusted, as explained in following procedure, to center the mount adjustment and establish a uniform height on all mounts.

1. 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 proper dimension, then retighten the locking nut.

Description	Specification
Distance from bottom of mount to bottom of trunnion	67 mm + 2 mm (2-5/8 in. + 1/16 in.)

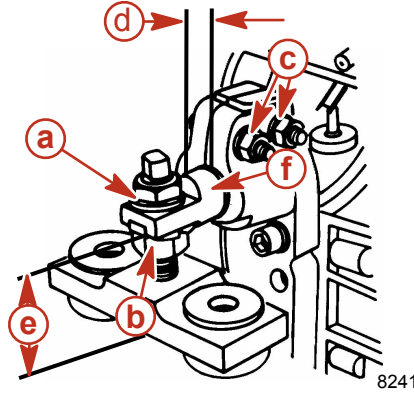
2. Loosen the clamping bolts and nuts on all four engine mount brackets to ensure the following:
 - Large diameter of mount trunnion extended as shown.

- Tighten the clamping bolts and nuts slightly to prevent moving in or out. Mounts must be free to pivot when installing the engine.



Typical front mount

- a** - Locking nut
- b** - Adjusting nut
- c** - Trunnion clamp bolts and nuts, with lockwashers



Typical rear mount

- d** - 10 mm + 2 mm (3/8 in. + 1/16 in.)
- e** - 67 mm + 2 mm (2-5/8 in. + 1/16 in.)
- f** - Mount trunnion

Initial Engine Alignment

NOTE: The center lifting eye tool (91-863375A-1) used for engine alignment can be ordered from the Mercury Precision Parts / Quicksilver Accessories Guide.

Alignment Hook	91-863375A 1
----------------	--------------

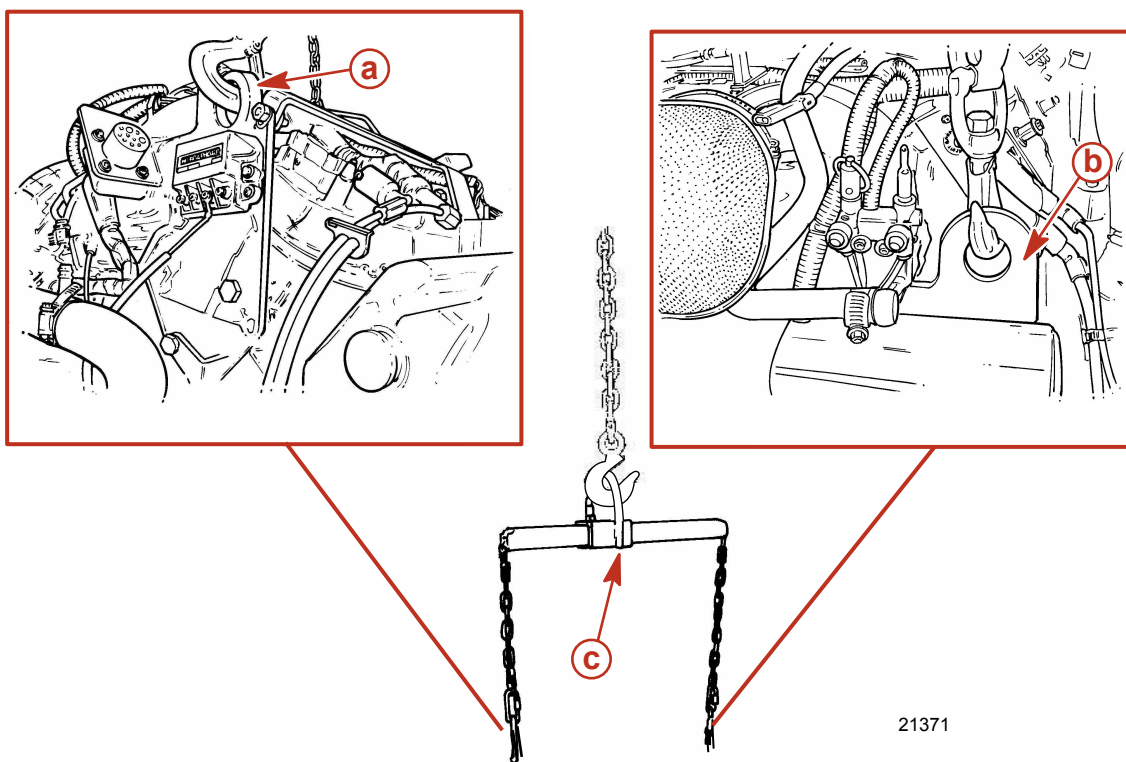
MODELS WITH 8 DEGREE DOWN ANGLE TRANSMISSIONS - VELVET DRIVE OR ZF MARINE

⚠ CAUTION

Engine MUST be lifted with a lifting arm or damage to engine components could occur.

1. Attach and adjust a suitable sling and lifting arm to the engine lifting eyes so that the engine is level when suspended.

2. Lift the engine into position in the boat using an overhead hoist.



21371

Sterndrive Shown Inboard Similar

a - Front engine lifting eye

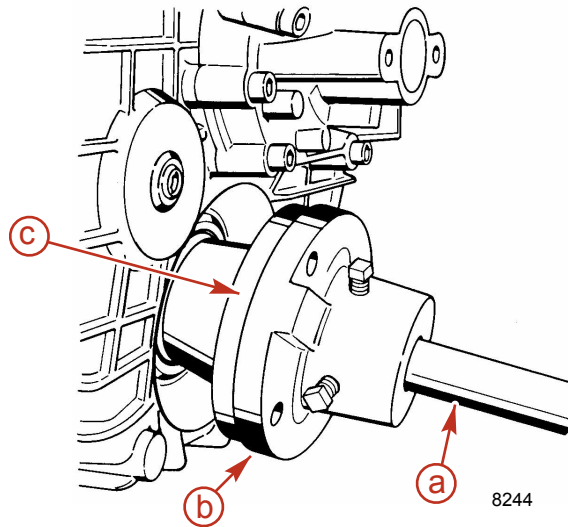
c - Suitable sling and lifting arm

b - Rear engine lifting eye

⚠ CAUTION

When lowering engine into position do not set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

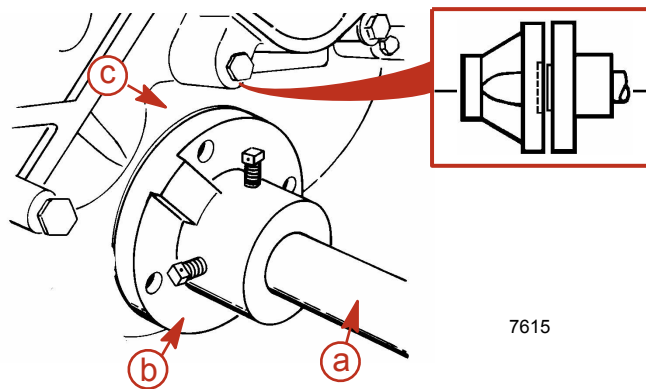
- Position the engine onto the engine bed so that the transmission output flange and propeller shaft coupler are visibly aligned (no visible gap seen between coupling faces when butted together). Adjust the engine bed height if necessary to obtain proper alignment. Do not use mount adjustments to adjust the engine position at this time.



a - Propeller shaft
b - Propeller shaft coupler

c - Transmission output flange

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 the initial alignment. This is necessary to allow for final engine alignment.



a - Propeller shaft
b - Propeller shaft coupler

c - Transmission output flange

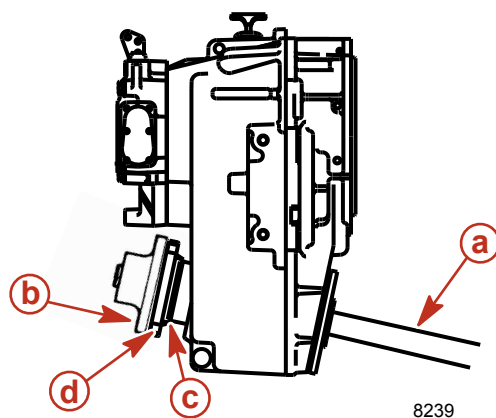
- Ensure that all four mounts are positioned properly, then fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts (of sufficient length) and flat washers. Tighten lag bolts securely.
- Disconnect the overhead hoist and remove the sling.

MODELS WITH V-DRIVE TRANSMISSIONS

- Lift the engine into the boat and position the engine so that enough propeller shaft protrudes through the transmission and output flange for the propeller shaft coupler to be attached.
- Install the coupler and position the engine so that there is no visible gap between the coupling faces when butted together.

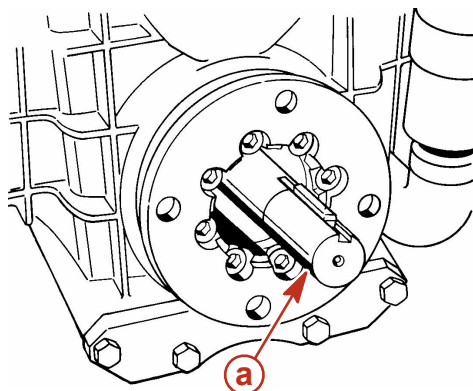
- Adjust the engine bed height if necessary to obtain proper alignment. Do not use mount adjustments to adjust the engine position at this time.

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



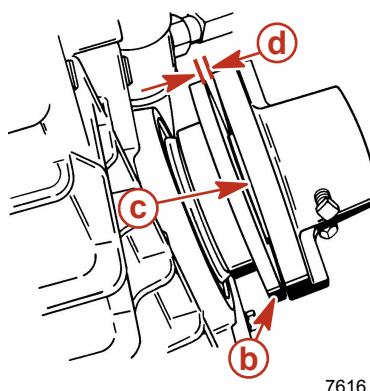
Velvet Drive

- | | |
|------------------------------------|---------------------------------------|
| a - Propeller shaft | c - Transmission output flange |
| b - Propeller shaft coupler | d - No visible gap allowed |



ZF Marine 63IV

- | | |
|------------------------------------|---------------------------------------|
| a - Propeller shaft | c - Transmission output flange |
| b - Propeller shaft coupler | d - No visible gap allowed |



- Ensure that all four mounts are 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 lag bolts securely.
- Disconnect the overhead hoist and remove the sling.

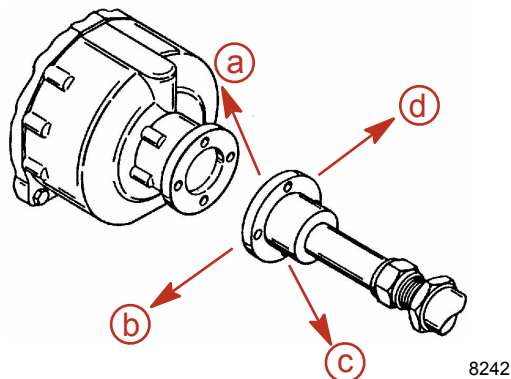
Final Engine Alignment

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

The engine must be aligned so that the transmission and propeller shaft coupling centerlines are aligned and the coupling faces are parallel within 0.07 mm (0.003 in.). This applies to installations with solid couplings as well as flexible couplings.

- Inspect the mating faces on the transmission output flange and propeller shaft coupler to ensure that they are clean and flat.
- 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 to the shaft.

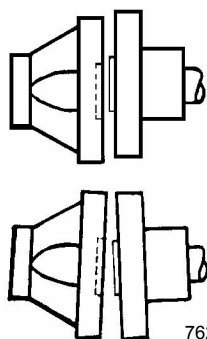


Typical down angle (V-drive similar)

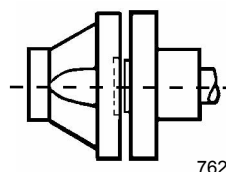
a - Up
b - Port

c - Down
d - Starboard

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

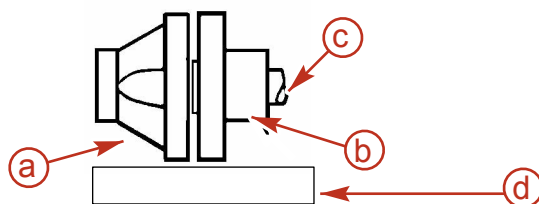


Incorrect



Correct

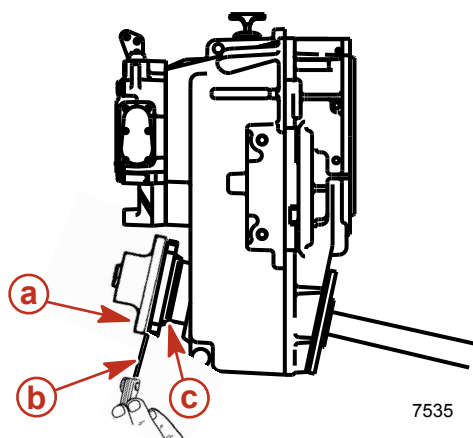
NOTE: Some propeller shaft couplers may not have a shoulder on the mating face. On these installations, use a straight edge to check the centerline alignment.



a - Transmission output flange
b - Propeller shaft coupler

c - Propeller shaft
d - Straight edge

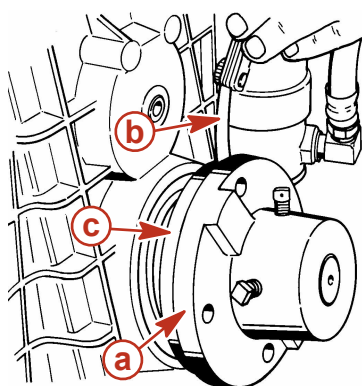
4. Check for angular misalignment by hand-holding the coupling faces tightly together and checking for a gap between the coupling faces with a 0.07 mm (0.003 in.) feeler gauge. Check the gap at 90-degree intervals.



Velvet drive

a - Propeller shaft coupler
b - Feeler gauge

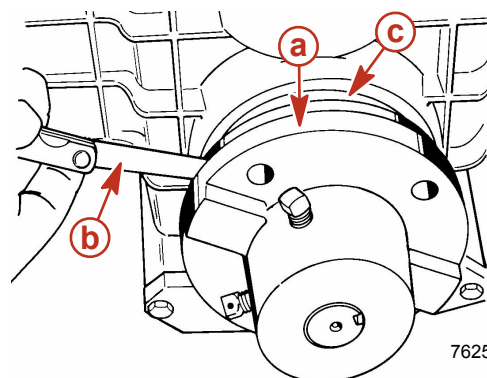
c - Transmission output flange



ZF Marine

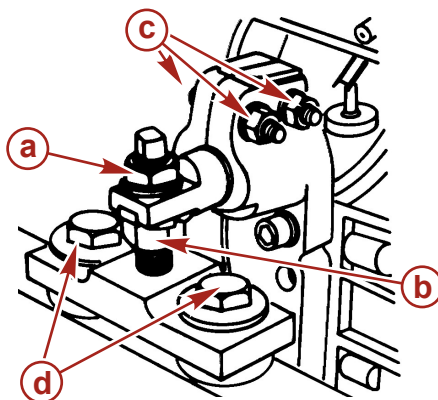
a - Propeller shaft coupler
b - Feeler gauge

c - Transmission output flange



5. If the coupling centerlines are not aligned or if the 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 locknut on the mounts requiring adjustment and turn the adjusting nuts in the desired direction to raise or lower.

IMPORTANT: Both front mount (or rear mount) adjusting nuts must be turned equally to keep the engine level from side to side.



19335

Typical mount

a - Locking nut
b - Adjusting nut

c - Clamping bolts and nuts, with lockwasher
d - Lag bolts

NOTE: Some rear mounts have one clamping screw and nut on each side.

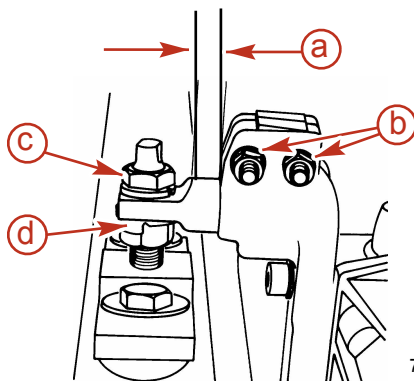
- b. **To move the engine to the left or right**, loosen the clamping bolts and nuts on all four mount brackets and move the engine to the left or right as necessary to obtain proper alignment. A small amount of adjustment can be obtained with the slot on front end of some mounts. Loosen the lag bolts (which fasten the mounts to the engine bed) and move the engine, as required. Retighten 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. Torque the clamping bolts and nuts on all four mount brackets.

Description	Nm	lb. in.	lb. ft.
Trunnion clamping bolt and nut	68		50

8. Tighten the locknut on all four mounts.
9. Bend one of the tabs on the tab washer down onto the flat of the adjusting nut.



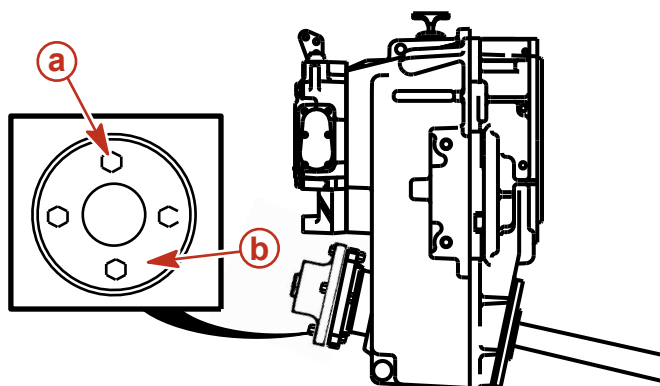
7537

a - Measurement -
 45 mm (1-3/4 inches)
b - Clamping bolts and nuts

c - Locknuts on all 4 mounts
d - Tab on tab washer

IMPORTANT: All coupler 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 couplers.

10. Secure the couplers together with bolts, lockwashers, and nuts. Torque the bolts and nuts.



7626

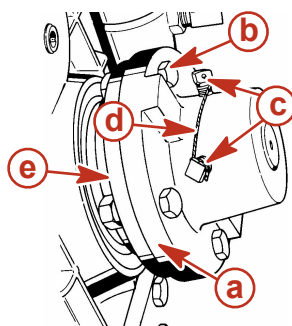
a - Bolt**b - Transmission coupler**

Description	Nm	lb. in.	lb. ft.
Coupler bolt and nut	68		50

- If the propeller shaft coupler has set screws, remove the set screws and mark dimple locations using a transfer punch.
- To drill dimples, remove the propeller shaft coupler and drill shallow dimples at the locations marked with the transfer punch.
- Reinstall the propeller shaft coupler and torque the coupling bolts.

Description	Nm	lb. in.	lb. ft.
Coupling bolt and nut	68		50

- Install the set screws and tighten securely. Connect safety wire between the set screws to ensure that they do not loosen.

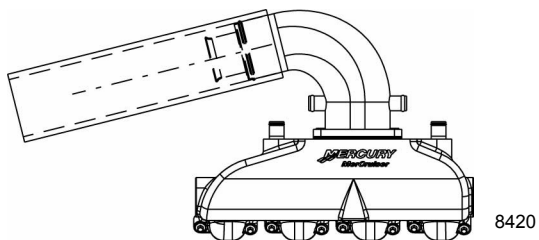


7627

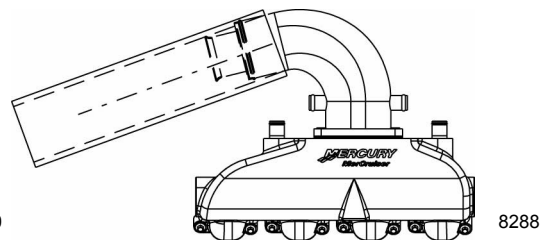
V-drive transmission, down angle transmission similar

a - Propeller shaft coupler**d - Safety wire****b - Bolt****e - Transmission output flange****c - Set screw**

11. Align the exhaust tubes.



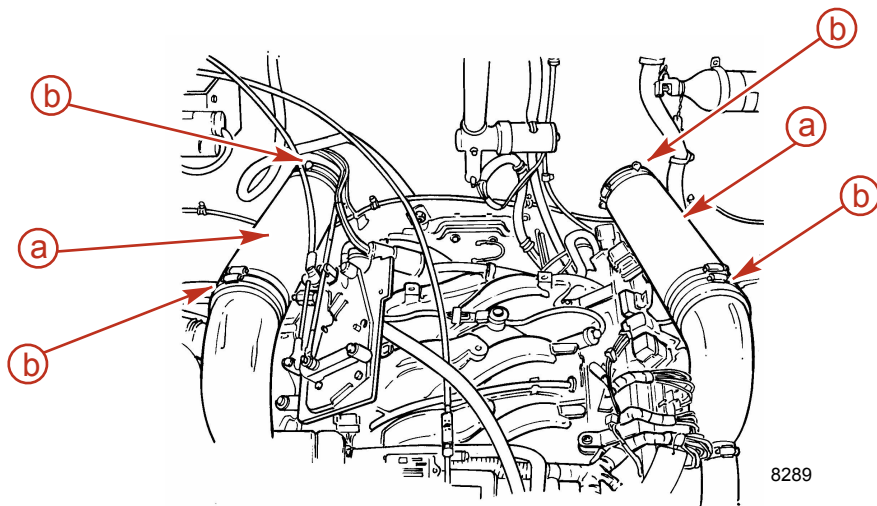
Correct alignment



Incorrect connection

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

12. Tighten all exhaust hose or exhaust tube clamps securely.



Typical

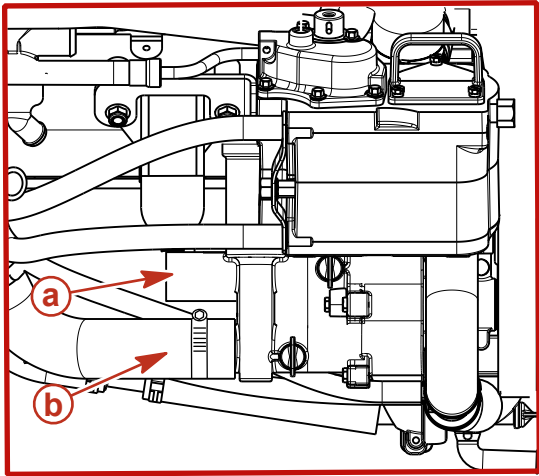
a - Exhaust tube

b - Clamp

Fluid Connections

Seawater Inlet Hose Connection

- 1. Connect the seawater inlet hose to the inlet fitting of the seawater pump.



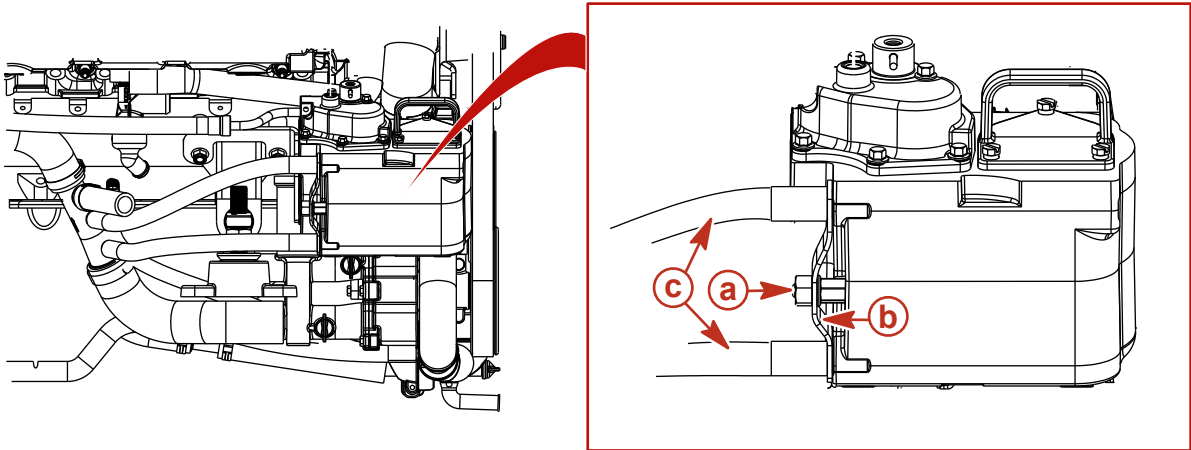
9321

Seawater pump connections

- a - Seawater pump inlet
- b - Seawater (out) hose to cooler

Gen III Cool Fuel Module Water Hose Connection

- 1. Connect the water hose and hose retainer bracket to the Gen III Cool Fuel Module. Secure with captured nut.
- 2. Torque the captured nut.



8208

- a - Captured nut
- b - Retainer bracket
- c - Water hose

Description	Nm	lb. in.	lb. ft.
Gen III Cool Fuel Module captured nut	19	168	

Shaft Log Seal Connection

⚠ CAUTION

Avoid engine overheating which could result in engine damage. Damage caused by improper cooling system connections for the propeller shaft log seal IS NOT covered by the Mercury MerCruiser limited warranty.

IMPORTANT: The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system and must not be removed.

1. Remove the plug from the reducer fitting on the exhaust manifold.

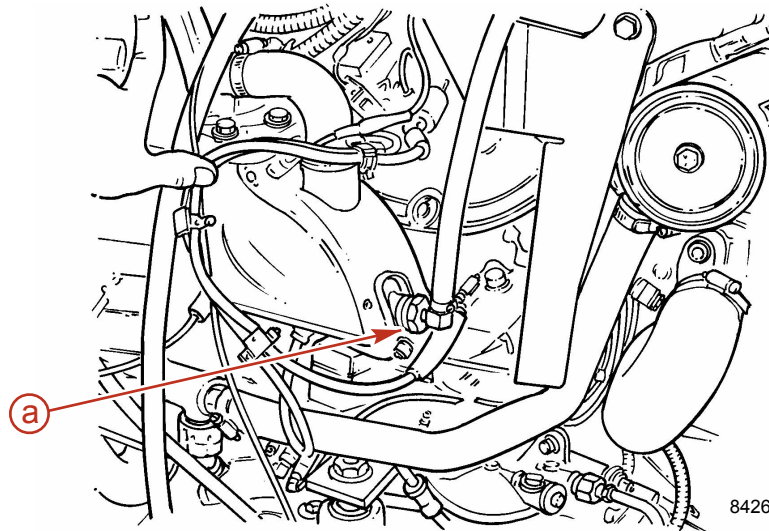
IMPORTANT: If not using a shaft log seal, this fitting must remain plugged.

2. Attach the shaft log seal cooling water hose to the reducer fitting on the exhaust manifold.

⚠ CAUTION

Engine damage may result from failure to route propeller shaft log seal hose properly. This could cause increased exhaust system corrosion, submersion damage or freeze damage to engine.

3. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows.
4. Fasten the hose securely to keep it properly positioned.



a - Reducer fitting

Fuel Supply Connections—Gen II Cool Fuel System

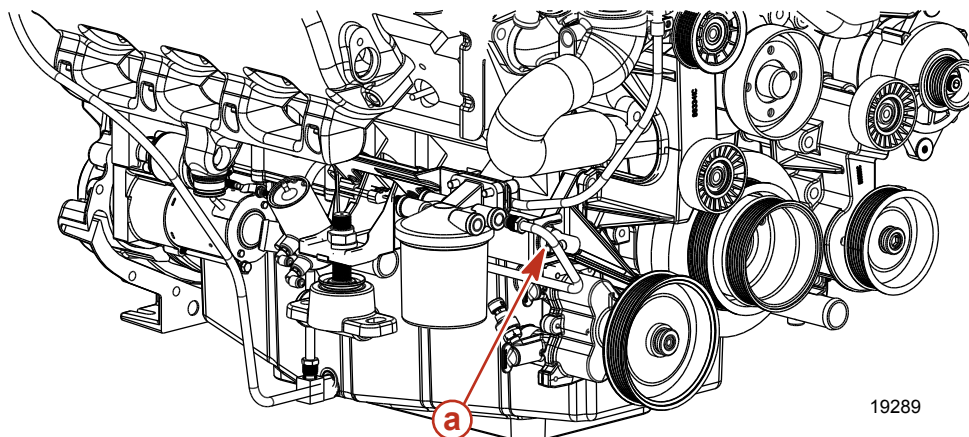
⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

A flexible fuel line must be used to connect the fuel line to the engine to absorb deflection when the engine is running.

IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel lines.

1. Connect the fuel line from the fuel tank to the boost pump inlet. Ensure that the connections are secure.



a - Fuel inlet hose connection

2. Open the fuel shut-off valve, if equipped. Check for leaks.

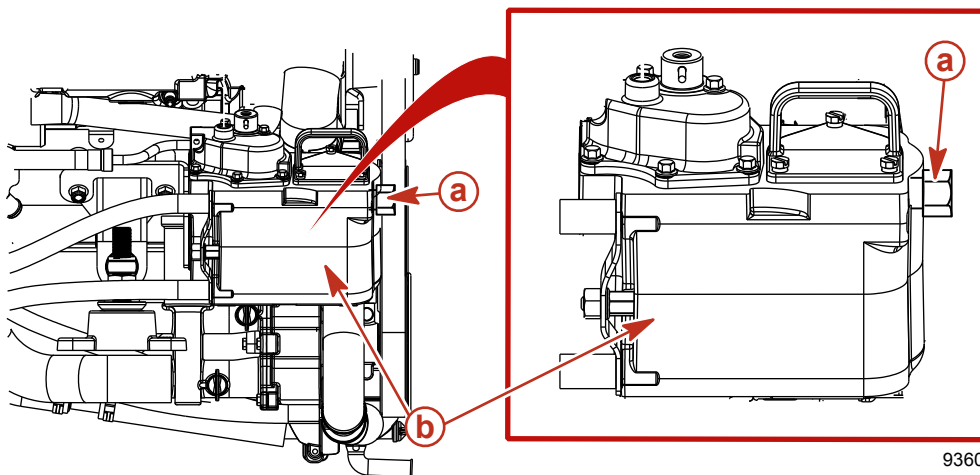
Fuel Supply Connection—Gen III Cool Fuel System

FUEL LINE CONNECTION

A flexible fuel line must be used to connect the fuel line to the engine to absorb deflection when the engine is running.

IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.

1. Connect the flexible fuel line to the Gen III Cool Fuel Module fitting.



a - Fuel fitting

b - Gen III Cool Fuel Module

2. Open the fuel shut-off valve, if equipped. Check for leaks.

Shift Cable Installation and Adjustment

See **Section 8A** and **8B**.

Throttle Cable Installation and Adjustment

1. Place the remote control handle in neutral idle position.

IMPORTANT: Ensure that the throttle cable is routed to avoid sharp bends and contact with moving parts. Do not fasten any items to the throttle cable. The outer cable must be free to move when the cable is actuated.

2. Remove the flame arrestor.
3. Install the cable end guide on the throttle lever, then push the cable barrel end lightly toward the throttle lever end. This will place a slight preload on the shift cable to avoid slack in the cable when moving the remote control lever. Adjust the barrel on the throttle cable to align with the hole in the anchor plate. Ensure that the hole in the barrel positions the cable as shown.
4. Secure the throttle cable with fasteners and tighten securely.
5. Place the remote control throttle lever in the WOT position. Ensure that the throttle plate is completely open.
6. Return the remote control throttle lever to idle position and ensure that the throttle plate is completely closed.
7. Reinstall the flame arrestor and tighten clamp securely.

Electrical Connections

Finding Other Diagrams

NOTICE

Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

CAUTION

Avoid damage to the electrical system components caused by improper work or diagnostic practices. Observe the following precautions when working on or around an electrical harness, or when adding electrical accessories:

- Do not tap electrical accessories into the engine electrical harness.
- Do not puncture (probe) wires for testing.
- Do not reverse battery leads.
- Do not splice wires into the electrical harness.
- Do not attempt diagnostics without 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 moving parts and hot spots on the engine.

SmartCraft Product

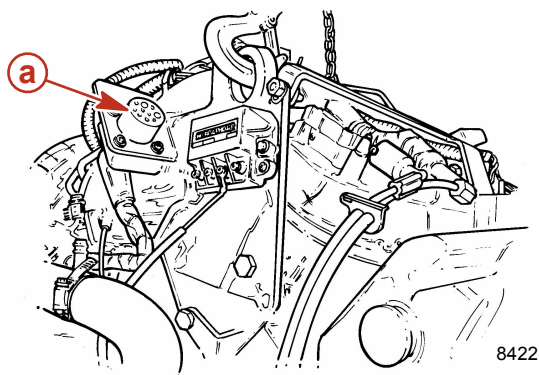
1. Connect the 10-pin CAN data harness if equipped.
2. Connect all SmartCraft sensor harnesses.

Engine Harness

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

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, be sure to secure the connection properly.
2. Fasten harnesses to the boat at least every 45.7 cm (18 in.), using the appropriate fasteners.

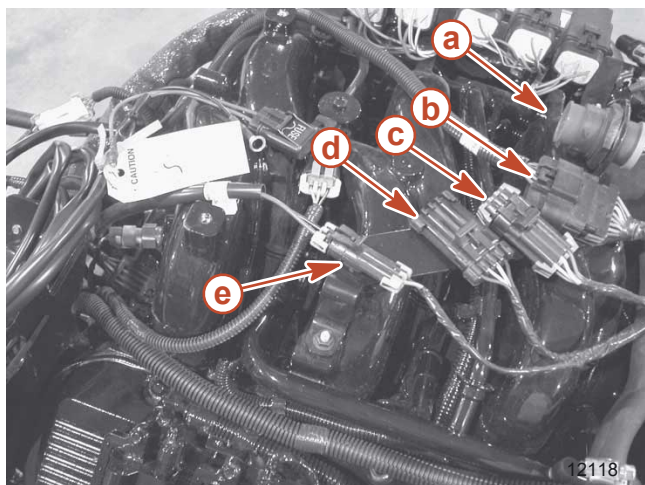
3. **Models with 10-pin harness or CAN connector harness:** Place a hose clamp over instrumentation wiring harness.
4. Connect the instrumentation wiring harness to the engine harness plug. Secure the connection with a hose clamp.



Typical round 10-pin harness shown

a - Engine harness plug

5. Tighten the hose clamp to secure the wiring harness to the engine harness plug.
- IMPORTANT: The 14-pin wiring harness cannot supply accessory power without relay and harness kit.**
6. **Models with 14-Pin harness,** connect the instrumentation wiring harness to the engine harness plug.
 - a. Connect the transom harness.
 - b. Connect the ALDL depth connector.
 - c. Connect the paddle wheel/tank level connector.
 - d. Connect the power harness connector.



14 pin harness connections

- | | |
|--|---|
| a - Engine harness connector | d - DLC/Depth transducer connector |
| b - Transom harness connector | e - Power harness connector/Clean |
| c - Paddle wheel/Tank level connector | Power w/ 5-amp fuse (DTS only) |

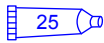
NOTE: See *Instrumentation Wiring Diagrams* for specific wiring diagrams.

BATTERY CABLES

1. Ensure that all accessory wiring (if equipped) is 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 battery terminals with a battery connection sealant to help retard corrosion.

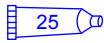
Tube Ref No.	Description	Where Used	Part No.
	Battery Connection Sealant	battery terminals	Obtain Locally

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

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

Battery Connection

1. Ensure that all accessory wiring (if equipped) is 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.
5. Apply sealant to the exposed terminals and electrical connections.

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

Engine

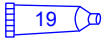
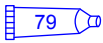
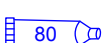
Section 3A - 496 cid (8.1L)

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	3M Brand Gasket Adhesive	Intake manifold gaskets Camshaft lobes	Obtain Locally
	Perfect Seal	Threads of cylinder head bolts and cylinder block external bolts Threads of head bolts. Threads of water circulating pump screws Retainer mating surface Front cover gasket Oil hose fitting	92-34227-1
	MerCruiser 4-cycle 25W40 Engine Oil	Front cover oil seal	92-802837A1
	SAE Engine Oil 30W	Crankshaft sealing surface Connecting rod bearings, pistons, rings, and cylinder walls Main bearings and crankshaft Journals and bearings Timing chain Camshaft bearing journals Outer surface of the new camshaft bearings Cylinder bores	Obtain Locally
	Three Bond 1217F	Neoprene gasket ends Joints of rear seal retainer and front cover. Rear main bearing cap mating surface	Obtain Locally

Engine Specifications

496 CID (8.1L) Engine Specifications

Model	496 MAG/8.1S Horizon	496 MAG HO/8.1S HO
Displacement	8.1L (496 cid)	
Bore	4.25 (108)	
Stroke	4.38 (111)	
Compression ratio	9.1:1	
Heads	Cast iron	
Intake manifold	Aluminum	
Block	Cast iron (4 bolt main bearing caps)	
Rods	Forged steel	
Pistons	Cast aluminum	
Crankshaft	Cast steel	Cast steel
Camshaft	Steel	
Engine compartment pressure differential	0.5 kPa (2 in H ₂ O)	
Engine compartment temperature	Maximum 80° C (176° F)	

CYLINDER BORE

Model			496 CID/8.1 L
Diameter			107.95–107.968 mm (4.250–4.2507 in.)
Out of round		Production	0.025 mm (0.0010 in.)
		Service	*
Taper	Production	Thrust side	0.013 mm (0.0005 in.)
		Relief side	0.025 mm (0.0010 in.)
	Service		*

PISTON

Model		496 CID/8.1 L
Clearance	Production	*
	Service	*

PISTON PIN

Model		496 CID/8.1 L
Diameter		(26.416–26.419 mm 1.04–1.0401 in.)
Clearance in pin	Production	0.010–0.017 mm (0.00039–0.00066 in.)
	Service	*
Fit in rod		0.049–0.020 mm (0.00019–0.0007 in.)

PISTON RING

Model				496 CID/8.1 L
Compression	Groove side clearance	Production	Top	(0.031–0.074 mm 0.0012–0.0029 in.)
			2nd	0.031–0.074 mm (0.0012–0.0029 in.)
		Service		*
	Gap	Production	Top	0.249–0.409 mm (0.0098–0.0161 in.)
			2nd	0.450–0.650 mm (0.0177–0.0256 in.)
		Service		*
Oil	Groove side clearance	Production		*
		Service		*
	Gap	Production		0.249–0.759 mm (0.0098–0.0099 in.)
		Service		*

CRANKSHAFT

Model			496 CID/8.1 L
Main journal	Diameter	No.1,2,3,4,5	69.804–69.822 mm (2.7482–2.7489 in.)
	Taper	Production	0.0102 mm (.0004 in.) (maximum)
		Service	*
	Out of round	Production	0.0102 mm (0.0004 in.) (maximum)
		Service	*
Main bearing clearance	Production	No.1,2,3,4	0.028–0.061 mm (0.0011–0.0024 in.)
		No.5	0.064–0.097 mm (0.0025–0.0038 in.)
	Service	No.1	*
		No. 2,3,4	*
		No.5	*
Crankshaft End Play			0.127–0.279 mm (0.0050 - 0.0110 in.)
Connecting rod journal	Diameter		*
	Taper	Production	0.0102 mm (0.0004 in.)
		Service	*
	Out of round	Production	0.0102 mm (0.0004 in.)
		Service	*
Rod bearing clearance		Production	0.0279–0.0736 mm (0.0011–0.0029 in.)
		Service	*
Rod side clearance			0.384–0.686 mm (0.0151–0.0270 in.)
Crankshaft runout at no.3 main bearing			*

VALVE SYSTEM

Model			496 CID/8.1 L
Lifter			Hydraulic, roller followers
Rocker arm ratio			1.70:1
Face angle (intake & amp; exhaust)			45
Seat angle (intake & amp; exhaust)			46
Seat runout (intake & amp; exhaust)			0.050 mm (0.002 in.) (maximum)
Seat width		Intake	0.800–1.200 mm (0.03–0.06 in.)
		Exhaust	1.651–2.159 mm (0.06–0.095 in.)
Stem clearance	Production	Intake	0.025–0.074 mm (0.001–0.0029 in.)
		Exhaust	0.030–0.079 mm (0.0012–0.0031 in.)
	Service	Intake	*
		Exhaust	*
Stem diameter		Intake	9.436–9.454 mm (0.3715–0.3722 in.)
		Exhaust	9.431–9.449 mm (0.3713–0.3720 in.)
Valve margin (intake and exhaust)			*
Valve lash (intake and exhaust)			*

VALVE SPRING

Model			496 CID/8.1 L
Valve spring 1	Free length		55.70 mm (2.1929 in.)
	Pressure	Closed at 46.680 mm (1.838 in.)	267–293 Nm (58–64 lb. ft.)
		Open at 33.980 mm (1.34 in.)	840–920 Nm (189–207 lb. ft.)
	Installed height		46.680–47.479 mm (1.838–1.869 in.)
Damper or damper shield	Free length		*
	Approximate number of coils		*
	Valve spring fit in damper shield		*

ROLLER TAPPET CAMSHAFT

Model		496 Mag/8.1S Horizon	496 Mag HO/8.1S H
Lobe lift	Exhaust	7.22 mm (0.284 in.)	0.30 in. (7.62 mm)
	Intake	7.16 mm (0.282 in.)	7.62 mm (0.30 in.)
Duration at 1.27mm (0.050 in.) cam lift	Exhaust	*	*
	Intake	*	*
Journal diameter		49.472–49.522 mm (1.9477–1.9479 in.)	
Journal out of round		*	*
Camshaft runout		0.051 mm (0.002 in.) (maximum)	
Timing chain deflection		9.5 mm (0.375 in.) from taut position. Total 19 mm (0.75 in.)	

CYLINDER HEAD

Model	496 Mag
Gasket surface flatness	0.1016 mm (0.004) overall maximum 0.076 mm (0.003 in.) with 152 mm (6 in.) span

General Information

Some of the repairs in this section must be completed with the engine removed from the boat. Engine removal depends upon the type of repair and boat design. Place the engine on the repair stand for major repairs.

When engine removal is not required, ensure that the battery cables are disconnected at the battery prior to performing any on-board repair procedures.

During reassembly lubricate all moving parts with engine oil or assembly lube. Apply sealant on the threads of and under heads of the cylinder head bolts and on the threads of all cylinder block external bolts, screws, and studs.

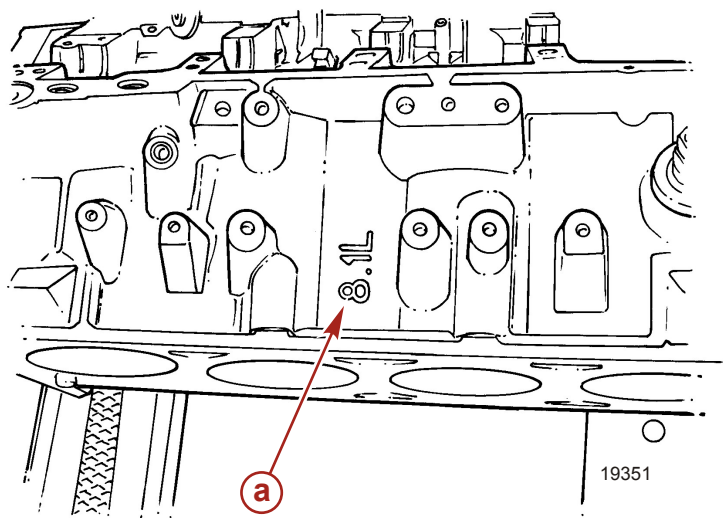
Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Threads of cylinder head bolts and cylinder block external bolts	92-34227-1

Special Notice

This section is primarily concerned with repairs to the block. Some external components that are not mentioned in the procedural steps must be removed for ease of repair. See appropriate sections of this manual for concerns regarding the removal and installation of any component hindering repairs made to the block.

Engine Identification

496 CID/8.1L



a - 8.1L identification on port side of engine block

Cylinder Head Identification

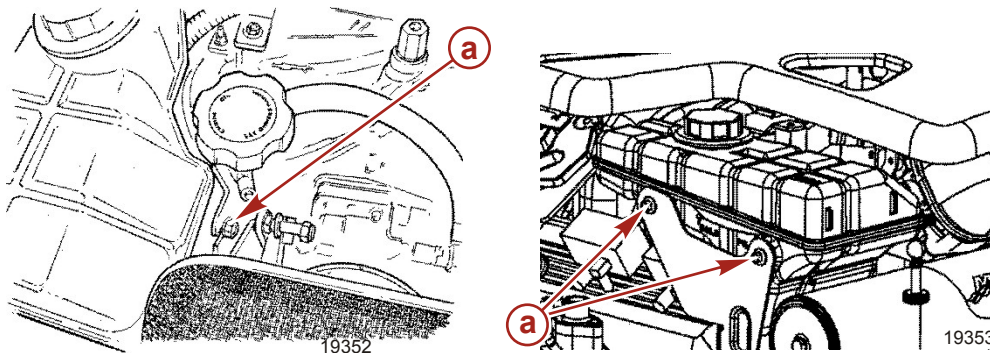
496 CID/8.1L

496 cid/8.1L cylinder heads are identified by their large rectangular ports and the absence of water jacket holes.

Rocker Arm Cover

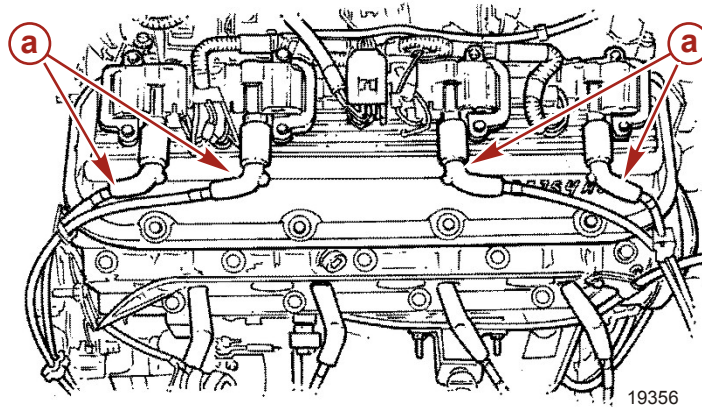
Removal

1. Remove the engine cover.
2. Remove the wiring harness from the top and front of engine.
3. On the port side, remove the remote oil lines. Some oil is retained in the oil filter and remote oil lines.
4. On the starboard side, drain the coolant from the coolant reservoir, then remove the coolant reservoir.



a - Coolant reservoir fasteners

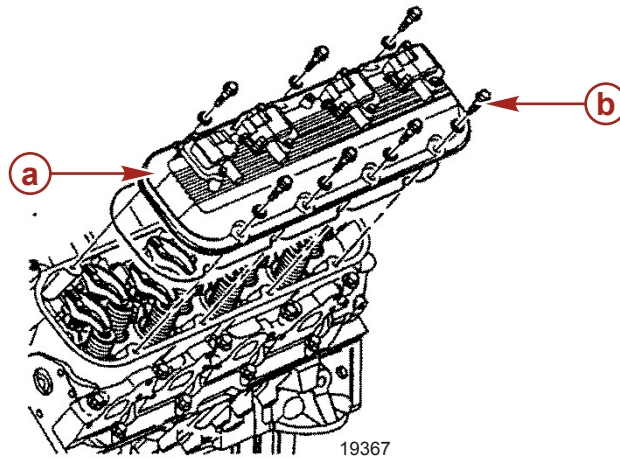
5. Remove the spark plug wires from the coils.



Exhaust manifold removed for clarity

a - Spark plug wires

6. Remove the exhaust manifold assemblies.
7. Remove the screws fastening the rocker arm cover to the engine.
8. Remove the rocker arm cover.



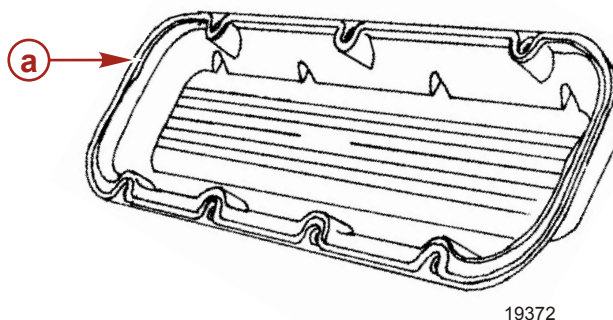
a - Rocker arm cover

b - Screws

Installation

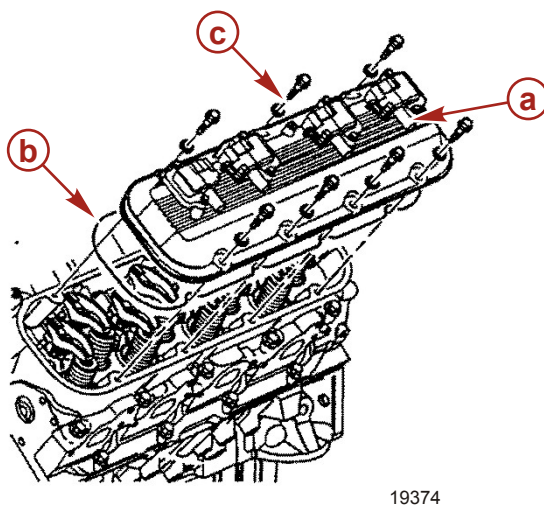
1. Clean the sealing surfaces on the cylinder head and rocker arm cover with degreaser.

2. Place the new rocker arm cover gasket on the rocker arm cover.



a - Rocker arm cover gasket

3. Install the rocker arm cover. Torque the screws.



a - Rocker arm cover
b - Gasket

c - Screws

Description	Nm	lb. in.	lb. ft.
Rocker arm cover screws	12	106	

4. Using new gaskets, reinstall the exhaust manifolds.
5. On the port side, install the remote oil lines.
6. On the starboard side, install the coolant reservoir.
7. Check the oil level. Add if necessary.
8. Fill the closed cooling system.
9. Connect the wiring harness.
10. Start the engine and check for oil and coolant leaks.

Intake Manifold

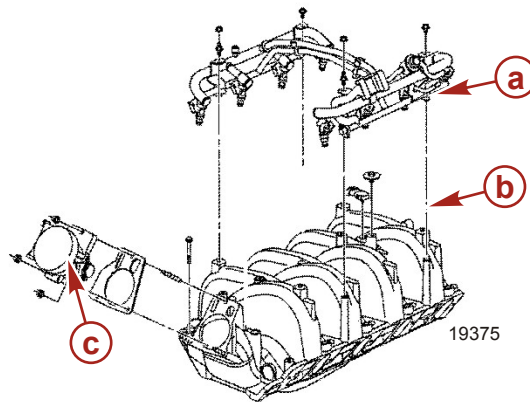
Removal

1. Disconnect the wiring harness leads interfering with removal.
2. Remove the gear lube monitor.
3. Disconnect the throttle cable from the throttle body, if equipped.
4. Remove the fuel line.
5. Remove the shift plate assembly, if equipped.
6. Remove the PCM and relay bracket.

IMPORTANT: It may be necessary to pry the intake manifold away from the cylinder heads and block in next step. Use extreme care to prevent damage to sealing surfaces.

7. Remove the intake manifold bolts.
8. Remove the intake manifold and the throttle body assembly.

NOTE: If the intake manifold requires replacement, transfer all remaining parts to the new manifold.



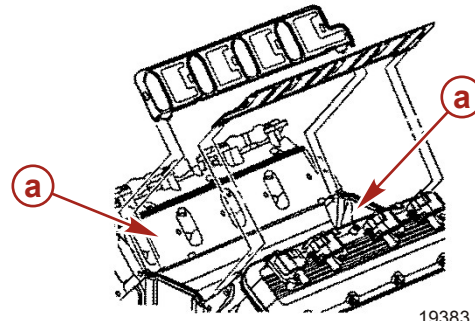
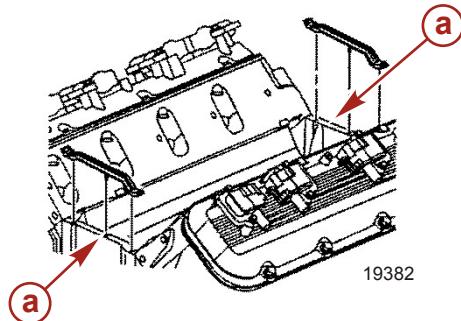
a - Fuel rail assembly
b - Intake manifold

c - Throttle body

Cleaning and Inspection

IMPORTANT: When cleaning the cylinder head mating surface, do not allow the gasket material to enter the engine crankcase or intake ports.

1. Clean gasket material from all mating surfaces.



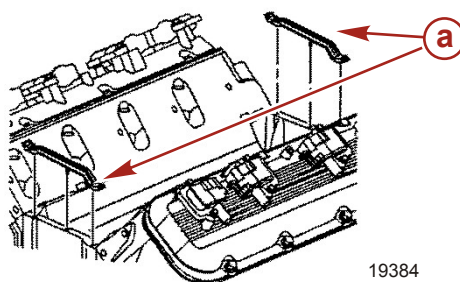
a - Cylinder head mating surfaces

2. Inspect the manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check the intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets ensure that the marked side is facing up. Both gaskets are identical.

1. Using adhesive, glue the new neoprene gaskets to the engine block between the cylinder heads.



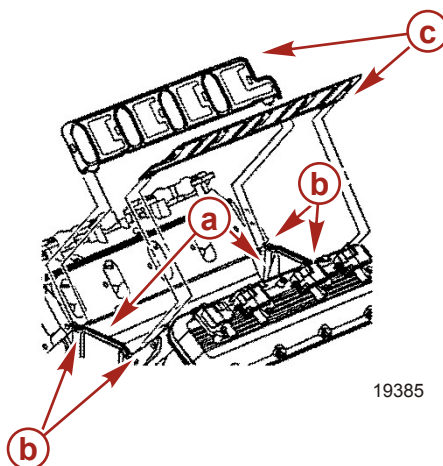
a - Neoprene gaskets

Tube Ref No.	Description	Where Used	Part No.
	3M Brand Gasket Adhesive	Intake manifold gaskets	Obtain Locally

2. Apply a small amount of sealant on the neoprene gasket ends.

Tube Ref No.	Description	Where Used	Part No.
	Three Bond 1217F	Neoprene gasket ends	Obtain Locally

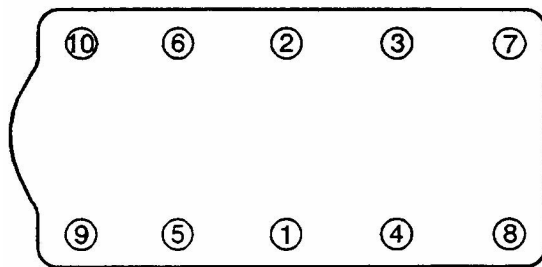
3. Set the intake manifold gaskets in place, aligning the bolt holes.



a - Neoprene gaskets
b - RTV sealer

c - Gaskets

4. Install the intake manifold assembly. Torque the intake manifold screws in sequence.



19386

Intake manifold torque sequence

Description	Nm	lb. in.	lb. ft.
Intake manifold assembly screws	12	106	

5. Connect all wiring harness leads.
6. Install the fuel line.
7. Reconnect the throttle cable, if equipped.
8. Install the shift plate assembly.
9. Install the gear lube monitor.
10. Connect the throttle cable from the throttle body, if equipped.
11. Install the PCM and relay bracket.
12. Start the engine.
13. Inspect the fuel line connections for fuel leaks.
14. Check the hose connections, gaskets, and seals for leaks.

Rocker Arm and Push Rod

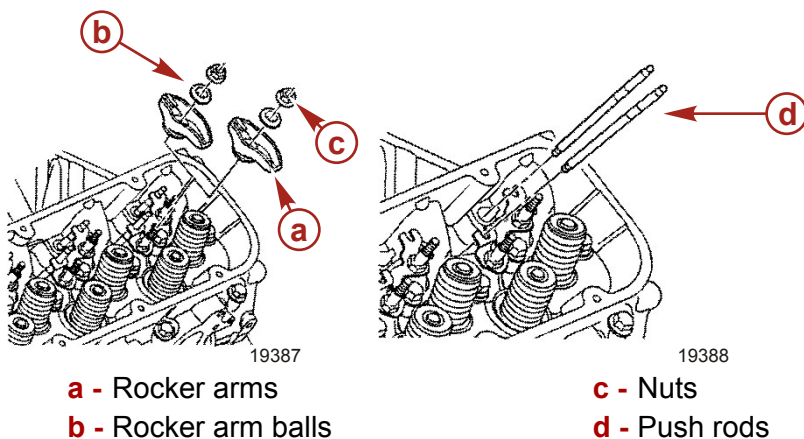
Removal

NOTE: When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing the rocker arms. When servicing all the rocker arms, bring the No. 1 piston up to TDC before removing the rocker arms.

1. Remove the rocker arm covers.

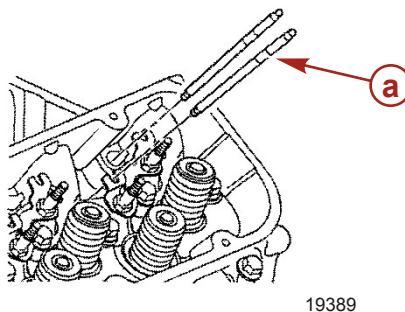
IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

2. Remove the rocker arm assemblies and the push rods.



Cleaning and Inspection

1. Clean the parts with solvent and dry with compressed air.

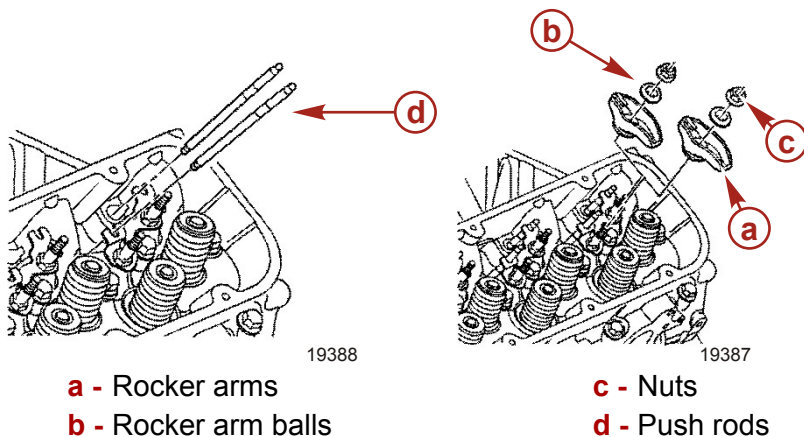


2. Inspect the push rods for straightness, by rolling them on a flat surface.
3. Inspect all the contact surfaces for wear. Replace all damaged parts.

Installation

IMPORTANT: When installing the rocker arms and rocker arm balls, coat the bearing surfaces of the rocker arms and rocker arm balls with engine oil.

1. Install the push rods in their original locations. Ensure that the push rods seat in the lifter socket.
2. Install rocker arm assemblies in their original locations.



3. Ensure that the cylinder is at TDC and both valves are closed. Torque the nuts.

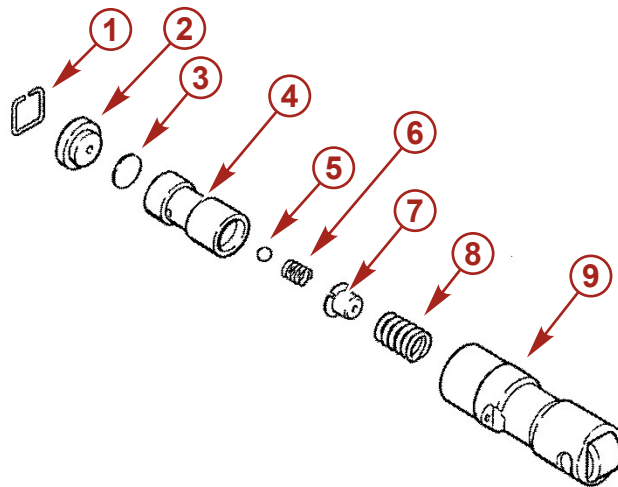
Description	Nm	lb. in.	lb. ft.
Rocker arm nuts	25		19

Valve Adjustment

No adjustment is required. The valve lash is automatically set when the rocker arm nuts are torqued.

Description	Nm	lb. in.	lb. ft.
Rocker arm nuts	25		19

Hydraulic Roller Valve Lifters



19390

- 1 - Push rod seat retainer
- 2 - Push rod seat
- 3 - Metering valve
- 4 - Plunger
- 5 - Check ball

- 6 - Check ball spring
- 7 - Check ball retainer
- 8 - Plunger spring
- 9 - Lifter body

Hydraulic valve lifters require little attention. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of the parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a stethoscope. Place the stethoscope near the end of each intake and exhaust valve to ease determining which lifter is at fault.

Alternately, place a finger on the face of the valve spring retainer. If the lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

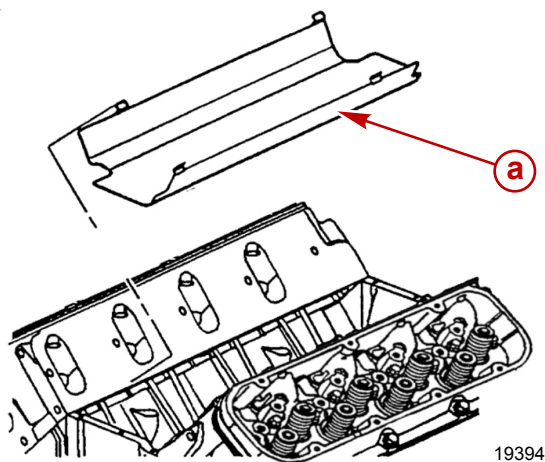
1. **Hard rapping noise.** Usually caused by the plunger becoming tight in bore of the lifter body so that the return spring cannot push the plunger back up to the working position. Probable causes are:
 - a. Excessive varnish or carbon deposit, causing abnormal stickiness.
 - b. Galling or "pickup" between the plunger and bore of the lifter body, usually caused by an abrasive piece of dirt or metal wedged between the plunger and lifter body.

2. **Moderate rapping noise.** Probable causes are:
 - a. Excessively high leakdown rate.
 - b. Leaky check valve seat.
3. **General noise throughout valve train.** This will, in most cases, indicate insufficient oil supply.
4. **Intermittent clicking.** Probable causes are:
 - a. A microscopic piece of dirt momentarily caught between the ball seat and check ball.
 - b. In rare cases, the ball itself may be out of round or have a flat spot.

Removal

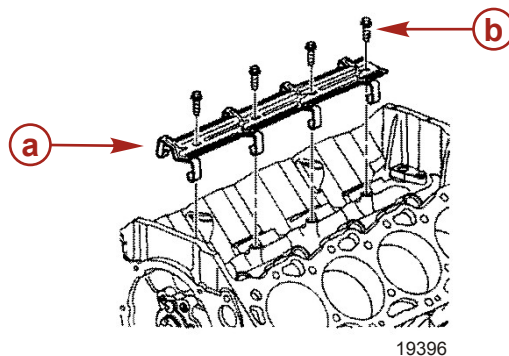
IMPORTANT: Keep the push rod and hydraulic valve lifter from each valve together as a matched set, and mark them so they can be reinstalled in the same location.

1. Remove the rocker arm covers.
2. Remove the intake manifold and related components.
3. Remove the rocker arm assemblies and push rods.
4. Remove the splash shield.



a - Splash shield

5. Remove the lifter restrictor retainer.



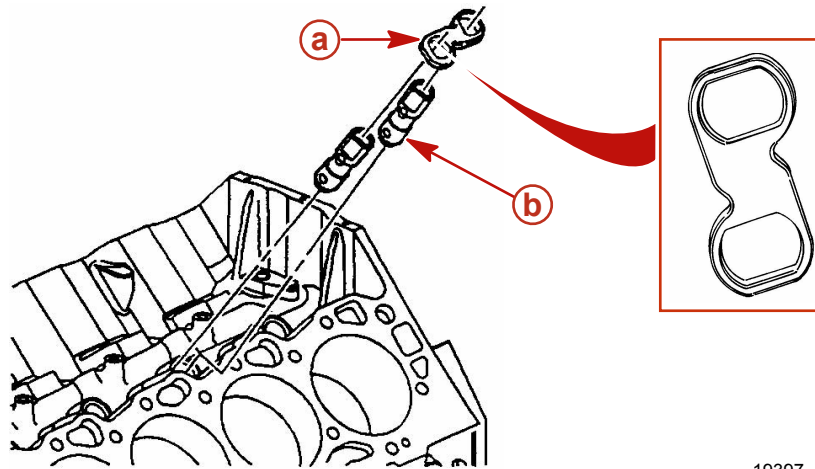
Cylinder heads remover for visual clarity.

a - Lifter restrictor retainer

b - Fasteners

6. Remove the lifter restrictors.

7. Remove the valve lifters.



Cylinder heads removed for visual clarity.

a - Lifter restrictor

b - Valve lifter

Installation

IMPORTANT: Mercury MerCruiser recommends changing the engine oil and installing a new oil filter whenever servicing the valve lifters or camshaft.

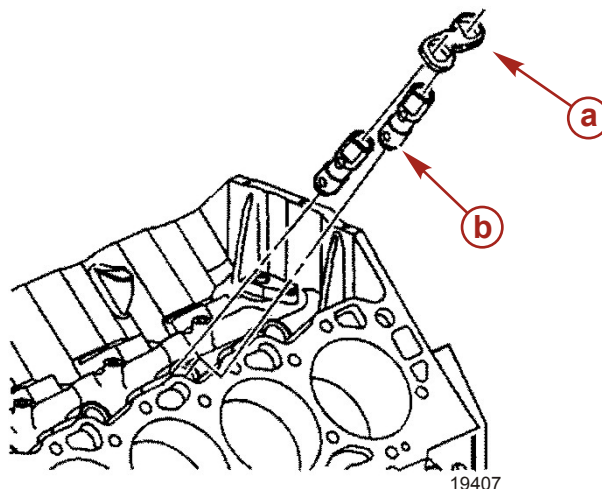
IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil or assembly lube. If new lifters or a new camshaft have been installed, pour an additive containing EP lube (such as General Motors Cam and Lifter Pre-lube or equivalent) over camshaft lobes before installing the lifters.

Tube Ref No.	Description	Where Used	Part No.
	Cam and Lifter Pre-lube	Camshaft lobes	Obtain Locally

IMPORTANT: Before installation, coat the entire valve lifter with engine oil.

IMPORTANT: Mercury MerCruiser recommends using new valve lifters if installing a new camshaft.

1. Install the valve lifters and restrictors.

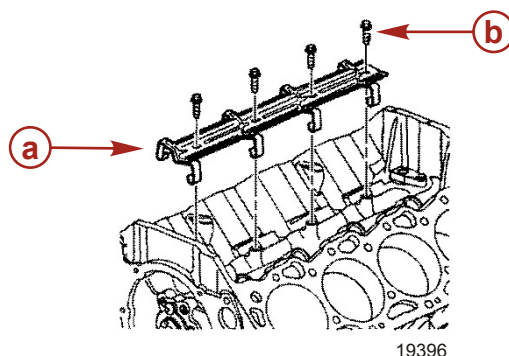


Cylinder heads remover for visual clarity.

a - Lifter restrictor

b - Valve lifter

2. Install the lifter restrictor retainer. Torque the screws.



Cylinder heads remover for visual clarity.

a - Lifter restrictor retainer

b - Screws

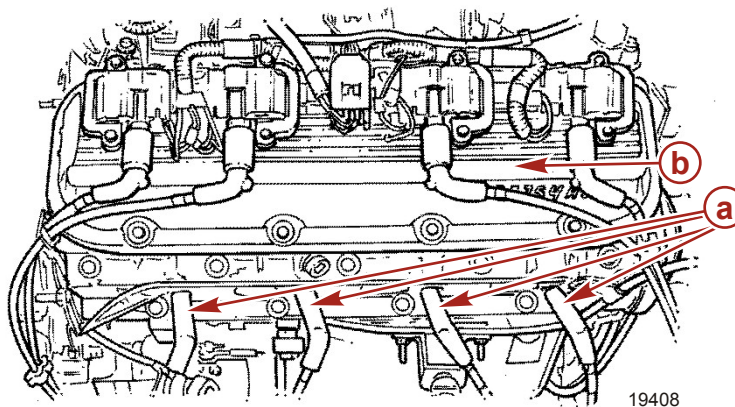
Description	Nm	lb. in.	lb. ft.
Lifter restrictor retainer screws	25		19

3. Install the splash shield.
4. Install the push rods and rocker arms.
5. Install the intake manifold and related components.
6. Install the rocker arm cover.
7. Start the engine and check for leaks.

Valve Stem Oil Seal and Valve Spring

Removal: Head Installed

1. Remove the spark plug of the affected cylinder.
2. Remove the rocker arm cover.



a - Spark plug location

b - Rocker arm cover

3. Remove the rocker arm assembly from the affected cylinder.

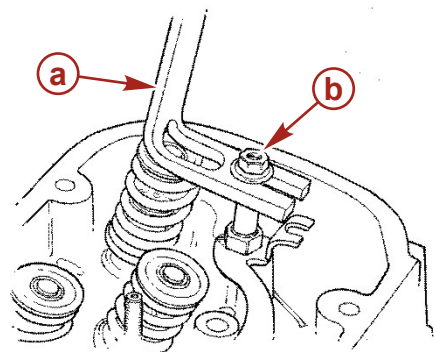
NOTE: When using the spark plug port adapter tool J-23590 follow the manufactures specifications on the amount of air pressure to apply.

4. Install the spark plug port adapter tool (J-23590) in the spark plug hole and apply compressed air to hold the valves in place.

IMPORTANT: Maintain air pressure in the cylinder while the springs, caps, and valve locks are removed or the valves will fall into the cylinder.

Description	Part Number
Spark plug port adapter tool	Obtain locally

5. Using the valve spring compressor, compress the valve spring and remove the valve locks.

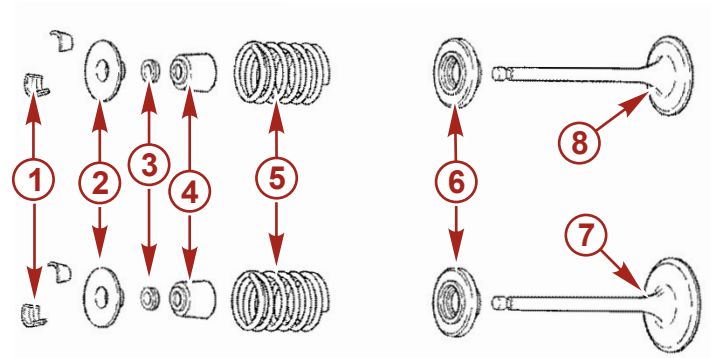


a - Valve spring compressor **b** - Rocker arm nut

Description	Part Number
Valve spring compressor	Obtain locally

6. Slowly release the valve spring compressor. Remove the cap, shield, and valve spring.
7. Remove the oil seals from the valve stems.

Valve Assembly (Exploded View)

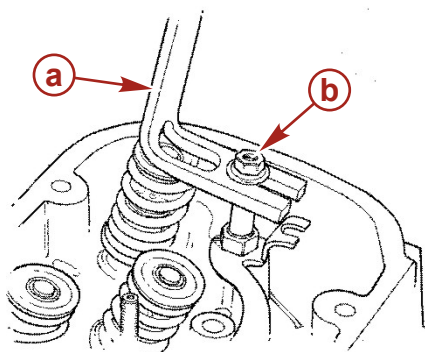


1 - Valve lock **5** - Outer spring
2 - Retainer **6** - Rotator
3 - Oil seal **7** - Intake valve
4 - Oil shield **8** - Exhaust valve

Installation: Head Installed

1. Place the rotator on the valve spring seat.
2. Coat the valve stem and new seal with engine oil. Install the shield and seal over the valve stem.
3. If taken apart, reassemble the damper and valve spring. Place on top of the rotator.
4. Set the valve spring assembly and cap in position over the valve stem.

5. Compress the spring using the valve spring compressor, and install the valve locks (grease may be used to hold the valve locks in place). Slowly release the tool and ensure that the valve locks seat properly in valve stem grooves.



19409

a - Valve spring compressor**b** - Rocker arm nut

Description	Part Number
Valve spring compressor	Obtain locally

6. Install the push rods and rocker arm assemblies.
7. Install the rocker arm cover.
8. Install and torque the spark plugs.

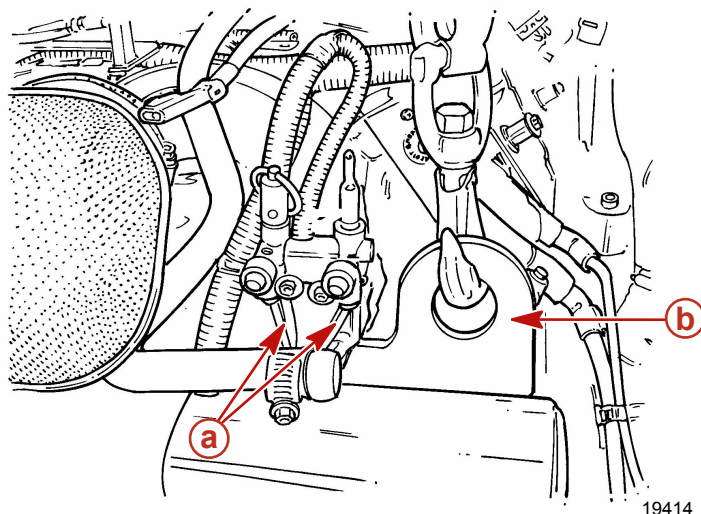
Description	Nm	lb. in.	lb. ft.
Spark plug	30		22

Cylinder Head

Removal

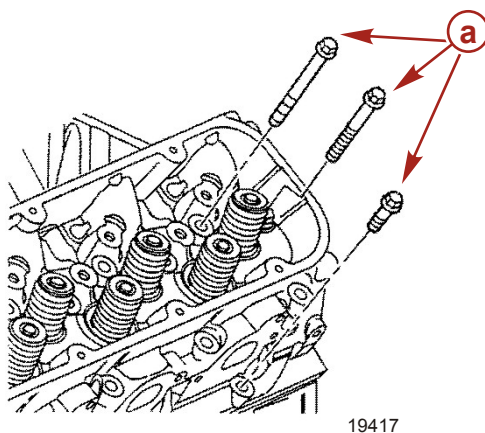
1. Drain the closed cooling system.
2. Remove the exhaust manifold assembly.
3. Remove the heat exchanger.
4. Remove the coolant crossover.
5. Remove the front and rear lifting eyes.

6. Disconnect the air-actuated drain system hoses.



a - Air-actuated drain system hoses **b** - Front lifting eye

7. Remove the alternator bracket.
8. Remove the intake manifold.
9. Remove the rocker arm covers.
10. Remove the rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
11. Remove the head bolts.

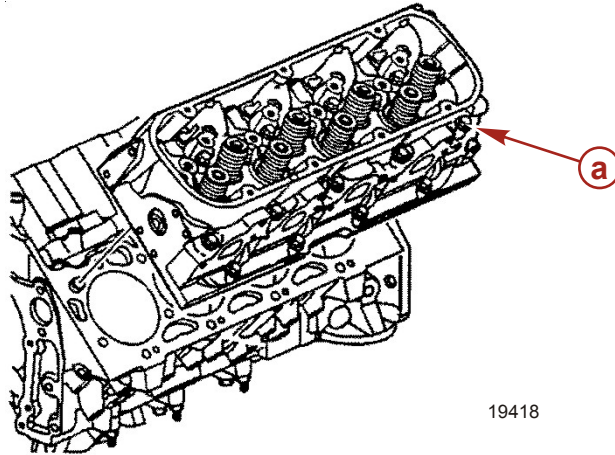


a - Head bolts

⚠ CAUTION

The head gasket may be holding the cylinder head to the block.
Be careful when prying the cylinder heads off to prevent damaging the gasket surfaces.
Be careful not to drop the cylinder heads.

12. Remove the cylinder head and place on wooden blocks to prevent damage to gasket surfaces.



19418

a - Cylinder head

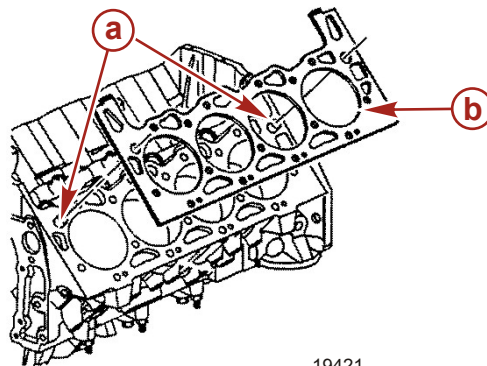
Cleaning

1. Clean the gasket material and sealer from the engine block and cylinder heads.
2. Clean the engine block bolt hole threads, ensuring no dirt, old oil, or coolant remain.
3. For more information, see **Cylinder Head and Valve Conditioning**.

Installation

IMPORTANT: Do not use sealer on the head gaskets. Possible engine failure could result.

1. Place the new cylinder head gasket in position over the dowel pins.

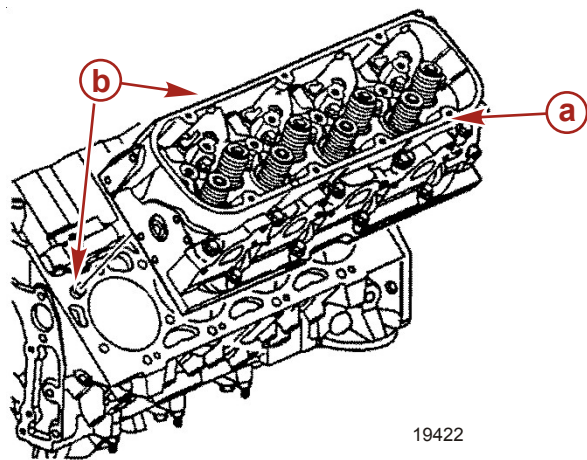


19421

a - Dowel pins

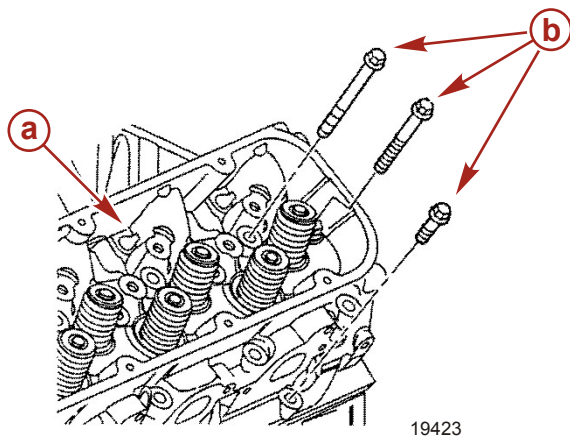
b - Head gasket

2. Align the cylinder head with the dowel pins and carefully set cylinder head in place.

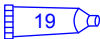


a - Cylinder head **b** - Dowel pins (one not visible)

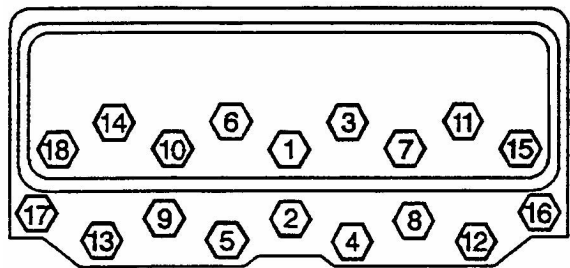
3. Coat the threads of the new head bolts with sealant, and install finger-tight.



a - Cylinder head **b** - Head bolts

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Threads of head bolts.	92-34227-1

4. Torque the head bolts in three steps, following the specified torque sequence.



Cylinder Head Bolt Torque Sequence

Description		Nm	lb. in.	lb. ft.
Head bolts	First pass	30		22
	Second pass	120°		
	Final pass short bolts (4, 5, 12, 13)	30°		
	Final pass medium and long bolts (1, 2, 3, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17)	60°		

Description	Part Number
Angle torque gauge	Obtain locally

5. Install the push rods and rocker arm assemblies in their original positions.
6. Install the intake manifold.
7. Install the rocker arm covers.
8. Install the exhaust manifolds.
9. Install the any components removed from the cylinder heads.
10. Refill the closed cooling system.
11. Provide adequate water supply to the seawater pickup.

⚠ CAUTION

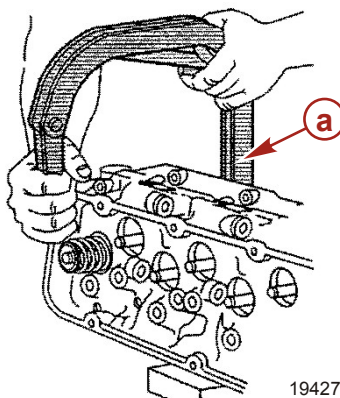
Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

12. Start the engine and check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using a valve spring compressor, compress the valve spring and remove the valve locks. Slowly release the tool.



a - Valve spring compressor

Description	Part Number
Valve spring compressor	Obtain locally

2. Remove all valve components.
3. Remove valves from the cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

1. Clean the push rods and rocker arm assemblies.
2. Remove carbon from the valves using a suitable carbon remover brush.



19433

a - Carbon remover brush

Description	Part Number
Carbon remover brush	Obtain locally

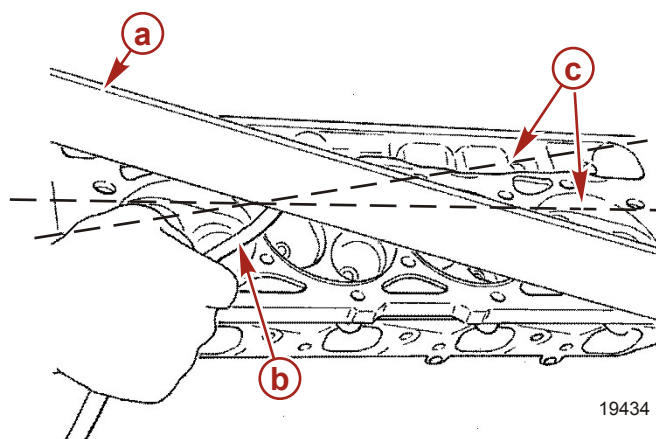
3. Clean gasket material from the cylinder head mating surfaces.
4. Clean all carbon from the combustion chambers and valve ports using a carbon remover brush.

Description	Part Number
Carbon remover brush	Obtain locally

5. Clean the valve guides with valve guide cleaner.

Inspection

1. Inspect cylinder heads for cracks in the exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace the cylinder heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, corrosion, or other damage. Also check the flatness of the cylinder head gasket surface using a machinist's straight edge and feeler gauges. Check flatness diagonally and straight down the center of the head.



19434

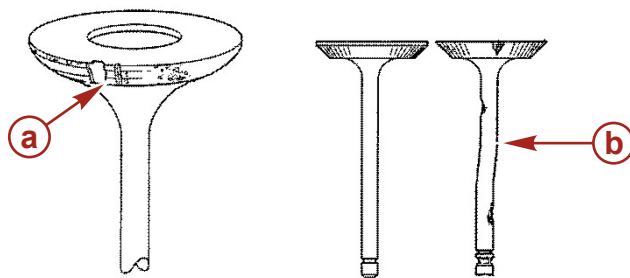
a - Straight edge
b - Feeler gauge

c - Measurement lines

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, the cylinder head-to-intake manifold gasket surface on the head must be milled to provide proper alignment between the intake manifold and head.

Specification	
Cylinder head surface flatness (entire surface)	0.100 mm (0.004 in.)

3. Inspect the valves for burned heads, cracked faces, or damaged stems.



19451

a - Cracked and pitted face

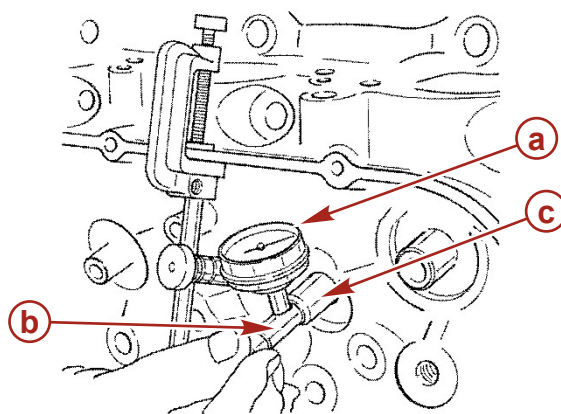
b - Damaged stems

4. Inspect the rocker arm nuts and push rod guides for wear and damage.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

5. Measure valve stem clearance as follows:

- Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
- Holding the valve head off seat about 2 mm (1/16 in.), move the valve stem back and forth. Compare the stem clearance with specifications.



19458

a - Dial indicator

c - Valve guide

b - Valve stem

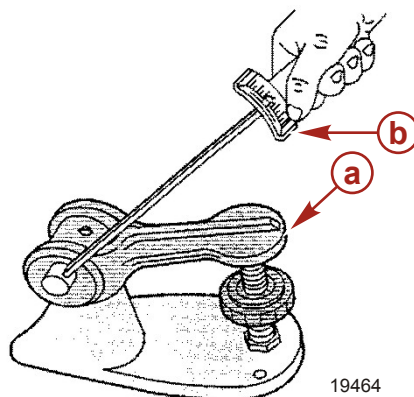
Specifications	
Valve stem clearance production intake	0.025–0.074 mm (0.0010–0.0029 in.)
Valve stem clearance production exhaust	0.030–0.079 mm (0.0012–0.0031 in.)

- If clearance exceeds specifications, ream the valve guides for oversized valves.

Valve Springs: Checking Tension

IMPORTANT: Springs should be replaced if not within 44 Nm (10 lb.) of the specified tension.

1. Use the valve spring tester to measure valve spring force. See **Engine Specifications**.



a - Valve spring tester

b - Torque wrench

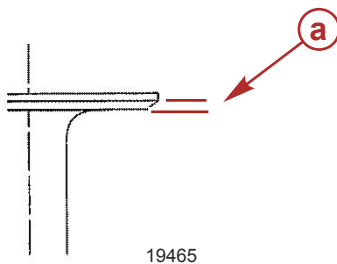
Description	Part Number
Valve spring tester	Obtain locally

Valve Seat Repair

Valve seat reconditioning is very important because seating of valves must be perfect for the engine to deliver maximum power and performance.

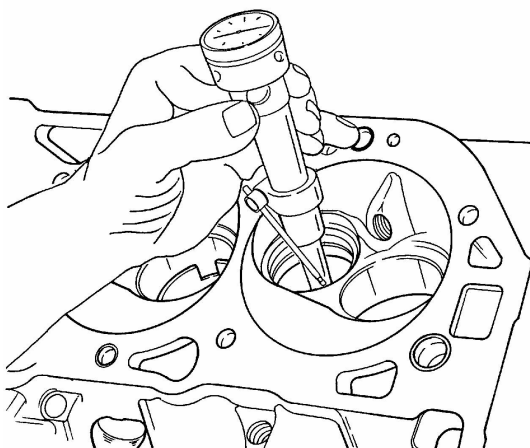
Another important factor is valve head cooling. Good contact between each valve and its seat in the head is important to ensure that heat in the valve head will be properly dispersed.

Several types of equipment are available for reseating valve seats. Follow equipment manufacturer's recommendations carefully to attain proper results.



a - Valve seat width

Regardless of the type of equipment, valve guide bores must be free from carbon or dirt to achieve proper centering of the pilot in the valve guide, ensuring concentricity.



19501

Measuring valve seat concentricity

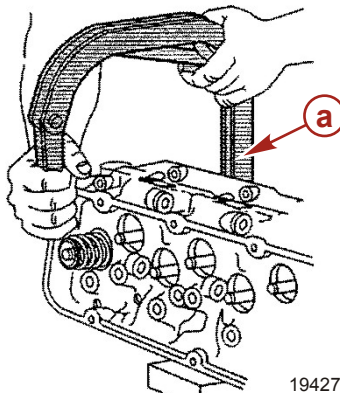
Valve Grinding

Pitted valves must be refaced to the proper angle. Valve stems that show excessive wear or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 0.8 mm (1/32 inches) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. Carefully follow the recommendation of the manufacturer of the equipment being for proper results.

Reassembly

1. Lubricate the valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve rotators, shims, springs, seals, and caps as shown under **Valve Assembly (Exploded View)**.
4. Using a valve spring compressor, compress the valve spring and install the valve locks (grease may be used to hold the locks in place).

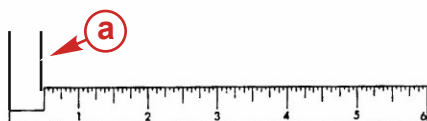


19427

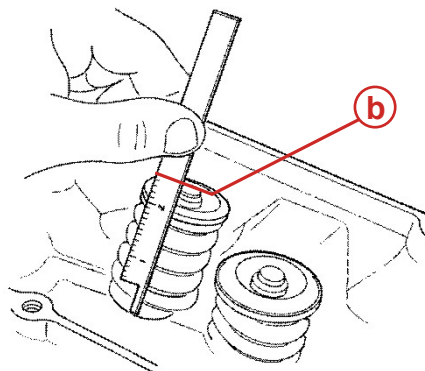
a - Valve spring compressor

Description	Part Number
Valve spring compressor	Obtain locally

5. Slowly release the tool, ensuring that the valve locks seat properly in the grooves of the valve stem.
6. Check the installed height of the valve springs using a narrow, thin scale cutaway as shown.
 - a. Measure from the spring seat to the top of the valve spring as shown.
 - b. If the 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.



a - Cut away this portion
13 mm (1/2 inches)



19503

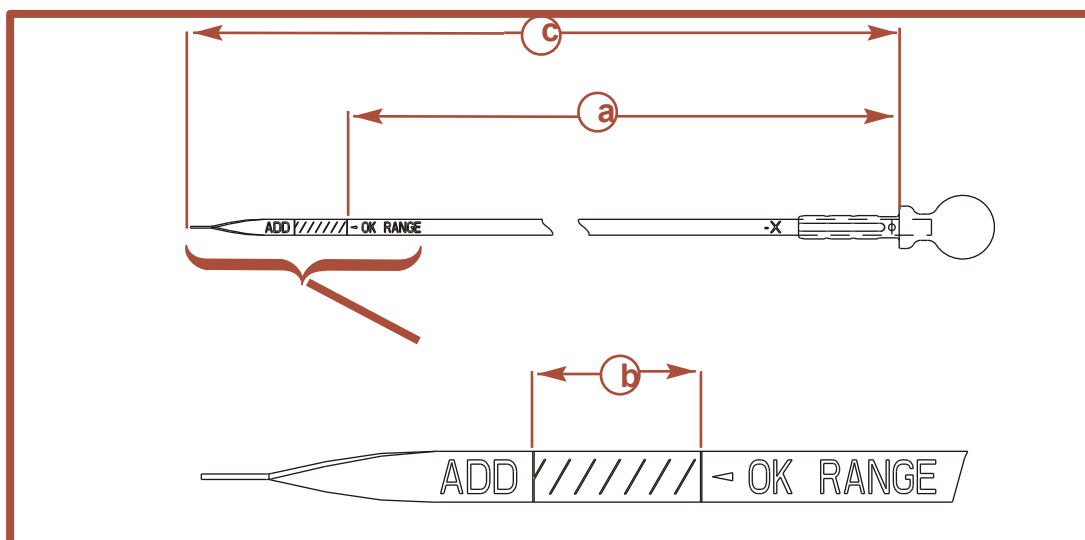
b - Valve spring installed height

Crankcase Oil Dipstick Specifications

All Engines

NOTICE							
Unit of measurement: millimeters (inches)							
Part Number	Length "A"	Length "A" Tolerance	Length "B"	Length "B" Tolerance	Length "C"	Length "C" Tolerance	Model
861942-10	1008 (39.67)	0.79 (0.031)	9.5 (0.375)	0.79 (0.031)	1076 (42.375)	3 (0.125)	496 Mag & 496 Mag HO Sterndrive Models
861942-11	613 (24.13)	0.79 (0.031)	9.5 (0.375)	0.79 (0.031)	676 (26.630)	3 (0.125)	8.1S Horizon & 8.1S HO Inboard Models

Part Number	Length "A"	Length "A" Tolerance	Length "B"	Length "B" Tolerance	Length "C"	Length "C" Tolerance	Model
861942-12	1016 (40.00)	0.79 (0.031)	9.5 (0.375)	0.79 (0.031)	1080 (42.500)	3 (0.125)	8.1S Horizon & 8.1S HO Inboard Models with V-Drive



19504

a - Length "A"
b - Length "B"

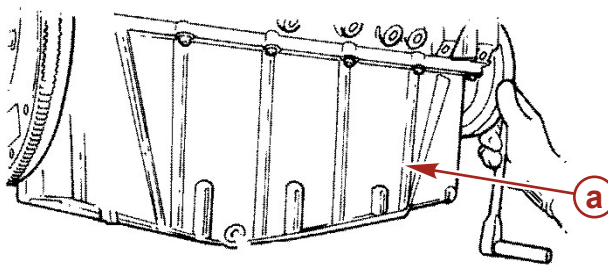
c - Length "C"

Oil Pan Removal

1. Drain the crankcase oil.
2. Remove the dipstick and tube.

IMPORTANT: Do not move or disturb the orientation of the fitting on the bottom of the pan or incorrect oil level readings may be obtained.

3. Remove the Cool Fuel Module on the port side.
4. Remove the oil pan.



19505

a - Oil pan

Inspection

1. Inspect the oil pan for wear and oil buildup.
2. Clean or replace the oil pan as necessary.

Installation

1. Clean sealing surfaces of the engine block and oil pan.
2. Apply a small amount of sealant to the joints of the rear seal retainer and the joints of the front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

Tube Ref No.	Description	Where Used	Part No.
 135	Three Bond 1217F	Joints of rear seal retainer and front cover.	Obtain Locally

3. Install the oil pan gasket in position on the oil pan

NOTE: A one-piece oil pan gasket may be reused if it is still pliable and is not cracked, torn, or otherwise damaged.

4. Install the oil pan. Starting from the center and working outward in each direction, torque to specification.

Description	Nm	lb. in.	lb. ft.
Oil pan screw	25		19

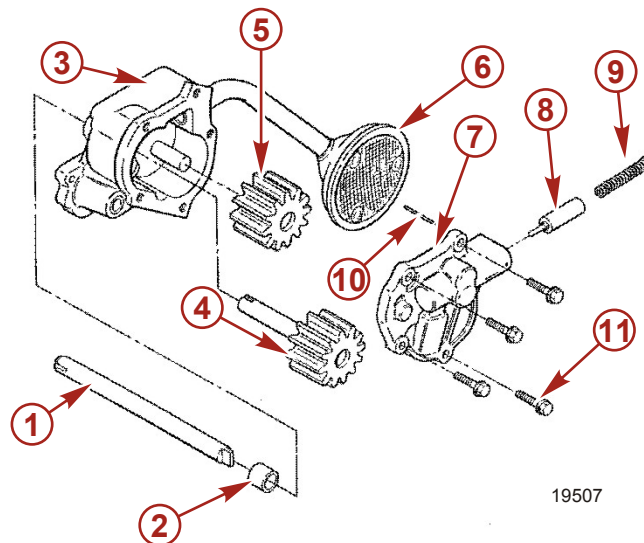
5. Install the dipstick tube(s) and dipstick(s). Ensure that the dipstick tubes are reassembled in original locations.

IMPORTANT: Do not move or disturb the orientation of the fitting on the bottom of the pan or incorrect oil level readings may be obtained.

6. Fill the crankcase with the required quantity of the oil of specified viscosity. See **Section 1B**.

Oil Pump

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. The oil pump is driven by the oil pump drive, which is driven by a helical gear on the camshaft.

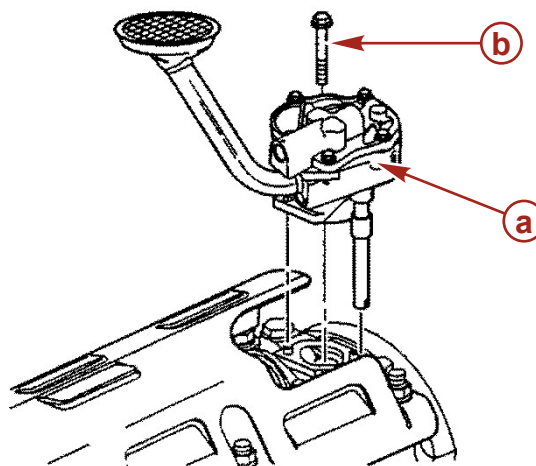


Oil pump assembly

- | | |
|-----------------------------------|--------------------------------------|
| 1 - Extension shaft | 7 - Pump cover |
| 2 - Shaft coupling | 8 - Pressure regulator valve |
| 3 - Pump body | 9 - Pressure regulator spring |
| 4 - Drive gear and shaft | 10 - Retaining pin |
| 5 - Idler gear | 11 - Screws |
| 6 - Pickup screen and pipe | |

Removal

1. Remove the oil pan.
2. Remove the oil pump.



a - Oil pump

b - Oil pump bolt

Disassembly

1. Remove the pump cover.

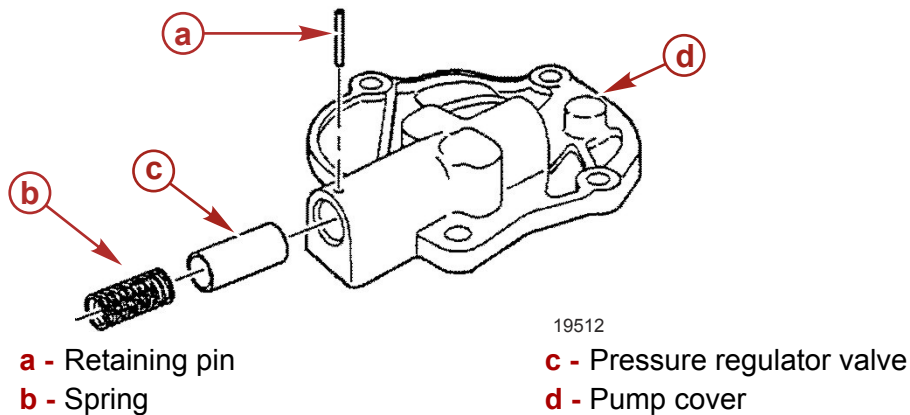
IMPORTANT: Mark gear teeth for reassembly with the same teeth indexing.

2. Remove the idler gear and the drive gear from the pump body.

⚠ CAUTION

The regulator valve spring is compressed. Use care when removing the retaining pin or a spring may release violently.

3. Remove the retaining pin from the pump cover with a punch. The spring may release violently.
4. Remove the spring and pressure regulator valve from the pump cover.



Cleaning

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect the pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for the loose drive gear shaft in the pump body.
5. Inspect the inside of the pump cover for wear that would permit oil to leak past the ends of the gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check the pressure regulator valve for fit.

IMPORTANT: The oil pump is not serviceable. If any parts are worn or damaged, replace the pump assembly and pickup tube.

Reassembly

IMPORTANT: Liberally coat internal parts with oil before installation.

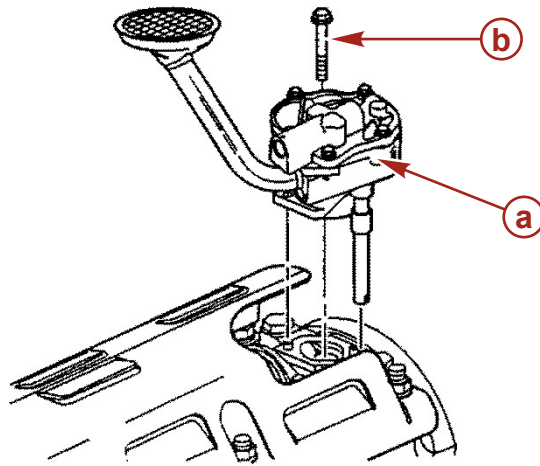
1. Install the pressure regulator valve and related parts.
2. Install the drive gear in the pump body.
3. Install the idler gear in the pump body with the smooth side of gear toward the pump cover opening. Align the marks made in disassembly.
4. Fill the gear cavity with engine oil.
5. Install the pump cover. Torque the pump cover screws.

Description	Nm	lb. in.	lb. ft.
Pump cover screws	12	106	

6. Turn the extension shaft by hand to check the oil pump for smooth operation.

Installation

1. Install the oil pump with extension shaft to the rear main bearing, aligning the extension shaft with the oil pump drive.
2. Torque the oil pump screw.



a - Oil pump

19511
b - Oil pump screw

Description	Nm	lb. in.	lb. ft.
Oil pump screw	75		56

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

3. Install the oil pan.
4. Fill the engine with the specified engine oil. Refer to **Section 1B**.
5. Supply cooling water to the engine.
6. Start the engine and check for leaks.

Water Circulating Pump

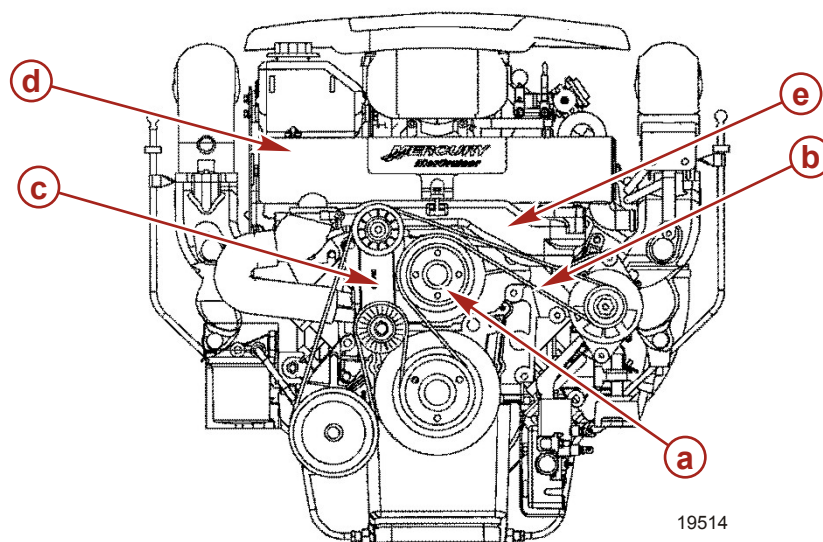
Removal

1. Drain the engine coolant system.
2. With the drive belt installed to prevent rotation, remove the water circulating pump pulley bolts

IMPORTANT: If a belt is to be reused, it must be installed in the same direction of rotation as before.

3. Mark the direction of rotation, and remove the drive belt.
4. Remove the dual idler pulley bracket, or automatic tensioner, and bracket, if equipped.
5. Loosen the hose clamps on the water circulating pump and the heat exchanger.
6. Remove the heat exchanger and crossover.

7. Remove the water circulating pump.



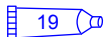
- a** - Water circulating pump pulley **d** - Heat exchanger
b - Drive belt **e** - Crossover
c - Dual idler pulley bracket

Inspection

1. Inspect for cracks or wear in the water pump body.
2. Inspect the pulley shaft for out of round or bent position.
3. Inspect sealing surfaces for cuts, scratches, or debris.
4. Clean the sealing surfaces on the pump and block.

Installation

1. Apply sealant to the threads of the water circulating pump screws.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Threads of water circulating pump screws	92-34227-1

2. Align the gaskets and water pump onto engine.
3. install the water circulating pump to the engine with four screws. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Water circulating pump screw	50		37

4. Install the crossover and the heat exchanger.
5. Install the hoses.
6. Install the idler bracket.
7. Install the water pump pulley.
8. Install the drive belt.
9. Fill the cooling system.

CAUTION

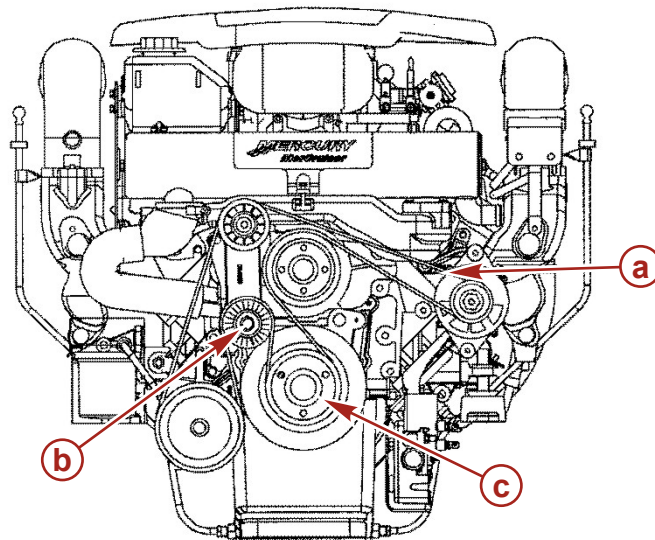
Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

10. Supply cooling water.
11. Start the engine, and check for leaks.

Torsional Damper

Removal

1. Remove the drive belt.
2. Remove the idler pulley, or automatic tensioner, if equipped.
3. Remove the crankshaft pulley.



Manual tensioner shown, automatic tensioner similar

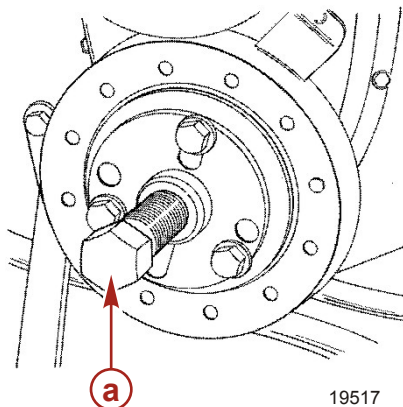
a - Drive belt
b - Idler pulley

c - Crankshaft pulley

4. Remove the torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw-type puller to remove the torsional damper (in the next step) as the outside ring of the torsional damper is bonded in rubber to the hub. Using a claw-type puller may break the bond, damaging the torsional damper.

5. Remove the torsional damper with the torsional damper remover and installer tool.



a - Torsional damper remover and installer tool

Description	Part Number
Torsional damper remover and installer tool	Obtain locally

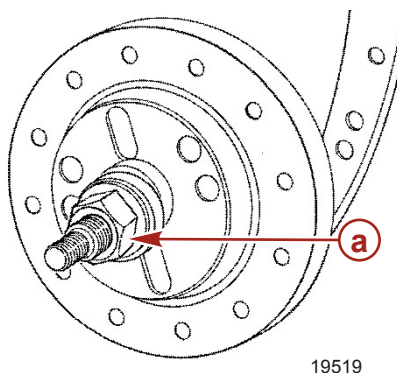
Installation

IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber-type material. The installation procedure (with the proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Coat seal surface of the torsional damper with engine oil.
2. Install the torsional damper on the crankshaft using the torsional damper remover and installer tool as follows:
 - a. Install the appropriate end of threaded rod into the crankshaft.

IMPORTANT: Be sure to install the threaded rod in the crankshaft at least 13 mm (1/2 in.) to prevent damage to threads.

- b. Install the plate, thrust bearing, washer, and nut on the rod.
 - c. Install the torsional damper on the crankshaft by turning the nut until it contacts the crankshaft.



a - Torsional damper remover and installer

Description	Part Number
Torsional damper remover and installer tool	Obtain locally

- d. Remove the tool from the crankshaft.
 - e. Install and torque the torsional damper bolt. Torque the bolt.

Description	Nm	lb. in.	lb. ft.
Torsional damper bolt	225		188

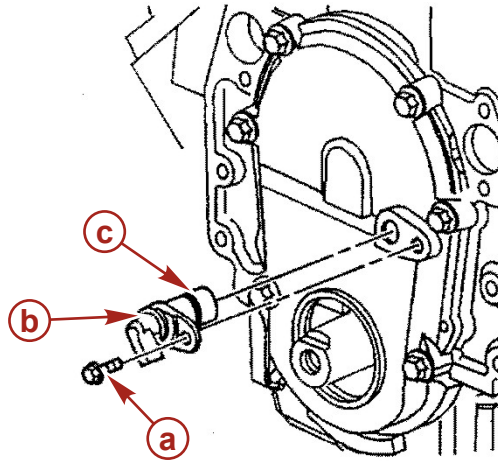
3. Install the crankshaft and the idler pulleys.
4. Install and adjust the drive belt.

Camshaft Position Sensor

Removal

1. Disconnect the camshaft position sensor electrical harness connector.
2. Remove the camshaft position sensor fastener.

3. Remove the camshaft position sensor.



19520

- a** - Camshaft position sensor fastener **c** - O-ring
b - Camshaft position sensor

4. Remove and discard the O-ring.

Inspection

1. Inspect the sensor for excessive wear or gouges. Replace if necessary.

Installation

1. Install the new O-ring onto camshaft position sensor.

IMPORTANT: Ensure that the O-ring is fully seated in the groove of the camshaft position sensor before installing the sensor into the front cover.

2. Firmly press the camshaft position sensor into the front cover.
3. Install the camshaft position sensor fastener. Torque the fastener.

Description	Nm	lb. in.	lb. ft.
Camshaft position sensor fastener	12		106

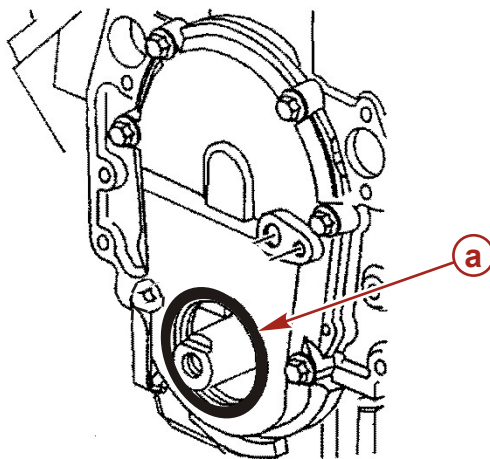
Front Cover and Oil Seal

Oil Seal Replacement (Without Removing the Front Cover)

REMOVAL

1. Remove the torsional damper.

2. Pry the seal out of the cover from the front with a large screwdriver, being careful not to distort the front cover or damage the crankshaft.



19521

a - Oil seal

INSTALLATION

1. Apply sealant to the seal retainer mating surfaces and apply lubricant to the seal lips.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Retainer mating surface	92-34227-1

Tube Ref No.	Description	Where Used	Part No.
 79	MerCruiser 4-cycle 25W40 Engine Oil	Front cover oil seal	92-802837A1

2. Install the new seal with the open end the of seal inward (lip of seal toward the inside of the engine).
3. Using the front cover seal installer, drive the seal into the front cover until it is completely seated into the front cover. Do not use excessive force.

Description	Part Number
Front cover seal installer	Obtain locally

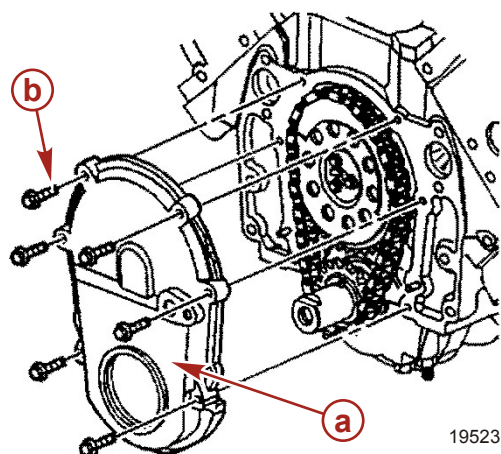
4. Install the torsional damper.

Front Cover

Removal

1. Remove the engine from the boat if necessary.
2. Drain the closed cooling system.
3. Remove the drive belt.
4. Remove the heat exchanger and crossover.
5. Remove the water circulating pump.
6. Remove the torsional damper.
7. Remove the camshaft position sensor.

8. Remove the front cover bolts.



a - Front cover

b - Bolts

9. Using a screwdriver, carefully separate and remove the front cover.
10. If damaged, drive the oil seal out from the rear of the front cover using a punch.

Cleaning

1. Clean the front cover in solvent and dry with compressed air.
2. Clean old gasket material and sealer from the mating surfaces on the cover and the cylinder block.

Inspection

IMPORTANT: The front cover is cast aluminum that has a molded O-ring-style gasket. This gasket is retained in a cast groove. The gasket must be replaced if damaged.

1. Check the gasket surface on front cover for distortion and correct if necessary. Surfaces must be clean and flat or oil may leak.

Installation

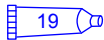
1. Apply sealant to the seal retainer mating surfaces and apply lubricant to the seal lips.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Retainer mating surface	92-34227-1

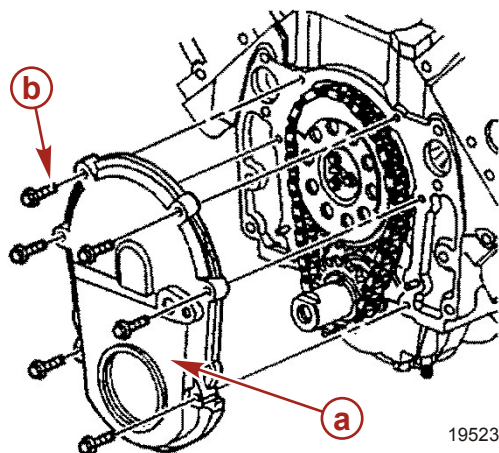
2. Install the oil seal into the front cover with the lip of the seal toward the inside of the engine.
3. Support the inside of the cover around the seal area with an appropriate tool.
4. Using the front cover seal installer, drive the seal into the front cover until it is completely seated into the front cover. Do not use excessive force.
5. Apply lubricant to the seal lips.

Tube Ref No.	Description	Where Used	Part No.
 79	MerCruiser 4-cycle 25W40 Engine Oil	Front cover oil seal	92-802837A1

6. Coat both sides of the front cover gasket with sealant and place in position on the engine.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Front cover gasket	92-34227-1

7. Install the front cover, ensure the holes in cover align with the dowel pins in the block. Torque the front cover screws.



a - Front cover

b - screws

Description	Nm	lb. in.	lb. ft.
Front cover screw	12	106	

8. Install the camshaft position sensor.
9. Install the torsional damper.
10. Install the water circulating pump.
11. Install the heat exchanger and crossover.
12. Install the drive belt.
13. Fill the engine with the specified engine oil. See **Section 1B**.
14. Refill the closed cooling section. Provide adequate water supply to the seawater pickup.

CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

15. Start the engine and check for water and oil leaks.

Flywheel Housing

Removal

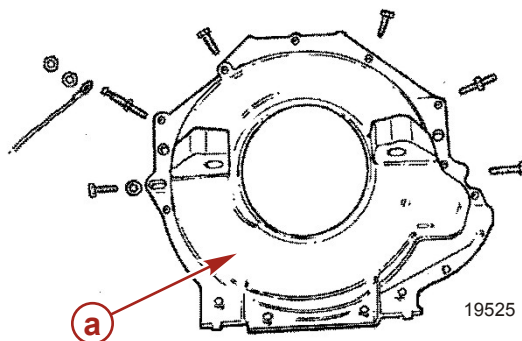
IMPORTANT: Use caution when removing water hoses. Do not damage the ends of the power-assisted steering cooler.

1. Remove the engine from the boat.
2. Remove the water hoses from the power-assisted steering cooler.
3. Remove the power-assisted steering cooler.
4. Remove the ground wires from the flywheel housing.

IMPORTANT: Flywheel housing screws, and studs must be installed in the same location as removed.

5. Remove the screws and studs from the flywheel housing.

- Remove the flywheel housing.



a - Flywheel housing

Inspection

- Inspect the flywheel housing for cracks, holes, and excessive wear.
- Replace the flywheel housing if necessary.
- Inspect the rear engine mounts for wear or damage. Replace the engine mounts if necessary. Refer to the appropriate **Mercury MerCruiser Sterndrive Service Manual**.

Installation

- Align the flywheel housing onto the guide dowels on the engine.

IMPORTANT: Flywheel housing screws, and studs must be installed in same location as removed.

- Install two studs and four screws.
- Torque the screws and studs.

Description	Nm	lb. in.	lb. ft.
Flywheel studs and screws	41		30

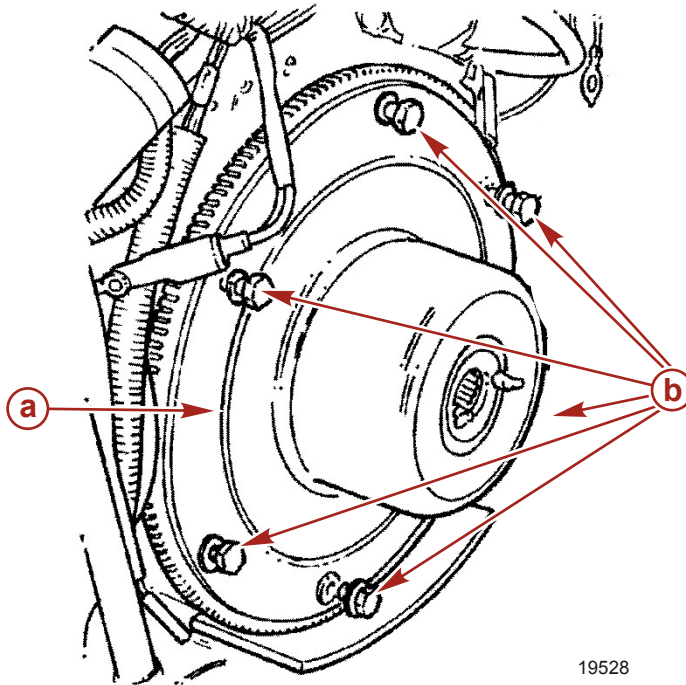
- Install the power-assisted steering cooler, hoses, and other components removed previously.

Sterndrive Coupler or Inboard Drive Plate

Removal

- Remove the engine from the boat.
- Remove the transmission if equipped.
- Remove the flywheel housing.

4. Remove the six engine coupler, or drive plate screws and lockwashers from the flywheel.



Typical coupler mounting

a - Coupler

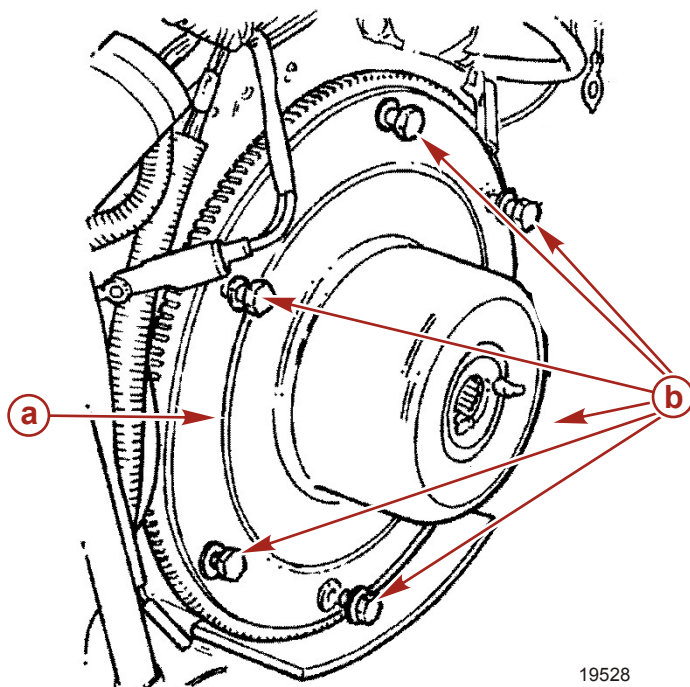
b - Screws and lockwashers (one not visible)

Inspection

1. Inspect the splines in drive plate or the coupler for wear.
2. Inspect the drive plate or the coupler for warping.
3. Replace as necessary.

Installation

1. Install the coupler, or drive plate using the six screws and lockwashers. Torque the coupler, or drive plate screws.



Typical sterndrive coupler mounting, inboard drive plate similar.

a - Coupler

b - Screws (one not visible)

Description	Nm	lb. in.	lb. ft.
Coupler, or drive plate screws	100		74

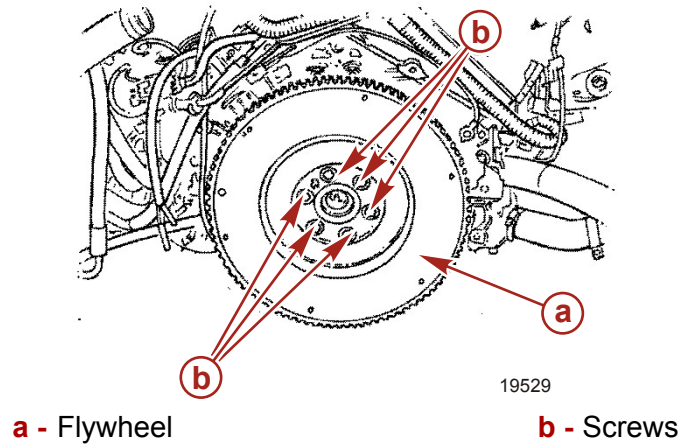
2. Install the flywheel housing.

Flywheel

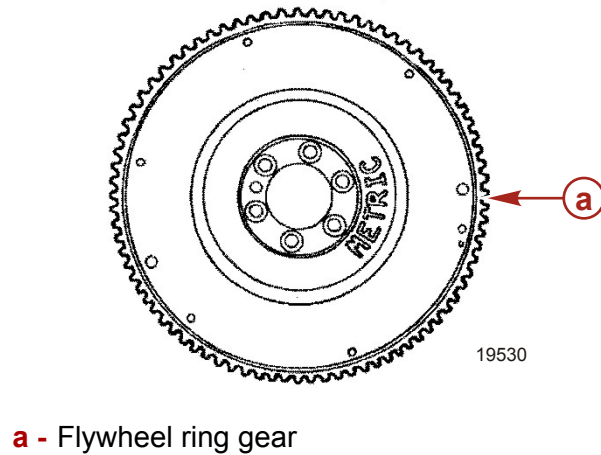
Removal

1. Remove the drive unit.
2. Remove the engine from the boat.
3. Remove the transmission, if equipped.
4. Remove the flywheel housing.
5. Remove the sterndrive coupler or inboard drive plate.

6. Remove the screws retaining the flywheel to the crankshaft.



Inspection

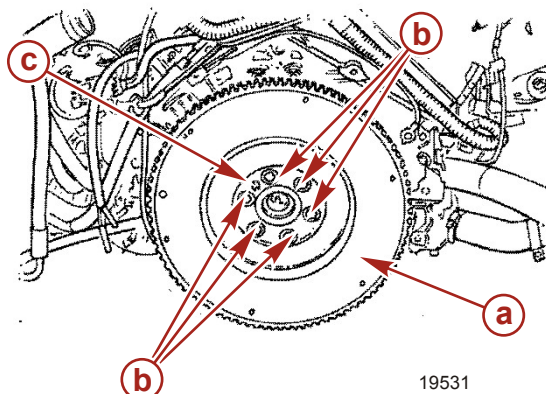


1. Check the flywheel ring gear for worn and missing teeth.
2. Clean the mating surfaces of the flywheel and the crankshaft. Remove any burrs. Mating surfaces must be clean, bare metal.
3. Replace the flywheel, if required.

Installation

1. Align the dowel hole in the flywheel with the dowel in the crankshaft.
2. Install the flywheel and tighten the screws.

3. Torque the the flywheel screws in a crosswise pattern.



a - Flywheel

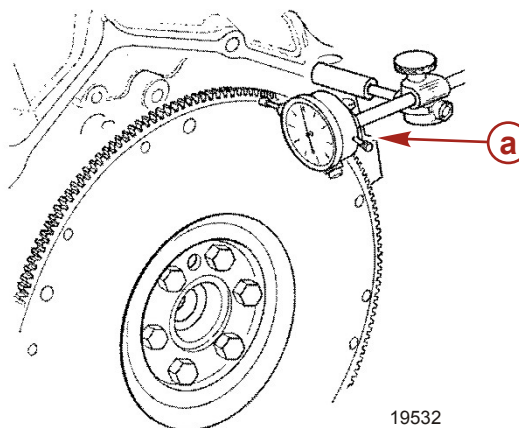
b - Screws

c - Dowel hole

Description	Nm	lb. in.	lb. ft.
Flywheel screws	100		74

4. Check flywheel runout as follows:

- Attach a dial indicator to the engine block.
- Take readings around the outer edge of the flywheel. Push in on the flywheel to remove crankshaft end play.
- Maximum runout is 0.203 mm (0.008 in.).



a - Dial indicator

- Replace the flywheel, if the measurement exceeds the specification.
- Install the sterndrive coupler or inboard drive plate.
 - Install the flywheel housing and related parts.
 - Install the flywheel housing cover.
 - Install the transmission (inboard only). Torque the screws.

Description	Nm	lb. in.	lb. ft.
Transmission screws	68		50

9. Install the engine. See **Section 2—Removal and Installation**.

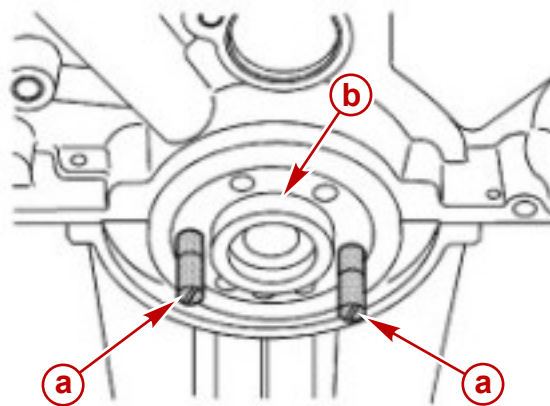
Rear Main Oil Seal

The rear main oil seal (crankshaft oil seal) can be replaced without removing the oil pan or the rear main bearing cap from the engine.

Removal

IMPORTANT: Do not nick or gouge the engine block or rear main bearing cap sealing surface. Protect the end of the crankshaft and crankshaft seal running surface from damage also.

1. Remove the flywheel.
2. Install the guide pins of the crankshaft rear oil seal puller into the crankshaft.

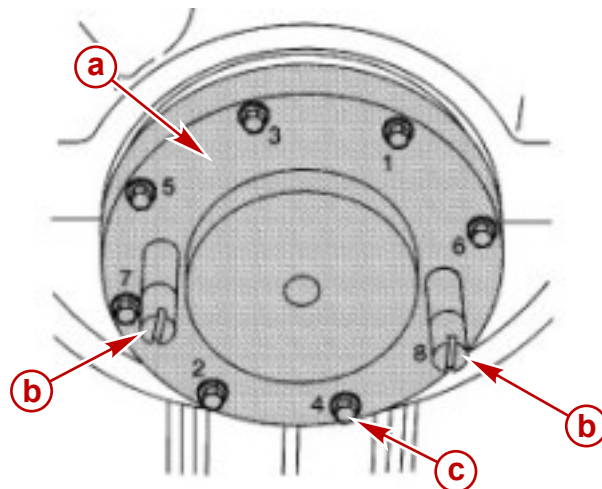


24648

a - Guide pins

b - Crankshaft

3. Install the crankshaft rear oil seal puller over the guide pins.
4. Insert the eight self-drilling sheet metal screws into the rear crankshaft oil seal. Insert the screws using a crisscross pattern.



24649

a - Crankshaft rear oil seal puller

c - Self drilling sheet metal screw

b - Guide pins

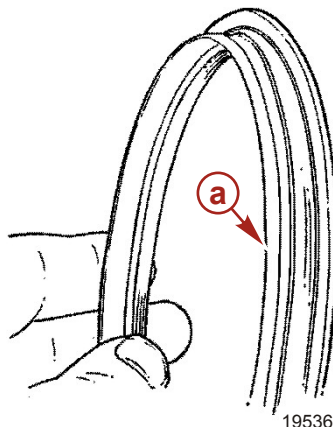
5. Install the center bolt of the crankshaft rear oil seal puller through the crankshaft rear oil seal puller, and into the crankshaft.
6. Tighten the center bolt of the crankshaft rear oil seal puller until the crankshaft rear oil seal is removed.

7. Remove the guide pins from the crankshaft.

Cleaning and Inspection

1. Clean the crankshaft rear oil seal running surface.
2. Ensure the crankshaft rear chamfer is free of grit, loose rust, and burrs.

IMPORTANT: Correct rotation oil seal must be used to prevent an oil leak.



Typical

a - Seal lip toward inside of engine

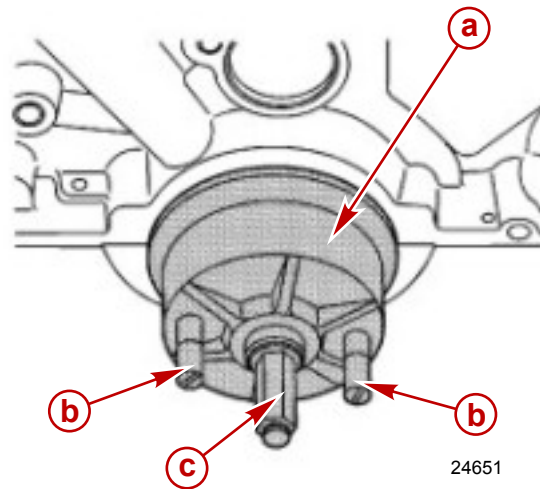
Installation

1. Apply a light film of oil onto the crankshaft sealing surface.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Crankshaft sealing surface	Obtain Locally

2. Do not apply oil to the sealing surface of the engine block.
3. Install the crankshaft rear oil seal onto the crankshaft rear oil seal installer.
4. Position the crankshaft rear oil seal and installer against the crankshaft.
5. Install the attaching screws through the crankshaft rear oil seal installer and into the crankshaft.
6. Tighten the crankshaft rear oil seal installer attaching screws securely to ensure that the crankshaft rear oil seal is properly aligned with the crankshaft.

7. Tighten the crankshaft rear oil seal installer center nut until the crankshaft rear oil seal installer is completely seated against the crankshaft and the crankshaft rear oil seal is installed.



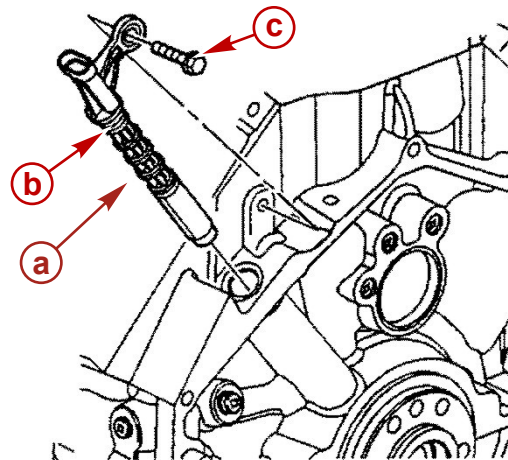
- a** - Crankshaft rear oil seal installer **c** - Center nut
b - Attaching screws

8. Remove the crankshaft rear oil seal installer.

Crankshaft Position Sensor

Removal

1. Disconnect the crankshaft position sensor electrical harness connector.
2. Remove the crankshaft position sensor screw.
3. Remove the crankshaft position sensor.



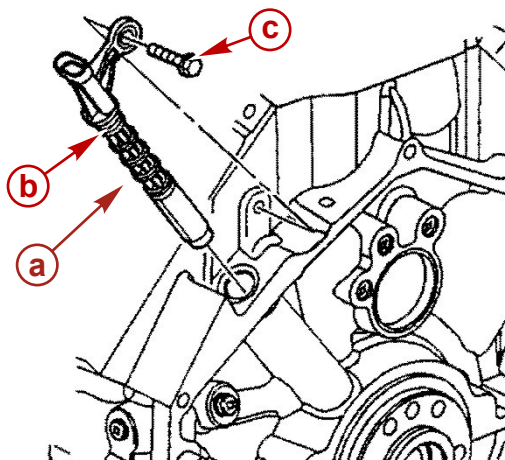
- a** - Crankshaft position sensor **c** - Screw
b - O-ring

Inspection

1. Inspect the sensor for excessive wear or gouges. Replace if necessary.
2. Inspect the crankshaft position sensor O-ring for damage. Replace if necessary.

Installation

1. Install the seal onto the crankshaft position sensor.
2. Firmly press the crankshaft position sensor into the cylinder block.
3. Install the crankshaft position sensor screw. Torque the screw.



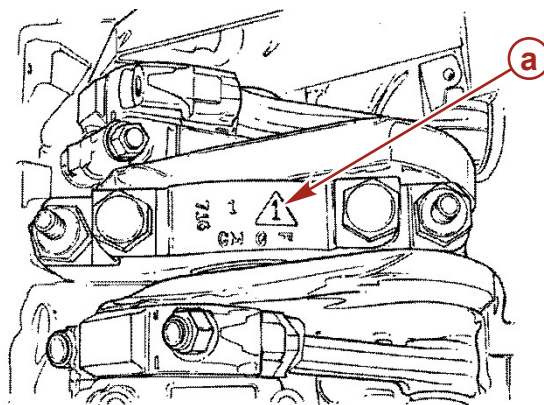
19544

a - Crankshaft position sensor**c** - Screw**b** - O-ring

Description	Nm	lb. in.	lb. ft.
Crankshaft position sensor screw	12	106	

Main Bearings

IMPORTANT: Before removing the main bearing caps or connecting rod caps, mark them for reassembly in their original locations.



19538

a - Main bearing cap mark

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are excessive, a new bearing, both upper and lower halves, is required. Service bearings are available as specified. in standard size and 0.001 in., 0.002 in., 0.010 in. and 0.020 in. undersize.

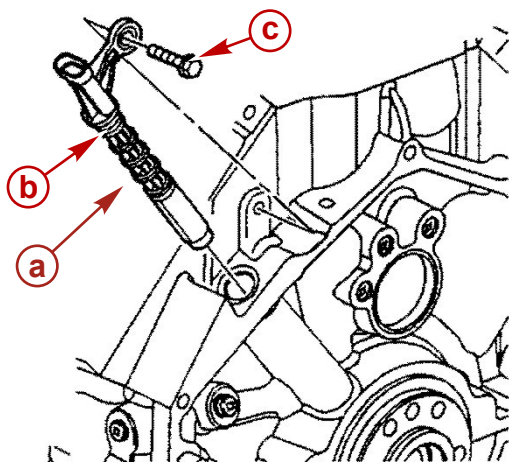
Main Bearing Specifications	
Standard size (service bearings)	See Engine Specifications
Service bearings (undersized)	0.001 in., 0.002 in., 0.010 in. and 0.020 in.

Inspection

In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If the lower half is suitable for use, the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Removal

1. Remove the oil pan, oil pump, and crankshaft oil deflector.
2. Mark the bearing caps for reassembly.
3. Remove the crankshaft position sensor.



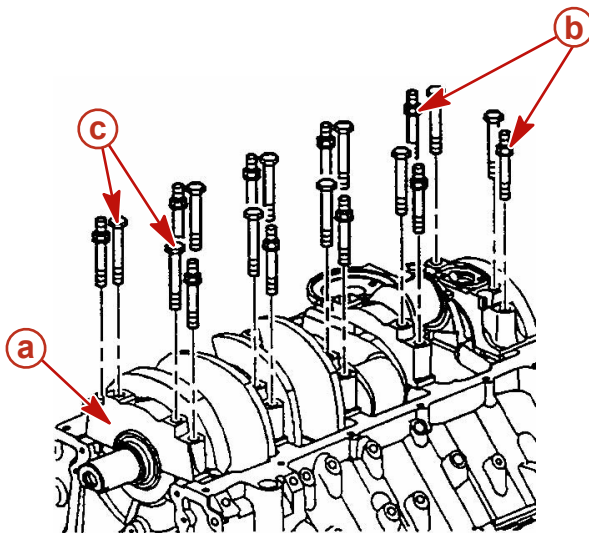
19544

a - Crankshaft position sensor

b - O-ring

c - Screw

4. Remove the bearing caps.



21962

a - Main cap

b - Outer stud

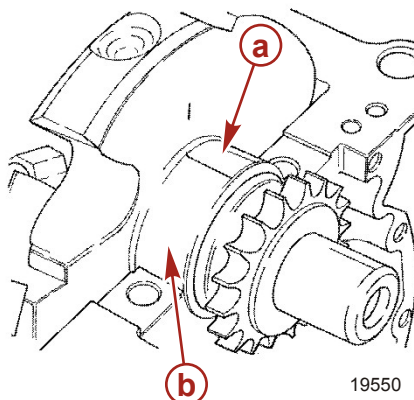
c - Inner bolt

Checking Clearances

To obtain accurate measurements while using Plastigage or its equivalent, the engine must be out of the boat and upside down so the crankshaft will rest on the upper bearings and total clearance can be measured between the lower bearing and journal.

1. Remove the bearing cap to be checked.
2. Wipe oil from the journal and bearing to be inspected.
3. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.

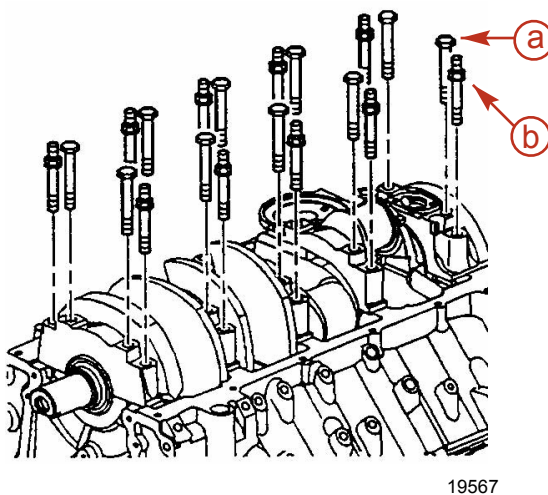
IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.



a - Gauging plastic

b - Journal

4. Install the bearing cap in their original position, and evenly tighten the retaining bolts.
5. Install and torque main bearing caps in the following sequence, as specified.

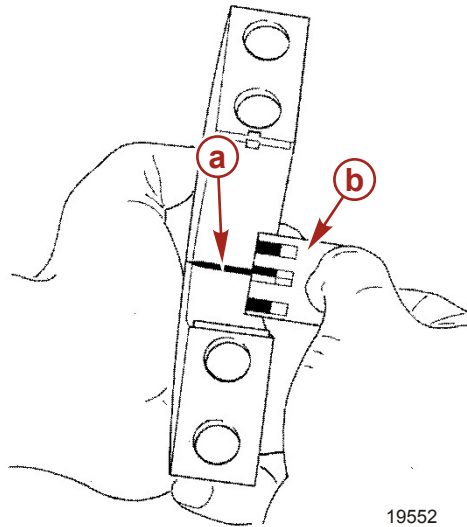


a - Inner bolts

b - Outer studs

Description		Nm	lb. in.	lb. ft.
Inner bolts	First Pass	30		22
	Second pass	Inner bolts an additional 90°		
Description		Nm	lb. in.	lb. ft.
Outer studs	First Pass	30		22
	Second pass	Outer studs an additional 80°		

6. Remove the bearing cap. The flattened gauging plastic will adhere to either the bearing cap or journal.
7. Do not remove the gauging plastic. Measure its compressed width (at the widest point) with the graduated scale on the gauging plastic envelope as shown.



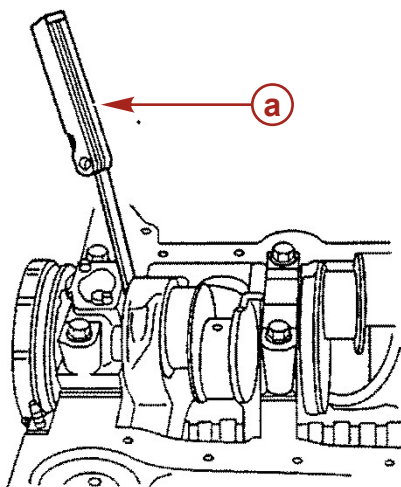
a - Compressed gauging plastic

b - Graduated scale

NOTE: Normally the main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (0.001 in. max.), 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 0.001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot, or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than 0.001 in. difference.

8. If the bearing clearance is within specifications, the bearing is satisfactory. If the clearance is not within specifications, replace the bearing. Always replace both upper and lower bearing as a unit.
9. A standard or 0.001 in. undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
10. Repeat steps 1–7 for each bearing cap.
11. After all the bearings, and journals have been checked and the bearing caps installed, rotate the crankshaft to check for drag.

12. Measure crankshaft end play by forcing the crankshaft to the extreme forward position. Measure at the front end of the rear main bearing with a feeler gauge. See **Engine Specifications** for proper clearance.



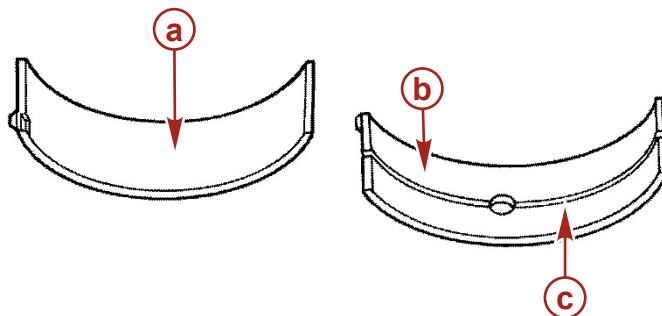
19553

Measuring crankshaft end play

a - Feeler gauges

Installation

NOTE: Main bearings may be replaced with or without removing the crankshaft.



19554

Main bearing identification

a - Lower bearing insert (install in cap)

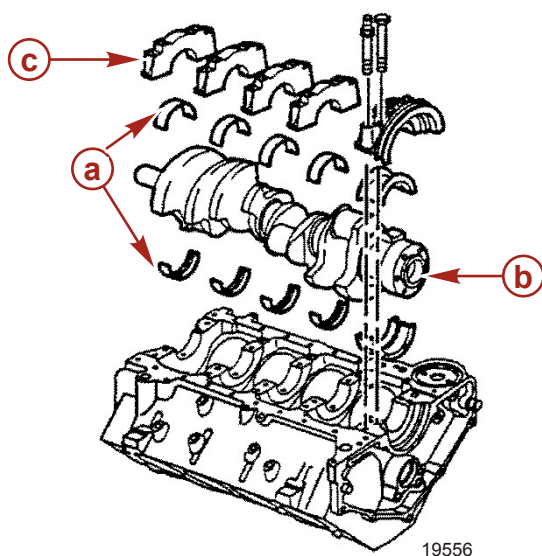
b - Upper bearing insert (install in block)

c - Oil groove

WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.

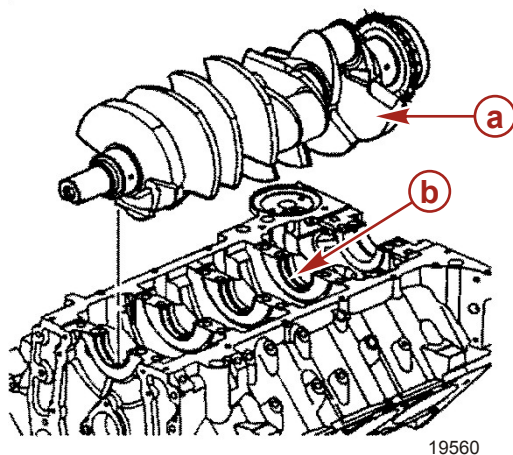
2. Remove the main bearings from the cylinder block and main bearing caps.



a - Main bearings
b - Crankshaft

c - Main bearing caps

3. Coat the bearing surfaces of new, correct size main bearings with oil and install in the cylinder block and main bearing caps
4. Install the crankshaft.



a - Crankshaft

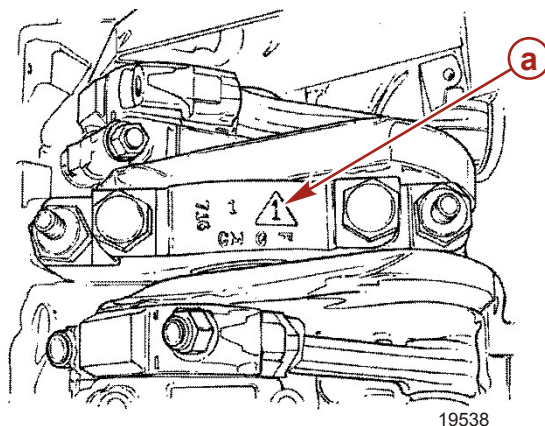
b - Upper main bearings

⚠ CAUTION

To ensure proper seating of the main bearing caps in the cylinder block cavity, you must use a brass or leather mallet. Do not use the attaching bolts to pull the main bearing caps into place.

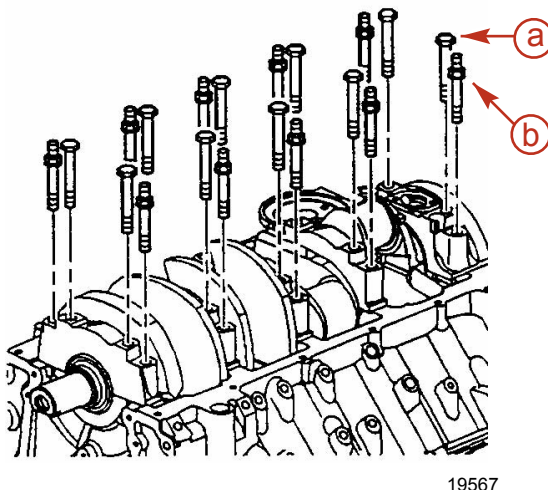
IMPORTANT: Ensure that the triangle symbols on the main bearing caps are facing the front of the engine.

5. Install the main bearing caps except the rear main bearing cap.



a - Main bearing cap mark

6. Torque main bearing caps in the following sequence, as specified.



a - Inner bolts

b - Outer studs

Description		Nm	lb. in.	lb. ft.
Inner bolts	First Pass	30		22
	Second pass	Inner bolts an additional 90°		

Description		Nm	lb. in.	lb. ft.
Outer studs	First Pass	30		22
	Second pass	Outer studs an additional 80°		

7. Apply a 13 mm (1/2 in.) wide film of sealant to the rear main bearing cap mating surface.

Tube Ref No.	Description	Where Used	Part No.
 135	Three Bond 1217F	Rear main bearing cap mating surface	Obtain Locally

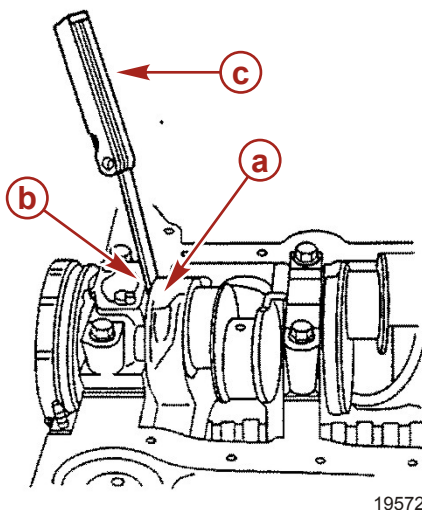
8. Install the rear main bearing and bearing cap.
 9. Torque the fasteners to specification starting with the inner bolts.

Description	Nm	lb. in.	lb. ft.
Fasteners	4		35

10. Firmly thrust the crankshaft, first rearward then forward, with a synthane hammer. This will align up the rear main bearing and crankshaft thrust surfaces. Then torque the rear main bearing cap in the following sequence, as specified.

Description		Nm	lb. in.	lb. ft.
Inner bolts	First Pass	30		22
	Second pass	Inner bolts an additional 90°		
Description		Nm	lb. in.	lb. ft.
Outer studs	First Pass	30		22
	Second pass	Outer studs an additional 80°		

11. Measure crankshaft end play by forcing the crankshaft to the extreme forward position. Measure at the front end of the rear main bearing with a feeler gauge. See **Engine Specifications** for proper clearance.

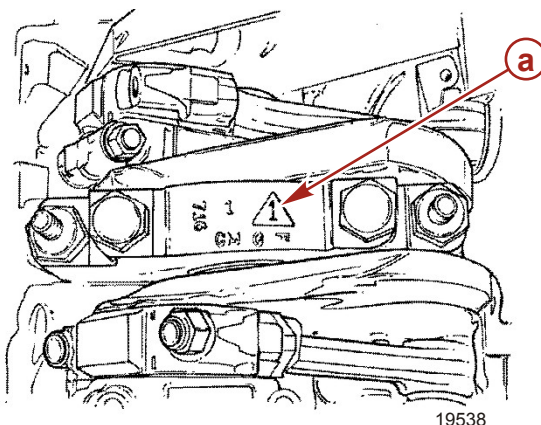


Measuring crankshaft end play

- a** - Crankshaft thrust surface **c** - Feeler gauge
b - Thrust bearing

WITHOUT CRANKSHAFT REMOVED

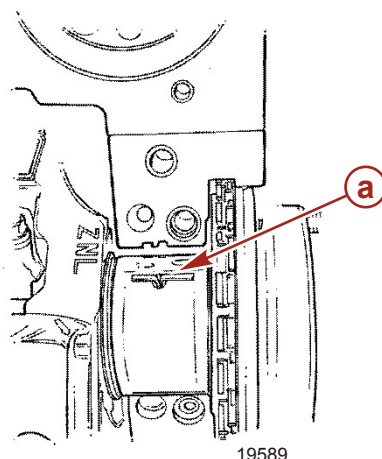
IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.



- a** - Main bearing cap mark

1. With the oil pan, oil pump, and crankshaft oil deflector.
2. Remove the spark plugs
3. Make suitable marks on the cap and remove the main bearing caps requiring replacement.
4. Remove the bearing from the cap.
5. Install the main bearing remover/installer in the oil hole in crankshaft journal. If the tool is not available, a cotter pin may be bent as shown.

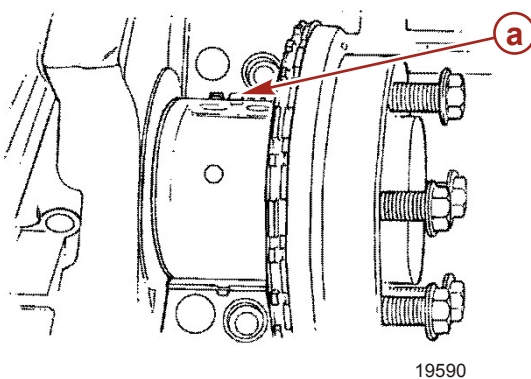
NOTE: If using the cotter pin method, ensure flatness to prevent scratching the journal surface.



a - Cotter pin

Description	Part Number
Main bearing remover/installer tool	Obtain locally

6. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper bearing out of the block.
7. Oil the new upper bearing and place on the crankshaft.
8. Insert the plain end between the crankshaft and the indented or notched side of block. Verify the notch will align properly.
9. Rotate the crankshaft.
10. Remove the main bearing remover/installer tool from the oil hole in the crankshaft journal.



a - Notched side of block

Description	Part Number
Main bearing remover/installer tool	Obtain locally

11. Oil the new lower bearing and install in the bearing cap.

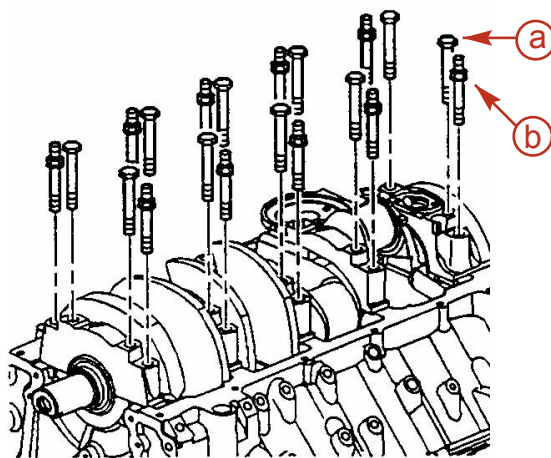
⚠ CAUTION

To ensure proper seating of the main bearing caps in the cylinder block cavity, you must use a brass or leather mallet. Do not use the attaching bolts to pull the main bearing caps into place.

IMPORTANT: Ensure that the triangle symbols on the main bearing caps are facing the front of the engine.

12. Install the main bearing caps, except the rear main bearing.

13. Torque the main bearing caps, in the following sequence, as specified.



19567

a - Inner bolts

b - Outer studs

Description		Nm	lb. in.	lb. ft.
Inner bolts	First Pass	30		22
	Second pass	Inner bolts an additional 90°		

Description		Nm	lb. in.	lb. ft.
Outer studs	First Pass	30		22
	Second pass	Outer studs an additional 80°		

14. Apply a 13 mm (1/2 in.) wide film of sealant to the rear main bearing cap mating surface.

Tube Ref No.	Description	Where Used	Part No.
 135	Three Bond 1217F	Rear main bearing cap mating surface	Obtain Locally

15. Install the rear main bearing.

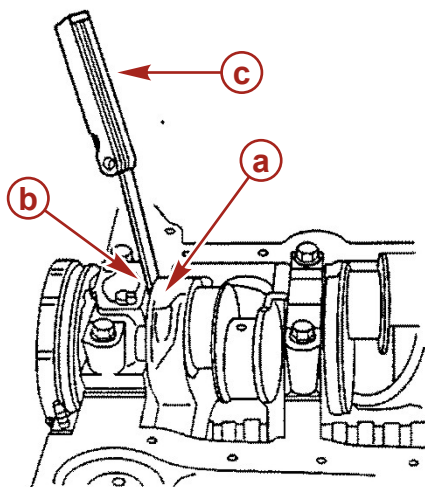
16. Torque the fasteners starting with the inner bolts.

Description	Nm	lb. in.	lb. ft.
Fasteners	4	35	

17. Firmly thrust the crankshaft, first rearward then forward, with a synthane hammer. This will line up the rear main bearing and crankshaft thrust surfaces. Then torque the rear main bearing cap in the following sequence, as specified.

Description		Nm	lb. in.	lb. ft.
Inner bolts	First Pass	30		22
	Second pass	Inner bolts an additional 90°		
Description		Nm	lb. in.	lb. ft.
Outer studs	First Pass	30		22
	Second pass	Outer studs an additional 80°		

18. Measure crankshaft end play by forcing the crankshaft to the extreme forward position. Measure at the front end of the rear main bearing with a feeler gauge. See **Engine Specifications** for proper clearance.



19572

Measuring crankshaft end play

a - Crankshaft thrust surface

c - Feeler gauge

b - Thrust bearing

Connecting Rod Bearings

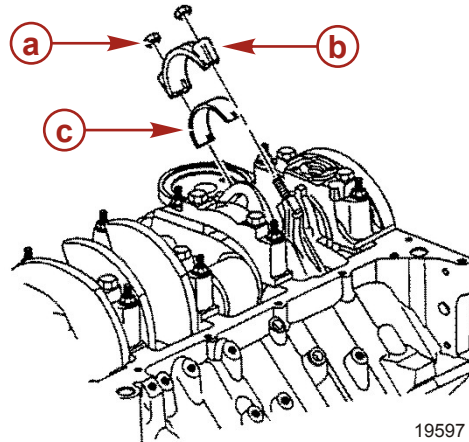
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. Do not file rods or rod caps. If clearances are excessive, a new bearing is required. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersize for use with new and used standard size crankshafts, and in 0.010 in. and 0.020 in. undersize for use with reconditioned crankshafts.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number and remove one connecting rod cap and bearing.

1. Remove the oil pan, oil pump, and oil deflector.

2. Mark the side of the rod and cap with the cylinder number, and remove one connecting rod cap and bearing.

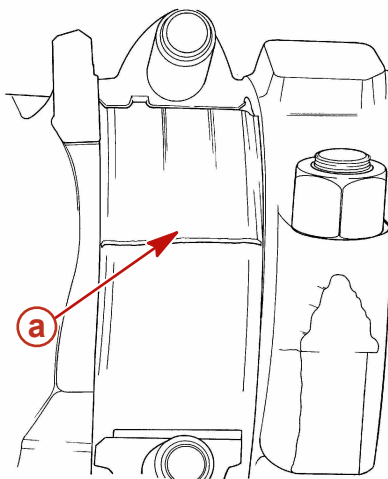


a - Connecting rod nut
b - Connecting rod cap

c - Connecting rod bearing

3. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
4. Wipe both upper and lower bearing and crankshaft journal clean of oil.
5. Measure the crankshaft journal for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the to determine new bearing size required. See **Connecting Rod Bearings**.
6. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankshaft journal, be sure to fit to the maximum diameter of the crankshaft journal. If the bearing is fitted to the minimum diameter, and the crankshaft journal is out of round 0.001 in., interference between the bearing and crankshaft journal will result in rapid bearing failure.

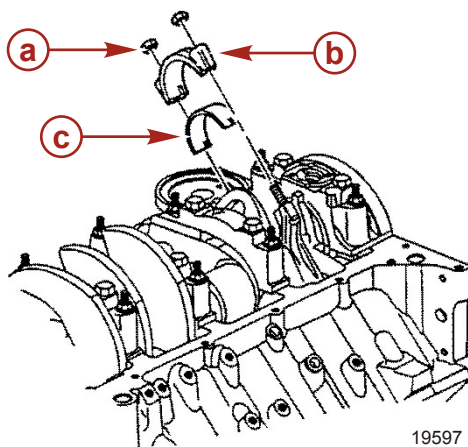
- a. Place a piece of gauging plastic the length of the bearing (parallel to the crankshaft) on the crankshaft journal or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell (Bearings are eccentric and false readings could occur if placed elsewhere).



19594

a - Gauging plastic

- b. Install the bearing in the connecting rod and connecting rod cap.
c. Install the bearing cap and evenly torque the rod cap nuts in sequence as specified.



19597

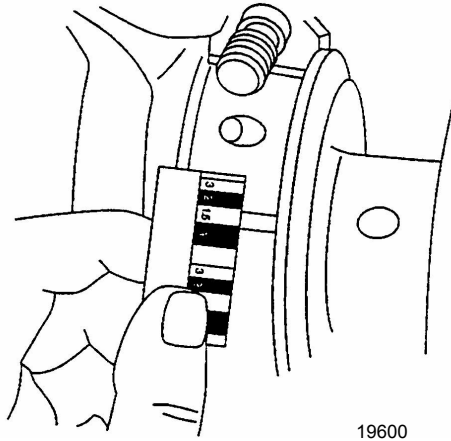
a - Connecting rod nut
b - Connecting rod cap

c - Connecting rod bearing

Description		Nm	lb. in.	lb. ft.
Rod cap nuts	First pass	30		22
	Second pass	Tighten an additional 90°		

- d. Remove the bearing cap and, using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.

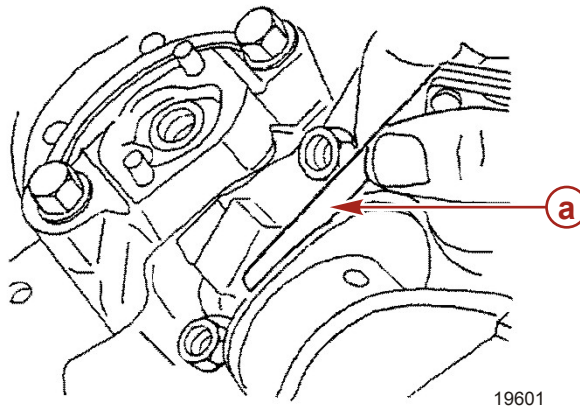
IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.



7. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance. Be sure to check what size bearing is being removed in order to determine the proper replacement size bearing. If clearance cannot be brought to within specifications, the crankshaft journal must be ground. If the crankshaft journal is already at maximum undersize, replace the crankshaft.
8. Coat the bearing surface with oil. Install the bearing cap and evenly torque the rod cap nuts in sequence as specified.

Description		Nm	lb. in.	lb. ft.
Rod cap nuts	First pass	30		22
	Second pass	Tighten an additional 90°		

9. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the journal) .
10. Using feeler gauges, measure all connecting rod side clearances between the connecting rod caps. See **Engine Specifications**.



a - Feeler gauge

Connecting Rod and Piston Assembly

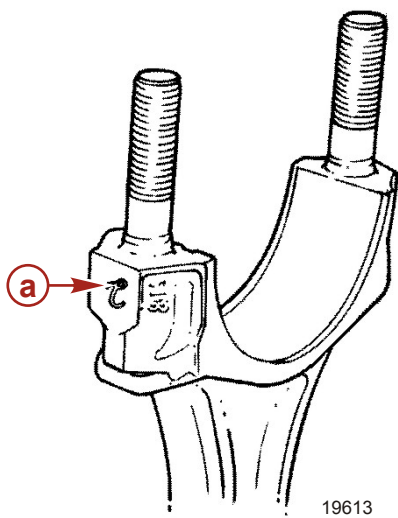
Removal

1. Remove the oil pan.
2. Remove the crankshaft oil deflector and oil pump.
3. Remove the exhaust manifolds.

4. Remove the intake manifold, throttle body, and fuel rail.
5. Remove the cylinder heads.

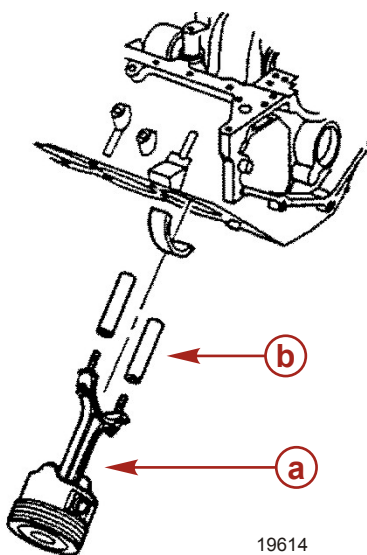
IMPORTANT: Before ridges or deposits are removed, turn the crankshaft until the piston is at bottom of stroke and place a cloth on top of the piston to collect cuttings. After the ridges or deposits are removed, turn the crankshaft until the piston is at the top of the stroke, then remove the cloth and cuttings.

6. Use a ridge reamer to remove any ridges or deposits from the upper end of the cylinder bore.
7. Mark the connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6, and 8 from front to rear on same side as piston thrust).



a - Connecting rod mark

8. Remove the connecting rod cap and install the connecting rod bolt guide on the bolts.
9. Push the connecting rod and piston assembly out of the top of the cylinder block.



a - Piston and rod assembly

b - Rod bolt guide

NOTE: Turn the crankshaft to disconnect and remove connecting rod and piston assemblies.

Cleaning and Inspection

CONNECTING RODS

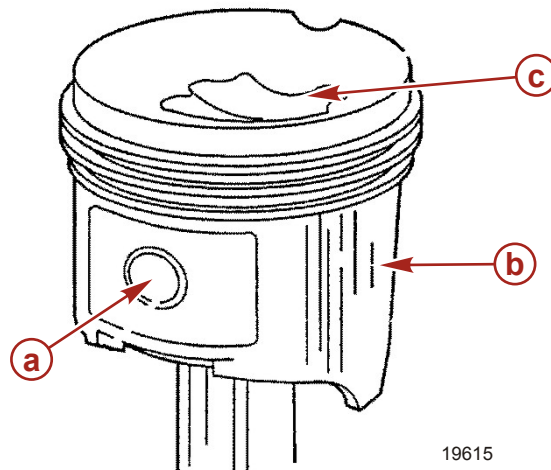
1. Wash the connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods.
3. Inspect the connecting rods for nicks and cracks.
4. Replace as necessary.

PISTONS

IMPORTANT: Do not use a wire brush on any part of the piston.

NOTE: Cylinder bore and taper must be within specifications before the pistons can be considered for re-use.

1. Clean varnish from the piston skirts with a cleaning solvent.
2. Clean the ring grooves.
3. Ensure that the oil ring holes are clean.
4. Inspect the piston top and skirt for damage and signs of excessive wear such as scuffing. Replace pistons, if necessary. See **Engine Specifications**.
5. Inspect the grooves for nicks and burrs.

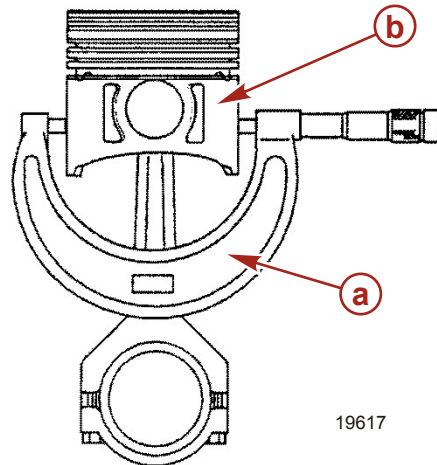


a - Pin and bore damage

b - Scuffed or damaged skirt

c - Eroded areas

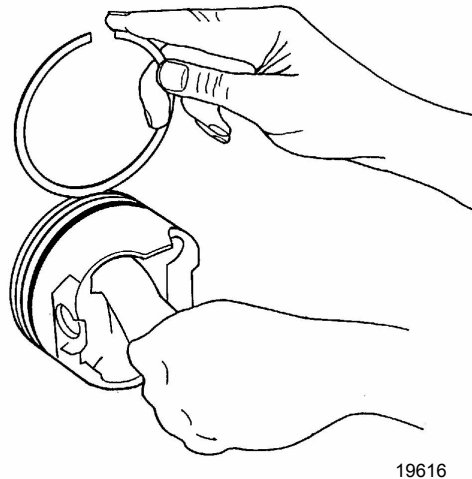
6. Measure the piston skirt and check clearance. See **Engine Specifications, and Cylinder Block—Piston Selection.**



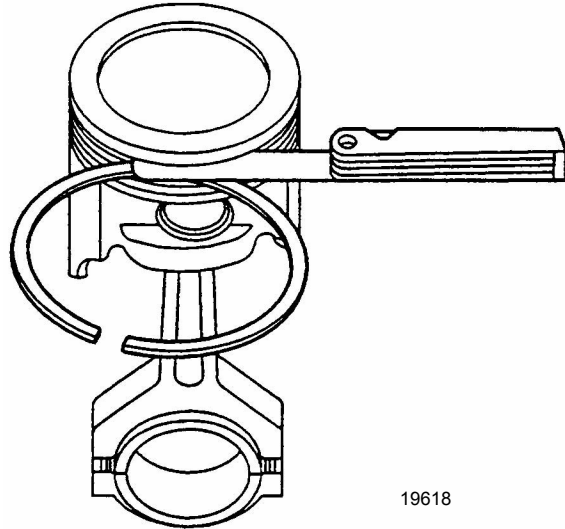
a - Micrometer

b - Piston skirt

7. Slip the outer surface of a new top and second compression ring into its respective piston ring groove and roll the ring entirely around the groove to verify that the ring is free. If binding occurs at any point, determine the cause. If caused by the ring groove, remove by dressing with a fine cut file. Binding could be caused by a distorted ring, check with another ring.



8. Proper clearance of the piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, measure clearances between ring and groove surfaces.



Measuring piston ring groove clearance

9. Replace the piston if it fails to pass inspection or meet specifications.

PISTON PINS

IMPORTANT: Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, the piston and piston pin are a matched set and not serviced separately.

Reassembly

IMPORTANT: Adhere to the following when reassembling pistons and connecting rods.

- Piston and pins are not serviced separately.
- If the original piston assemblies are being used, reinstall in the same cylinders from which they were removed.
- Connecting rod bearing tangs are always toward the outside of the cylinder block.
- The notch or relief valve in the piston must be positioned correctly for the engine being repaired.

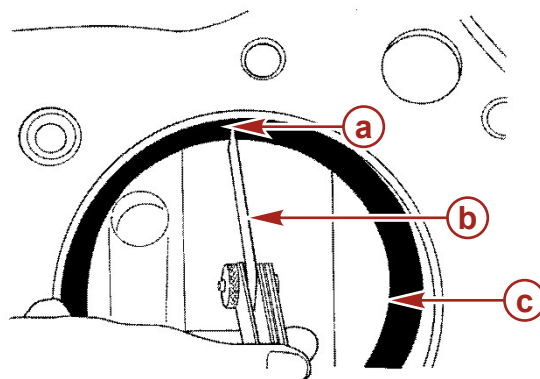
PISTON RINGS

All compression rings are marked on the upper side of the ring. When installing the compression rings, ensure that the marked side is toward the top of the piston.

Oil rings consist of two rings and a spacer.

1. Select rings comparable in size to the cylinder bore and piston size.
2. Slip the compression ring in the cylinder bore, then press the ring down into the cylinder bore about 6 mm (1/4 in.) below the ring travel. Be sure that the ring is square with the cylinder wall.

3. Measure the gap between the ends of the ring with a feeler gauge as shown.



a - Gap

b - Feeler gauges

19619

c - Compression ring

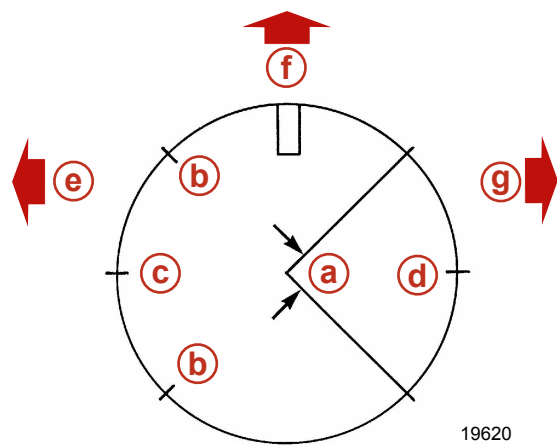
4. If the gap between the ends of the ring is below specifications, remove the ring and try another for fit. See **Engine Specifications**.
5. Fit each compression ring to the cylinder in which it is going to be used.
6. Install the piston rings as follows:
- Install the oil ring spacer in the groove, and insert the anti-rotation tang in the oil hole.
 - Hold the spacer ends butted, and install the lower steel oil ring rail with the gap properly located.
 - Install the upper steel oil ring rail with the gap properly located.
 - Flex the oil ring assembly to verify the ring is free. If binding occurs at any point, determine the cause and, if caused by the ring groove, remove by dressing the groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use a piston ring expander for compression ring installation.

- Install the lower compression ring with the marked side up, using a ring expander.
- Install the top compression ring with the marked side up, using a ring expander.

Description	Part Number
Piston ring expander	Obtain locally

g. Position the ring gaps as shown.



Ring gap location

- a** - Oil ring spacer gap (tang in hole or slot within arc)

b - Oil ring gaps

c - 2nd compression ring gap

d - Top compression ring gap
- e** - Port side

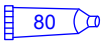
f - Engine front

g - Starboard side

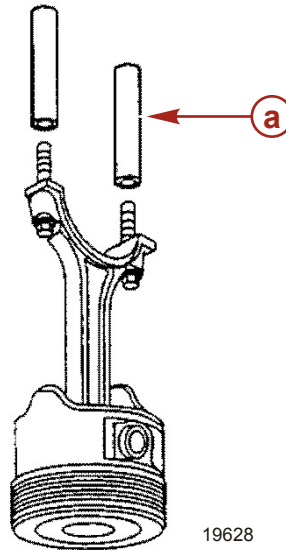
Installation

IMPORTANT:

- Prior to installing the pistons:
 - Clean the cylinder bores with a light honing as necessary.
 - Clean the cylinder bores with hot water and detergent wash.
 - After cleaning the cylinder bores, swab the bores several times with light engine oil and a clean cloth.
 - Wipe the cylinder bores with a clean, dry cloth.
- Lubricate the connecting rod bearings, and install in rods and rod caps.
- Lightly coat the pistons, rings, and cylinder walls with lubricant.

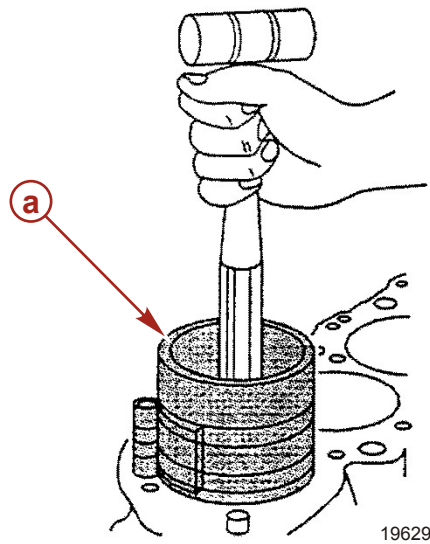
Tube Ref No.	Description	Where Used	Part No.
	SAE Engine Oil 30W	Connecting rod bearings, pistons, rings, and cylinder walls	Obtain Locally

4. With the bearing caps removed, install the connecting rod bolt guide on the connecting rod bolts.



a - Connecting rod bolt guide

5. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward the outside of the cylinder block. Use a piston ring compressor to compress the rings. Guide the connecting rod into place on the crankshaft journal with the connecting rod bolt guide. Use a hammer handle with light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all of the piston rings have entered cylinder bore.

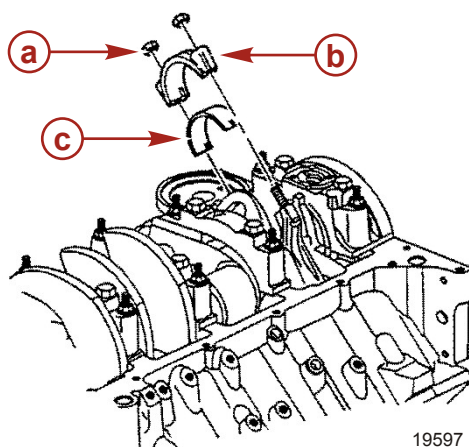


a - Piston ring compressor (J-8037)

Description	Part Number
Piston ring compressor	Obtain locally

IMPORTANT: Be sure to install new pistons in the same cylinders for which they were fitted and used pistons in same the 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 in the left bank and 2, 4, 6, and 8 in the right bank). Numbers on the connecting rod and bearing cap must be on 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.

6. Remove the connecting rod bolt guide.
7. Install the connecting rod bearing caps using the bearing cap nuts. Torque the nuts in sequence as specified.



a - Connecting rod nuts
b - Connecting rod caps

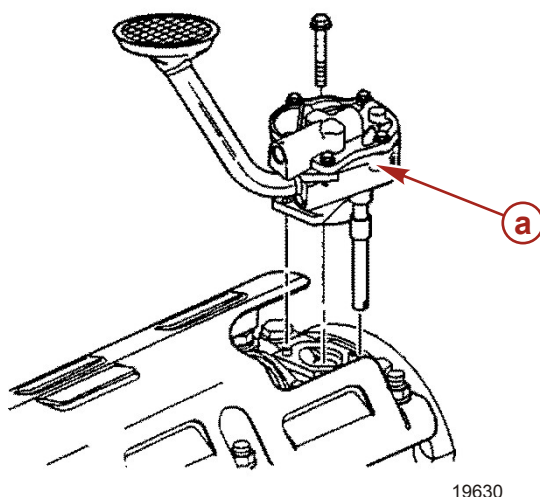
c - Lower bearing

Description		Nm	lb. in.	lb. ft.
Connecting rod nut	First pass	30		22
	Second pass	90°		

8. Check connecting rod side clearance as previously described.

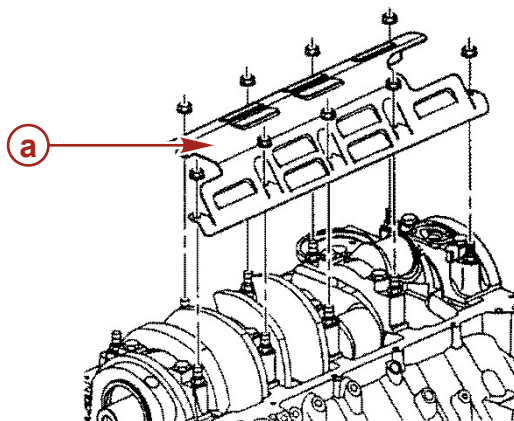
NOTE: If bearing replacement is required, see **Connecting Rod Bearings**.

9. Install the oil pump.



a - Oil pump

10. Install the crankshaft oil deflector.



19633

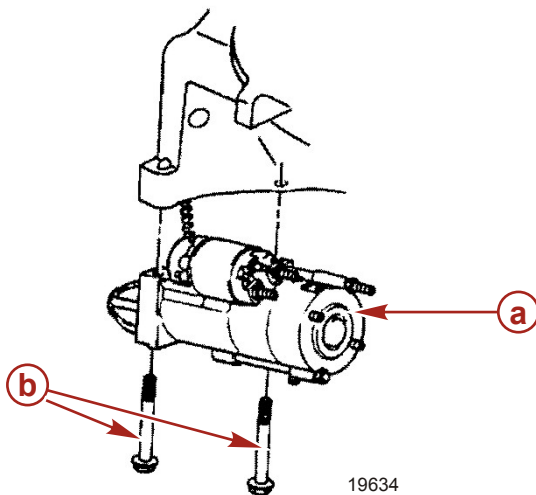
a - Crankshaft oil deflector

11. Install the oil pan and dipstick tube.
12. Install the cylinder heads.
13. Install the intake manifold.
14. Install all other components removed.
15. Fill the cooling system.
16. Fill the engine with the specified engine oil. Refer to **Section 1B**.

Crankshaft

Removal

1. Remove the drive unit, if equipped, from the engine.
2. Remove the engine from the boat.
3. Remove the transmission, if equipped.
4. Drain the crankcase oil.
5. Drain the coolant.
6. Remove the starter.

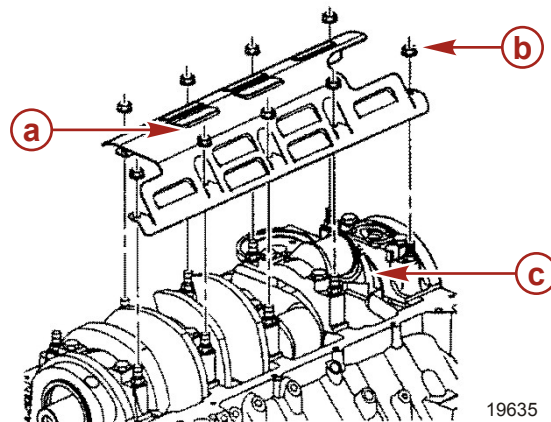


19634

a - Starter

b - Bolts

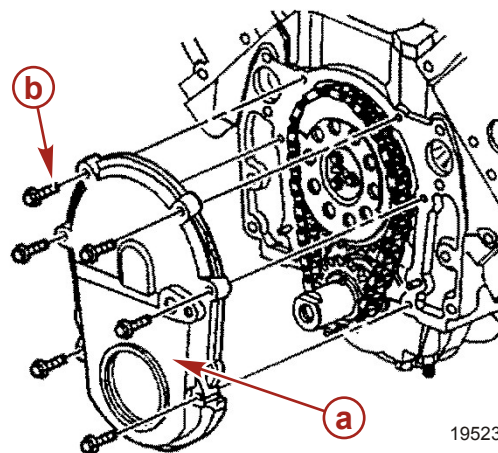
7. Remove the flywheel housing.
8. Remove the coupler, or drive plate.
9. Remove the flywheel.
10. Remove the drive belt.
11. Remove the water circulating pump.
12. Remove the crankshaft pulley and torsional damper.
13. Remove the oil pan and dipstick tube.
14. Remove the oil pump.
15. Remove the crankshaft oil deflector.



a - Crankshaft oil deflector
b - Nuts (9)

c - Crankshaft

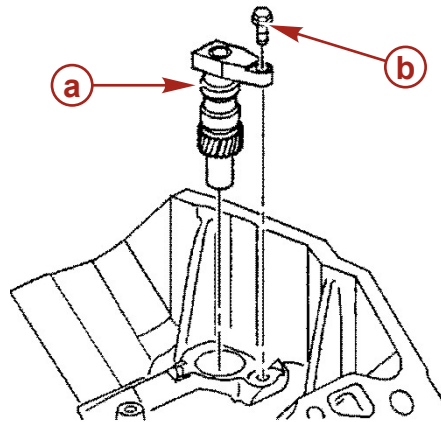
16. Remove the front cover.



a - Front cover

b - Screw (6)

17. Remove the oil pump drive.

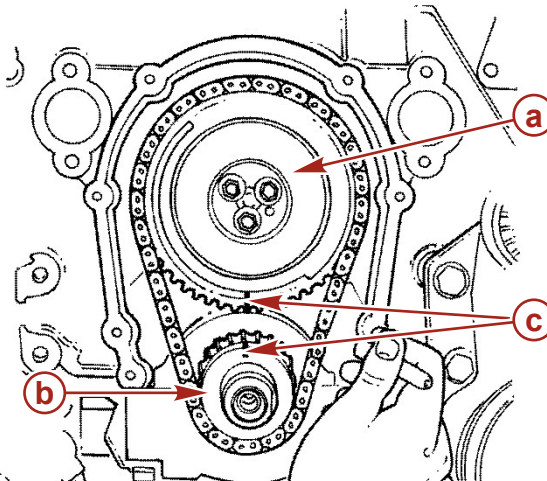


19636

a - Oil pump drive

b - Screw

18. Turn the crankshaft to align the timing mark with the camshaft mark, or mark both gears for alignment in reassembly.



19637

a - Camshaft gear

b - Crankshaft gear

c - Alignment marks

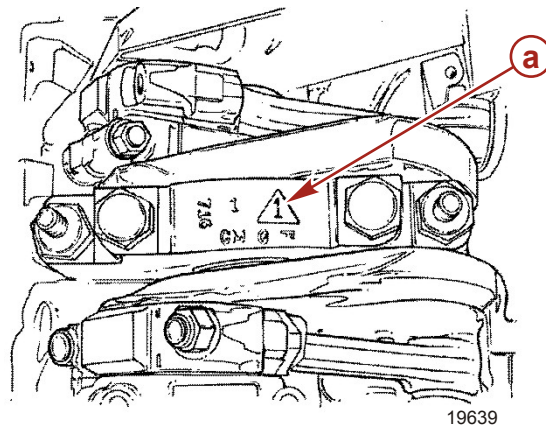
19. Remove the camshaft gear.

20. Remove the timing chain.

21. Remove the rear main seal.

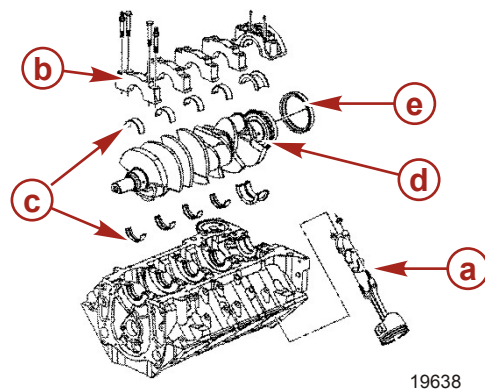
IMPORTANT: Inspect the bearing caps for orientation marks before removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

22. Ensure that all bearing caps are marked for reinstallation in their original locations.



a - Bearing cap marking

23. Remove the connecting rod bearing caps, and push the piston and rod assemblies toward the heads.



a - Piston and rod assemblies

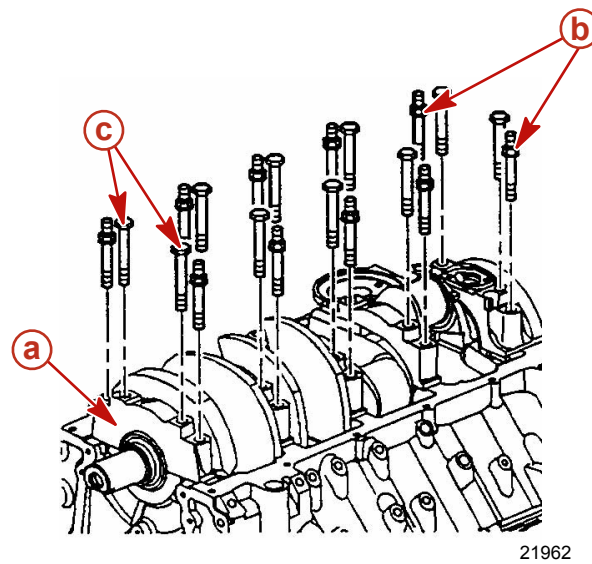
b - Bearing caps

c - Main bearings

d - Crankshaft

e - Rear main seal

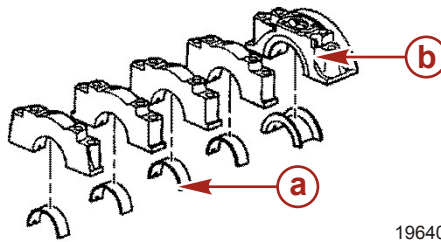
24. Remove the main bearing cap fasteners and main bearing caps.



a - Main bearing cap
b - Outer stud

c - Inner bolt

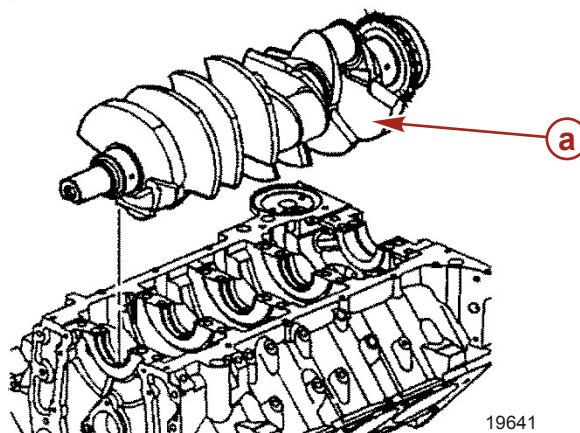
25. Remove the main bearings from the main bearing caps.



a - Main bearing

b - Main bearing cap

26. Carefully remove the crankshaft.



a - Crankshaft

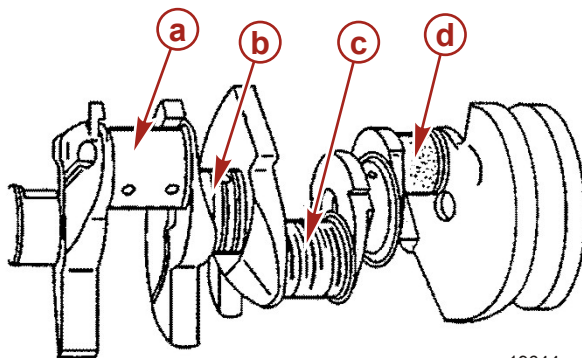
27. If the new main or connecting rod bearings are to be installed:

- a. Remove the main bearings from the cylinder block and bearing caps.

- b. Remove the connecting rod bearings from the connecting rod and caps.
- c. Install the new bearings.

Cleaning and Inspection

1. Wash the crankshaft in solvent and dry with compressed air.
2. Measure the main bearing journals with a micrometer for out-of-round, taper, or undersize.
3. Inspect the crankshaft. See **Engine Specifications**.

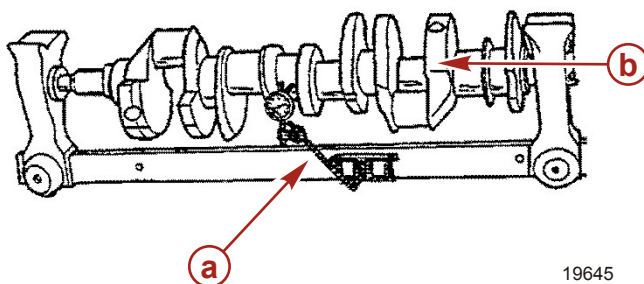


19644

a - Smooth surface
b - Grooves

c - Scratches or uneven surface
d - Pitted surface

4. Check the crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks). Check at front and rear intermediate journals with a dial indicator. See **Engine Specifications**.



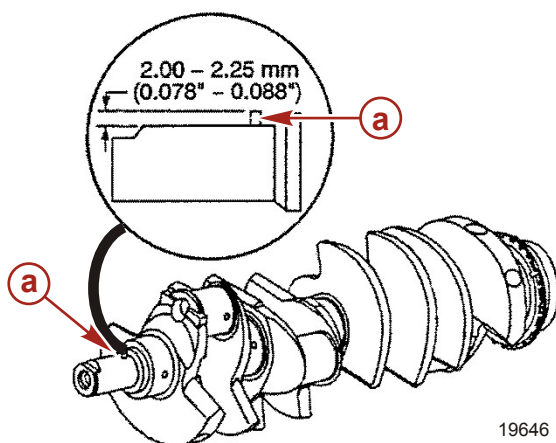
19645

a - Dial indicator (J-7872)

b - Crankshaft

Description	Part Number
Dial indicator	Obtain locally

5. Inspect the crankshaft pin for wear or damage.

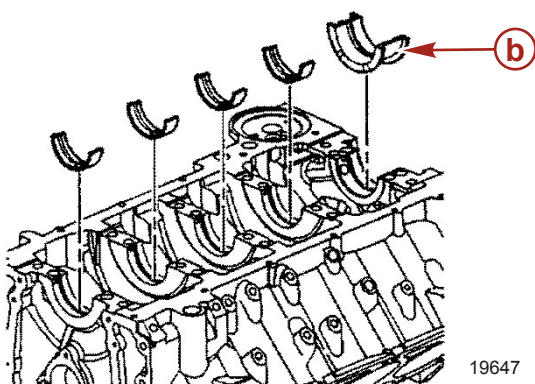


a - Crankshaft pin

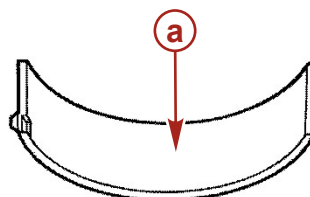
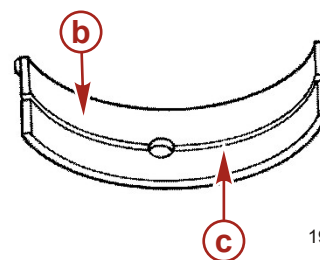
6. Replace or recondition the crankshaft if not within specifications.

Installation

1. Remove the timing gear from the old crankshaft and reinstall on the new crankshaft.
IMPORTANT: Verify that all bearings and crankshaft journals are clean.
2. Install the main bearings in the engine block.



19647

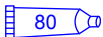
**a****b****c**

19648

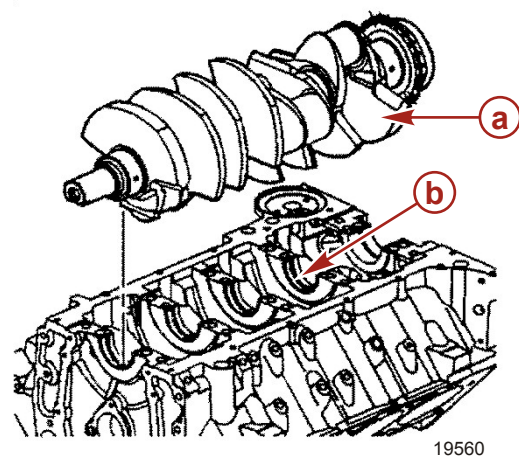
Main bearing identification

- a** - Lower bearing (install in cap) **c** - Oil groove
b - Upper bearing (install in block)

3. Lubricate the main bearings, and crankshaft.

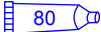
Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Main bearings and crankshaft	Obtain Locally

4. Carefully lower the crankshaft into place. Be careful not to damage the bearing surface.

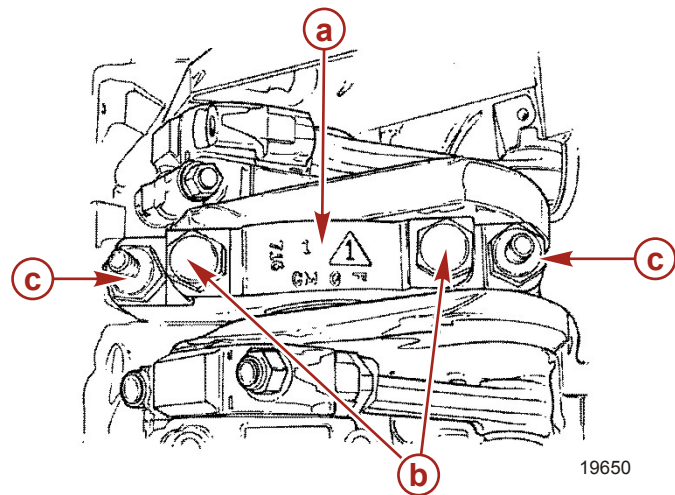


a - Crankshaft **b** - Bearing surface

5. Check the clearance of each main bearing, following the procedure outlined under **Main Bearings**. If bearing clearances are satisfactory, apply engine oil to journals and bearings.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Journals and bearings	Obtain Locally

6. Using new bearing cap screws and studs, install the main bearing caps.
7. Torque the main bearing caps in sequence as specified.

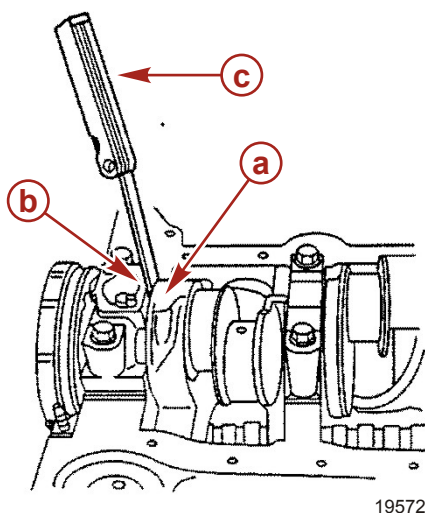


a - Main bearing cap **b** - Inner bolts **c** - Outer studs

Description		Nm	lb. in.	lb. ft.
Cap bolts	First pass	30		22
	Second pass	Cap bolts an additional 90°		

Description		Nm	lb. in.	lb. ft.
Cap studs	First pass	30		22
	Second pass	Cap studs an additional 80°		

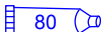
8. Check crankshaft end play. See **Main Bearings**.



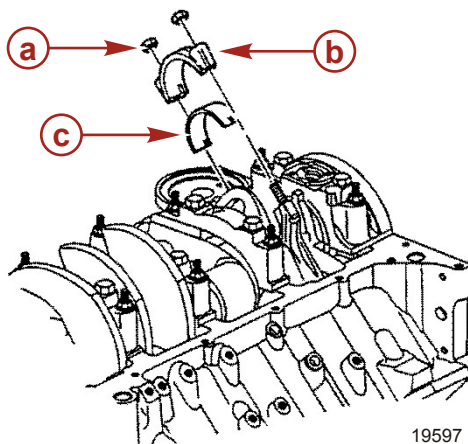
a - Crankshaft thrust surface
b - Thrust bearing

c - Feeler gauge

9. Check clearance for each connecting rod bearing, following the procedure under **Connecting Rod Bearings**. If bearing clearances are satisfactory, apply engine oil to the journals and bearings.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Journals and bearings	Obtain Locally

10. Install the rod caps and evenly torque the nuts in sequence as specified.



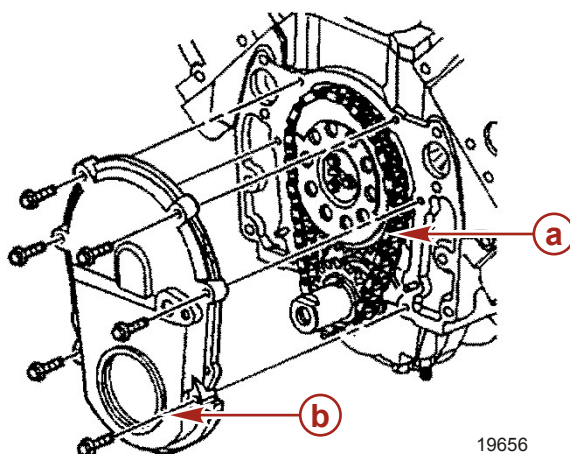
a - Connecting rod nut
b - Connecting rod cap

c - Lower bearing

Description		Nm	lb. in.	lb. ft.
Connecting rod nut	First pass	30		22
	Second pass	90°		

11. Turn the crankshaft so the mark on the timing gear is facing the camshaft.
 12. Install the timing chain and gear on the camshaft and align the marks with the crankshaft.

13. Install the front cover.



a - Timing chain

b - Front cover

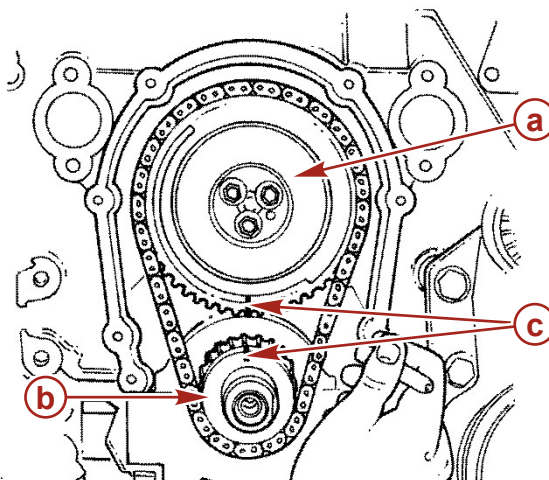
14. Install the oil pump and crankshaft oil deflector.
15. Install the dipstick tube and oil pan.
16. Install the torsional damper and crankshaft pulley.
17. Install the water circulating pump.
18. Install the drive belt.
19. Install the flywheel and drive coupler/plate.
20. Install the flywheel housing.
21. Install the the starter.
22. Install the new oil filter.
23. Fill the engine with the specified engine oil. See **Section 1B**.
24. Fill the closed cooling system and supply a sufficient water supply to the engine.
25. Start the engine and check for leaks.

Timing Chain and Sprocket

Removal

1. Remove the torsional damper and front cover.

- Turn the crankshaft until the timing marks on the crankshaft and the camshaft sprockets are in alignment, or mark both sprockets for alignment during reassembly.

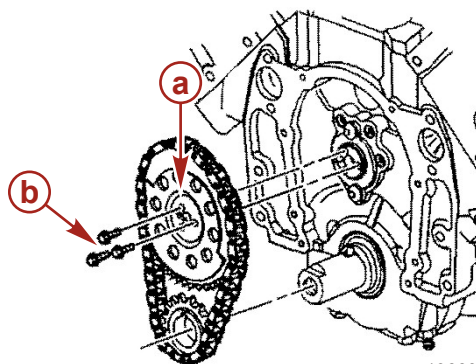


19637

a - Camshaft sprocket
b - Crankshaft gear

c - Alignment marks

- Remove the camshaft sprocket and timing chain. 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.



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a - Camshaft sprocket

b - Camshaft sprocket screws

- Remove the crankshaft sprocket if it requires replacement.

Cleaning and Inspection

- Clean all parts in solvent and dry with compressed air.
- Inspect the timing chain for wear and damage.
- Inspect the sprockets for wear and damage.

Installation

- Install the crankshaft sprocket.
- Install the timing chain on the camshaft sprocket. Hold the sprocket vertical with the chain hanging down. Align the marks on the camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive the sprocket on the camshaft, as the welsh plug at rear of engine can be dislodged.

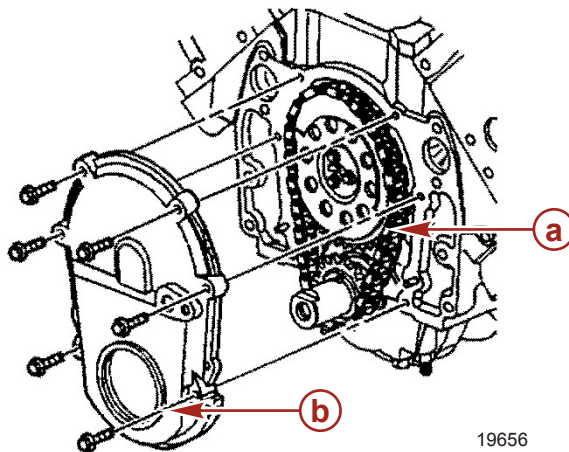
- Install the sprocket on the camshaft. Torque screws to specification.

Description	Nm	lb. in.	lb. ft.
Camshaft sprocket screws	30		22

- Lubricate the timing chain with engine oil.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Timing chain	Obtain Locally

- Check the timing chain deflection. See **Crankshaft Sprocket—Checking timing Chain Deflection**.
- Install the front cover.



a - Timing chain

b - Front cover

- Install the torsional damper.
- Reinstall any other components removed in the repair process.

Crankshaft Sprocket

Removal

- Remove the torsional damper and front cover.
- Remove the camshaft gear and timing chain.
- Remove the crankshaft sprocket using a crankshaft gear puller.

Description	Part Number
Crankshaft gear puller	Obtain locally

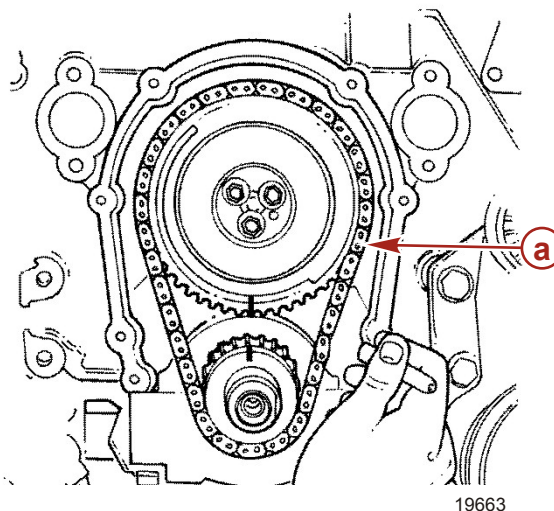
Installation

- Using a crankshaft gear and sprocket installer, install the sprocket on the crankshaft.
- Install the timing chain.

Checking Timing Chain Deflection

- Rotate the camshaft in either direction to place tension on one side of the chain.
- Establish a reference point on the block on the taut side of the chain, and measure from this point to the chain.
- Rotate the camshaft in the opposite direction to slacken the chain, then force the chain out with your fingers and again measure the distance between the reference point and timing chain.

4. The deflection is the difference between these two measurements. If the deflection exceeds 19 mm (3/4 in.), the timing chain should be replaced.



a - Timing chain

5. Install the front cover.
6. Install the torsional damper.

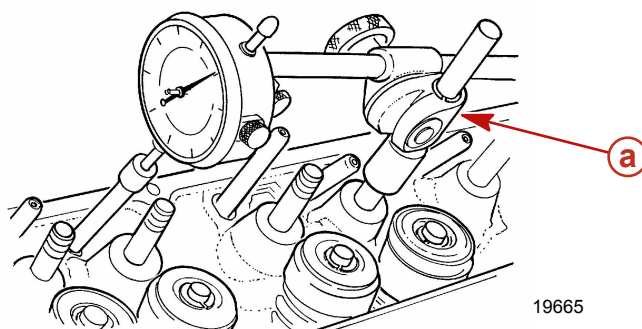
Camshaft

Measuring Lobe Lift

NOTE: This procedure is similar to checking valve timing. If improper valve operation is indicated, measure the lift of each push rod in consecutive order and record the readings.

1. Remove the valve mechanism.
2. Adapt a dial indicator to the cylinder head by temporarily installing a suitable stud in the bolt hole. Position the indicator with a ball socket adapter tool from the Lift Indicator Tool Kit on the push rod. Ensure that the push rod is in the lifter socket.

Description	Part Number
Lift Indicator Tool Kit (dial indicator, ball socket adaptor)	Obtain locally



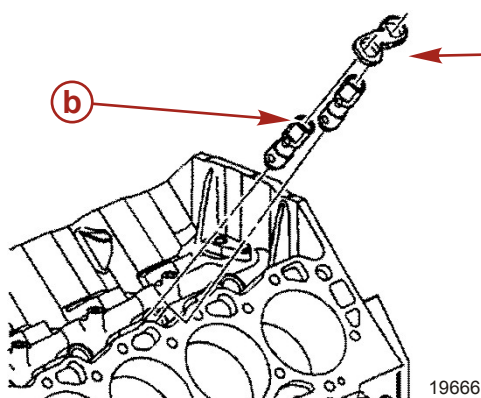
a - Ball Socket Adapter Tool

3. Rotate the torsional damper slowly in the direction of rotation until the lifter is on the heel of the cam lobe. The push rod will be in its lowest position.

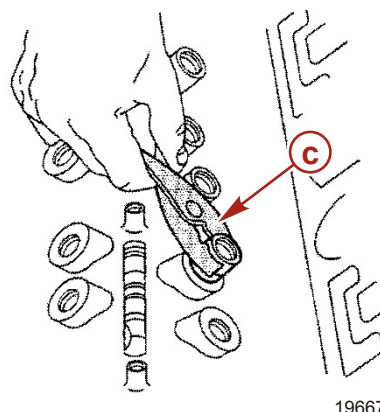
4. Set the dial indicator to zero, then rotate the torsional damper slowly until the push rod is in the fully raised position.
5. Compare the total lift recorded from the dial indicator with lobe lift specifications. See **Engine Specifications**.
6. Continue to rotate the engine until the indicator reads zero. This checks the accuracy of the original indicator reading.
7. If the camshaft readings for all lobes are within specifications, remove the dial indicator assembly and hardware.
8. Install and torque the valve mechanism.

Camshaft Removal

1. Drain the engine coolant.
2. Drain the engine oil.
3. Remove the intake manifold.
4. Remove the splash shield.
5. Remove the lifter restrictor retainer.
6. Remove the valve lifters. The valve lifter removal tool can be used to ease removal.



a - Valve lifter restrictor
b - Valve lifter

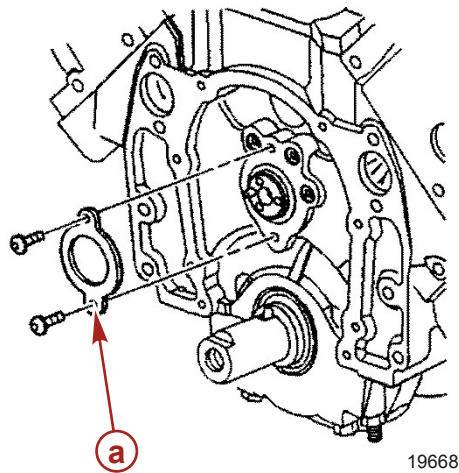


c - Valve lifter removal tool

Description	Part Number
Valve lifter removal tool	Obtain locally

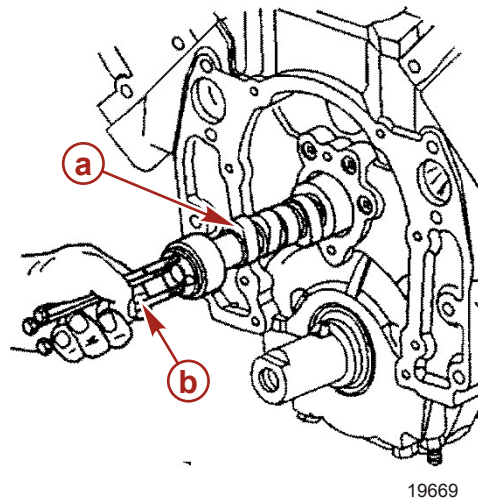
7. Remove the heat exchanger.
8. Remove the cross over.
9. Remove the water circulation pump.
10. Remove the front cover.
11. Remove the timing chain and sprocket.

12. Remove the camshaft retainer.



a - Camshaft retainer

13. Install three 5/16-18 × 5 inch bolts in the camshaft bolt holes and carefully remove the camshaft.



a - Camshaft

b - 5/16-18 × 5 inches bolts

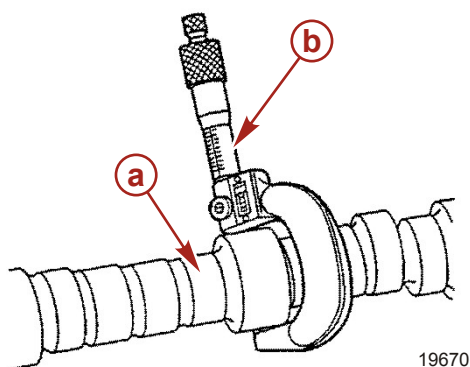
Inspection

1. Measure the camshaft bearing journals with a micrometer for out-of-round condition. If the journals exceed the maximum out-of-round specifications replace the camshaft.

Specifications

Camshaft bearing journal (maximum out of round)

0.025 mm (0.001 in.)

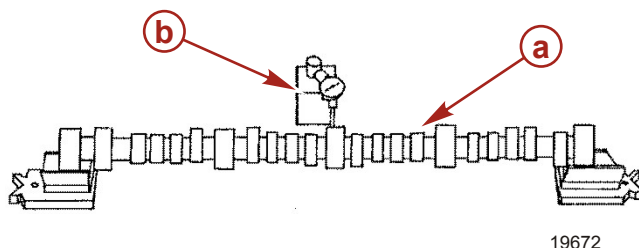
**a** - Camshaft**b** - Micrometer

2. Check the camshaft for runout with V-blocks and a dial indicator that indicates the exact amount of camshaft runout. If the camshaft runout (dial indicator reading) is more than specified the camshaft should be replaced.

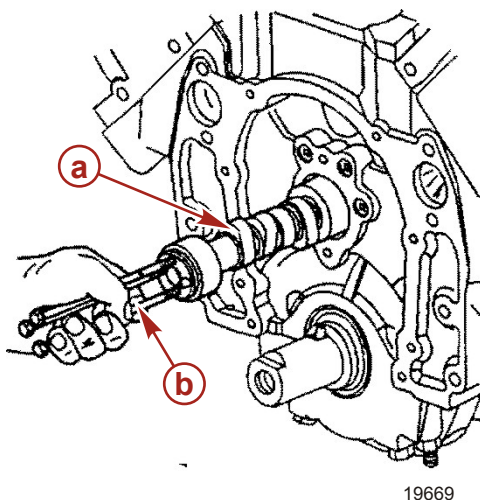
Specifications

Camshaft bearing journal (maximum runout)

0.051 mm (0.002 in.)

**a** - Camshaft**b** - Dial indicator**Installation**

1. Install three 5/16-18 × 5 inches bolts in the camshaft bolt holes, then lubricate the camshaft bearing journals with engine oil.

**a** - Camshaft**b** - 5/16-18 × 5 inches bolts

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Camshaft bearing journals	Obtain Locally

- Lubricate the camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.

Tube Ref No.	Description	Where Used	Part No.
	Cam and Lifter Prelube	Camshaft lobes	Obtain Locally

- Install the camshaft. Be careful not to damage the bearings.
- Install the camshaft retainer. Torque the retainer screws.

Description	Nm	lb. in.	lb. ft.
Camshaft retainer screw	12	106	

- Install the timing chain.
- Install the front cover, valve lifters, lifter restrictors, and lifter restrictor retainer.
- Install the all other components removed in the repair process.
- Fill the engine with the specified engine oil, see **Section 1B**.
- Change the engine oil filter.
- Fill the closed cooling system.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

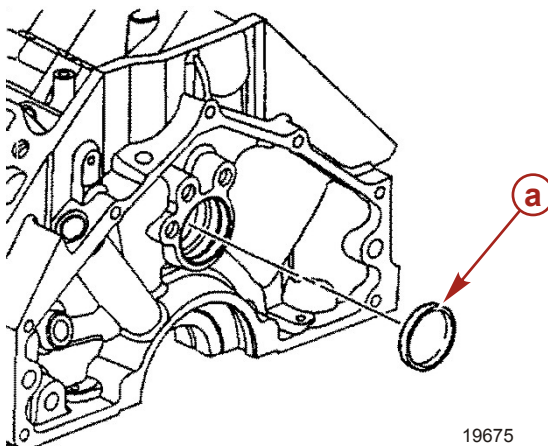
- Supply sufficient water to the engine.
- Start the engine and check for leaks.

Camshaft Bearings

Removal

Camshaft bearings can be replaced while the engine is disassembled for overhaul or without complete disassembly. Remove the camshaft, leaving the cylinder heads attached and the crankshaft and pistons in place.

- Remove the camshaft.
- Drive the camshaft rear plug from the cylinder block.



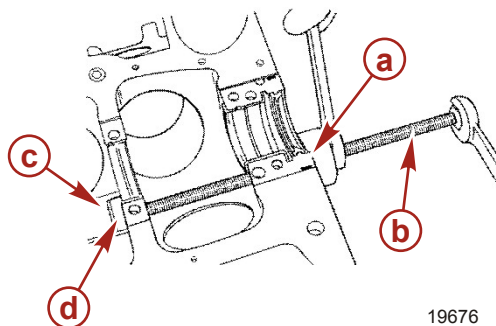
a - Camshaft rear plug

NOTE: This procedure is based on removing the bearings from the center of the engine first, thus requiring a minimum amount of turns to remove all bearings.

3. Install the nut and thrust washer to the end of the threads on the camshaft bearing remover and installer set (J-33049).

Description	Part Number
Camshaft bearing remover and installer set	Obtain locally

4. Position the pilot in front of the camshaft bearing.
5. Install the puller screw through the pilot.
6. Install the tool with the shoulder toward the bearing. Ensure that a sufficient number of threads are engaged.
7. Using two wrenches, hold the puller screw while turning the nut.
8. Pull the bearing from the camshaft bore.
9. Remove the tool and bearing from the puller screw.
10. Remove the remaining bearings (except front and rear) in the same manner.
11. Position the pilot in the rear camshaft bearing to remove the rear intermediate bearing.



a - Index pilot

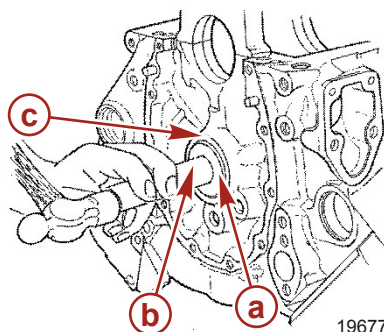
b - Puller screw

19676

c - Driver

d - Bearing

12. Assemble the driver on the driver handle and remove the front and rear camshaft bearings by driving toward the center of cylinder block.



19677

a - Driver

b - Driver handle

c - Bearing

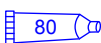
Cleaning and Inspection

1. Clean the camshaft bearing bores in the cylinder block with solvent, and dry with compressed air.
2. Ensure that the grooves and drilled oil passages are clean.

Installation

IMPORTANT: Front and rear bearings must be installed last as the pilot will not fit into the bearing bores if the bearings are installed.

NOTE: Lubricate the outer surface of the new camshaft bearings with engine oil to ease installation.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Outer surface of the new camshaft bearings	Obtain Locally

IMPORTANT: Not all camshaft bearings are the same. Be sure to install bearings in the proper locations (indicated by bearing manufacturer) and to position the bearings as follows (directional references are in reference to the engine in its normal operating position): the front bearing must be positioned so that the oil holes are an equal distance from the 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward the left side of block and at a position even with bottom of the cylinder bore). The rear bearing must be positioned so that oil hole is at the 12 o'clock position.

INTERMEDIATE AND CENTER BEARINGS

1. Install the nut and thrust washer onto the puller screw.
2. Position the pilot in the front camshaft bearing bore and insert the screw through the pilot.
3. Index the center camshaft bearing.
4. Position the appropriate size removal and installation tool in the bearing and thread the puller screw into tool. Be sure at least 13 mm (1/2 in.) of threads are engaged.
5. Using two wrenches, hold the puller screw and turn the nut until the bearing has been pulled into position.
6. Remove the removal and installation tool and ensure that the oil hole(s) in the bearing are positioned correctly.
7. Install the intermediate bearings in the same manner. Ensure that the bearings are indexed correctly. Position the pilot in the rear camshaft bearing bore to install the rear intermediate bearing.

FRONT AND REAR BEARINGS

1. Install the appropriate size removal and installation tool on the drive handle.
2. Index the front bearing and drive it into position with the tool.
3. Ensure that the bearing is positioned correctly. Index the rear bearing and drive it into position with the tool.
4. Install a new camshaft rear plug.

IMPORTANT: The plug must be installed flush to 0.8 mm (1/32 in.) deep and must be parallel with rear surface of cylinder block.

5. Install the camshaft.

Cylinder Block

Cleaning

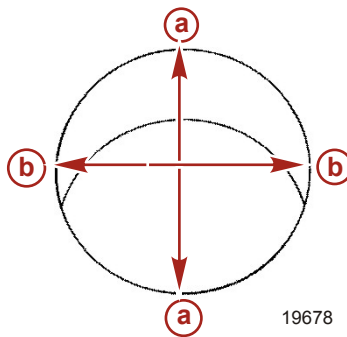
1. Remove all engine components.
2. Remove the oil gallery plugs and clean all oil passages.
3. Remove the expansion plugs.

NOTE: These plugs may be removed with a sharp punch or they may be drilled and pried out.

4. Wash the cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
5. Clean water passages in the cylinder block.

Inspection

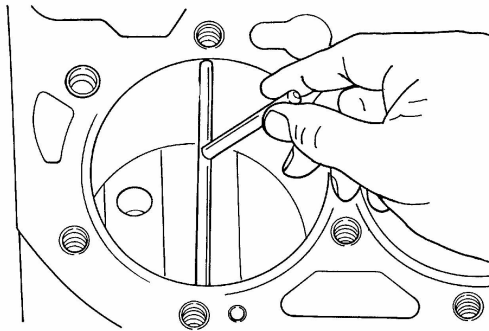
1. Inspect the water passages in the cylinder block.
2. Inspect the cylinder block for cracks in the cylinder walls, water jacket valve lifter bores, and main bearing webs.
3. Measure the cylinder walls for taper, out-of-round, or excessive ridge at the top of ring travel using a dial indicator or inside micrometer. Carefully work the gauge up and down the cylinder to determine taper and turn it to different points around the cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring or honing is necessary.



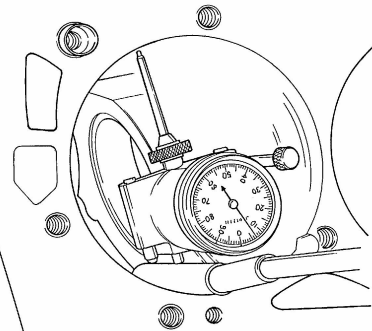
Cylinder measurement

a - At right angle to centerline of engine

b - Parallel to centerline of engine

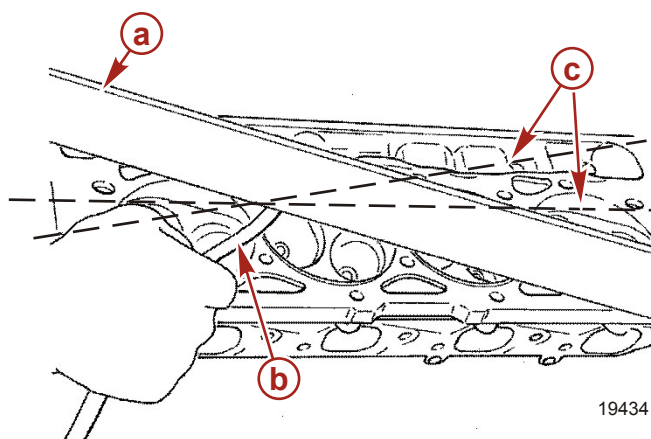


Telescope Gauge



Dial Indicator

4. Check cylinder head gasket surfaces for warpage with a machinist's straight-edge and a feeler gauge as shown. Take measurements diagonally across the surfaces (both ways) and straight down the center. If surfaces are warped more than 0.07 mm (0.003 in.) in a 6 in. area or 0.17 mm (0.007 in.) overall, the block must be resurfaced by an automotive machine shop.



a - Machinist's straight edge
b - Feeler gauge

c - Measurement lines

Cylinder Head and Cylinder Block	
Maximum cylinder head and cylinder block resurfacing	0.3048 mm (0.012 in.)

CYLINDER CONDITIONING

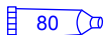
1. Performance of the following operation depends upon engine condition at time of repair.
2. If the cylinder block inspection indicates that the block is suitable for continued use (except for out-of-round or tapered cylinders), the cylinders can be conditioned by honing or boring.
3. If cylinders have less than 0.127 mm (0.005 in.) taper or wear, they can be conditioned with a hone and fitted with a high-limit standard size piston. A cylinder bore of more than 0.005 in. wear or taper may not clean up entirely when fitted to a high-limit piston. To entirely clean up the bore, bore for an oversize piston. If more than 0.005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean, dry cloth.

CYLINDER HONING

1. Follow the hone manufacturer's recommendations for use of the hone.
2. Several times during the honing operation, clean the cylinder bore and check the piston for correct fit in the cylinder.
3. When finish-honing a cylinder bore to fit a piston, move the hone up and down at a sufficient speed to obtain very fine, uniform surface finish marks in a crosshatch pattern of approximately 30° to the cylinder bore. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.
4. Permanently mark the piston (for the cylinder to which it has been fitted) and hone the cylinders and fit the remaining pistons.

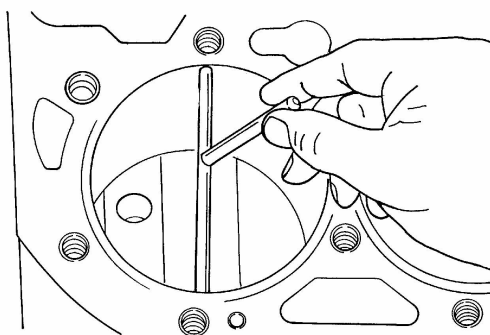
IMPORTANT: Handle pistons with care and do not attempt to force them through the cylinder until the cylinder is honed to the correct size.

5. Clean the cylinder bores with hot water and detergent. Scrub with a stiff bristle brush and completely rinse with hot water. If any abrasive material remains in the cylinder bores, it will rapidly wear new rings and cylinder bores. Swab the bores several times with light engine oil on a clean cloth, then wipe with a clean, dry cloth. Do not clean cylinders with kerosene or gasoline. Clean the remainder of the cylinder block to remove excess material spread during honing.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Cylinder bores	Obtain Locally

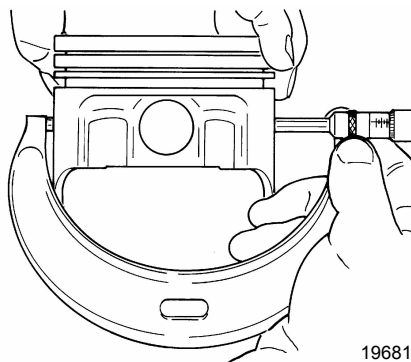
PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
 - a. Measure the cylinder bore diameter with a telescope gauge 64 mm (2-1/2 in.) from top of the cylinder bore as follows.



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- b. Measure the piston diameter at the skirt across the centerline of the piston pin.



19681

- c. Subtract the piston diameter from the cylinder bore diameter to determine the piston-to-bore clearance.
 - d. Determine if the piston-to-bore clearance is in the acceptable range. See specifications.
2. If the used piston is not satisfactory, determine if a new piston can be selected to fit the cylinder bore within the acceptable range.
3. If the cylinder bore must be reconditioned, measure the new piston diameter (across the centerline of the piston pin), then hone the cylinder bore to correct the clearance (preferable range).
4. Mark the piston to identify the cylinder for which it was fitted.

Compression Test

NOTE: Compression pressure is 100 psi (690 kPa) minimum. Minimum compression recorded in any one cylinder should not be less than 70% of the highest recorded cylinder.

1. Disable the ignition system and remove all spark plugs.

NOTE: Use a fully charged battery when performing the following procedure.

2. Open the throttle plate completely.
3. Starting with the compression gauge at "0," crank the engine through four compression strokes (four puffs).
4. Record the compression for each cylinder.
5. If some cylinders have low compression, use a pump-type oil can to inject three squirts of oil into each combustion chamber through the spark plug hole. Do a second compression check on each cylinder.
6. No cylinder should read less than 100 psi (690 kPa). Compression recorded on any one cylinder should not be less than 70% of the highest cylinder.
7. Four characteristics may be evident:
 - Normal: Compression builds up quickly and evenly in each cylinder.
 - Piston rings leaking: Compression low on first stroke then increases on following strokes, but does not reach normal. Compression improves considerably with three squirts of oil.
 - Valves leaking: Compression low on first stroke and does not build up on following strokes or with three squirts of oil.
 - Adjacent cylinders having lower than normal compression: Inject three squirts of oil into the cylinders. If the compression does not increase, the cause may be a blown head gasket between cylinders.

Oil Filter Bypass Valves and Adapter

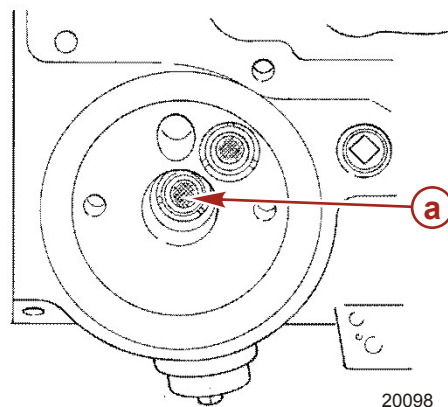
Inspection and Replacement

The oil bypass valve and adapter should be inspected whenever the engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

Refer to the **Engine Parts List** when ordering parts for the oil filter bypass valve, adapter assembly, or remote oil filter parts.

1. Remove the oil hose from the adapter.
2. Remove the adapter fitting and adapter fitting seal from the adapter.
3. Remove the adapter and adapter seal.
4. Clean the parts in solvent and dry with compressed air.

5. Inspect the oil bypass valves for cracks or other damage. Ensure that the valves fit tightly against the seats. Push each valve down and release it. Valves should return freely to their seats. If valve operation is questionable, the oil bypass valve should be replaced.



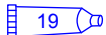
Typical Bypass Valve

a - Oil bypass valve

6. Wipe out the valve chamber in the cylinder block to remove any foreign material.
7. Install the oil bypass valve, if replaced.
8. Lubricate the adapter seal with engine oil.
9. Install the adapter using the adapter fitting and adapter fitting seal. Torque the adapter fitting.

Description	Nm	lb. in.	lb. ft.
Adapter fitting	27		20

10. Apply sealant to the threads of the oil hose fitting.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Oil hose fitting	92-34227-1

11. Install the oil hose fitting into the adapter. Torque the oil hose fitting.

Description	Nm	lb. in.	lb. ft.
Oil hose fitting	38		28

Electrical System

Section 4A - Starting System

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Starter Specifications.....	4A-2		

Lubricants, Sealants, Adhesives

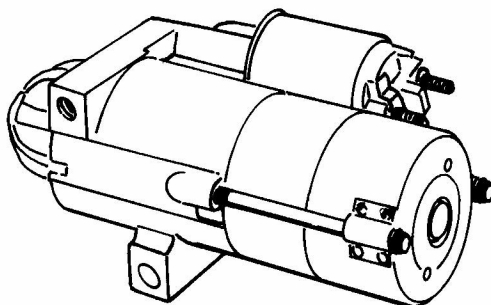
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Starter terminals	92-25711-3

Finding Other Diagrams

NOTICE
Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

Delco PG260 Starter Motor

Identification



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Starter Specifications

Delco I.D. Number	MerCruiser part number
9000821	50-806964

Starter Specifications

Engine Rotation	No Load Test					Brush Spring Tension Grams (Oz.)
	Volts	. Amps	Max Amps	Min. RPM	Max. RPM	
LH	10.6	60	95	2750	3250	2352–2948 (83–104)
Pinion Clearance		0.025–4.06 mm (0.010–0.160 in.)				
Bearing Depth (gear)		0.038 mm (0.014 in.) Maximum				
Bearing Depth (housing)		0.4 mm (0.017 in.) Maximum				

Starter Removal

CAUTION

Always disconnect the battery cables from the battery before working around electrical system components to prevent injury and damage to the electrical system if a wire should accidentally cause a short circuit.

1. Disconnect the battery cables from the battery.
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.

Periodic Inspection

The starter motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect the terminals for corrosion and loose connections.
2. Inspect the wiring for frayed and worn insulation.
3. Ensure that the starter mounting bolts are torqued.

Description	Nm	lb. in.	lb. ft.
Starter mounting bolt	41		30

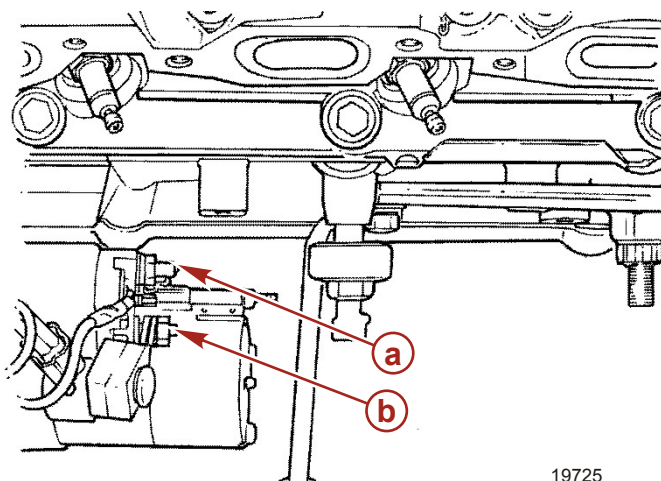
Installation

IMPORTANT: Install the special mounting shim (if equipped) between the starter motor and the engine block.

1. Place the starter motor in position and install the mounting bolts. Torque the bolts.

Description	Nm	lb. in.	lb. ft.
Starter mounting bolts	41		30

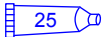
2. Connect the YELLOW/RED wire to the upper solenoid terminal. Connect the the ORANGE wire, RED wire, and battery cable to the lower solenoid terminal. Tighten the fasteners securely. Apply sealant to the starter terminals. Install the battery cable boot.



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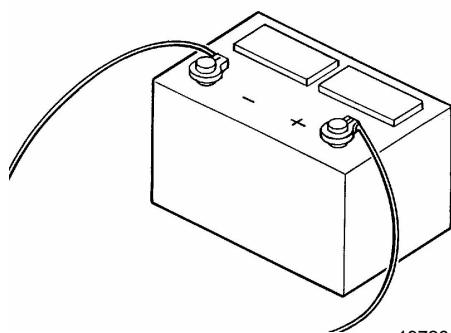
a - Upper solenoid terminal

b - Lower solenoid terminal

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

3. Connect the battery cables to the battery in the following order:
 - a. Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.

- b. Connect the negative (-) battery cable to the negative (-) battery terminal and tighten the clamp.



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Typical

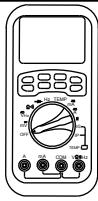
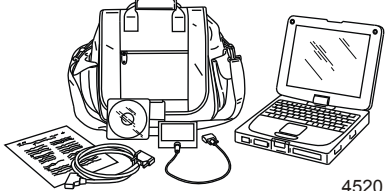
Electrical System

Section 4B - Ignition System

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Special Tools

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.
Computer Diagnostic System (CDS)	Order through SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

Finding Other Diagrams

NOTICE
Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

Spark Plug Specifications

IMPORTANT: All of the spark plugs installed in the engine must be of the same type.

IMPORTANT: Servicing dealers should refer to the latest spark plug listing for acceptable spark plugs.

Description	Specification
Firing order	1-8-7-2-6-5-4-3
Spark plug type	AC Platinum (AC 41-983)
Spark plug gap	1.52 mm (0.060 in.)

Ignition System Components

EFI System Maintenance Precautions

⚠ CAUTION
Always disconnect the battery cables from the battery before working around electrical system components to prevent injury and damage to the electrical system if a wire should accidentally cause a short circuit.

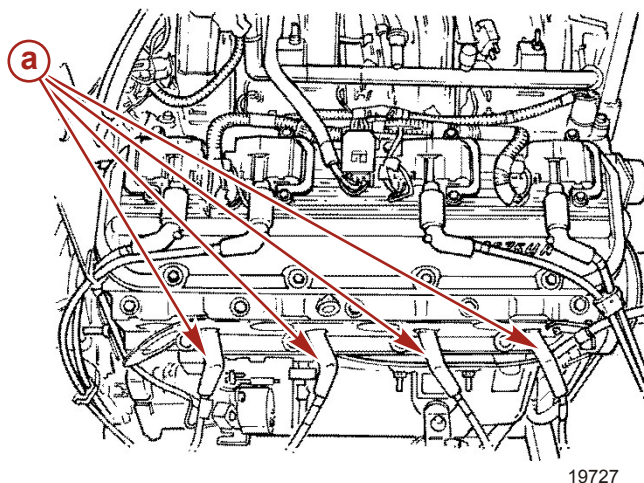
⚠ CAUTION

Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories:

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

Spark Plugs CHECKING

1. Disconnect the spark plug wires (high-tension leads) from the spark plugs.



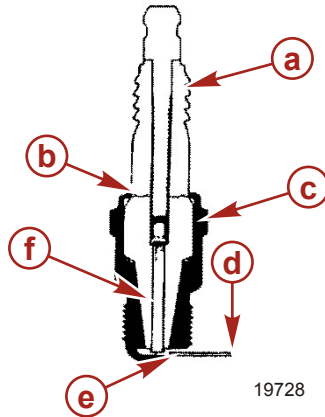
Exhaust manifold removed for visual clarity

a - Spark plug wires (high-tension leads)

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 to remove the wire from the spark plug.

2. Remove the spark plugs.
3. Ensure that all of the spark plugs are from the same manufacturer and have the same spark plug number.
4. Inspect each spark plug gap, adjust as necessary to maintain proper specifications.
5. Inspect each spark plug individually for badly worn electrodes and glazed, broken, or blistered porcelain. Note the cylinder location of any damaged spark plug for future reference.
6. If a damaged spark plug is found, replace all of the spark plugs in the engine.

NOTE: Cracks often occur at the base of the insulator.



a - Porcelain insulator
b - Insulator base
c - Shell

d - Proper gap
e - Side electrode
f - Center electrode

7. Clean the plug seating area on the cylinder heads and spark plugs.
8. Reinstall and torque the spark plugs that pass inspection. If any spark plug requires replacement, replace all of the spark plugs.

Description	Nm	lb. in.	lb. ft.
spark plugs	20		15

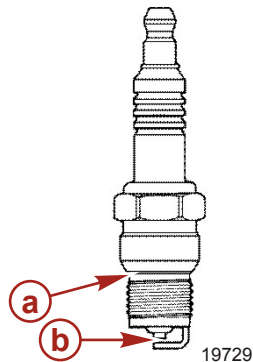
9. Connect the spark plug wires (high-tension leads) onto the spark plugs.

REPLACING

1. Clean the plug seating area on the cylinder heads and spark plugs.

IMPORTANT: When adjusting gap, do not bend the center electrode.

2. Adjust the spark plug gap with a round feeler gauge. Bend the side electrode to adjust the gap.



a - Seating area

b - Gap

IMPORTANT: Spark plugs should be torqued to the amount specified. If they cannot be torqued, the spark plugs should be hand tightened until the plug contacts the cylinder head. Then, using an appropriate wrench and socket, slightly rotate (approximately 1/8 or less of a full turn) to create a seal and secure the spark plug.

3. Install the spark plugs and torque to specifications.

Description	Nm	lb. in.	lb. ft.
New spark plug	30		22

4. Install the spark plug wires in the proper order.

Spark Plug Wires

CHECKING

1. Inspect the spark plug wires for damage, such as being cracked, cut, or oil soaked.
2. Inspect the spark plug boots for damage.
3. Check the spark plug wires for continuity using a multi-meter, digital/volt/ohm meter.

Spark plug wires (high tension lead)		
Maximum ohms per 25.4 mm (1 in.)		1000

DMT 2004 Digital Multimeter	91-892647A01
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Computer Diagnostic System (CDS)	Order through SPX
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4. Replace any spark plug wires that do not meet specifications.
5. if any damaged spark plug wires are found, replace all of the spark plug wires.

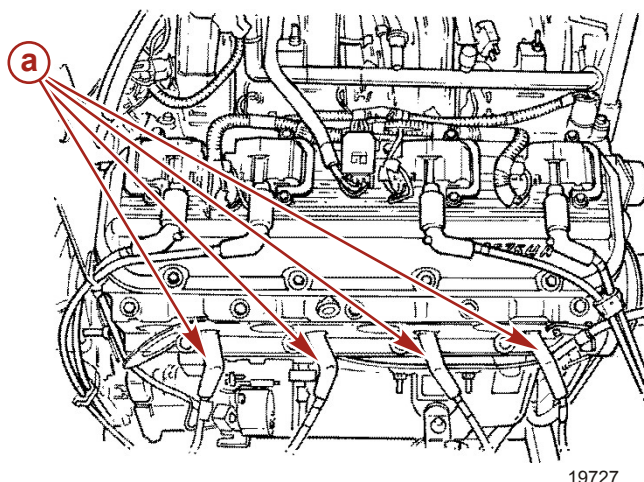
REPLACING

IMPORTANT: Only use spark plug wires recommended for marine application.

NOTE: Replace one spark plug wire at a time to reduce the risk of instillation error.

1. Disconnect individual spark plug wires.

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 to remove the spark plug wire from the spark plug.



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Exhaust manifold removed for visual clarity

a - Spark plug

2. Install the new spark plug wires in the proper order.

IMPORTANT: Spark plug wire routing must be kept intact during service and followed exactly when spark plug wires have been disconnected or when spark plug wire replacement is necessary. Failure to route the spark plug wires properly can lead to radio frequency interference, cross firing of the plugs, and shorting of leads to ground.

- a. Position the spark plug wires in the spark plug wire supports and retainers.

- b. Attach the spark plug wires to the appropriate spark plug and coil pack. Each end must fit securely.

Ignition Coil

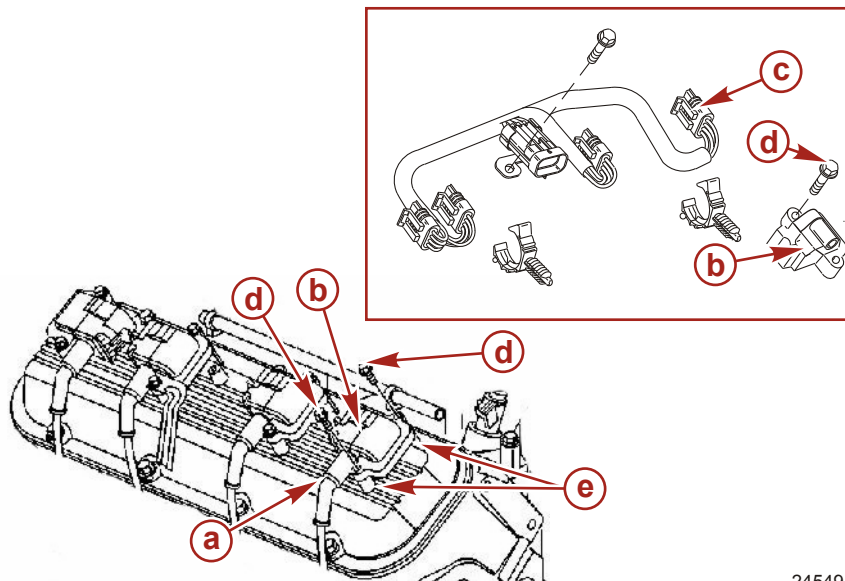
NOTE: For ignition coil troubleshooting refer to the appropriate *Mercury MerCruiser PCM Diagnostic Service Manual*.

REMOVAL

⚠ CAUTION

Always disconnect the battery cables from the battery before working around electrical system components to prevent injury and damage to the electrical system if a wire should accidentally cause a short circuit.

1. Disconnect both battery cables from the battery.
2. Remove the engine cover.
3. Disconnect the spark plug wires at the ignition coils.
4. Disconnect the ignition coil harness connector from the ignition coil.
5. Remove and retain the ignition coil mounting screws.
6. Remove the ignition coil.



- a** - Spark plug wire
b - Ignition coil
c - Ignition coil harness connector

- d** - Ignition coil mounting screw
e - Ignition coil mounting location

24549

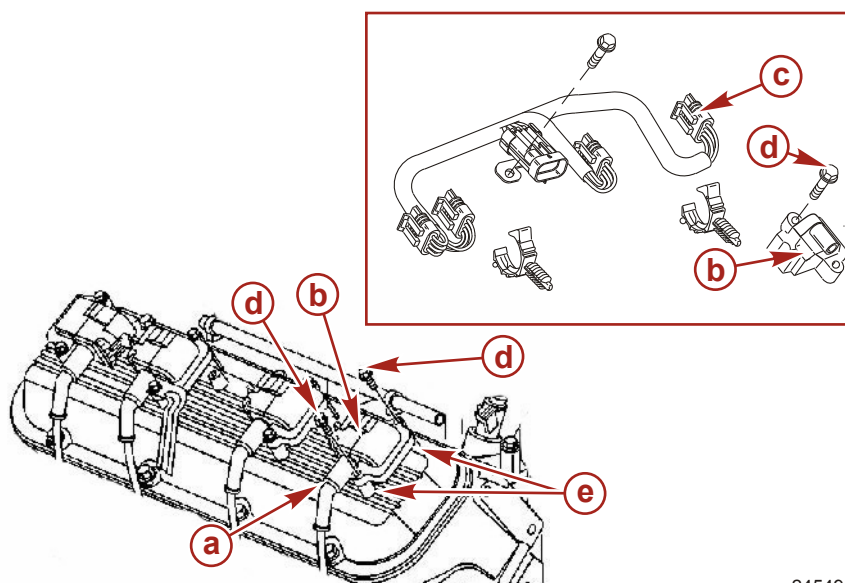
Installation

1. Position the ignition coil onto the ignition coil mounting location on the valve cover.
2. Install the ignition coil onto the valve cover, secure using the ignition coil screws. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Ignition coil screw	12	106	

3. Connect the ignition coil harness to the ignition coil.

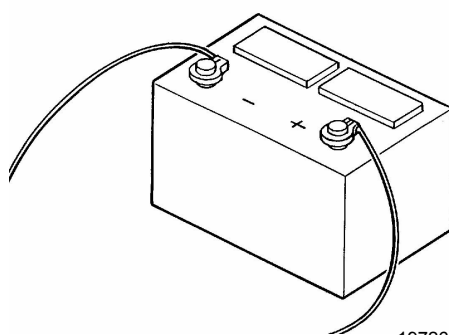
4. Connect the spark plug wires to the ignition coils.



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- | | |
|--|--|
| a - Spark plug wire | d - Ignition coil mounting screw |
| b - Ignition coil | e - Ignition coil mounting location |
| c - Ignition coil harness connector | |

5. Install the engine cover.
6. Connect the battery cables to the battery in the following order:
 - a. Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.
 - b. Connect the negative (-) battery cable to the negative (-) battery terminal and tighten the clamp.



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Typical

Notes:

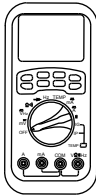
Electrical System

Section 4C - Charging System

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Checking.....	4C-5			
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Installation and Adjustment.....	4C-6			

Special Tools

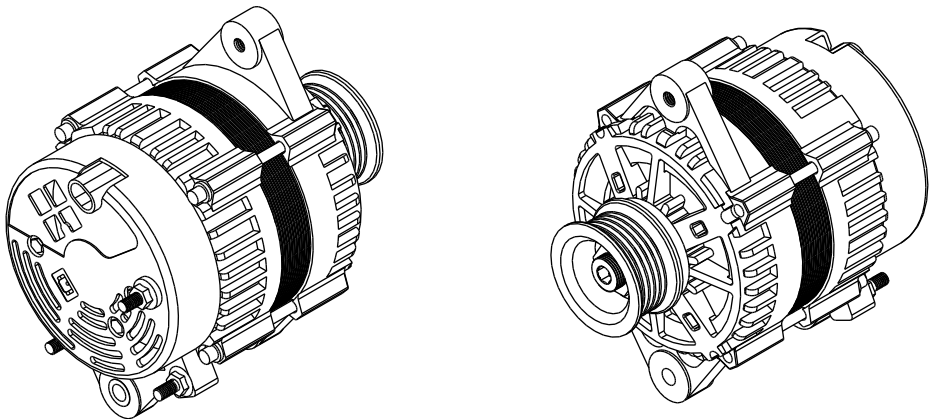
DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Finding Other Diagrams

NOTICE
Refer to the appropriate Mercury MerCruiser Diagram Binder for wiring diagrams or other diagrams not found in this manual.

Delco Alternator

Identification



23405

Delco 65-amp alternator

Replacement Parts Warning

⚠ WARNING
Electrical, ignition, and fuel system components on Mercury MerCruiser engines and sterndrives are designed and manufactured to comply with U.S. Coast Guard rules and regulations to minimize risks of fire or explosion. The use of replacement electrical, ignition, or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided. When servicing the electrical, ignition, and fuel systems, it is extremely important that all components be properly installed and tightened. Otherwise, any opening in the electrical or ignition system would permit sparks to ignite fuel vapors from leaks in the fuel system, if they existed.

Specifications

Description	Specification
Excitation Circuit	1.3 to 2.5 Volts
Current Output	65 Amp.
Voltage Output	13.9 to 14.7 Volts

NOTE: Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. See **Installation and Adjustment**.

Tools

Description	Part Number
Multi-Meter / DVA Tester	91-99750A1
Ammeter (0–100 Amp)	Obtain locally

Precautions

The following precautions must be observed when working on the charging system. Failure to observe these precautions may result in serious damage to the alternator or charging system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed in the **Troubleshooting Tests**.
3. Never disconnect the alternator output lead or battery cables when the alternator is operating.
4. Never disconnect the regulator lead from the alternator regulator terminal when the alternator is operating.
5. Always remove the negative (–) battery cable from the battery before working on the charging system.
6. When installing the battery, be sure to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to the negative (–) battery terminal.
7. If a charger or booster battery is to be used, be sure to connect it in parallel with the existing battery (positive to positive; negative to negative).

EFI Electrical System Precautions

 CAUTION
Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories: • Do not tap accessories into engine harness. • Do not puncture wires for testing (probing). • Do not reverse battery leads. • Do not splice wires into harness. • Do not attempt diagnostics without proper, approved service tools.

Charging System Components

The alternator system consists of the alternator, battery, the ignition switch, and the wiring that connects these components.

Periodic Maintenance

⚠ CAUTION

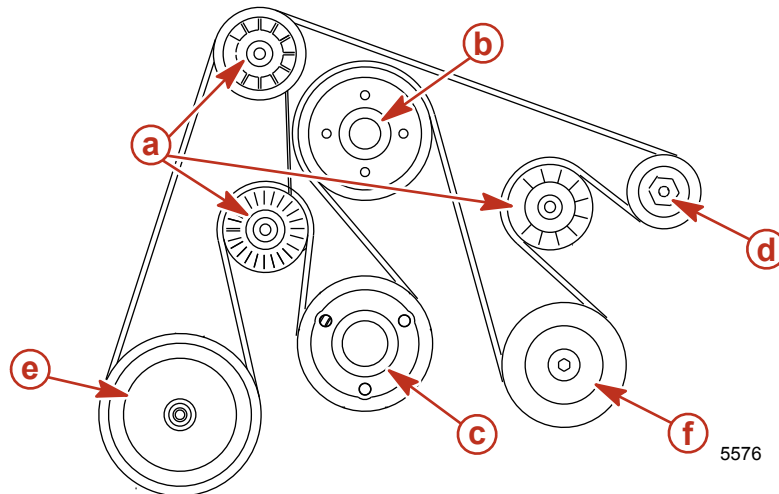
Avoid causing a short in the electrical system. Before conducting the following check, disconnect all battery cables from the battery.

1. Inspect the entire alternator system for corroded or loose connectors.
2. Check the wiring for frayed or worn insulation.
3. Check the alternator drive belt for excessive wear, cracks, fraying, and glazed surfaces.
4. Check the drive belt tension and adjust, if necessary, as explained under **Installation and Adjustment**.
5. Check the alternator mounting bolts for adequate tightness.
6. Inspect the alternator flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. The screen must be clean or the alternator may overheat.

Serpentine Drive Belt—Manual Tensioner

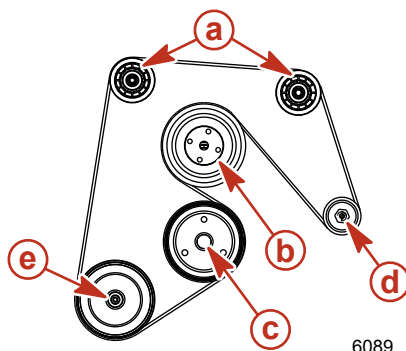
⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



Belt Routing Diagram—Sterndrive

- | | |
|------------------------------------|--|
| a - Idler pulley | d - Alternator pulley |
| b - Circulating pump pulley | e - Seawater pump pulley |
| c - Crankshaft pulley | f - Power assisted steering pump pulley |



Belt Routing Diagram—Inboard

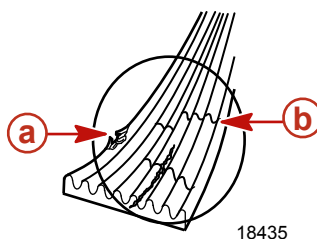
- | | |
|------------------------------------|---------------------------------|
| a - Idler pulley | d - Alternator pulley |
| b - Circulating pump pulley | e - Seawater pump pulley |
| c - Crankshaft pulley | |

Checking

Inspect the drive belt for the following:

- Excessive wear
- Fraying
- Glazed surfaces
- Proper tension (6 mm [1/4 in.] deflection with moderate thumb pressure on the belt at the location that has the longest distance between two pulleys)
- 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.



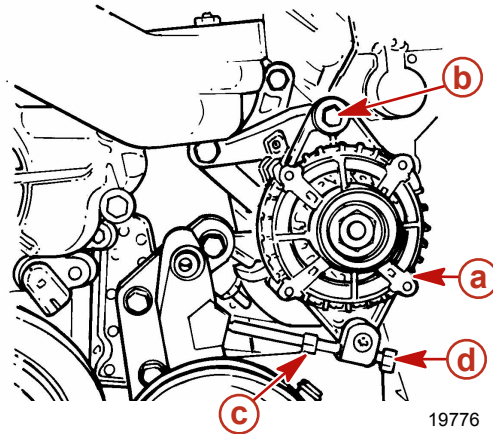
a - Fraying

b - Cracks

Removal

1. Loosen the alternator mounting bolt, and nut.
2. Loosen the tension bolt retainer nut.

3. Loosen the tension bolt.



- | | |
|---|-------------------------|
| a - Alternator | c - Retainer nut |
| b - Alternator mounting bolt (nut not shown) | d - Tension bolt |

4. Move the alternator to relieve tension on the drive belt.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

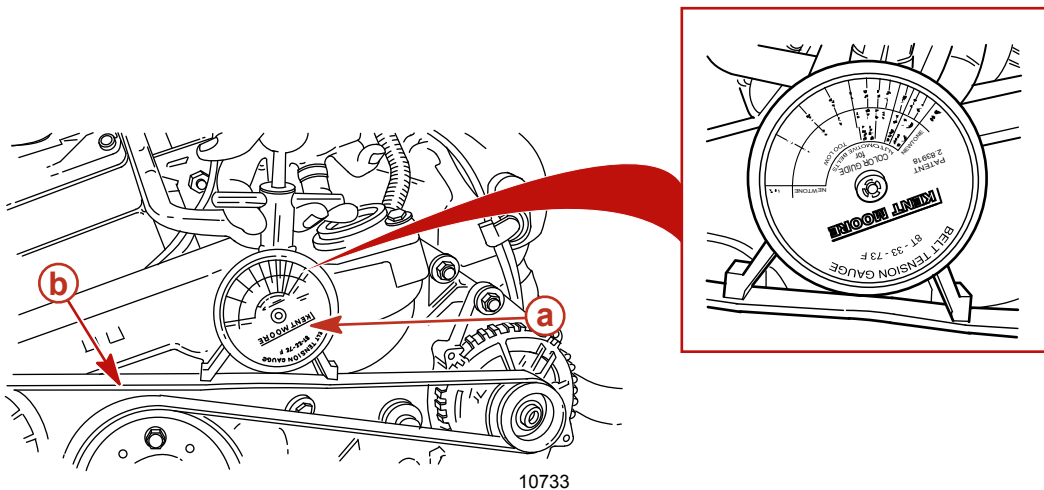
5. If the belt is to be reused, mark the direction of the rotation.
6. Remove the belt.

Installation and Adjustment

1. Install the drive belt onto the pulleys.
2. Position the tension bolt into the idler pulley bracket.
3. Tighten the tension bolt until the belt is taut.

NOTE: Measure belt deflection on the belt at the location that has the longest distance between the two pulleys.

4. Check the belt deflection between the upper idler pulley and the alternator pulley using one of the following methods.
 - a. Attach a Kent Moore Belt Tension Gauge to the drive belt. The gauge has different ranges for new and used belts.



- | | |
|-------------------------------------|----------------------------|
| a - Kent Moore Tension Gauge | b - Serpentine belt |
|-------------------------------------|----------------------------|

- b. If a belt tension gauge tool is not available, check the belt deflection by applying moderate downward pressure on the drive belt. Proper deflection is approximately 6 mm (1/4 in.).
5. Securely tighten the tension stud retainer nut.
6. Tighten the alternator attaching bolt and nut.
7. Supply cooling water to the engine.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

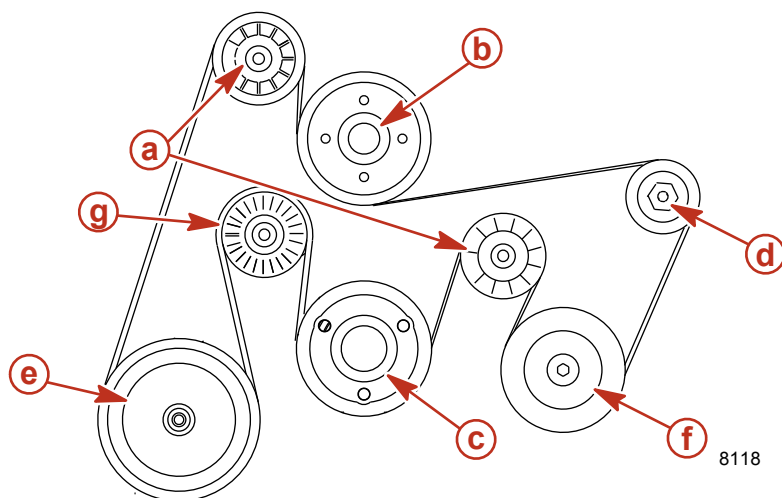
8. Operate the engine for a short period of time. Recheck the drive belt adjustment.

Serpentine Drive Belt—Automatic Tensioner

Serpentine Drive Belt—Sterndrive Models

⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



Belt Routing Diagram—Sterndrive

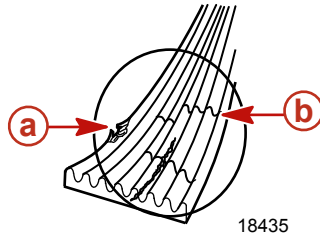
- | | |
|--|---------------------------------------|
| a - Idler pulley | e - Seawater pump pulley |
| b - Water circulating pump pulley | f - Power steering pump pulley |
| c - Crankshaft pulley | g - Tensioner pulley |
| d - Alternator pulley | |

CHECKING

Inspect the drive belt for the following:

- Excessive wear
- Fraying
- Glazed surfaces
- Proper tension (6 mm [1/4 in.] deflection with moderate thumb pressure on the belt at the location that has the longest distance between two pulleys)
- 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.



a - Fraying

b - Cracks

REMOVAL

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

The belt tensioner is designed to operate within the limits of arm movement provided by the cast stops when the belt length and geometry are correct.

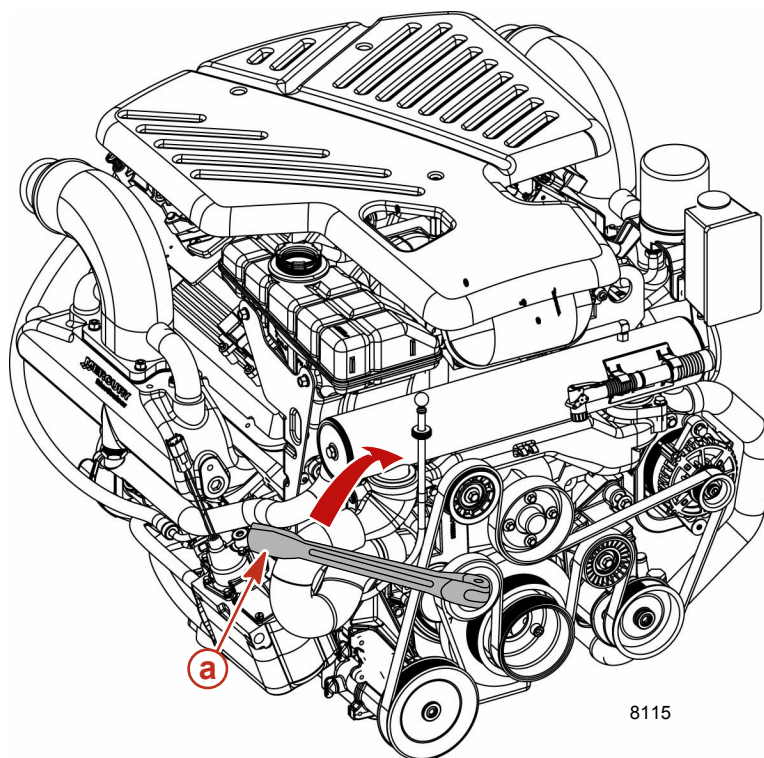
If the tensioner is contacting either of the limits during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the limits.

CAUTION

The belt tensioner assembly contains a high tension spring. Rapid release of the tensioner, or allowing the tensioner to snap back quickly, could injure the operator or cause product damage. Relieve the spring tension slowly to avoid injury or product damage.

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

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



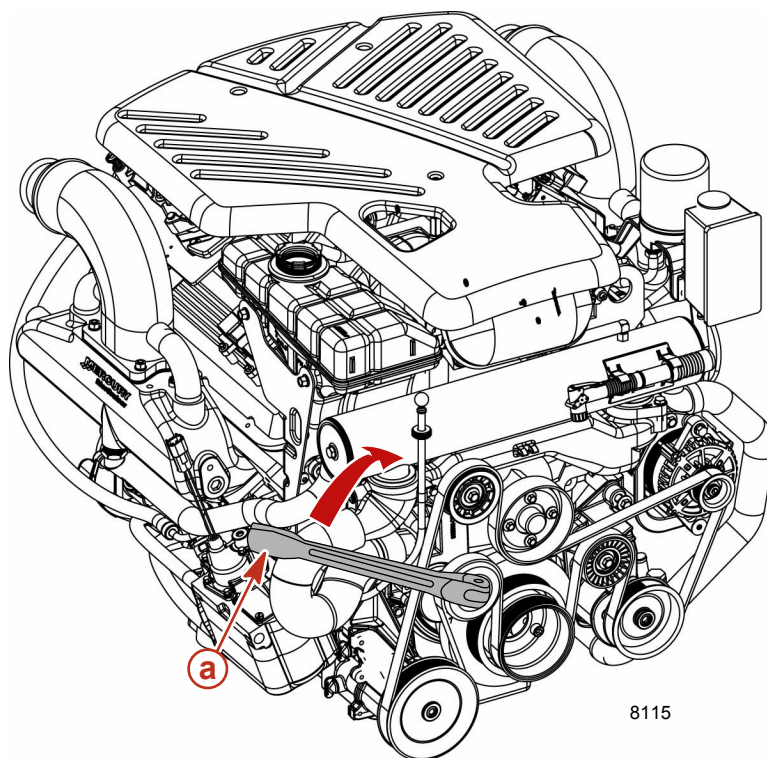
Breaker bar with arrow in direction of movement to relieve tension.

a - Breaker bar

INSTALLATION

1. Use a breaker bar and appropriate socket to position the tensioner back to the engine running location.

2. Install the the belt over the tensioner pulley. Slowly relieve the tensioner to the belt.



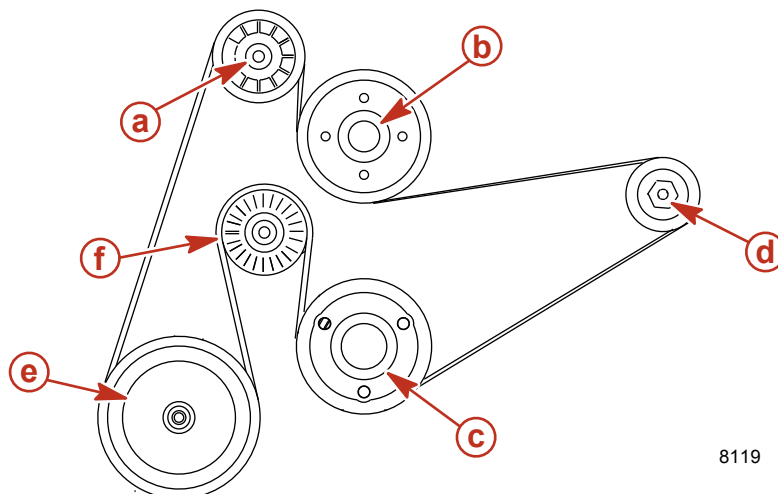
Breaker bar with arrow in the opposite direction of movement to reposition in tension.

a - Breaker bar

Serpentine Drive Belt—Inboard Models

⚠ WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.



a - Idler pulley

b - Water circulating pump pulley

c - Crankshaft pulley

d - Alternator pulley

e - Seawater pump pulley

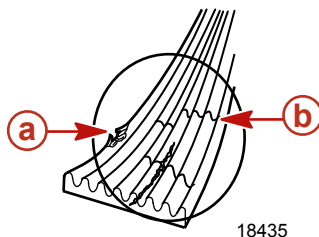
f - Tensioner pulley

CHECKING

Inspect the drive belt for the following:

- Excessive wear
- Fraying
- Glazed surfaces
- Proper tension (6 mm [1/4 in.] deflection with moderate thumb pressure on the belt at the location that has the longest distance between two pulleys)
- 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.



a - Fraying

b - Cracks

REMOVAL

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

The belt tensioner is designed to operate within the limits of arm movement provided by the cast stops when the belt length and geometry are correct.

If the tensioner is contacting either of the limits 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 limits.

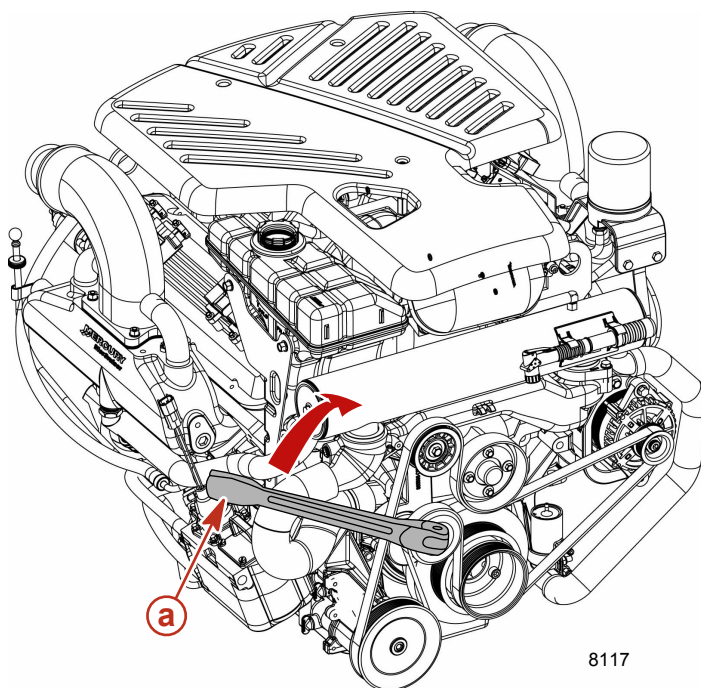
See your authorized MerCruiser dealer for service if these conditions exist.

CAUTION

The belt tensioner assembly contains a high tension spring. Rapid release of the tensioner, or allowing the tensioner to snap back quickly, could injure the operator or cause product damage. Relieve the spring tension slowly to avoid injury or product damage.

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

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

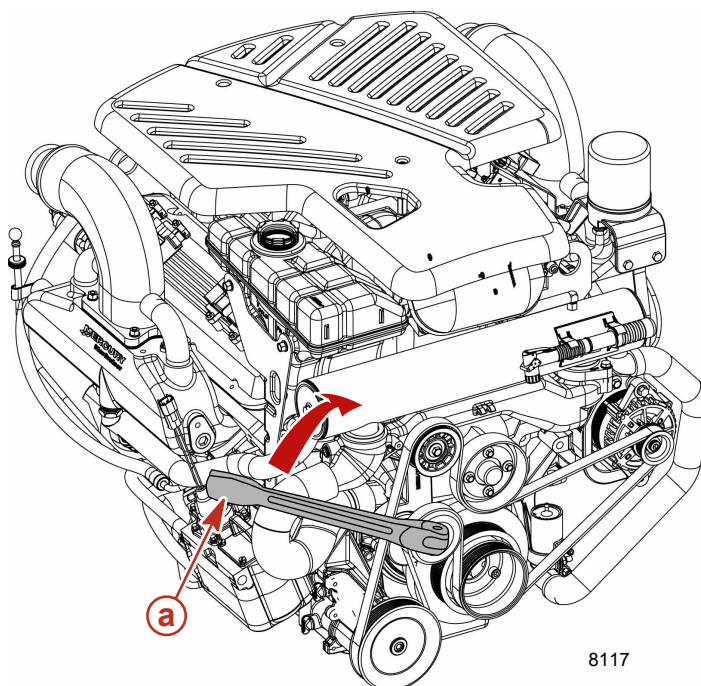


Breaker bar with arrow in direction of movement to relieve tension.

a - Breaker bar

INSTALLATION

1. Use a breaker bar and appropriate socket to position the tensioner back to the engine running location.
2. Install the belt over the tensioner pulley. Slowly relieve the tensioner to the belt.



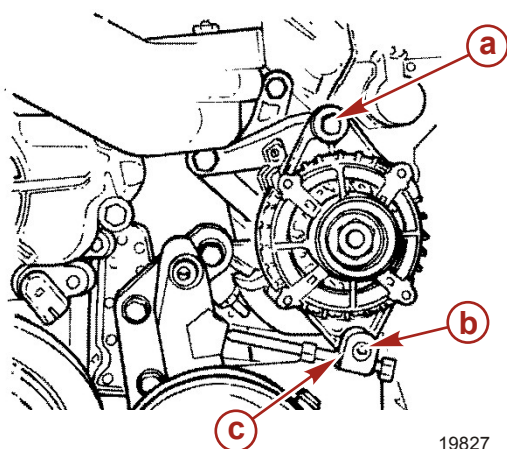
Breaker bar with arrow in the opposite direction of movement to reposition in tension.

a - Breaker bar

Alternator

Removal

1. Disconnect the negative (–) battery cable from the battery.
2. Disconnect the wiring harness from the alternator.
3. Remove the serpentine drive belt.
4. **For models equipped with a belt adjustment assembly:**
 - a. **If replacing the alternator**, remove the belt adjustment assembly.
 - b. Remove the alternator mounting bolt, and locknut.



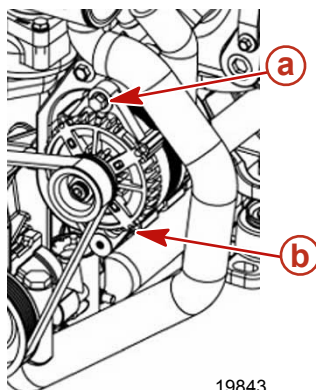
Typical

a - Alternator mounting bolt (locknut not shown)

c - Belt adjustment assembly

b - Belt adjustment assembly screw

5. **For models equipped with automatic belt tensioner**, remove the upper alternator mounting bolt, and locknut, and lower alternator mounting screw.



Typical

a - Upper alternator mounting bolt (locknut not shown)

b - Lower alternator mounting screw (not shown)

6. Remove the alternator.

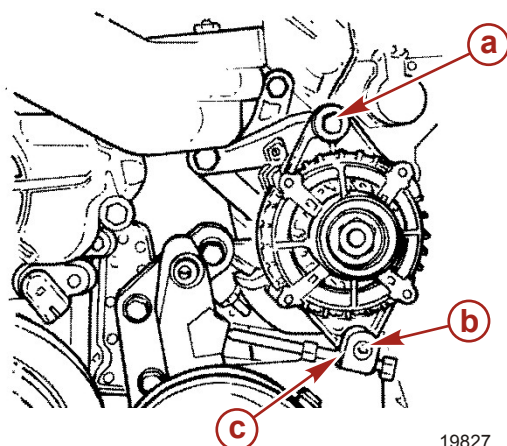
Installation

1. Position the alternator in the mounting bracket.
2. **For models equipped with a belt adjustment assembly:**

- a. Install the upper mounting bolt and locknut. Do not tighten at this time.
- b. **If the alternator was replaced**, install the belt adjustment assembly. Torque the screw.

Description	Nm	lb. in.	lb. ft.
Belt adjustment assembly screw	35		26

- c. Position the tension bolt into the idler pulley bracket



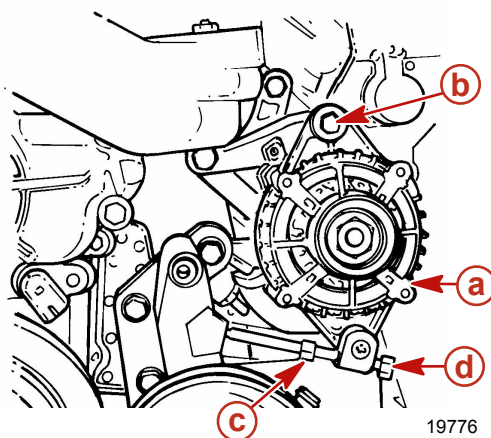
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- a** - Alternator mounting bolt and locknut (locknut not shown)
- b** - Belt adjustment assembly screw
- c** - Belt adjustment assembly

- d. Position the serpentine drive belt on the pulleys and adjust the tension.
- e. Torque the upper alternator bolt and locknut.

Description	Nm	lb. in.	lb. ft.
Alternator mounting bolt and locknut	25		19

- f. Adjust, and tighten the retainer nut.

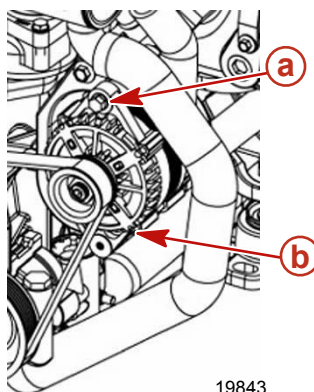


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- a** - Alternator
- b** - Alternator mounting bolt (locknut not shown)
- c** - Retainer nut
- d** - Tension bolt

3. For models equipped with automatic belt tensioner:

- a. Install the upper alternator mounting bolt, and locknut, and lower alternator mounting screw. Torque the alternator mounting bolt, and locknut, and lower alternator mounting screw.

**Typical**

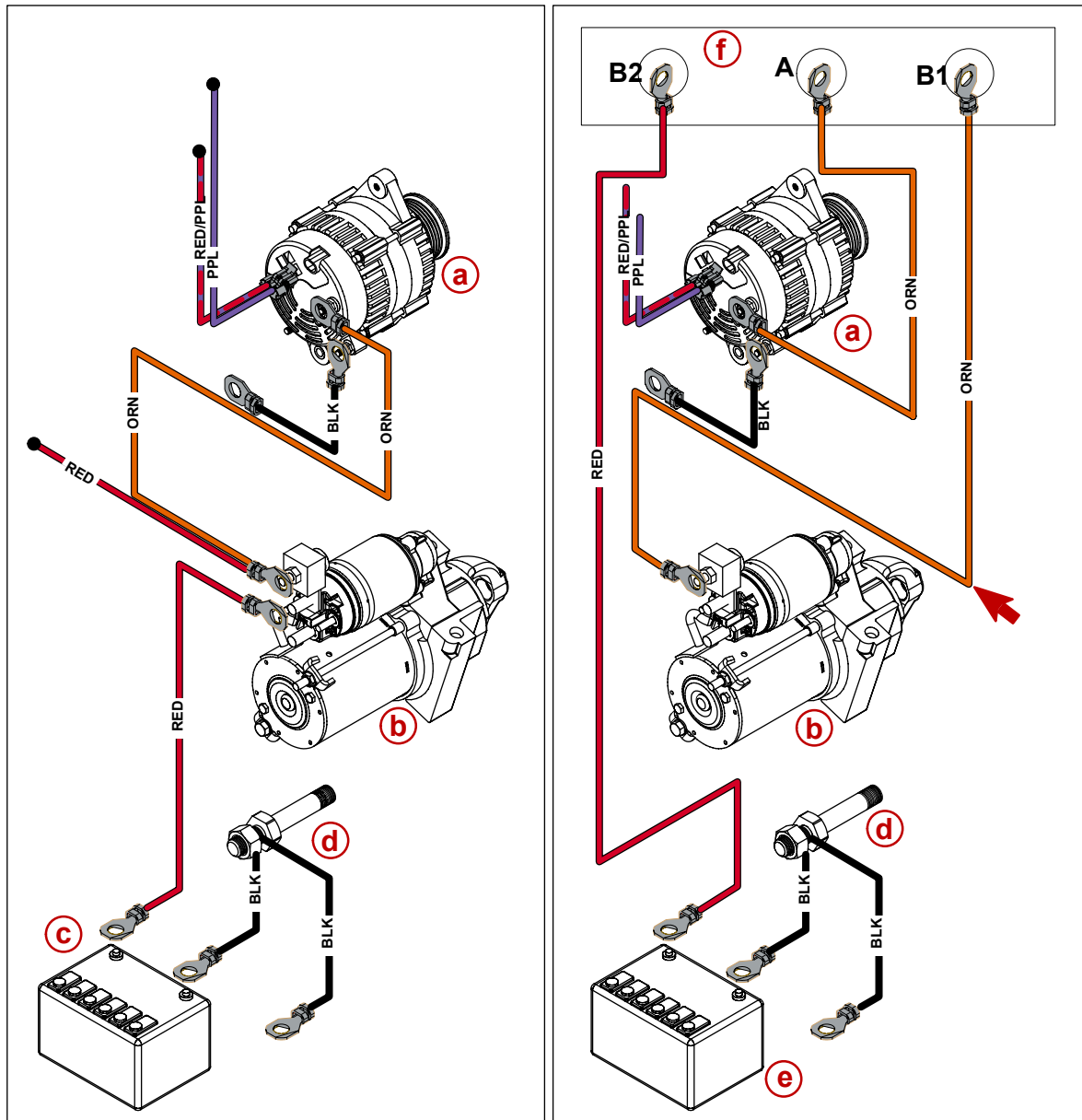
a - Upper alternator mounting bolt
(locknut not shown)

b - Lower alternator mounting screw
(not shown)

Description	Nm	lb. in.	lb. ft.
Upper alternator mounting bolt, and locknut	36		27
Lower alternator mounting screw	91		72

- b. Install the serpentine drive belt.
4. Reconnect the wiring harness to the alternator.
5. Connect the negative battery cable to the battery.

BATTERY ISOLATOR DIAGRAM



24376

a - Alternator
b - Starter
c - Cranking battery

d - Ground stud
e - Auxiliary battery
f - Isolator

1. Disconnect the orange wire from the alternator battery terminal. Splice sufficient gauge wire to the orange wire and connect as shown.
2. The splice wire must be a minimum of 8 AWG.

Troubleshooting Tests (Alternator on the Engine)

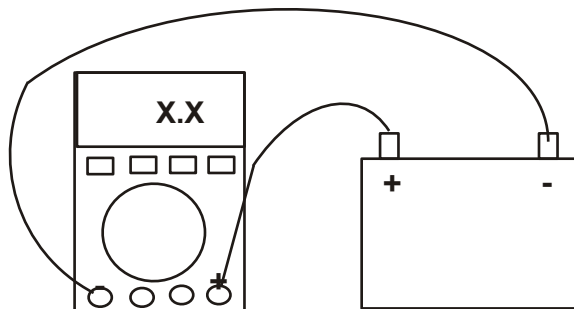
Use the following tests in conjunction with **Section 1—Troubleshooting**. Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe **Precautions**, preceding, to prevent damage to the alternator system.

1. An undercharged battery can be caused by excessive current draw from accessories or by operating the engine at low speeds for extended periods.

2. Check the physical condition and charge of the battery. The battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If the battery does not meet the minimum specifications, charge the battery before testing the charging system.
3. Inspect the entire charging system wiring for defects. Ensure that all connections are secure and clean.
4. Check the drive belt for excessive wear, cracks, fraying, and glazed surfaces. Replace if necessary.
5. Check the drive belt tension and adjust if necessary.

Charging System

1. With a fully charged battery, connect the voltmeter leads directly to the battery posts.



19780

DMT 2004 Digital Multimeter

91-892647A01

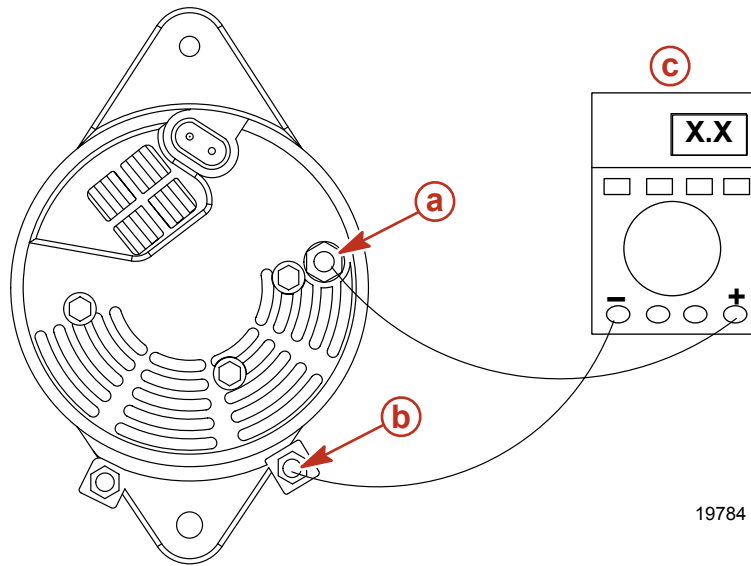
⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

2. Supply cooling water to the engine.
3. Start the engine and run at 1300–1500 RPM. Read the voltmeter in VDC position. Most systems will read 13.8–14.8 volts.

NOTE: If the voltage reading is within specifications, switch the voltmeter to the AC volt position. There should not be more than a 0.250 AC voltage reading with the engine running. A reading more than 0.250 AC volts indicate defective diodes in the alternator.

4. If the voltmeter reading at the battery posts is below 13.5 volts, connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the ground terminal on the alternator. Repeat step 4.



Typical

a - Output terminal
b - Ground terminal

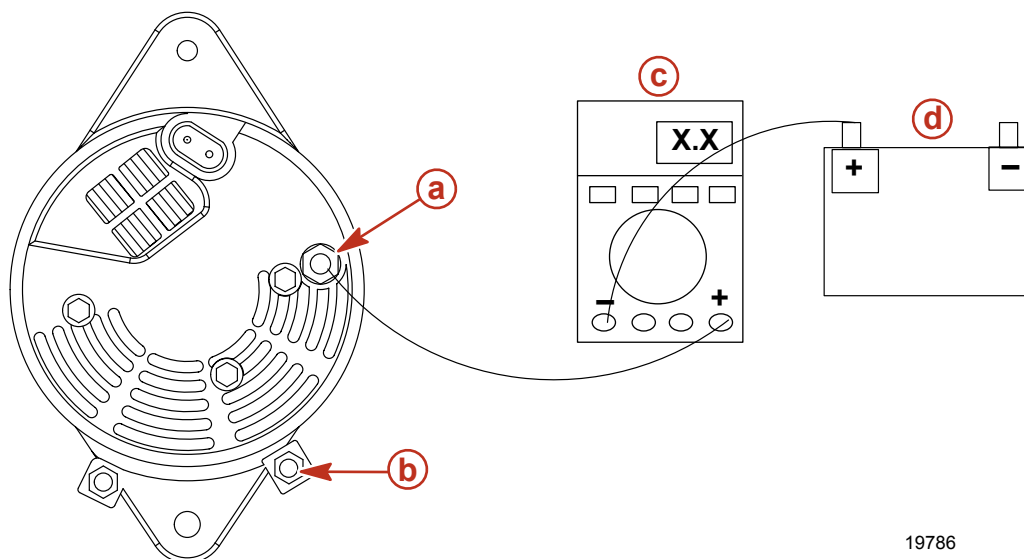
c - Voltmeter

5. If the voltmeter reading is now within specifications too much resistance exists between the alternator and the battery
6. If the reading is below 12.5 volts, the alternator may not be charging. Check all of the wiring leading to the alternator.

Charging System Resistance

1. Pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
2. Crank the engine over for 15 seconds to discharge the battery slightly.
3. Reset the the lanyard stop switch (if equipped), or enable the ignition circuit by installing the fuse marked "CD", and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal (ORANGE wire). Connect the voltmeter negative (–) lead to the battery positive (+) post.

NOTE: Connect the voltmeter leads to the battery post, not the battery cable end.



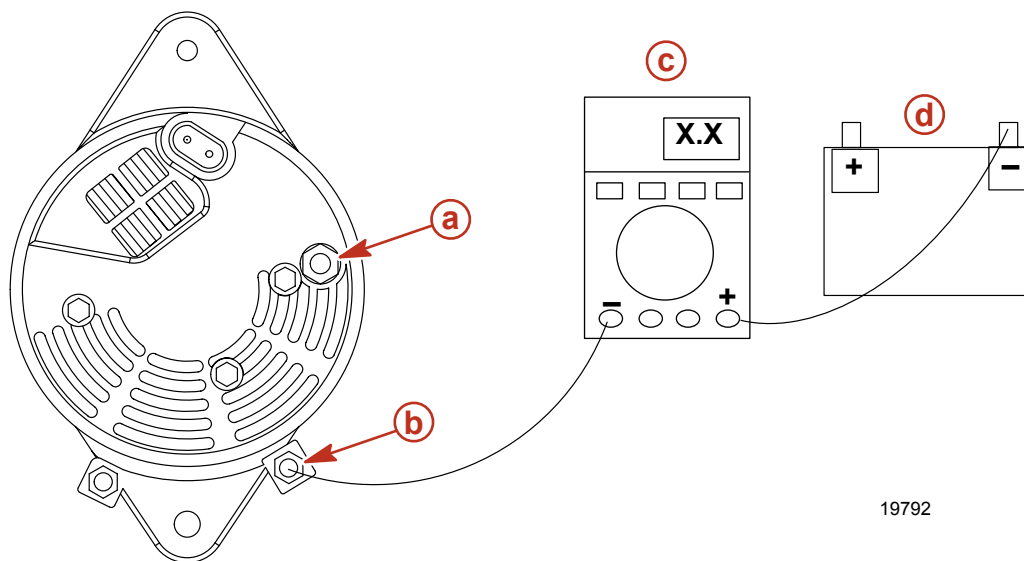
Typical

a - Output terminal
b - Ground terminal

c - Voltmeter
d - Battery

DMT 2004 Digital Multimeter	91-892647A01
-----------------------------	--------------

5. Start the engine and run at 1300–1500 RPM. Read the voltmeter. A reading of more than 0.5 volts shows excessive resistance in the wiring.
6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect the voltmeter positive (+) lead to the battery negative (–) post.



Typical

a - Output terminal
b - Ground terminal

c - Voltmeter
d - Battery

7. Repeat step 5.

Circuitry

Perform the following tests, using a 0–20 volt DC voltmeter, to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

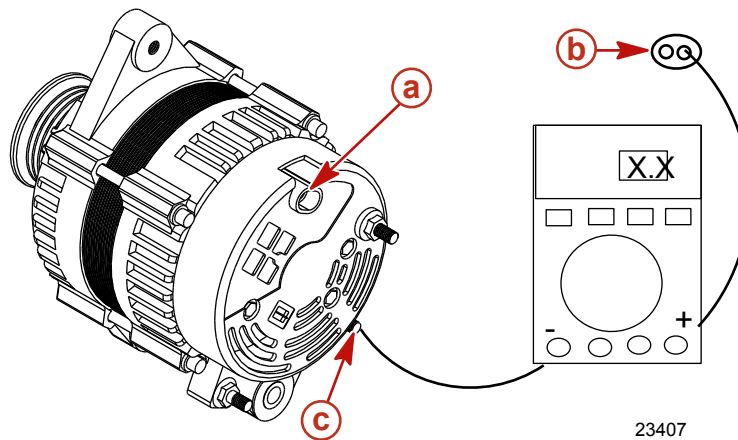
DMT 2004 Digital Multimeter	91-892647A01
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SENSING AND EXCITATION CIRCUITS

1. Unplug the PURPLE, and RED/PURPLE connector from the alternator.
2. Connect the positive (+) voltmeter lead to the RED/PURPLE lead and negative (–) voltmeter lead to the ground terminal.

DMT 2004 Digital Multimeter	91-892647A01
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3. The voltmeter should indicate battery voltage. If battery voltage is not present, check the sensing circuit (RED/PURPLE lead) for loose or dirty connection or damaged wiring.



Typical

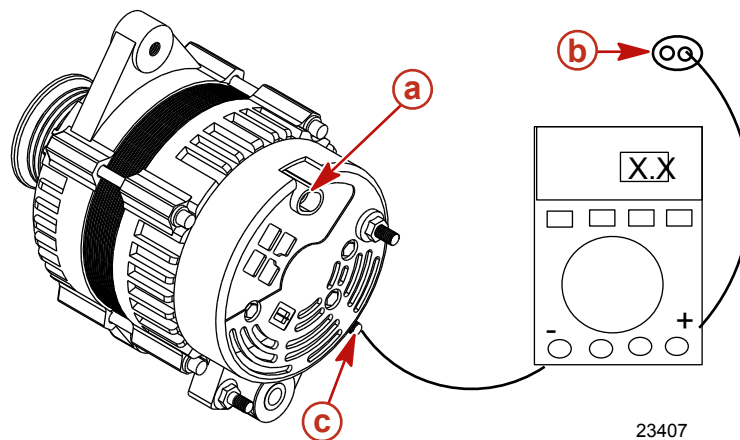
a - Connector location

b - RED and RED / PURPLE
connector

c - Ground

4. Connect the positive (+) voltmeter lead to the PURPLE lead and negative (–) voltmeter lead to the ground terminal.
5. Turn the ignition switch to the "ON" position.

6. The voltmeter should indicate battery voltage. If battery voltage is not present, check the excitation circuit (PURPLE lead) for loose or dirty connection or damaged wiring.



Typical

a - Connector location

b - PURPLE and RED / PURPLE
connector

c - Ground

Notes:

Fuel System

Section 5A - Fuel Delivery System—Gen II Cool Fuel System

Table of Contents

Specifications.....	5A-2	Removal.....	5A-7
Tools.....	5A-2	Installation.....	5A-7
Precautions.....	5A-2	Fuel Boost Pump.....	5A-7
Terminology.....	5A-3	Removal.....	5A-7
Fuel Delivery System.....	5A-4	Installation.....	5A-8
Recommendations.....	5A-4	Cool Fuel System Repair.....	5A-8
Cool Fuel System Exploded View.....	5A-5	Removal.....	5A-8
Fuel System Flow Diagrams.....	5A-6	Disassembly.....	5A-9
Multi-Port Injection.....	5A-6	Reassembly.....	5A-9
Water-Separating Fuel Filter.....	5A-7	Installation.....	5A-12

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	liquid soap	Fuel line O-rings	Obtain Locally
		Elbow fitting O-rings	
	Loctite 242 Threadlocker	Threads of mounting studs	92-809821

Specifications

Description	Specification
Pump Pressure	6 psi (41 kPa)

Tools

Description	Part Number
Fuel pressure gauge	Obtain locally
Fuel line at fuel rail remover	Obtain locally

Precautions

WARNING

Electrical, ignition, and fuel system components on Mercury MerCruiser engines and sterndrives are designed and manufactured to comply with U.S. Coast Guard rules and regulations to minimize risks of fire or explosion.

The use of replacement electrical, ignition, or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition, and fuel systems, it is extremely important that all components be properly installed and tightened. Otherwise, any opening in the electrical or ignition system would permit sparks to ignite fuel vapors from leaks in the fuel system, if they existed.

WARNING

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

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or overheating damage to engine may result.

⚠ WARNING

Serious injury or death can occur from a fire or explosion caused by a gasoline fuel leak. Improper installation of fuel system fittings or plugs into the fuel pump or the fuel filter base can crack the casting or result in improperly engaged threads that can cause a fuel leak. Follow all instructions and procedures regarding the installation of fuel system fittings and plugs to ensure proper installation and avoid fuel leaks.

IMPORTANT: The installation of additional filters may cause:

- Fuel vapor locking.
- Difficult warm-starting.
- Piston detonation due to lean fuel mixture.
- Poor driveability.

Terminology

Abbreviations

BARO	Barometric Pressure
BAT	Battery Positive Terminal, Battery or System Voltage
B+	Battery Positive
CKT	Circuit
CONN	Connector
CYL	Cylinder
DEG	Degrees
DIAG	Diagnostic
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DTS	Digital Throttle and Shift
DVOM	Digital Volt OhmMeter
PCM	Propulsion Control Module
ECT	Engine Coolant Temperature
EEPROM	Electronic Erasable Programmable Read Only Memory
EMI	ElectroMagnetic Interference
ENG	Engine
GND	Ground
GPH	Gallons Per Hour
IAC	Idle Air Control
IAT	Intake Air Temperature
in.hg	Inches of Mercuy
IC	Ignition Control
IGN	Ignition
INJ	Injection
kPa	kiloPascal
KS	Knock Sensor System
KV	Kilovolts
MAP	Manifold Absolute Pressure

MAT	Manifold Air Temperature
msec	Millisecond
N/C	Normally Closed
N/O	Normally Open
PROM	Programmable Read Only Memory
RAM	Random Access Memory
REF HI	Reference High
REF LO	Reference Low
ROM	Read Only Memory
SLV	Slave
TACH	Tachometer
TERM	Terminal
TPS	Throttle Position Sensor
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle

Fuel Delivery System

Recommendations

WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when constructing the engine compartment.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance that you received from the tank or boat manufacturer.

Consider the following, but not limited to the following, additional fuel connection related points, applying to all engines unless otherwise stated. Refer to **Boating Standards (NMMA, ABYC) and Coast Guard Regulations** for complete guidelines.

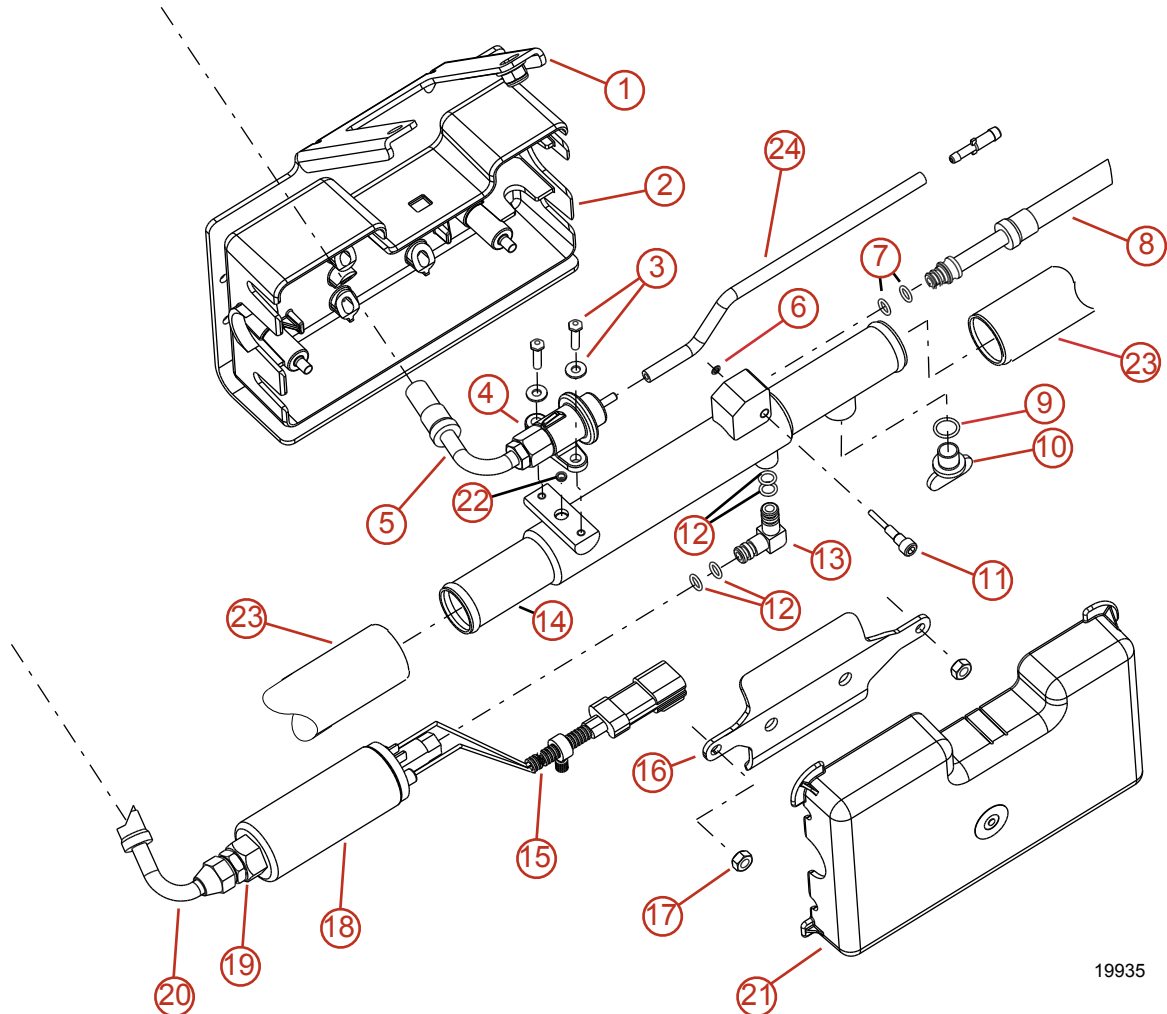
1. The fuel pickup should be at least 25 mm (1 in.) from the bottom of the fuel tank to prevent fuel supply restriction.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. The diameter of the fittings and lines must be 10 mm (3/8 in.) inner diameter, or larger.

IMPORTANT: Vacuum readings higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance due to fuel starvation.

4. The maximum measured vacuum at the engine's fuel inlet must not exceed 2 in. Hg (6.9 kPa) at Idle/650 RPM, 3000 RPM, and at wide open throttle (WOT).
5. On multi-engine gasoline installations, we recommend separate fuel pickup and supply lines for each engine. If a single pickup and line is used to supply fuel to multiple engines the line must not be smaller than 13 mm (1/2 in.) I.D.
6. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
7. Fuel lines should be installed free of stress and firmly secured to prevent vibration and chafing.
8. Sharp bends in fuel lines must be avoided.

9. A flexible fuel line must be used to connect the fuel supply line to the fuel inlet fitting on the engine to absorb deflection when the engine is operated.
10. All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

Cool Fuel System Exploded View

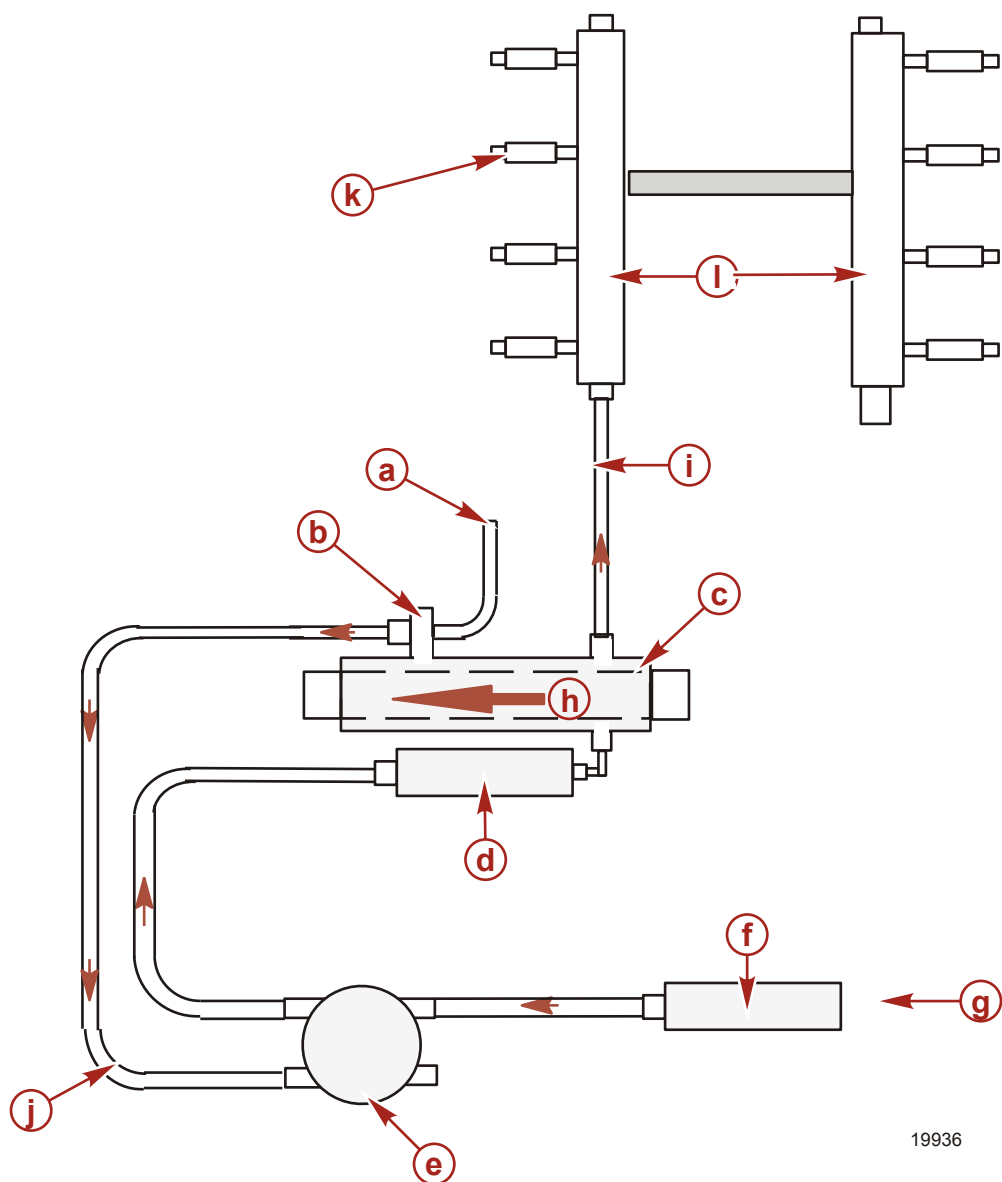


19935

- | | |
|------------------------------------|--|
| 1 - Bracket | 13 - Elbow |
| 2 - Cover base | 14 - Fuel cooler |
| 3 - Screw and washer (2) | 15 - Fuel pump wiring harness |
| 4 - Fuel pressure regulator | 16 - Retainer bracket |
| 5 - Return fuel line | 17 - Nut (2) |
| 6 - Retaining ring | 18 - Electric fuel pump |
| 7 - O-rings (2) | 19 - Inlet fitting |
| 8 - Fuel line to fuel rail | 20 - Fuel line inlet |
| 9 - Gasket | 21 - Cover |
| 10 - Drain plug | 22 - Filter |
| 11 - Stepped screw | 23 - Seawater hoses (hose clamps not shown) |
| 12 - O-rings (4) | 24 - Vacuum hose |

Fuel System Flow Diagrams

Multi-Port Injection

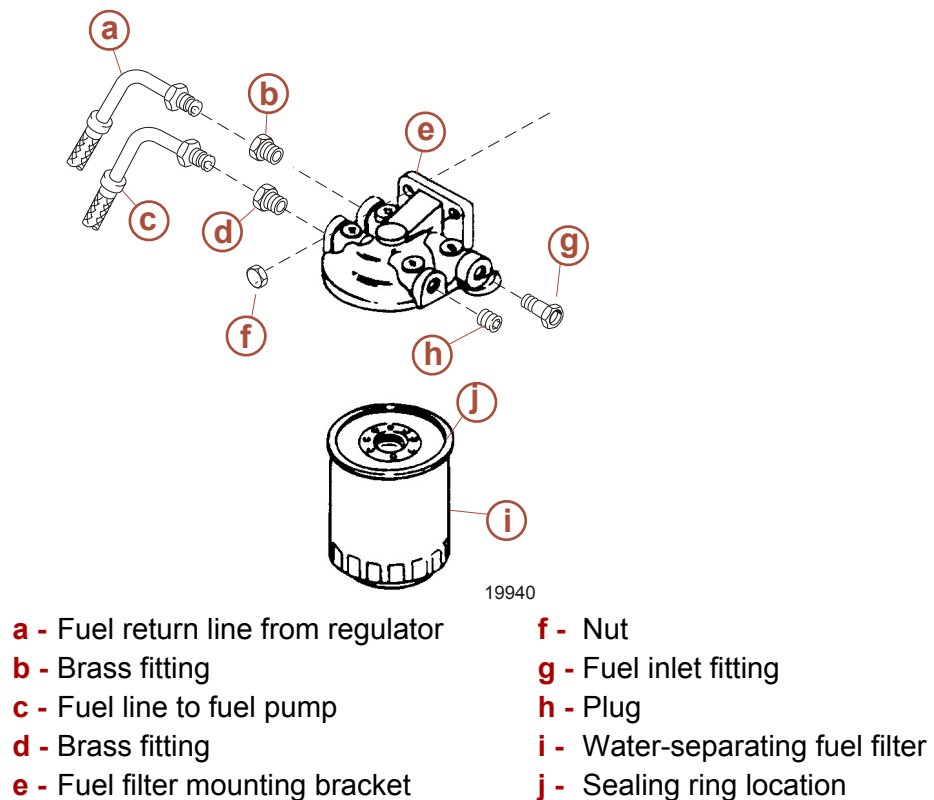


19936

- a** - Vacuum line to intake manifold base
- b** - Fuel pressure regulator
- c** - Fuel cooler
- d** - Electric fuel pump
- e** - Water separating fuel filter
- f** - Fuel boost pump

- g** - Fuel from tank
- h** - Direction of water flow
- i** - Fuel line to fuel rail
- j** - Excess fuel return to water-separating fuel filter
- k** - Fuel injectors (8)
- l** - Fuel rail

Water-Separating Fuel Filter



Removal

1. Remove the water-separating fuel filter and sealing ring from the mounting bracket.
2. Discard the filter and sealing ring.

Installation

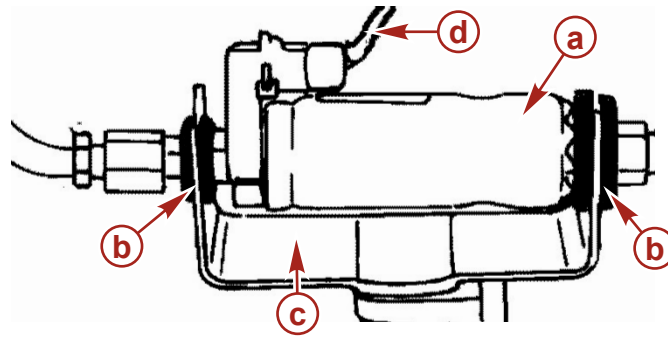
1. Coat the sealing ring on the new water-separating fuel filter with new engine oil.
2. Thread the water-separating fuel filter onto the bracket and tighten securely by hand. Do not use a filter wrench.
3. Start and operate the engine. Check the connections for gasoline leaks. If leaks exist, stop the engine immediately and recheck the filter installation.

Fuel Boost Pump

Removal

1. Disconnect the battery cables from the battery.
2. Remove the fuel tank inlet line at the fuel boost pump and plug the line.
3. Disconnect the electrical harness to the fuel boost pump.
4. Remove the fuel line connecting the fuel boost pump to the water-separating fuel filter base.

5. Press the fuel boost pump toward the engine to remove it from the bracket.



- 19945
- | | |
|----------------------------|-------------------------------|
| a - Fuel boost pump | c - Bracket |
| b - Rubber grommets | d - Electrical harness |

6. Remove the fuel line from the fuel boost pump.

Installation

1. Place the fuel boost pump in the bracket.
2. Attach the fuel line between the water-separating fuel filter and the fuel boost pump.
3. Connect the electrical harness to the fuel boost pump.
4. Attach the fuel tank inlet line.
5. Connect the battery cables to the battery.
6. Start and operate the engine. Check the connections for gasoline leaks. If leaks exist, stop the engine immediately and recheck the pump installation.

Cool Fuel System Repair

Removal

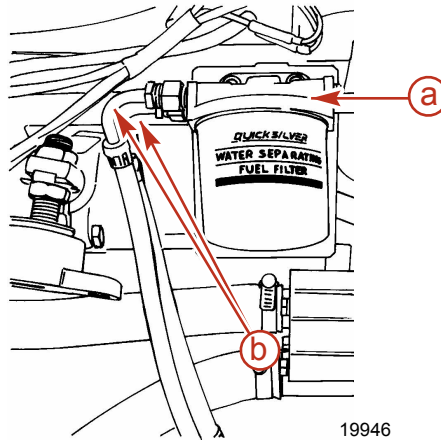
1. Disconnect the battery cables from the battery.
- IMPORTANT: Suitably plug the open ends of fuel line connections to prevent fuel leaks and entry of water or contaminants into the fuel lines while working.**
2. Close the fuel shutoff valve, if equipped, and remove the fuel tank inlet line from the fuel boost pump. If the boat is not equipped with a fuel tank shutoff valve, remove the fuel tank inlet line at the fuel boost pump and plug the fuel line.

⚠ CAUTION

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

3. Close the seacock, if equipped. If the boat is not equipped with a seacock, remove and plug the seawater inlet hose.
4. Drain the seawater system. See **Section 1B**.
5. Disconnect the seawater hoses from the fuel cooler.

6. Disconnect the fuel lines from the water-separating fuel filter adapter.



a - Water-separating fuel filter adapter

b - Fuel line

7. Remove the front cover.
8. Disconnect the fuel line from the fuel rail using the fuel line removal tool.

Description	Part Number
Fuel line to fuel rail removal tool	Obtain locally

9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose connected to the pressure regulator in the Cool Fuel system.
11. Remove the two upper engine mount bracket nuts securing the fuel cooler bracket to the engine.
12. Carefully remove the Cool Fuel system assembly.

Disassembly

NOTE: Retain all fasteners and hardware unless instructed otherwise.

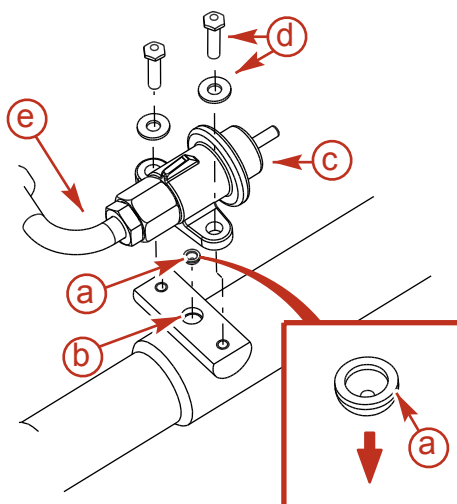
1. Remove and retain the fuel module front cover.
2. Remove the two nuts from the Cool Fuel retaining bracket studs. Lift the retainer bracket and cooler/pump assembly from the cover base.
3. Disconnect the fuel lines from the fuel cooler assembly.
4. Disconnect the elbow fitting and fuel pump from the cooler assembly.
5. Remove the elbow fitting from the fuel pump (to allow replacement of O-rings during assembly).
6. Remove the two screws retaining the fuel pressure regulator to the fuel cooler.
7. Remove the fuel pressure regulator and filter.
8. Remove and retain the seawater drain plug and seal from the fuel cooler.

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the fuel pressure regulator onto the fuel cooler using the two screws with washers. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Fuel pressure regulator screw	5.8	51	

3. Connect the fuel line to the fuel pressure regulator. Tighten securely.



19949

- a** - Filter
- b** - Fuel cooler orifice
- c** - Pressure regulator
- d** - Screw and washer
- e** - Fuel line

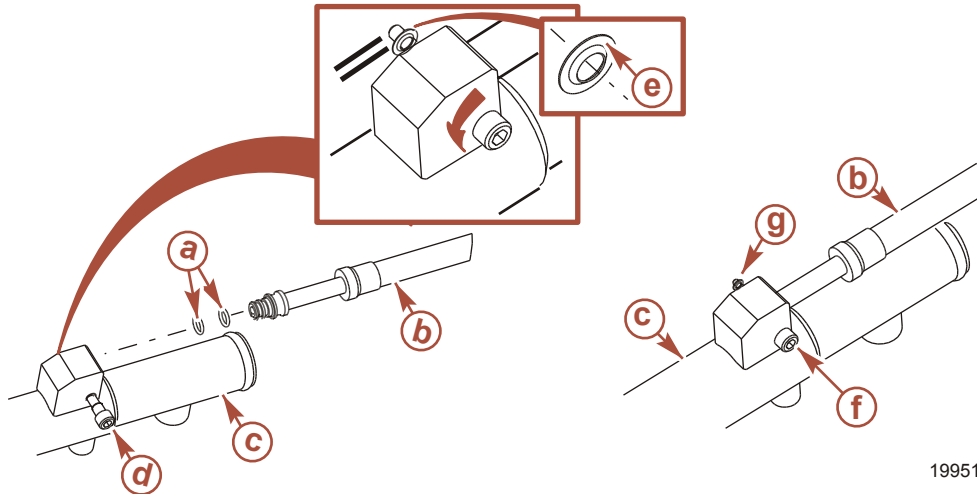
4. Install the fuel rail fuel line as follows:
 - a. Install two (of six) O-rings onto the cooler-to-fuel rail fuel line where it attaches to the cooler, if not already present.
 - b. Completely loosen, but do not remove, the stepped screw that retains the fuel line.
 - c. Lubricate the two fuel line O-rings with a small amount of liquid soap.

Tube Ref No.	Description	Where Used	Part No.
	liquid soap	Fuel line O-rings	Obtain Locally

- d. Insert the fuel line into the cooler orifice. Hand-tighten the stepped screw.
- e. Torque the stepped screw.

Description	Nm	lb. in.	lb. ft.
Screw	9	79	

IMPORTANT: To prevent the loss of the stepped screw used to secure the cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer or stepped screw.



19951

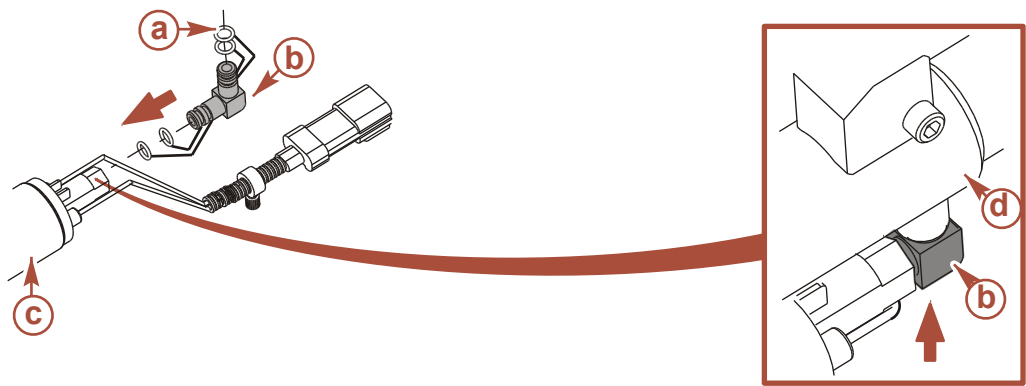
- a** - Fuel line O-rings
- b** - Fuel line, cooler-to-fuel rail
- c** - Fuel cooler
- d** - Stepped screw—loosened to accept fuel line
- e** - Retainer ring
- f** - Stepped screw—torqued
- g** - Retainer ring

5. Connect the fuel line to the fuel pump inlet. Tighten securely.
6. Install the fuel pump to the cooler as follows:
 - a. Install the remaining four (of six) O-rings on the fuel pump/cooler elbow fitting as shown.
 - b. Lubricate the O-rings for the elbow fitting with a small amount of liquid soap.

Tube Ref No.	Description	Where Used	Part No.
	liquid soap	Elbow fitting O-rings	Obtain Locally

- c. Install the elbow into the fuel pump.

d. Install the fuel pump with the elbow fitting into the fuel cooler assembly.



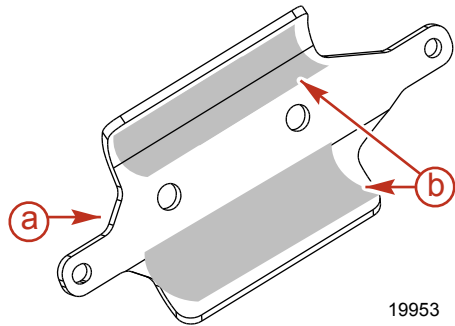
19952

- a** - O-rings (4)

b - Elbow fitting
- c** - Fuel pump

d - Fuel cooler

7. Position the completed fuel cooler assembly in the cover base.
8. Apply a thin, even coating of thermal grease on all of the inside surfaces of the retainer bracket where it contacts the cooler and the fuel pump when installed.



19953

- a** - Retainer bracket
- b** - Thermal grease

9. Install the retainer bracket over the cooler and fuel pump. Apply sealant to the threads of the mounting studs. Torque the two nuts.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Threads of mounting studs	92-809821

Description	Nm	lb. in.	lb. ft.
Nuts	5.6		50

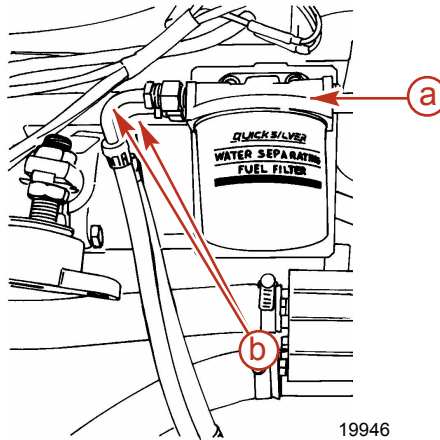
10. Install and securely tighten the seawater drain plug.

Installation

1. If removed, reinstall the fuel filter assembly mounting bracket, and secure using the two self-locking nuts. Tighten securely.
2. Route the fuel lines as needed and place the Cool Fuel assembly on the engine mount studs. Install and torque the two engine mounting nuts.

Description	Nm	lb. in.	lb. ft.
Engine mounting nuts	41		30

3. Connect the fuel lines to the fuel filter adapter. Tighten securely.



a - Filter adapter

b - Fuel lines

4. Install the cooler-to-fuel rail line as follows:
 - a. Route the fuel line to the back side of engine.
 - b. Connect the fuel line to the fuel rail fitting. Pull firmly on the fuel line to ensure proper connection.
5. Connect the vacuum line to the fuel pressure regulator at the Cool Fuel box.
6. Attach the engine harness electrical connector to the fuel pump harness connector.

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or overheating damage to engine may result.

7. Connect the seawater hoses to the Cool Fuel system. Tighten the hose clamps securely.
8. Unplug and connect the seawater inlet hose. Open the seacock, if equipped.
9. Unplug and connect the fuel tank supply inlet hose. Tighten the hose clamp securely. Open the fuel shutoff valve, if equipped.

⚠ CAUTION

When installing the battery, connect the positive (+) battery cable to the positive (+) battery terminal first, and the negative (–) battery cable to the negative (–) battery terminal last. Reversing battery cables or the connection order will damage the electrical system.

10. Clean the battery cable clamps and terminals and reconnect the cables.
11. Coat the terminals with a battery terminal anti-corrosion spray to help retard corrosion.
12. Start the engine and check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.

⚠ WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

13. Install the fuel module front cover.

Notes:

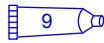
Fuel System

Section 5B - Fuel Delivery System—Gen III Cool Fuel System

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Installing the Fuel Line.....	5B-9	Gen III Cool Fuel Module Installation.....	5B-27

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Fuel line inlet connector to adapter.	92-809822

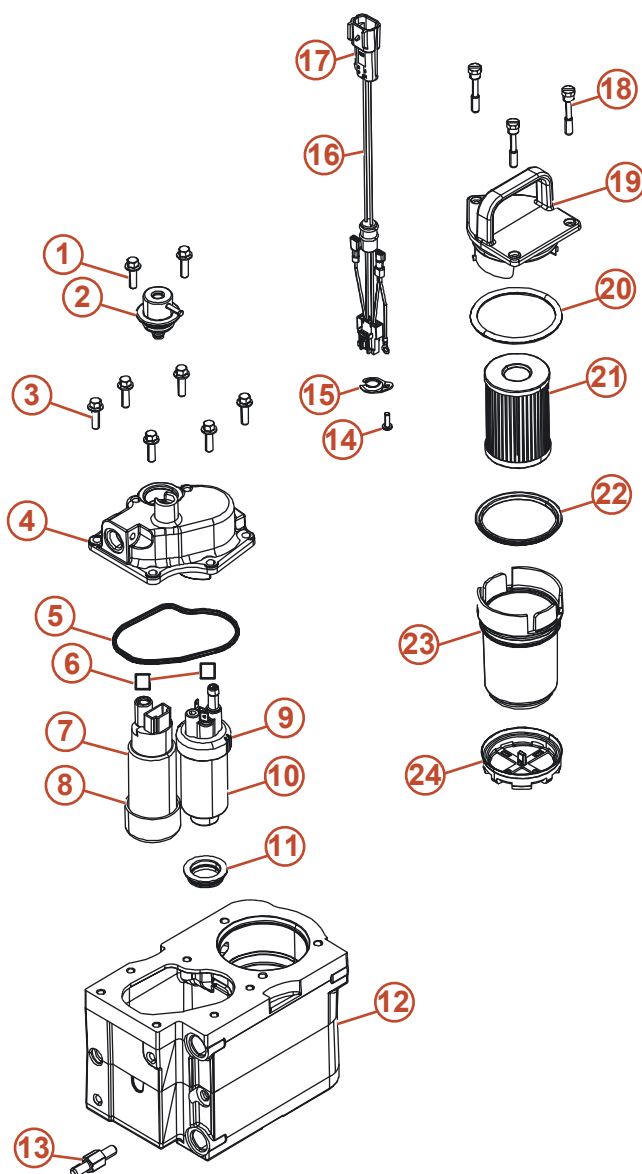
General Information

Introduction

This manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly, and installation to enable dealers and service mechanics to diagnose and repair the Generation III Cool Fuel Module.

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

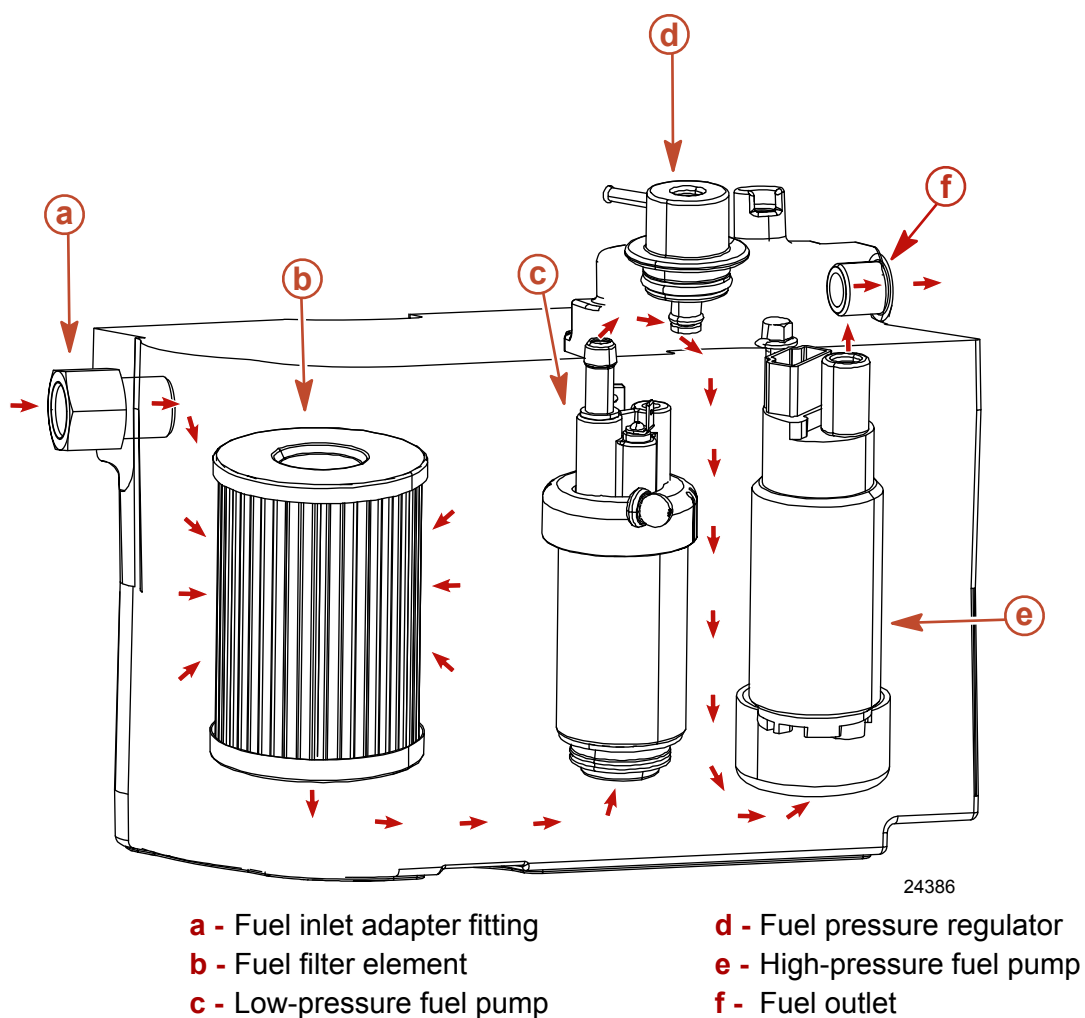
Gen III Cool Fuel Module Exploded View



8810

- | | |
|--|---|
| 1 - Pressure regulator screws | 13 - Stud |
| 2 - Pressure regulator | 14 - Screw, Wire harness retainer |
| 3 - Screws, Top cover | 15 - Wire harness retainer |
| 4 - Top cover | 16 - Wire harness |
| 5 - Seal, Top cover | 17 - 2-pin electrical connector (plug) |
| 6 - Fuel pump outlet seal | 18 - Screws, Filter cap |
| 7 - High-pressure fuel pump | 19 - Filter cap |
| 8 - Isolator, High-pressure fuel pump | 20 - O-ring |
| 9 - Isolator, Low-pressure fuel pump | 21 - Fuel filter |
| 10 - Low-pressure fuel pump | 22 - Seal, Filter cup |
| 11 - Inlet seal, Low-pressure fuel pump | 23 - Filter cup |
| 12 - Cool Fuel Module housing | 24 - Filter disc |

Gen III Cool Fuel Module Fuel Flow Diagram



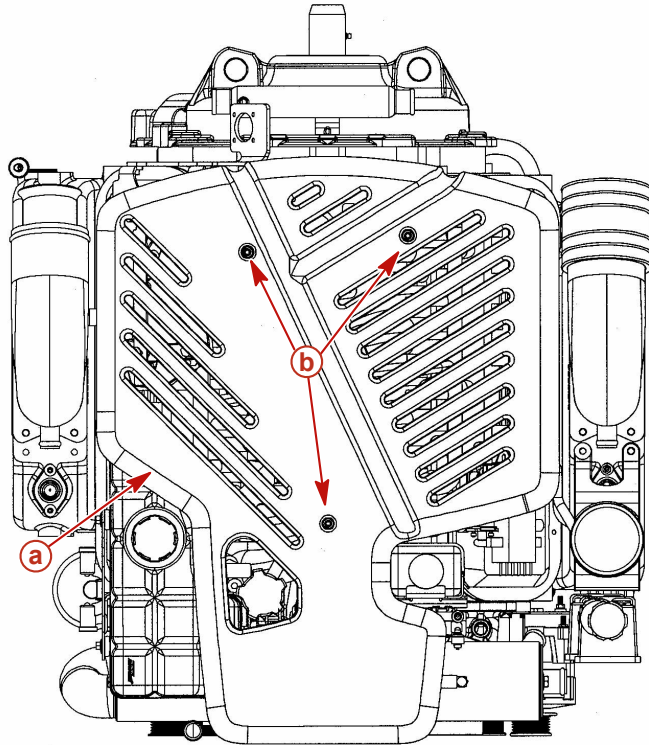
Gen III Cool Fuel—Fuel Line

Removing the Engine Cover

IMPORTANT: Allow the engine to cool for at least 12 hours before servicing the fuel system.

1. Remove and retain the three fasteners from the engine cover.

2. Remove and retain the engine cover.



19961

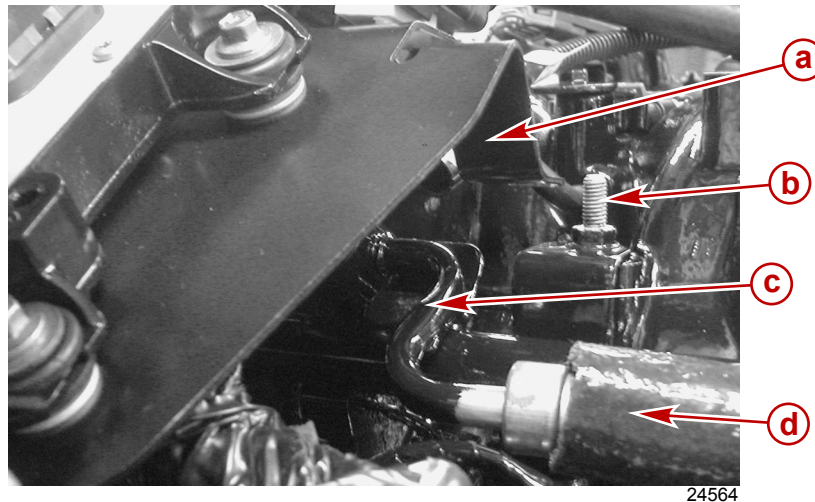
a - Engine cover

b - Fasteners

Loosening the PCM Bracket

1. Remove and retain the two nuts with integrated washers from the two outer tabs of the PCM mounting bracket.
2. Remove and retain the two nuts and two washers from the remaining two tabs on the PCM mounting bracket.
3. For engines with 14-pin harness connectors only:
 - a. Loosen, but do not remove, the nut connecting the wiring bracket attached to the PCM mounting bracket.
 - b. Remove the 14-pin connector bracket from the stud.

4. Reposition the PCM bracket to allow access to the fuel line connection to the fuel rail.



a - Inner tab of PCM mounting bracket
b - Stud

c - Fuel line
d - Heat-resistant sleeve (pulled back for visual clarity)

Removing the Fuel Line

⚠ WARNING

Environmental Hazard. Use a suitable container to collect fuel. Clean up any spills immediately and dispose of fuel in a safe manner in accordance with all local, federal, and international regulations.

⚠ WARNING

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

⚠ CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

IMPORTANT: Allow the engine to cool for at least 12 hours before removing the fuel line.

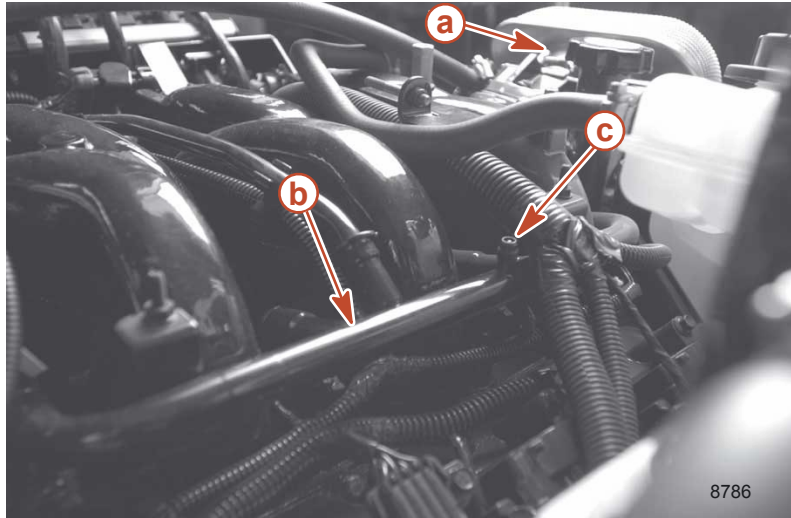
1. Disconnect the negative (-) battery cable from the battery (usually black).
2. Disconnect the positive (+) battery cable from the battery (usually red).

NOTE: Place a rag or other suitable material under fuel line fittings and connections to catch any fuel drips.

3. Relieve fuel system pressure as follows:
 - a. Connect a fuel pressure gauge kit to the Schrader valve.

Fuel pressure gauge kit

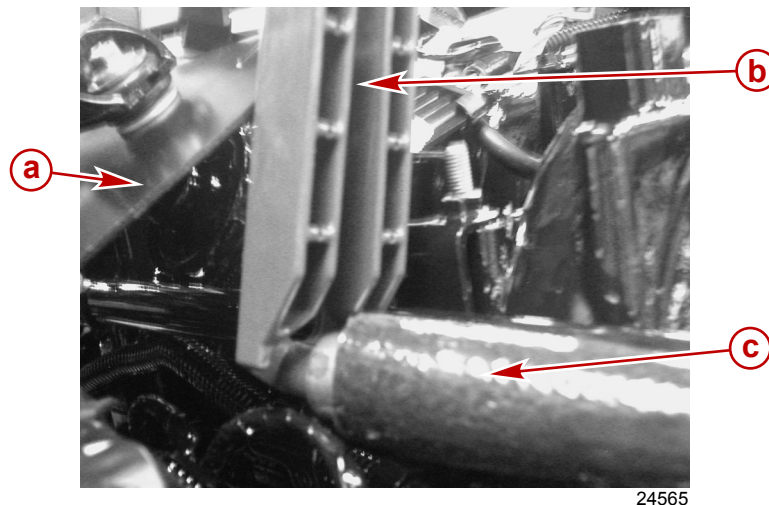
91-881883A2



View from starboard side of engine looking forward

a - Throttle body and flame arrestor **c** - Schrader valve
b - Fuel rail

- b. Place the fuel pressure gauge relief line into a suitable container.
- c. Open the fuel pressure gauge relief valve to relieve pressure.
4. Disconnect the fuel line from the fuel rail fitting:
 - a. Using a 3/8-inch fuel line disconnect tool, disconnect the fuel line from the fuel rail.

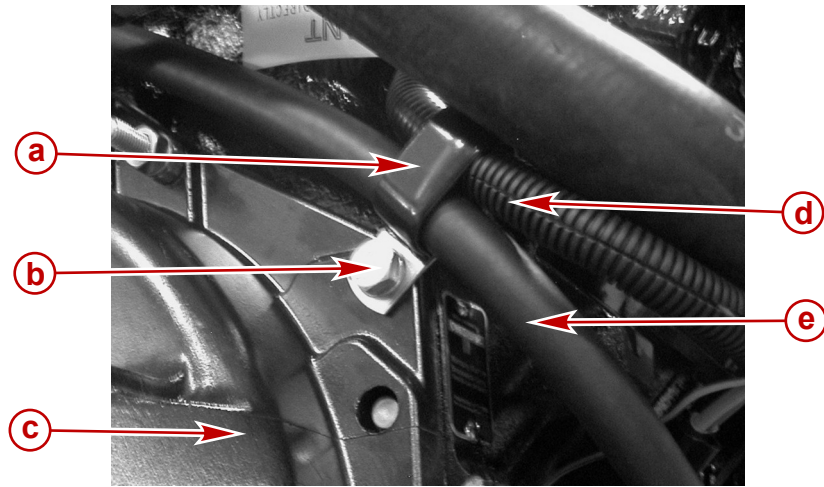


a - PCM mounting bracket **c** - Fuel line
b - Fuel line disconnect tool
 (Kent-Moore 3/8" tool shown)

Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 (313) 774-9500	
Description	Part Number
3/8" Fuel Line Disconnect Tool	J-41769-1

- b. Drain any fuel remaining in the fuel line into a suitable container.

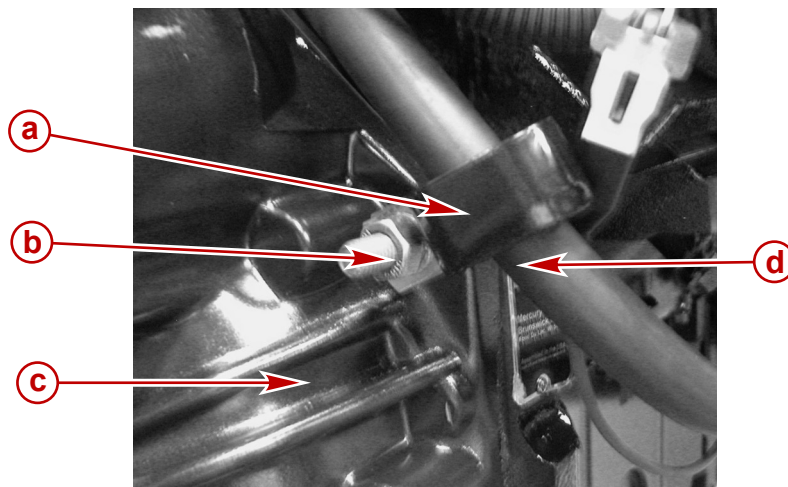
5. On sterndrive models, locate the double tube clamp, if equipped, securing the starter harness and fuel line to the flywheel housing.
6. Remove and retain the double tube clamp screw from the flywheel housing.
7. Remove the double tube clamp from the starter harness and fuel line. Retain the double tube clamp.



a - Double tube clamp
b - Screw
c - Flywheel housing

d - Starter harness
e - Fuel line

8. On inboard models, locate the double tube clamp, if equipped, securing the fuel line to the upper starboard side of the flywheel housing.
9. Remove and retain the washer and nut securing the fuel line to the upper starboard side of the flywheel housing ground stud.
10. Remove the double tube clamp from the fuel line. Retain the double tube clamp.

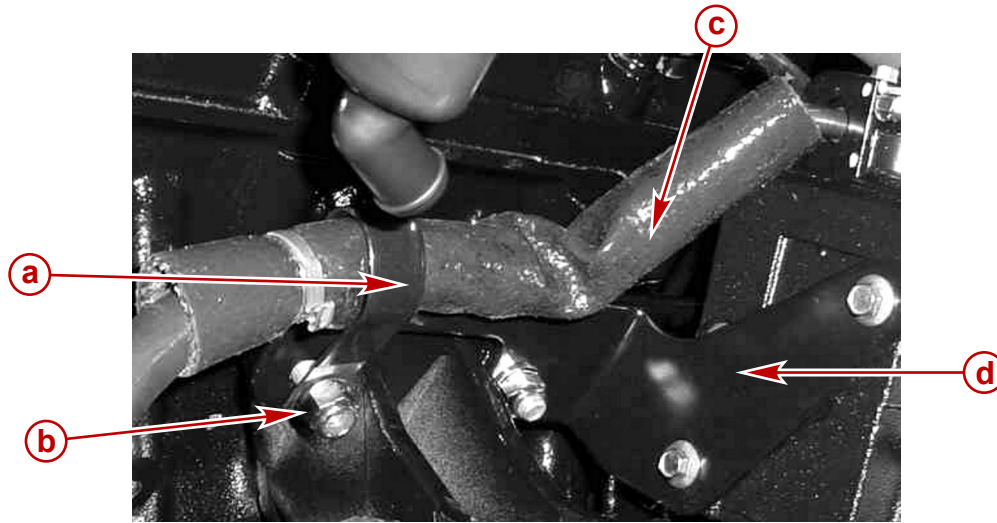


a - Double tube clamp
b - Nut

c - Flywheel housing
d - Fuel line

11. If equipped, remove the J-clip from the Cool Fuel Module mounting bracket stud.
 - a. Remove and retain the nut.

- b. Slide the curved end of the J-clip over the top of fuel line and heat-resistant sleeve. Retain the J-clip.

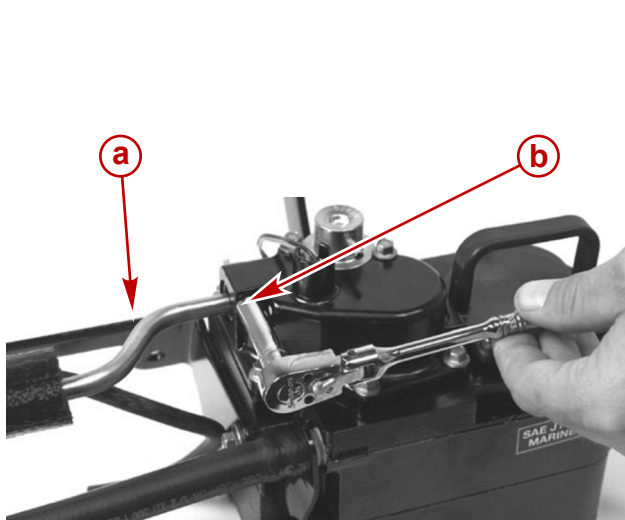


a - J-clip
b - Nut

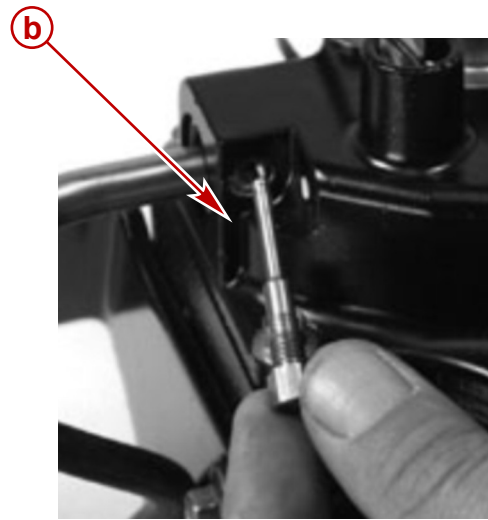
c - Fuel line
d - Bracket

12. Disconnect the fuel line from the Gen III Cool Fuel Module:

- a. Remove the fuel line retainer screw. The fuel line retainer screw may differ from the fuel line retainer screw pictured.



a - Fuel line (heat-resistant sleeve pulled back for clarity)



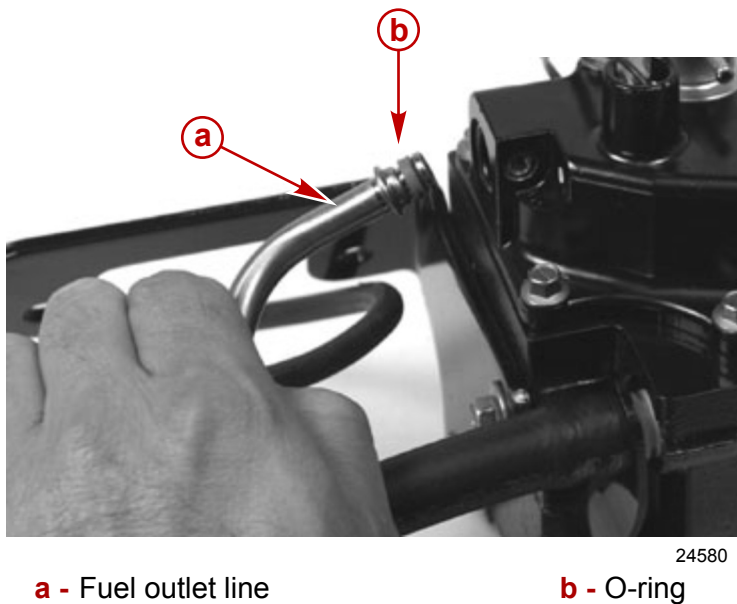
b - Typical fuel line retainer screw

- b. Carefully pull the fuel line straight out from the module and plug the line.

Installing the Fuel Line

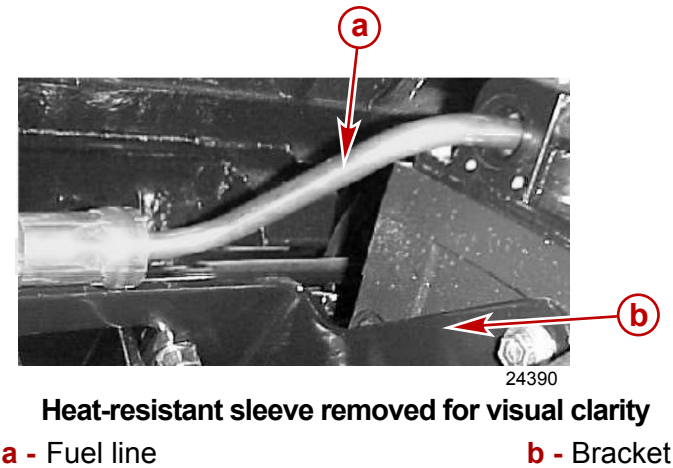
1. Inspect the fuel line O-ring. Replace if damaged.
2. Apply a thin layer of oil to the O-ring.

3. Install the O-ring on the fuel line connector as shown.

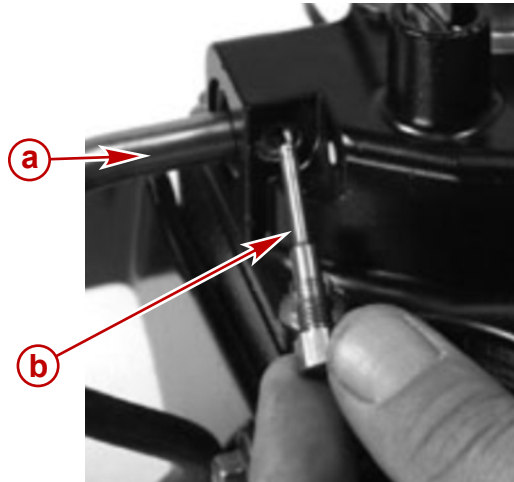


Description	Where used	Part No.
Mercury/Quicksilver Synthetic Blend, NMMA FC-W rated, 4-cycle oil	Fuel line O-ring	92-883724K01

4. Carefully insert the fuel line into the Gen III Cool Fuel Module.
5. Rotate the fuel line toward the engine block as shown in the following photograph.



6. Install the fuel line retainer screw. Torque to specification. The fuel line retainer screw may differ from the screw pictured.



24692

a - Fuel line

b - Typical fuel line retainer screw

Description	Nm	lb. in.	lb. ft.
Fuel line retainer screw	9	80	

IMPORTANT: The fuel line has a heat-resistant sleeve pre-installed. Do not remove the sleeve from the fuel line; ensure that the sleeve covers the fuel line to within 6 mm (1/4 in.) of the connection.

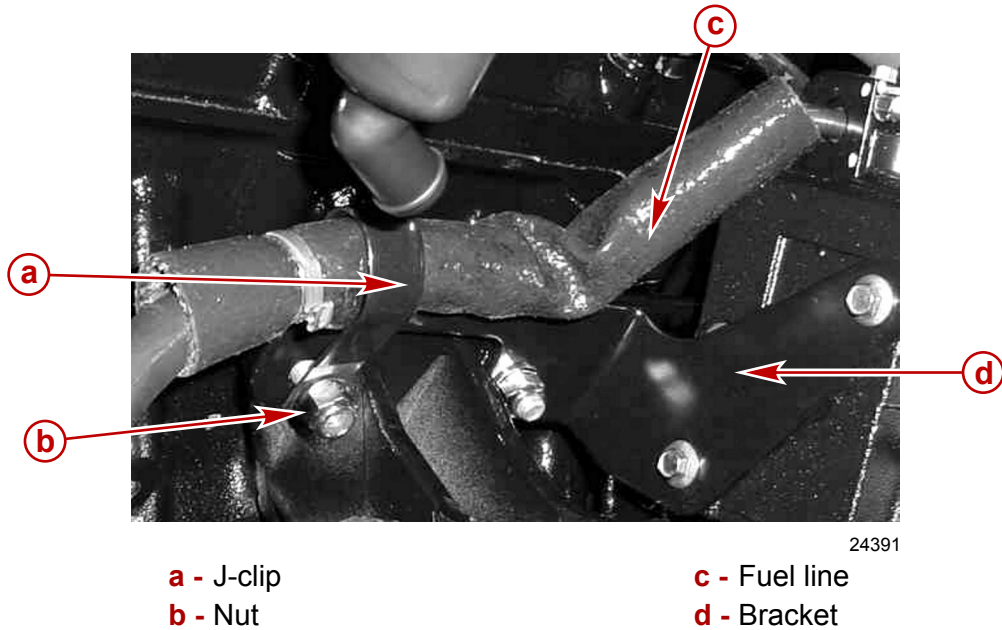
7. Pull the heat-resistant sleeve over the fuel line to within 6 mm (1/4 in.) of the Gen III Cool Fuel Module.

Installing the J-clip

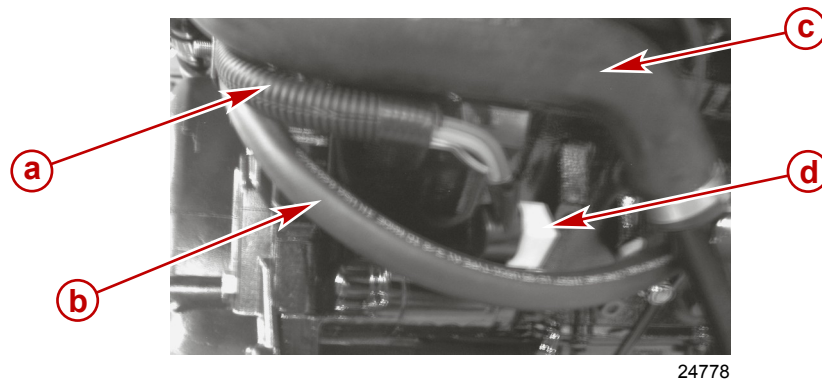
1. Install the J-clip onto the Cool Fuel Module mounting bracket stud, and secure the J-clip with the nut. Torque the nut.

Description	Nm	lb. in.	lb. ft.
J-clip Nut	48		36

2. Slide the curved end of the J-clip over the top of fuel line and heat-resistant sleeve as shown. The open end of the clip faces the engine block.



3. Route the fuel line behind the cooling hoses and under the electrical harness. Ensure that the fuel line is not restricted, pinched, or in contact with any sharp or rough surfaces.



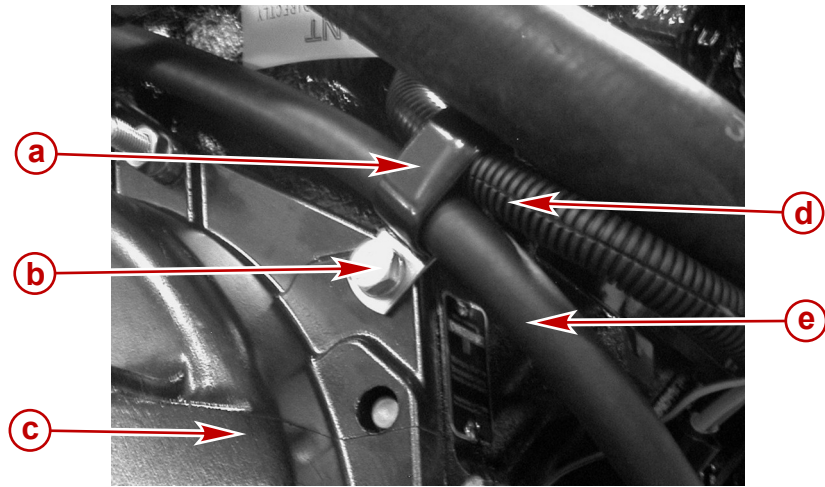
Fuel line routing

Installing the Double Tube Clamp

STERNDRIIVE MODELS

1. Ensure that the fuel line is not restricted, pinched, or in contact with any sharp or rough surfaces.
2. Install the double tube clamp over both the fuel line and starter harness. Orient the flat edge of the clamp toward the flywheel housing.

3. Install the double tube clamp screw. Torque the screw.



24603

a - Double tube clamp
b - Screw
c - Flywheel housing

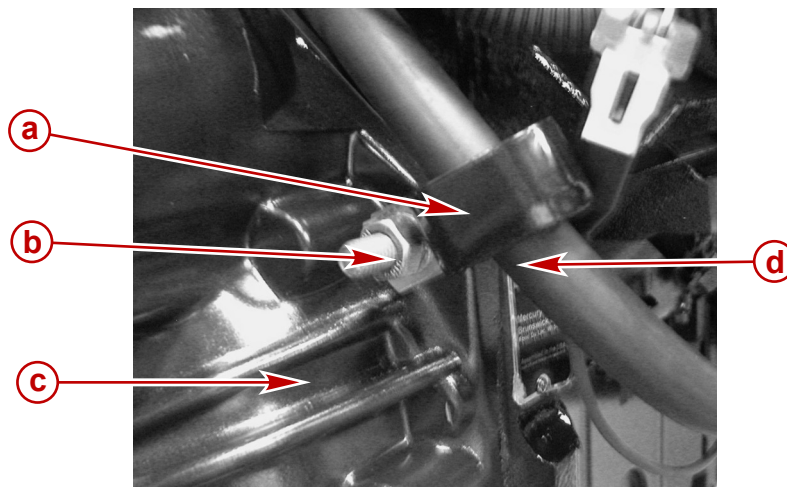
d - Starter harness
e - Fuel line

Description	Nm	lb. in.	lb. ft.
Double tube clamp screw	38		28

INBOARD MODELS

1. Ensure that the fuel line is not restricted, pinched, or in contact with any sharp or rough surfaces.
2. Install the double tube clamp over the fuel line. Orient the flat edge of the clamp toward the flywheel housing.
3. Install the washer and nut. Torque the nut.

Description	Nm	lb. in.	lb. ft.
Double tube clamp nut	38		28



24605

a - Double tube clamp
b - Nut

c - Flywheel housing
d - Fuel line

Connecting the Fuel Line to the Fuel Rail

1. Route the fuel line under the electrical harnessing. Avoid any restrictions, compressions, or contact with sharp edges.
2. Insert the fuel line to the fuel rail fitting. Listen for a snap.
3. Test that the fuel line is properly seated by tugging firmly on the line.
4. Pull the heat resistant sleeve until the fuel line to within 6 mm (1/4 in.) of the fuel rail fitting.
5. Install the PCM bracket and, if applicable, the 14-pin connector bracket.
6. Install the engine cover.
7. Connect the positive (+) battery cable to the battery (usually red).
8. Connect the negative (-) battery cable to the battery (usually black).

WARNING

Check for any fuel leaks and repair them before closing the engine hatch.

9. Ventilate the engine compartment.
10. Start the engine and test for fuel leaks. If leaks exist, stop the engine immediately. Wipe up any leaked fuel. Find and repair any fuel leaks before restarting the engine.

Removal and Disassembly

Gen III Cool Fuel Module Removal

WARNING

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

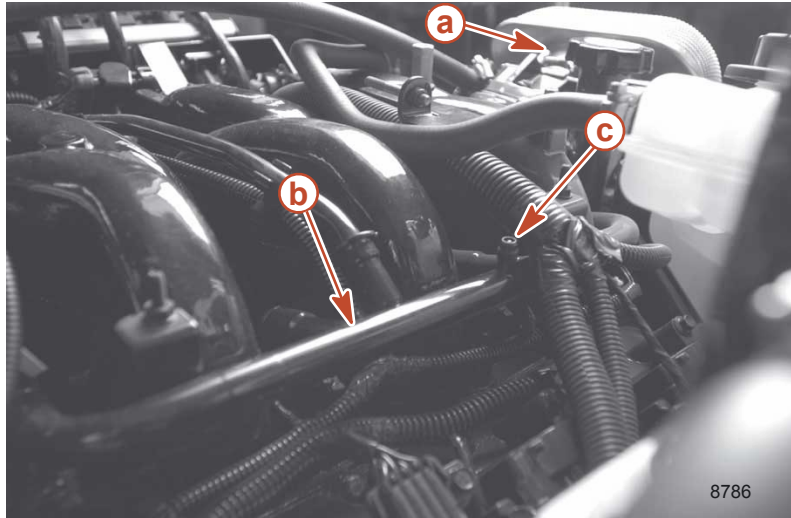
WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

1. Close the fuel supply valve.
2. Relieve fuel system pressure as follows:
 - a. Connect a fuel pressure gauge kit to the Schrader valve.

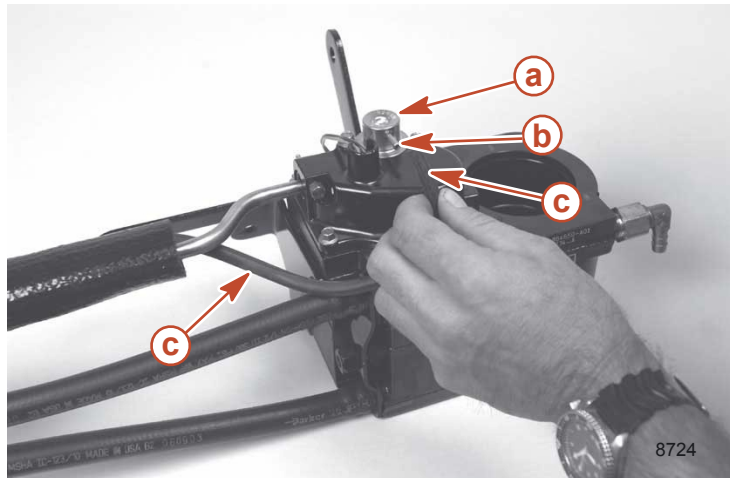


View from starboard side of engine looking forward

a - Throttle body and flame arrestor **c** - Schrader valve
b - Fuel rail

- b. Place the fuel pressure gauge relief line into an approved container.
- c. Open the fuel pressure gauge relief valve to relieve pressure.
3. Close the seacock.
4. Disconnect the negative (-) battery cable from battery (usually black).
5. Disconnect the positive (+) battery cable from battery (usually red).
6. Disconnect the Cool Fuel Module 2-pin harness connector.
7. Disconnect the fuel supply (inlet) hose and plug the hose.

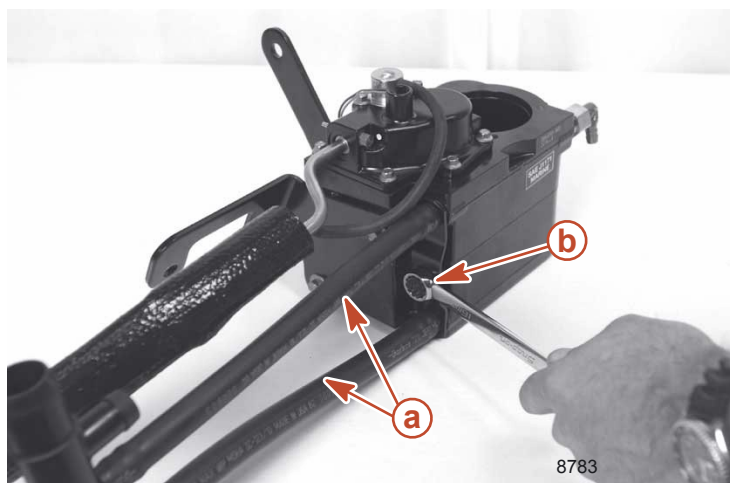
8. Disconnect the fuel pressure regulator vacuum hose from fuel pressure regulator on the Cool Fuel Module.



a - Fuel pressure regulator
b - Fuel pressure regulator hose fitting

c - Fuel pressure regulator vacuum hose

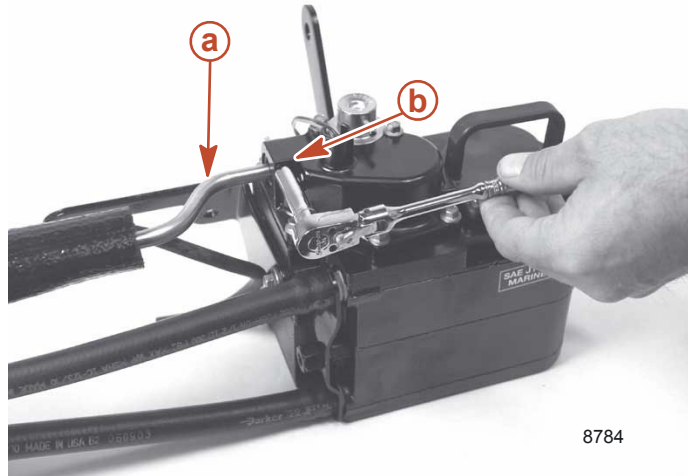
9. Loosen the nut on the cooling hose bracket and remove the cooling hoses from the Cool Fuel Module.



a - Cooling hoses

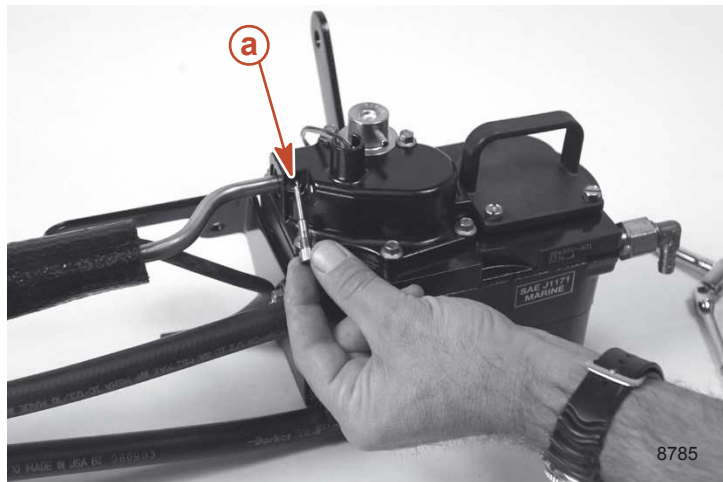
b - Bracket nut

10. Remove the fuel outlet line retainer screw. Screw length and appearance may vary.



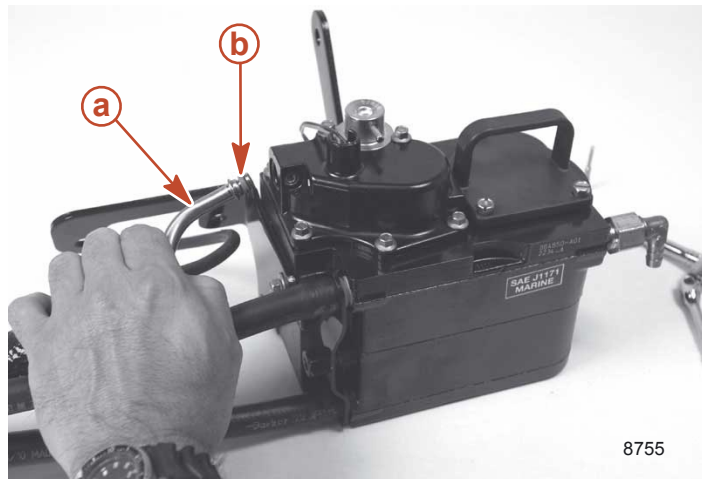
a - Fuel outlet line

b - Fuel outlet screw



a - Typical fuel outlet line retainer screw

11. Carefully pull the fuel outlet line straight out from the module and plug the line.



a - Fuel outlet line

b - O-ring

12. Remove the Cool Fuel Module mounting brackets from engine.

13. On models equipped with a J-clip to secure the fuel line to the engine, retain the J-clip.
See **Gen III Cool Fuel—Fuel Line**.
14. Carefully remove the Cool Fuel Module from the engine.

Gen III Cool Fuel Module Disassembly

NOTE: Retain all fasteners and hardware unless instructed otherwise.

IMPORTANT: Do not remove the fuel inlet adapter fitting.



a - Fuel inlet adapter fitting.

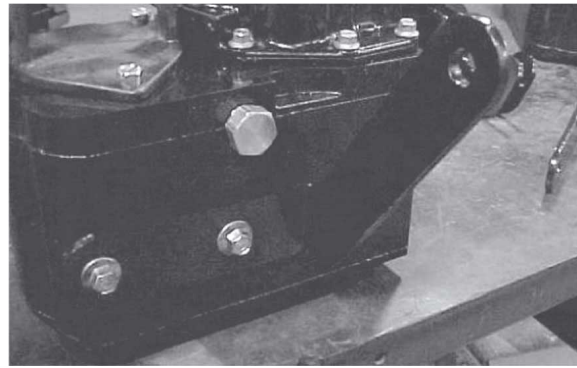
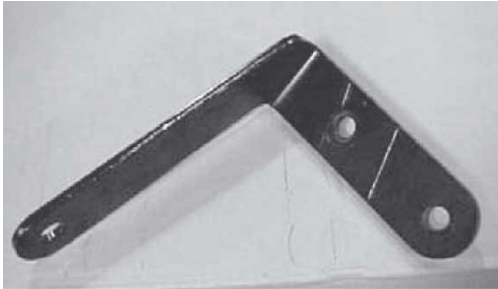
1. Remove Cool Fuel Module from engine. Refer to Gen III Cool Fuel Module Removal.
2. Remove primary mounting bracket from Cool Fuel Module.



8795

Primary Bracket

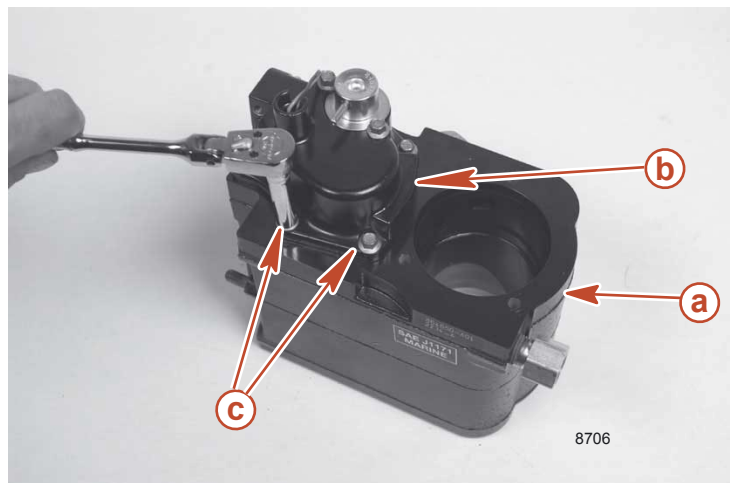
3. Remove support bracket from Cool Fuel Module.



8796

Support Bracket

4. Remove filter assembly. Refer to Section 1B of this manual for filter removal procedure.
5. Remove 6 screws holding top cover.

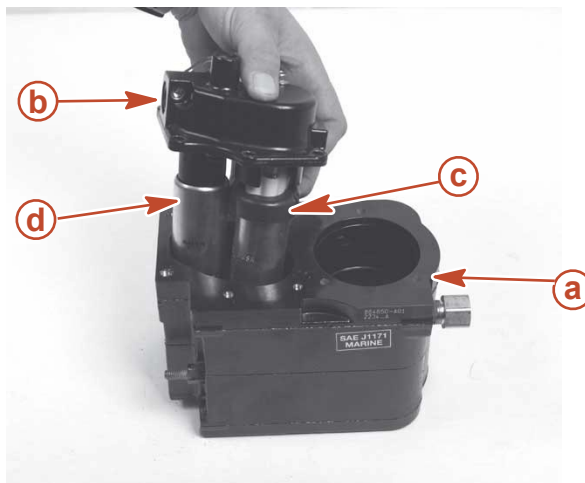


8706

a - Gen III Cool Fuel Module
b - Top cover

c - Top cover screws (not all shown)

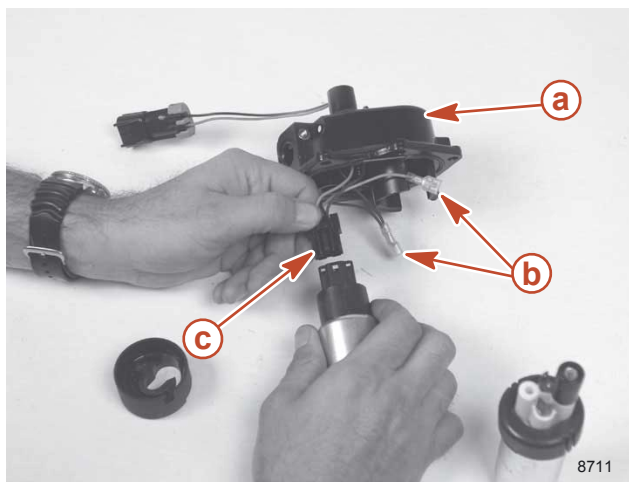
6. Pull top cover straight up.



a - Gen III Cool Fuel Module
b - Top cover

c - Low-pressure fuel pump
d - High-pressure fuel pump

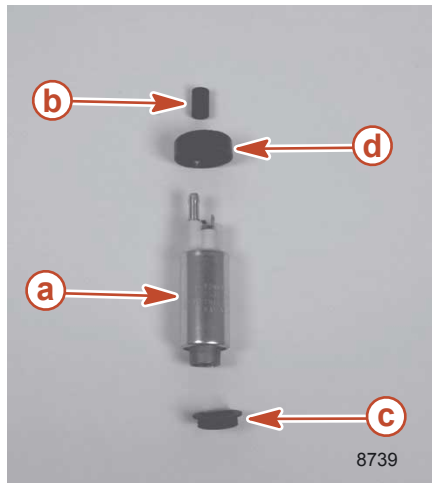
7. Disconnect electrical connections from the low-pressure and high-pressure pumps and remove the pumps from the top cover.



a - Top cover
b - Low-pressure fuel pump electrical connections

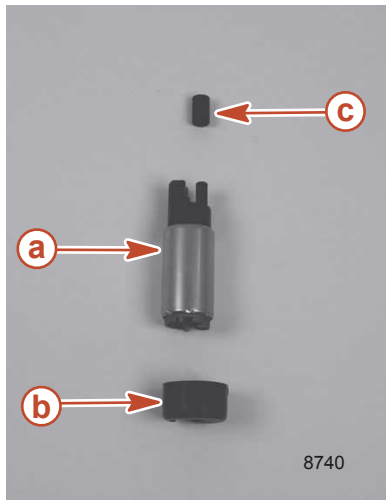
c - High-pressure fuel pump electrical connector

8. Remove seals and isolators from fuel pumps.



Low-pressure Fuel Pump

- | | |
|-----------------------------------|-----------------------|
| a - Low-pressure fuel pump | c - Inlet seal |
| b - Outlet seal | d - Isolator |



High-pressure Fuel Pump

- | | |
|------------------------------------|------------------------|
| a - High-pressure fuel pump | c - Outlet seal |
| b - Isolator | |

NOTE: Fuel inlet seal for low-pressure pump may not come out with the pump when pump is removed from the Cool Fuel Module housing. Be sure to remove the seal from the housing before low-pressure fuel pump installation.

9. Drain fuel from Gen III Cool Fuel Module into an approved container.

Assembly and Installation

Gen III Cool Fuel Module Assembly

FUEL INLET ADAPTER FITTING

1. Install the fuel filter assembly. Refer to Section 1B for filter installation procedure.
2. Hand thread the fuel inlet fitting adapter with pre-applied sealant into the Cool Fuel Module.

3. Torque the fuel inlet adapter fitting to specification.



a - Fuel inlet fitting adapter.

⚠ WARNING

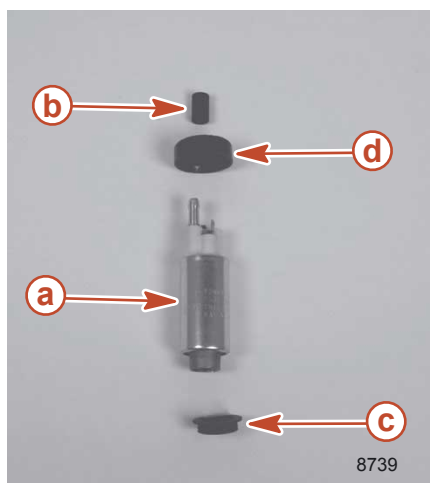
Overtightening the fuel inlet fitting can lead to fuel leaks, avoid severe personal injury or death from a gasoline fire or explosion. Do not use a power tool (i.e. impact wrench) to tighten the fuel inlet fitting.

Description	Nm	lb. in.	lb. ft.
Fuel inlet fitting adapter	22		16

TOP COVER AND FUEL PUMPS

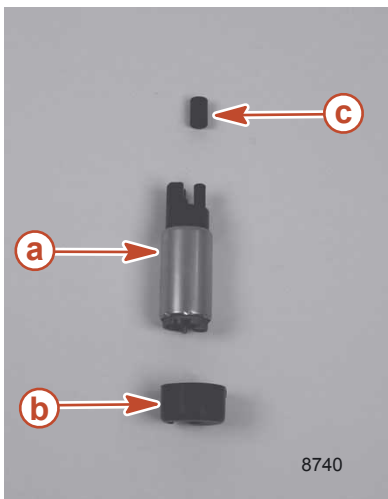
1. Place the fuel pump outlet seals and isolators onto both fuel pumps.
2. Place the inlet seal for the low-pressure pump into the Cool Fuel Module housing.

IMPORTANT: The inlet (bottom) seal on the low-pressure pump must be placed in the Cool Fuel housing for installation. Do NOT place the inlet seal on the pump prior to pump installation. The seal may become dislodged during pump installation and cause the pump not to seal properly.



Low-pressure Fuel Pump

- a** - Low-pressure fuel pump **c** - Inlet seal
b - Outlet Seal **d** - Isolator

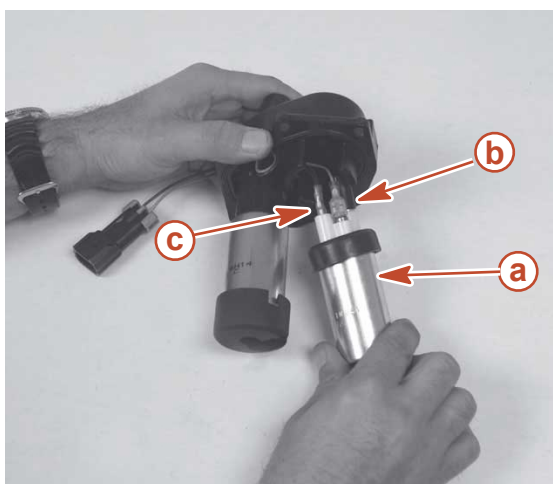


High-pressure Fuel Pump (low-pressure fuel pump removed for visual clarity)

a - High-pressure fuel pump
b - Isolator

c - Outlet seal

3. Connect the electrical connectors to the low-pressure pump. Red wire to positive terminal. Black wire to negative terminal. The fuel pump is marked (+) positive and (-) negative on the top of the pump. Spade connection sizes are matched to the appropriate connection as well.

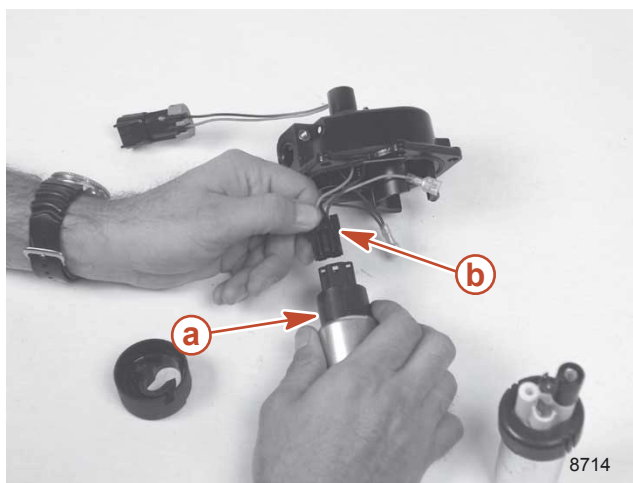


Low-pressure Fuel Pump

a - Low-pressure fuel pump
b - Positive (+) electrical connection

c - Negative (-) electrical connection

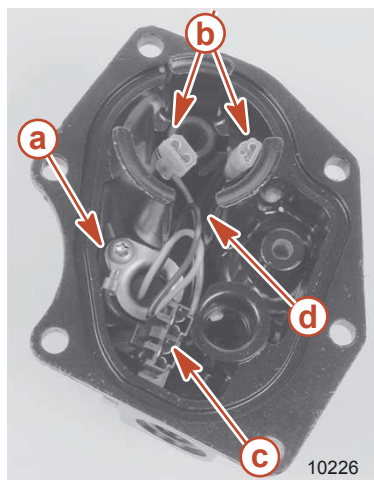
4. Connect the electrical connector to the high-pressure fuel pump.



High-pressure Fuel Pump (low-pressure pump disconnected for clarity)

a - High-pressure fuel pump **b** - Electrical connector

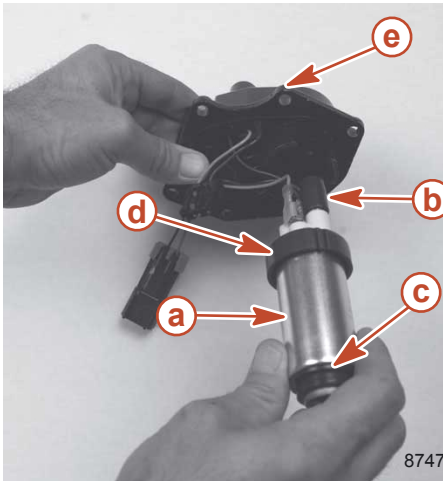
5. Route the wires as shown. Ensure that the ground wire terminal at the harness end is positioned against the outer wall of the casing. Low-pressure pump wiring must be routed through the slot and above the fuel pump. High-pressure pump wiring must also be routed above the fuel pump. Ensure that the wiring is not bound or pinched.



Fuel Pumps Not Shown For Visual Clarity

a - Ground wire terminal **c** - High-pressure pump electrical connector
b - Low-pressure pump electrical connectors **d** - Slot (low-pressure pump wire routing)

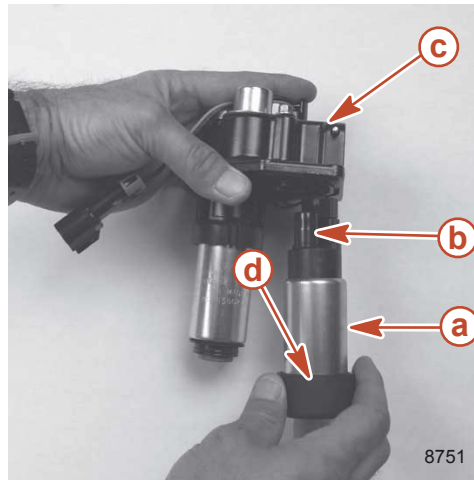
6. Insert the low-pressure pump into the top cover.



Low-pressure Fuel Pump Installation

- | | |
|-----------------------------------|----------------------|
| a - Low-pressure fuel pump | d - Isolator |
| b - Outlet seal | e - Top cover |
| c - Inlet seal | |

7. Insert the high-pressure pump into the top cover.

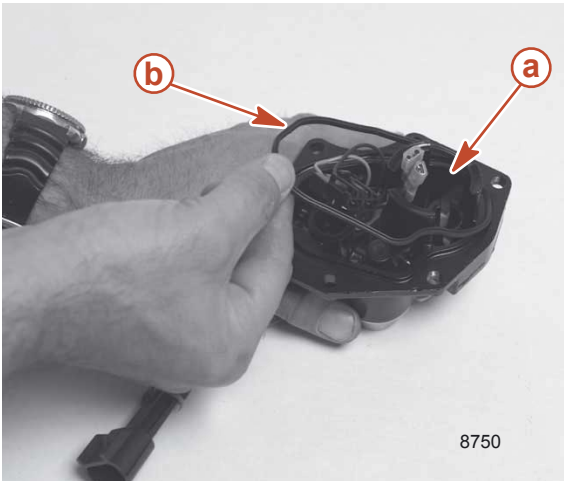


High-pressure Fuel Pump Installation

- | | |
|------------------------------------|----------------------|
| a - High-pressure fuel pump | c - Top cover |
| b - Outlet seal | d - Isolator |

8. Verify that the top cover seal is not damaged. Replace if necessary.

9. Place the top cover seal into the groove in the top cover.

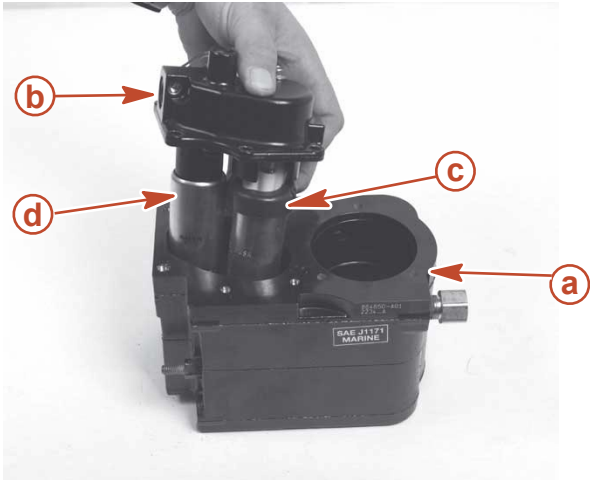


Fuel Pumps Not Shown For Visual Clarity

a - Cool Fuel Module top cover **b** - Top cover seal

NOTE: Be sure that mating surfaces are clean and clear of any debris before installation of the top cover.

Carefully lower the top cover with fuel pumps into the Cool Fuel Module housing.



a - Cool Fuel Module housing **c** - low-pressure pump
b - Top cover **d** - High-pressure pump

11. Install the top cover screws and hand-tighten.
12. Verify that the top cover is not bound and pull the cover gently into place with the top cover screws.

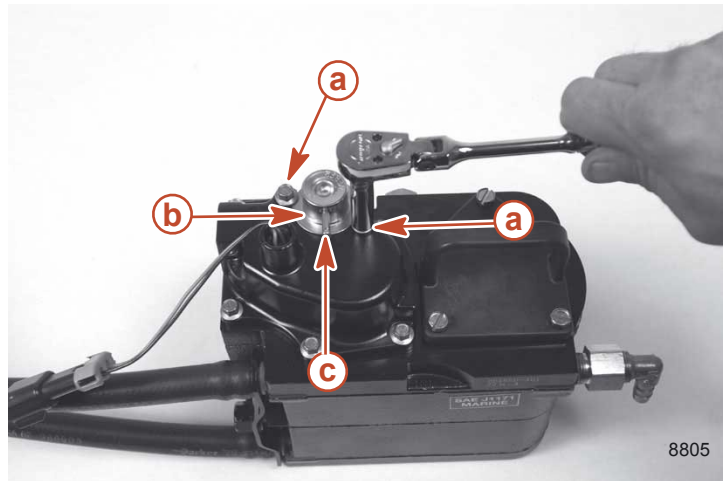
IMPORTANT: Be sure to tighten the top cover screws evenly when pulling the top cover down into place.

13. Torque top cover screws.

Description	Nm	lb. in.	lb. ft.
Top cover screws	14	124	

FUEL PRESSURE REGULATOR

1. Insert the fuel pressure regulator into the top cover with the hose barb facing the outboard side of the Cool Fuel Module.



- a** - Fuel pressure regulator screws (2) **c** - Fuel pressure regulator vacuum hose barb
b - Fuel pressure regulator

2. Install the (2) pressure regulator screws and torque to specification.

Description	Nm	lb. in.	lb. ft.
Pressure regulator screws	14	124	

Gen III Cool Fuel Module Installation

1. Connect the primary mounting bracket to the Cool Fuel Module. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Primary bracket screws (Cool Fuel Module)	23		17

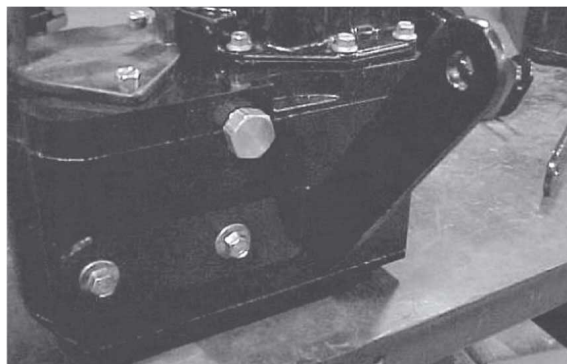
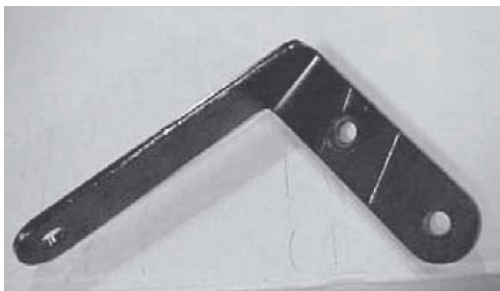


8795

Primary Bracket

2. Connect the support bracket to the Cool Fuel Module. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Support bracket screws (Cool Fuel Module)	23		17



8796

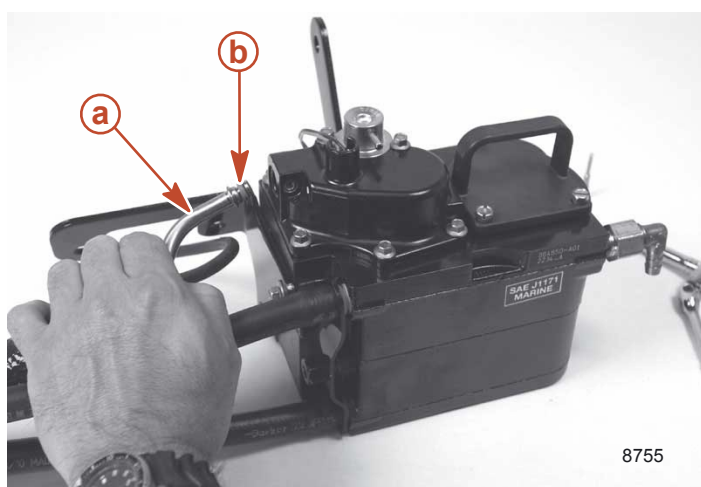
Support Bracket

3. Install the Cool Fuel Module onto the engine. Torque bracket fasteners to specification.
4. On models equipped with a J-clip, install the J-clip onto the primary bracket stud using the primary bracket nut. See **Gen III Cool Fuel—Fuel Line**.

Description	Nm	lb. in.	lb. ft.
Primary bracket screw (engine)	23		17
Primary bracket nuts (engine)	47		35
Support bracket nut (engine)	31		23

5. Inspect the fuel outlet line O-ring. Replace if damaged.
6. Apply a thin coat of oil to the O-ring.

Description	Where used	Part No.
Mercury/Quicksilver Synthetic Blend, NMMA FC-W rated, 4-cycle oil	Fuel outlet line O-ring	92-883724K01

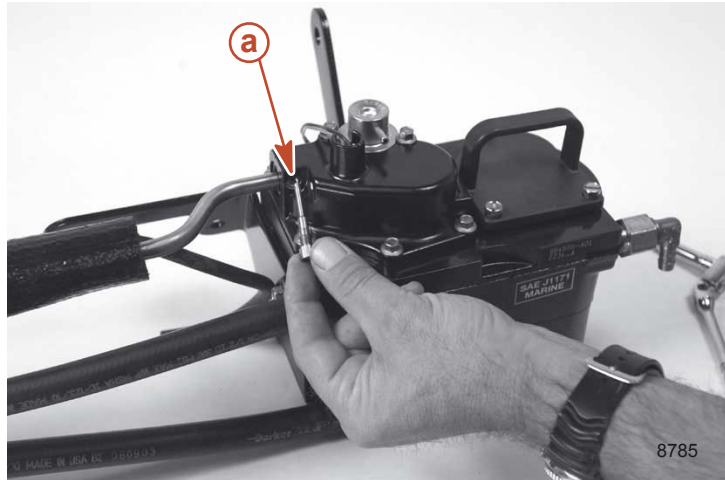


a - Fuel outlet line

b - O-ring

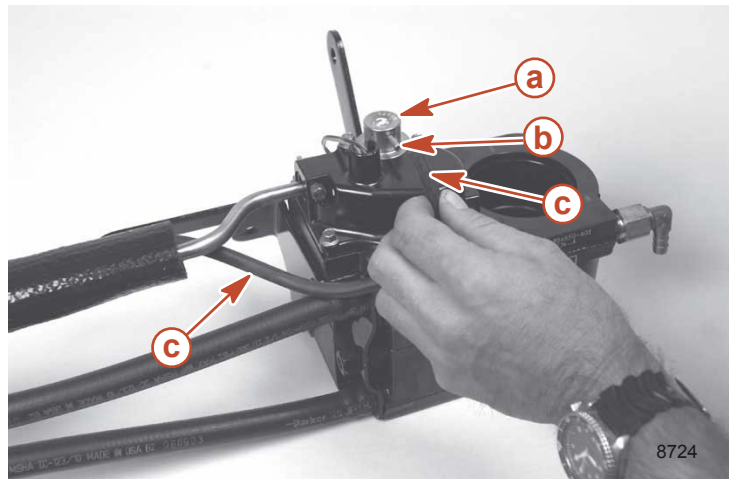
7. Carefully insert the fuel outlet line into the Cool Fuel Module.
8. Install the fuel outlet line retainer screw. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Fuel outlet line retainer screw	9	80	



a - Fuel outlet line retainer screw

9. On models equipped with a J-clip, secure the fuel line in the J-clip. See **Gen III Cool Fuel—Fuel Line**.
10. Install the vacuum hose onto the fuel pressure regulator.



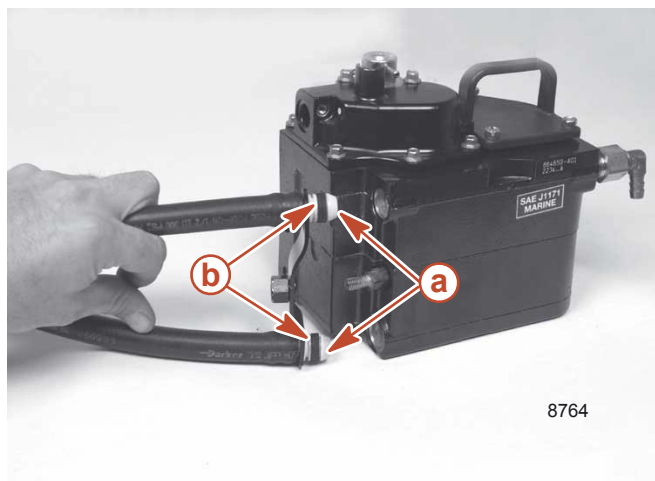
a - Fuel pressure regulator

b - Fuel pressure regulator hose nipple

c - Fuel pressure regulator vacuum hose

11. Inspect quad rings on cooling hose orifices. Replace if damaged.
12. Coat quad rings with lubricant.

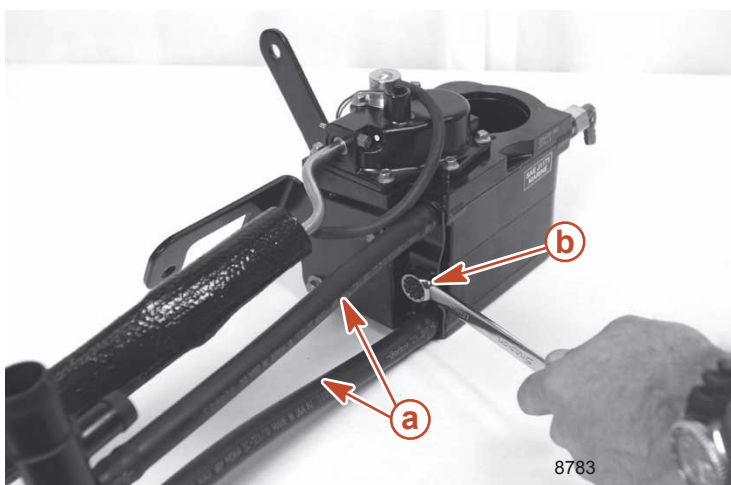
Description	Where used	Part No.
Parker Super Lube™	Cooling hose quad rings	Obtain locally



a - Cooling hose orifices

b - Quad rings

13. Align the cooling hoses and bracket to the Cool Fuel Module and connect the bracket with the attached nut. Push the cooling hose ends into place on the Cool Fuel Module.



a - Cooling hoses and bracket

b - Cooling hose bracket nut

14. Torque the cooling hose bracket nut to specification.

Description	Nm	lb. in.	lb. ft.
Cooling hose bracket nut	1.5	13	

15. Pull the heat-resistant sleeve until the fuel outlet line is completely covered at the module.

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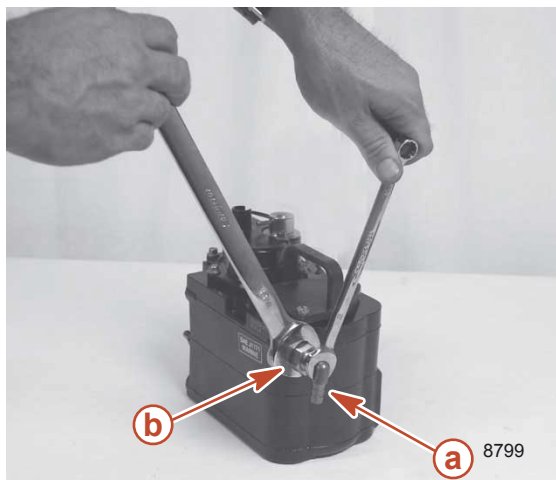
a - Heat resistant sleeve
b - Fuel pressure regulator vacuum hose
c - Fuel outlet line

Tube Ref No.	Description	Where Used	Part No.
	Loctite 567 PST Pipe Sealant	Fuel line inlet connector to adapter.	92-809822

Apply Loctite Pipe Sealant with Teflon to the threads of the fuel inlet connector. Do not use Teflon tape. To prevent cracking the casting and/or fuel leaks, turn the inlet connector in by hand finger-tight, then tighten it an additional 1-3/4 to 2-1/2 turns with a wrench. Do not overtighten. Inspect for leaks.

19. While holding the fuel inlet adapter fitting securely, tighten the fuel line inlet connector an additional 1-3/4 to 2-1/2 turns with a wrench. Do not overtighten.

IMPORTANT: Hold fuel inlet adapter fitting securely when installing fuel line inlet connector.



Typical

a - Fuel line connector (typical 90-degree hose barb)

b - Fuel inlet adapter fitting

20. Connect the Cool Fuel Module 2-pin harness connector.
21. Connect the positive (+) battery cable to the battery (usually red).
22. Connect the negative (-) battery cable to the battery (usually black).
23. Open the seacock, if equipped.
24. Open the fuel supply valve, if equipped.
25. Run the engine and check for any leaks. Stop the engine immediately if any leak exists and correct before continuing.

Fuel System

Section 5C - Fuel Injection Disassembly and Reassembly

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Throttle position sensor screw	92-809821

Special Tools

Computer Diagnostic System (CDS)	Order through SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

Precautions

⚠ WARNING

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

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor; ensure that ignition is off. Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no fuel vapors are present during the next steps to prevent the possibility of a FIRE. Ground high-tension lead of coil to block. Failure to ground high-tension lead may cause damage to coil in addition to being a safety hazard.

⚠ WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

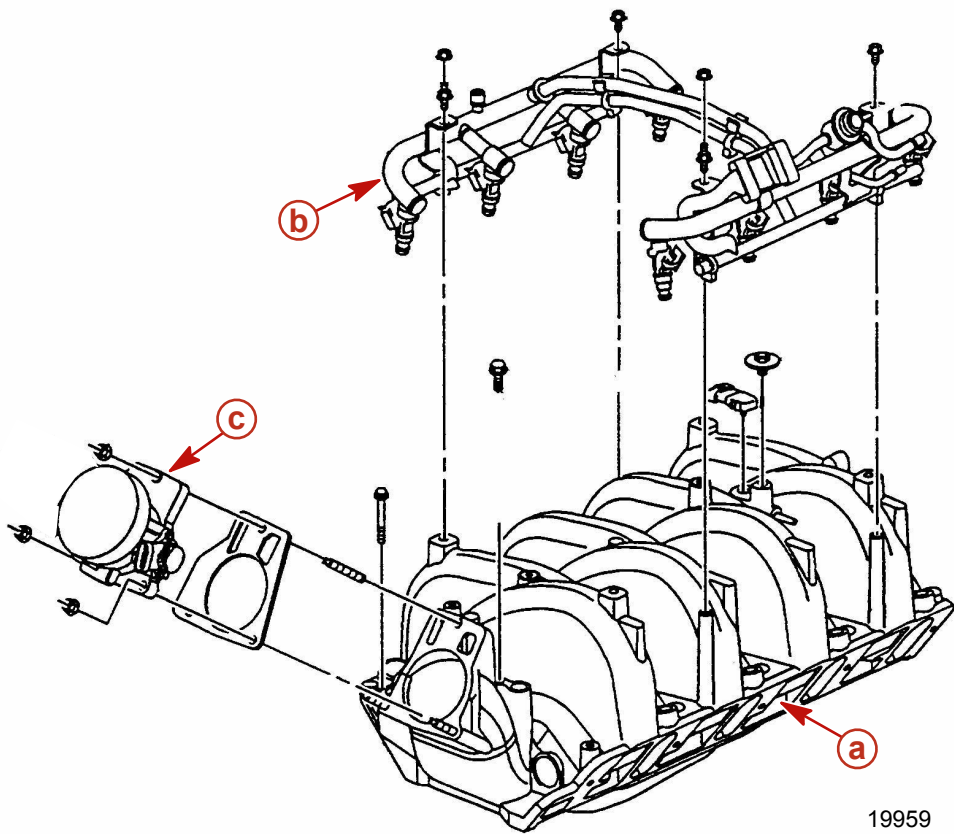
⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or overheating damage to engine may result.

Description	Nm	lb. in.	lb. ft.
Throttle position sensor	2	20	
IAC valve	2	20	
MAP sensor	6	53	
Knock sensor to block	19		14
Intake manifold to plenum	17	150	
Fuel rail	12	105	
Fuel line connections	24		18
Fuel inlet and return lines	31		23
Throttle body-to-intake manifold	10	89	
Flame arrestor clamp	4.7	42	
ECT sensor	Hand tight + 2 1/2 turns maximum		

Intake Manifold, Fuel Rail, and Throttle body Exploded view

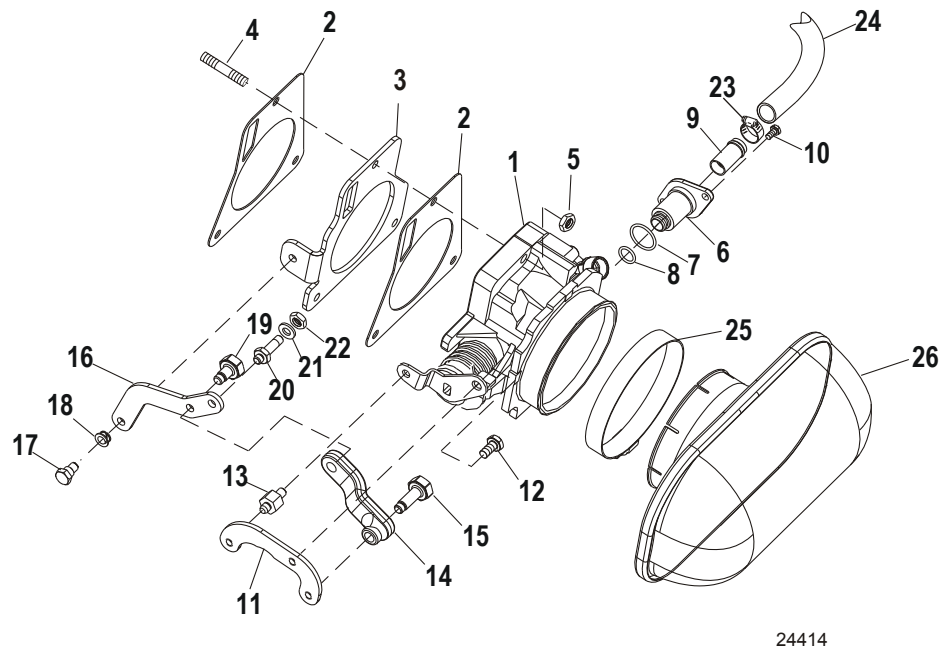
Intake Manifold, Fuel Rail, and Throttle Body Exploded View



a - Intake manifold
b - Fuel rail

c - Throttle body

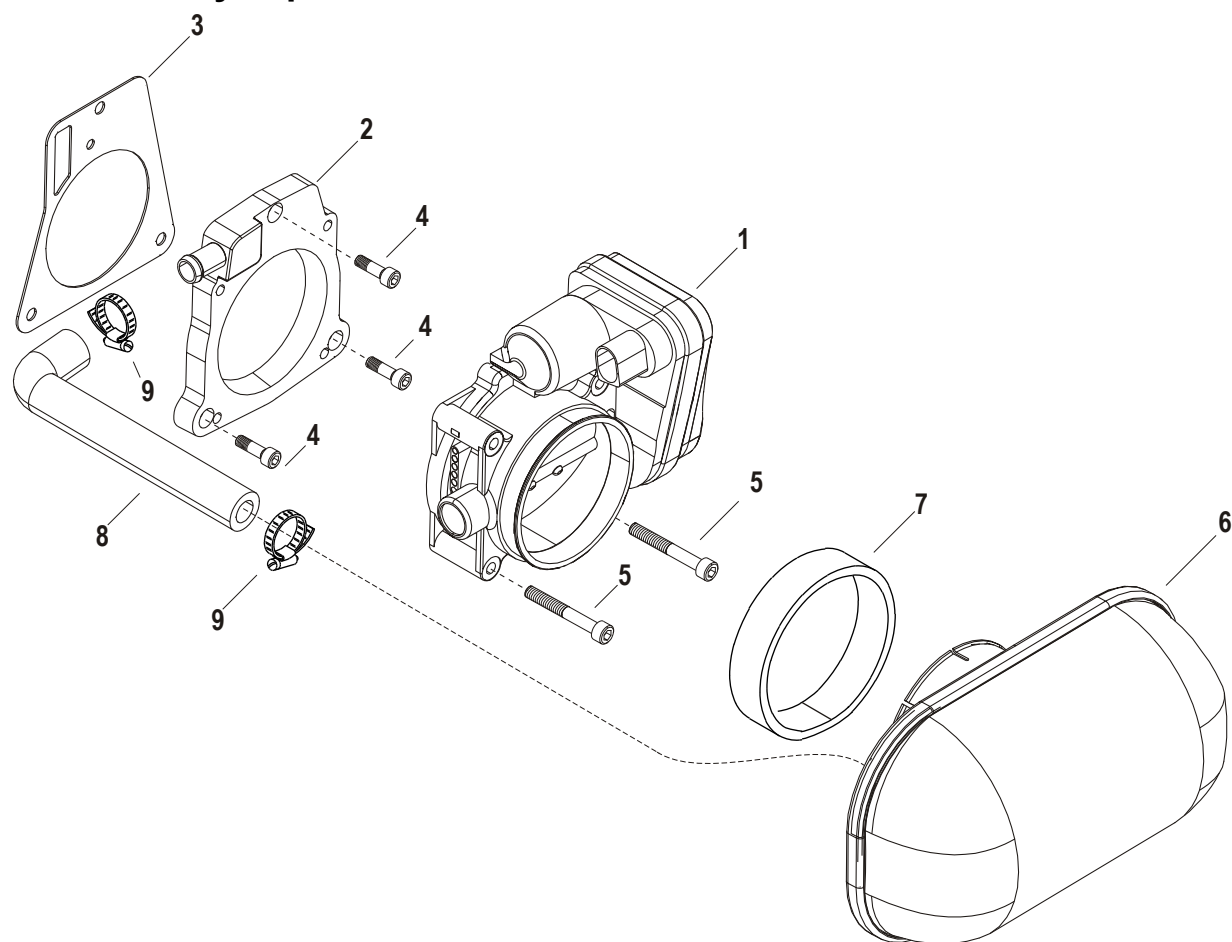
Non-DTS Throttle Body Exploded View



Non-DTS Throttle Body Exploded View

Ref. No.	Qty.	Description
1	1	Throttle body
2	2	Gasket
3	1	Throttle linkage bracket
4	3	Stud
5	3	Nut
6	1	Intake air control plug kit adaptor
7	1	O-ring
8	1	O-ring
9	1	Air valve fitting
10	2	Screw
11	1	Throttle lever
12	1	Screw
13	1	Special stud
14	1	Link
15	1	Screw (M8 x 35)
16	1	Cable arm
17	1	Special screw
18	1	Flanged bushing
19	1	Primary linkage pin
20	1	Stud
21	1	Washer
22	1	Nut
23	1	Hose clamp
24	1	Air bypass hose
25	1	Flame arrestor clamp
26	1	Flame arrestor

DTS Throttle Body Exploded View



1669

DTS Throttle Body Exploded View

Ref. No.	Qty.	Description
1	1	Throttle body
2	1	Throttle body adaptor
3	1	Gasket
4	3	Screw (M6 x 20)
5	4	Screw (M6 x 45)
6	1	Flame arrestor
7	1	Flame arrestor clamp
8	1	Hose
9	2	Hose clamp

Fuel Pressure Relief—Gen II Cool Fuel Module

1. Disconnect electrical connectors at both fuel pumps.
2. Crank the engine for 10 seconds (if the engine starts, allow it operate until it stops) to relieve any fuel pressure in the system.

Fuel Pressure Relief—Gen III Cool Fuel Module

⚠ WARNING

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

⚠ WARNING

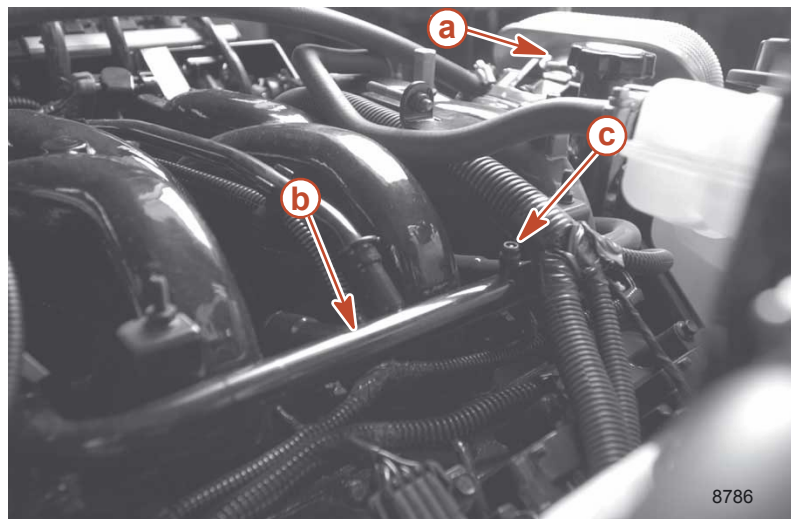
Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

⚠ CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

1. Close the fuel supply valve.
2. Relieve fuel system pressure as follows:
 - a. Connect the fuel pressure gauge kit to Schrader valve.

Fuel pressure gauge kit	91-881883A2
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View from starboard side of engine looking forward

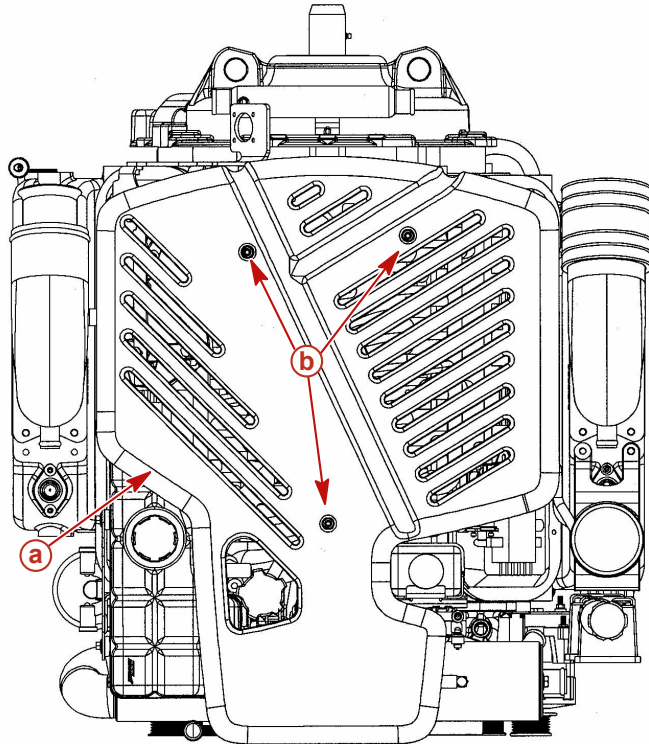
a - Throttle body and flame arrestor **c** - Schrader valve
b - Fuel rail

- b. Place the fuel pressure gauge relief line into an approved container.
- c. Open the fuel pressure gauge relief valve to relieve pressure.

Flame Arrestor

Removal

1. Remove the engine cover.



19961

a - Engine cover

b - Fasteners

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

Cleaning and Inspection

1. Clean the flame arrestor in warm soapy water.
2. Dry the flame arrestor with compressed air.

Installation

1. Reinstall the flame arrestor and secure using the flame arrestor clamp. Torque the flame arrestor clamp.

Description	Nm	lb. in.	lb. ft.
Flame arrestor clamp	4.7	42	

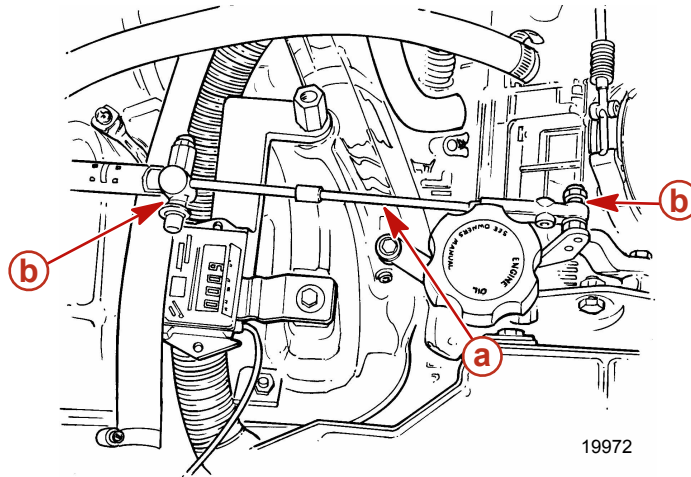
2. Install the engine cover. Secure with fasteners.

Throttle Body

Removal

1. On non-DTS models:
 - a. Remove the engine cover.
 - b. Remove the flame arrestor.

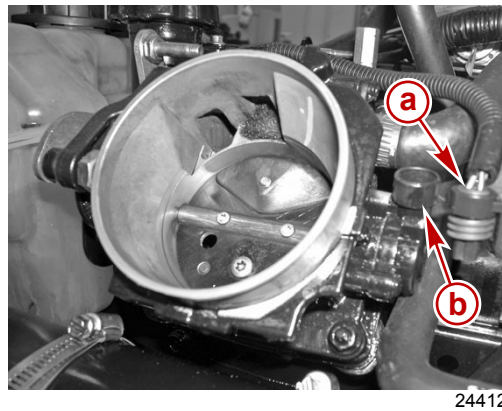
- c. Disconnect the throttle linkage from the throttle body.



a - Throttle cable

b - Throttle cable connections

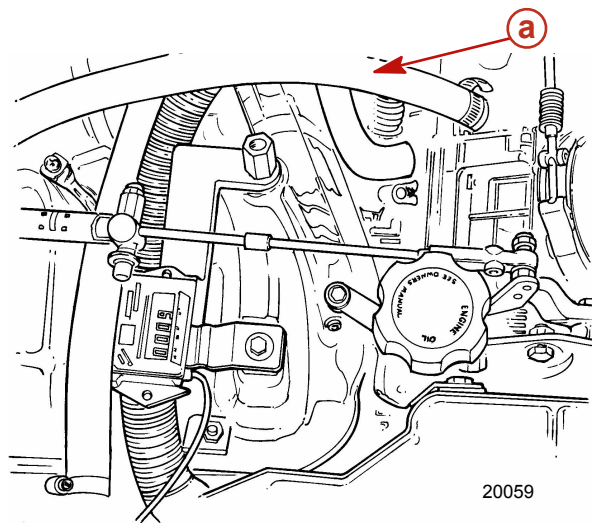
- d. Disconnect the electrical harness from the throttle position sensor.



a - Throttle position sensor electrical connector

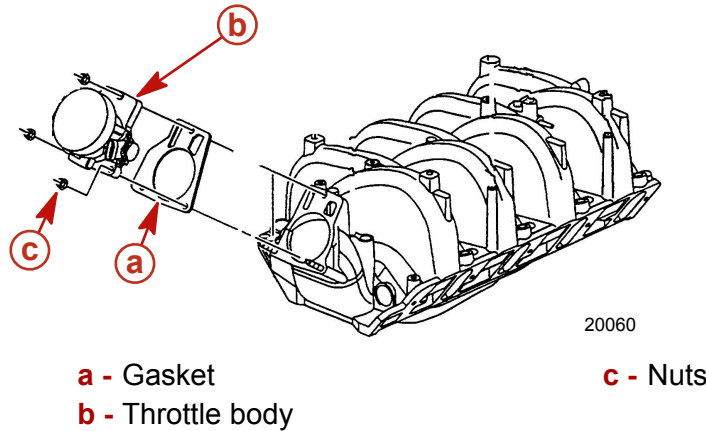
b - Throttle position sensor

- e. Disconnect the hose to the IAC fitting.



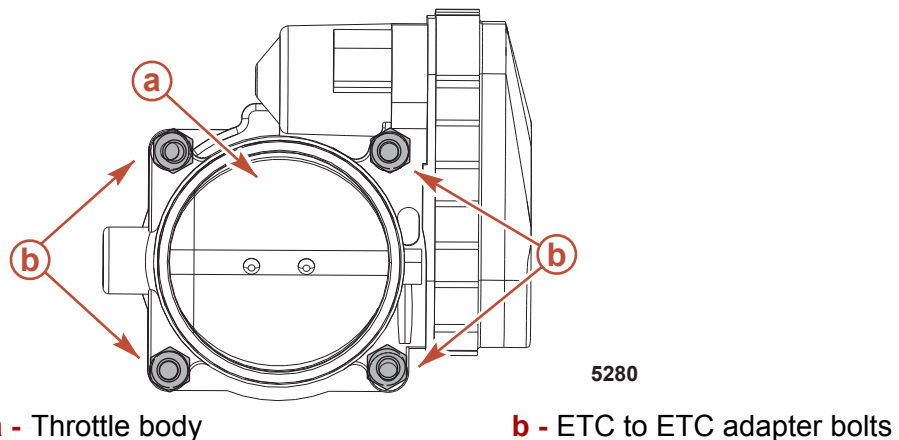
a - Hose to IAC fitting

- f. Remove the nuts (3) retaining the throttle body and remove the throttle body from the intake.



IMPORTANT: Insert a clean shop towel into the opening of the intake to prevent foreign material from entering the engine.

2. On DTS Models equipped with electronic throttle control (ETC):
 - a. Remove the flame arrestor from the throttle body.
 - b. Disconnect electrical harness from ETC.
 - c. Remove the four bolts securing ETC to the ETC adapter. Remove the ETC.



IMPORTANT: Insert a clean shop towel into the opening of the intake to prevent foreign material from entering the engine.

Cleaning and Inspection

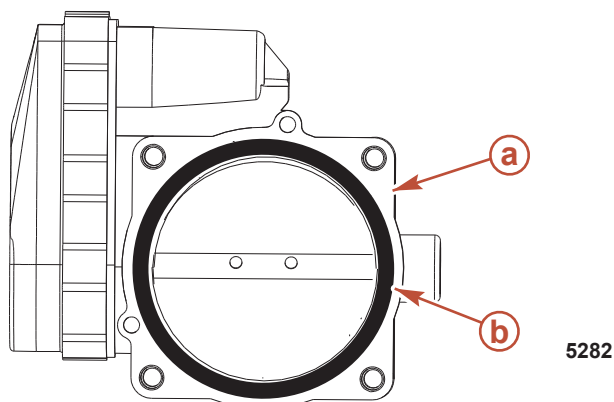
IMPORTANT: Do not use cleaners containing methyl ethyl ketone. They are not necessary for cleaning throttle bore and valve deposits.

IMPORTANT: Do not allow the throttle position sensor to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from the intake manifold and throttle body.

1. On non-DTS models:
 - a. Carefully remove all gasket material from the intake manifold and throttle body.
 - b. Thoroughly clean all parts of the throttle body. Ensure that all passages are free of dirt and burrs.
 - c. Inspect the mating surfaces for damage that could affect gasket sealing.

- d. Inspect the throttle body for cracks in the casting.
- e. Inspect the throttle plates, linkage, and return springs for damage, wear, and foreign material.
2. On DTS Models equipped with electronic throttle control (ETC):
 - a. Inspect the mating surfaces of the throttle body and adapter for gashes, cuts, or other imperfections that could affect seal.
 - b. Inspect the sealing O-ring on the throttle body for cuts, or other imperfections that could affect seal.

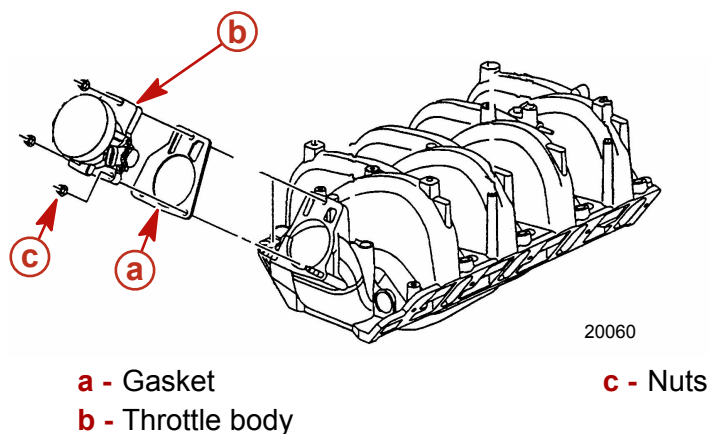


a - Throttle body mating surface

b - Throttle body sealing O-ring

Installation

1. On non-DTS models:
 - a. Install the throttle body gasket between the throttle body and the intake manifold.
 - b. Install the throttle body onto the intake manifold. Torque the throttle body nuts.



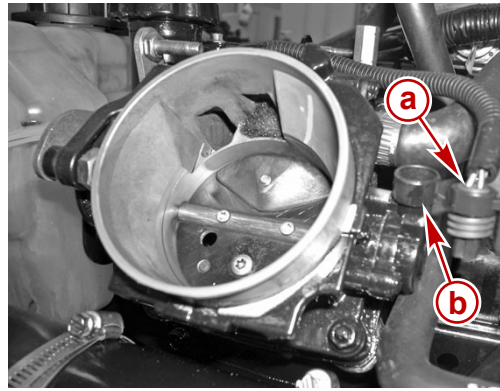
a - Gasket

b - Throttle body

c - Nuts

Description	Nm	lb. in.	lb. ft.
Throttle body nut	10	89	

- c. Connect the electrical harness from the throttle position sensor.



24412

- a** - Throttle position sensor electrical connector **b** - Throttle position sensor

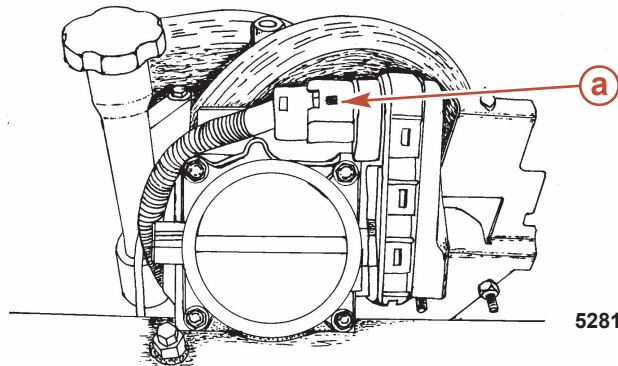
2. Connect the throttle cable to the throttle lever. See **Section 2** for throttle cable adjustment.
3. Reconnect the IAC hose to the IAC fitting.
4. Install the flame arrestor and tighten the clamp. Torque the flame arrestor clamp.

Description	Nm	lb. in.	lb. ft.
Flame arrestor clamp.	4.7	42	

5. On DTS Models equipped with electronic throttle control (ETC):
 - a. Align the ETC with ETC adapter plate.
 - b. Using the 4 screws, fasten the ETC to the adapter plate. Torque the screws.

Description	Nm	lb. in.	lb. ft.
ETC screw	7	62	

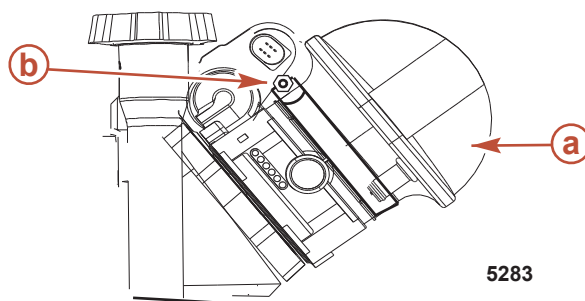
- c. Reconnect electrical harness to the ETC.



5281

- a** - ETC electrical harness connector

- d. Install the flame arrestor. Torque the flame arrestor clamp.



a - Flame arrestor

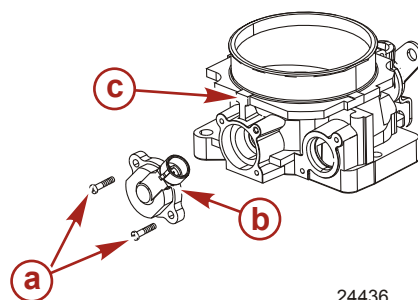
b - Flame arrestor clamp

Description	Nm	lb. in.	lb. ft.
Flame arrestor clamp	4.7	42	

6. Install the engine cover.

Throttle Position Sensor

1. Remove the engine cover.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the harness connector from the TP sensor.
4. Remove the throttle body from the intake manifold.
5. Remove the screws from the TP sensor.
6. Remove the TP sensor from the throttle body.



a - Screw (2)

c - Throttle body

b - Throttle position (TP) sensor

Cleaning and Inspection

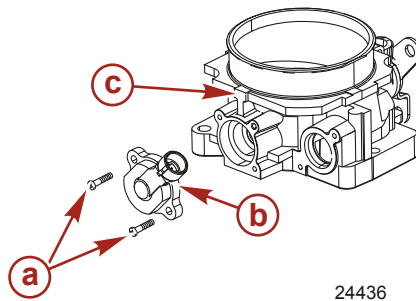
1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the sensor for signs of wear or damage.

Installation

1. Apply adhesive to threads of the TP sensor screws.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Throttle position sensor screw	92-809821

2. Install the TP sensor onto the throttle body using the screws. Torque the screws.



a - Screw (2)

b - Throttle position (TP) sensor

c - Throttle body

Description	Nm	lb. in.	lb. ft.
Throttle position sensor screw	2	20	

3. Place a new gasket on the intake manifold.
4. Install the throttle body onto the intake manifold. Torque the throttle body nuts.

Description	Nm	lb. in.	lb. ft.
Throttle body nut	10	89	

5. Connect the harness connector to the TP sensor.
6. Place the flame arrestor over the throttle body and tighten the clamp securely.
7. Install the engine cover. Tighten the fasteners securely.
8. Supply cooling water.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

9. When the negative (–) battery cable has been reconnected, start the engine and check for the TP sensor output voltage using the Computer Diagnostic System (CDS). It should be approximately 0.7 volts at idle and 4.5 volts at wide open throttle.

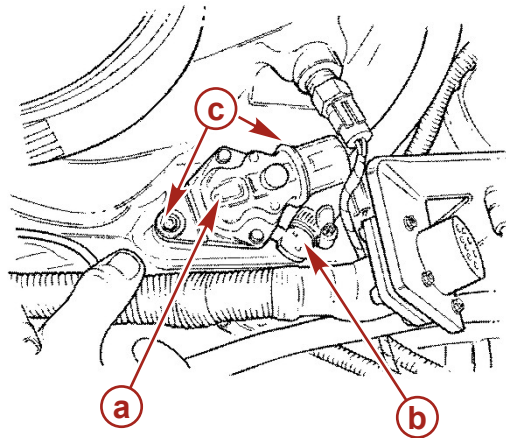
Computer Diagnostic System (CDS)	Order through SPX
----------------------------------	-------------------

Idle Air Control (IAC) Valve

Removal

1. Remove the engine cover.
2. Disconnect the harness electrical lead.

3. Remove the two hex screws fastening the IAC valve at the rear of the engine, and remove the IAC valve.



a - IAC valve

b - Hose connection

20064

c - Hex screws (1 hidden)

Cleaning and Inspection

IMPORTANT: See the carburetor cleaner manufacturer's instructions for safety precautions.

1. Remove and discard the sealing gasket from the IAC valve. Clean sealing surfaces and the air passage with a carburetor cleaner to remove carbon deposits.
2. Inspect the entire assembly for any obvious physical damage.

Installation

1. Install a new gasket on the IAC valve.
2. Install the IAC valve onto the intake manifold using the two hex screws. Torque the hex screws.

Description	Nm	lb. in.	lb. ft.
Hex screw	2	20	

3. Connect the harness electrical lead to the IAC.
4. Supply cooling water.

⚠ CAUTION

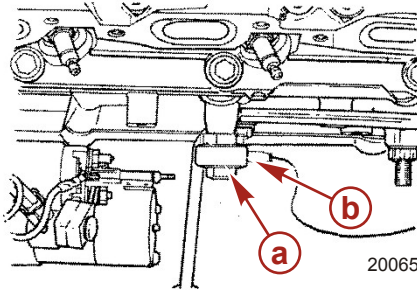
Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

5. Start the engine and check for proper idle operation.

Knock Sensor

Removal

1. Disconnect the electrical connector at the knock sensor (located just ahead of the starter motor).



a - Knock sensor

b - Electrical connector

2. Remove the knock sensor from the engine block.

Cleaning and Inspection

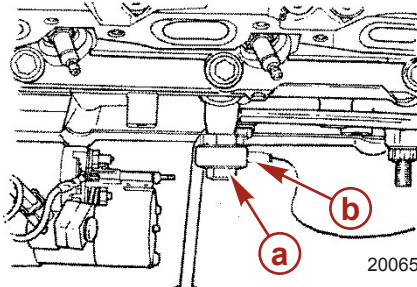
1. Clean the knock sensor with a dry cloth, paying special attention to the threads on the base.
2. Inspect the surfaces of the knock sensor for signs of wear or physical damage.

Installation

IMPORTANT: If installing a new knock sensor, replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. Do not use sealer on threads.

1. Install knock sensor into the engine block. Torque the knock sensor.



a - Knock sensor

b - Electrical connector

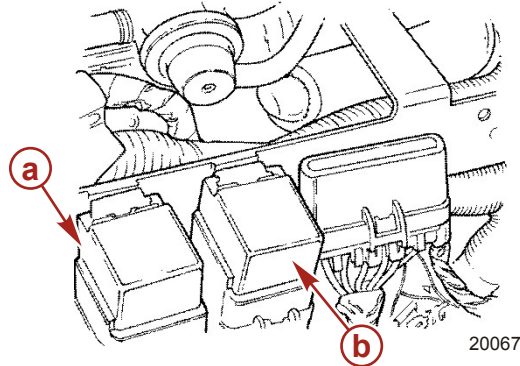
Description	Nm	lb. in.	lb. ft.
Knock sensor	19		14

2. Connect electrical connector to knock sensor.

Main System and Fuel Pump Relays

Removal

1. Remove relays from electrical bracket.



a - Fuel pump relay

b - Main system relay

2. Remove the top cap from the relay.

Cleaning and Inspection

IMPORTANT: The fuel pump relay is an electrical component. Do not soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

Installation

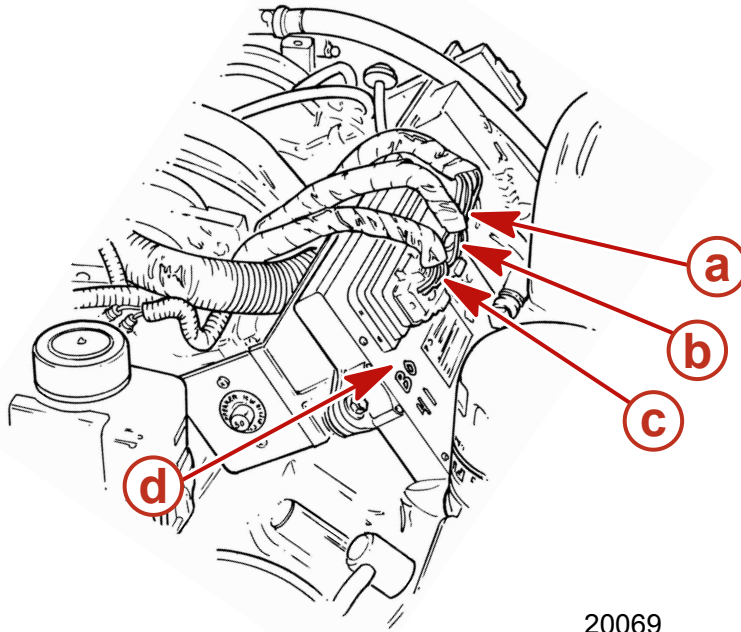
1. Connect the top cap to the relays.
2. Attach the relays to the electrical bracket.

Propulsion Control Module (PCM)

IMPORTANT: The PCM is a sensitive electrical device, subject to electrostatic damage. Do not touch connector pins when removing or installing the module.

Removal

1. Disconnect A, B, and C electrical connectors at the propulsion control module (PCM). Do not touch connector pins when removing.



a - Connector A
b - Connector B

c - Connector C
d - PCM

2. Remove the PCM from the electrical bracket.

Cleaning and Inspection

1. Clean the exterior of the PCM with a dry cloth, being careful to avoid contact with connector pins.
2. Inspect the outer surfaces for any obvious damage.
3. Visually inspect the electrical pins on the PCM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: The PCM is a sealed electrical component. If the PCM is shown to be defective, the unit must be replaced with an PCM of an equivalent part number.

Installation

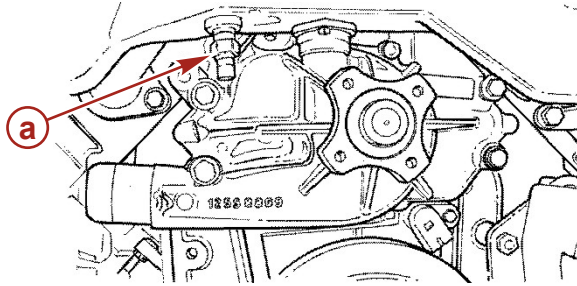
1. Mount the new PCM to the electrical bracket using screws and washers.
2. Connect the electrical connectors to the PCM. Do not touch connector pins when installing.

Engine Coolant Temperature (ECT) Sensor

Removal

IMPORTANT: Handle the ECT carefully as any damage to it will affect the operation of the system.

1. Disconnect the electrical connector at the engine coolant temperature (ECT) sensor.



20071

Water pump pulley removed for visual clarity

a - Engine coolant temperature sensor (ECT)

2. Remove the ECT sensor from the crossover.

Cleaning and Inspection

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

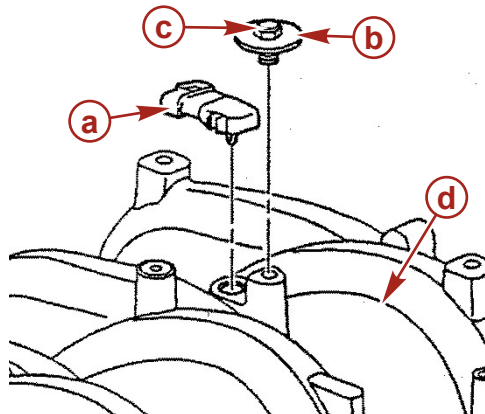
Installation

1. Install the ECT sensor. Tighten hand-tight plus 2-1/2 turns maximum.
2. Connect the electrical connector to the ECT sensor.

Manifold Absolute Pressure (MAP) Sensor

Removal

1. Disconnect the electrical connector from the manifold absolute pressure (MAP) sensor.



20074

a - Manifold Absolute Pressure (MAP) Sensor
b - Washer

c - Bolt
d - Intake Manifold

2. Remove the MAP sensor from the intake manifold.

Cleaning and Inspection

1. Clean the surfaces of the MAP sensor with a dry cloth.
2. Inspect the MAP sensor for signs of wear or damage.
3. Inspect the seal on the MAP sensor. Replace if deteriorated or hardened.

Installation

1. Install the seal on the MAP sensor.
2. Install the MAP sensor onto the intake manifold using a washer and screw. Torque the screw.

Description	Nm	lb. in.	lb. ft.
MAP sensor screw	6		53

3. Connect the electrical connector to the MAP sensor.

Notes:

Fuel System

Section 5D - Troubleshooting and Repair

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Special Tools

Fuel Shut Off Tool	91-805918A1
 7051	Tests fuel system pressure / vacuum

Gen III Cool Fuel Module Diagnostics

Electrical

1. Disconnect the electrical connector at the Cool Fuel Module.
2. Connect a Digital Volt / Ohm Meter (DVOM) to the engine side of the electrical connector.
3. Turn the ignition switch to the run position.
4. Verify that there is 12 volt battery (+) power going to the Cool Fuel Module. If voltage is less than 11.5 vdc, find and correct the voltage drop or no voltage condition.

NOTE: The fuel pump relay will only remain active for 2-3 seconds while the key is in the RUN position.

Checking Fuel Pressure and Fuel Supply Vacuum

1. Connect a fuel pressure gauge to the schrader valve on the fuel rail.
2. Cycle key switch 2-3 times (OFF to RUN position) at 3 second intervals to reach maximum fuel pressure.
3. Verify that the pressure is within specification.
4. If fuel pressure exceeds 44 psi (303 kPa), replace the fuel pressure regulator.
5. If fuel pressure is less than 40 psi (276 kPa), but greater than 13 psi (90 kPa):
 - a. Relieve the fuel pressure in the fuel rail. Refer to section 2A for fuel pressure relief procedure.
 - b. Use a tee fitting and connect a vacuum gauge to the fuel inlet side of the Cool Fuel Module. Do not remove the fuel inlet fitting adapter.
 - c. Cycle the key switch 2-3 times (OFF to RUN position) at 3 second intervals to reach maximum pressure.
 - d. Verify that the vacuum from the fuel source is within specification. If the vacuum exceeds 2 in. Hg (7 kPa) , excessive fuel restriction exists. Correct the fuel restriction before proceeding.
 - e. With the vessel secured to the dock and the engine running in neutral, restrict the fuel supply with fuel shut-off tool and verify that the Cool Fuel Module has the ability to cause an inlet vacuum reading of 11 in. Hg (37 kPa) or greater. If the vacuum reading is less than 11 in. Hg (37 kPa) with the fuel supply restricted, but fuel pressure is within specification, replace the low-pressure pump.

Fuel Shut Off Tool	91-805918A1
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6. If fuel pressure is 13 psi (90 kPa) or less and inlet vacuum is less than 15 in. Hg (51 kPa), replace high-pressure pump and fuel pressure regulator.

In-Water Test

1. With a vacuum gauge and a fuel pressure gauge in place, operate the boat throughout the RPM range and record the pressure and vacuum readings.
2. If the fuel the supply vacuum reading is greater than 2 in. Hg (7 kPa) , find and correct the fuel supply restriction.

3. If fuel pressure is less than 40 psi (276 kPa), but greater than 13 psi (90 kPa):
 - a. Verify that the vacuum from the fuel source is within specification. If the vacuum exceeds 2 in. Hg (7 kPa) , excessive fuel restriction exists. Correct the fuel restriction before proceeding.
 - b. If no excessive fuel supply restriction exists, replace low-pressure fuel pump.
4. If fuel pressure is 13 psi (90 kPa) or less and no excessive fuel supply restriction exists, replace high-pressure pump and fuel pressure regulator.

IMPORTANT: It will be necessary to sea-trial the boat following repairs to be sure that the pressure and the fuel system vacuum remain within specification throughout the RPM range.

Notes:

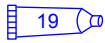
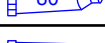
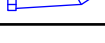
Cooling System

Section 6A - Closed Cooling Section

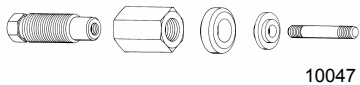
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Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Paker Superlube (863772)	Crossover to heat exchanger seals Bypass seal	Obtain Locally
	Perfect Seal	End cover screw	92-34227-1
	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821
	Loctite 609	Retainer/seal	Obtain Locally
	SAE Engine Oil 30W	Outer diameter of the bearings	Obtain Locally
	Extended Life Antifreeze/Coolant	Coolant section of the cooling system Closed cooling system	92-877770K1

Special Tools

Pulley Pusher Installer	91-93656A1
	Installs the pulley onto the power steering pump.

Specifications

Closed Cooling System Capacity

NOTICE	
Unit Of Measurement: Liters (U.S. Quarts). All capacities are approximate fluid measures.	
Model	8.1L (496 cid)
Closed cooling system	21.76 liters (23 qt.)

Thermostat

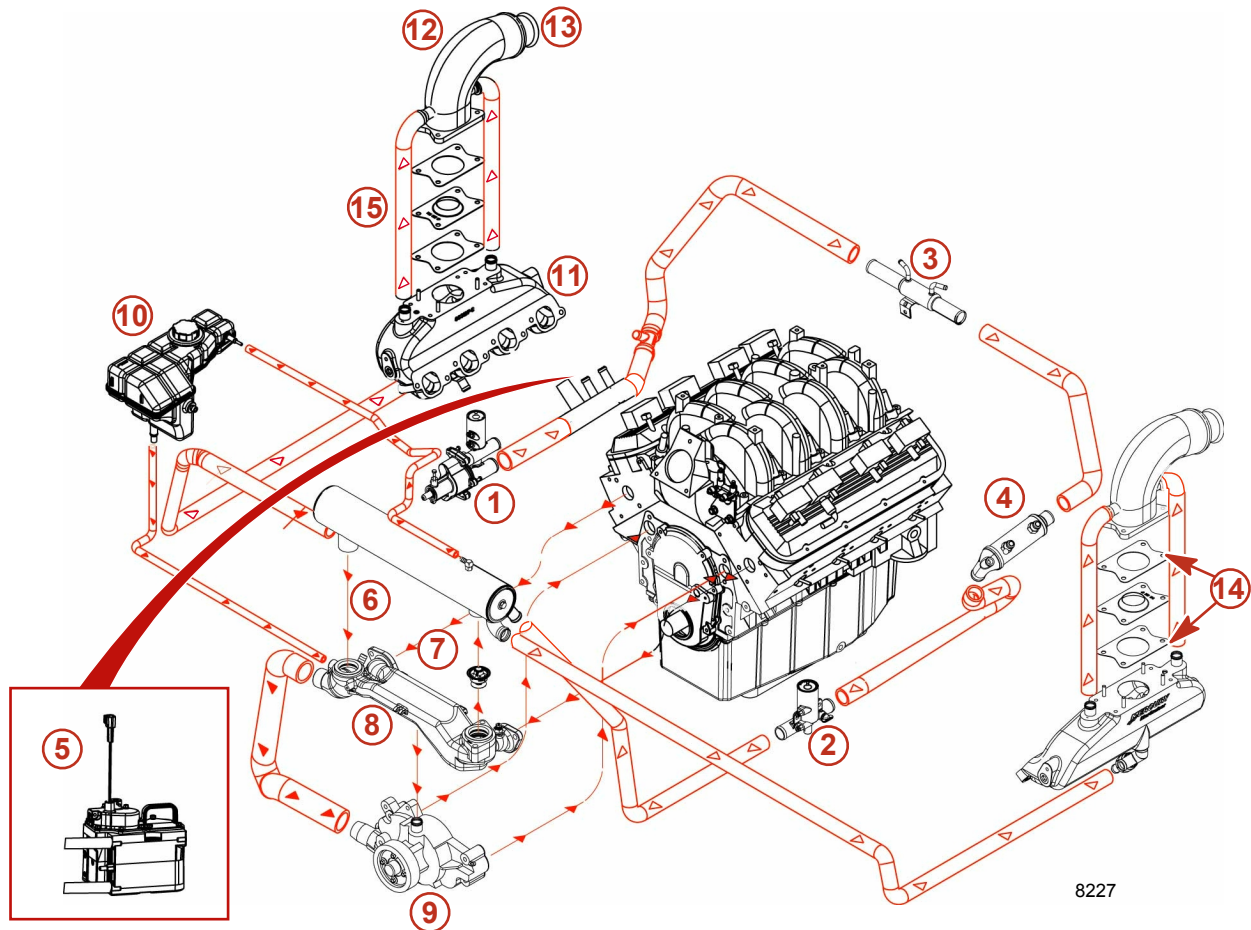
Engine	Specification
8.1L (496 cid)	71° C (160° F)

Pressure Cap Rating

Engine	Specifications
8.1L (496 cid)	103 kPa (15 psi)

Coolant and Water Flow Diagrams

NOTE: Certain components in the following diagram may look different from your particular power package, but the water and coolant flow paths remain similar on all engines.



- | | |
|--------------------------------|-------------------------------|
| 1 - Seawater pump/Air actuator | 9 - Water circulating pump |
| 2 - Air actuator | 10 - Coolant reservoir |
| 3 - Transmission cooler | 11 - Exhaust manifold |
| 4 - Oil cooler | 12 - Elbow |
| 5 - Gen III Cool Fuel Module | 13 - Water and exhaust outlet |
| 6 - Heat exchanger | 14 - Gasket (2 per side) |
| 7 - Thermostat | 15 - Turbulator (1 per side) |
| 8 - Crossover | |

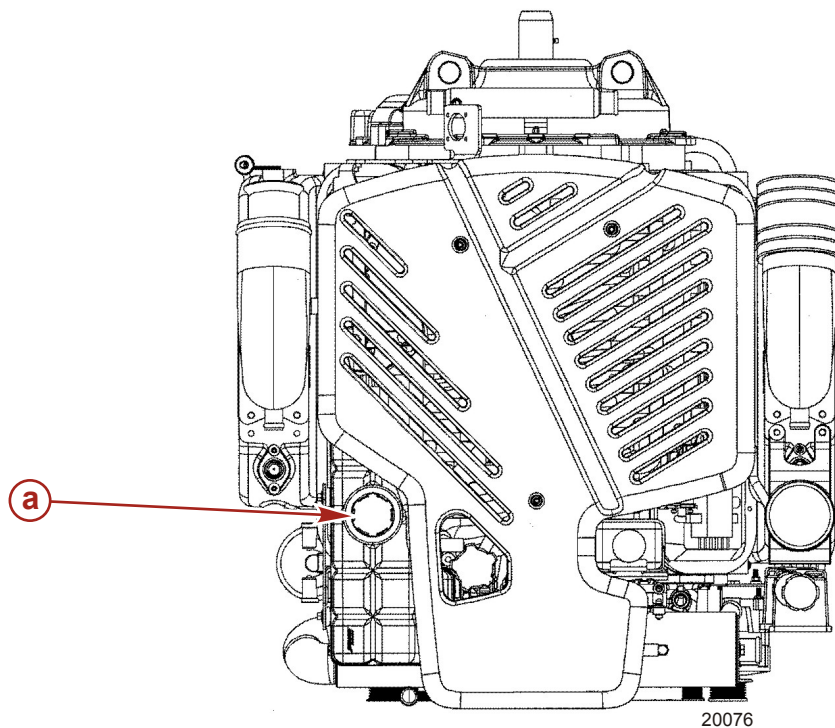
Pressure Cap Maintenance

The pressure cap is designed to maintain pressure in the fresh water section of the closed cooling system once the engine has reached normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, the cap should be cleaned and inspected periodically.

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn and allow the pressure to escape slowly, then remove the cap.

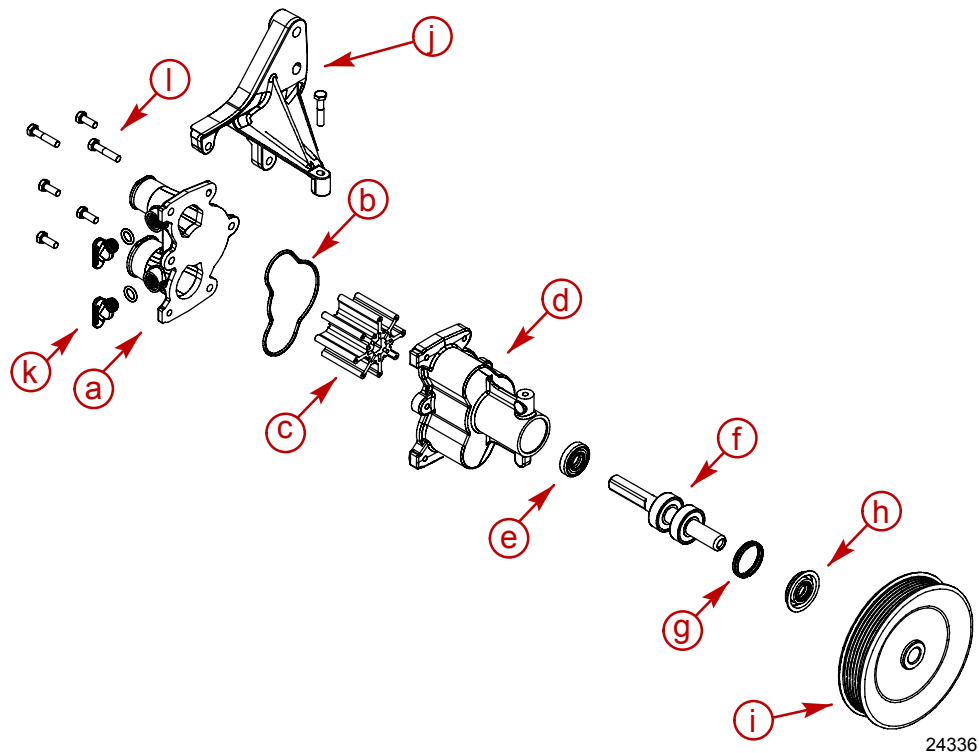
1. Remove the pressure cap from the coolant reservoir.
2. Wash the cap with clean water to remove any deposits or debris.
3. Inspect the cap for cuts, cracks, or other signs of deterioration. Replace the cap if necessary.



a - Reservoir pressure cap

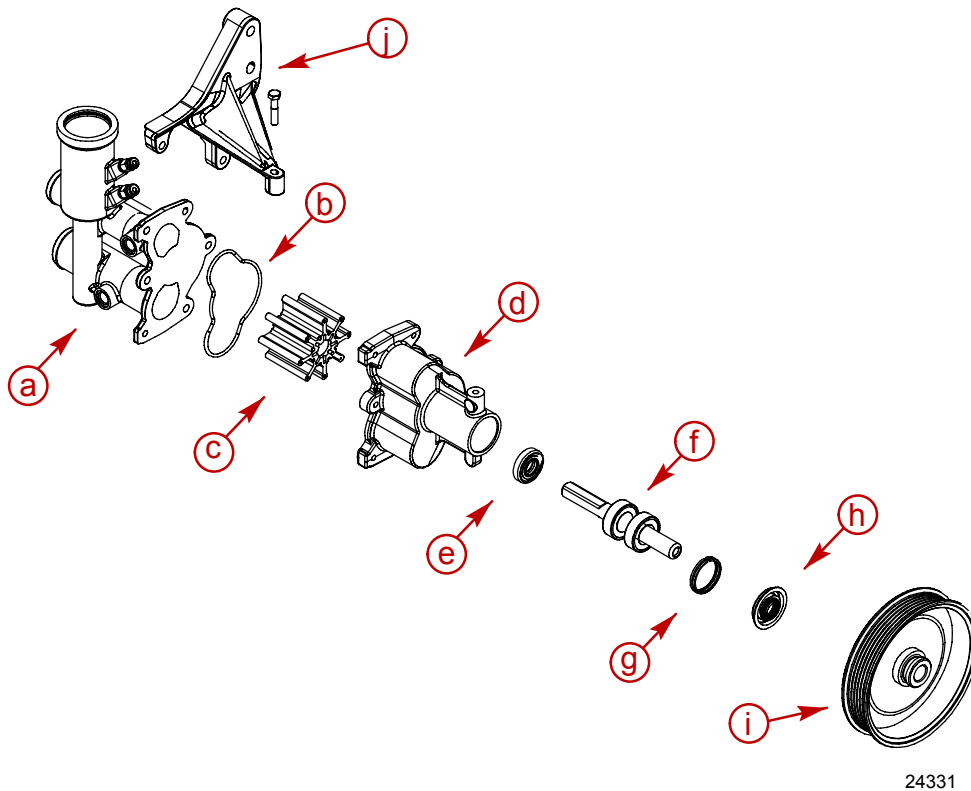
4. Clean the sealing surfaces on the coolant reservoir. Inspect surfaces for any damage or deposits that may prevent the cap from sealing properly.
5. Reinstall the pressure cap, tighten securely.

Seawater Pump Maintenance



Seawater pump with out air actuator

- | | |
|---|----------------------------------|
| a - Seawater pump impeller housing cover | g - Tolerance ring |
| b - O-ring | h - Retainer/Seal |
| c - Impeller | i - Pulley |
| d - Seawater pump impeller housing | j - Seawater pump bracket |
| e - Rear oil seal | k - Blue drain plug |
| f - Bearing shaft assembly | |



Seawater pump with air actuator

- | | |
|---|-----------------------------------|
| a - Seawater pump actuator housing | f - Bearing shaft assembly |
| b - O-ring | g - Tolerance ring |
| c - Impeller | h - Retainer/Seal |
| d - Seawater pump impeller housing | i - Pulley |
| e - Rear oil seal | j - Seawater pump bracket |

Removal

1. Drain seawater section of the cooling system.
2. Remove both of the hoses from the aft side of the seawater pump.
3. For models equipped with an air-actuated drain valve:
 - a. Disconnect the vent hose from the top of the drain valve.
 - b. Disconnect the air hoses from the drain valve, 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.
5. Remove the dual idler pulley bracket or the automatic tensioner bracket from the front of the engine.
6. Remove the seawater pump and bracket assembly.

Disassembly

⚠ CAUTION

Avoid injury and product damage. Removal of the snap ring from the top of the air-actuated drain valve can cause the components to come apart violently. The valve is not serviceable. Do not remove the snap ring.

1. Remove the seawater pump mounting bracket.
2. Remove the seawater pump pulley using an appropriate puller.
3. Remove the seawater pump impeller housing cover or the seawater pump actuator housing if equipped.
4. Remove the O-ring.
5. Remove the impeller.
6. Remove the retainer/seal from the front of the seawater pump housing.
7. Remove the tolerance ring.
8. Press the shaft and bearing assembly out of the housing from the impeller side.
9. Remove the rear oil seal.

Cleaning and Inspection

⚠ CAUTION

Do not spin bearings dry with compressed air, as this could cause bearing to score.

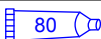
1. Clean the metal parts in solvent and dry with compressed air.
2. Clean all gasket material and sealant from the sealing surfaces.
3. Inspect the bearing housing. Examine the surfaces (where the bearings contact the housing) for evidence of the bearing outer races turning in the housing.
4. Inspect the seals in the bearing housing for signs of damage or leaks.
5. Rotate the impeller/pulley shaft in the bearing housing. Replace the impeller/pulley shaft and bearing assembly if bearings feel rough or if either end of shaft wobbles.
6. Inspect the impeller housing and impeller housing cover surfaces where the impeller rides. Replace the impeller housing if significant grooves exist.
7. Inspect the face of the impeller housing cover for grooves. The face of the impeller housing cover can be resurfaced to remove grooves. Remove a maximum of 1.0 mm (0.040 in.) of material.
8. Inspect the pump impeller and replace 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.

Assembly

1. Install the rear seal with the spring toward the impeller cavity

IMPORTANT: The bearing shaft assembly is a slip fit in the bearing housing. Minimal force is required to install the bearing shaft assembly into the housing.

2. Lubricate the outer diameter of the bearings.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Outer diameter of the bearings	Obtain Locally

3. 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.

4. Insert the tolerance ring into the impeller housing.
5. Apply adhesive to the outer diameter of retainer/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	Retainer/seal	Obtain Locally

6. Install the retainer/seal onto the bearing shaft assembly and slide it down until it contacts the end of the impeller housing.
7. Press the retainer/seal into place. Wipe away excess adhesive.
8. Lubricate the impeller with soapy water. Align the flat surfaces of the impeller hub and bearing shaft and install the impeller into the impeller cavity.
9. Install the O-ring into the groove in the impeller housing rear face.
10. Align and install the impeller housing cover or the seawater pump actuator housing if equipped onto the impeller housing assembly.
11. Apply adhesive to the threads of the impeller housing cover or the seawater pump actuator housing screws.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

12. Install the four short impeller housing cover or the seawater pump actuator housing screws and torque.

Description	Nm	lb. in.	lb. ft.
Impeller housing cover or the seawater pump actuator housing screw	10	88	

13. Install the seawater pump bracket onto the seawater pump assembly. Install the two long screws through the bracket and into the seawater pump assembly. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Seawater pump bracket to seawater pump assembly screw	10	88	

14. Apply adhesive to the threads of the remaining seawater pump bracket screw that attaches the seawater pump bracket to the top of the seawater pump assembly. Install and torque the screw.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

Description	Nm	lb. in.	lb. ft.
Impeller housing cover or the seawater pump actuator housing screw	10	88	

15. Install the seawater pump pulley onto the seawater pump shaft using an appropriate pulley installer. Ensure that the end of the shaft is even with the face of pulley hub.

Pulley Pusher Installer	91-93656A1
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16. Install the blue drain plugs in the seawater pump cover or actuator housing if removed.

Installation

1. Install the seawater pump and bracket assembly onto the studs in front of the cylinder block.
2. Install the dual idler pulley bracket or idler/tensioner bracket onto the studs in front of cylinder block using the nuts previously removed. Torque the nuts.

Description	Nm	lb. in.	lb. ft.
Idler pulley bracket or idler/tensioner bracket	50		37

3. Install the seawater inlet and outlet hoses. Tighten the hose clamps securely.
4. For models equipped with an air-actuated drain valve:
 - a. Install the vent hose onto the top of the drain valve.

NOTE: The air lines for the air-actuated drain valve are two different sizes.

- b. 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.

5. Install the serpentine drive belt.

CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

6. Supply cooling water.
7. Start the engine and check for leaks

Seawater Pump Pressure Sensor

Sterndrives with serial numbers before 0W060000, and inboard units with serial numbers before 0W090000 are equipped with a 0–100 psi seawater pump pressure sensor mounted on the seawater pump impeller cover. Units after the serial numbers indicated have a 0–50 psi seawater pump pressure sensor mounted on the power steering cooler or transmission oil cooler (located above the flywheel housing across the back of the engine). Refer to Service Manual Number 33 for diagnostic procedures.

REMOVAL

1. Disconnect the engine wiring harness from the seawater pressure sensor.
2. Remove the seawater pressure sensor from the seawater pump impeller cover or cooler.

INSTALLATION

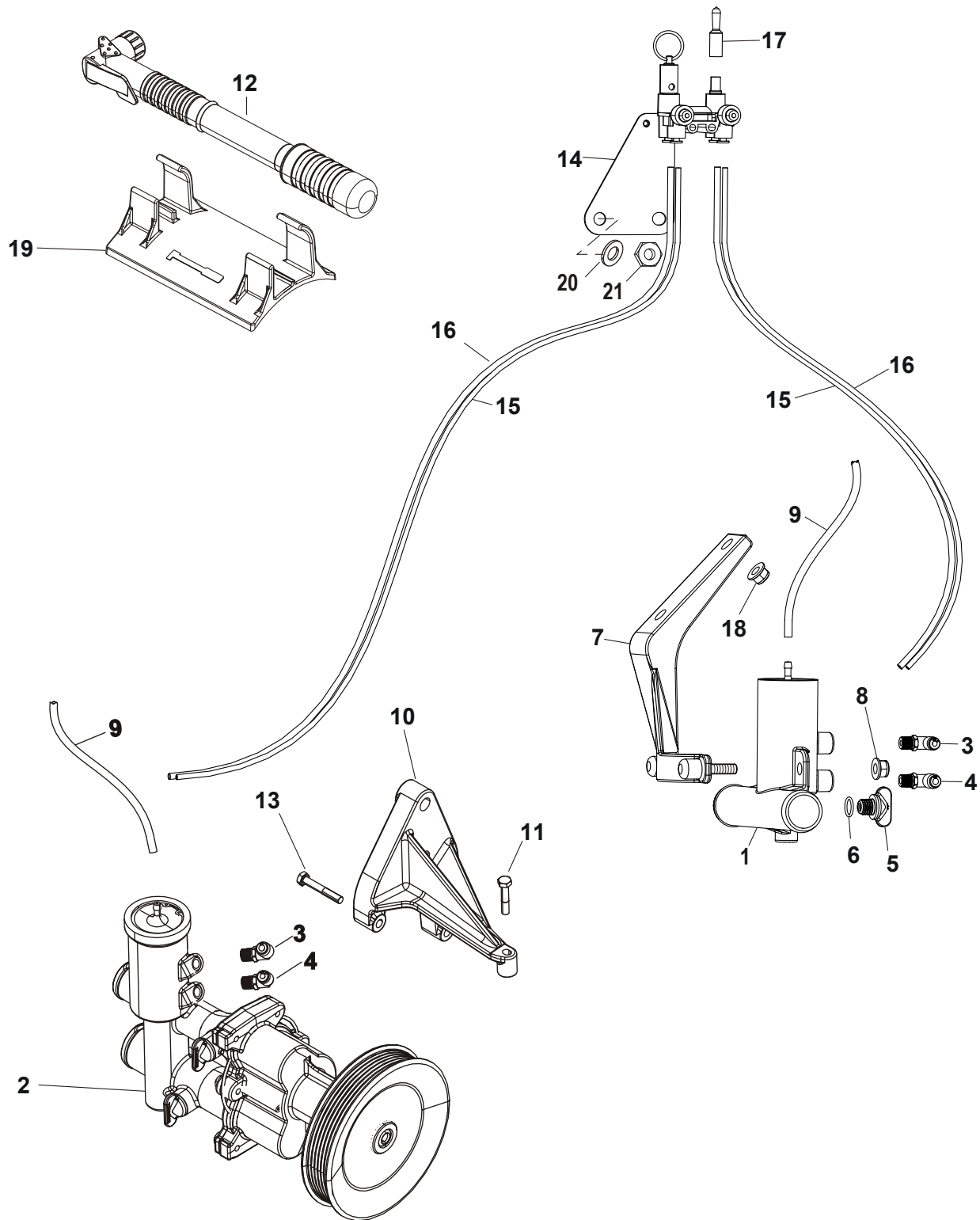
1. Install the seawater pressure sensor onto the seawater pump impeller cover or cooler. Torque the sensor.

Description	Nm	lb. in.	lb. ft.
Seawater pressure sensor	13	115	

2. Connect the harness to the pressure sensor.

Air-Actuated Drain System

Air Actuated Drain System Exploded View



18437

Air Actuated Drain System Exploded View

Ref. No.	Qty.	Description
1	1	Air actuator
2	1	Seawater pump with air actuated drain
3	1	Gray 90 degree fitting
4	1	Orange 90 degree fitting
5	1	Blue drain plug
6	1	O-ring
7	1	Air actuator mounting bracket
8	4	Nut (M8)
9	2	Black vent hose
10	1	Bracket
11	1	Screw (M6 x 30)
12	1	Air pump
13	1	Screw (M6 x 40)
14	1	Air manifold assembly
15	2	Green air line
16	2	Gray air line
17	1	Service point cap
18	1	Lock nut (M8)
19	1	Air pump bracket
20	2	Washer
21	2	Nut (M10)

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 which releases the compressed air from the system. The manual release valve also functions as an automatic pressure relief valve that opens at approximately 70 psi, thereby protecting the compressed air circuit from damage due to excess pressure.

Testing

CAUTION

Ensure that boat is out of the water or seacock is closed and that bilge pump is operating. Excess water in the bilge can damage engine or cause boat to sink.

CAUTION

Avoid injury and product damage. Removal of the snap ring from the top of the air-actuated drain valve can cause the components to come apart violently. The valve is not serviceable. Do not 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 air circuit by pulling up on 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 green 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.

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. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Air manifold assembly to bracket screw	5	40	

3. Test the drain system for proper operation.

Air-Actuated Drain Valve

REMOVAL

1. Remove the boat from the water.
2. If the air-actuated drain valve to be replaced is part of the seawater pump assembly, the entire seawater pump assembly must be removed from the engine. See **Seawater Pump Maintenance Removal** and see **Seawater Pump Maintenance Disassembly**.
3. Disconnect any water hoses connected to the air-actuated drain valves.
4. Disconnect the air lines from the drain valves. Push in and hold the plastic ring around the air line, and pull the air line out of the fitting.
5. Disconnect the cylinder vent hose from the top of the drain valve.
6. Remove the nuts that secure the port drain valve to the mounting bracket.

⚠ CAUTION

Avoid injury and product damage. Removal of the snap ring from the top of the air-actuated drain valve can cause the components to come apart violently. The valve is not serviceable. Do not remove the snap ring.

7. Remove the drain valve.

INSTALLATION

1. If the air-actuated drain valve to be replaced is part of the seawater pump assembly, install the new drain valve onto the seawater pump and install the seawater pump onto the engine. See **Seawater Pump Maintenance Removal** and see **Seawater Pump Maintenance Disassembly**.
2. Install the port drain valve onto the mounting bracket and secure with the nuts. Torque the nuts.

Description	Nm	lb. in.	lb. ft.
Port drain valve nut	24		18

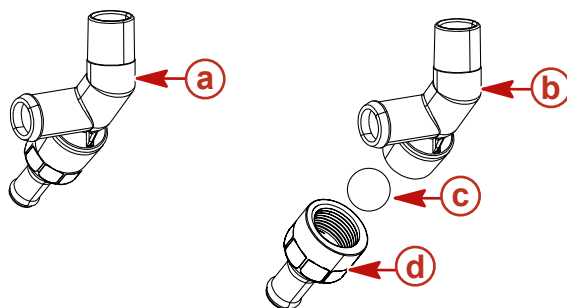
Connect the vent hose to top of drain valve. Route the vent hose the same as it was before removal.

3. Connect the air lines to the drain valve by fully inserting the air lines into the fittings.
4. Install the water hoses onto the drain valve. Tighten the hose clamps securely.
5. Test the drain system for proper operation.

Exhaust Manifold Drain Check Valve

GENERAL INFORMATION

496, and 8.1L Sterndrive, and Inboard Models are equipped with drain check valves located on the port and starboard exhaust manifolds. The drain check valve is a non-serviceable item.



24406

a - Exhaust manifold drain check valve

b - Drain fitting

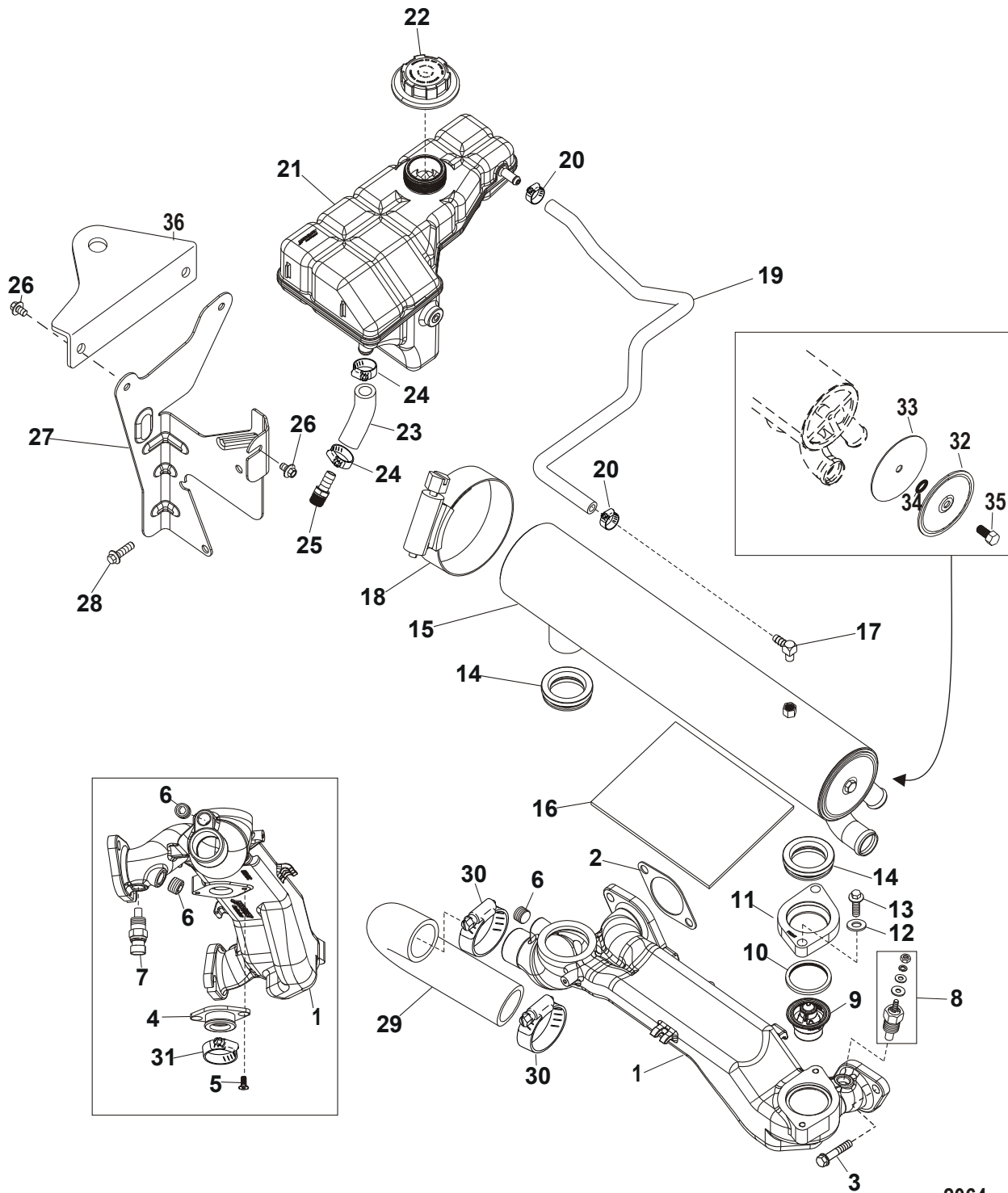
c - Check ball

d - Connector

Notes:

Testing the Closed Cooling System

Closed Cooling System Exploded View



Closed Cooling System Exploded View

Ref. No.	Qty.	Description
1	1	Coolant crossover
2	2	Cylinder head to crossover gasket
3	4	Screw (M10 x 30)
4	1	Seal
5	2	Screw (M6 x 14)
6	2	Brass plug
7	1	Coolant sensor
8	1	Temperature sender
9	1	Thermostat 71°C (160°F)
10	1	Thermostat seal
11	1	Thermostat retainer
12	2	Washer
13	2	Screw (M8 x 30)
14	2	Heat exchanger to crossover seal
15	1	Heat exchanger
16	1	Heat exchanger pad
17	2	90 degree elbow fitting
18	1	Hose clamp
19	2	Coolant bleed hose
20	1	Hose clamp
21	2	Coolant reservoir
22	1	Coolant reservoir cap
23	1	Reservoir to crossover hose
24	1	Hose clamp
25	2	Straight hose fitting
26	1	Screw (M10 x 16)
27	3	Coolant reservoir bracket
28	1	Screw (M8 x 12)
29	3	Crossover to water circulating pump hose
30	1	Hose clamp
31	2	Hose clamp
32	1	Heat exchanger end cover (used with 3 3/4 in. diameter heat exchanger)
33	2	Heat exchanger end cover gasket (used with 3 3/4 in. diameter heat exchanger)
34	2	Special O-ring
35	2	Screw (3/4-16 x 5/8)
36	1	Flush mount bracket

Testing Closed Cooling System

TESTING COOLANT FOR ALKALINITY

WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn and allow the pressure to escape slowly, then remove the cap.

The coolant in the fresh water section should be changed per maintenance schedule recommendations and should be checked for alkalinity at least once between change intervals.

1. Obtain pink litmus paper from a local supplier.
2. Remove the pressure cap from the coolant reservoir 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. See **Changing Coolant**.

PRESSURE TESTING SYSTEM

WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn and allow the pressure to escape slowly, then remove the cap.

If the coolant section of the closed cooling system is suspected of leaking or not holding sufficient pressure and no visible signs of leaking can be found, perform the following test:

1. Remove the pressure cap from the reservoir.
2. Clean and inspect pressure cap to ensure that the cap is maintaining proper pressure in the system.
3. Inspect sealing surfaces for debris or damage that would hinder proper sealing.
4. Adjust the coolant level to the "FULL" mark on the coolant reservoir.
5. Test the pressure cap using the Stant adapter for testing the pressure cap.

Description	Part Number
Stant pressure cap tester	Obtain locally

6. Attach an automotive-type cooling system pressure tester, and pressurize the closed cooling section to the amount specified in the following chart, based on the pressure cap rating for your engine.

Description	Part Number
Stant automotive-type cooling system pressure tester	Obtain locally

Closed Cooling System Pressure Specifications	
Pressure cap rating (coolant reservoir)	103 kPa (15 psi)
Closed cooling system pressure test	131 kPa (19 psi)

7. Observe the gauge reading for approximately 2 minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until the leak is found.

8. While maintaining the specified pressure on the closed cooling section, visually inspect the external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal) for leaks. Also, listen closely for bubbling or hissing; either indicates a leak.
9. If no leaks could be found in the above steps, the engine may be leaking internally, possibly due to one or more of the following:
 - Loose cylinder head bolts or a damaged gasket.
 - Loose intake manifold bolts or a damaged gasket.
 - Cracked or porous cylinder head or block.
 - Internal heat exchanger leak.
10. Proceed as follows until the location of the internal leak is found.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

- a. Provide cooling water.
- b. Start the engine. Re-pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, compression or combustion may be leaking into the closed cooling section from a leak in the combustion chamber.
- c. Remove the spark plugs (one at a time) from the cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing indicates a leak.
- d. Drain oil from the engine and examine for presence of coolant. The oil will be milky if coolant is present. If coolant is present, remove the engine from the boat and drop the oil pan. With the engine in the upright position, re-pressurize the closed cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.
- e. If no leaks can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Heat Exchanger

Testing and Inspection

INTERNAL LEAKS AND BLOCKAGE

An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Drain the seawater section of the cooling system.
2. Remove the heat exchanger end caps, bolts, gaskets, and seals.
3. Remove any debris found in the ends of the heat exchanger.
4. Inspect the heat exchanger tubes for blockage by blowing compressed air into one end of the tubes and feeling for air coming out of each tube at the other end.
5. Pressurize the closed cooling system to 131 kPa (19 psi) with a Stant Tester.

Closed Cooling System Pressure Specifications	
Closed cooling system pressure test	131 kPa (19 psi)

6. Observe tubes in the ends of heat exchanger. Coolant or water flow from any tube indicates a leak in that tube. Coolant leaking from around any of the tubes indicates a failure of the solder joint between the tube and header plate.

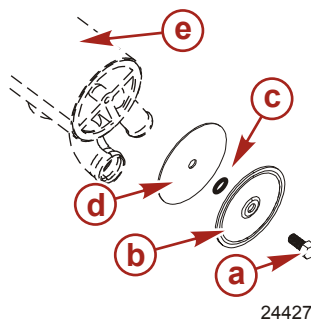
Removal

1. Drain both the seawater and the coolant sections of the cooling system.
2. Remove the flame arrestor.
3. Disconnect the vent hose from the top of the heat exchanger.
4. Remove the hoses connected to the heat exchanger.
5. Remove or cut the hose clamps that secure the heat exchanger to the coolant crossover.
6. Loosen the thermostat retainer screws.
7. Carefully lift the heat exchanger from crossover.

Disassembly

IMPORTANT: The heat exchanger on some 496 / 8.1L models are equipped with a special stud used to secure the port end cover. The special stud is used for manufacturing purposes, and is not sold separately. For information on a suitable replacement for the special stud, *refer to the appropriate Mercury MerCruiser Parts Catalog*.

1. Remove the screws that secure the end covers to each end of the heat exchanger.
2. Remove the end covers, seal washers, and gaskets. Discard the seal washers and gaskets.



a - Screw

b - End cover

c - O-ring

d - Gasket

e - Heat exchanger (starboard side)

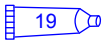
Cleaning

The efficiency of a closed cooling system depends greatly 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, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. The seawater section of the heat exchanger should be cleaned at least once every two years or whenever decreased cooling efficiency is suspected.

1. Clean gasket material from the end plates and heat exchanger.
2. Clean the water passages in the heat exchanger by inserting a suitable size rod and wire brush into each passage. Use compressed air to blow loose particles out of the water passages.

Assembly

1. Apply sealant to both sides of the new end cover gaskets, then reinstall the end covers using the end cover screws, new gaskets, and O-ring. (Be sure to install O-ring between end covers and gaskets). Torque the screws.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	End cover screw	92-34227-1

Description	Nm	lb. in.	lb. ft.
End cover screw	6		54

⚠ CAUTION

Avoid damaging the seawater pickup pump impeller. Do not operate the engine without supplying cooling water to the Seawater pickup pump.

2. With the boat in the water or cooling water properly supplied to the seawater pickup pump, start the engine, and inspect for leaks.

Heat Exchanger Repair

IMPORTANT: Brazing shut a leaking tube is only a temporary solution. Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. To repair a leaking tube, braze shut the ends of the leaking tube. Usually another tube will start leaking after a short period of time, causing a reduction in cooling capacity. Do not close more than three tubes.

Installation

1. Ensure that the thermostat retainer screws are loose.
2. Install the new seals into the coolant crossover and thermostat retainer. Coat the inside diameters of seals with lubricant.

Tube Ref No.	Description	Where Used	Part No.
 19	Paker Superlube (863772)	Crossover to heat exchanger seals	Obtain Locally

3. Align the heat exchanger fittings with the seals and push the heat exchanger downward until it rests on the crossover.
4. Firmly press the heat exchanger into the crossover fittings.
5. Install the heat exchanger clamps around the crossover and heat exchanger. Tighten the clamps securely.
6. Tighten the thermostat retainer screws. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Thermostat retainer screw	16		12

7. Install the hoses to the heat exchanger.
8. Install the hose from the coolant reservoir. Tighten the hose clamps securely.
9. Fill the closed cooling system.
10. Install the flame arrestor.
11. Start the engine and allow it to reach normal operating temperature, then check for leaks.

Thermostat

Removal

NOTE: If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into drain holes to ensure that there are no obstructions in the passages.

1. Remove the heat exchanger.

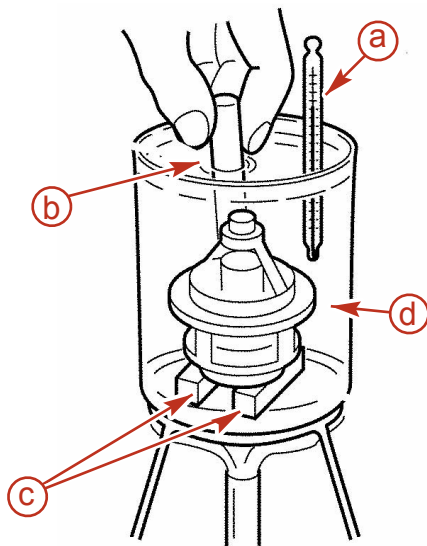
2. Remove the thermostat retainer.
3. Remove the thermostat.
4. Remove the rubber O-ring from the thermostat.

Cleaning and Inspection

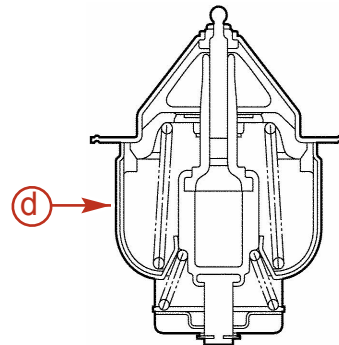
1. Clean the thermostat with soapy water.
2. Inspect the O-ring for cuts, scrapes, and wear. Replace if necessary.
3. Inspect the thermostat retainer for damage that would cause coolant to leak. Replace if necessary.

Testing

1. Place the thermostat on blocks in a container.
2. Completely submerge the thermostat in water.
3. Heat the water.
4. Stir the water constantly to avoid direct heat being applied to the thermostat.
5. See **Specifications:**
 - a. Check the thermostat initial opening temperature.
 - b. Check the thermostat full opening temperature.
 - c. Check valve lift at fully open position.



a - Thermometer
b - Agitating rod



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c - Wooden blocks
d - Thermostat

Installation

1. Install a new O-ring and thermostat into the crossover. Ensure that the thermostat seats in the groove of the crossover.
2. Install the thermostat retainer with two screws and washers. Do not tighten.
3. Install the heat exchanger.
4. Torque thermostat retainer screws.

Description	Nm	lb. in.	lb. ft.
Thermostat retainer fittings	16		12

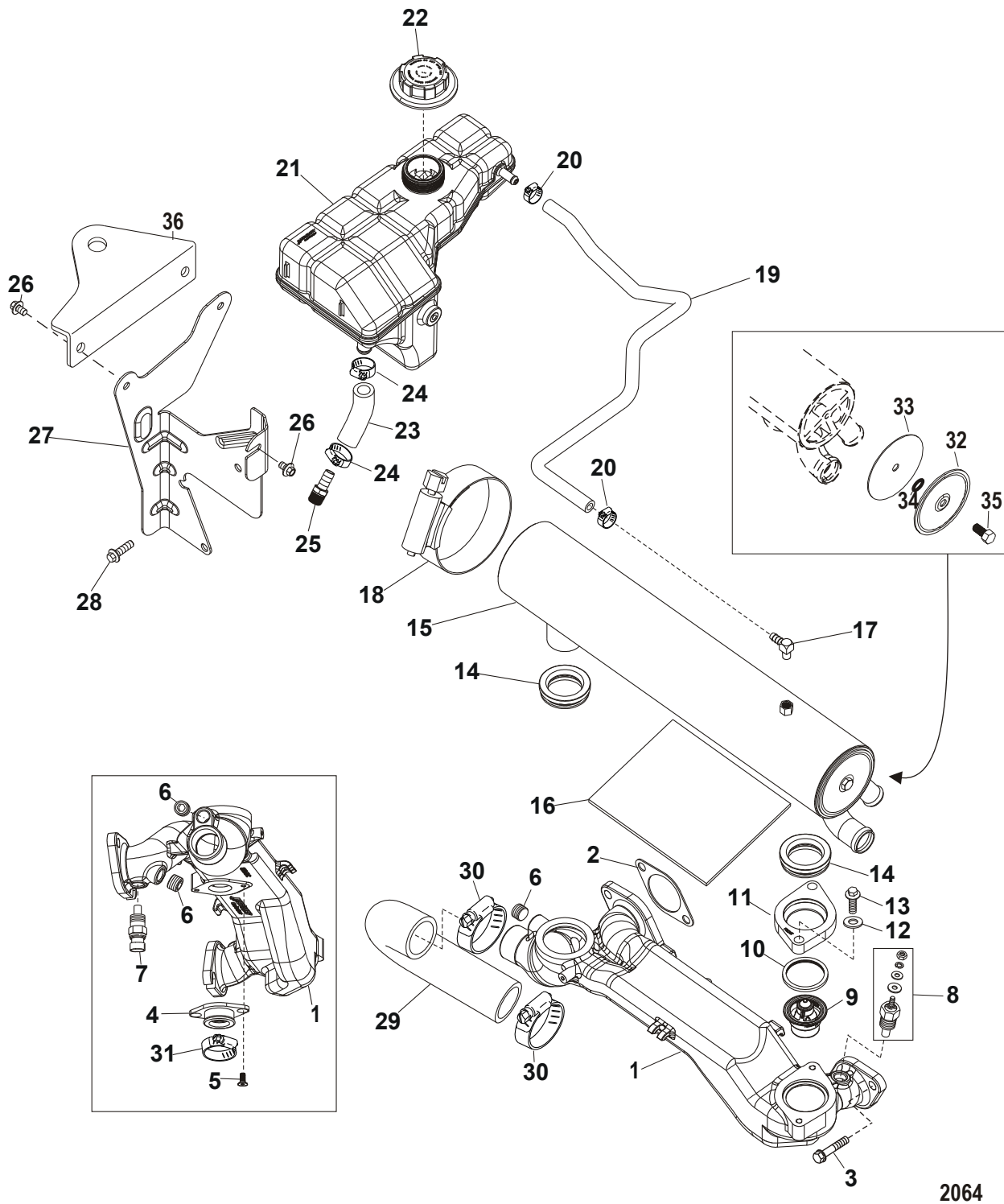
5. Refill the closed cooling system.

 CAUTION

Avoid damaging the seawater pickup pump impeller. Do not operate the engine without supplying cooling water to the Seawater pickup pump.

6. Start the engine and check for leaks.

Closed Cooling System Exploded View



Closed Cooling System Exploded View

Ref. No.	Qty.	Description
1	1	Coolant crossover
2	2	Cylinder head to crossover gasket
3	4	Screw (M10 x 30)
4	1	Seal
5	2	Screw (M6 x 14)
6	2	Brass plug
7	1	Coolant sensor
8	1	Temperature sender
9	1	Thermostat 71°C (160°F)
10	1	Thermostat seal
11	1	Thermostat retainer
12	2	Washer
13	2	Screw (M8 x 30)
14	2	Heat exchanger to crossover seal
15	1	Heat exchanger
16	1	Heat exchanger pad
17	2	90 degree elbow fitting
18	1	Hose clamp
19	2	Coolant bleed hose
20	1	Hose clamp
21	2	Coolant reservoir
22	1	Coolant reservoir cap
23	1	Reservoir to crossover hose
24	1	Hose clamp
25	2	Straight hose fitting
26	1	Screw (M10 x 16)
27	3	Coolant reservoir bracket
28	1	Screw (M8 x 12)
29	3	Crossover to water circulating pump hose
30	1	Hose clamp
31	2	Hose clamp
32	1	Heat exchanger end cover (used with 3 3/4 in. diameter heat exchanger)
33	2	Heat exchanger end cover gasket (used with 3 3/4 in. diameter heat exchanger)
34	2	Special O-ring
35	2	Screw (3/4-16 x 5/8)
36	1	Flush mount bracket

Crossover

Removal

1. Remove the heat exchanger.
2. Remove the coolant reservoir.
3. Remove the harness connection to water temperature sender and sensor.
4. Loosen the hose clamp on the water pump bypass seal.
5. Loosen the hose clamp on the water inlet hose.
6. Loosen the crossover mounting bolts at each cylinder head. Remove the mounting bolts, coolant crossover, and gaskets.

Disassembly

1. Remove the thermostat retainer, thermostat, and seal.
2. Remove the bypass seal from the bottom of the coolant crossover
3. Remove the coolant temperature sensor, coolant temperature sender, and any fittings and pipe plugs.

Cleaning and Inspection

1. Clean the gasket material from all mating surfaces.
2. Inspect the crossover for cracks or scratches. Sealing surfaces must be clean and free of any damage that could cause a leak.
3. Check the crossover passages for scale buildup and other foreign material. Clean as necessary.
4. Inspect the pipe plugs and fittings for cracks or thread damage. Replace as necessary.
5. Inspect the hose connections for wear or debris.
6. Inspect the heat exchanger pads for wear. Inspect for indications of contact between the heat exchanger and crossover.
7. Inspect the gaskets for wear or damage. Replace as necessary.

Assembly

1. Install the seal onto the thermostat.
2. Install the thermostat into the thermostat cavity in the crossover.
3. Place the thermostat retainer over the thermostat and install the washers and screws. Do not tighten screws at this time.
4. Install the bypass seal and screws onto the flange on the bottom of the crossover. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Crossover flange screw	7	63	

5. Install the temperature sensor (2-pin plug) into the vertical port on the bottom of the crossover at the end opposite to the thermostat cavity. Torque the sensor.

Description	Nm	lb. in.	lb. ft.
Temperature sensor	23		17

6. Install the temperature sender into the port on top of the crossover at the end closest to the thermostat cavity. Torque the sender.

Description	Nm	lb. in.	lb. ft.
Temperature sender	23		17

7. Install the straight hose fitting into the angled port on top of the crossover at end opposite the thermostat cavity. Torque the fitting.

Description	Nm	lb. in.	lb. ft.
Straight hose fitting	23		17

8. If the engine is to supply hot coolant to a cabin heater or water heater:
 - a. Install the appropriate outlet fitting into the angled port on the bottom of the crossover at the end opposite the thermostat cavity.
 - b. Install the appropriate return fitting into the post directly over the bib for the circulating pump hose. Torque the fittings.

Description	Nm	lb. in.	lb. ft.
Coolant outlet fitting	23		17
Coolant return fitting			

9. Install pipe plugs into any remaining ports. Torque the pipe plugs.

Description	Nm	lb. in.	lb. ft.
Pipe plugs	23		17

Installation

1. Apply soapy water to the inside of the rubber portion of the bypass seal on the bottom of the crossover. Place the hose clamp around the rubber portion of the bypass seal.

Tube Ref No.	Description	Where Used	Part No.
	Soapy water	Bypass seal	Obtain Locally

2. Position the rubber portion of the bypass seal over the fitting extending from the top of the circulating pump. Push down on the crossover until the end of the rubber portion of the bypass seal is against the top of the circulating pump.
3. At each end of the crossover, position the flange gasket between the flange and the cylinder head.
4. Install the crossover mounting screws through the holes in crossover and gasket and into the holes in the cylinder head. Torque the screws after both gaskets and all four bolts are installed.

Description	Nm	lb. in.	lb. ft.
Crossover mounting screw	50		37

5. Tighten the hose clamp on the bypass seal.

Description	Nm	lb. in.	lb. ft.
Hose clamp	21		16

6. Install the hose clamps onto the circulating pump hose and install the circulating pump hose onto the crossover and circulating pump. Tighten the clamps securely.
7. Connect the wiring harness to the coolant temperature sensor and coolant temperature sender.
8. Connect the auxiliary heater supply and return the hoses to the appropriate fittings on the crossover, if equipped.
9. Install the coolant reservoir.
10. Install the heat exchanger.
11. Fill the coolant section of the cooling system with the appropriate coolant

Tube Ref No.	Description	Where Used	Part No.
	Extended Life Antifreeze/ Coolant	Coolant section of the cooling system	92-877770K1

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

12. Start the engine and check for leaks while allowing the engine coolant to reach normal operating temperature. Stop the engine.
13. After the engine has cooled completely, check the coolant level.

Coolant Requirement

⚠ CAUTION

Propylene glycol, alcohol or methanol based antifreeze is not recommended for use in the closed cooling system.

Use *de-ionized* or *distilled* water to dilute the antifreeze if it is not pre-diluted.

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. The color of this antifreeze is orange. Any "top-off" fluid used must be Extended Life Coolant.

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

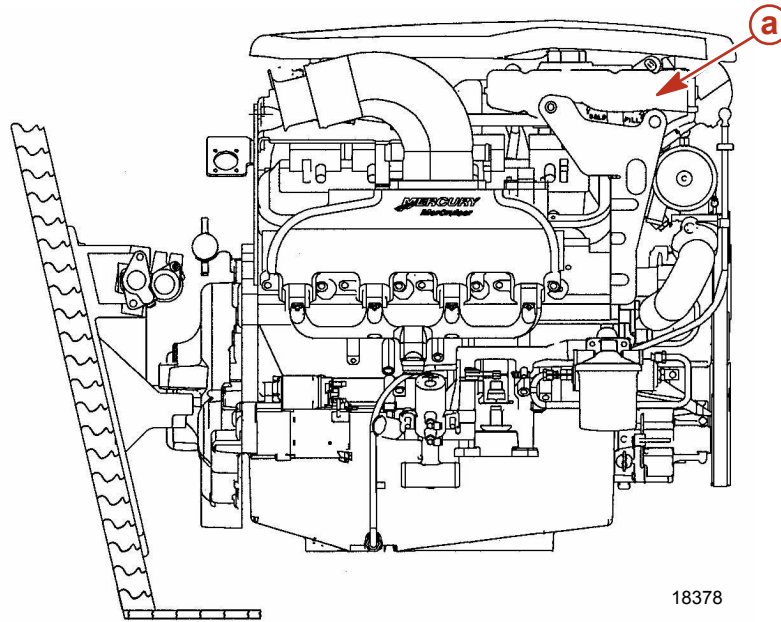
Checking Coolant Level

⚠ WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

IMPORTANT: When reinstalling the pressure cap, ensure that it is tightened securely.

1. The coolant level should be at the "FULL" mark on the coolant reservoir with the engine cold.



a - Coolant reservoir

Draining

IMPORTANT: The engine must be as level as possible to ensure complete draining of the cooling system.

IMPORTANT: The closed cooling section must be kept filled year-round with the recommended coolant. If the engine will be exposed to freezing temperatures, ensure that the closed cooling section is filled with a solution of Extended Life Coolant and distilled water properly mixed to protect the engine to the lowest temperature to which it will be exposed.

IMPORTANT: Observe the precautions previously outlined before proceeding.

⚠ WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

1. Remove the pressure cap from the coolant reservoir.
2. Remove both of the hex head drain plugs located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the engine coolant into a suitable container.
4. After the coolant has drained completely, reinstall the drain plugs. Tighten the drain plugs securely.

Cleaning the Closed Cooling System

The closed cooling section of closed cooling system should be cleaned 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 manufacturer's instructions for the cleaner. If the closed cooling section is extremely dirty, use a pressure flushing device to flush out remaining deposits. Flushing should be done in the direction opposite normal coolant flow to allow water to get behind deposits and force them out. For proper hookup and flushing procedures refer to instructions which accompany the flushing device.

Filling the Closed Cooling System

IMPORTANT: The engine must be cooled to ambient temperature to correctly perform the following procedure.

⚠ CAUTION
Propylene glycol, alcohol or methanol based antifreeze is not recommended for use in the closed cooling system.
Use <i>de-ionized</i> or <i>distilled</i> water to dilute the antifreeze if it is not pre-diluted.

The coolant section of the closed cooling system must be filled with a 50/50 mixture of Extended Life Coolant and distilled water.

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

NOTE: Coolant section capacity is approximately 22 liters (23 U.S. qt.).

Model	8.1L (496 cid)
Closed cooling system	21.76 liters (23 qt.)

⚠ WARNING
Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

IMPORTANT: When filling the coolant section after it has been completely drained, the engine should be level or slightly lower at the flywheel end.

1. Remove the pressure cap from the coolant reservoir.
2. Fill the reservoir to the "FULL" mark with the recommended coolant solution.
3. When refilling the coolant section after it has been completely drained, fill the reservoir to within 12 mm (0.50 in.) of top of reservoir neck before starting the engine.
4. Replace the pressure cap.

⚠ CAUTION
DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

5. Supply cooling water to the engine.
6. With the engine running, check the hose connections, fittings, and gaskets for leaks. Also observe the engine temperature gauge to ensure that the engine operating temperature is normal. If the gauge indicates excessive temperature, stop the engine immediately and determine the cause.

⚠ WARNING

Avoid personal injury and burns from hot engine coolant. Allow the engine to cool down before removing the coolant pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently.

7. After the engine has cooled completely, recheck the coolant level and add coolant, if necessary.
8. If the reservoir was completely emptied of coolant, a significant amount of air remains in the cooling system. Refill the reservoir to the "FULL" mark, repeat the warm-up/cool-down cycle, and check the coolant level again.
9. Maintain the coolant level in the reservoir at or near the "FULL" mark with the engine cold.

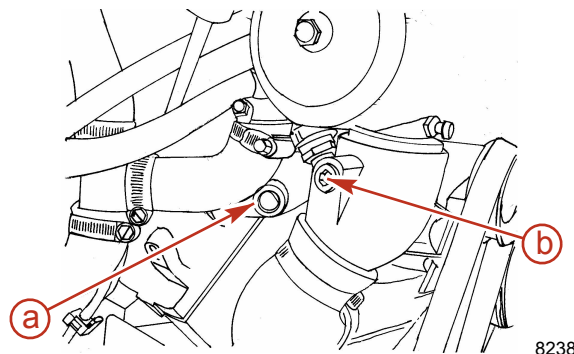
Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

- 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.) I.D. (inside diameter).
- Make heater connections only at the locations described in the following instructions.
- Check the complete system for leaks after the heater is connected into the cooling system.
- Check for overheating condition (of the engine) after the heater is connected.

⚠ CAUTION

Avoid engine overheating which could result in engine damage. An air pocket may form in the closed cooling system if the cabin heater or hot water heater is mounted higher than the cap on the coolant reservoir. Mount the cabin heater or hot water heater lower than the cap on the coolant reservoir.



a - Supply hose connection

b - Return hose connection

Notes:

Exhaust System

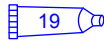
Section 7A - Manifolds and Elbows

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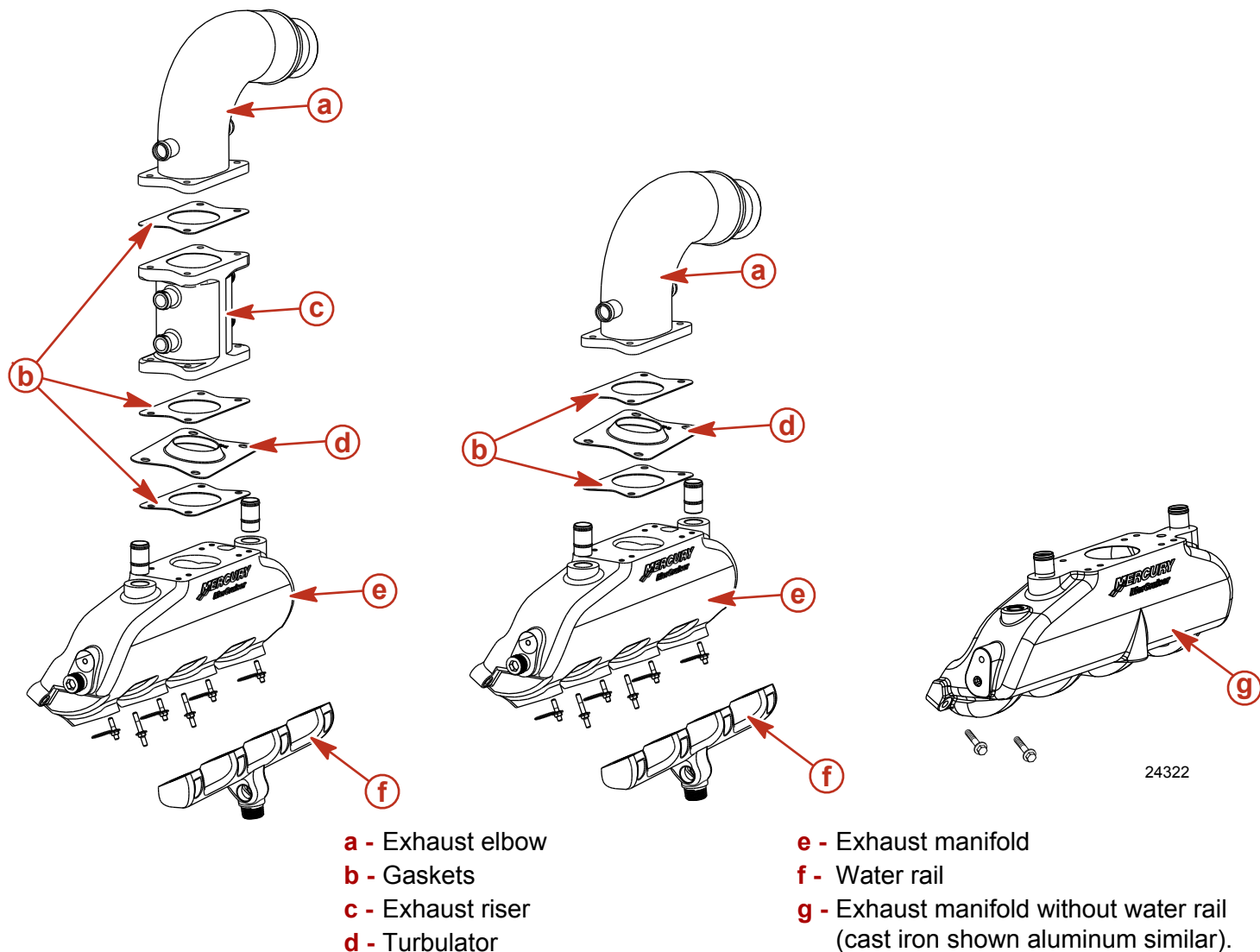
Exploded View.....	7A-2	Cleaning and Inspection.....	7A-3
Exhaust Manifold Identification.....	7A-3	Installation.....	7A-4
Removal.....	7A-3	Manifold.....	7A-4



Lubricant, Sealant, Adhesives

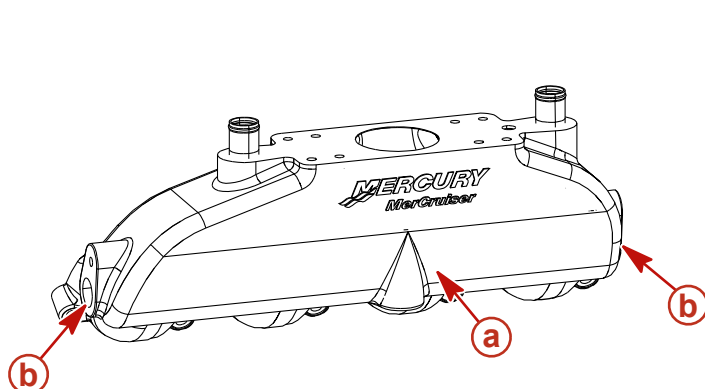
Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Coarse threads of exhaust elbow studs	92-809819
 19	Perfect Seal	Exhaust manifold threads	92-34227-1
 66	Loctite 242 Threadlocker	Coarse threads of water rail studs	92-809821

Exploded View

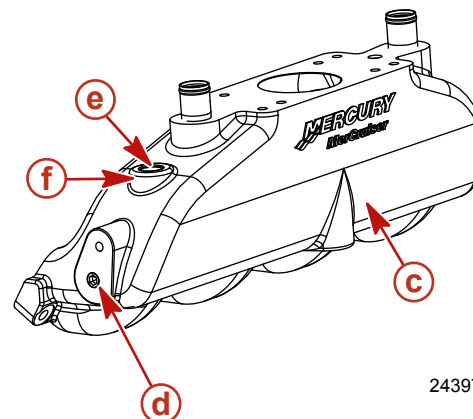


Exhaust Manifold Identification

The following information has been developed to aid in the visual identification of the aluminum and cast iron exhaust manifolds without water rails. The aluminum exhaust manifold is equipped with two 3/4 in. drain plugs located in each end of the exhaust manifold. The cast iron exhaust manifold is equipped with a single 3/8 in. drain plug located in one end of the exhaust manifold. The cast iron exhaust manifold is also equipped with one expansion plug located in a casting boss on the upper edge of the exhaust manifold.



- a** - Aluminum exhaust manifold (without water rail)
- b** - 3/4 in. drain plug
- c** - Cast iron exhaust manifold



- d** - 3/8 in. drain plug
- e** - Expansion plug
- f** - Casting boss

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Removal

⚠ WARNING

Avoid injury or product damage from a short in the electrical system. Before proceeding, disconnect all battery cables from the battery.

1. Disconnect the battery cables from the battery.

⚠ CAUTION

Avoid severe engine damage. Exhaust elbows and manifolds must be drained to prevent coolant from entering combustion chambers when exhaust elbows are removed.

2. Drain the water from the manifold, elbow, and riser, if equipped.
3. Disconnect the exhaust and cooling hoses.
4. Remove any other components that are mounted to the exhaust manifold, exhaust elbow, and exhaust riser, if equipped.
5. Remove the exhaust elbow and exhaust riser, if equipped.
6. Remove the exhaust manifold fasteners.
7. Remove the exhaust manifold assembly and discard the gaskets.
8. Remove and retain the water rail nuts and water rail, if equipped.
9. If necessary remove the water rail studs, if equipped.

Cleaning and Inspection

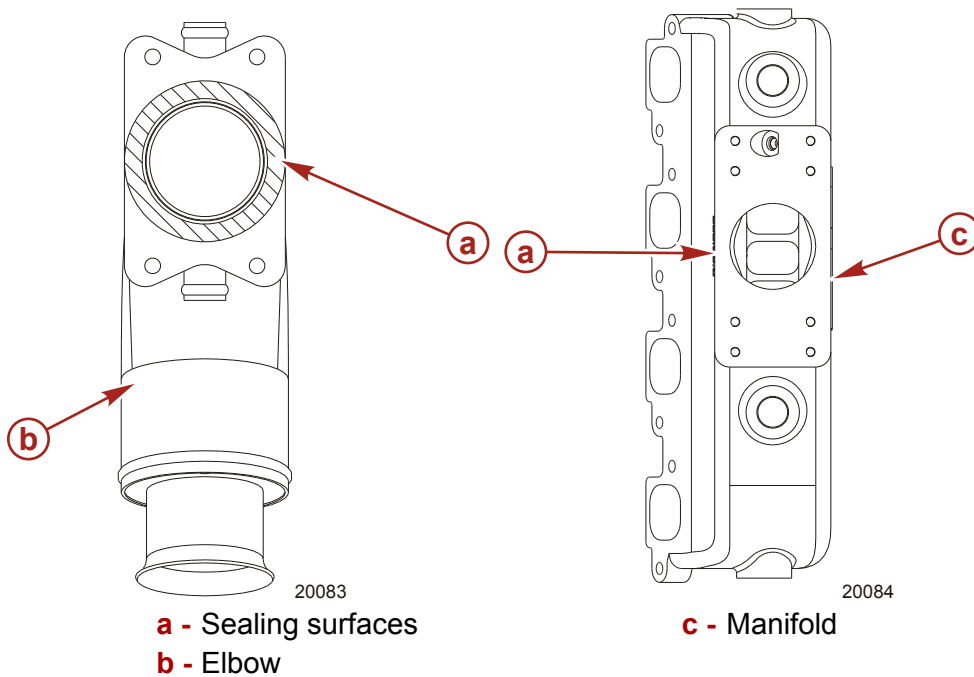
1. Clean the gasket material from all surfaces.

2. Check the water passages for foreign material. The passages must be clean for efficient cooling.
3. If a more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold.

IMPORTANT: If the plugs are removed, coat the threads with sealant before reinstalling.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Exhaust manifold threads	92-34227-1

4. Check for cracks.
5. To test the exhaust manifold and water rail, if equipped, for leaks, block-off plates, plugs, or short hoses with plugged ends must be used. 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.
6. Inspect all sealing surfaces carefully. Machined surfaces must be clean and free of all marks and deep scratches or exhaust leaks may result.



7. Check the flatness of all gasket surfaces. Maximum overall warp is 0.07 mm (0.003 in.) , with not more than a 0.02 mm (0.001 in.) difference within 25 mm (1 in.).

NOTE: Maximum material that can be removed is 0.25 mm (.010 inches) to flatten a gasket surface.

8. Look at the condition of the metal around the exhaust outlet in the casting. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser, if equipped. Replace all damaged parts.

Installation

Manifold

1. For models without water rails, skip to step 8.
2. Align the O-rings onto the water rail, if equipped.

3. Apply adhesive to the coarse threads of the water rail studs, if equipped.

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Coarse threads of water rail studs	92-809821

4. Install the water rail studs into the exhaust manifold. Torque the studs.

Description	Nm	lb. in.	lb. ft.
Water rail stud	10		7

5. Install the water rail onto the exhaust manifold, and secure using the nuts. Torque the nuts.

Description	Nm	lb. in.	lb. ft.
Water rail nut	8		6

6. If using cap screws, install the water rail onto the exhaust manifold using the cap screws. Torque the cap screws.

Description	Nm	lb. in.	lb. ft.
Water rail cap screw	10		7

7. For exhaust manifolds with or without water rails.

8. Position a new exhaust manifold gasket onto the exhaust manifold.

9. Install the exhaust manifold onto the cylinder head, and secure using the exhaust manifold screws. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Exhaust manifold screw	35		26

10. To install the exhaust elbow without riser:

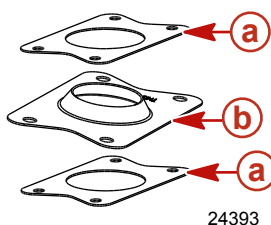
- a. For exhaust manifolds equipped with water rails and aluminum exhaust manifolds without water rails, apply adhesive to the coarse threads of the exhaust elbow studs.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Coarse threads of exhaust elbow studs	92-809819

- b. Install the exhaust elbow studs into exhaust manifold. Torque the studs.

Description	Nm	lb. in.	lb. ft.
Exhaust elbow stud	20		15

- c. For exhaust manifolds equipped with water rails, aluminum exhaust manifolds without water rails, and cast iron exhaust manifolds, position the exhaust elbow gaskets, and turbulator onto the exhaust manifold as shown.



a - Exhaust elbow gasket

b - Turbulator

- d. For exhaust manifolds equipped with water rails and aluminum exhaust manifolds without water rails, Install the exhaust elbow onto the exhaust manifold and secure using the exhaust elbow nuts. Torque the nuts.

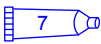
Description	Nm	lb. in.	lb. ft.
Exhaust elbow nut	16		12

- e. For cast iron exhaust manifolds, Install the exhaust elbow onto the exhaust manifold and secure using cap screws. Torque the cap screws.

Description	Nm	lb. in.	lb. ft.
Exhaust elbow cap screw	16		12

11. To install the exhaust elbow with 152 mm (6 in.) riser:

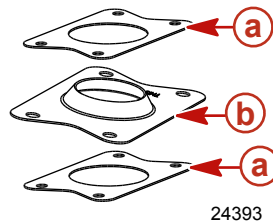
- a. Apply adhesive to the coarse threads of the exhaust elbow and riser studs.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Coarse threads of exhaust elbow studs	92-809819

- b. Install the exhaust elbow, and riser studs into exhaust manifold. Torque the studs.

Description	Nm	lb. in.	lb. ft.
Exhaust elbow and riser stud	20		15

- c. Position the exhaust elbow gaskets, and turbulator onto the exhaust manifold as shown.



a - Exhaust elbow gasket

b - Turbulator

- d. Position the 152 mm (6 in.) riser onto the exhaust manifold, and elbow studs until seated onto the exhaust manifold.
- e. Position the exhaust riser to exhaust elbow gasket onto the exhaust riser.
- f. Install the exhaust elbow onto the exhaust riser, and secure using the exhaust elbow nuts. Torque the nuts.

Description	Nm	lb. in.	lb. ft.
Exhaust elbow nut	16		12

12. Install any components previously removed.

13. Install exhaust elbows and cooling hoses.

14. Reconnect the battery cables to the battery. Tighten securely.

15. Start the engine and check for fuel, exhaust, and water leaks.

Exhaust System

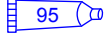
Section 7B - Collectors

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**7
B**

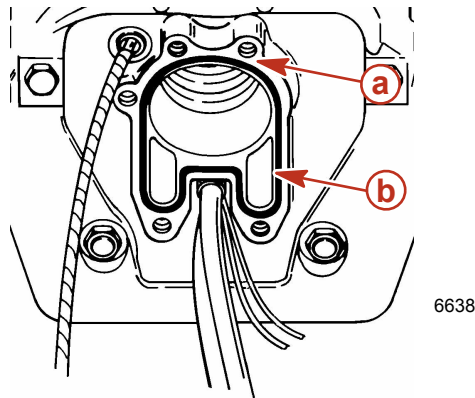
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Automotive weather-strip adhesive	Air intake filter	Obtain Locally
	2-4-C with Teflon	Air cylinder-to-silencer pipe flapper at clevis and pin	92-802859A1

Component Replacement

To replace any components in the exhaust system, adhere to the following:

- All mating surfaces must be clean.
- The O-ring must remain in the groove to properly seal the joints to prevent leakage.
- Tighten all clamps securely.

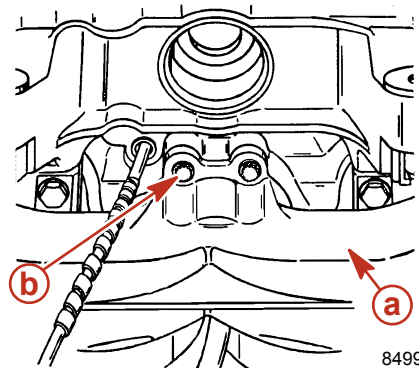


a - Mating surface

b - O-ring

Through Propeller Exhaust

1. Install the exhaust pipe assembly using the 4 screws and lockwashers. Torque the screws.



a - Exhaust pipe

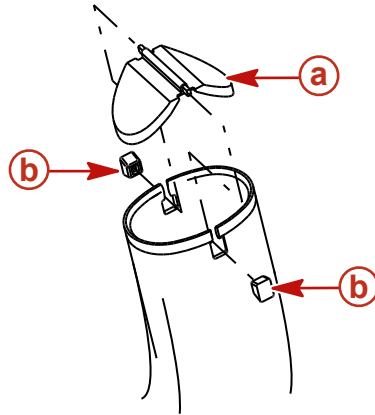
b - Bolts and lockwashers (4)

Description	Nm	lb. in.	lb. ft.
Exhaust pipe screw	34		25

Water Shutter Replacement

IMPORTANT: All exhaust connections, including those at the exhaust elbow, must be secured with 2 hose clamps. ABYC standards also specify the use of stainless steel clamps with a minimum 13 mm (1/2 in.) band width. Do not use spring tension clamps.

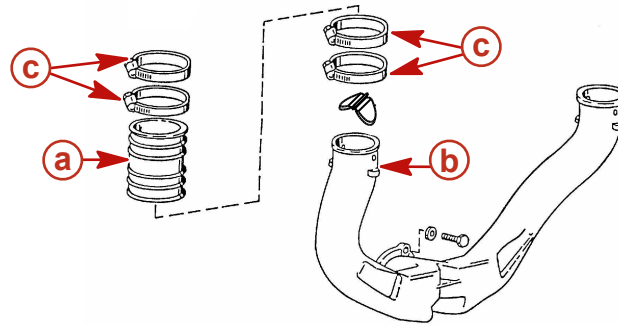
1. Remove and retain the intermediate exhaust pipe from the Y pipe.
2. Remove and discard the the water shutter and grommets from the Y pipe.
3. Install the water shutter into the Y pipe. Ensure that the water shutter is seated into the rubber grommets.



18483

a - Water shutter**b** - Rubber grommet

4. Install the intermediate exhaust pipe onto the Y pipe and secure with hose clamps. Torque the hose clamps.

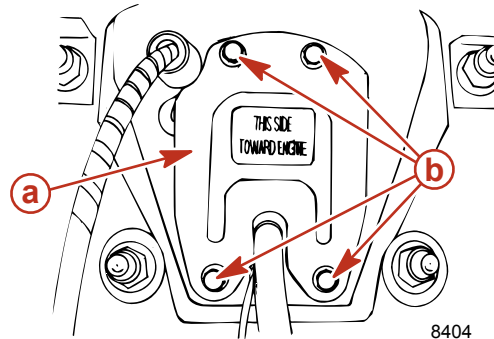


18530

Description	Nm	lb. in.	lb. ft.
Hose clamp (exhaust tube)	4	35	

Through the Transom Exhaust

IMPORTANT: A block off plate must be installed when using through the transom exhaust or below swim platform kits.



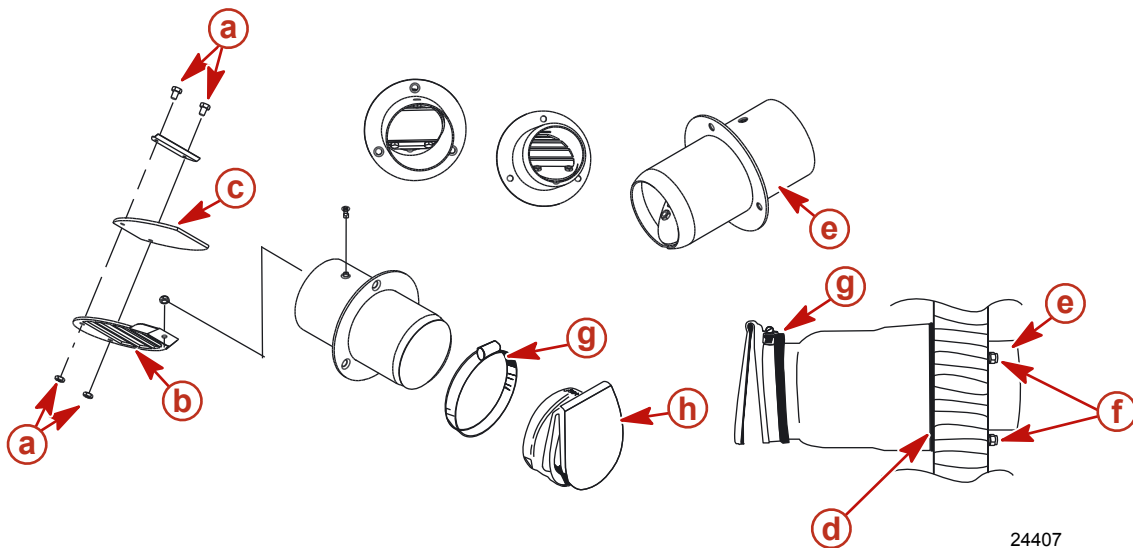
8404

a - Block off plate

b - Bolts (4)

Shutter Replacement

1. Remove the exhaust hose clamps.
2. Remove the exhaust hose.
3. Install the new shutter. Tighten the screws and nuts securely.
4. Reinstall the exhaust hose. Tighten clamps securely.



24407

Transom exhaust kit

a - Screw and nut (2)

b - Support member

c - Water shutter

d - Gasket

e - Exhaust flange

f - Bolts, washers and nuts (3)

g - Clamp

h - Cover (flapper)

Silent Choice Exhaust System

IMPORTANT: When installing the Silent Choice exhaust, it is required that the exhaust bellows on the transom assembly be removed, and replaced with an exhaust tube. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats.

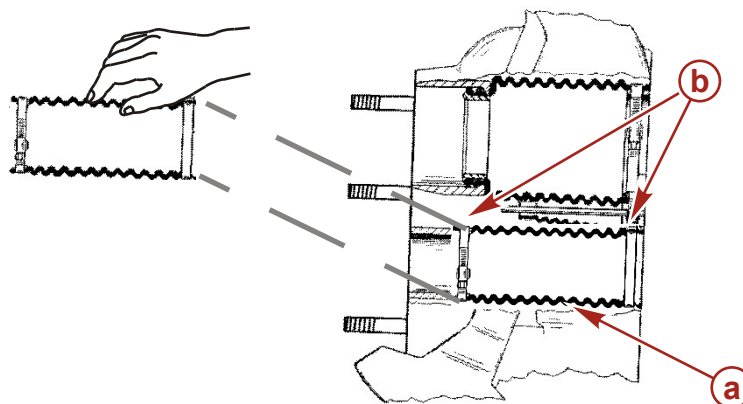
⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by Mercury MerCruiser Warranty, unless this damage is the result of defective parts.

Exhaust Tube Installation

IMPORTANT: When installing through the propeller exhaust:

- With Bravo One and Bravo Two Sterndrives, the exhaust bellows must be removed and an exhaust tube must be installed.
 - With Bravo Three Sterndrives, the exhaust bellows must be removed and an exhaust tube must be installed.
 - With an exhaust system that can be switched from either through the propeller or through the transom exhaust, the exhaust bellows must be removed and an exhaust tube must be installed.
 - With any application, installation of an exhaust tube will increase exhaust noise.
1. Remove and discard the clamps and exhaust bellows from the gimbal housing.



20130

a - Exhaust bellows

b - Clamps

⚠ CAUTION

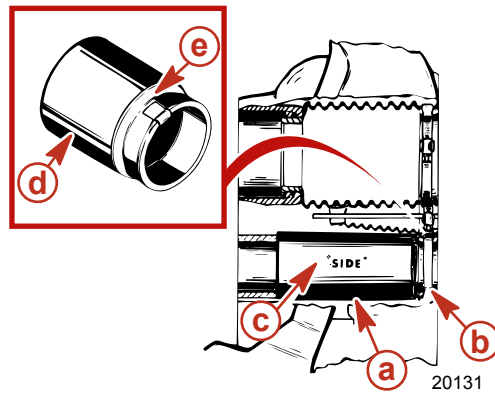
Exhaust tube clamp may corrode if grounding clip is not installed.

2. Install the grounding clip on the exhaust tube.

NOTE: Bellows adhesive is not used when installing an exhaust tube

3. Position the tube so that the "side" markings on the tube are facing toward the right and left sides.
4. Install the clamp.

5. Tighten the clamp securely.

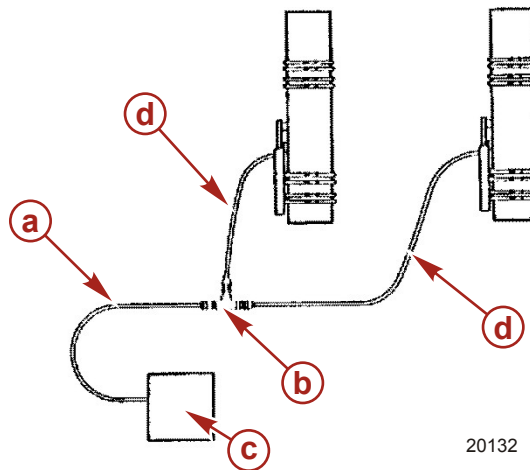


a - Exhaust tube
b - Clamp
c - "Side" marking

d - Exhaust tube
e - Grounding clip

Air Tube Routing

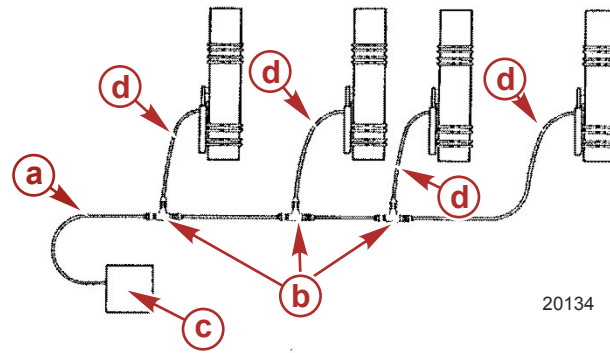
1. Route the air tubing from the air pump to the silencer valve cylinders. Do not route the air tubing close to hot surfaces. Excessive heat will damage the air tubes.



Single engine

a - Air tube
b - T-fittings

c - Air pump assembly
d - Air tube to air cylinder—on each silencer valve

**Dual engine**

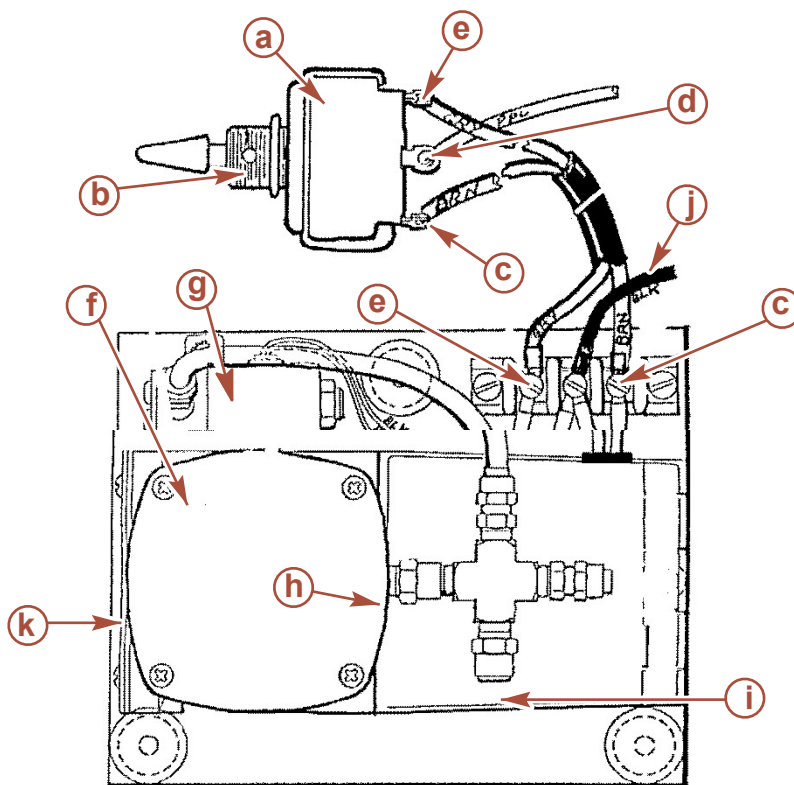
a - Air tube
b - T-fittings

c - Air pump assembly
d - Air tube to air cylinder—on each
silencer valve

Maintenance

1. The air intake filter (32-17272) must be checked once each year. If the filter is clogged or partially clogged, replace the filter. The filter pad is glued in and may be removed with needle-nose pliers. Clean the surface in casting, apply a single dot of adhesive to the center of the air intake filter, and install the new filter. Be careful not to coat the filter or clog the air intake holes with adhesive.

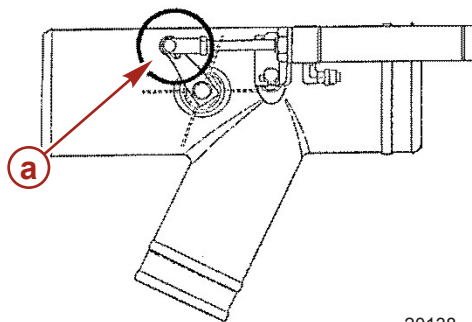
Tube Ref No.	Description	Where Used	Part No.
	Automotive weather-strip adhesive	Air intake filter	Obtain Locally



20136

- a** - Mode switch
- b** - Keyway—install in down position
- c** - BROWN wire to terminal 3—
activates compressor
- d** - PURPLE wire—12 volt; connect to
12-volt source in control panel
area
- e** - GRAY wire to terminal 1—
activates solenoid
- f** - Air pump
- g** - Solenoid
- h** - Check valve
- i** - Relief valve—30 psi
- j** - 610 mm (2 ft.) ground wire
- k** - Air intake filter

2. Lubricate the air cylinder-to-silencer pipe flapper at the clevis and pin, as needed, with lubricant.



20138

a - Clevis and pin

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with Teflon	Air cylinder-to-silencer pipe flapper at clevis and pin	92-802859A1

Notes:

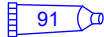
Drives

Section 8A - Velvet Drive 5000 Series Transmission

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Drain plug threads	92-34227-1
 91	Engine Coupler Spline Grease	Transmission input shaft splines	92-802869A1
 95	2-4-C with Teflon	Poppet ball, spring, and holes	92-802859A1

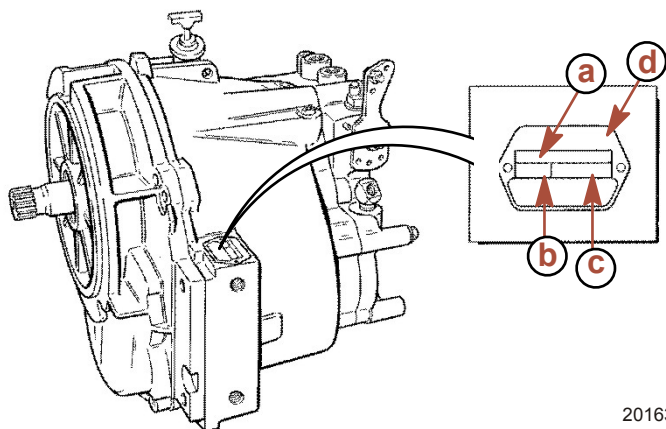
Tools

Description	Part Number
Pressure gauge (0–500 psi)	Obtain locally

Velvet Drive 5000A Down Angle

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to the following charts to determine engine and transmission combinations.



20163

Transmission identification plate

- | | |
|-------------------------------------|--|
| a - Model number | c - Serial number |
| b - Ratio (A and B position) | d - Identification plate model color code |

Specifications

RATIOS AND PART NUMBERS

Ratio (nominal)	Identification plate color code	Velvet drive model number	Mercury Marine part number
1.5:1	Black	20-01-003	805495A6
2.1:1		20-01-004	805495A4
2.5:1		20-01-005	805495A5
2.8:1		20-01-006	805495A7

FLUID SPECIFICATIONS

NOTICE
Unit of Measurement: U.S. Quarts (Liters). All capacities are approximate fluid measures.

Make and Model	Capacity	Fluid Type
Velvet Drive 5000A Down Angle (all ratios)	2.75 (2.6) 1	Dexron III Automatic Transmission Fluid

NOTE: Use the dipstick to determine fluid exact level.

Warm Fluid Level Check: The transmission should be at operating temperature [79 °C (175 °F)] maximum to receive an accurate oil level reading.

Cold Fluid Level Check: To ease checking the fluid level, the dipstick can be marked or scribed. First perform the procedure for warm fluid level, then allow the engine to cool overnight. Remove and wipe clean the dipstick. Insert the clean dipstick and mark the cold fluid level.

PRESSURE SPECIFICATIONS

Engine RPM	Neutral gear psi (kPa)		Forward gear or reverse gear psi (kPa)	
900	Min.	Max.	Min.	Max.
	10 (69)	50 (344)	250 (1724)	400 (2757)
2400	50 (344)	70 (483)		

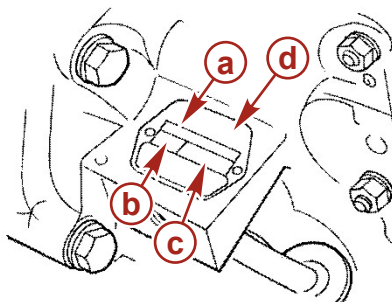
TORQUE SPECIFICATIONS

Description	Nm	lb. in.	lb. ft.
Drain plug	34		25
Fluid hose-to-cooler			
Fluid hose-to-housing			
Rear mounts-to-transmission	61		45
Shift lever-to-valve	13	114	
Transmission-to-flywheel housing	61		45
Neutral start safety switch	14	120	
Propeller shaft coupler-to-output flange	68		50

Velvet Drive 5000V V-Drive

Identification

The transmission identification plate is on the top left side of the transmission. See the following charts to determine engine and transmission combinations.



20165

Transmission identification plate

a - Model number

b - Ratio (A and B position)

c - Serial number

d - Identification plate model color code

Specifications

RATIOS AND PART NUMBERS

Ratio (nominal)	Identification plate color code	Velvet drive model number	Mercury Marine part number
1.5:1	Blue	20-02-003	807481A5
2.1:1		20-02-004	807481A6
2.5:1		20-02-005	807481A7

FLUID CAPACITIES

Notice		
Unit of Measurement: U.S. Quarts (Liters). All capacities are approximate fluid measures.		
Make and Model	Capacity	Fluid Type
Velvet Drive 5000V	3.5 (3.3) 1	Dexron III Automatic Transmission Fluid

NOTE: ¹ Use the dipstick to determine exact fluid level.

Warm Fluid Level Check: The transmission should be at operating temperature [79 °C (175 °F)] maximum to receive an accurate oil level reading.

Cold Fluid Level Check: To ease checking the fluid level, the dipstick can be marked or scribed. First perform the procedure for warm fluid level, then allow the engine to cool overnight. Remove and wipe clean the dipstick. Insert the clean dipstick and mark the cold fluid level.

PRESSURE SPECIFICATIONS

Engine RPM	Neutral gear psi (kPa)		Forward gear or reverse gear psi (kPa)	
	Min.	Max.	Min.	Max.
900	10 (69)	50 (344)	250 (1724)	400 (2757)
2400	50 (344)	70 (483)		

TORQUE SPECIFICATIONS

Description	Nm	lb. in.	lb. ft.
Drain plug (bushing)	34		25
Fluid hose to bushing	34		25
Pump housing to adapter	27		20
Rear mounts to transmission	61		45
Shift lever to valve	14		10
Transmission to flywheel housing	68		50
Neutral start switch	14		10

Velvet Drive 5000 Series

Engine

All current production engines are LH rotation. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

The installed angle of the MIE inboard transmission and engine should not exceed a maximum of 18 degrees of the water line.

Transmission

The transmission gear ratio is marked on the transmission identification plate, which is located on the port (left) side of the transmission. The transmission output shaft rotation and propeller rotation required are indicated on a decal on the transmission case. Transmission rotation is described when viewed from the rear of the transmission with the transmission in the forward gear selector position.

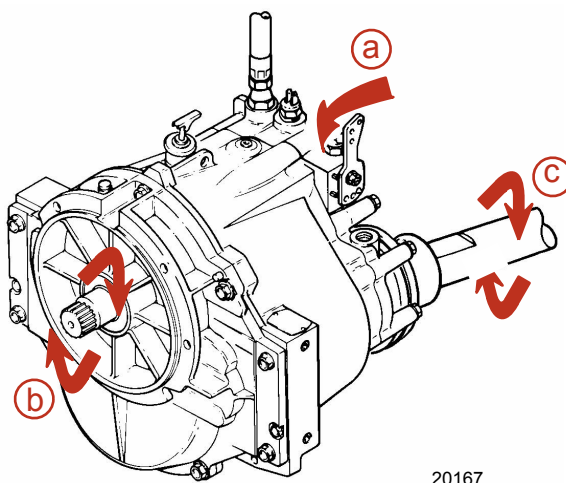
- Do not start or crank the engine without fluid in the transmission.
- Use only the recommended fluid in the transmission.
- Except in an emergency, never shift the transmission at engine speeds above 1000 RPM.
- Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Ensure that the proper fluid level exists before free wheeling the propeller.
- Do not paint the shift lever poppet ball and spring. Paint will prevent proper action of the detent.
- Always replace the oil cooler and hoses after a transmission failure or before 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 oil cooler, hoses, and fittings.

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow). The term left-hand (LH) refers to rotation in the counterclockwise (CCW) direction. The term right-hand (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

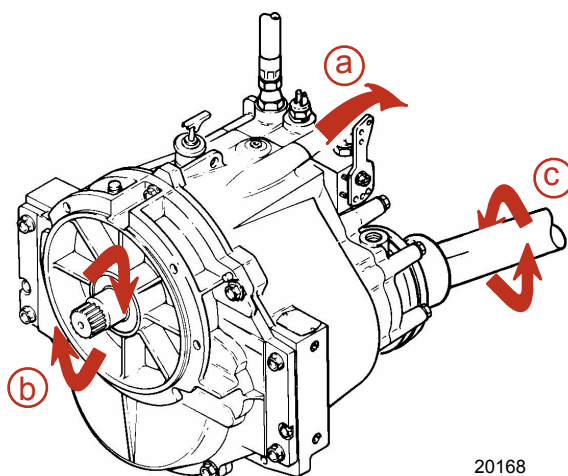
Transmission/Propeller Rotation

These transmissions are full power reversing transmissions, allowing a standard LH rotation engine to be used for both propeller rotations. Propeller rotation (output shaft rotation) is determined by shift cable attachment at the remote control. Be sure to use the correct rotation propeller and shift cable hook up for the direction desired.



Typical

- a** - Direction of shift lever engagement (Position A toward flywheel)
- b** - Engine/ transmission input shaft shaft rotation direction (LH)
- c** - Transmission output/ propeller shaft rotation direction (LH)



Typical

- a** - Direction of shift lever engagement (Position B away from flywheel)
- b** - Engine/ transmission input shaft rotation direction (LH)
- c** - Transmission output/ propeller shaft rotation direction (RH)

Transmission Fluid Level

TRANSMISSION WARM

The transmission should be at operating temperature (87° C [190° F] maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect the oil level.

IMPORTANT: The oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.

1. When the transmission is at operating temperature, place the selector lever in neutral.
2. Shut off the engine.
3. Remove the dipstick and wipe clean.

IMPORTANT: Do not screw in the dipstick; press it in firmly and remove.

4. Immediately insert the clean dipstick and read the oil level.
5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.

1. Let the boat sit overnight. Insert the clean dipstick and read the level.
2. Put a mark on the dipstick at the cold oil level.

NOTE: You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark.

FILLING

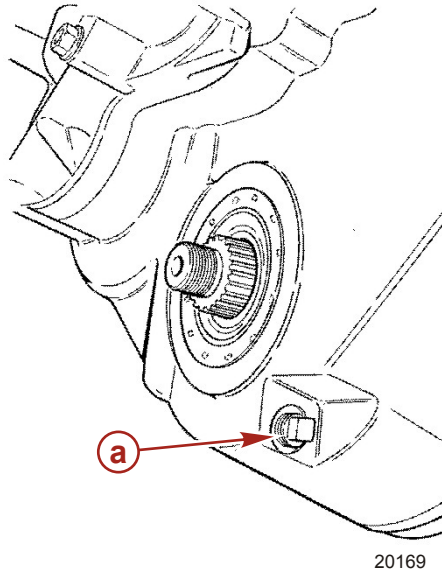
If the transmission fluid level is low, use the specified transmission fluid to fill.

1. Remove the dipstick.
2. Fill the transmission with fluid through the dipstick hole to bring the fluid up to the full mark.
3. Reinstall the dipstick. Be sure to tighten the T-handle securely. Do not overtighten.
4. If transmission fluid level was extremely low, carefully check the transmission, fluid cooler, and hoses for leaks.

CHANGING

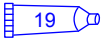
1. Clean the area around the drain plug shown.
2. Remove the dipstick

- Remove the drain plug. Drain the oil from the transmission into a suitable container.



a - Drain plug

- Check oil for the following foreign matter:
 - Metal particles. A few small particles are normal. Larger metal chips are an early sign of transmission failure, which indicates the transmission should be disassembled and inspected for internal damage.
 - Rubber particles. Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.
- Coat drain plug threads with sealant. Install and torque the drain plug to specification.

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Drain plug threads	92-34227-1

- Refill the transmission with the specified fluid.

Removal

NOTICE

The following procedure describes the removal of the transmission without removing the engine. If the engine must be removed, see **Section 2**.

- Disconnect the both battery cables.
 - If required, drain the transmission fluid
 - Disconnect the cooler water hoses.
- NOTE:** *The fluid cooler should be removed with the transmission.*
- Disconnect the shift cable from the transmission.
 - Disconnect the wires from the neutral start safety switch.
 - Disconnect the wires from the transmission fluid temperature switch.
 - Loosen the trunnion clamping fasteners on the engine mounts (port and starboard).
 - Remove the coupling nuts and bolts and separate the propeller shaft flange from the transmission output flange.
 - Remove the four rear engine mount-to-engine bed fasteners and hardware.

10. Support the rear of the engine using a suitable hoist or wooden blocks under the flywheel housing.
11. Support the transmission with a hoist or by 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.

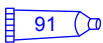
⚠ CAUTION

Avoid damage to the transmission input shaft or engine coupler. Ensure that the transmission is completely supported before removing the hardware attaching the transmission to the flywheel housing.

13. Remove all hardware attaching the transmission to the flywheel housing.
14. Move the transmission straight back and away from the engine to completely disengage the splines on the input shaft.
15. Carefully lift out the transmission.

Installation

1. Check the transmission output shaft rolling torque.
2. Apply grease to the transmission input shaft splines and engine drive plate splines.

Tube Ref No.	Description	Where Used	Part No.
 91	Engine Coupler Spline Grease	Transmission input shaft splines	92-802869A1

3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Slide the transmission into place and secure with the attaching hardware. Torque the transmission to flywheel housing fasteners to specification. Remove the hoist.
5. Install the rear mount brackets to the transmission. Torque the fasteners and hardware to specification.
6. Using a hoist, raise the engine and transmission to remove the blocks (if employed). Lower the assembly to the engine bed. Securely tighten the four rear engine mount-to-engine bed fasteners with the hardware. Relieve the hoist tension.
7. Connect the wires to the neutral start safety switch.
8. Connect the wires to the transmission fluid temperature switch.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

9. Connect and adjust the shift cables. See **Shift Cable Adjustment**.
10. See **Section 2C** and check the engine final alignment.
11. After final engine and coupler alignment has been properly set (with the boat in the water), connect the propeller shaft coupler-to-transmission output flange with bolts, lockwashers, and nuts. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Propeller shaft coupler-to-transmission output flange	68		50

IMPORTANT: Be certain to torque the trunnion clamping fasteners on the engine mounts (port and starboard) that were loosened during removal.

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better with a shoulder (grip length) long enough to pass through the face mating plane of the couplers.

12. Install the transmission fluid cooler and hoses. Torque the hose fittings at the cooler and transmission housing to specification.
13. Refill the transmission with the specified fluid.
14. Connect the both battery cables. Tighten clamp securely.
15. Check for leaks and check the fluid level after the first engine start-up.

Shift Control And Cables

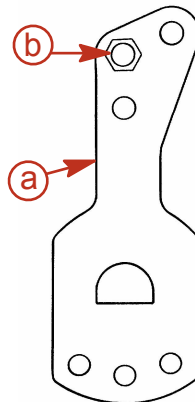
⚠ CAUTION

Transmission failure may occur. Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.

IMPORTANT: The Velvet Drive warranty is jeopardized if the shift lever poppet spring or the ball is permanently removed, if the shift lever is changed in any manner or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

TRANSMISSION SHIFT LEVER AND SHIFT CABLE BRACKET

1. The shift lever has three holes as illustrated following. The shift cable anchor stud is installed in the middle hole when using Quicksilver Remote Control cables.



20170

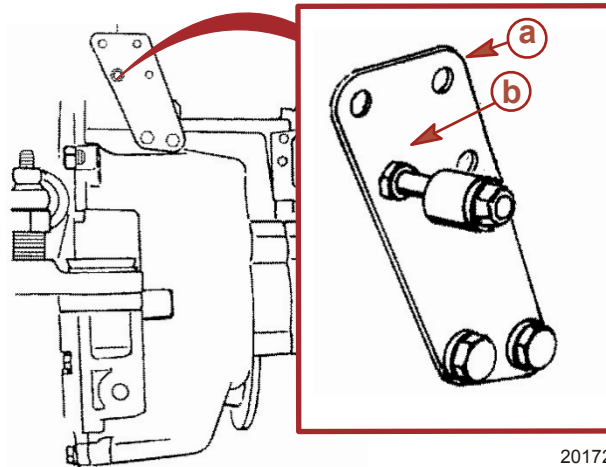
a - Shift lever

b - Shift cable anchor stud location (for Quicksilver Shift Cables)

⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

- The shift cable bracket has four holes as illustrated following. The shift cable anchor stud is installed in the in the lower front hole when using Quicksilver Remote Control cables.



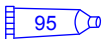
20172

a - Shift cable bracket**b** - Shift cable anchor stud location

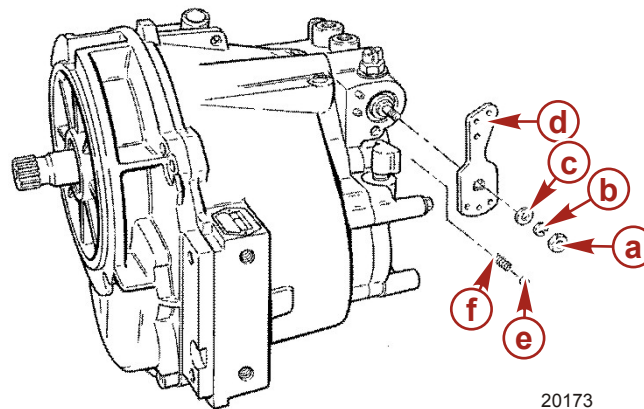
SHIFT LEVER INSTALLATION

The shift lever and related parts must be assembled as shown.

- Lubricate the poppet ball, spring, and holes in the shift lever with lubricant.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with Teflon	Poppet ball, spring, and holes	92-802859A1

- Install the poppet spring and ball. Retain the ball by placing the shift lever on the shaft.
- Install the flat washer, lockwasher, and nut on shaft.
- Torque the nut to specification.



20173

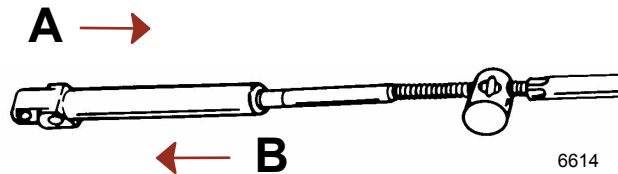
a - Nut**b** - Lockwasher**c** - Flat washer**d** - Shift lever**e** - Poppet ball**f** - Poppet spring

- After installation, move the shift lever through the forward, neutral, and reverse positions. No more than finger-tip effort should be required. If the valve binds, find and correct the cause for binding.

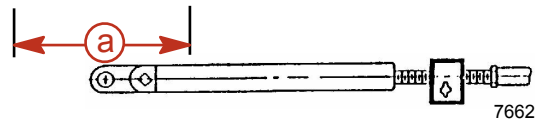
SHIFT CABLE ADJUSTMENT

For left-hand propeller shaft rotation, the shift cable hookup at the remote control must result in the shift cable end guide moving in direction "A" when the remote control handle is placed in the forward position.

For right-hand propeller shaft rotation, the shift cable hookup at the remote control must result in the shift cable end guide moving in direction "B" when the remote control handle is placed in the forward position.

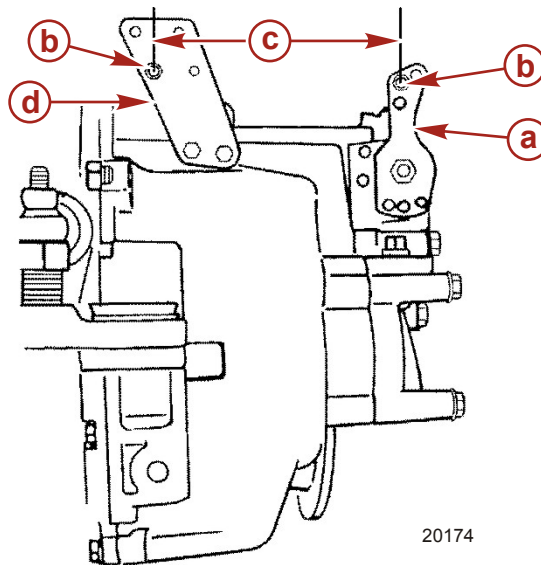


The remote control must provide a total shift cable travel (at transmission end) of at least 70 mm (2-3/4 in.). This is necessary to position the transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause the transmission to slip and eventually fail.



a - Total minimum shift cable travel (70 mm [2-3/4 in.]

IMPORTANT: The distance between anchor studs (dimension "c") shown in the following illustration is set at 181 mm (7-1/8 in.).



a - Shift lever

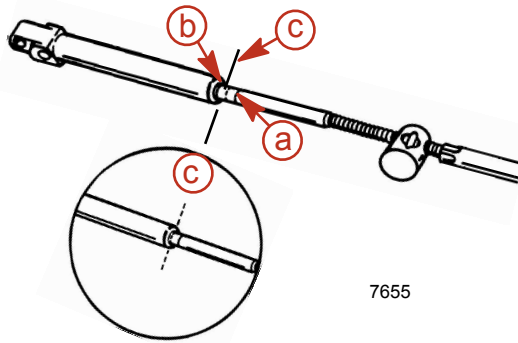
b - Anchor stud

c - Dimension between anchor studs—
181 mm (7-1/8 in.)

d - Shift cable bracket

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

1. Place the remote control shift lever and transmission shift lever in neutral position.
2. Remove nuts and washers from the shift cable attaching studs.
3. Locate the center of the remote control and control shift cable play (backlash) as follows:
 - a. Check that the remote control is in the neutral position.
 - b. Push in on the control cable end with enough pressure to remove play; mark position "a" on the tube.
 - c. Pull out on the control cable end with enough effort to remove the play; mark position "b" on the tube.
 - d. Measure the distance between marks "a" and "b;" mark position "c" halfway between marks "a" and "b."

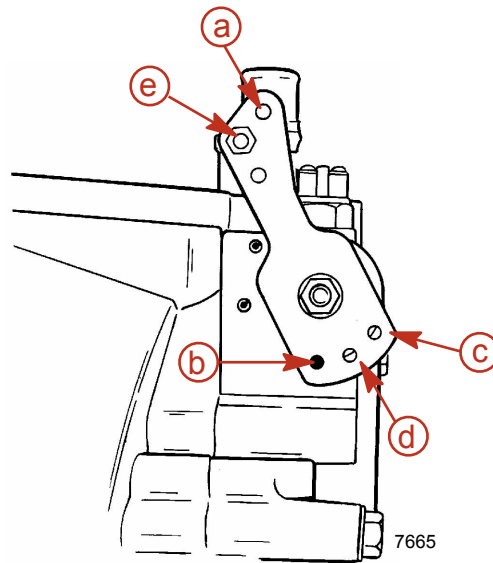


4. Center the cable end-play, then adjust the cable barrel to align the holes in the barrel and in the cable end guide with the attaching points on the transmission.
 5. Temporarily install the shift cable. Do not secure at this time.
- IMPORTANT: Transmission is "fully" in gear when the shift lever comes to a stop in either direction.**
6. Place the remote control shift lever in gear and check the position of the transmission shift lever. The shift lever must be positioned as shown.

⚠ CAUTION

The remote control and shift cable must position the transmission shift lever exactly as shown; otherwise transmission failure may occur. The spring-loaded poppet ball assists in maintaining the position of the transmission shift lever. Do not remove the poppet ball or spring.

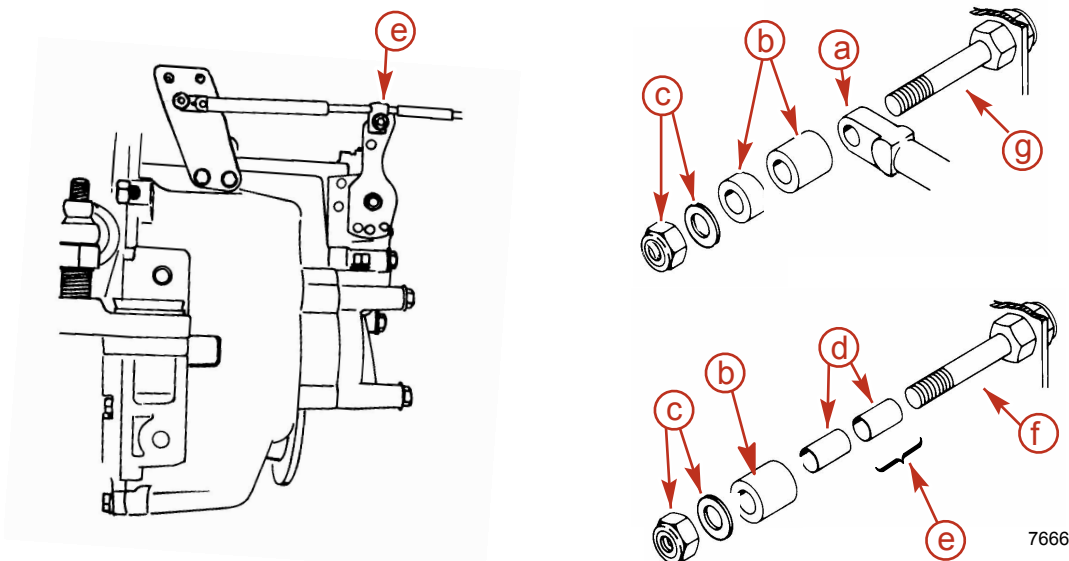
IMPORTANT: The Velvet Drive Transmission warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and shift cable do not position the shift lever exactly as shown.



- a** - Transmission shift lever
- b** - Poppet ball must be centered in this detent hole when left-hand propeller shaft rotation is desired
- c** - Poppet ball must be centered in this detent hole when right-hand propeller shaft rotation is desired
- d** - Poppet ball must be centered in this detent hole for neutral position
- e** - Install shift lever stud in this hole when using quicksilver shift cables

7. Place the remote control shift lever in the opposite gear and again check the transmission shift lever position. The lever must be positioned as shown by "c."
8. If the transmission shift lever will not position properly in one or both gears, recheck the shift cable adjustment and travel as previously instructed. If proper positioning is still not obtained, the remote control does not provide sufficient shift cable travel and must be repaired or replaced.
9. Install the nut and washer to the cable end guide stud. Tighten until contacts, then loosen one full turn.

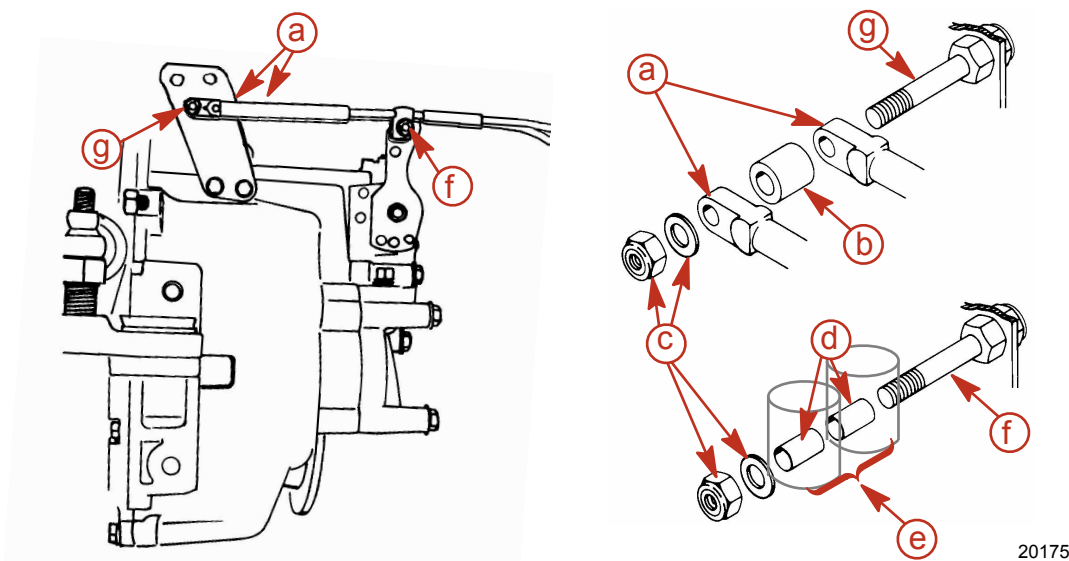
10. Install the nut and washer to the cable barrel stud. Tighten until they contact. Tighten securely, but do not overtighten.



Typical single cable installation - rear approach

- a** - Cable end guide
- b** - Spacer (as required)
- c** - Elastic stop nut and washer
- d** - Bushings

- e** - Cable barrel (position only indicated in right drawing)
- f** - Cable barrel stud
- g** - Cable end guide stud



Typical dual cable installation - rear approach

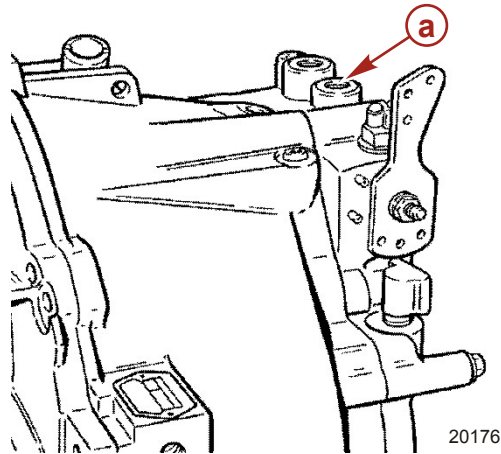
- a** - Cable end guide
- b** - Spacer (as required)
- c** - Elastic stop nut and washer
- d** - Bushings

- e** - Cable barrels (positions only indicated in right drawing)
- f** - Cable barrel stud
- g** - Cable end guide stud

Pressure Test

1. Remove the transmission temperature switch.

2. Install a suitable pressure gauge.



a - Main line pressure tap

3. With the boat in the water, start the engine and operate until normal operating temperature is reached.
4. Refer to **Specifications** for pressure readings.

Transmission Repair

Mercury Marine does not stock or sell replacement parts for the down angle transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors have a dealer network to service the transmissions. Service manuals for each transmission can be obtained from Velvet Drive.

For the location of your closest distributor or for service literature contact:

Velvet Drive Transmissions
Division of Regal Beloit
200 Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
(508) 979-4800

Drives

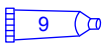
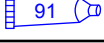
Section 8B - ZF Marine Transmissions—HSW 63A, 63IV, 80A

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads and the service port plug	92-809822
 25	Liquid Neoprene	Neutral start switch wire connections Exposed electrical terminals and connections.	92-25711-3
 28	Dexron III Automatic	Transmission	Obtain Locally
 91	Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A1

Specifications

Operating Specifications

Description	Specification	
Operating Temperature	54–79° C (130–175° F)	
Temperature Switch Settings ± 10°	Open	Close
	87.8° C (190° F)	110° C (230° F)

Pressure Specifications

Description	Specification	
Shifting Pressure	Position A	21.5–23.5 bar (312–341 PSI) at 2000 RPM
	Position B	

Ratios and Part Numbers

Specification			
Ratio (Normal) Ratio may be rounded off in some cases.	ZF Marine Model	Hurth Model Number	Mercury Marine Part Number
1.5:1	63A	630A	863744T2
2.1:1			863744T3
2.5:1			863744T4
1.55:1	63IV	630V	863745T2
2.0:1			863745T3
2.5:1			863745T4
2.85:1	80A	800A	806730A1

Fluid Specifications

NOTE: All capacities are approximate fluid measures. ALWAYS use the dipstick to determine the exact fluid level.

Manufacturer	Model	Capacity Always use the dipstick to determine the exact quantity of oil or fluid required.	Fluid Type
ZF Marine (Hurth)	63A	4.5 liters (4-3/4 U.S. qt.)	Dexron III Automatic Transmission Fluid
	63IV	4.75 liters (5.0 U.S. qt.)	
	80A	5.5 liters (5 3/4 U.S. qt.)	

Important Information

Engine

All current production engines are left-hand rotation. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end). Installed angle of the transmission and the engine should not exceed a maximum of 12 degrees of the water line.

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow). The term left-hand (LH) refers to rotation in the counterclockwise (CCW) direction. The term right-hand (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise.

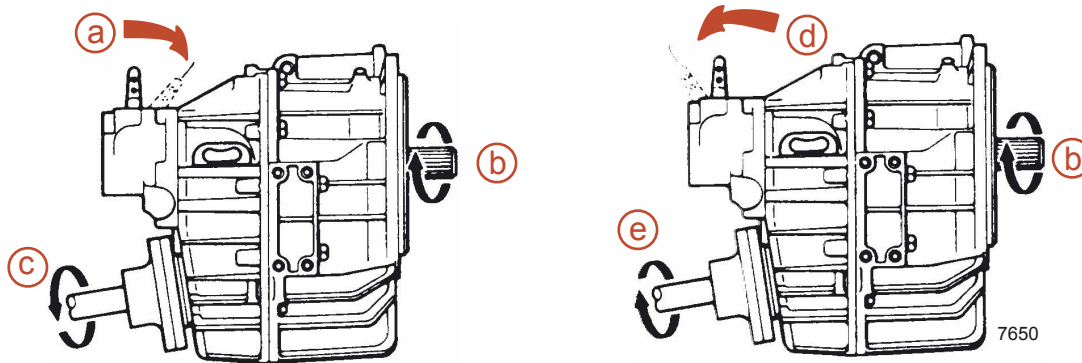
Precautions

The transmission gear ratio is marked on the transmission identification plate, which is located on the top of the transmission. Transmission rotation is described when 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
- Free wheeling of one propeller (in a twin-engine boat) at trolling speeds will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Ensure that proper fluid level exists before free wheeling the propeller.
- Always repair or replace the oil 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 oil cooler, hoses, and fittings.

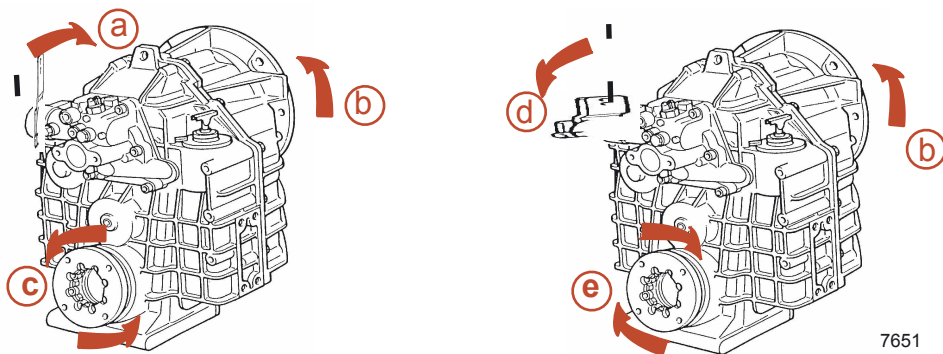
Transmission And Propeller Rotation

The ZF Marine transmissions are full power reversing transmissions, allowing a standard LH rotation engine to be used for both propeller rotations. Propeller rotation is determined by the shift cable attachment at the remote control. Use the correct rotation propeller and shift cable hookup for the direction desired.



ZF Marine 63A—8 degree down-angle transmission, 45A similar

- | | |
|--|--|
| a - Direction of shift lever engagement (toward flywheel) | d - Direction of shift lever engagement (away from flywheel) |
| b - Transmission input shaft rotation direction (LH) | e - Transmission output and propeller shaft rotation direction (LH) |
| c - Transmission output shaft rotation direction (RH) | |



ZF Marine 63IV—V-drive transmissions

- | | |
|--|--|
| a - Direction of shift lever engagement (toward flywheel) | d - Direction of shift lever engagement (away from flywheel) |
| b - Transmission input shaft rotation direction (LH) | e - Transmission output and propeller shaft rotation direction (RH) |
| c - Transmission output shaft rotation direction (LH) | |

Transmission Fluid

Checking

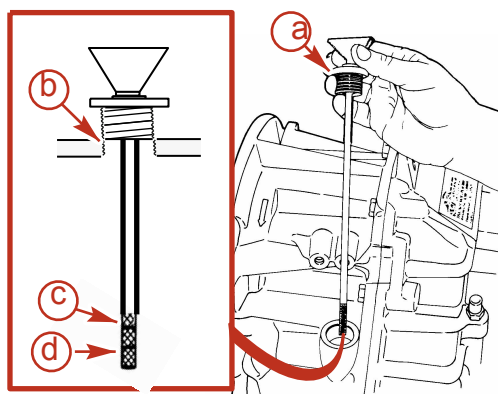
1. Remove the dipstick.

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.

- Check the fluid level as indicated on the dipstick with the dipstick resting on the 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.

- If low, add transmission fluid to bring the level up to the maximum mark on the dipstick.



16604

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 2 minutes immediately prior to checking the level.

- Start the engine and operate at 1500 RPM for 2 minutes to fill all the hydraulic circuits.
- Stop the engine and quickly check the fluid level with the dipstick resting on the top of the threaded hole.
- If low, add transmission fluid to bring the level up to the maximum mark on the dipstick.

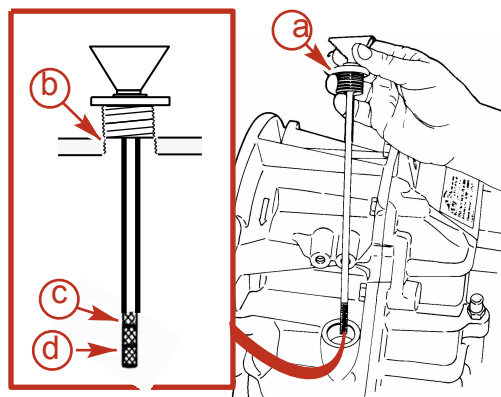
Tube Ref No.	Description	Where Used	Part No.
 28	Dexron III Automatic	Transmission	Obtain Locally

- Install the dipstick.

Filling

- If necessary, add specified automatic transmission fluid through the dipstick threaded hole to bring the level up to the maximum mark on the dipstick.

IMPORTANT: Use only specified Automatic Transmission Fluid (ATF).



16604

a - Dipstick

b - Threaded hole

c - Maximum fluid level

d - Minimum fluid level

NOTE: If the transmission fluid level was extremely low, contact your authorized Cummins MerCruiser Diesel dealer or distributor.

Manufacturer	Model	Capacity Always use the dipstick to determine the exact quantity of oil or fluid required.	Fluid Type
ZF Marine (Hurth)	45A	3.0 liters (3-1/4 U.S. qt.)	Dexron III Automatic Transmission Fluid
	63A	4.5 liters (4-3/4 U.S. qt.)	
	63IV	4.9 liters (5-1/4 U.S. qt.)	

2. Install the dipstick.

IMPORTANT: To accurately check the fluid level, the engine must be run at 1500 RPM for 2 minutes immediately prior to checking the level.

3. See **Checking** and check the fluid level.

Changing

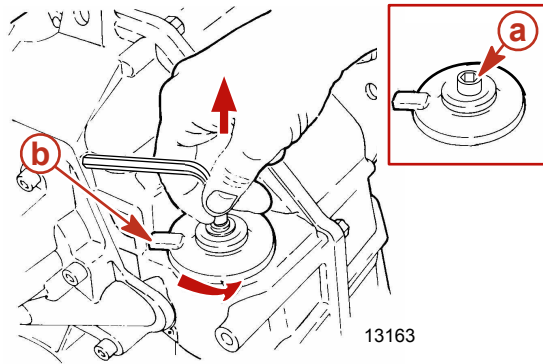
IMPORTANT: Do not start or crank the engine without fluid in the transmission.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities.

1. Clean the exterior of the transmission around the fluid filter assembly.

2. Use a 6 mm Allen wrench and remove the fluid filter assembly by turning the assembly nut counterclockwise and pulling at the same time.

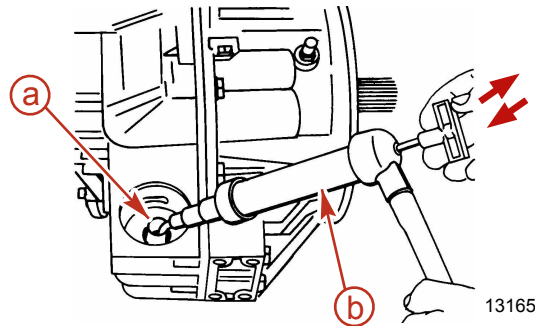


a - Fluid filter assembly

b - Assembly nut

3. **On 63A and 45A 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 fluid properly.

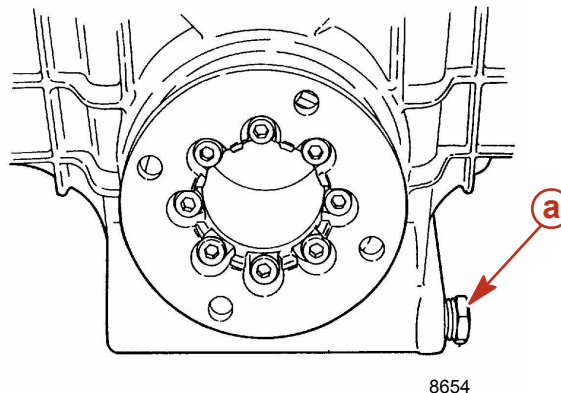


a - Suction pipe

b - Suction pump

4. **On 63IV transmissions:**

- a. Remove the drain plug from the transmission and allow the fluid to drain.

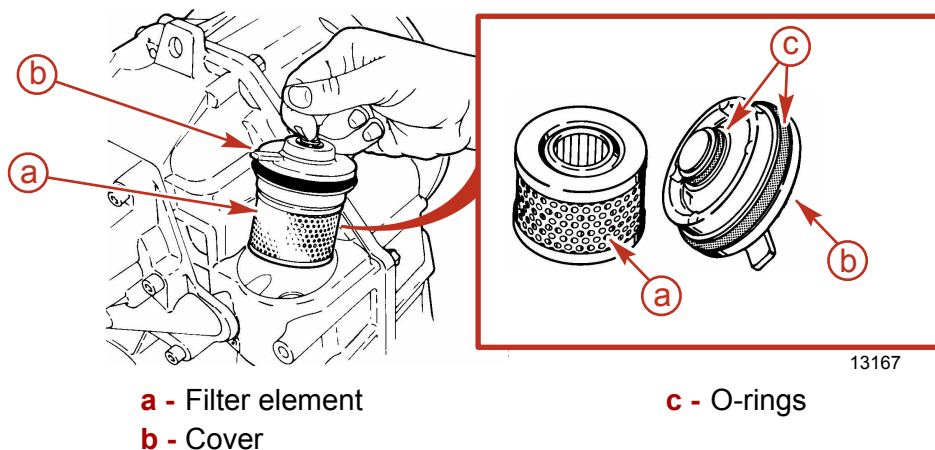


Typical 63IV transmission

a - Drain plug

- b. Install and securely tighten the drain plug after the transmission is drained.
5. Check the fluid for the following foreign matter:

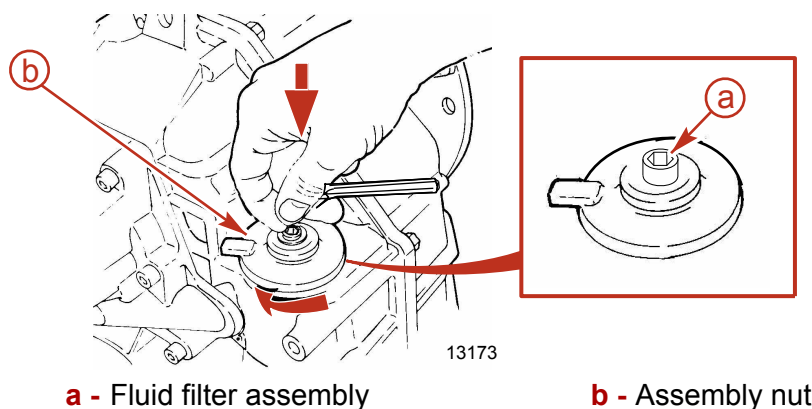
- Metal particles—a few small particles are normal. Larger metal chips are an early sign of transmission failure, which may mean the transmission should be disassembled and inspected for internal damage.
 - Rubber particles—indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.
6. Remove and discard the filter element and the O-rings.
 7. Coat the new O-rings with transmission fluid.
 8. Install the new O-rings and filter element.



CAUTION

The transmission fluid filter assembly must be properly seated to avoid fluid foaming or loss of fluid resulting in decreased efficiency and damage to transmission.

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. Torque the filter 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. See **Filling**.

Removal

WARNING

Avoid injury or death and product damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities.

NOTE: The following procedure describes removal of the transmission without removing the engine. If the engine must be removed, see **Section 2**.

1. Disconnect the battery cables from the battery.
2. If required, drain the transmission fluid.
3. Disconnect the transmission fluid cooler hoses.

NOTE: The fluid cooler should be removed with the transmission.

4. On non DTS transmissions, disconnect the shift cable from the transmission.
5. Disconnect the wires from the neutral start switch.
6. Disconnect the wires from the transmission fluid temperature switch.

IMPORTANT: Make note of how the transmission harness is routed and connected for future reference.

7. On DTS transmissions, disconnect the transmission harness from the shift solenoids and pressure transducers.
8. Disconnect the wires from the transmission fluid temperature switch.
9. Loosen the trunnion clamping fasteners on the engine mounts (port and starboard).
10. Remove the nuts and bolts from the coupling and separate the propeller shaft coupler from the transmission output flange.
11. Remove the four rear engine mount to engine bed fasteners and hardware.
12. Support the rear part of the engine using a suitable hoist, or put wooden blocks under the flywheel housing.
13. Support the transmission with a hoist or by other suitable means through the lifting eye on the transmission case.
14. Remove the port and starboard rear mount brackets (with base and trunnion) from the transmission.

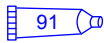
CAUTION

Avoid damage to the transmission input shaft or engine coupler. Ensure that the transmission is completely supported before removing the hardware attaching the transmission to the flywheel housing.

15. Remove all hardware attaching the transmission to the flywheel housing.
16. Pull the transmission straight back and away from the engine to completely disengage the splines on the input shaft.
17. Carefully lift out the transmission.

Installation

1. Check the transmission output shaft rolling torque.
2. Apply lubricant to the transmission input shaft splines and 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	92-802869A1

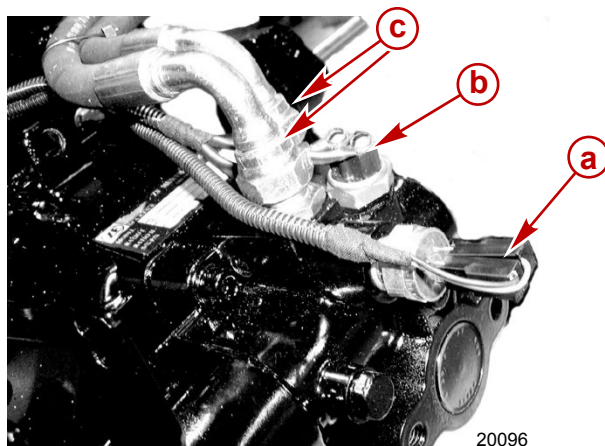
3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Push the transmission into place and secure with attaching hardware.

Description	Nm	lb. in.	lb. ft.
Transmission to flywheel housing fasteners	61		45

5. Remove the hoist.
6. Install the rear mount brackets to the transmission. Torque the fasteners and hardware.

Description	Nm	lb. in.	lb. ft.
Rear mount brackets to transmission fasteners	61		45

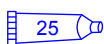
7. Using a hoist, raise the engine and transmission to remove blocks, if employed.
8. Lower the assembly to the engine bed.
9. Relieve hoist tension.
10. Securely tighten the four rear engine mount to bed fasteners with hardware.
11. Install the transmission fluid cooler hoses. Torque the hose fittings at the transmission housing.
12. For non DTS transmissions, connect the neutral start switch and fluid temperature switch wiring.
13. Coat the neutral start switch connections with sealant.



Typical

a - Fluid temperature switch
b - Neutral start switch

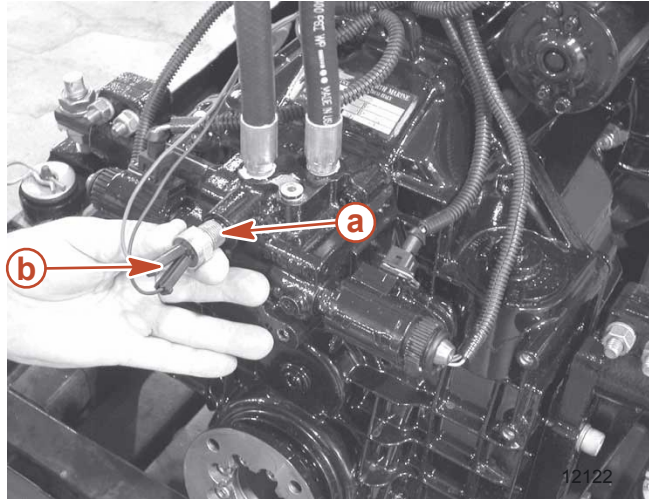
c - Transmission fluid cooler hose fitting

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Neutral start switch wire connections	92-25711-3

Description	Nm	lb. in.	lb. ft.
Transmission fluid cooler hose fitting	34		25

14. For DTS transmissions, connect the transmission harness to the shift solenoids and pressure transducers. Connect and route the transmission harness the same as prior to removal.

15. Connect the transmission fluid temperature switch wiring.



a - Fluid temperature sensor

b - Wire connections

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

16. Check engine final alignment. See **Section 2B**.

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

17. 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. Torque the bolts.

Description	Nm	lb. in.	lb. ft.
Propeller shaft coupler to transmission output flange bolt	68		50

IMPORTANT: Be certain to torque the trunnion clamping fasteners on the engine mounts (port and starboard) that were loosened during removal.

18. Torque the trunnion clamping fasteners on the engine mounts (port and starboard) that were loosened during removal.

19. Refill the transmission with the specified fluid. See **Filling**.

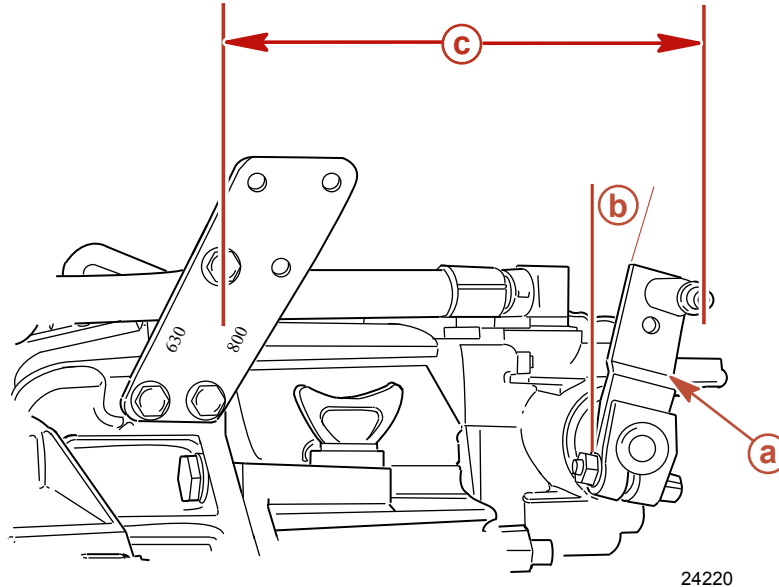
20. Connect and adjust the shift cables.

21. Connect the battery cables.

22. Check for leaks and check the fluid level after the first engine start-up.

Shift Cable Installation and Adjustment

IMPORTANT: Ensure that the shift lever is positioned approximately 10 degrees aft of vertical as shown when in the neutral detent position. Also, ensure that the distance between the studs in the following is set at 181 mm (7-1/8 in.). If necessary, loosen the clamping bolt and position the lever so that dimension "c" is as shown when in the neutral detent position, and retighten the clamping bolt.



Typical ZF Marine Transmission shown

a - Shift lever

b - Shift lever in neutral detent

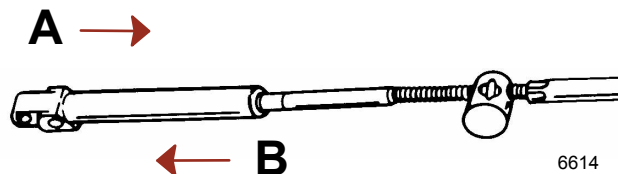
c - Dimensions between studs:
181 mm (7-1/8 in.)

IMPORTANT: ZF Marine transmissions are full reversing transmissions. Direction of the output/propeller rotation is determined by the hookup of the shift cable at the remote control.

The shift cable must be hooked up to the remote control before starting installation and adjustment procedures. See **Transmission and Propeller Rotation** for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

For Right Hand Propeller Rotation: The shift cable hookup at remote the control must result in the shift cable end guide moving in direction "A" when the remote control handle is placed in forward position.

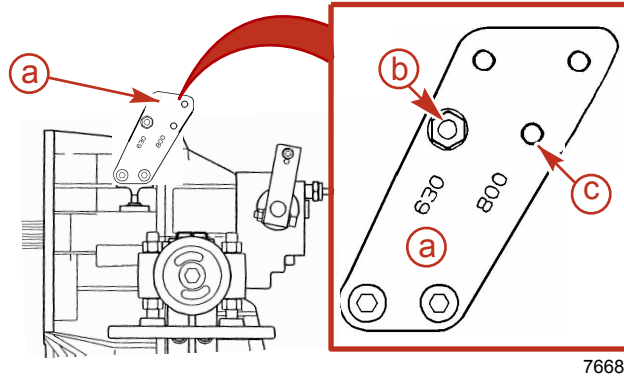
For Left Hand Propeller Rotation: The shift cable hookup at the remote control must result in the shift cable end guide moving in direction "B" when the remote control handle is placed in forward position.



⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

1. Ensure the anchor stud is installed in the correct mount hole as shown by the following illustration.



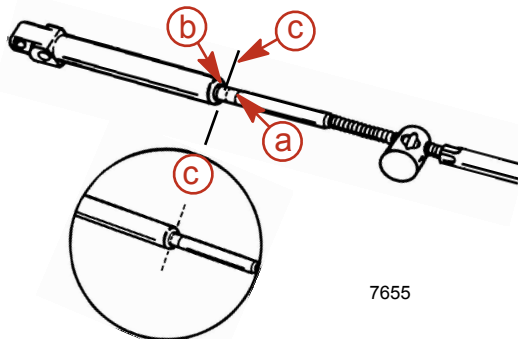
7668

Shift cable bracket - anchor stud positions

- | | |
|--|---|
| a - Cable bracket | c - Quicksilver shift cable anchor stud location—80A |
| b - Quicksilver shift cable anchor stud location—63A and 63IV | |

IMPORTANT: When installing shift cables, ensure that the cables are routed in such a way as to avoid contact with moving parts and/or sharp bends. All bends must make greater than a 20.3 cm (8 in.) radius. Do not fasten any items to the shift cables.

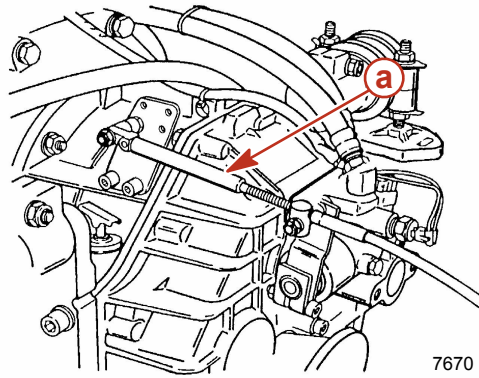
2. Place the remote control shift lever, and transmission shift lever, in NEUTRAL position.
3. Remove the nuts and washers from the shift cable attaching studs.
4. Locate the center of the remote control and control shift cable play (backlash), as follows:
 - a. Check that remote control is in neutral position.
 - b. Push in on control cable end with enough pressure to remove play, and mark position "a" on tube.
 - c. Pull out on control cable end with enough pressure to remove play, and mark position "b" on tube.
 - d. Measure distance between marks "a" and "b;" and mark position "c," half-way between marks "a" and "b".



7655

5. Center cable-end play; then, adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.

6. Temporarily install shift cable. Do not secure at this time.



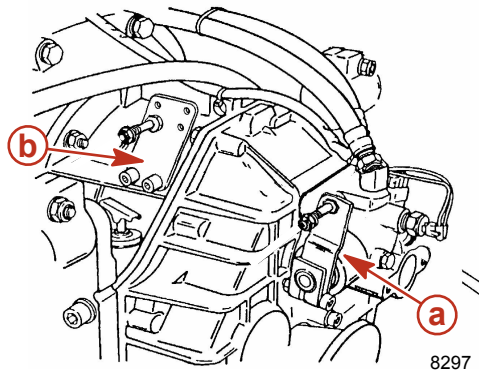
7670

Typical

a - Shift cable end guide

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop in either direction.

7. Place remote control shift lever in forward gear position. Ensure that transmission is fully in gear, as follows:
 - a. Hold shift lever in position.
 - b. Carefully slide shift cable off of anchor points.
 - c. Attempt to move shift lever further.
8. Place remote control shift lever in the reverse gear position. Ensure that transmission is fully in gear, following same procedure.
9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment.
10. If transmission shift lever will not position properly in both gears, move transmission shift lever stud to the other hole and recheck shift cable position.
11. If transmission shift lever is still not positioned properly for both gears, move anchor stud on shift cable bracket to another hole and recheck shift cable position.
12. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



8297

Typical ZF Marine transmission shown

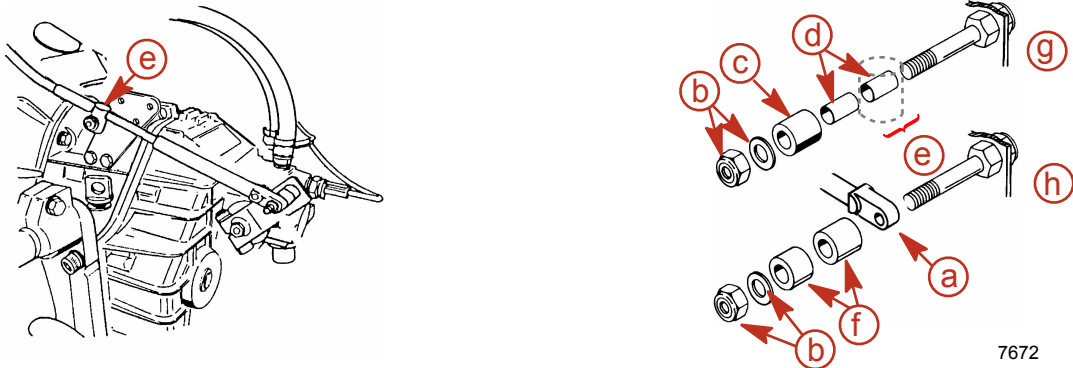
a - Shift lever

b - Shift cable bracket

13. Reattach locknut and washer to cable end guide stud. Tighten until they contact, then loosen 1/2 turn.

14. Reattach locknut and washer to cable barrel stud. Tighten securely, but do not overtighten.

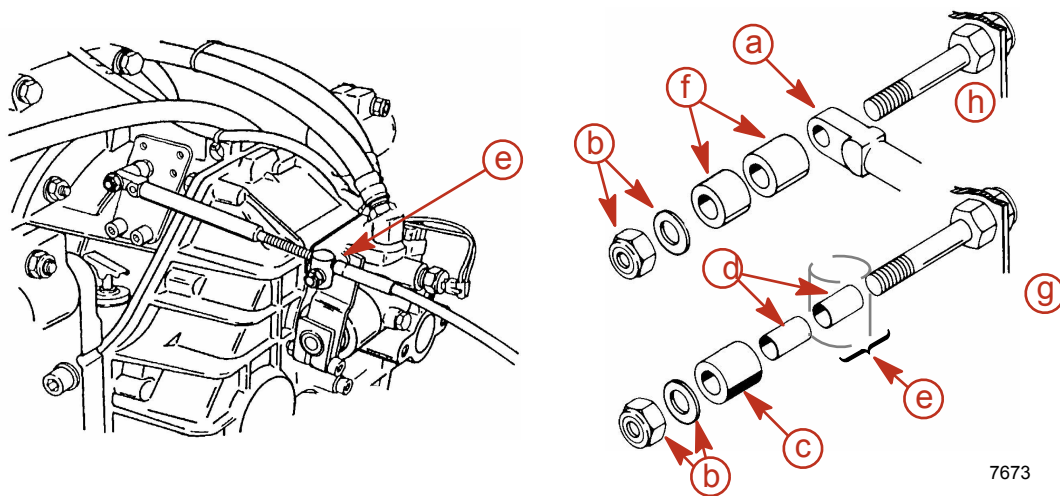
NOTE: To change cable approach direction on single or dual station installations, only the spacers/bushings have to be switched to the opposite stud (the studs are identical).



Typical single cable—forward entry

- | | |
|--|------------------------------------|
| a - Cable end guide | e - Cable barrel location |
| b - Locknut and washer | f - Spacer (fits over stud) |
| c - Spacer (fits over bushings) | g - Cable barrel stud |
| d - Bushings | h - Cable end guide stud |

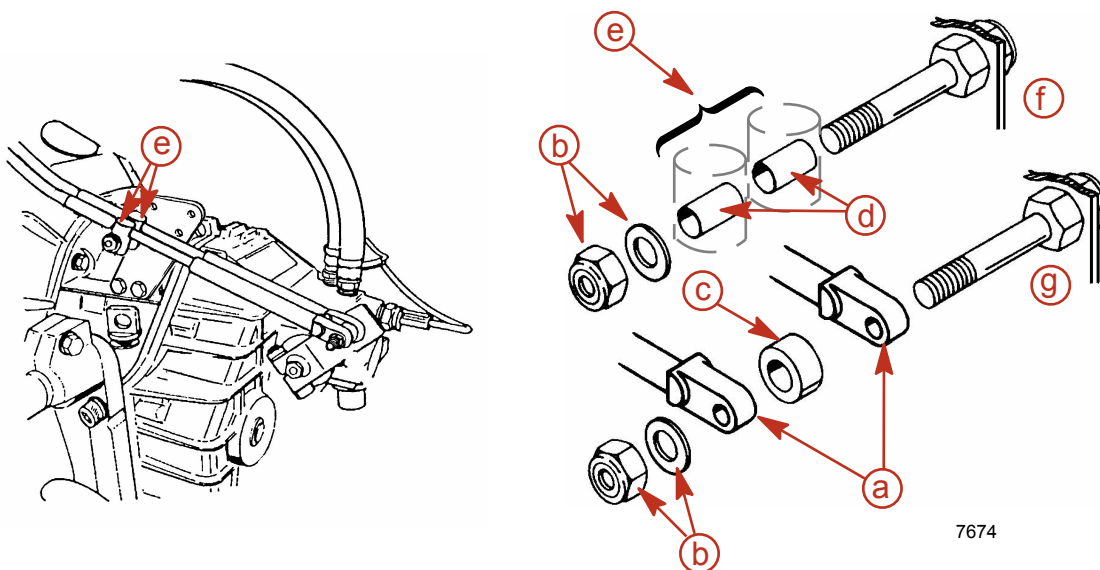
NOTE: Ensure the spacer is installed at the cable ends.



Typical single cable - rear entry

- | | |
|--|------------------------------------|
| a - Cable end guide | e - Cable barrel location |
| b - Locknut and washer | f - Spacer (fits over stud) |
| c - Spacer (fits over bushings) | g - Cable barrel stud |
| d - Bushings | h - Cable end guide stud |

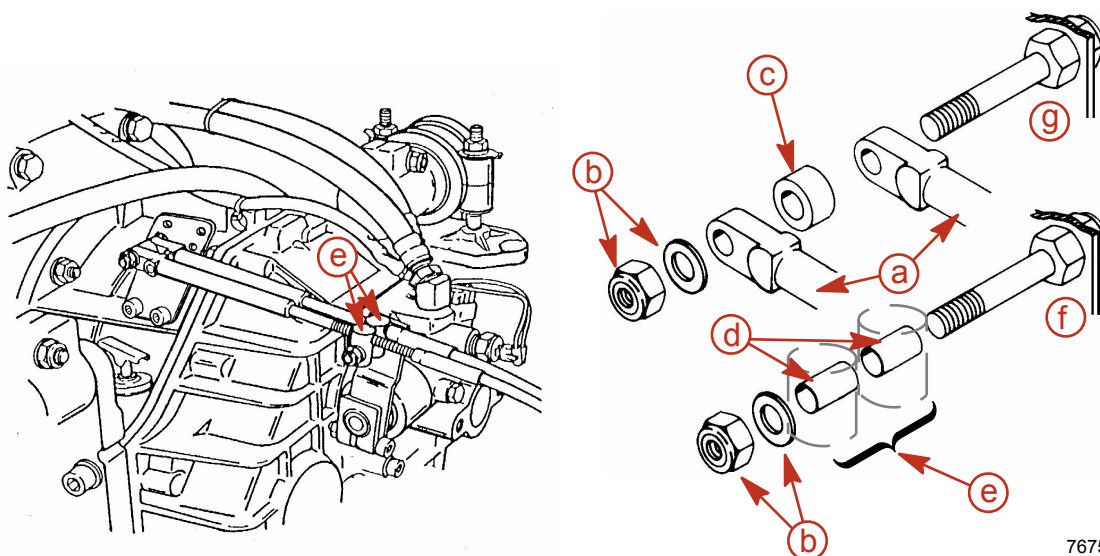
NOTE: Ensure the spacer is installed at the cable ends.



Typical dual cable—forward entry

- | | |
|--|----------------------------------|
| a - Cable end guide | e - Cable barrel location |
| b - Locknut and washer | f - Cable barrel stud |
| c - Spacer (fits over bushings) | g - Cable end guide stud |
| d - Bushings | |

NOTE: Ensure the spacer is installed at the cable ends.



Typical dual cable - rear entry

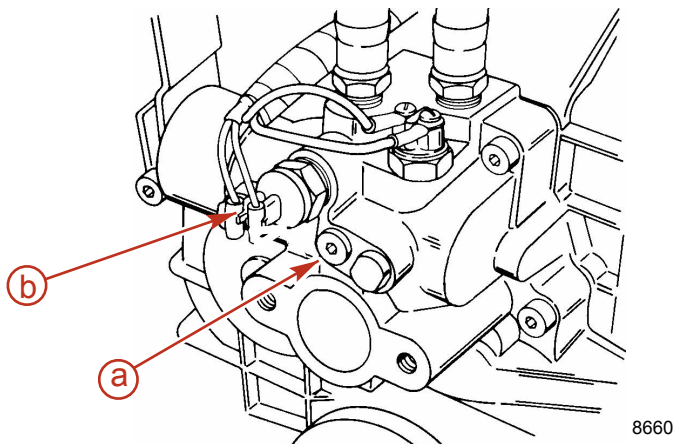
- | | |
|--|----------------------------------|
| a - Cable end guide | e - Cable barrel location |
| b - Locknut and washer | f - Cable barrel stud |
| c - Spacer (fits over bushings) | g - Cable end guide stud |
| d - Bushings | |

Electronic Shift Control Installation and Adjustment

Refer to the appropriate Mercury MerCruiser SmartCraft DTS Service Manual.

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.



Typical ZF Marine transmission

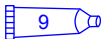
a - Service port plug—Port A

b - Fluid temperature switch—Port B

5. Operate the boat with a normal load on board.
6. Ensure that the fluid temperature and shifting pressure are as specified.

Description	Specification	
Operating temperature	54–79 degrees C (130–175 degrees F)	
Shifting pressure	Position A	21.5–23.5 bar (312–341PSI) 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 sealant to the fluid temperature switch threads and the service port plug.

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads and the service port plug	92-809822

10. Install and securely tighten the fluid temperature switch and service port plug.
11. Connect the two fluid temperature switch wires. Apply sealant 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

12. Upon first operation, check for leaks.

Notes:

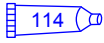
Power-Assisted Steering System

Section 9A - Power-Assisted Steering Pump and Related Components

Table of Contents

Power-Assisted Steering Specifications.....	9A-2	Power-Assisted Steering System—Fluid Level	
Power-Assisted Steering Pump.....	9A-2		9A-4
Removal.....	9A-2	Power-Assisted Steering—Hydraulic Hoses	
Inspection.....	9A-3		9A-6
Installation.....	9A-3		

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 28	Dexron III Automatic Transmission Fluid	Power steering system	Obtain Locally
 114	Power Trim and Steering Fluid	Power steering system	92-858074K01

Power-Assisted Steering Specifications

IMPORTANT: Power-assisted steering pumps are considered non-repairable units and are intended to be removed and replaced with new units when found to be defective.

NOTICE

For more information on the power-assisted steering system and components, refer to the appropriate Mercury MerCruiser sterndrive service manual.

Power-Assisted Steering Pump

Removal

IMPORTANT: Power-assisted steering pumps are considered non-repairable units and are intended to be removed and replaced with new units when found to be defective.

⚠ CAUTION

Avoid injury or product damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery.

1. Disconnect both battery cables from the battery.
2. Remove the serpentine drive belt.
3. Remove the three screws securing the power-assisted steering pump to the engine. Retain the screws.
4. Remove the fluid reservoir from the fluid reservoir bracket.

⚠ CAUTION

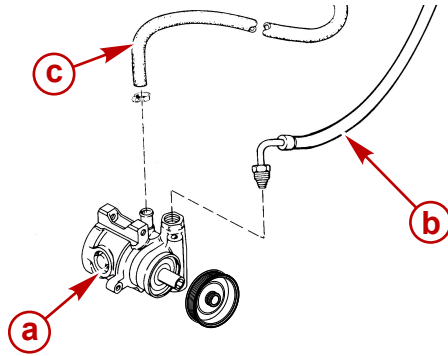
Contamination in the hydraulic system may damage the components or cause the system to malfunction which could result in injury or product damage. When servicing hydraulic systems or components, make sure that the work area and tools are clean. Do not use cloth rags to clean components, lint may contaminate the system. Cap or plug all open hydraulic connections. Place disassembled components in clean plastic bags when not working on them.

5. Drain the fluid from the power-assisted steering pump and reservoir into a suitable container. Do not reuse the fluid.
6. Dispose of the fluid properly.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities.

7. Remove the reservoir hose and pressure hose from the power-assisted steering pump. Cap or plug all open hydraulic connections.

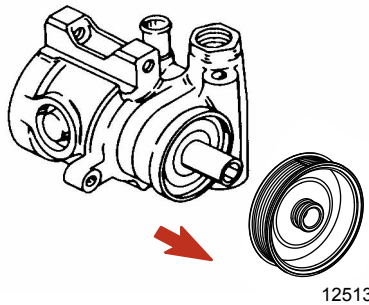


21775

a - Power steering pump
b - Pressure hose

c - Reservoir hose

8. Using a suitable puller, remove the pulley from the power-assisted steering pump shaft. Retain the pulley for installation.



12513

Typical

Inspection

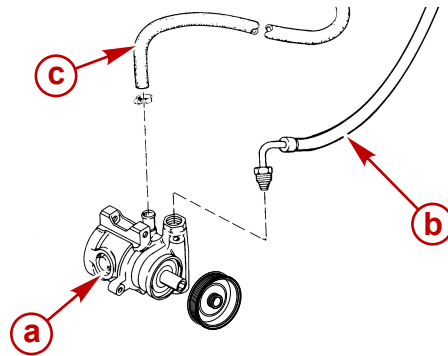
1. Inspect the power-assisted steering pump pulley for warping and excessive wear.
2. Inspect the pressure hose fitting and the O-ring.
3. Inspect the return hose clamp.
4. Inspect the power-assisted steering pump bracket for warping, cracks, and excessive wear.
5. Inspect the power steering fluid reservoir and cap for cracks, excessive wear, and signs of leaking.
6. Replace any components that do not pass inspection.

Installation

1. Remove the cap or plug from the hydraulic connections.
2. Install the reservoir hose and pressure hose onto the power-assisted steering pump. Ensure that the O-ring is in position on the pressure hose fitting. Torque the fitting.

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

3. Tighten the reservoir hose clamp securely.



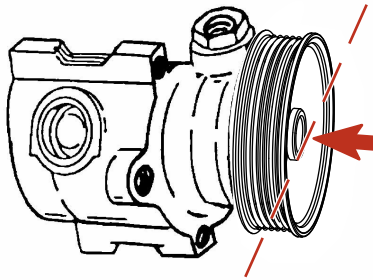
21775

- a** - Power-assisted steering pump **c** - Reservoir hose
b - Pressure hose

4. Install the reservoir onto the reservoir bracket.
5. Install the power-assisted steering pump onto the pump bracket using the three screws retained in removal. Torque the screws.

Description	Nm	lb. in.	lb. ft.
Power-assisted steering pump to pump bracket screw	26		19

6. Using a suitable screw and a flat washer, push (install) the pulley onto the power-assisted steering pump shaft until the pulley face is flush with the shaft end. The screw head and washer will make contact with the shaft end.



12514

Pulley installed flush with shaft end

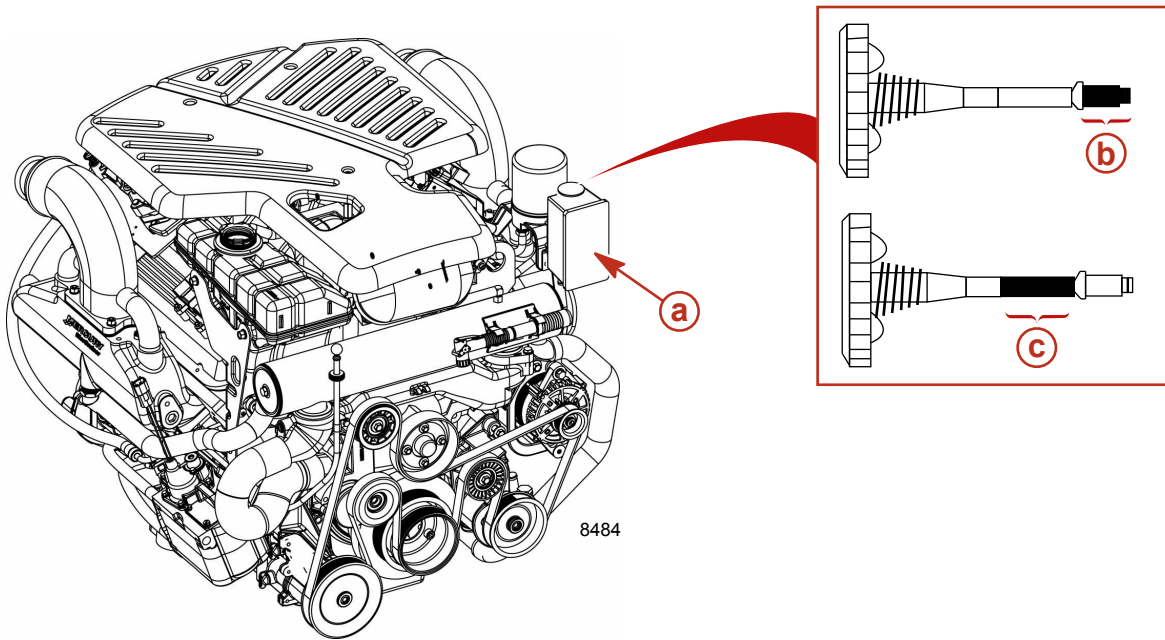
7. Drain any remaining fluid out of the power-assisted steering reservoir into an approved container. Do not reuse the fluid.
8. Dispose of the old fluid properly.
9. Fill the power-assisted steering reservoir with the specified fluid.
10. Connect both battery cables.
11. Install the serpentine drive belt.

Power-Assisted Steering System—Fluid Level

CHECKING

1. Stop the engine and center the sterndrive.
2. Remove the fill cap/dipstick from the power steering fluid reservoir and observe the level.
 - a. The proper fluid level with the engine at the normal operating temperature should be within the warm range.

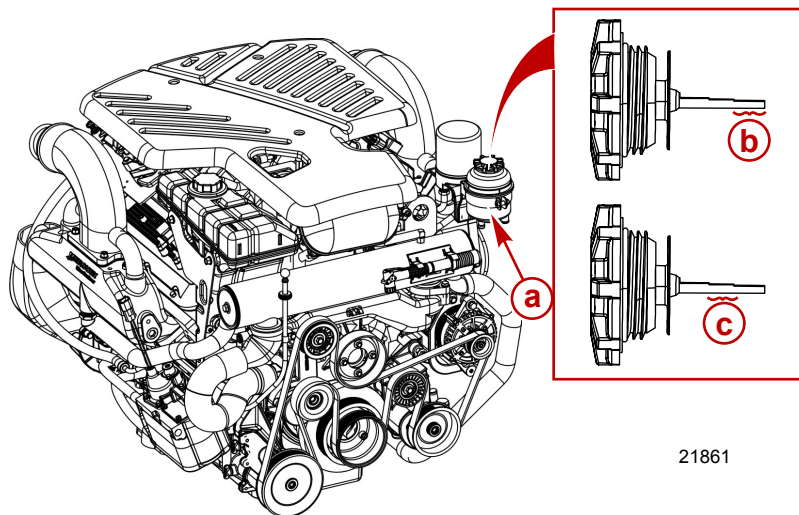
- b. The proper fluid level with the engine cold should be within the cold range.



Square reservoir

a - Reservoir
b - Cold range

c - Warm range



Round reservoir

a - Reservoir
b - Cold range

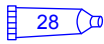
c - Warm range

3. Fill to the "FULL" line with the specified fluid.

IMPORTANT: If fluid is not visible in the fluid reservoir, locate and repair the leak.

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 range.

Tube Ref No.	Description	Where Used	Part No.
 28	Dexron III Automatic Transmission Fluid	Power steering system	Obtain Locally
 114	Power Trim and Steering Fluid	Power steering system	92-858074K01

3. Reinstall the fill cap/dipstick.

Power-Assisted Steering—Hydraulic Hoses

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

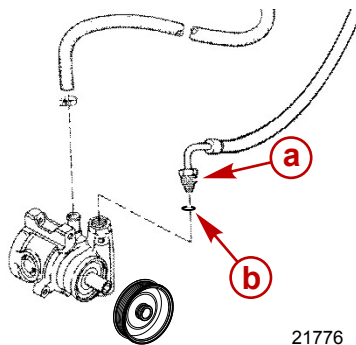
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

PRESSURE HOSE (PUMP-TO-CONTROL VALVE)

REMOVAL

NOTE: Catch any fluid that drains from the power-assisted steering pump, hoses, fluid reservoir, or fluid cooler in a suitable container.

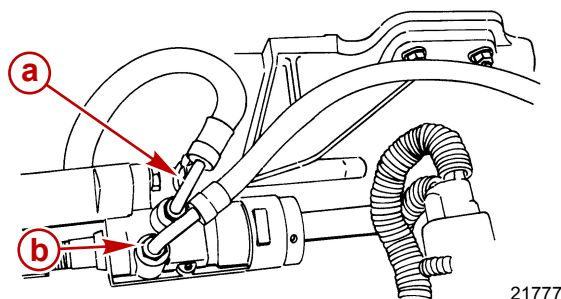
1. Disconnect the the pressure hose from the power-assisted steering pump.



a - Pressure hose fitting

b - O-ring

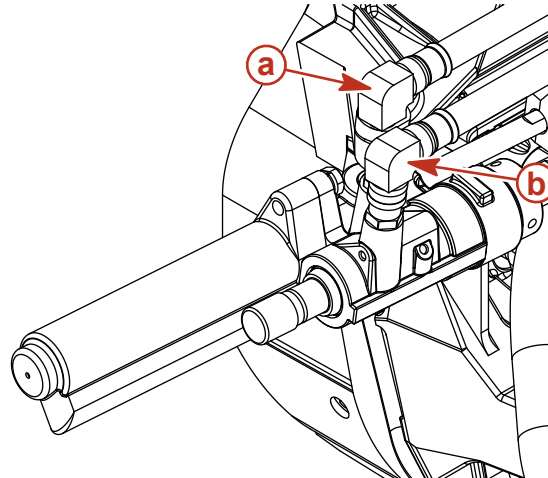
2. Remove and discard the O-ring.
3. **On models with standard fittings:**
 - a. Disconnect the pressure hose from the control valve at the transom.
 - b. Remove and discard the O-ring.



a - Pressure hose fitting

b - Return hose fitting

4. **On models with quick-connect fittings**, disconnect the pressure hose from the quick-connect fitting on the control valve at the transom.



a - Pressure hose

b - Return hose

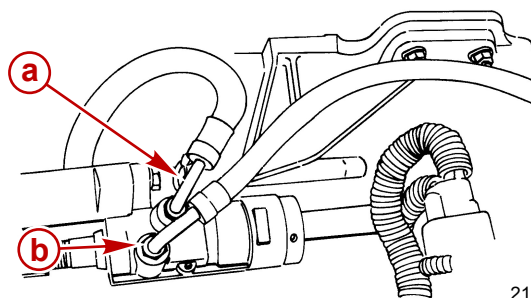
INSTALLATION

⚠ CAUTION

Avoid kinks in the hoses. Route hoses exactly as shown below to help avoid stress on the hose fittings and avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. Route the pressure hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
 - a. Ensure that the O-ring is in position on the pressure hose fitting.
 - b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.



a - Pressure hose fitting

b - Return hose fitting

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

- 11/10/2019



b - Return hose

- || ||

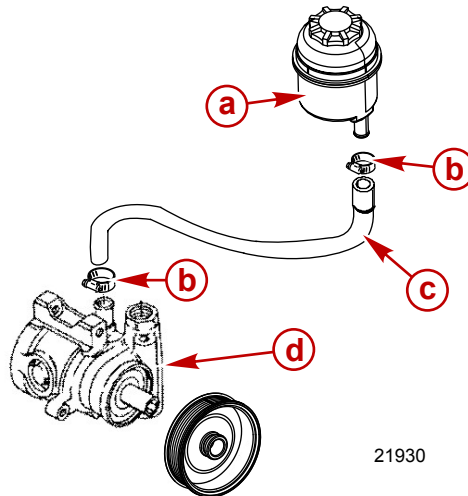
b - O-ring

6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

- ### USE (RESERVOIR TO PUMP)

REMOVAL

1. Loosen the hose clamps on the reservoir hose at the reservoir and the power-assisted steering pump. Remove the hose.



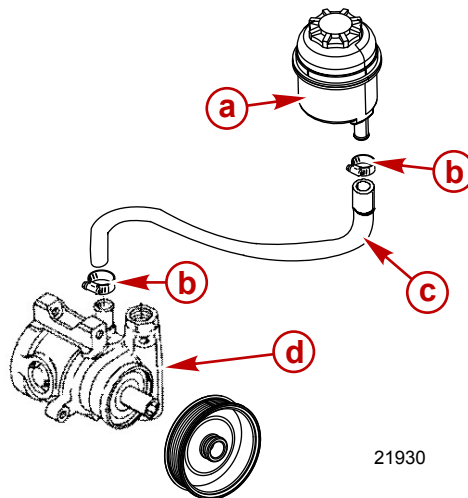
a - Reservoir
b - Hose clamp

c - Reservoir hose
d - Power-assisted steering pump

INSTALLATION

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.

1. Using a hose clamp, install the new reservoir hose onto the reservoir. Tighten the clamp securely.
2. Using a hose clamp, install the new reservoir hose onto the pump. Tighten the clamp securely.



a - Reservoir
b - Hose clamp

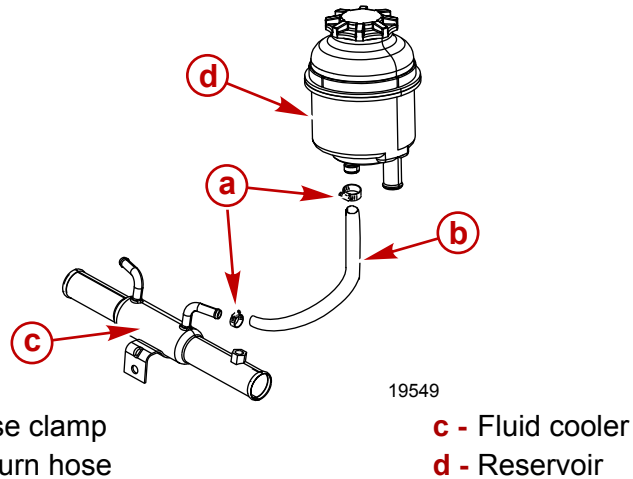
c - Reservoir hose
d - Power-assisted steering pump

RETURN HOSE (COOLER-TO-RESERVOIR) REMOVAL

NOTE: Catch any fluid that drains from the power-assisted steering pump, hoses, fluid reservoir, or fluid cooler in a suitable container.

1. Loosen the hose clamp and remove the return hose from the fluid cooler.

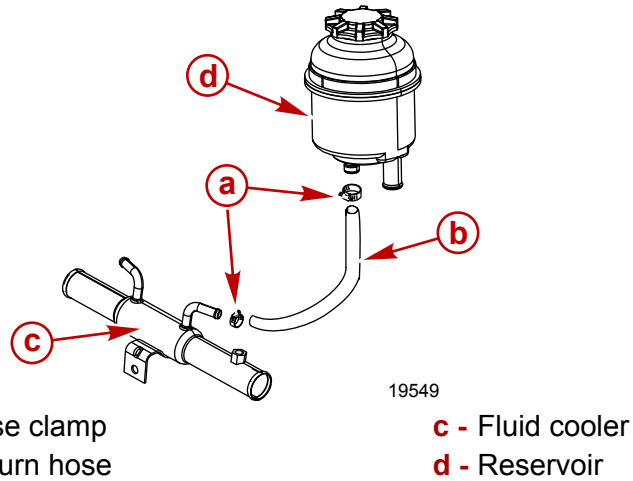
2. Loosen the hose clamp and remove the hose from the fluid reservoir.



INSTALLATION

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.

1. Using a hose clamp, install the new return hose onto the reservoir. Tighten the clamp securely.
2. Using a hose clamp, install the return hose onto the fluid cooler. Tighten the clamp securely.



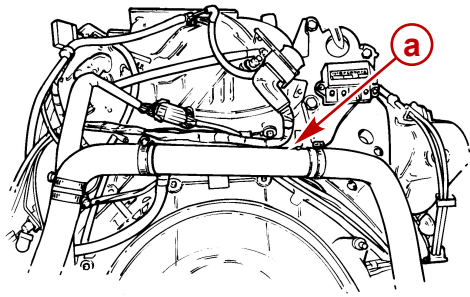
3. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

RETURN HOSE (CONTROL VALVE-TO-COOLER)

REMOVAL

NOTE: Catch any fluid that drains from the power-assisted steering pump, hoses, fluid reservoir, or fluid cooler in a suitable container.

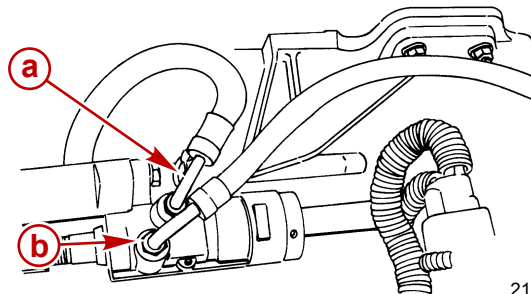
1. Loosen the hose clamp and remove the hose from the fluid cooler.



21787

a - Return hose

2. **On models with standard fittings**, disconnect the return hose from the control valve at the transom.

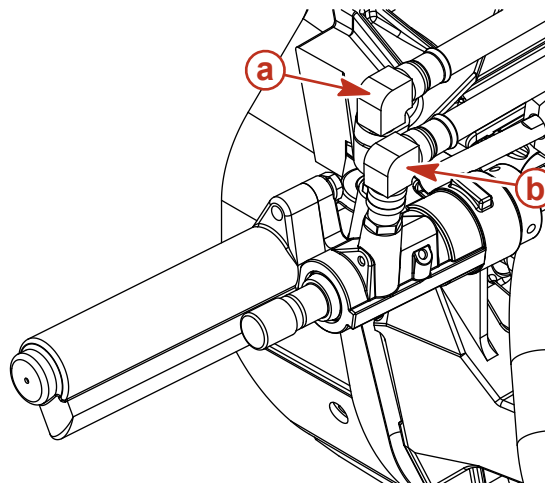


21777

a - Pressure hose

b - Return hose

3. **On models with quick-connect fittings**, disconnect the return hose from the quick-connect fitting on the control valve at the transom.



6686

a - Pressure hose

b - Return hose

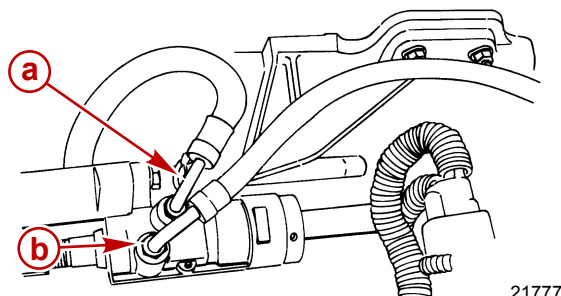
4. Remove the return hose.

INSTALLATION

IMPORTANT: Route the hoses to avoid extreme heat, stress on the hose fittings, and hose kinks.

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. Route the return hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
 - a. Ensure that the O-ring is in position on the return hose fitting.
 - b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.

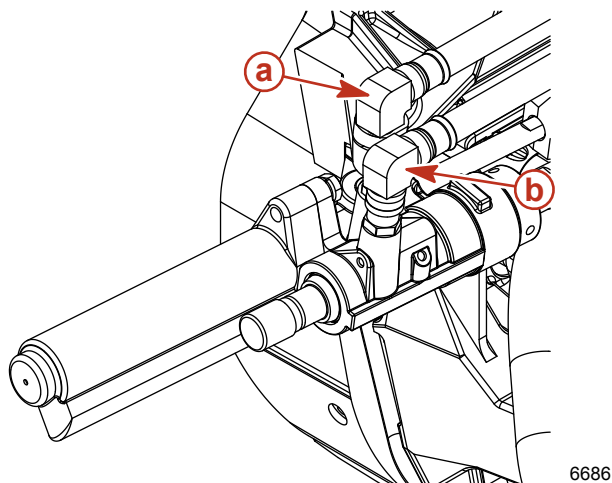


a - Pressure hose

b - Return hose

Description	Nm	lb. in.	lb. ft.
Return hose fitting	31		23

3. **On models with quick-connect fittings,** install the return hose onto the quick-connect fitting on the control valve at the transom. Ensure that the quick-connect fitting snaps into place.

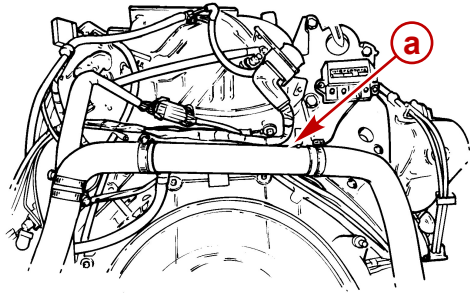


a - Pressure hose

b - Return hose

4. Route the return hose along the flywheel housing and secure the hose with the J-clamps provided.

5. Using a hose clamp, install the low pressure hose onto the fluid cooler. Tighten the clamp securely.



21787

a - Return hose

6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

Notes: