Important Information

Section 1A - General Information

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Introduction

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

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

Quicksilver Products

Accessories

Quicksilver gauges, remote controls, steering systems, propellers, and other accessories are available for this product. Mercury MerCruiser recommends the use of Quicksilver parts on all applications. Refer to **Mercury Precision Parts Accessories Guide** for a complete listing.

This Guide is available from:
Attn: Parts Department
Mercury Marine
W6250 W. Pioneer Road
P.O. Box 1939
Fond du Lac, WI 54935-1939

Outside of U.S.A., order through Distribution Center or Distributor.

How to Use This Manual

This manual is divided into volumes and sections that represent the major components and systems.

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

Refer to the **Service Manual Outline** following **Models Covered** in this manual for section titles.

MerCruiser Color Wiring Diagrams

Large scale, oversized color wiring diagrams are available in the MerCruiser Diagram Binder. The initial distribution of the MerCruiser Diagram Binder was delivered to MerCruiser authorized repair facilities in June and July of 2007. As new diagrams are developed they will be distributed along with a revised, comprehensive index for addition to an existing binder.

The MerCruiser Diagram Binder features:

- An index that identifies the diagrams by harness number, by engine group and drive, and by engine size and type
- The diagrams are printed on an extremely durable, coated synthetic paper and can be wiped clean of grease and oil after use.
- The larger diagrams are easier to read. The diagrams will come in two sizes, depending on the complexity of the related harness.
- Removable pages are easier to reference and allow the technician to take only the required diagram to a repair site instead of a complete service manual.
- Dry erase markers can be used directly on the diagrams for tracing circuits or for training. They wipe clean after use.
- Harness number headings make the drawings easy to find. The accompanying MerCruiser Diagram Binder Index speeds lookup when the harness number is not known.

For information about ordering additional copies of the MerCruiser Diagram Binder or binder updates contact:

- MerCruiser Authorized Dealers, Repair Centers, or OEMs can order service literature on MercNET.
- Consumers can order service literature through the Mercury Dock Store (www.mercurydockstore.com), contacting Mercury MerCruiser publications at 920-929-5110 or by contacting their local MerCruiser Authorized Dealer or Repair Center.

Abbreviations

IMPORTANT: Throughout this manual abbreviations of terms will be used, following is a listing of the abbreviations and related definitions.

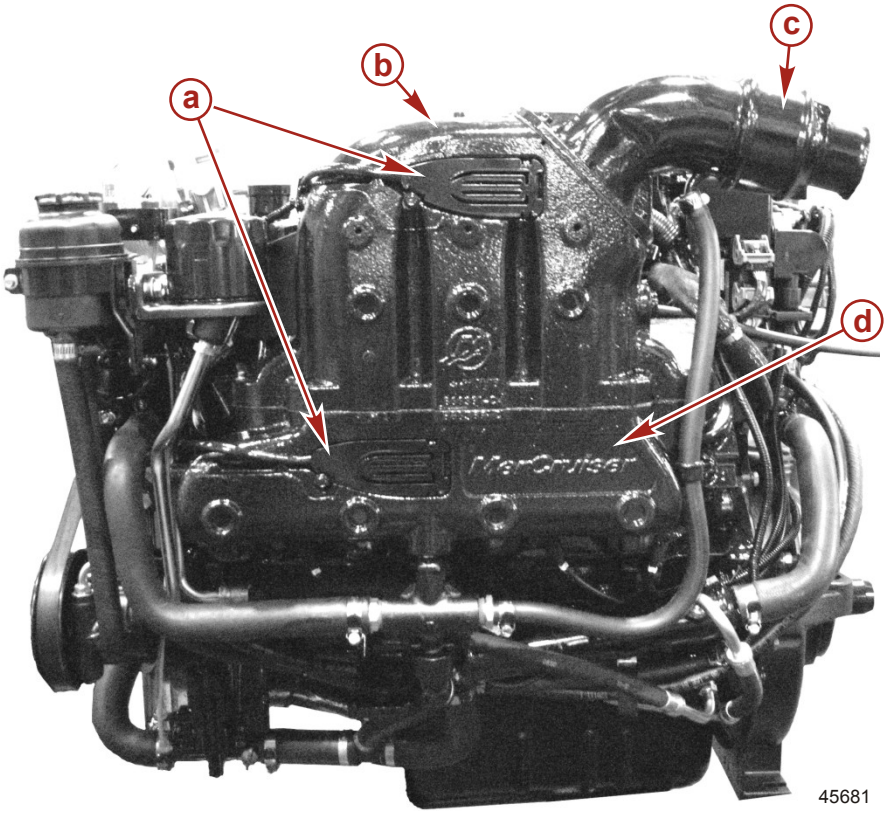
BARO	Barometric Pressure	INJ	Injection
BAT	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor
CKT	Circuit	KV	Kilovolts

CONN	Connector	MAP	Manifold Absolute Pressure
CYL	Cylinder	MDTC	Marine Diagnostic Trouble Code
DEG	Degrees	MIL	Malfunction Indicator Lamp
DIAG	Diagnostic	mSec	Millisecond
DIST	Distributor	N/C	Normally Closed
DLC	Data Link Connector	N/O	Normally Open
DTC	Diagnostic Trouble Code	OBD	On Board Diagnostic
DVOM	Digital Volt Ohm Meter	PROM	Programmable Read Only Memory
PCM	Propulsion Control Module	RAM	Random Access Memory
ECT	Engine Coolant Temperature	REF. HI	Reference High
EPROM	Electronic Erasable Programmable Read Only Memory	REF. LO	Reference Low
EMI	Electromagnetic Interference	ROM	Read Only Memory
ENG	Engine	SLV	Slave
EST	Electronic Spark Timing	SW	Switch
GND	Ground	TACH	Tachometer
GPH	Gallons Per Hour	TERM	Terminal
HEI	High Energy Ignition	TPS	Throttle Position
IAC	Idle Air Control	V	Volts
IAT	Intake Air Temperature	VAC	Vacuum
IC	Ignition Control	WOT	Wide Open Throttle
IGN	Ignition	in. Hg	Inches of Mercury
		MCM	MerCruiser Marine
		MIE	Mercury Inboard Engine
		MPI	Multi-Port Injection

Sterndrive Models Identification

Engine Exhaust With and Without Emissions Control

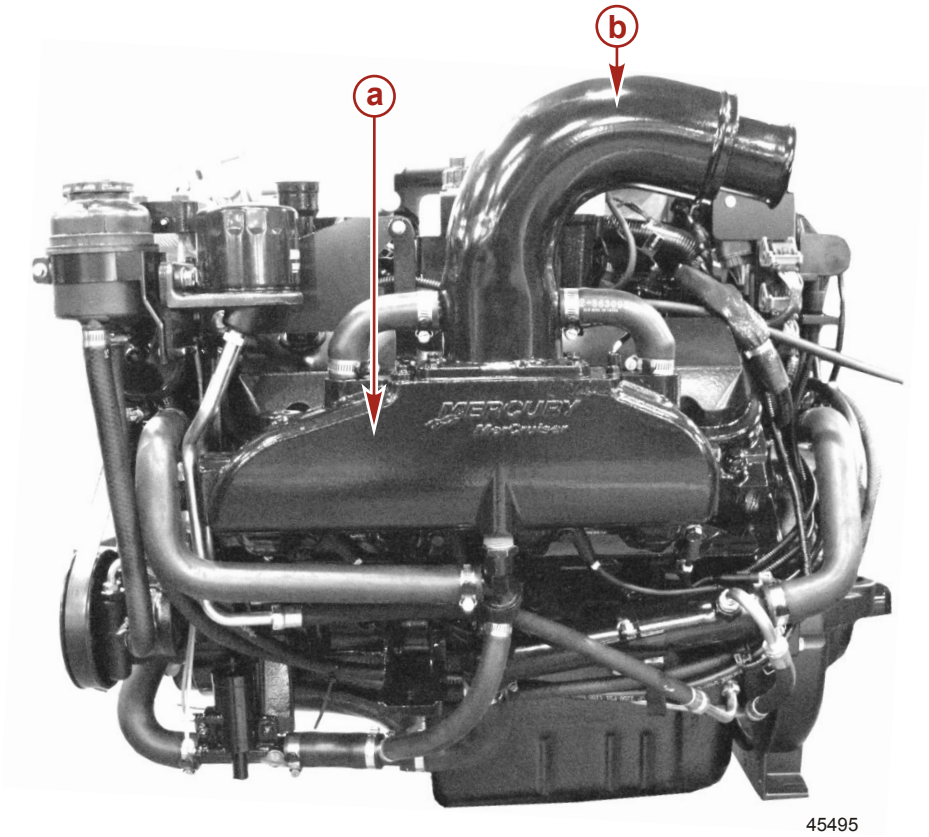
Engine With Emissions Control



Typical 8.2 MAG sterndrive with emissions control

- **a -** Catalyst sensors
- **b -** Exhaust collector
- **c -** Exhaust elbow riser
- **d -** Exhaust manifold

Engine Without Emissions Control

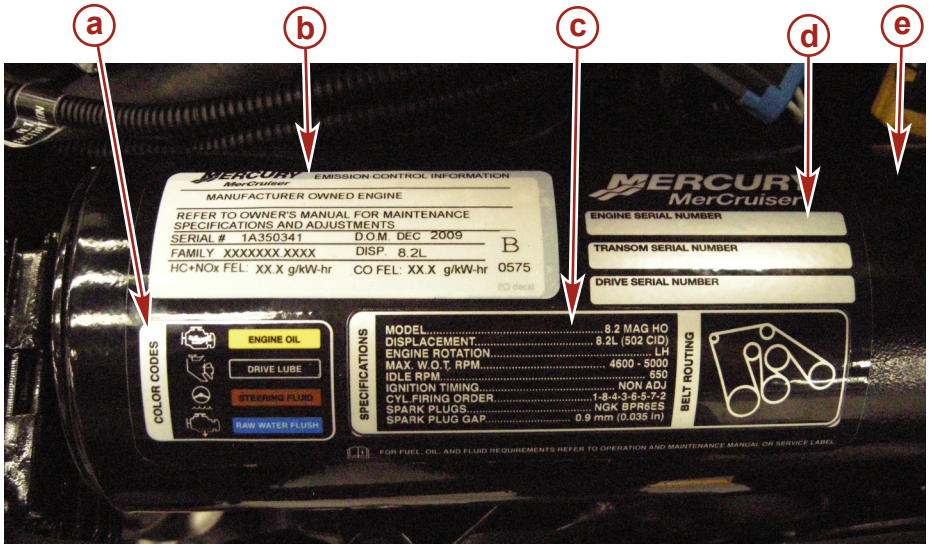


Typical 8.2 MAG sterndrive without emissions control

a - Exhaust manifold
b - Exhaust elbow

Information Decal

The information decal is located on the top starboard side of the heat exchanger.



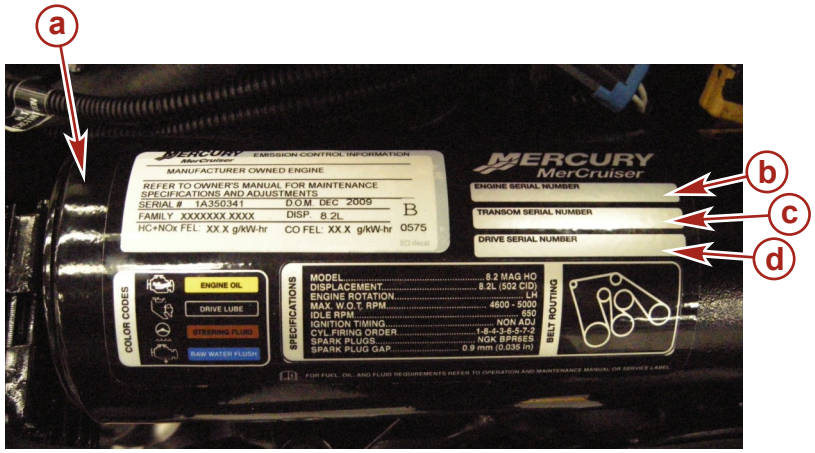
a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Heat exchanger

Serial Number Decal Strips

There are 3 sets of engine, transom assembly, and sterndrive serial number decal strips provided with each power package. Affix one of each to the following:

- Serial numbers decal
- Warranty registration Card

- Operation, Maintenance and Warranty Manual identification page



43188

a - Heat exchanger
b - Engine serial number
c - Transom serial number
d - Sterndrive serial number

Engine Serial Number

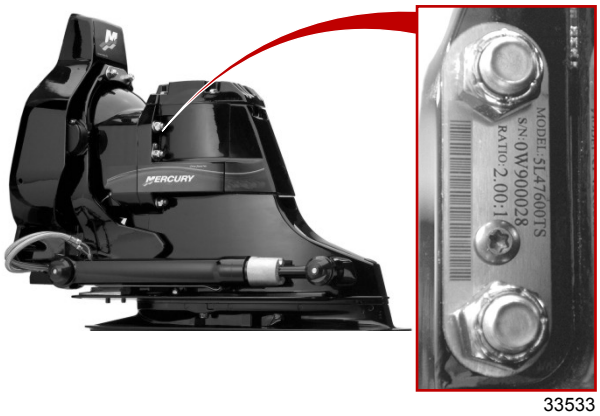
The engine serial number stamp is located on the starboard-side of the engine block next to the flywheel housing cover.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Bravo Sterndrive Serial Number and Identification

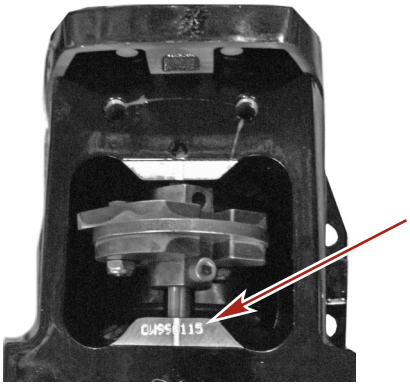
The Bravo sterndrive serial number, gear ratio, model number, and bar code are embedded in the ground plate on the port side of the sterndrive.



33533

Bravo sterndrive information on ground plate

The serial number is also stamped on the drive shaft housing behind the back cover. This is used as a permanent reference for authorized MerCruiser Dealers.

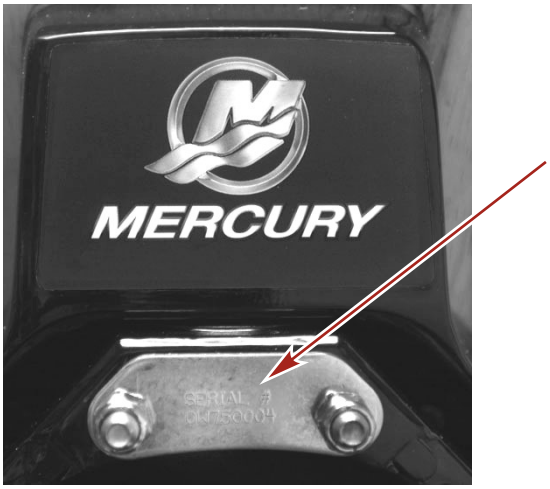


44426

Bravo sterndrive serial number stamping

Bravo Transom Serial Number

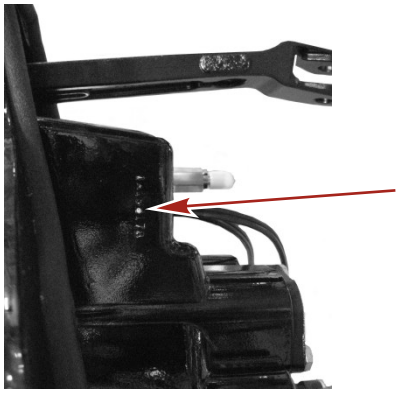
The Bravo transom serial number is stamped in the U-bolt plate of the Bravo transom assembly.



44433

Serial number location on U-bolt plate

The serial number is also stamped on the gimbal housing. This is used as a permanent reference for authorized MerCruiser Dealers.



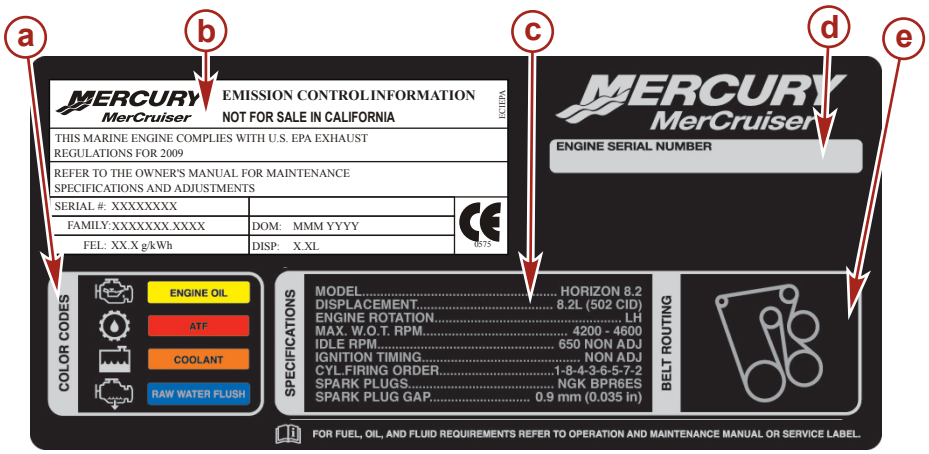
44425

Serial number location on gimbal housing

Inboard Models Identification

Information Decal

The information decal is located on the top starboard-side of the heat exchanger.



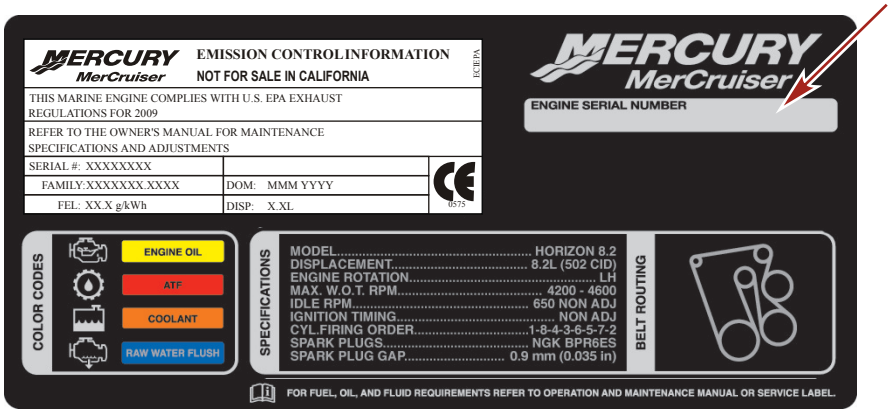
43688

a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Belt routing

Serial Number Decal Strips

There are 3 sets of engine serial number decal strips provided with each power package. Affix one to the following:

- Engine serial number decal
- Warranty registration Card
- Operation, Maintenance and Warranty Manual identification page



43689

Engine serial number decal on heat exchanger

Engine Serial Number

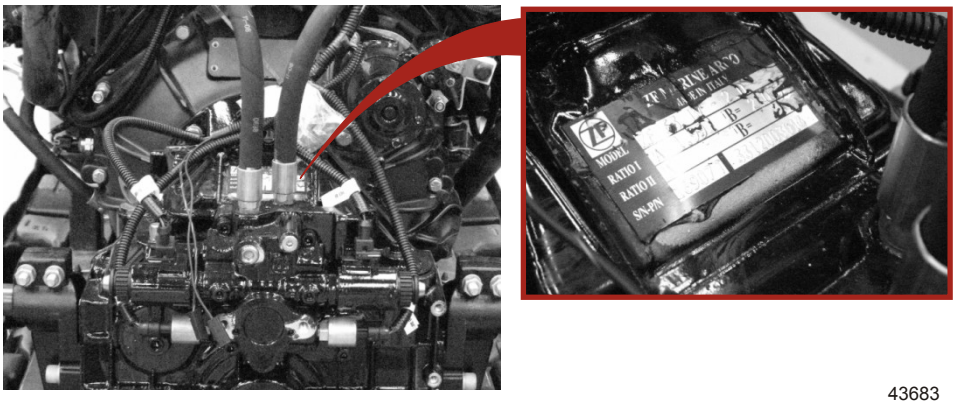
The engine serial number stamp is located on the starboard-side of the engine block next to the flywheel housing cover.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Transmission Identification Plate

On the ZF Marine 8 Degree Down-Angle and V-Drive Transmissions, the transmission identification plate indicates gear ratio, serial number, and model.



43683

Typical ZF Marine down-angle transmission shown (V-drive similar)

SeaCore Models

SeaCore Components and Castings

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

Stainless Steel Fasteners

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

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

Apply a lubricant, such as Special Lubricant 101 or an equivalent, on the threads of stainless steel fasteners during installation to avoid galling. Lubricate at least the first 8 mm (1/4 in.) of the threads before installation.

SeaCore System

The SeaCore System is a complete engine sterndrive package. The SeaCore engine and sterndrive enhancements are:

- Hardcoat anodized external castings
- Additional stainless steel fasteners and hardware

- Closed cooling on the engine
- Freshwater flush system—flushes the entire system

The SeaCore System provides corrosion protection for the engine with these standard features:

- Closed-cooling system with 5-year, long-life coolant
- Stainless steel steering shaft
- Stainless steel engine motor mounts and fasteners
- Dry joint exhaust
- MerCathode Corrosion Protection System
- SmartCraft Engine Guardian
- Compatible with 87 octane fuel

The following stainless steel fasteners and hardware are used on this engine and sterndrive package for increased corrosion resistance:

- Gimbal housing studs
- Power steering hose—high pressure end
- Flywheel housing bolts
- Pulley attaching bolts and all engine component fasteners
- Engine mount stud and fastener

NOTE: *Hardcoat anodizing is more abrasion resistant than case-hardened steel, and if the drive is scratched, the anodizing slows the destructive growth of corrosion through the drive surface.*

The SeaCore System provides corrosion protection for the sterndrive with the following standard features:

- Industrial hardcoat anodized XK360 aluminum drive housings and transom components
- Protected interior passages
- Through-the-propeller exhaust
- Non-conductive surface to reduce galvanic corrosion
- Stainless steel sterndrive and transom fasteners
- Power Trim XD
- New SeaCore transom identification plate
- Bravo III stainless steel bearing carrier
- The transom is equipped with stainless steel upper swivel shaft (and new shaft seal)

Corrosion Information

Corrosion Protection

Mercury MerCruiser power packages are equipped with anodes to help protect them from galvanic corrosion under moderate conditions. However, for severe conditions or if using a stainless steel propeller, it is recommended that a Quicksilver Anti-Corrosion Anode Kit and/or a MerCathode System with 2 additional transom mounted anode assemblies be installed (some models have a MerCathode System as standard equipment). A MerCathode Monitor also is available to allow the operator to check the operation of the MerCathode System with the push of a button. (Refer to **Mercury Precision Parts Accessories Guide** for part numbers.)

Boats that are connected to AC shore power require additional protection to prevent destructive low voltage galvanic currents from passing through the shore power ground wire. A Quicksilver Galvanic Isolator can be installed to block the passage of these currents while still providing a path to ground for dangerous fault (shock) currents. (Refer to **Mercury Precision Parts Accessories Guide** for part number.)

IMPORTANT: If AC shore power is not isolated from boat ground, the MerCathode System and anodes may be unable to handle the increased galvanic corrosion potential.

Anti-Fouling Paint

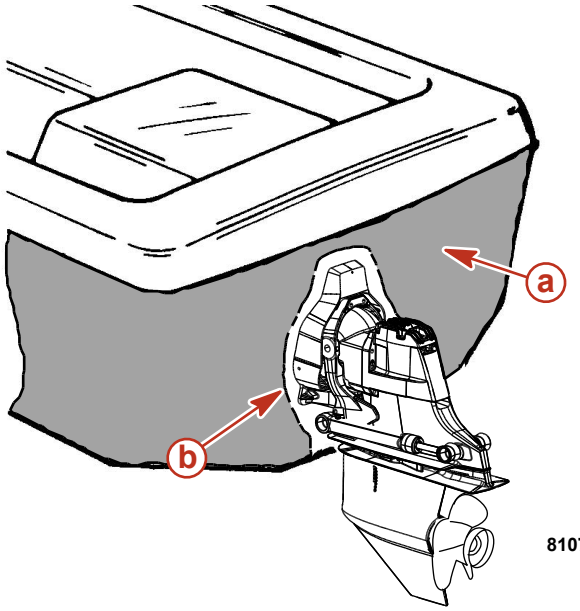
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

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

IMPORTANT: Do not paint anodes or pressure wash anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

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

- **Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on transom of the boat around these items.**

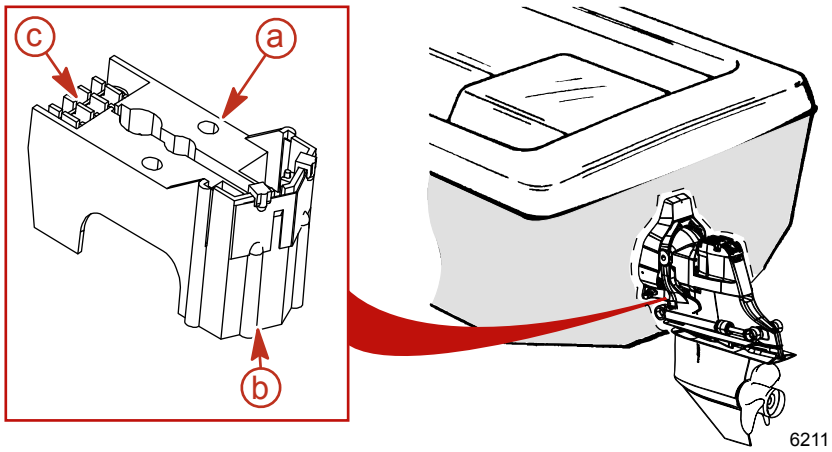


a - Painted boat transom
b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly

NOTE: Sterndrive unit and transom assembly can be painted with a good quality marine paint or an anti-fouling paint that DOES NOT contain copper or any other material that could conduct electrical current. Do not paint drain holes, anodes, MerCathode system or items specified by boat manufacturer.

NOTICE
Washing the MerCathode assembly can damage components and lead to rapid corrosion. Do not use any cleaning equipment such as brushes or high-pressure washers to clean the MerCathode assembly.

Do not wash the sterndrive unit with a power washer as this can damage the coating on the reference wire of the MerCathode assembly, if equipped, and increase corrosion.

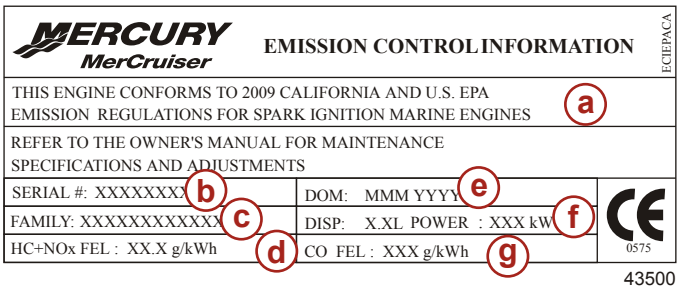


a - MerCathode reference electrode
b - Do not paint
c - Do not pressure wash

Emissions Information For Engines With Emission Control

Emission Control Information Label

A tamper-resistant emission control information (ECI) label is affixed to the engine in a visible location at the time of manufacture by Mercury MerCruiser. Please note that the low emissions certification will not affect the fit, function, or performance of the engine. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding. In addition to the required emissions statement, the label lists the engine serial number, family, applicable emission standard, date of manufacture (month, year), and engine displacement.



- **a -** Applicable standard
- **b -** Engine serial number
- **c -** Engine family name
- **d -** Hydrocarbons plus oxides of nitrogen family emission limit
- **e -** Date of manufacture
- **f -** Engine displacement, engine power
- **g -** Carbon monoxide family emission limit

IMPORTANT: A CE mark in the lower right corner of the Emission Control Information label indicates that an EU Declaration of Conformance applies. Refer to the front page of this manual for further information.
IMPORTANT: Engines designated as exempt from either Federal EPA or California emission control regulations are not covered by a separate emission control component warranty. The product's Mercury MerCruiser manufacturer's warranty is not affected by the engine's designation under Federal EPA or California emission control regulations.

ECI Label	Standard of Compliance
MERCURY MerCruiser EMISSION CONTROL INFORMATION NOT FOR SALE IN CALIFORNIA ECIEPA THIS MARINE ENGINE COMPLIES WITH U.S. EPA EXHAUST REGULATIONS FOR 2009 REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43518	Indicates a marine engine compliant with United States EPA exhaust emission regulations for 2009. This marine engine is not for sale in California.
MERCURY MerCruiser EMISSION CONTROL INFORMATION ECICARB THIS ENGINE CONFORMS TO 2009 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY:XXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43519	Indicates a marine engine compliant with California CARB exhaust emission regulations for 2009
MERCURY MerCruiser EMISSION CONTROL INFORMATION ECIEPACA THIS ENGINE CONFORMS TO 2009 CALIFORNIA AND U.S. EPA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43520	Indicates a marine engine compliant with California CARB and U.S. EPA regulations for 2009

ECI Label	Standard of Compliance
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** **NOT FOR SALE IN CALIFORNIA** ECIEXEMP THIS ENGINE IS EXEMPT UNDER 40 CFR 1068.255 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43521	Indicates a marine engine exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations for 2010. This marine engine is not for sale in California.
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** ECICARBX THIS ENGINE CONFORMS TO 2010 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES. THIS ENGINE IS EXEMPT UNDER 40 CFR 1068.255 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS. REFER TO THE OWNERS MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS. SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43522	Indicates a marine engine compliant with 2010 California emission regulations and exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** ECISERV THIS ENGINE DOES NOT COMPLY WITH U.S. EPA NONROAD EMISSION REQUIREMENTS. SELLING OR INSTALLING THIS ENGINE FOR ANY PURPOSE OTHER THAN TO REPLACE A NONROAD ENGINE BUILT BEFORE JANUARY 1, 2010 MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY. SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43499	Indicates a service marine engine that can replace a marine engine built prior to January 1, 2010.

Owner Responsibility

The operator must have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The operator may not modify the engine in any manner that alters the horsepower or allows emissions levels to exceed factory specifications.

Emission Certification Star Label

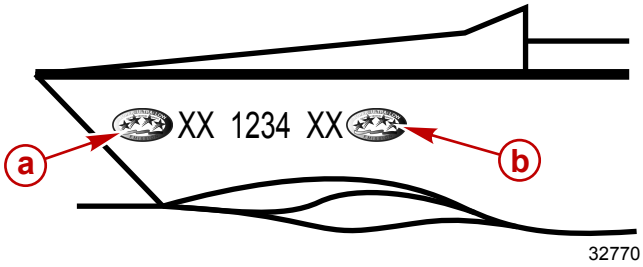
Your boat is labeled on the hull with one of the following star labels. The Symbol for Cleaner Marine Engines Means:

1. Cleaner Air and Water - for a healthier lifestyle and environment.
2. Better Fuel Economy - burns up to 30-40 percent less gas and oil than conventional carbureted two-stroke engines, saving money and resources.
3. Longer Emission Warranty - Protects consumer for worry free operation.

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

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

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



a - Recommended location
b - Secondary location

One Star - Low emission	
mc79569-1	The one-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted two-stroke engines. These engines are equivalent to the U.S. EPA's 2006 standards for marine engines.
Two Stars - Very Low emission	
42145	The two-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low-Emission engines.
Three Stars - Ultra Low emission	
42146	The three-star label identifies engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2008 exhaust emission standards or the Sterndrive and Inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.
Four Stars - Super Ultra Low emission	
42155	The Four Star label identifies engines that meet the Air Resources Board's Sterndrive and Inboard marine engine 2009 exhaust emission standards. Personal Watercraft and Outboard marine engines may also comply with these standards. Engines meeting these standards have 90% lower emissions than One Star - Low Emission engines.

Hang Tag

The dealer must mark the appropriate box on one hang tag to match the Star label affixed to the boat. The dealer is responsible for displaying the hang tag in a visible location on the boat on display in California. Failure to properly display the hang tag could result in a citation and possible fine to the dealer from the California Air Resources Board.

If in California, the dealer must place the hang tag in a visible location in the boat prior to displaying the boat.

Hang tag front side

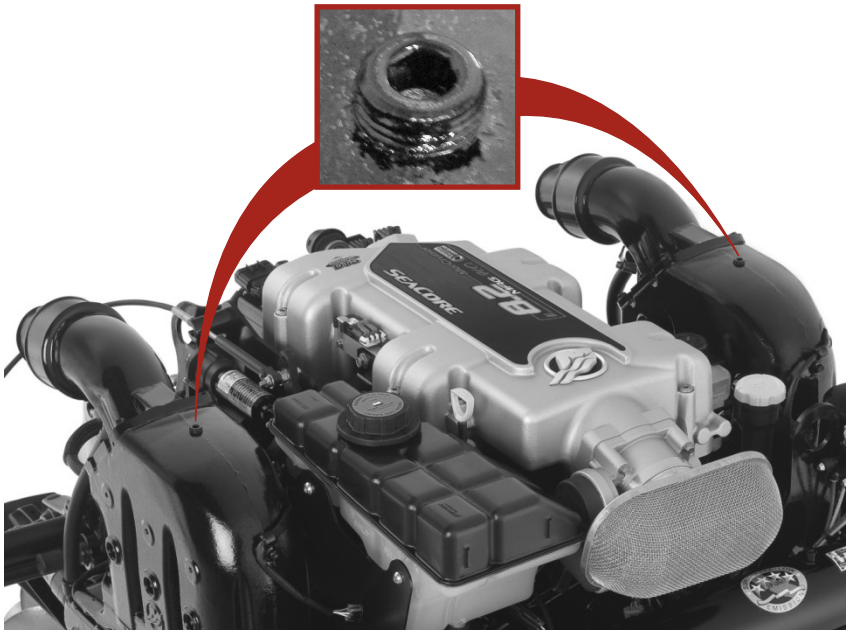
43291

Hang tag back side

Exhaust Gas Sampling

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

IMPORTANT: To comply with exhaust gas emission regulations, design considerations determined by the boat builder and specific engine installations must allow for field access to the exhaust gas sampling ports.
The 8.2 engine models exhaust gas sampling access area is located on the exhaust elbow and is secured with a pipe plug.



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Pipe plug access for exhaust gas sampling

Emissions Control System Overview

Combustion

Combustion is a rapid chemical reaction, called oxidation, in which fuel chemically combines with oxygen to produce heat energy. Among other elements, air contains oxygen and nitrogen, and gasoline contains hydrogen and carbon. These four primary elements combine chemically during combustion to form new chemical compounds.

If combustion were complete, the oxidation of air and gasoline would result in water, carbon dioxide, and nitrogen, which are not harmful to the environment. For combustion to be complete, it needs to occur at a specific air-to-fuel ratio called the stoichiometric ratio (14.7:1 for gasoline). Although this ratio is ideal for reducing hydrocarbons (HC) and carbon monoxide (CO), it is a lean mixture that can be difficult or slow to ignite, reducing engine power and efficiency.

Emissions

Since combustion is usually incomplete, not all of the exhaust gases burn, causing emissions. All engines sold in the state of California must comply with the standards legislated by the California Air Resources Board (CARB). In accordance with these standards, and in preparation of future standards, Mercury Marine is working to reduce the following: carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx).

Carbon Monoxide (CO)

Carbon monoxide (CO) is a poisonous gas created by incomplete combustion of gasoline. If combustion occurs in an oxygen-deficient environment, the limited amount of oxygen allows only one oxygen (O) atom to bond with a cabon (C) atom, creating CO from partially burned fuel. Richer air-to-fuel ratios create more CO than lean ratios.

Hydrocarbons (HC)

Hydrocarbon (HC) emissions are caused by incomplete combustion of gasoline and other hydrocarbon-based fuels. When gasoline burns, oxidation occurs; however, some hydrocarbons do not oxidize. Lower engine temperatures make it harder for the hydrocarbons to oxidize. Therefore, some hydrogen and carbon atoms remain bonded and pass through the exhaust system as HC gases from unburned fuel.

Oxides of Nitrogen (NOx)

Oxides of nitrogen (NOx) is a generic term for a group of chemical compounds that contain nitrogen (N) and oxygen (O) in varying amounts (x). NOx is created by overheated hydrogen and oxygen. At extremely high tempertures, N atoms can combine with O atoms to create NOx. Unlike CO and HC, which form when combustion temperatures are too low, NOx forms when combustion temperatures are too high. NOx itself is not harmful. However, when exposed to sunlight, NOx combines with unburned hydrocarbons to create the visible air pollutant called smog.

Controlling Emissions With Catalysts

Catalyst Components

A catalyst, or catalytic converter, is a device installed into the engine's exhaust system that reduces the toxicity of emissions. Mercury MerCruiser engines use three-way catalysts with the following components:

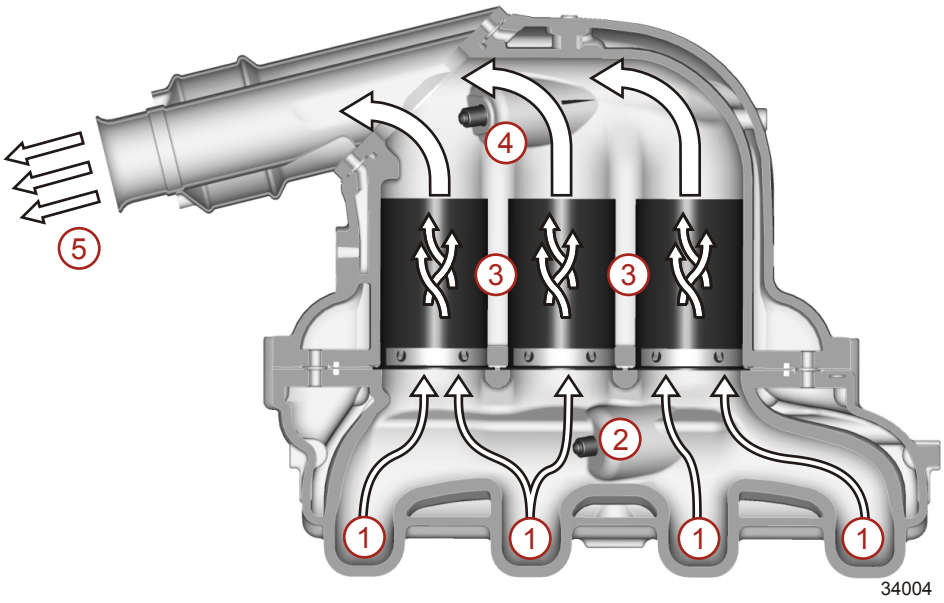
- Substrate—The substrate is a metallic foil core that provides a large surface area for the washcoat.
- Washcoat—The washcoat is applied to the substrate to act as a carrier for the catalyst. This washcoat creates an irregular, porous surface, providing more surface area for the precious metal of the catalyst.
- Catalyst—The catalyst is a combination of precious metals applied to the porous structure of the washcoat. The heated exhaust gases react with the precious metals in the catalyst to reduce harmful emissions. This catalyst assembly is housed in the mantle.
- Mantle—The mantle is the tube that contains the catalyst. The mantle is installed in the exhaust manifold housing.
- Oxygen sensors—Multiple oxygen sensors transmit emissions data to the propulsion control module (PCM) to control emissions.
- Propulsion control module—Models with emissions control use a PCM09 controller to manage fuel delivery to the engine and maintain CARB (California Air Resources Board) emissions standards.

Catalyst Operation

Mercury MerCruiser's engines with emissions control meet the CARB requirements for exhaust emissions levels that went into effect January 2008 in the state of California. These engines feature three-way catalysts, which use a combination of platinum, palladium, and rhodium (and other precious metals) to convert harmful emissions to safe levels. A three-way catalyst reduces emissions in the following ways:

- It reduces nitrogen oxides to nitrogen and oxygen ($2NOx \rightarrow xO_2 + N_2$).
- It oxidizes carbon monoxide into carbon dioxide ($2CO + O_2 \rightarrow CO_2$).

- It oxidizes unburnt hydrocarbons to carbon dioxide and water ($C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$).

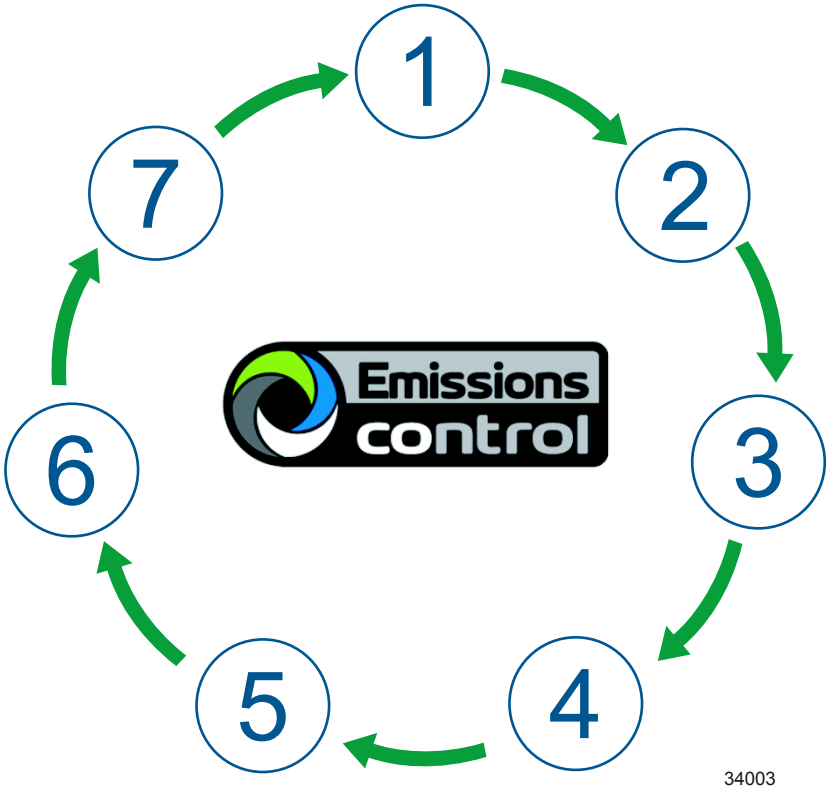


Typical exhaust manifold shown

1 - Exhaust gases from the combustion chamber
2 - Pre-catalyst oxygen sensor
3 - Catalysts
4 - Post-catalyst oxygen sensor
5 - Reduced emissions

Closed-Loop Control

The oxygen sensors send oxygen information to the PCM before and after the catalysts in the exhaust system. This dual-sensor system provides a closed-loop monitoring system, ensuring required air-to-fuel ratios and emissions. This engine is equipped with a catalytic converter on each exhaust manifold. Each catalytic converter houses three catalysts, a pre-oxygen sensor, and a post-oxygen sensor.



Closed-loop control

Reference	Action
1	PCM calculates air-fuel ratio.

Reference	Action
2	Fuel system delivers the required air-to-fuel ratio to the combustion chamber.
3	Combustion occurs (power stroke).
4	Exhaust gases enter the exhaust manifold (exhaust stroke).
5	The first oxygen sensor sends a signal to the PCM, delivering pre-catalyst oxygen information.
6	The exhaust gases pass through the catalyst. Reactions in the catalyst oxidize hydrocarbons (HC) and carbon monoxide (CO) and reduce oxides of nitrogen (NOx).
7	The second oxygen sensor sends a signal to the PCM, delivering post-catalyst oxygen information.

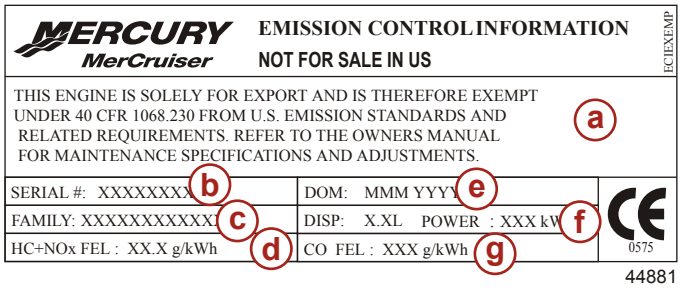
NOTE: *Each oxygen sensor is protected by a 5 amp fuse.*

NOTE: *Mercury MerCruiser engines do not depend on closed-loop control to calculate air-to-fuel ratios at all times. During some operating situations, the PCM operates in open-loop control, relying on its default programming to make fuel-delivery calculations.*

Emissions Information For Engines Without Emission Control

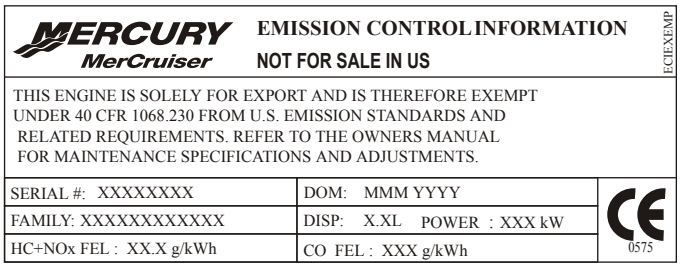
Emission Control Information Label

A tamper-resistant emission control information (ECI) label is affixed to the engine in a visible location at the time of manufacture by Mercury MerCruiser. Please note that the low emissions certification will not affect the fit, function, or performance of the engine. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding. In addition to the required emissions statement, the label lists the engine serial number, family, applicable emission standard, date of manufacture (month, year), and engine displacement.



- **a -** Applicable standard
- **b -** Engine serial number
- **c -** Engine family name
- **d -** Hydrocarbons plus oxides of nitrogen family emission limit
- **e -** Date of manufacture
- **f -** Engine displacement, engine power
- **g -** Carbon monoxide family emission limit

IMPORTANT: A CE mark in the lower right corner of the Emission Control Information label indicates that an EU Declaration of Conformance applies. Refer to the front page of this manual for further information.
IMPORTANT: Engines designated as exempt from either Federal EPA or California emission control regulations are not covered by a separate emission control component warranty. The product's Mercury MerCruiser manufacturer's warranty is not affected by the engine's designation under Federal EPA or California emission control regulations.

ECI Label	Standard of Compliance
	Indicates a marine engine for export and is exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations for 2010. This marine engine is not for sale in U.S.

Owner Responsibility

The operator must have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The operator may not modify the engine in any manner that alters the horsepower or allows emissions levels to exceed factory specifications.

Notes:

Important Information

Section 1B - Maintenance Sterndrive Models

1 B

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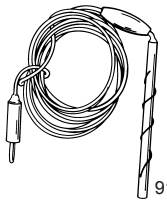
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All electrical connections	92- 25711 3
28	Dexron III Automatic Transmission Fluid	Power-assisted steering system	Obtain Locally
34	Special Lubricant 101	Steering cable grease fitting	92-802865Q02
		Steering cable	
		Propeller shaft splines	
42	U-joint and Gimbal Bearing Grease	Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	92-802870A1
87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01
		Sterndrive unit	
91	Engine Coupler Spline Grease	Driveshaft splines and U-joint O-rings	92-802869A 1
		Coupler	
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
114	Power Trim and Steering Fluid	Power-assisted steering pump	92-858074K01
		Power trim pump	
115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
120	Corrosion Guard	Painted surfaces	92-802878 55
122	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1
124	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

Special Tools

Propeller Nut Tool	91-805457T 1
10677	Aids in the removal and installation of the front propeller nut.

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

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

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

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

Gasoline and Engine Oil

Fuel Requirements

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

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

Fuel Ratings

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

USA and Canada - A posted pump Octane Rating of 87 (R+M)/2, minimum. Premium gasoline 92 (R+M)/2 Octane is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - A posted pump Octane Rating of 91 RON, minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and are acceptable for use in your Mercury MerCruiser engine. The two types of oxygenates used in these fuels are alcohol (ethanol) and ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasoline Containing Alcohol**.

Gasoline Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), be aware of possible adverse effects. These adverse effects are more severe with methanol and worsen according to the percentage of alcohol in the fuel.

Alcohol in gasoline can absorb moisture from the air, causing the water and the alcohol to separate from the gasoline in the fuel tank.

IMPORTANT: The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

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

IMPORTANT: If you use gasoline that contains or might contain alcohol, you must increase the frequency of inspection for leaks and abnormalities.
IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, do not store the gasoline in the fuel tank for long periods. Cars normally consume alcohol-blend fuels before they can absorb enough moisture to cause trouble, boats often sit idle long enough for phase separation to take place. Internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Engine Oil

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

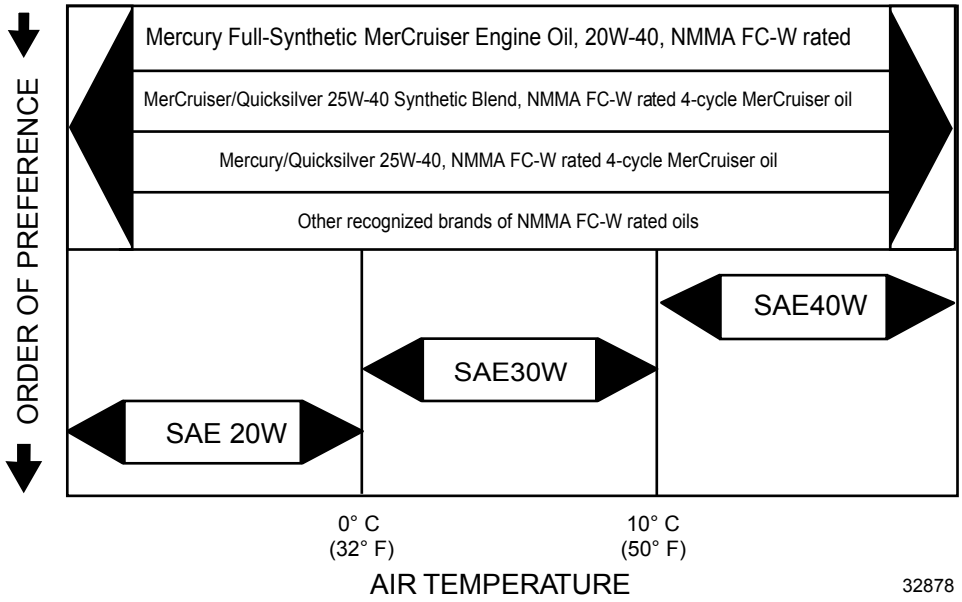
Application	Recommended Oil
All MerCruiser engines	Mercury MerCruiser Full-Synthetic Engine Oil, 20W-40, NMMA FC-W rated

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

If Mercury MerCruiser Full-Synthetic, 20W-40 oil is unavailable, use the following lubricants, listed in order of recommendation. If you are servicing a catalyst engine, use these for short periods of time only.

1. Mercury/Quicksilver 25W-40 Synthetic Blend, NMMA FC-W–rated 4-cycle MerCruiser oil
2. Mercury/Quicksilver 25W-40, NMMA FC-W–rated 4-cycle MerCruiser oil
3. Other recognized brands of NMMA FC-W–rated 4-cycle oils
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: *We do not recommend 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.*



Engine Specifications Sterndrive Models

8.2 MAG EC, 8.2 MAG H.O. EC and SeaCore 8.2 MAG EC, 8.2 MAG H.O. EC

NOTE: *Performance specifications are obtained and corrected in accordance with SAE J1228/ISO 8665 Crankshaft Power.*
All measurements are taken with the engine at normal operating temperature.
RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.
Oil pressure must be checked with the engine at normal operating temperature.

NOTE: *Oil pressure specifications are for reference and may vary.*

		8.2 MAG	8.2 MAG H.O.
Propshaft power		283 kW (380 hp)	320 kW (430 hp)
Displacement		8.2 L (502 cid)	
Alternator amperage	Hot	72 A	
	Cold	65 A	
RPM	WOT	4400–4800	4600–5000
	Rev limiter	4950	5150
Idle RPM	Mechnical	650	
	DTS		
Minimum oil pressure	At 2000 RPM	207 kPa (30 psi)	
	At idle	103 kPa (15 psi)	
Thermostat		76° C (170° F)	
Timing at idle		Not Adjustable	
Firing order		1-8-4-3-6-5-7-2	
Minimum battery rating	Non-DTS models	750 CCA, 950 MCA, 180 Ah	
	DTS models	800 CCA, 1000 MCA, 190 Ah	
Spark plug type		NGK BPR6ES	
Spark plug gap		0.83 mm (0.033 in.)	
Emission control system		Electronic engine control (EC), heated oxygen sensor (HO2S), catalyst	

Fluid Specifications

Engine

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Bravo Sterndrives

NOTE: *Oil capacity includes gear lube monitor.*

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

Power-Assisted Steering and Power Trim Fluids

Approved Power-Assisted Steering Fluids

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

Approved Power Trim Fluids

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

Maintenance Schedule Sterndrive Models

Routine Maintenance

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

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. (You can extend this interval based on experience with the product.) • Check the sterndrive gear lube level. • Check the trim pump oil level. • Check the power-assisted steering pump or the compact hydraulic steering fluid level, depending on the steering system of your model.

Task Interval	Maintenance to Be Performed
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Inspect the sterndrive anodes and replace if 50% eroded.
Every two months or 50 hours	• Lubricate the propeller shaft and retorque the nut. (If operating only in freshwater, you can extend the interval to every four months.) • If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. (If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.)

Scheduled Maintenance

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

Task Interval	Maintenance to Be Performed
After the initial 20-hour break-in period	Change the engine oil and filter.
Every 100 hours or annually (whichever occurs first)	• Touch-up the paint on the power package. • Change the engine oil and filter. • Change the sterndrive gear lube. • Check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section. • Tighten the connection of the gimbal ring to the steering shaft to specifications. • Replace the water-separating fuel filter. • Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages. • Check the continuity circuit for loose or damaged connections. Test the MerCathode unit output if equipped. • Recommended Maintenance and replacement of the PCV valve. • Clean the flame arrestor, IAC muffler, and the crankcase ventilation hoses. • Inspect the condition and the tension of the belts. • Driveshaft extension models: Lubricate the driveshaft U-joints, and tailstock input and output bearings.

Task Interval	Maintenance to Be Performed
Every 300 hours or 3 years	• Check the engine mount nuts for tightness and torque if necessary. • Replace spark plugs. • Inspect the spark plug wires and replace as necessary. • 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. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Check the engine alignment. • Inspect the U-joints, the splines, the bellows, and check the clamps. • Lubricate the U-joint splines and cross bearings, if equipped with grease fittings. • Inspect the gimbal bearing for roughness. Replace if necessary. • Lubricate the engine coupler. • Replace the vent valve and duckbill valve on each exhaust elbow (port and starboard).
Every 5 years	• Replace the coolant/antifreeze. Replace every two years if not using extended-life coolant/antifreeze.

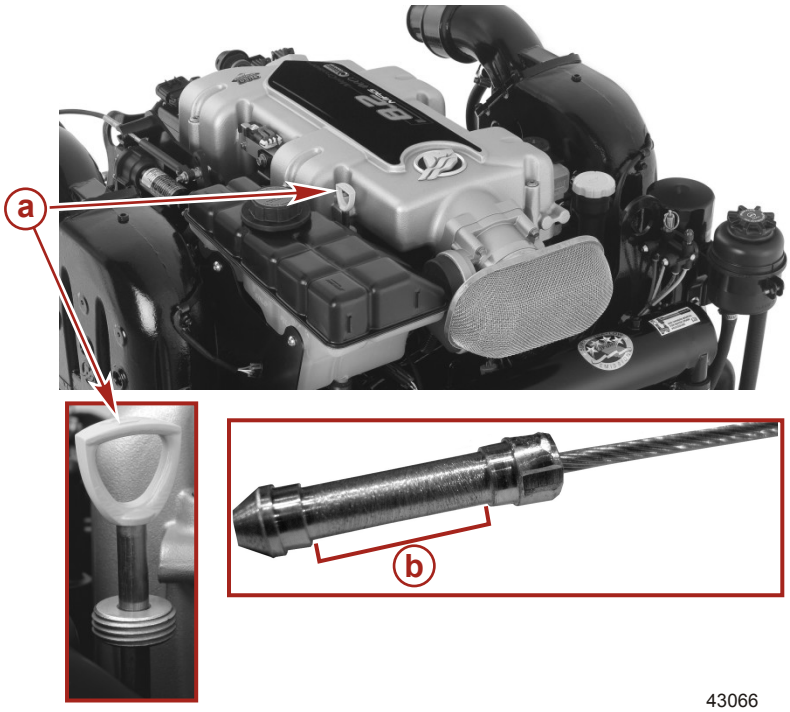
Engine Oil

NOTICE

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

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.



43066

a - Oil dipstick handle
b - Operating range

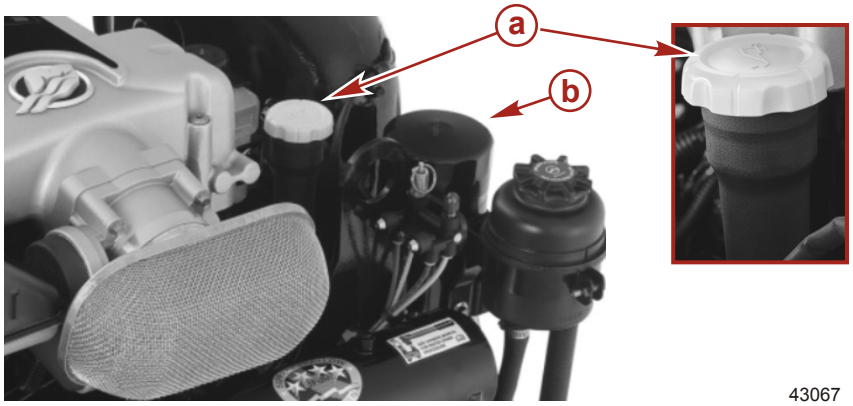
IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the operating range mark on the dipstick.

3. Remove the dipstick and observe the oil level. Oil level must be in the operating range. 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 oil required.

1. Remove oil fill cap.



43067

a - Oil fill cap
b - Oil filter

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

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

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 liters (7 U.S. Quart)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

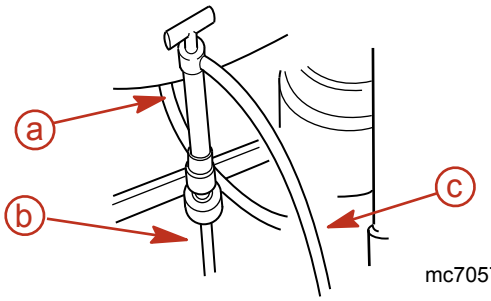
Changing Oil and Filter

See **Maintenance Schedule** for the change interval. Engine oil should be changed before placing the boat in storage.

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

Oil Removal with Drain Pump

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



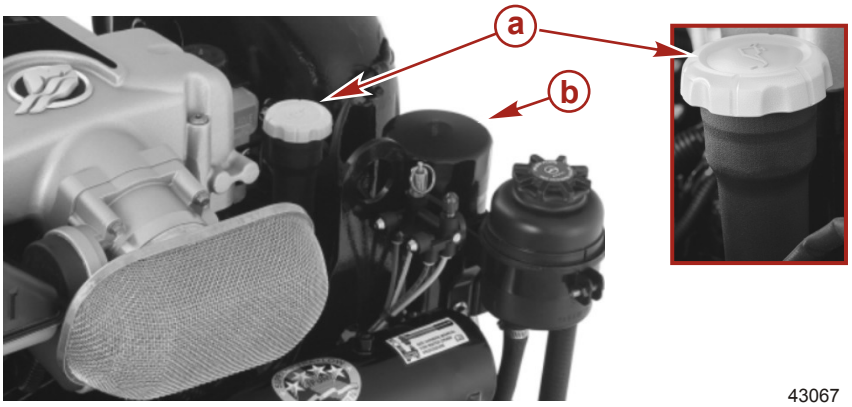
mc70571-1

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

4. Insert the hose end of the crankcase oil pump onto an appropriate container and use the handle to pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing the Oil Filter

1. Remove and discard oil filter.



43067

Oil filter
a - Oil fill cap
b - Oil filter

2. Coat the sealing ring on the new filter with engine oil.
3. Install and tighten the oil filter securely following the filter manufacturer's instructions. Do not overtighten.
4. Remove oil fill cap.
5. Use the dipstick to determine the amount of engine oil required. Replace the dipstick.
6. Add the required amount of the recommended oil to bring the level up to the bottom of the OK range on the dipstick.
7. With the boat at rest in the water, repeat steps 5 and 6 if necessary.
   NOTE: *Adding 0.95 L (1 US qt) of engine oil raises the level from the bottom of the operating range to the top of the operating range.*

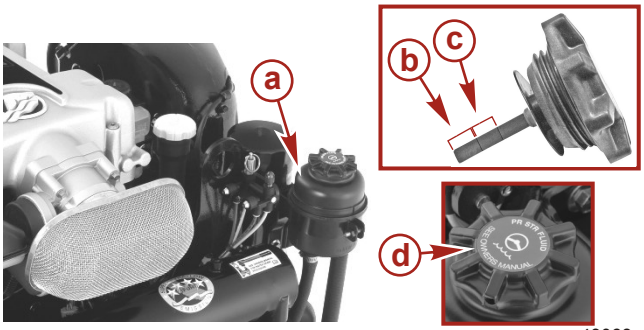
All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

8. Start the engine and operate for three minutes, checking for leaks.
9. Stop the engine and allow the oil to drain into the oil pan for approximately five minutes with the boat at rest in the water.

Power-Assisted Steering Fluid

Checking

1. Stop the engine and center the sterndrive.
2. Remove the fill cap from the power steering fluid reservoir and observe the level. The oil level should be at the lower mark when the engine is cold and at the upper mark when the engine is warm.



43068

a - Reservoir
b - Add range
c - Operating range
d - Fill cap

3. Add the specified fluid if necessary. Refer to **Filling**.

Filling

1. Remove the fill cap and dipstick and observe the fluid level.
2. Add the specified fluid to bring the fluid level up to the proper level.

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

28	Dexron III Automatic Transmission Fluid	Power-assisted steering system	Obtain Locally

3. Install the fill cap and dipstick.

Changing

Power-assisted steering fluid does not require changing unless it becomes contaminated with water or debris.

Closed Cooling System

Coolant Requirement

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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

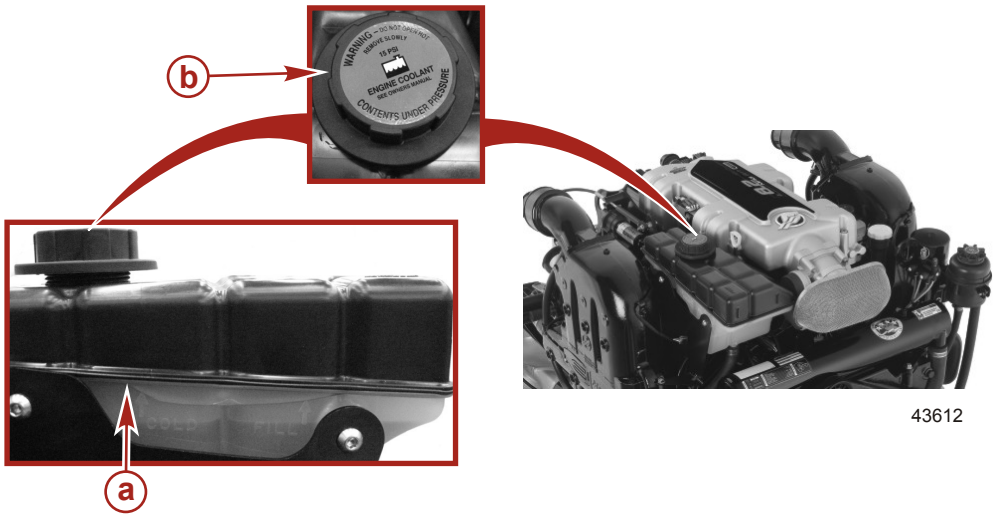
Checking Coolant Level

⚠ CAUTION

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

IMPORTANT: 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.



43612

Coolant reservoir

a - Full mark (engine cold)

b - Coolant reservoir cap

Filling the Closed Cooling System

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

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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.
	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1

NOTE: *Coolant section capacity is approximately 14.3 L (15 U.S. qt.).*

Model	8.2 (502 cid)
Closed cooling system	14.3 L (15 U.S. qt)

⚠ CAUTION

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

IMPORTANT: 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. Replace the pressure cap.

NOTICE

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

4. Supply cooling water to the engine.
5. 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.

⚠ CAUTION

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

6. After the engine has cooled completely, recheck the coolant level and add coolant, if necessary.
7. 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.
8. Maintain the coolant level in the reservoir at or near the "FULL" mark with the engine cold.

Sterndrive Gear Lube

Checking

NOTICE

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

NOTE: *The oil level fluctuates during operation, so check with the engine cold before starting.*

1. Check the gear lube oil level. Keep the oil level within the recommended operating range.
2. Inspect the gear lube oil in the monitor for any condition that may indicate a problem in the sterndrive:
   a. If any water is visible at the bottom of the gear lube monitor
   b. If the gear lube appears milky
   c. If the gear lube smells burned and looks dark

d. If metal particles are present

43200

Gear lube monitor

Filling

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

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

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

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

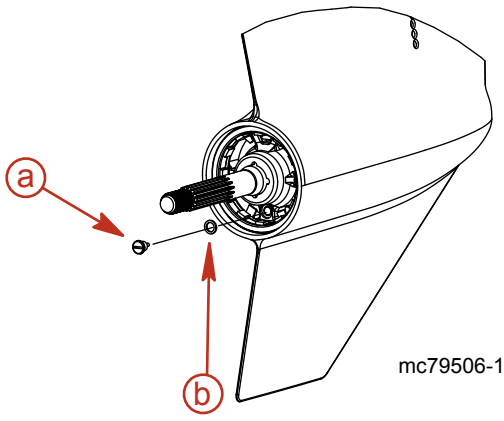
Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01

3. Replace the cap.

Changing

IMPORTANT: If any water drains from the sterndrive, or if the fluid appears milky, the sterndrive is leaking.

1. Remove the gear lube monitor from the bracket.
2. Empty the contents into a suitable container.
3. Install the gear lube monitor in the bracket.
4. Bravo One Models:
   a. Remove the propeller.
   b. Position the sterndrive to the full down position.
   c. Remove the oil fill and drain screw and sealing washer. (If water runs out, the sterndrive is leaking.)
   d. Drain the fluid into a suitable container.

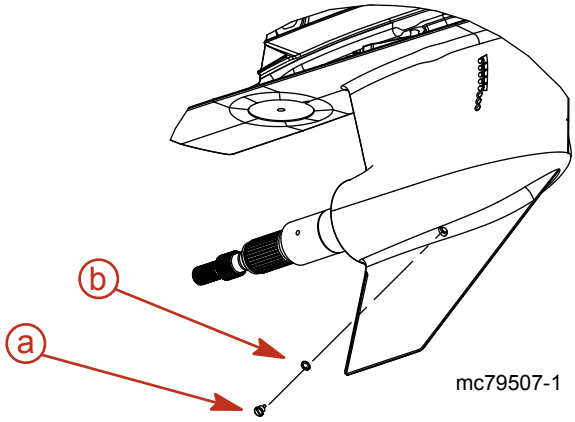


mc79506-1

a - Oil fill and drain screw
b - Sealing washer

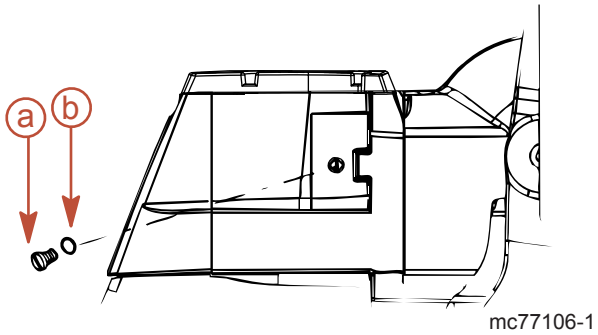
5. All Other Models:

a. Place the sterndrive in full trim out position.
b. Remove the oil fill and drain screw and sealing washer. (If water runs out, the sterndrive is leaking.)
c. Drain the fluid into a suitable container.



a - Oil fill and drain screw
b - Sealing washer

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



a - Oil vent screw
b - Sealing washer

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

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

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

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

13. Remove the pump from the oil fill and drain hole. Quickly install the sealing washer and screw. Tighten securely.
14. Reinstall the propeller.
15. Check the oil level after the first use.

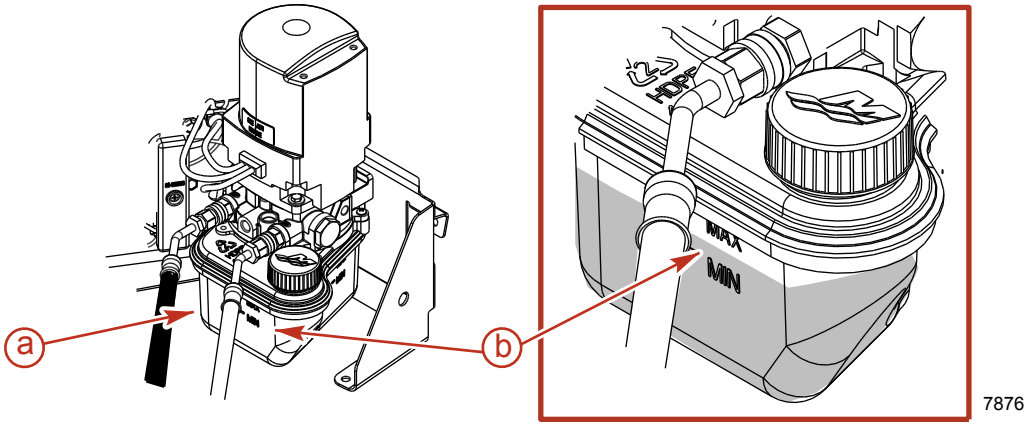
IMPORTANT: Oil level in the gear lube monitor rises and falls during operation. Always check the oil level when the sterndrive is cool and the engine is off.

Power Trim Fluid

Checking

IMPORTANT: Check the oil level with the sterndrive in the full down/in position only.

1. Place the sterndrive in full down/in position.
2. Observe the oil level. Level must be between the "MIN" and "MAX" lines on the reservoir.



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

3. Fill as necessary with the specified fluid.

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

Filling

1. Remove the fill cap from the reservoir.
   NOTE: *Fill cap is vented.*
2. Add lubricant to bring 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

3. Install the cap.

Changing

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

Battery

Refer to specific instructions and warnings accompanying your battery. If this information is not available, observe the following precautions when handling a battery.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

Multiple EFI Engine Battery Precautions

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for 2 different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself, and the engine will operate normally. The ECM shuts off and resets itself so quickly that the engine may only seem to have an ignition miss.

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's ECM has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is operating off of its own battery. Do not operate engines with switches in both or all position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

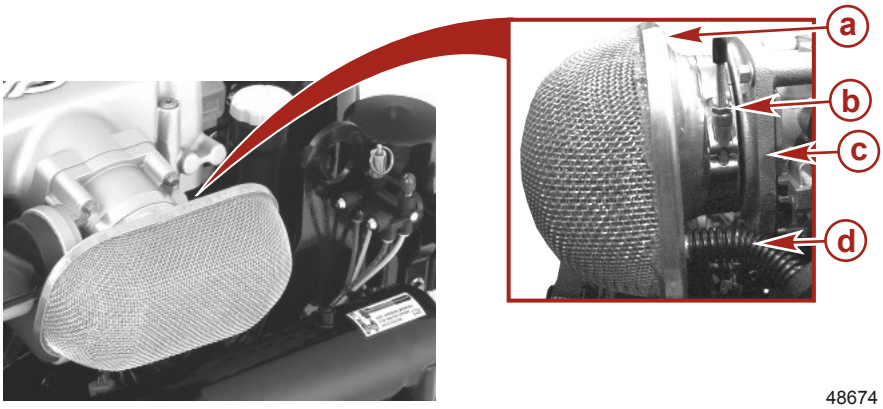
Generators: The generators battery should be considered another engine's battery.

Cleaning the Flame Arrestor

⚠ WARNING

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

1. Remove the vent hose from the flame arrestor.
2. Loosen the flame arrestor clamp nut.
3. Pull the flame arrestor from the throttle body.

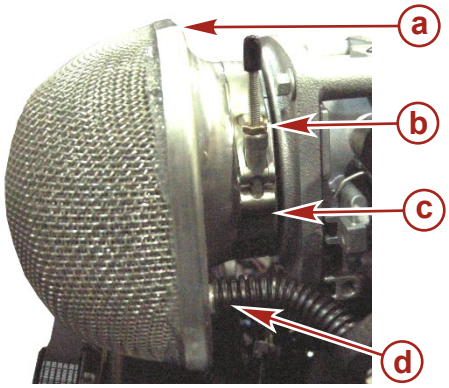


a - Flame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

48674

4. Clean the flame arrestor with solvent and dry with compressed air or set aside and allow to air dry completely.
5. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
6. Push the flame arrestor onto the throtte body.
7. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.

8. Tighten the clamp to specification. Do not overtighten the clamp.



48442

a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

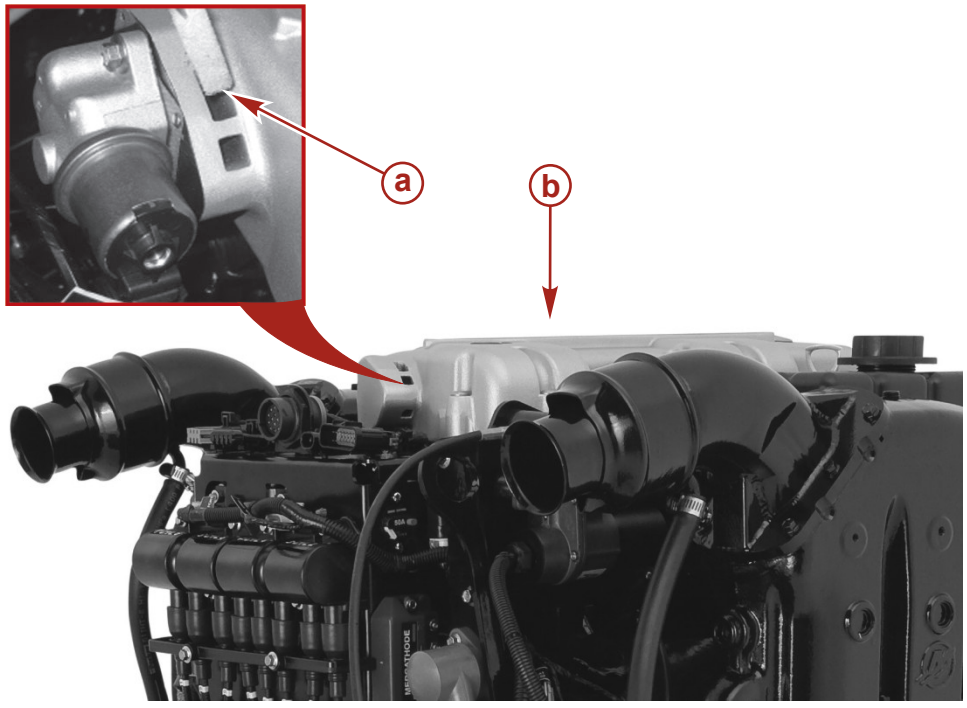
9. Install the vent hose to the bib fitting.

Cleaning the IAC Muffler (Non-DTS Models Only)

⚠ WARNING

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

1. Locate the idle air control valve (IAC) on the rear of the engine.
2. Remove the IAC muffler from the slot in the plenum.



43638

a - IAC muffler
b - Plenum

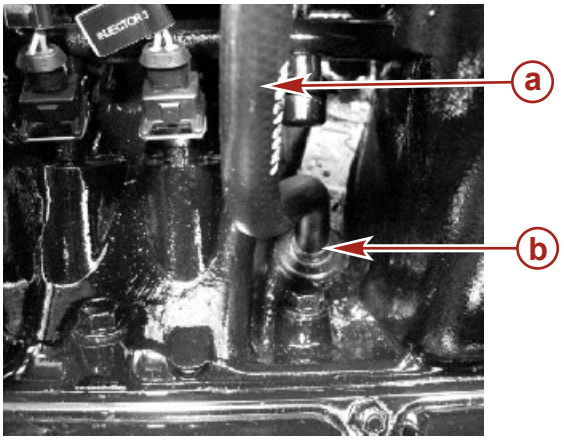
3. Inspect the muffler for holes, cracks, or deterioration. Replace if damaged.
   IMPORTANT: Do not use a cleaner that contains methyl ethyl ketone and do not use cleaner on electrical connections.
4. Clean the muffler with warm water and mild detergent. Replace if necessary.
5. Allow the IAC muffler to dry completely before use.

6. Install the IAC muffler.

Changing the Positive Crankcase Ventilation (PCV) Valve

This engine is equipped with a positive crankcase ventilation (PCV) valve . We recommend changing it every 100 hours of operation or at least once a year, whichever occurs first.

1. Pull the PCV valve out of the intake manifold and remove the PCV valve from the hose.



a - Hose from plenum to PCV valve
b - PCV valve

43215

2. Inspect the PCV valve and replace if necessary.
3. Install the PCV valve into the intake manifold.
4. Ensure that the PCV valve is tightly seated into the intake manifold.

We recommend the use of Mercury MerCruiser replacement parts.

Water-Separating Fuel Filter

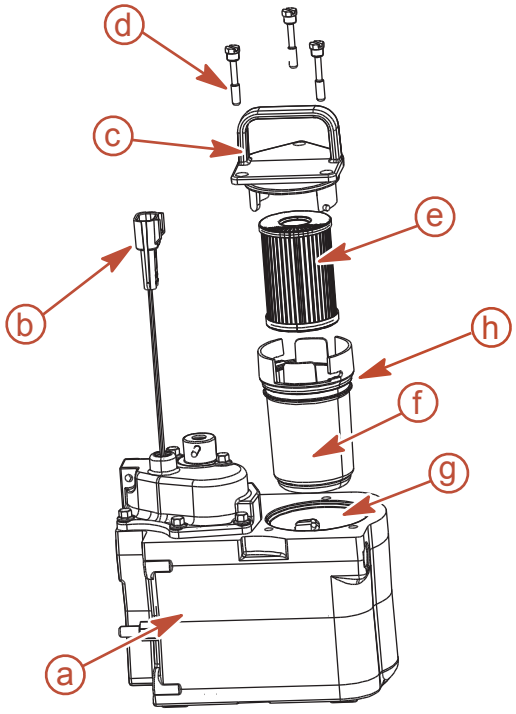
⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

GEN III Models



8837

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

Removal

1. Allow the engine to cool down.
   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*
2. Close fuel supply valve, if equipped.
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 5 seconds.
5. Turn key switch to off position.
6. Loosen each filter assembly retaining screw until the screw is 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 remove the filter assembly from the Cool Fuel Module at this time.
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 in a clockwise direction 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 that may be in the filter cup.

Installation

1. Install a new water-separating fuel filter element into the filter cup. Push the element into the cup until completely seated.
2. Install new O-ring on the filter cup.
3. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction while holding the filter cup stationary, until the filter cap locks securely into place.
4. 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.
5. 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	–

6. Open fuel supply valve, if equipped.

7. Reconnect the Cool Fuel Module harness to the engine wiring harness.
8. Properly ventilate the engine compartment.

NOTICE

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

9. Supply cooling water to the engine.
10. Start the engine. Check for gasoline leaks around the fuel filter assembly. If leaks exist, stop the engine immediately. Recheck the filter installation, clean spilled fuel and properly ventilate the engine compartment. If leaks continue, stop the engine immediately, locate the cause, and repair as required.

Lubrication

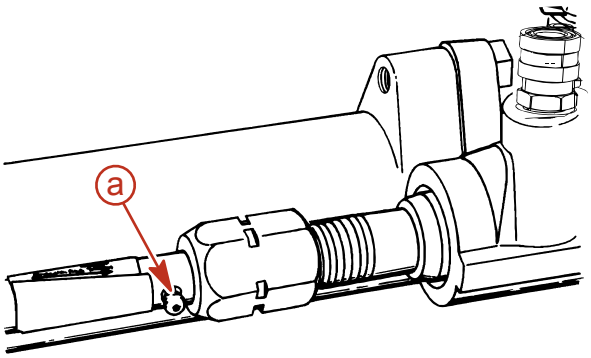
Steering System

⚠ WARNING

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

NOTE: *If steering cable does not have grease fitting, inner wire of cable cannot be greased.*

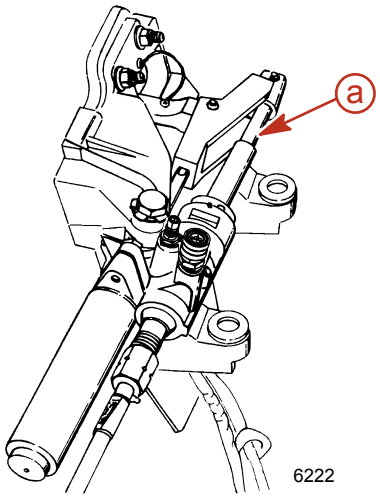
1. **If Steering Cable Has Grease Fittings:** Turn steering wheel until steering cable is fully retracted into cable housing. Apply approximately 3 pumps of grease from a typical hand-operated grease gun.



a - Steering cable grease fitting

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Steering cable grease fitting	92-802865Q02

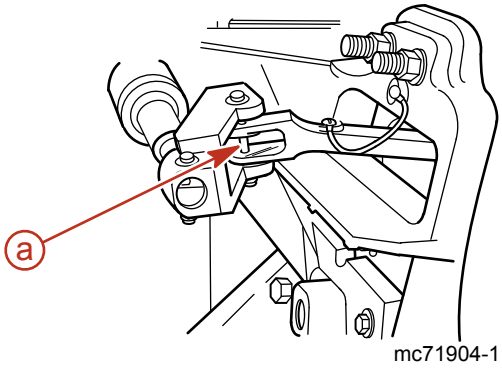
2. Turn steering wheel until steering cable fully extended. Lightly lubricate the exposed part of cable.



a - Extended steering cable

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Steering cable	92-802865Q02

3. Lubricate the steering pin.



a - Steering pin

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Steering pin	92-883725K01

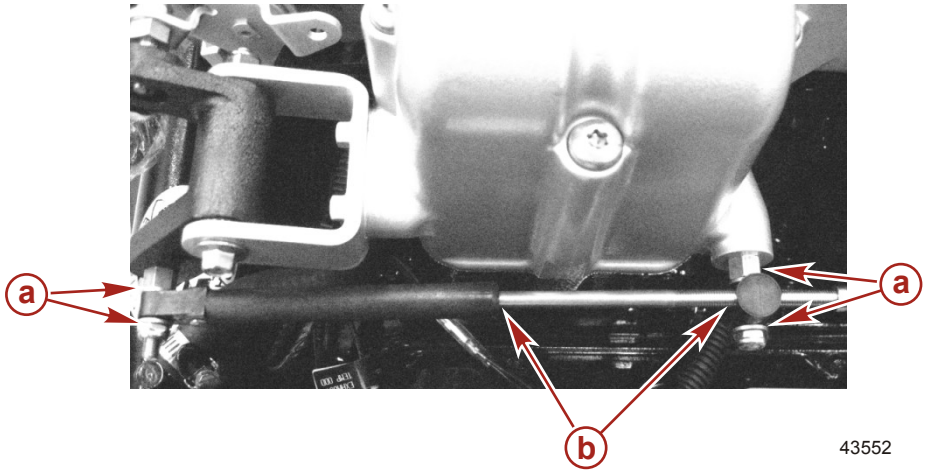
4. On dual engine boats: Lubricate the tie bar pivot points.

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Tie bar pivot points	92-883725K01

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.

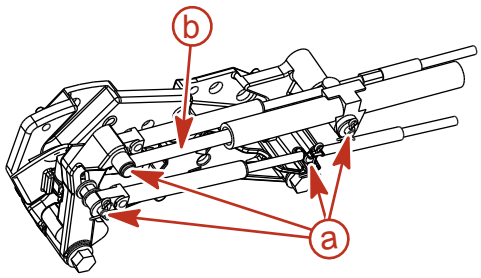


a - Pivot points
b - Guide contact surfaces

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Throttle cable pivot points & guide contact surfaces	92-883725K01

Shift Cable - Typical

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

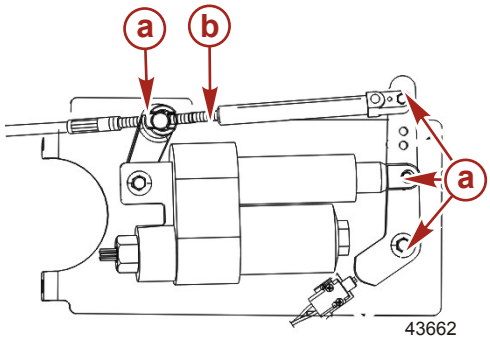


mc79736

a - Pivot points
b - Guide contact surfaces

Shift Cable - DTS

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



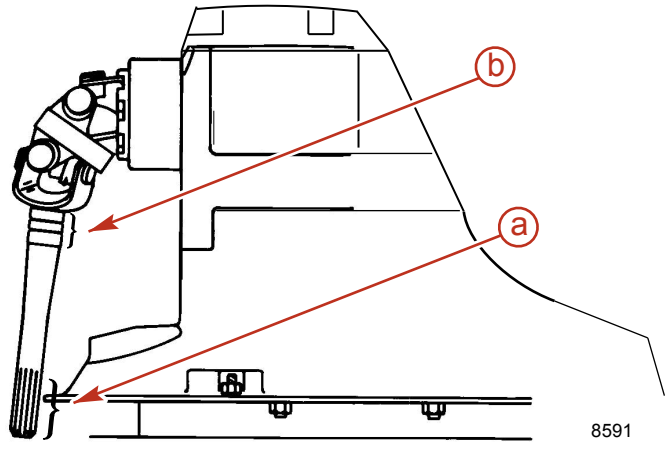
43662

a - Pivot points
b - Guide contact surfaces

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Shift cable pivot points & guide contact surfaces	92-883725K01

Sterndrive U-joint Shaft Splines And O-rings (Sterndrive Unit Removed)

1. Coat sterndrive U-joint O-rings and driveshaft splines with grease.



8591

a - Driveshaft splines
b - U-joint O-rings (3)

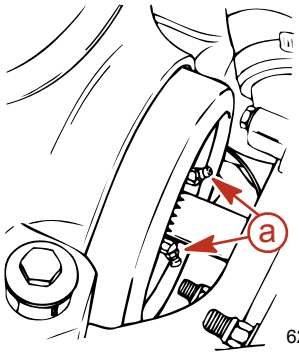
Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Driveshaft splines and U-joint O-rings	92-802869A 1

2. For propeller shaft lubrication, refer to Propellers.

Engine Coupler

1. Lubricate engine coupler splines through grease fittings on 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.*



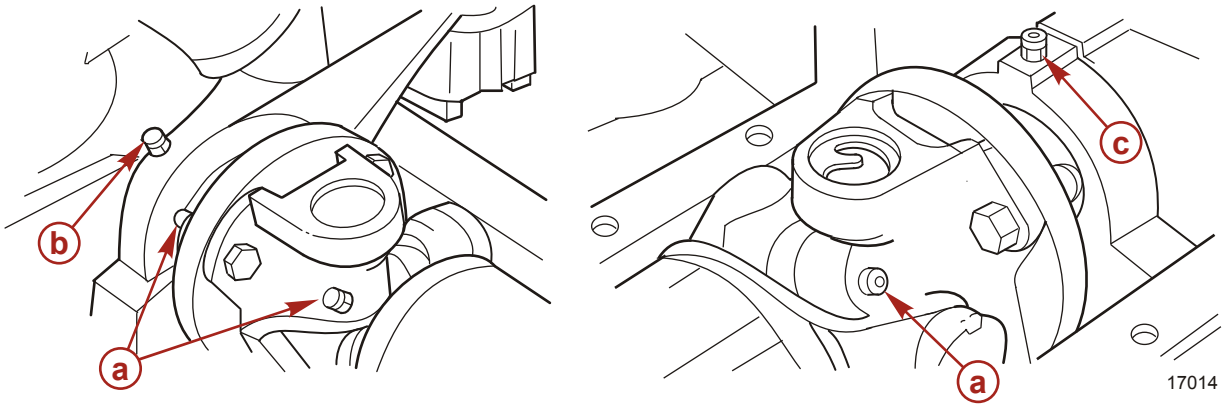
Bravo drive coupler
a - Grease fitting

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Coupler	92-802869A 1

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

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.



a - Driveshaft grease fittings
b - Transom end grease fitting
c - Engine end grease fitting

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

Propellers

Propeller Repair

Some damaged propellers can be repaired.

Bravo Sterndrive Propeller Removal

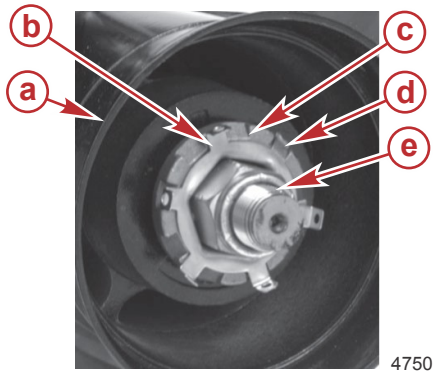
⚠ WARNING

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

Bravo One Models

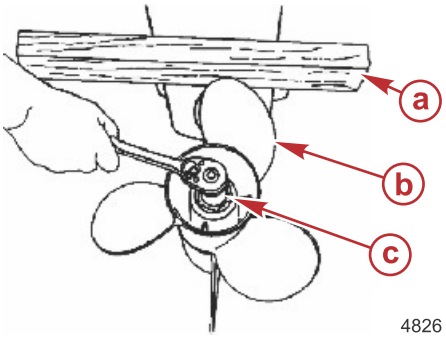
NOTE: *Bravo One XR models do not use the tab washer.*

1. If Equipped, straighten the bent tabs of the tab washer on the propeller shaft.



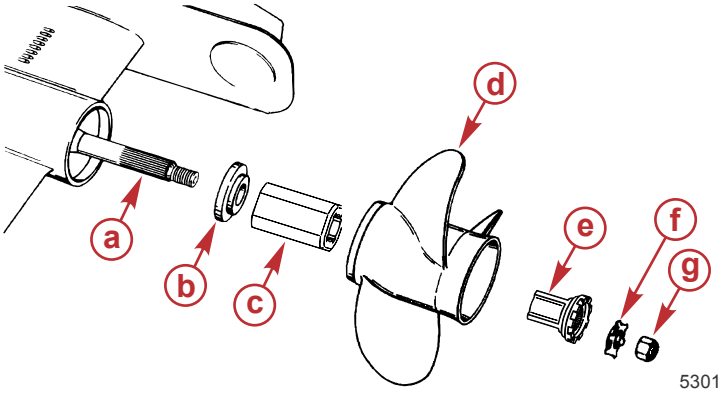
- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.



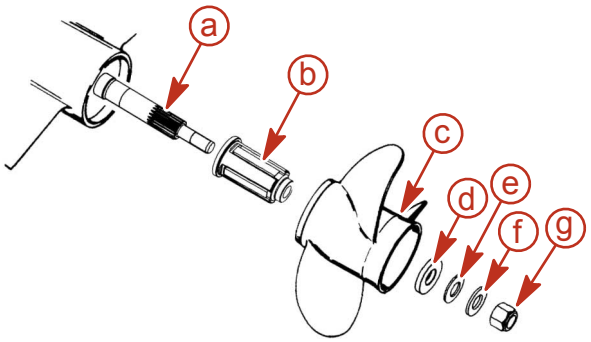
- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

3. Turn the propeller shaft nut counterclockwise and remove the nut.
4. Slide the propeller and the attaching hardware from the propeller shaft.



Bravo One models

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Flo-Torque II drive hub
- **d -** Propeller
- **e -** Drive sleeve adapter
- **f -** Tab washer
- **g -** Propeller nut

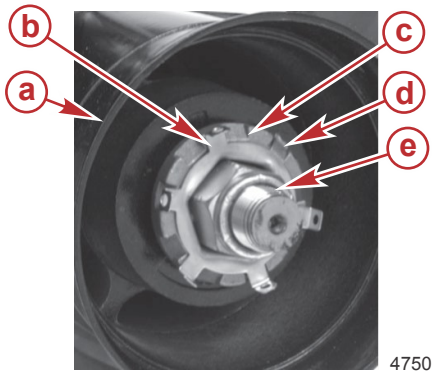


Bravo One XR models

- **a -** Propeller shaft
- **b -** Propeller hub insert with snubbers
- **c -** Propeller
- **d -** Thrust washer
- **e -** Washer
- **f -** Washer
- **g -** Propeller nut

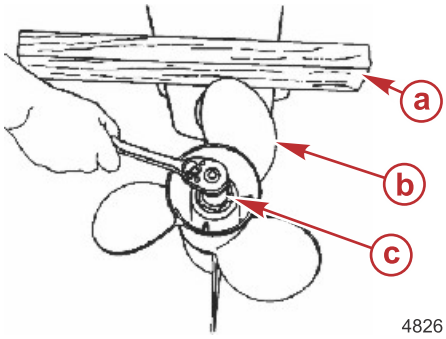
Bravo Two Models

1. Straighten the bent tabs of the tab washer on the propeller shaft.



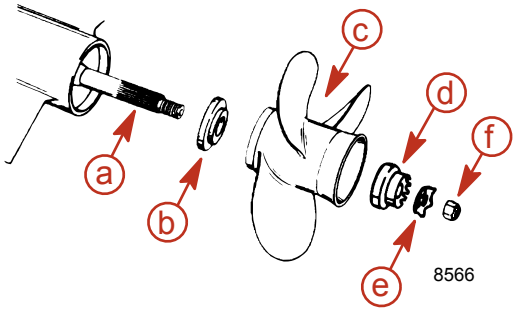
- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.



- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

3. Turn propeller shaft nut counterclockwise to remove nut.
4. Slide the propeller and attaching hardware from the propeller shaft.



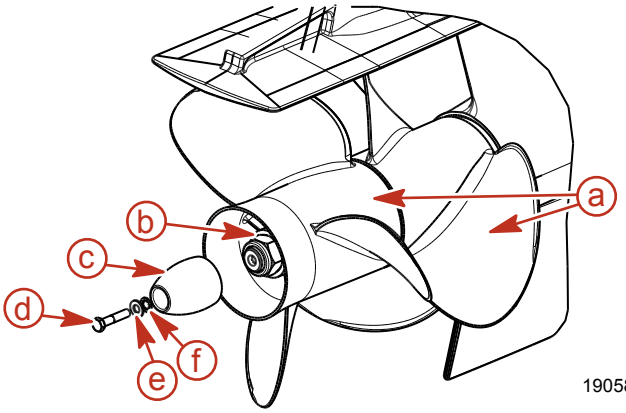
Bravo Two

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Propeller
- **d -** Spline washer
- **e -** Tab washer
- **f -** Propeller nut

Bravo Three Models

1. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.
2. Remove the bolt and washers securing the propeller shaft anode.

3. Remove the propeller shaft anode.

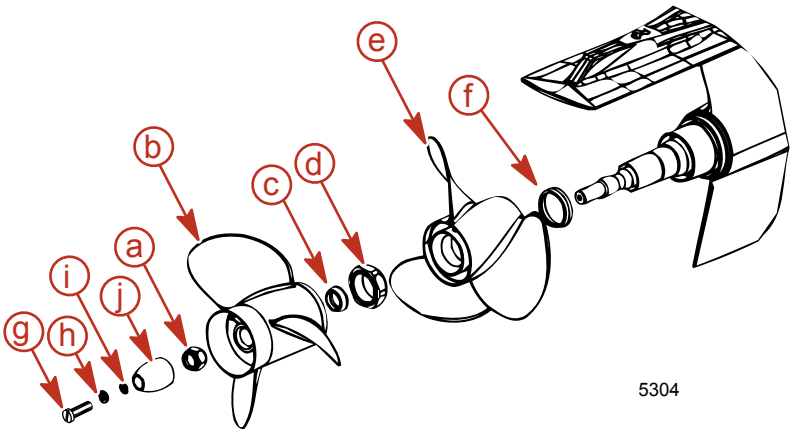


- **a -** Propeller
- **b -** Propeller shaft nut
- **c -** Propeller shaft anode
- **d -** Propeller shaft anode screw
- **e -** Flat washer
- **f -** Star washer

4. Turn aft propeller shaft nut counterclockwise to remove nut.
5. Slide propeller and thrust hub off propeller shaft.
6. Use the Propeller Nut Tool, turn the front propeller shaft nut counterclockwise and remove the nut.

Propeller Nut Tool	91-805457T 1

7. Slide the propeller and the thrust hub off the propeller shaft.



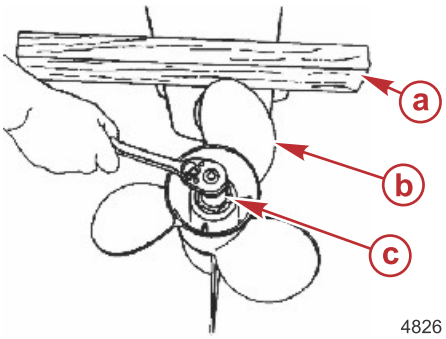
Bravo Three

- **a -** Aft propeller nut
- **b -** Aft propeller
- **c -** Aft propeller thrust hub
- **d -** Front propeller nut
- **e -** Front propeller
- **f -** Front propeller thrust hub
- **g -** Propeller shaft anode screw
- **h -** Flat washer
- **i -** Star washer
- **j -** Propeller shaft anode

Bravo Sterndrive Propeller Installation

⚠ WARNING

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



- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

Bravo One Models

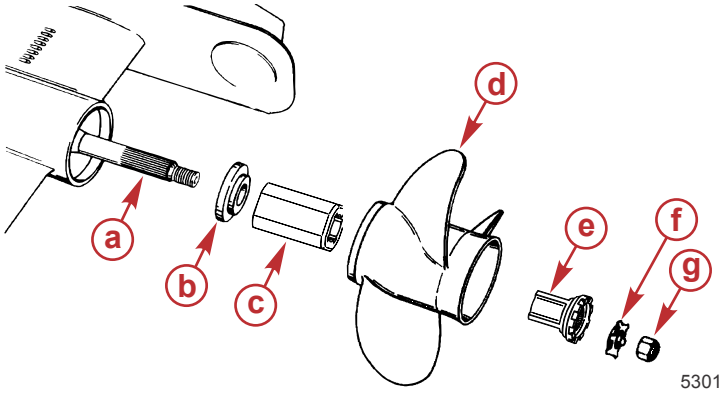
IMPORTANT: Use the correct rotation propeller. The propeller rotation must match the direction of rotation of the propeller shaft.

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1

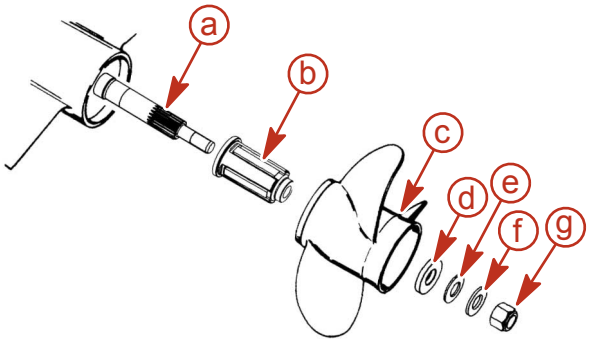
NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Install the propeller with the attaching hardware as shown.
3. Torque the propeller nut.



Typical Bravo One models

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Flo-Torque II drive hub
- **d -** Propeller
- **e -** Drive sleeve adapter
- **f -** Tab washer
- **g -** Propeller nut



Bravo One XR models

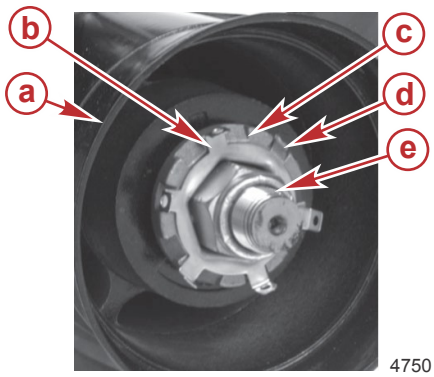
- **a -** Propeller shaft
- **b -** Propeller hub insert with snubbers
- **c -** Propeller
- **d -** Thick washer
- **e -** Washer
- **f -** Washer
- **g -** Propeller nut

NOTE: *The propeller torque stated is a minimum torque value.*

Description	Nm	lb. in.	lb. ft.
Bravo One propeller nut	75	–	55

NOTE: *Bravo One XR models do not use the tab washer.*

4. Models equipped with the tab washer: Continue to tighten the propeller nut until the three tabs on the tab washer align with the grooves on the spline washer.
5. Bend the three tabs down into the grooves.



- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

Bravo Two Models

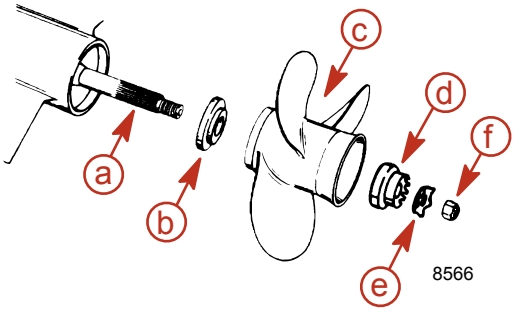
IMPORTANT: Use the correct rotation propeller. The propeller rotation must match the direction of rotation of the propeller shaft.

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1

NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Install the propeller with the attaching hardware as shown.
3. Torque the propeller nut.

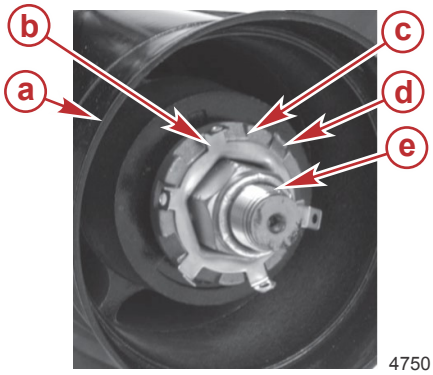


Bravo Two
- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Propeller
- **d -** Spline washer
- **e -** Tab washer
- **f -** Propeller nut

NOTE: *The propeller torque stated is a minimum torque value.*

Description	Nm	lb. in.	lb. ft.
Bravo Two propeller nut	81	–	60

4. Continue to tighten the propeller nut until the three tabs on the tab washer align with the grooves on the spline washer.
5. Bend the three tabs down into the grooves.



- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

Bravo Three

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1

NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Slide forward thrust hub onto propeller shaft, with tapered side toward propeller hub.
3. Align splines and place front propeller on propeller shaft.
4. Install front propeller locknut and torque using the Propeller Nut tool.

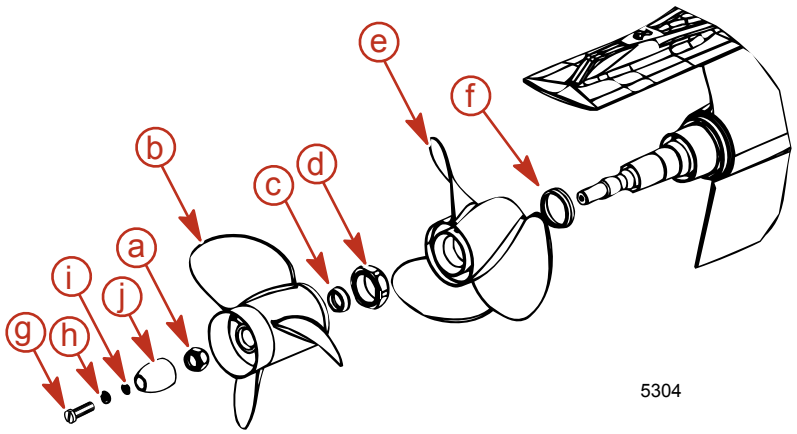
Propeller Nut Tool	91-805457T 1

Description	Nm	lb. in.	lb. ft.
Bravo Three front propeller nut	136	–	100

5. Slide aft thrust hub onto propeller shaft with tapered side toward propeller hub
6. Align splines and install aft propeller.
7. Install propeller nut and torque.

Description	Nm	lb. in.	lb. ft.
Bravo Three rear propeller nut	81	–	60

8. Install propeller shaft anode and screw and torque.



Bravo Three

- **a -** Rear propeller nut
- **b -** Rear propeller
- **c -** Rear propeller thrust hub
- **d -** Front propeller nut
- **e -** Front propeller
- **f -** Front propeller thrust hub
- **g -** Propeller shaft anode screw
- **h -** Flat washer
- **i -** Star washer
- **j -** Propeller shaft anode

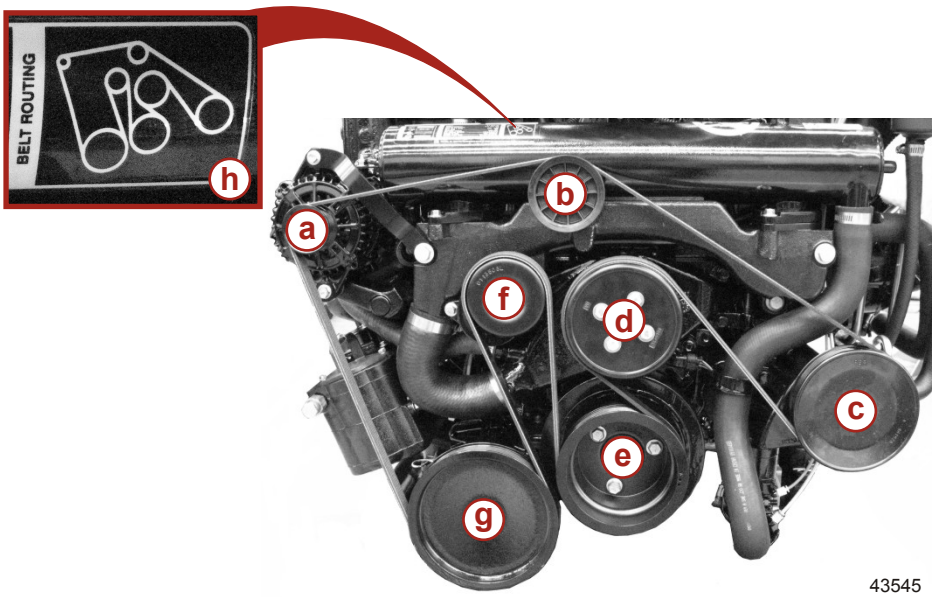
Description	Nm	lb. in.	lb. ft.
Propeller shaft anode screw	19	168	–

Serpentine Drive Belt

Inspection

⚠ WARNING

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



43545

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram

Checking

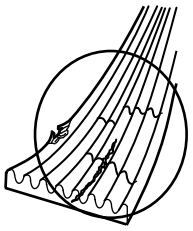
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

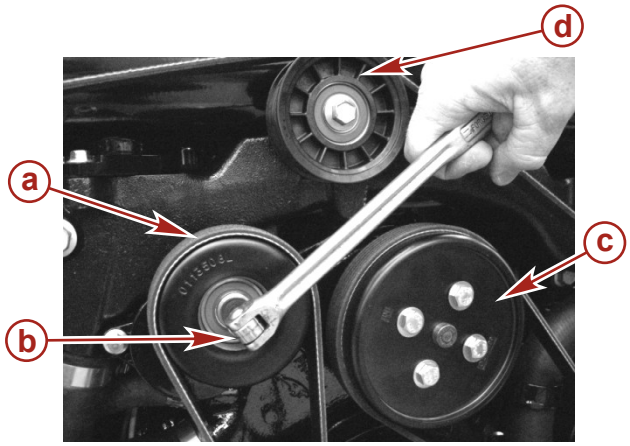
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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



43546

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

Description	
Deflection[1]	13 mm (½ in.)

Corrosion Protection

Corrosion Information

Whenever two or more dissimilar metals 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. For more information refer to the **Mercury Precision Parts / Marine Corrosion Protection Guide** (90-881813003).

Maintaining Ground Circuit Continuity

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

MerCathode System Battery Requirements

The Mercury MerCruiser MerCathode system requires a minimum battery charge of 12.6 volts at all times to maintain functionality.

Boats equipped with a MerCathode system that use shore power, and are not run for a long period of time, must use a battery charger to maintain a minimum battery charge of 12.6 volts or above.

Boats equipped with a MerCathode system that do not have access to shore power must be operated often enough to maintain a minimum battery charge of 12.6 volts or above at all times.

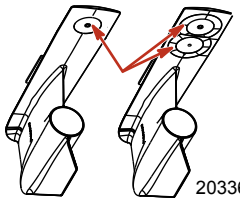
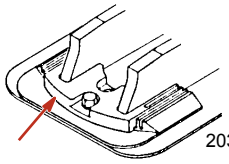
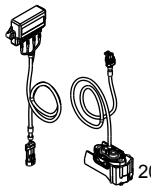
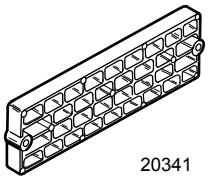
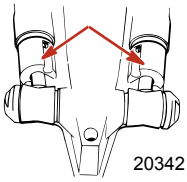
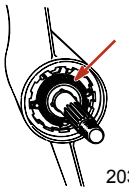
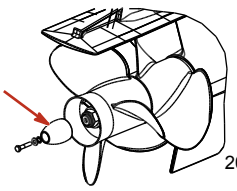
Anodes and MerCathode System Locations

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

1. Use moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

The following sacrificial anodes are installed at different locations on your power package. These anodes help protect against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the metal components on the power package.

MerCathode System— Electrode assembly replaces the Anode block. System should be tested to ensure adequate output. The test should be performed where boat is moored, using Quicksilver Reference Electrode and Test Meter.

Description	Location	Figure
Gearcase anode plate	Mounted on the underside of the lower gearcase.	 20336
Ventilation plate anode	Mounted on the front of the gearcase.	 20338
MerCathode System	The MerCathode electrode is mounted to the underside of the gimbal housing. The MerCathode controler is mounted on the engine or on the boat transom. The controler harness connects to the electrode harness.	 20340
Anode kit (if equipped)	Mounted to the boat transom.	 20341
Trim cylinder anodes	Mounted on each of the trim cylinders.	 20342
Bearing carrier anode (Bravo One)	Located in front of the propeller, between the front side of the propeller and the gear housing.	 20343
Propshaft anode (Bravo Three)	Located behind the aft propeller.	 20344

Checking the Quicksilver MerCathode System

The MerCathode system should be tested to ensure adequate output. Perform the test where the boat is moored, using the reference electrode and test meter.

Reference Electrode	91-76675T 1

Power Package Exterior Surfaces

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

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

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

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

Boat Bottom Care

To achieve maximum performance and fuel economy, the boat bottom must be kept clean. Accumulation of marine growth or other foreign matter can greatly reduce boat speed and increase fuel consumption. To ensure best performance and efficiency, periodically clean the boat bottom in accordance with manufacturer's recommendations.

In some areas, it may be advisable to paint the bottom to help prevent marine growth. Refer to the following information for special notes about the use of anti-fouling paints.

Anti-fouling Paint

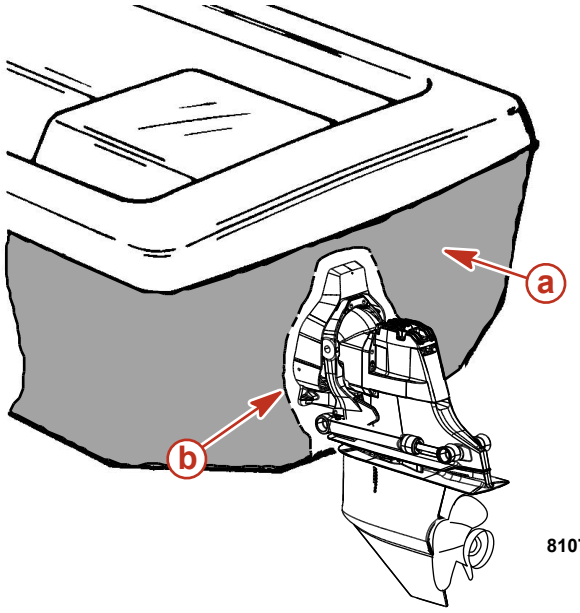
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

You may apply anti-fouling paint to the boat hull and boat transom but you must observe the following precautions:

IMPORTANT: Do not paint or pressure-wash the anodes or the MerCathode System reference electrode and anode. Doing so will render them ineffective as inhibitors of galvanic corrosion.

IMPORTANT: If anti-fouling protection is required for the boat hull or boat transom, you can use copper-based paint if it is not prohibited by law. If you are using copper based anti-fouling paint, observe the following precaution:

- **Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on transom of the boat around these items.**



a - Painted boat transom

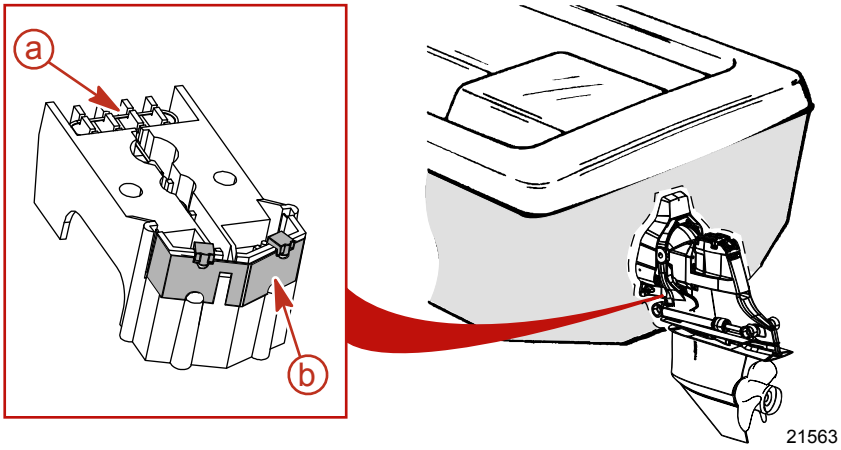
b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly

NOTE: Sterndrive and transom assembly can be painted with a good marine paint or an anti-fouling paint that DOES NOT contain copper 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.

NOTICE

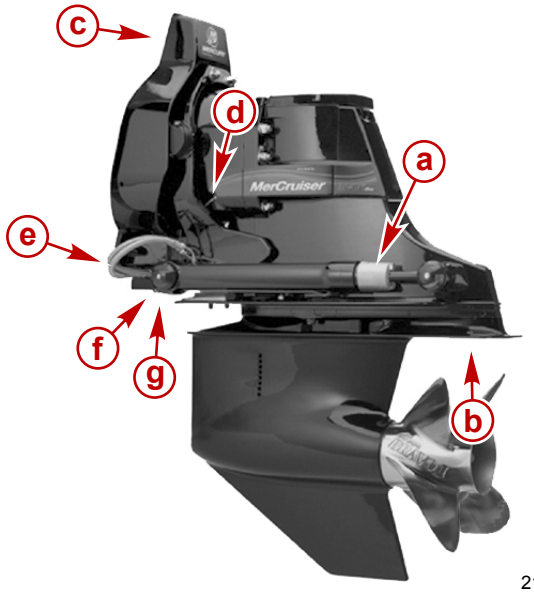
Washing the MerCathode assembly can damage components and lead to rapid corrosion. Do not use any cleaning equipment such as brushes or high-pressure washers to clean the MerCathode assembly.

Do not power-wash a sterndrive that has a MerCathode assembly. Doing so can damage the coating on the reference wire of the MerCathode assembly and increase corrosion.



a - Reference electrode
b - Anode plate

Sterndrive Surface Care



Standard Bravo sterndrive

a - Sacrificial trim cylinder anode
b - Sacrificial anodic plate
c - Steering lever ground wire
d - Ground wire between the gimbal ring and bell housing
e - Stainless steel hoses
f - Ground wire between the gimbal housing and trim cylinder
g - Ground wire between the gimbal ring and gimbal housing

We recommend the following maintenance items to help keep your sterndrive corrosion-free:

- Maintain a complete paint covering on the sterndrive.
- Check the finish regularly. Prime and paint nicks and scratches using Mercury enamel paint and touch up paint. Use only tin–based anti–fouling paint or its equivalent on or near aluminum surfaces below the waterline.
- If bare metal is showing, apply 2 coats paint.

Description	Where used	Part number
Mercury Phantom Black	Bare metal	92- 802878-1

- Spray all electrical connections with sealant.

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

- Inspect the sacrificial trim tab or anode plate if equipped, at regular intervals and replace it before it is half gone. If a stainless steel propeller is installed, additional anodes or a MerCathode System will be required.

- Inspect the propeller shaft for fishing line, which can cause corrosion on a stainless steel shaft.
- Remove the propeller at least every 60 days and lubricate the propeller shaft.
- Do not use lubricants containing graphite on or near the aluminum in saltwater.
- Do not paint trim tabs or the mounting surface.

Flushing the Seawater System—Sterndrive Models

General Information—Bravo Sterndrive

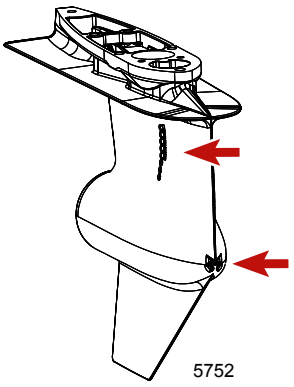
Your boat could be equipped with a combination of any of three different types of water pickups: through-hull, through-transom, and through-sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups.

Flushing Attachments

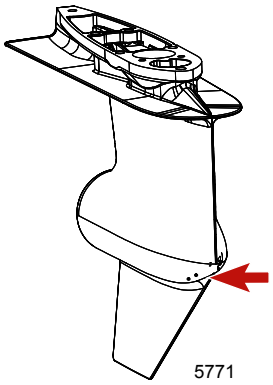
Flushing Device	91-44357Q 2
Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1
Flushing Kit	91-849996T 1

Sterndrive Water Pickups

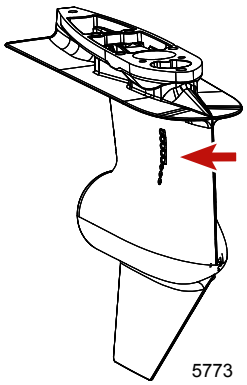
There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side pickups. Dual water pickups require the flushing attachment (44357Q 2) and the flush seal kit (881150K 1), low water pickups require the flushing attachment (849996T 1), and side pickups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



Dual Water Pickup



Low Water Pickup



Side Pickup

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

8. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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.
13. Stop the engine.
14. Immediately shut off the supply water. Do not remove the flushing attachment from the sterndrive at this time.

NOTICE

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

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

15. Close the seacock, if equipped, then disconnect 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.

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

9. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in neutral for 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.
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.**

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.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

2. Close the seacock, if equipped, then disconnect 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

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

SeaCore Power Package Flushing Procedure

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

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

Models Using The Sterndrive Water Pickup

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

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

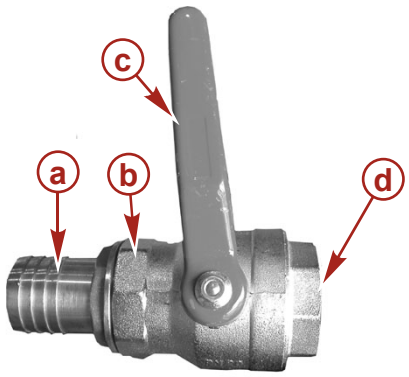
⚠ WARNING

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

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

1. Remove the boat from the water.

2. Close the seacock, if equipped.

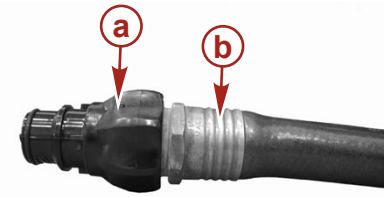


18510

For visual clarity, the secock shown is not installed

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

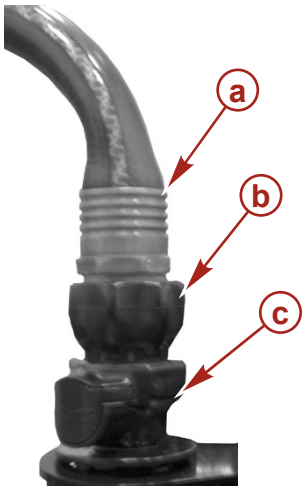
3. If equipped with an alternative water pickup and not equipped with a seacock, disconnect the water hose from the alternative water pickup and plug both ends, excluding the Bravo sterndrive.
4. Ensure that the inlet water hose from the sterndrive to the engine is connected.
5. Remove the quick-connect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



18487

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

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



18489

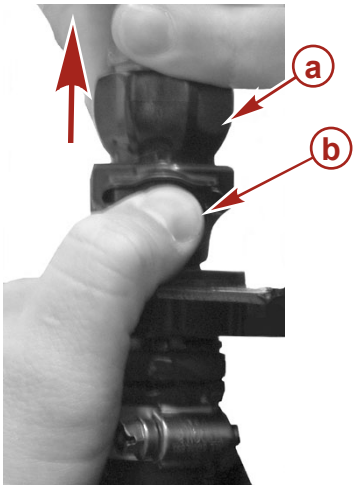
- **a -** Water hose
- **b -** Quick-connect fitting (water hose end)
- **c -** Flush socket

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

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

11. Operate the engine at idle speed in neutral gear. Do not exceed 1200 RPM.
12. Monitor the engine temperature while operating the engine.

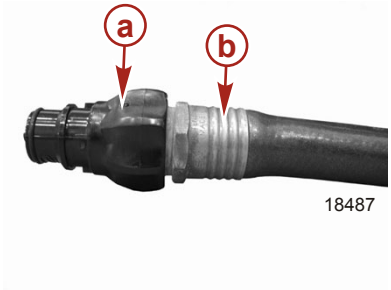
13. Flush the engine for 5 to 10 minutes or until discharge water is clear.
14. Shut off the engine.
15. Turn off the water source.
16. Disconnect the quick-connect fitting and water hose from the flush socket on the engine by pressing the release button on the flush socket.



18488

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

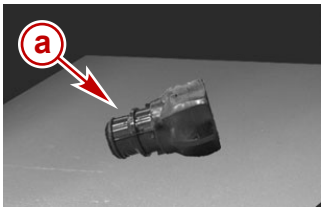
17. Remove the quick-connect fitting from the water hose.



18487

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

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



25900

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

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

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

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

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

Cold Weather or Extended Storage

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

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

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

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

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. Check the antifreeze concentration. Refer to the **Specifications** section.
3. 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 Mercury/Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to **Fuel Requirements** for additional information.
4. Flush the cooling system. Refer to the **Maintenance** section.
5. Supply cooling water to engine. Refer to the **Maintenance** section
6. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Mercury/Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off the engine.
7. Change the oil and oil filter.
8. Prepare the engine and fuel system for storage. See **Engine and Fuel System Preparation**.
9. Drain the engine seawater cooling system. See **Draining the Seawater System**.

NOTICE

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

10. For additional assurance against freezing and rust, after draining, fill the seawater 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.
11. Store the battery according to the manufacturer's instructions.

Engine and Fuel System Preparation

⚠ WARNING

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

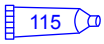
⚠ WARNING

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

NOTICE

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

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

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

2. Allow the engine to cool.
   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 five minutes.
6. After the specified operating time is complete, slowly return the throttle to idle and shut the 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. Refer to **Section 5**.

Maintenance

⚠ WARNING

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

⚠ WARNING

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

IMPORTANT: Refer to the maintenance schedule for the complete listing of all scheduled maintenance to be performed.

NOTE: *Maintenance points are color-coded for ease of identification.*

Maintenance Point Color Codes	
Yellow	Engine oil
Black	Drive lube
Brown	Power steering fluid
Blue	Drain or flush

Draining the Seawater System

⚠ CAUTION

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

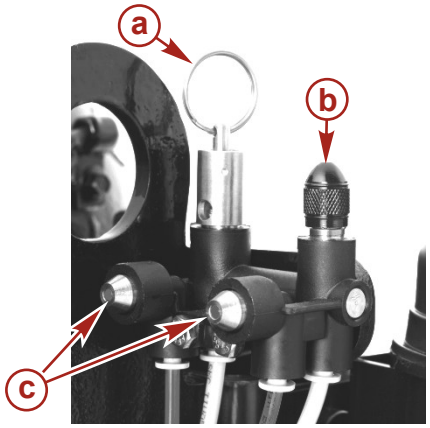
IMPORTANT: Only drain the seawater section of the closed cooling system.
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

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.

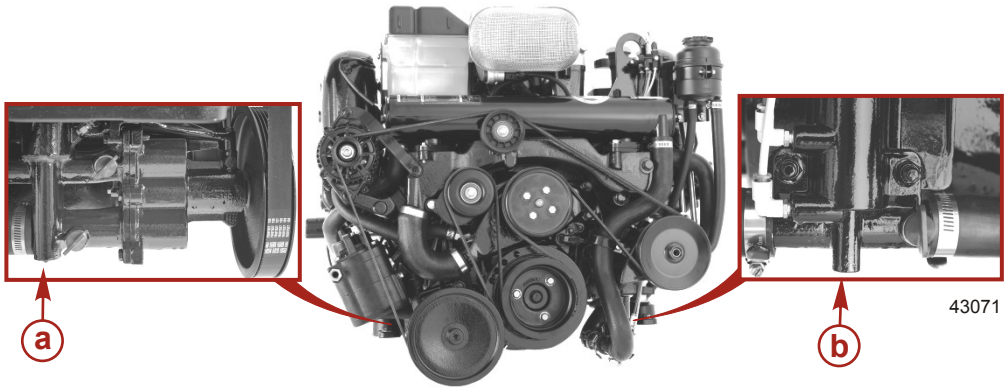
Drain System Identification

Air Actuated Single Point Drain System



43070

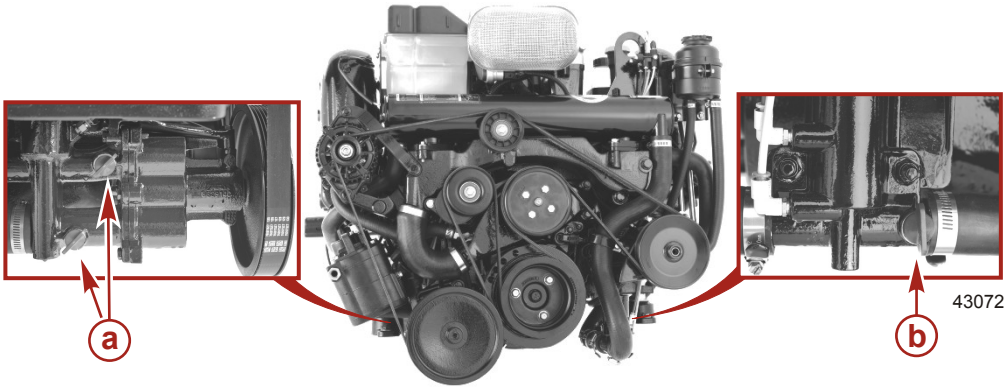
a - Manual pressure release valve
b - Threaded cap for air connection
c - Green indicators



43071

a - Starboard side air actuated drain location
b - Port side air actuated drain location

Manual Drain System



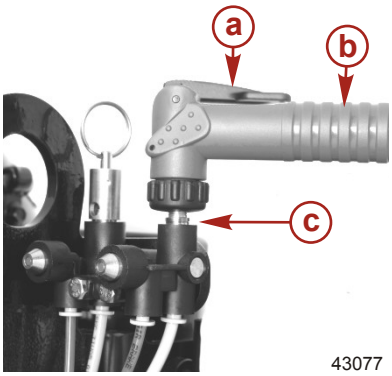
a - Starboard side blue drain plugs
b - Port side blue drain plug

Air Actuated Single Point Drain System

Boat in the Water

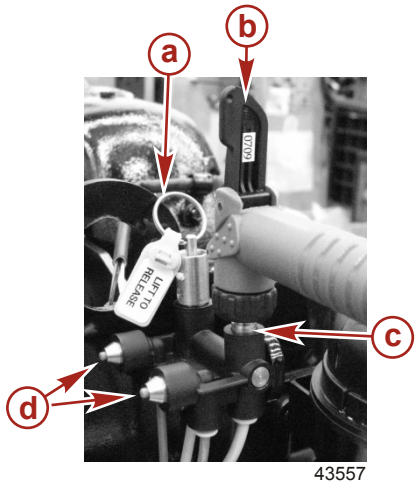
NOTE: *This procedure is written for the air pump that was shipped with the engine from the factory. However, any air source can be used.*

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Obtain the air pump.
3. Remove the threaded cap from the air connection.
4. Ensure that the lever on top of the air pump is against the handle (horizontal).
5. Install the air pump on the air connection.



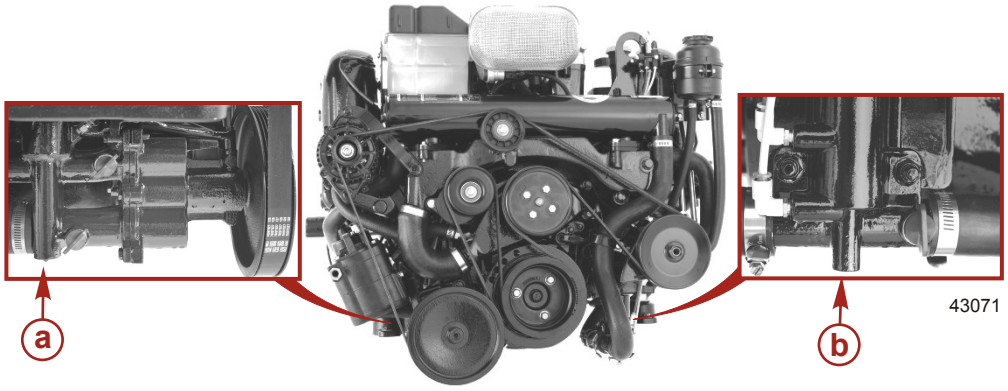
a - Lever
b - Air pump
c - Air connection

6. Pull the lever on the air pump (vertical) to seal the pump to the connection.
7. 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.



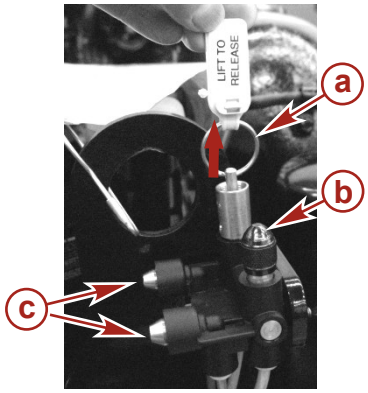
a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

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



a - Starboard side air actuated drain location
b - Port side air actuated drain location

9. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
10. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
11. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
12. Remove the air pump from the air connection and return it to the mounting bracket.
13. 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.
14. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



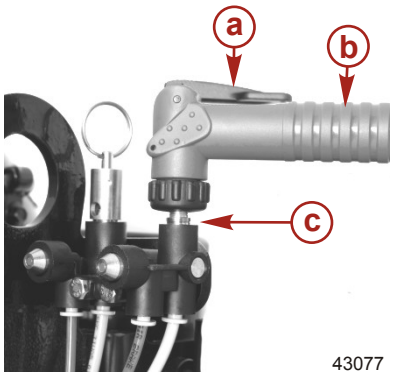
a - Manual release valve pull ring
b - Threaded cap on air connection
c - Green indicators

15. 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.*

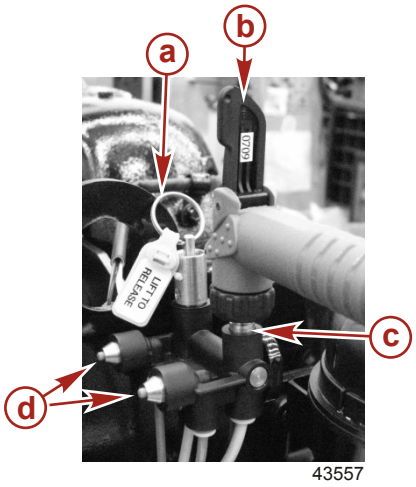
1. Place the boat on a level surface and ensure the boat is level.
2. Obtain the air pump.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the air connection.



a - Lever
b - Air pump
c - Air connection

5. Pull the lever on the air pump (vertical) to seal the pump to the air connection.

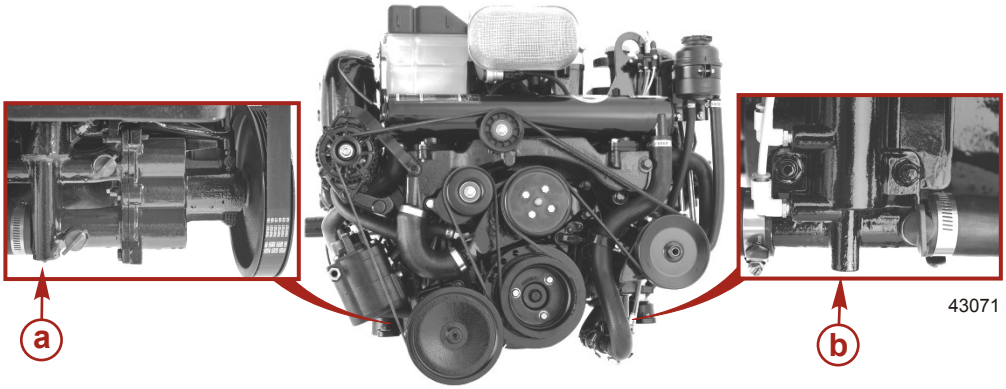
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

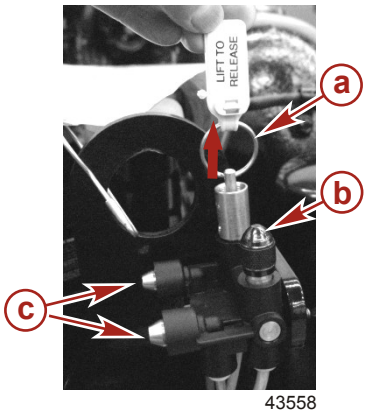
7. Verify that water is drining from each opening. If not, use the **Manual Drain System** instructions.



43071

a - Starboard side air actuated drain location
b - Port side air actuated 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.



43558

a - Manual release valve pull ring
b - Threaded cap
c - Green indicators

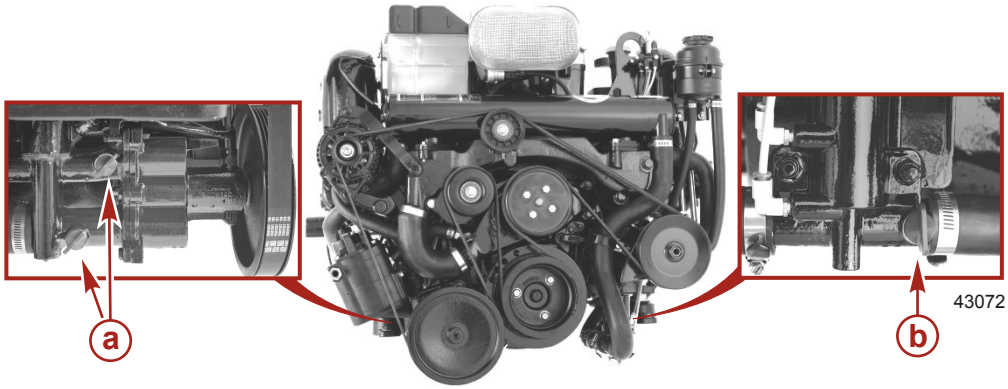
Manual Drain System

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 hoses are disconnected.*

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



a - Starboard side blue drain plugs
b - Port side blue drain plug

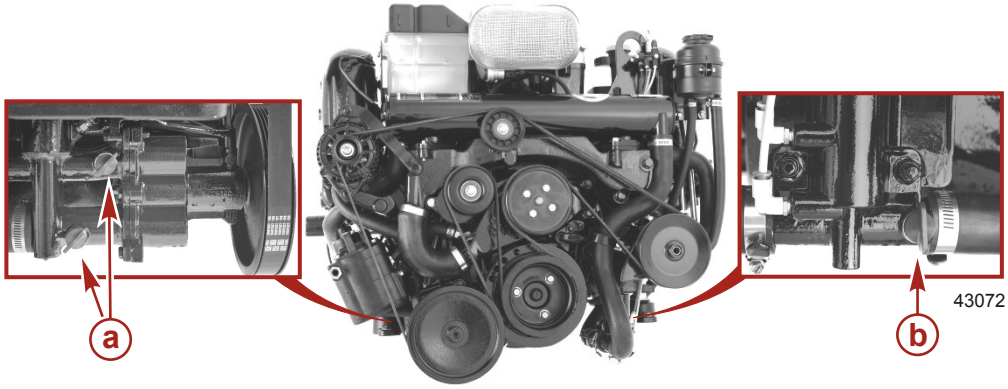
3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. 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 lever surface to ensure complete draining of the system.
2. Remove the port side blue drain plug.
3. Remove two blue drain plugs from the seawater pickup pump (front, starboard side).



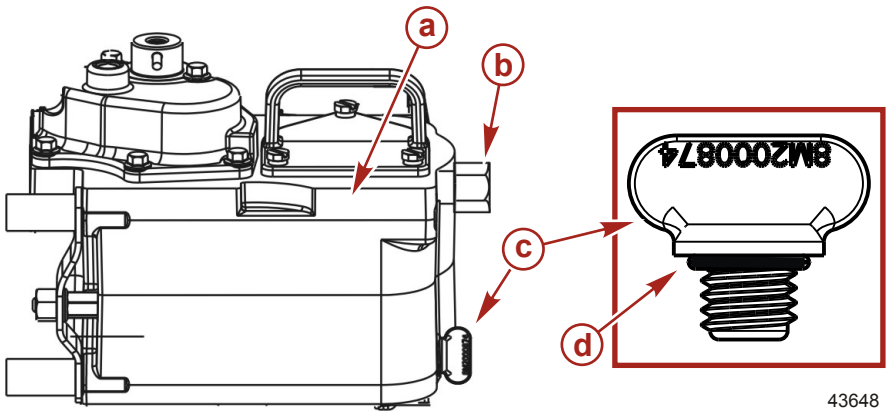
a - Starboard side blue drain plugs
b - Port side blue drain plug

4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of five 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. For DTS engines, 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 two blue drain plugs.

Draining Water From the Gen III Cool Fuel Module

Mercury MerCruiser recommends draining the Gen III Cool Fuel module if it is equipped with a drain plug.

1. Remove the drain plug from the Gen III Cool Fuel module and allow the water to completely drain from the module.
2. Inspect the drain plug and the O-ring for damage. Replace if needed.
3. Place the O-ring on the drain plug and install the drain plug in the module drain hole. Tighten the drain plug to finger tight.

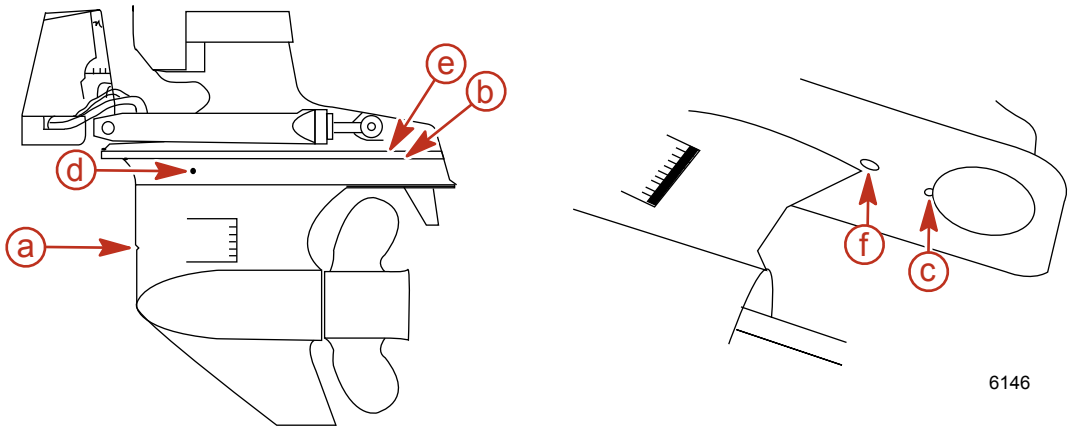


a - Gen III Cool Fuel module
b - Fuel inline fitting
c - Drain plug
d - O-ring

Draining the Sterndrive

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

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



Sterndrive Water Drain Holes

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

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

2. Lower the sterndrive unit to the full down/in position.
3. For additional assurance against freezing and rust, after draining, fill the cooling system with propylene glycol mixed to the manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

Battery Storage

Whenever the battery will be stored for an extended period of time, be sure the cells are full of water and the battery is fully charged and in good operating condition. It should be clean and free of leaks. Follow the battery manufacturer's instructions for storage.

Recommissioning the Power Package

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

⚠ CAUTION

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

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect cables. 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 **Operation Chart**.

NOTICE

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

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

Notes:

Important Information

Section 1C - Maintenance Inboard Models

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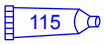
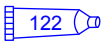
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

Gasoline and Engine Oil

Fuel Requirements

NOTICE

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

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

Fuel Ratings

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

USA and Canada - A posted pump Octane Rating of 87 (R+M)/2, minimum. Premium gasoline 92 (R+M)/2 Octane is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - A posted pump Octane Rating of 91 RON, minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and are acceptable for use in your Mercury MerCruiser engine. The two types of oxygenates used in these fuels are alcohol (ethanol) and ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasoline Containing Alcohol**.

Gasoline Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), be aware of possible adverse effects. These adverse effects are more severe with methanol and worsen according to the percentage of alcohol in the fuel.

Alcohol in gasoline can absorb moisture from the air, causing the water and the alcohol to separate from the gasoline in the fuel tank.

IMPORTANT: The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

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

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

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

Engine Oil

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

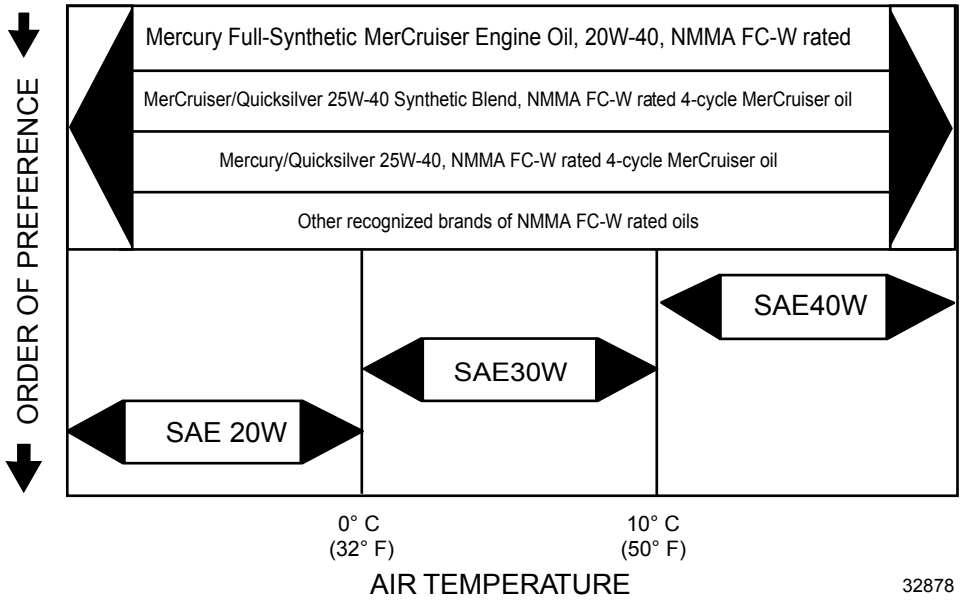
Application	Recommended Oil
All MerCruiser engines	Mercury MerCruiser Full-Synthetic Engine Oil, 20W-40, NMMA FC-W rated

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

If Mercury MerCruiser Full-Synthetic, 20W-40 oil is unavailable, use the following lubricants, listed in order of recommendation. If you are servicing a catalyst engine, use these for short periods of time only.

1. Mercury/Quicksilver 25W-40 Synthetic Blend, NMMA FC-W–rated 4-cycle MerCruiser oil
2. Mercury/Quicksilver 25W-40, NMMA FC-W–rated 4-cycle MerCruiser oil
3. Other recognized brands of NMMA FC-W–rated 4-cycle oils
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: *We do not recommend 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.*



Cruising RPM

Material and design advancements allow modern inboard engines to operate at higher engine speeds than their predecessors. Increased RPM significantly increases the horsepower of these new engines and is a critical part performance and efficiency. The materials and design of the new engines allow these higher speeds without durability penalty. Over-propping the boat to reduce its cruising RPM to previous levels increases the engine's susceptibility to engine damage from detonation and pre-ignition. The recommended cruising RPM ranges are:

Cruising RPM for peak efficiency	
Model	**RPM range**
Horizon 8.2	3200–3600
8.2 H.O.	3400–3800

Engine Specification Inboard Models

Horizon 8.2 EC and 8.2 H.O. EC

NOTE: *Performance specifications are:*

- *Obtained and corrected in accordance with SAE J1228/ISO 8665 Crankshaft Power.*
- *All measurements are taken with the engine at normal operating temperature.*
- *RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.*
- *Oil pressure must be checked with the engine at normal operating temperature.*

NOTE: *Oil pressure specifications are for reference and may vary.*

		Horizon 8.2	8.2 H.O.
Propshaft power		280 kW (375 hp)	317 kW (425 hp)
Displacement		8.2 L (502 cid)	
Alternator amperage	Hot	72 A	
	Cold	65 A	
RPM	WOT	4200–4600	4400–4800
	Rev limiter	4750	4950
Idle RPM	Mechanical	675	
	DTS		
Minimum oil pressure	At 2000 RPM	431 kPa (60 psi)	
	At idle	207 kPa (30 psi)	
Thermostat	MPI models with Closed Cooling	76° C (170° F)	
Timing at idle		Not Adjustable	
Firing order		1-8-4-3-6-5-7-2	
Minimum battery rating	Non-DTS models	750 CCA, 950 MCA, 180 Ah	
	DTS models	800 CCA, 1000 MCA, 190 Ah	
Spark plug type		NGK BPR6ES	
Spark plug gap		0.83 mm (0.033 in.)	
Emission Control System		Electronic control (EC), heated oxygen sensor (HO2S), catalyst	

Maintenance Schedule Inboard Models

Routine Maintenance

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

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. You can extend this interval based on experience with the product. • Check the transmission fluid level.
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Check the transmission fluid.

Task Interval	Maintenance to Be Performed
Every two months or 50 hours	• If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.

Scheduled Maintenance

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

Task Interval	Maintenance to Be Performed
After the initial 20-hour break-in period	Change the engine oil and filter. • Change the engine oil and filter. • Change the transmission fluid and filter. ZF Marine requires changing the transmission fluid and filter to maintain warranty.
Every 100 hours or annually (whichever occurs first)	• Touch up the paint on the power package. • Change the engine oil and filter. • Change the transmission fluid (Transmission Models). • If the condition of the spark plugs, spark plug wires, and the distributor cap and rotor was satisfactory at the initial inspection (as listed in **Every 300 hours or 3 years**), inspect the condition of these components. Replace as necessary. • Replace the water-separating fuel filter element. • Clean the flame arrestor and the crankcase ventilation hoses. • Replace the positive crankcase ventilation (PCV) valve. • Inspect the condition and the tension of the belts. • On models with closed cooling, check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section.
Every 300 hours or 3 years (whichever occurs first)	• Check the engine mounts for tightness and tighten to specifications if necessary. • Inspect the condition of the spark plugs, spark plug wires, and the distributor cap and rotor, if equipped. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. • Check the electrical system for loose, damaged, or corroded fasteners. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • On models with closed cooling, clean the seawater section of the closed cooling system. • Clean, inspect, and test the pressure cap of the closed cooling system. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Replace the vent valve and duckbill valve on each exhaust elbow (port and starboard).
Every 5 years	• On models with closed cooling, replace the coolant/anitifreeze. Replace every two years if not using extended-life coolant/antifreeze.

Fluid Specifications

Engine

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Transmission

Model	Capacity	Fluid Type
63A	4.3 L (4.5 US qt)	Dexron III Automatic Transmission Fluid
63V	4.3 L (4.5 US qt)	
80A	5.7 L (6 US qt)	

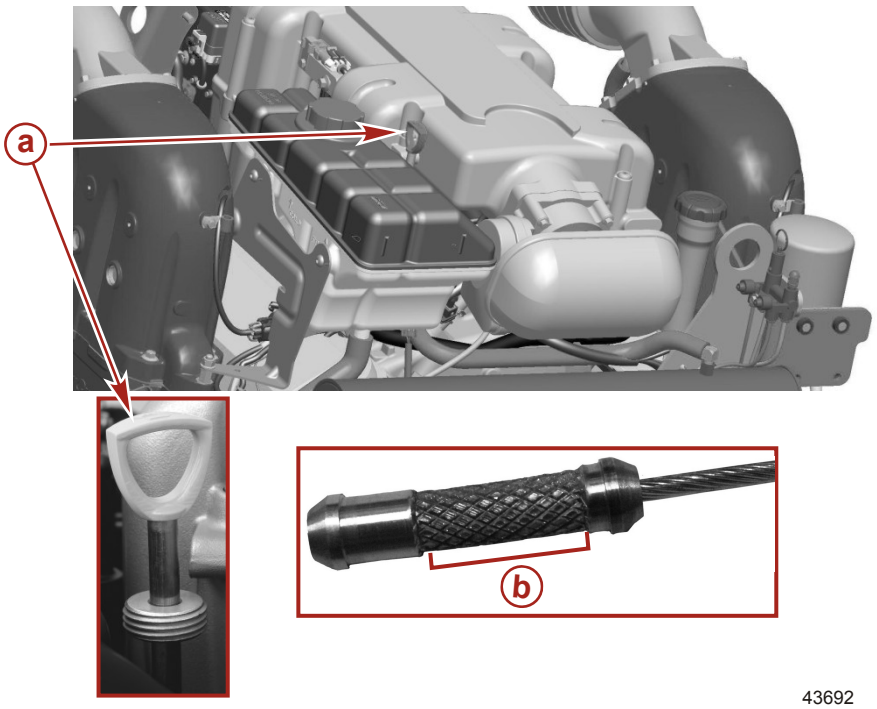
Engine Oil

Checking

NOTICE

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

1. Stop the engine. Allow the oil to drain into the oil pan for approximately five minutes with the boat 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.



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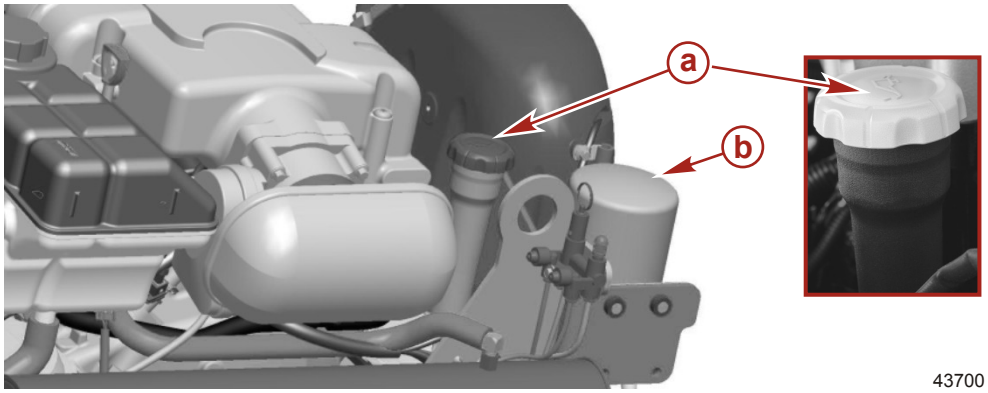
a - Oil dipstick handle
b - Operating range

3. Inspect the dipstick reading, which should indicate a level at the operating range (cross markings) on the dipstick. Reinstall the dipstick into the dipstick tube. If the oil level is low, refer to **Filling**.

Filling

IMPORTANT: Always use the dipstick to determine the exact quantity of oil or fluid required. Do not overfill the engine with oil.

1. Remove oil fill cap.



a - Oil fill cap
b - Oil filter

2. Add the specified engine oil to bring the level up to, but not over, the operating range (cross markings) on the dipstick.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

3. Check the oil level and replace the fill cap.

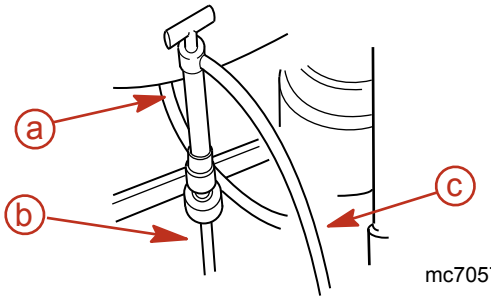
Changing Oil and Filter

See **Maintenance Schedule** for the change interval. Engine oil should be changed before placing the boat in storage.

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

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.

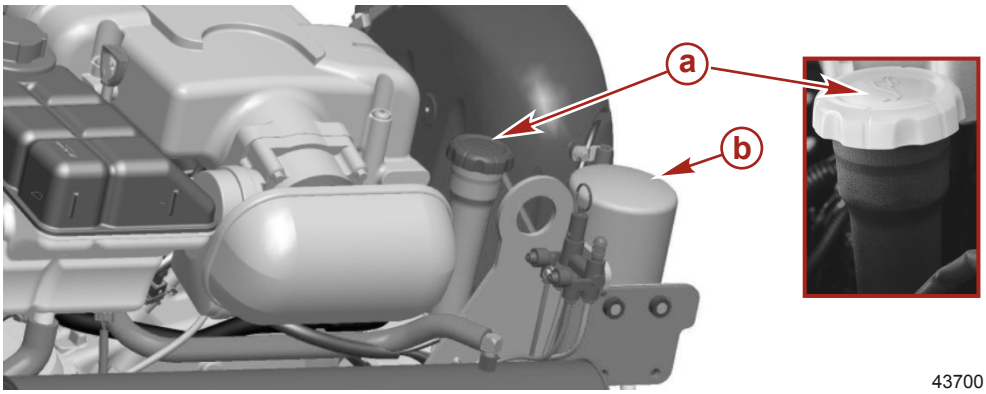


a - Oil pump
b - Dipstick tube
c - Oil drain hose

4. Insert the hose end of the crankcase oil pump onto an appropriate container and usie the handle to pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing the Oil Filter

1. Remove and discard oil filter.



a - Oil fill cap
b - Oil filter

2. Coat the sealing ring on the new filter with engine oil.
3. Install and tighten the oil filter securely following the filter manufacturer's instructions. Do not overtighten.
4. Remove oil fill cap.
5. Use the dipstick to determine the amount of engine oil required. Replace the dipstick.
6. Add the required amount of the recommended oil to bring the level up to the bottom of the OK range on the dipstick.
7. With the boat at rest in the water, repeat steps 5 and 6 if necessary.

   NOTE: *Adding 0.95 L (1 US qt) of engine oil raises the level from the add mark to the top of the operating range.*

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

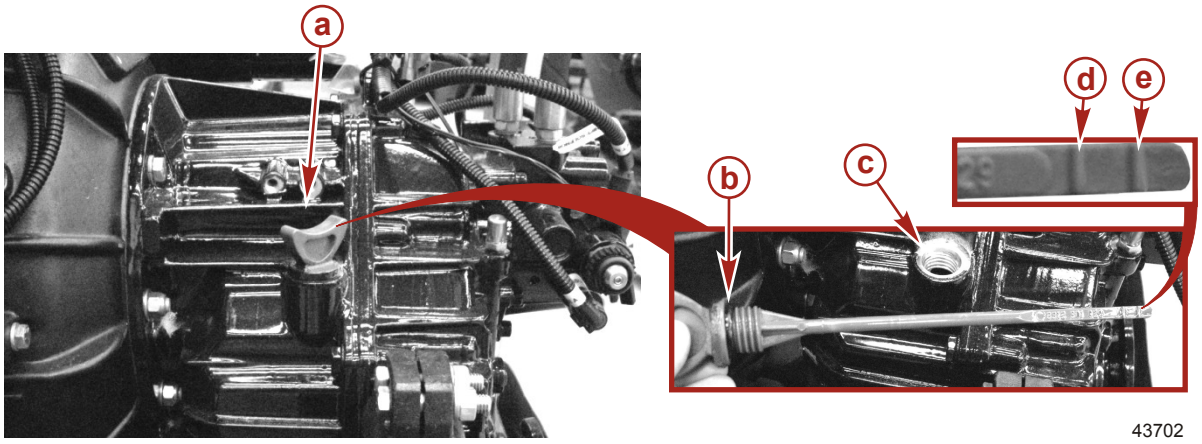
8. Start the engine and operate for three minutes, checking for leaks.
9. Stop the engine and allow the oil to drain into the oil pan for approximately five minutes with the boat at rest in the water.

Transmission Fluid

Checking While Engine is Warm

1. Stop the engine.
2. Remove the dipstick from the transmission.
3. If the fluid level is below the add mark on the dipstick, add the specified fluid through the dipstick hole. Do not overfill.

4. Install the dipstick, hand tighten the T-handle to seat the O-ring. Do not overtighten.



Typical ZF Marine Transmission

- **a -** Dipstick
- **b -** O-ring
- **c -** Dipstick hole
- **d -** Full mark
- **e -** Add mark

Checking While Engine is Cold

NOTE: *Cold Fluid Level Check: To ease checking the fluid level, the dipstick can be marked or scribed with a cold level mark.*

1. Follow the procedure for the warm fluid level check, then allow the boat to sit overnight.
2. Remove the dipstick, wipe clean and reinsert.
3. Remove the dipstick, observe the fluid level and mark the cold fluid level.
4. Install the dipstick, hand tighten the T-handle to seat the O-ring. Do not overtighten.

Transmission Fluid

Model	Capacity	Fluid Type
63A	4.3 L (4.5 US qt)	Dexron III Automatic Transmission Fluid
63V	4.3 L (4.5 US qt)	
80A	5.7 L (6 US qt)	

Changing

Refer to **Transmission**.

Closed Cooling System

Coolant Requirement

NOTICE
Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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

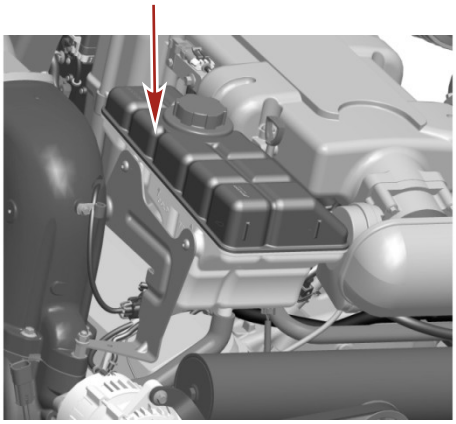
Checking Coolant Level

⚠ CAUTION

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

IMPORTANT: Tighten the pressure cap securely.

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



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Coolant recovery bottle

Filling the Closed Cooling System

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

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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 approximate.*

Model	8.2
Closed cooling system	14.3 liters (15 qt.)

⚠ CAUTION

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

IMPORTANT: 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.

NOTICE

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

5. Supply cooling water to the engine.
6. 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.

⚠ CAUTION

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

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

Refer to specific instructions and warnings accompanying your battery. If this information is not available, observe the following precautions when handling a battery.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

Multiple EFI Engine Battery Precautions

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for 2 different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself, and the engine will operate normally. The ECM shuts off and resets itself so quickly that the engine may only seem to have an ignition miss.

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's ECM has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is operating off of its own battery. Do not operate engines with switches in both or all position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

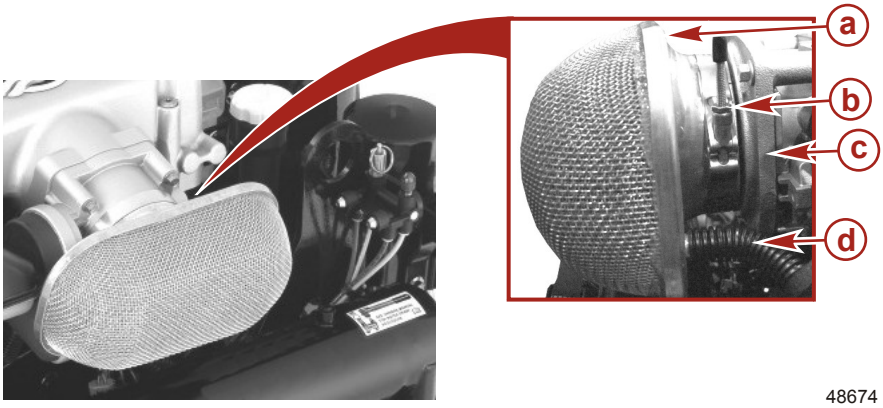
Generators: The generators battery should be considered another engine's battery.

Cleaning the Flame Arrestor

⚠ WARNING

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

1. Remove the vent hose from the flame arrestor.
2. Loosen the flame arrestor clamp nut.
3. Pull the flame arrestor from the throttle body.



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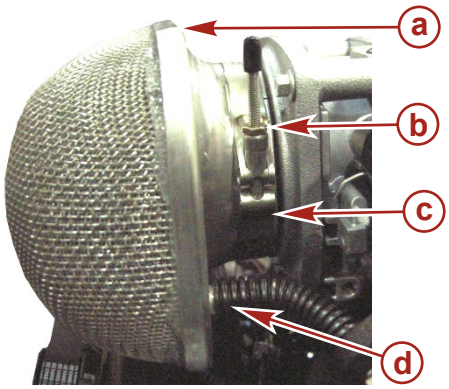
a - Flame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

4. Clean the flame arrestor with solvent and dry with compressed air or set aside and allow to air dry completely.
5. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
6. Push the flame arrestor onto the throtte body.
7. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.
8. Tighten the clamp to specification. Do not overtighten the clamp.



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a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

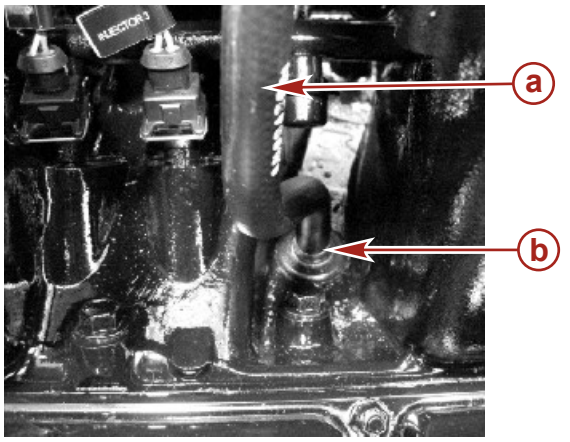
Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

9. Install the vent hose to the bib fitting.

Changing the Positive Crankcase Ventilation (PCV) Valve

This engine is equipped with a positive crankcase ventilation (PCV) valve . We recommend changing it every 100 hours of operation or at least once a year, whichever occurs first.

1. Pull the PCV valve out of the intake manifold and remove the PCV valve from the hose.



a - Hose from plenum to PCV valve
b - PCV valve

43215

2. Inspect the PCV valve and replace if necessary.
3. Install the PCV valve into the intake manifold.
4. Ensure that the PCV valve is tightly seated into the intake manifold.

We recommend the use of Mercury MerCruiser replacement parts.

Water-Separating Fuel Filter

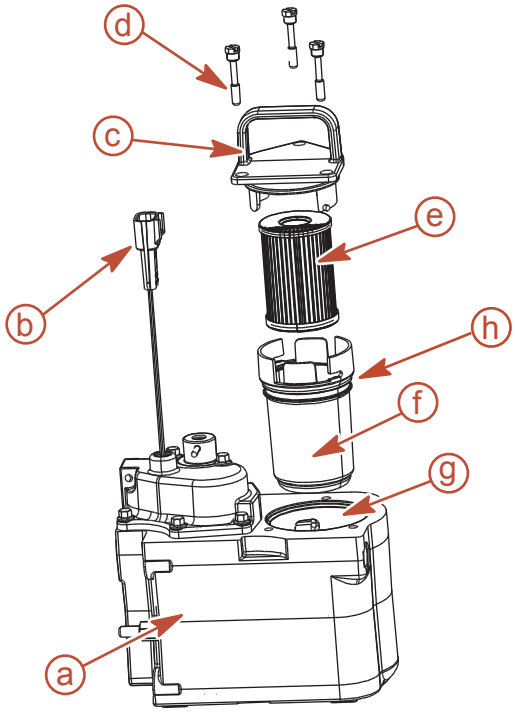
⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

GEN III Models



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

Removal

1. Allow the engine to cool down.
   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*
2. Close fuel supply valve, if equipped.
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 5 seconds.
5. Turn key switch to off position.
6. Loosen each filter assembly retaining screw until the screw is 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 remove the filter assembly from the Cool Fuel Module at this time.
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 in a clockwise direction 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 that may be in the filter cup.

Installation

1. Install a new water-separating fuel filter element into the filter cup. Push the element into the cup until completely seated.
2. Install new O-ring on the filter cup.
3. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction while holding the filter cup stationary, until the filter cap locks securely into place.
4. 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.
5. 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	–

6. Open fuel supply valve, if equipped.

7. Reconnect the Cool Fuel Module harness to the engine wiring harness.
8. Properly ventilate the engine compartment.

NOTICE

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

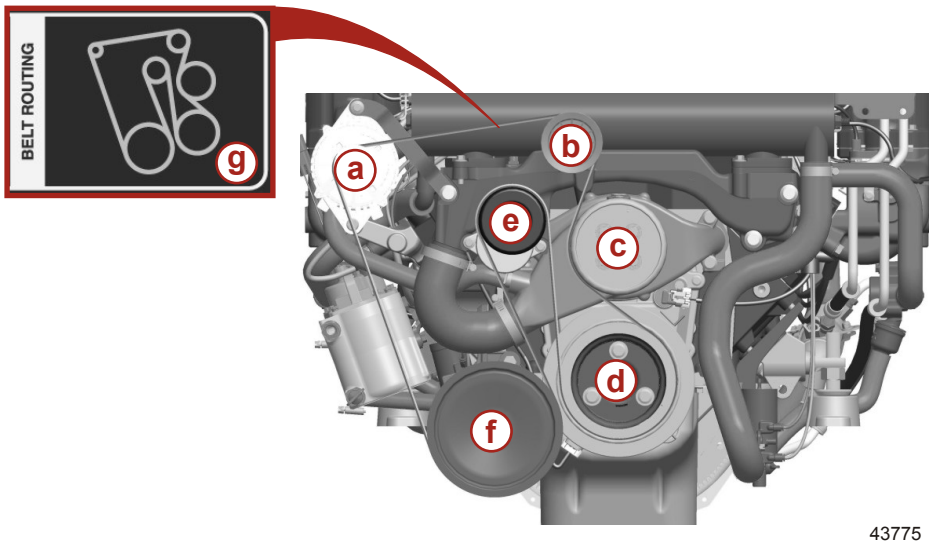
9. Supply cooling water to the engine.
10. Start the engine. Check for gasoline leaks around the fuel filter assembly. If leaks exist, stop the engine immediately. Recheck the filter installation, clean spilled fuel and properly ventilate the engine compartment. If leaks continue, stop the engine immediately, locate the cause, and repair as required.

Serpentine Drive Belt

Inspection

⚠ WARNING

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



- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

Checking

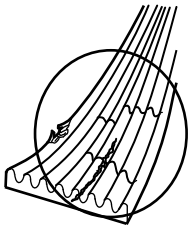
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.



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Replacing

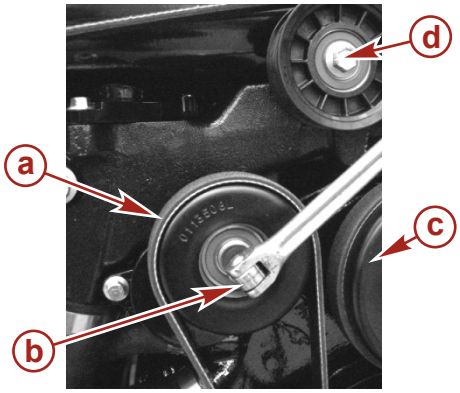
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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



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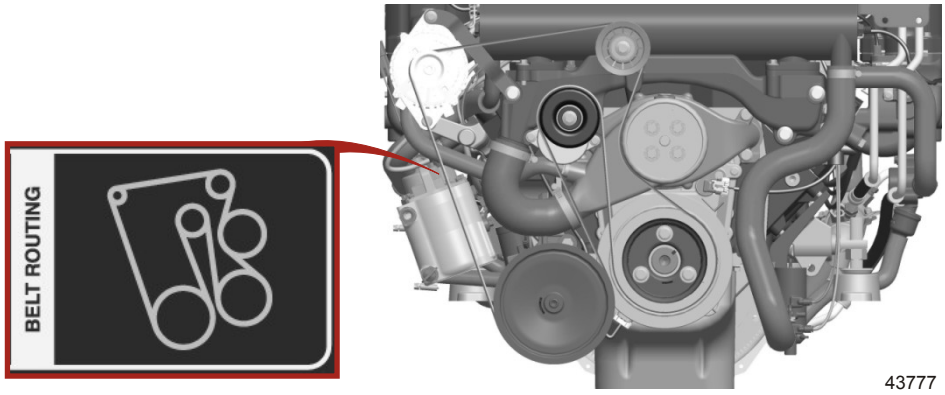
a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

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



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Description	
Deflection	13 mm (½ in.)

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: We recommend flushing after each outing in salty, brackish, mineral-laden, or polluted water and before cold weather and extended storage.

⚠ WARNING

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

1. 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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 power packages operated in salty, brackish, mineral-laden, or polluted water:* Continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to idle speed position.
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: We recommend flushing the engine after each outing in salty, brackish, mineral-laden, or polluted water and before cold weather and extended storage.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

1. Close the seacock, if equipped, then disconnect 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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 power packages operated in salty, brackish, mineral-laden, or polluted water:* Continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to idle speed position.
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.

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 temperatures IS NOT covered by the Mercury MerCruiser Limited Warranty.

NOTICE

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

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

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

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. Check the antifreeze concentration. Refer to the **Specifications** section.
3. 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 Mercury/Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to **Fuel Requirements** for additional information.
4. Flush the cooling system. Refer to the **Maintenance** section.
5. Supply cooling water to engine. Refer to the **Maintenance** section
6. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Mercury/Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off the engine.
7. Change the oil and oil filter.
8. Prepare the engine and fuel system for storage. See **Engine and Fuel System Preparation**.
9. Drain the engine seawater cooling system. See **Draining the Seawater System**.

NOTICE

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

10. For additional assurance against freezing and rust, after draining, fill the seawater 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.
11. Store the battery according to the manufacturer's instructions.

Engine and Fuel System Preparation

⚠ WARNING

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

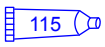
⚠ WARNING

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

NOTICE

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

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

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

2. Allow the engine to cool.
   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 five minutes.
6. After the specified operating time is complete, slowly return the throttle to idle and shut the 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. Refer to **Section 5**.

Draining the Seawater System

⚠ CAUTION

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

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

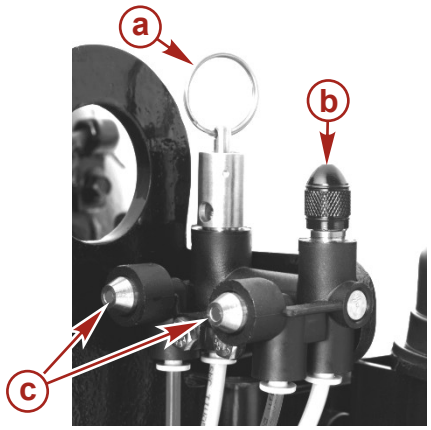
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

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.
IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. 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.

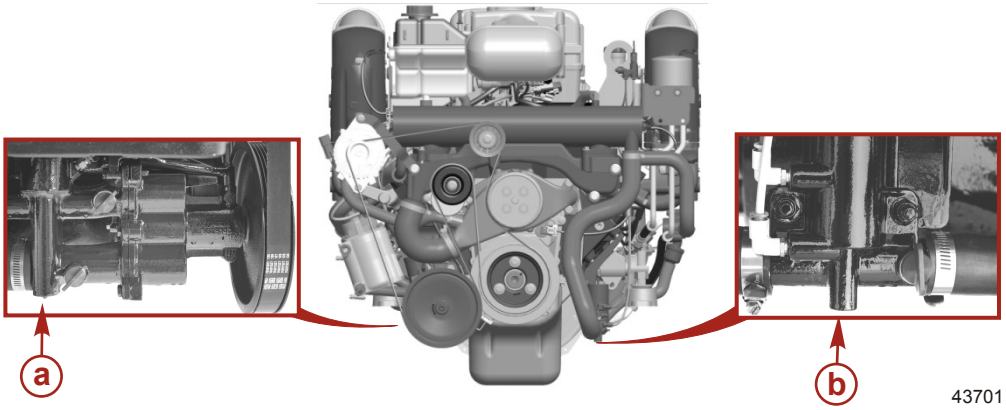
Drain System Identification

Air Actuated Single Point Drain System



43070

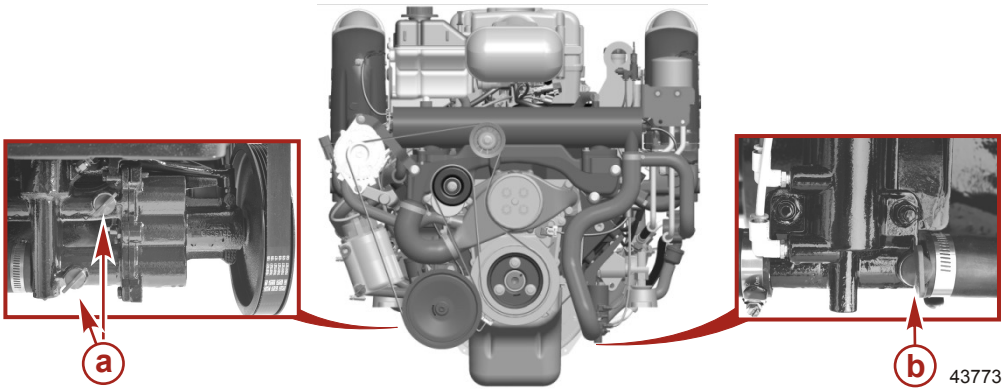
- **a -** Manual pressure release valve
- **b -** Threaded cap for air connection
- **c -** Green indicators



43701

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

Manual Drain System



43773

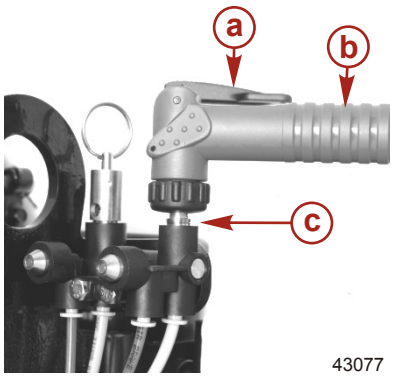
- **a -** Starboard side blue drain plugs
- **b -** Port side blue drain plug

Air Actuated Single Point Drain System

Boat in the Water

NOTE: *This procedure is written for the air pump that was shipped with the engine from the factory. However, any air source can be used.*

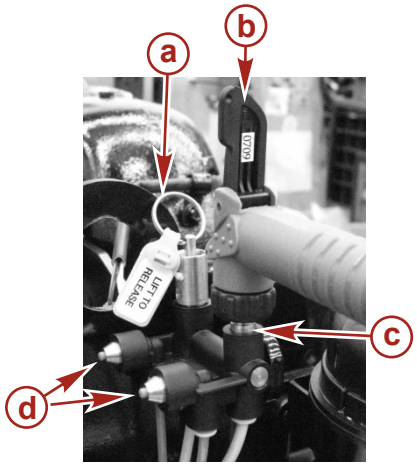
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Obtain the air pump.
3. Remove the threaded cap from the air connection.
4. Ensure that the lever on top of the air pump is against the handle (horizontal).
5. Install the air pump on the air connection.



43077

a - Lever
b - Air pump
c - Air connection

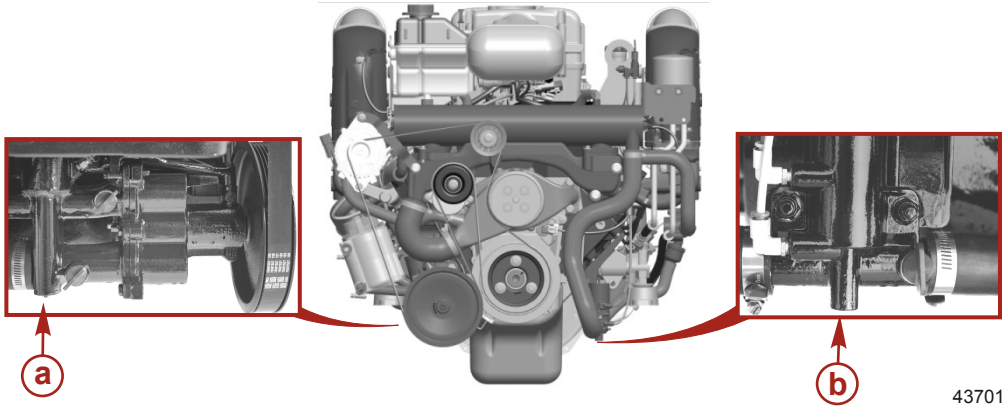
6. Pull the lever on the air pump (vertical) to seal the pump to the connection.
7. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

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

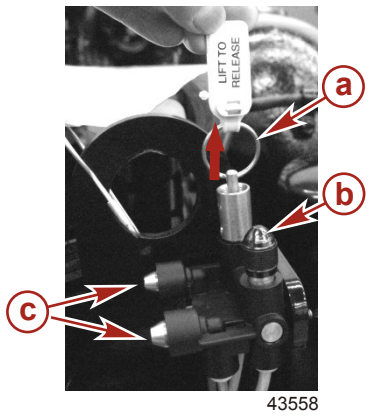


43701

a - Starboard side air actuated drain location
b - Port side air actuated drain location

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

10. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
11. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
12. Remove the air pump from the air connection and return it to the mounting bracket.
13. 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.
14. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



43558

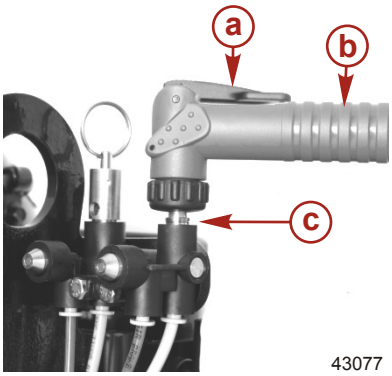
a - Manual release valve pull ring
b - Threaded cap on air connection
c - Green indicators

15. 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 and ensure the boat is level.
2. Obtain the air pump.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the air connection.

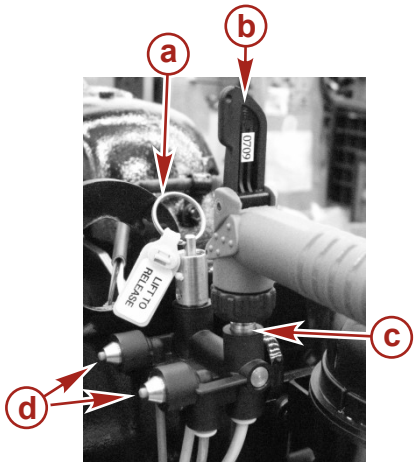


43077

a - Lever
b - Air pump
c - Air connection

5. Pull the lever on the air pump (vertical) to seal the pump to the air connection.

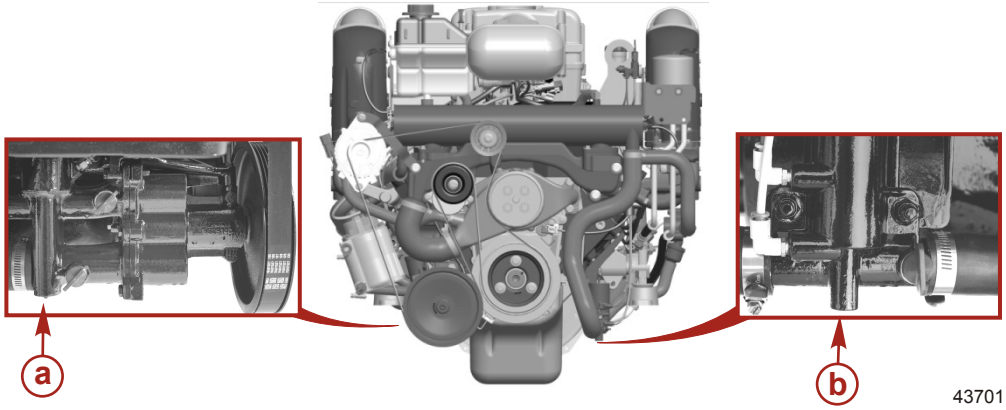
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

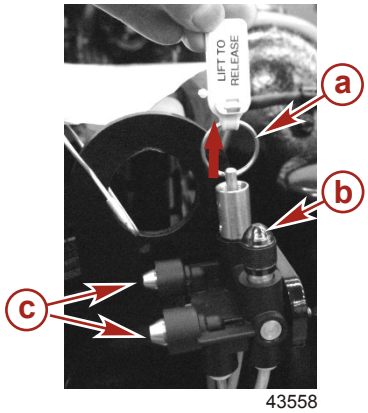
7. Verify that water is draining from each opening. If not, use the **Manual Drain System** instructions.



43701

a - Starboard side air actuated drain location
b - Port side air actuated 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.



43558

a - Manual release valve pull ring
b - Threaded cap
c - Green indicators

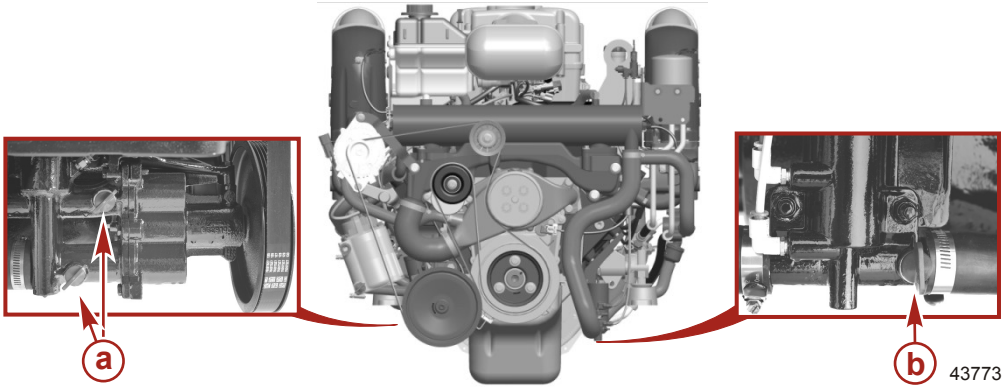
Manual Drain System

Boat in the Water

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

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

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



a - Starboard side blue drain plugs
b - Port side blue drain plug

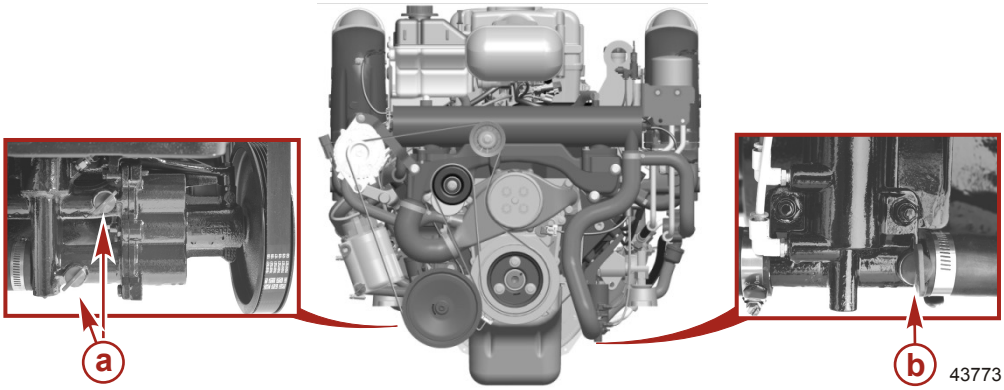
3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. 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 lever surface to ensure complete draining of the system.
2. Remove two blue drain plugs from the seawater pickup pump (front, starboard side).



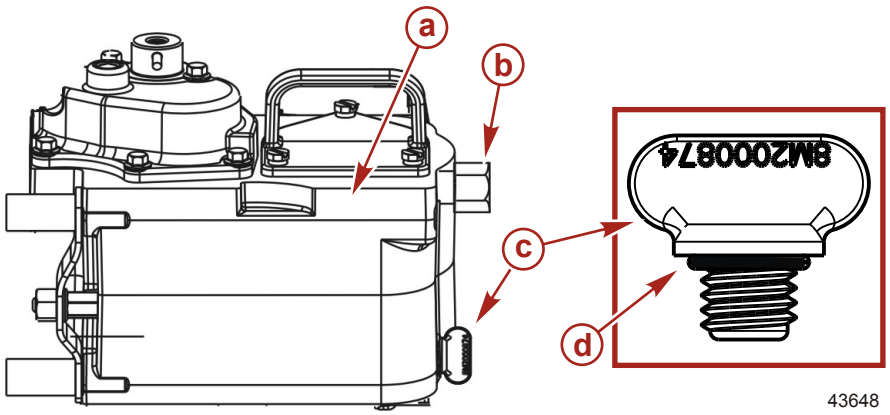
a - Starboard side blue drain plugs
b - Port side blue drain plug

3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five 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.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the two blue drain plugs.

Draining Water From the Gen III Cool Fuel Module

Mercury MerCruiser recommends draining the Gen III Cool Fuel module if it is equipped with a drain plug.

1. Remove the drain plug from the Gen III Cool Fuel module and allow the water to completely drain from the module.
2. Inspect the drain plug and the O-ring for damage. Replace if needed.
3. Place the O-ring on the drain plug and install the drain plug in the module drain hole. Tighten the drain plug to finger tight.



a - Gen III Cool Fuel module
b - Fuel inline fitting
c - Drain plug
d - O-ring

Battery Storage

Whenever the battery will be stored for an extended period of time, be sure the cells are full of water and the battery is fully charged and in good operating condition. It should be clean and free of leaks. Follow the battery manufacturer's instructions for storage.

Recommissioning the Power Package

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

⚠ CAUTION

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

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect cables. 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 **Operation Chart**.

NOTICE

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

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

Notes:

Important Information

Section 1D - Troubleshooting

1 D

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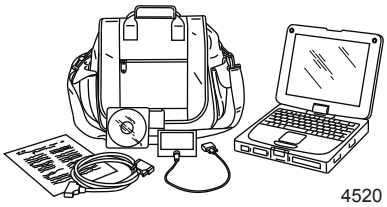
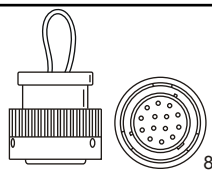
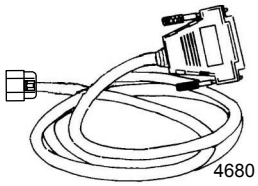
Special Tools

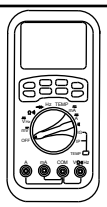
Computer Diagnostic System (CDS)	Order through SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA -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

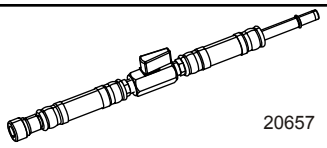
CDS G3 Diagnostic Interface Tool With Harness	8M0046124
41993	Provides diagnostic support for the Computer Diagnostic System.

Terminal Test Probe Kit	SPX P/N MM-46523
7915	Test probes adapt test meter leads to harness connections without damaging harness terminals. May be used with Computer Diagnostic System (CDS).

12 Volt Shunt Connector	889675A01
 8036	Connects to data harness allowing operation of the DTS system with the Digital Diagnostic Terminal.

Can 1 Diagnostic Cable	84-892663
 4680	Connects into a junction box or male to male adapter cable for Command Module configuration. Not for use with DDT.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Fuel Shut Off Tool	91-805918A 1
 20657	Used to perform fuel system pressure tests.

Finding Other Diagrams

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

Audio and Visual Warning System

Warning Horn

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem. Refer to **Section 4D: Audio and Visual Warning System**.

There are three warning horn states:

- Caution
- Severe
- Onboard Diagnostic Marine (OBDM) fault (not available for non-emissions controlled engines)

Visual Warning

An emissions controlled Mercury MerCruiser power package is required to have a visual warning system installed to be compliant with the EPA and CARB regulations. This Onboard Diagnostic Marine (OBDM) visual warning activates for faults related to emissions or fuel systems. Refer to **Section 4D: Audio and Visual Warning System**.

DTS Diagnostics

DTS Statement

Refer to the **Mercury MerCruiser PCM 09 Diagnostic Service Manual** for troubleshooting DTS engines.

General Information

NOTE: *All of the following are determined by the calibration of the PCM. Upgrading the calibration can result in changes to these settings.*

Default Sensor Values

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

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

Most pressure sensors default to a preprogrammed number also. MAP sensors usually default to 100 kPa (29.5 in. Hg). This can be verified by unplugging the sensor in question and watching the data stream value. Other pressure sensors will have their own default values which may be determined as described previously.

Fault Conditions

Most faults can be detected with the engine running, or key-on, engine off. However, some faults require the presence of engine RPM, and cannot be detected key-on, engine off. Examples of this type of fault are EST (cylinders 1 through 8) shorted circuit and all injector faults (fuel and direct).

Some faults are only detected in the key-on, engine off mode. Examples of the type of fault would be EST (cylinders 1 through 8) open circuit.

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

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

Sticky/Non-Sticky Faults

All faults are classified as either sticky or non-sticky.

Sticky means that the fault, once set, will continue to show up as active, even if the circuit or problem has corrected itself. A key switch cycle is required to reset a sticky fault. The CDS G3 will continue to display a sticky fault as active, even though the cause of the fault has been corrected. Cycle the key to reset all faults if there is difficulty correcting a fault. Some faults may require up to 3 running (90 seconds minimum) cycles of key on then key off, waiting 60 seconds between key cycles.

A non-sticky fault is a fault that will change it's status from active to inactive without requiring a key switch cycle.

Engine Guardian

Engine Guardian reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Below are some examples of what Engine Guardian monitors:

- Oil pressure
- Engine overspeed
- Exhaust manifold temperature
- Seawater pressure
- Coolant temperature
- Transmission pressure

IMPORTANT: Guardian can reduce power anywhere from 100% to idle, depending on the severity of the problem. If forced to idle, boat speed might not respond to throttle operation.

Computer Diagnostic System (CDS) G3

Models Covered	Serial Number Range
Models with Emissions Control	All

Mercury Marine is pleased to announce that it has developed a PC-based diagnostic tool kit to enhance and supplement the Mercury Computer Diagnostic System (CDS). The new program, CDS G3, runs efficiently on any of the CDS computers sold through SPX. CDS G3 and the current version of CDS are compatible with one another and can be installed on the same computer.

CDS G3 will complement the current version of CDS by providing diagnostic support for engines and Joystick Boat Control systems not covered by CDS. In its first release, CDS G3 will provide limited diagnostic coverage for the MerCruiser engines with Emissions Control (EC). Internet updates are planned to complete the diagnostic functionality for the EC product. Future updates on the Internet will provide support for additional engines and control systems.

CDS G3 presents an easy-to-use graphical interface with a fresh new design and appearance. The first release will provide the following electronic data:

- **Configuration:** Provides a means for configuration of the Axius electronic steering system, Axius and standard DTS helm stations, Axius electronic compasses and all CAN-based (controller-area network) TrackPads.
- **Module Data:** Provides detailed information on each module on the SmartCraft CAN-bus. Data will include, but is not limited to: software and calibration IDs, city IDs (electronic addresses), module status and module quantity.
  - **Fault Status:** Displays the active and historic faults (trouble codes) available from each module, as well as freeze frame buffers where applicable.
  - **Data Stream:** Displays sensor values, ECU (engine control unit) calculations, actuator information and other important information.
- **Active Tests:** Allows the technician to set and adjust ECU parameters and control ECU outputs. These types of functions help the technician to quickly configure product for delivery, as well as providing powerful functions that will enhance the diagnostic experience.

The current version of CDS continues to be offered through SPX in several configurations: software-only, on a Dell laptop, or on a Panasonic ToughBook. Basic and deluxe versions of the kits are available for both laptop brands. Electronic service manuals will continue to be hosted by the current version of CDS. For more information, visit http://mercurymarinecds.spx.com/ (Europe: http://www.spxeurope.com/index.php?id=260).

At this time, English is the only language available for the CDS G3 program. Additional languages are planned for future updates. CDS G3 will require a new interface cable, which will be available for purchase from Mercury Marine Parts and Accessories. The CDS G3 program is included with the cable. The interface cable will provide communication with two separate SmartCraft CAN-bus networks and connects to a standard SmartCraft 10-pin junction box-style connector.

Connection points are made at the engine or the helm. Regardless of connection point, proper CAN bus termination must be maintained. When removing a termination resistor to allow connection of the interface cable, use adapter harness part number 8M0045065, which is provided in the kit and has a termination resistor. This adapter harness must be used when connecting to the CAN P connection on the engine wire harness where the termination resistor has been removed.

The interface cable may be extended by using a suitable yellow 10-pin SmartCraft data cable. On EC product only, you may use either yellow or blue 10-pin SmartCraft data cables. Proper termination must be maintained when using any extension.

Minimum Computer Specifications for CDS and CDS G3

Requirement	Note
1.2 GHz Pentium processor	Or equivalent
2 GB RAM	4 GB or higher recommended
120 GB hard drive	A 40 GB minimum hard drive is recommended if installing all of the electronic service manuals and the Electronic Parts Catalog.
Integrated 9-pin RS-232 serial port	
Graphics 1024 × 768 display	The graphics resolution requirement for the current version of CDS was originally 800 × 600. The specification for CDS G3 (and recommended for current CDS) is 1024 × 768.
USB 2.0 port	
DVD-ROM optical drive	
PCMCIA card slot	
Windows XP Professional, Service Pack 3 (Recommended OS is Windows 7 Professional)	Earlier version of Windows XP can be upgraded through Windows or Microsoft Update.

Operating System Requirements

The CDS G3 program will work on all CDS computer systems sold through SPX Corporation. If you purchased a CDS kit with a Dell or Panasonic computer before September 2004, your computer was shipped with the Windows 2000 operating system. Because G3 requires Windows XP, Service Pack 3, it is necessary to update the operating system on these computers. As originally planned, computers purchased with CDS kits from SPX are licensed for Windows 2000 and Windows XP. Through an agreement with Dell, Panasonic, and Microsoft, these computers have a Windows XP certificate of authority and were "downgraded" from Windows XP to Windows 2000 at SPX. SPX shipped these early Dell and Panasonic computers with special Windows 2000 recovery CDs that would return the computer to its original setup (as it left SPX). SPX also included the Windows XP recovery discs that were supplied by Dell or Panasonic. These discs will return the computer to its original Dell or Panasonic factory setup with Windows XP. These discs will be needed to upgrade the operating system to Windows XP.

NOTE: *The Windows 2000 downgrade process remained in effect from the original release of CDS through CDS Version 3.23. Starting with CDS Version 4.18, CDS became compatible with Windows XP. At that time (September of 2004), SPX stopped the downgrade process and began shipping computers (Dell, HP, or Panasonic) with their original Windows XP operating system intact. If you are currently using an SPX computer with the Windows 2000 operating system, watch for future communications detailing the Windows XP upgrade process. Now is a good time to locate the Windows XP recovery CDs that were shipped with your CDS kit.*

IMPORTANT: Restoring the computer to the original factory setup will result in the loss of all data and programs stored on the hard drive. Before restoring the computer to its original factory setup, follow the kit instructions concerning backup of all data and having program discs available.

Special Tools - DTS Troubleshooting

NOTE: *The CDS G3 service tool is software that is designed for use on products using PCM-09 and above, and all engines equipped with emissions control. G3 is also required for Axius. All communications to the computer are through a smartcomms cable. You must install special CDS G3 software to the CDS laptop and have access to the internet to use G3 software. Contact your Product Integration Engineer (PIE) or Technical Account Manager (TAM) for assistance.*

Computer Diagnostic System (CDS)	Order through SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124
Terminal Test Probe Kit	SPX P/N MM-46523
12 Volt Shunt Connector	889675A01
Can 1 Diagnostic Cable	84-892663

DMT 2004 Digital Multimeter	91-892647A01
CAN P Diagnostic Cable	84-892663
Fuel Shut Off Tool	91-805918A 1

Precautions

⚠ WARNING

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

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

NOTICE

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

⚠ WARNING

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

NOTICE

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

NOTICE

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

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

⚠ WARNING

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

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 G3 (Computer Diagnostic System), or a diagnostic tool. If faults are present, correct the fault before proceeding.

   NOTE: *The tool Computer Diagnostic System (CDS G3) procedural information is available in the* ***Mercury MerCruiser PCM 09 Diagnostic Service Manual****.*

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
Computer Diagnostic System (CDS)	Order through SPX

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. Disable the ignition system to prevent ignition of gasoline vapors.
6. 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 Clean power harness not connected.	**1.3** Connect the clean power harness.
	1.4 Water in the fuel.	**1.4** 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.
	1.5 Low grade or stale fuel.	**1.5** Drain the fuel tank and refill with fuel that is known to be fresh.
	1.6 Faulty fuel pump relay.	**1.6** Check the fuel pump relay.
	1.7 Slow cranking battery.	**1.7** Check the battery and battery connections.
	1.8 Vapor lock.	**1.8** 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

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

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 ETC.
	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.

Symptom	Cause	Action
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 G3) 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
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 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

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.
	2.6 Worn cylinder.	**2.6** Inspect the cylinder. Bore as necessary. Replace the cylinders if necessary.
3. Engine noise in camshaft area, front of the engine, timed to 1/2 engine speed.	**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.

Symptom	Action	Cause
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.

Symptom	Action	Cause
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

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 **Section 3 - On the Water**, in the **Operation Maintenance and Warranty Manual**.
	1.1 Water ingestion through the exhaust system.	**1.1** Verify the exhaust elbow height. Repair the exhaust system.
	1.2 Improper engine or exhaust hose installation.	**1.2** Check the engine installation specifications.
	1.3 Cracked exhaust manifold.	**1.3** Replace the exhaust manifold.
	1.4 Corroded exhaust elbow.	**1.4** Replace the exhaust elbow.
	1.5 Loose cylinder head bolts.	**1.5** Tighten the cylinder head bolts.
	1.6 Blown cylinder head gasket.	**1.6** Determine the cause of blown gasket and replace the gasket.
	1.7 Cracked valve seat.	**1.7** 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

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—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 shrader 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	91-805918A 1

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.

Removal and Installation

Section 2A - Sterndrive Models

2
A

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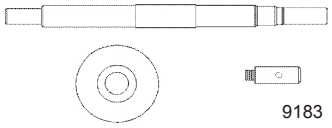
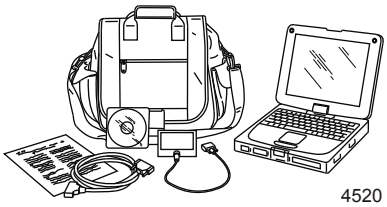
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02
25	Liquid Neoprene	All electrical connections	92- 25711 3
34	Special Lubricant 101	Rear engine mounting bolts	92-802865Q02
		Shift cable stud	
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally
91	Engine Coupler Spline Grease	Coupler splines	92-802869A 1

Special Tools

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

Computer Diagnostic System (CDS G3)	Order from SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System G3 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

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
41993	Provides diagnostic support for the Computer Diagnostic System.

CDS G3 Termination Harness	84-8M0045065
43351	Contains termination resistors to allow communication when G3 is connected to the engine's diagnostic connector.

Engine Removal

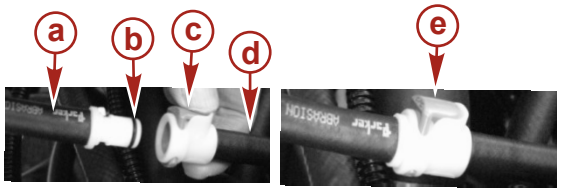
Removal

⚠ WARNING

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

IMPORTANT: The propellers and sterndrive must be removed prior to engine removal. Refer to the Mercury MerCruiser Bravo Sterndrive Service Manual.

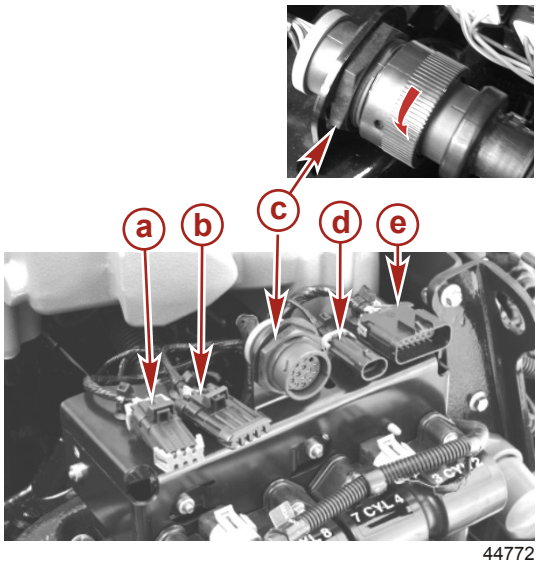
1. Remove the boat from the water.
2. Disconnect the negative (–) battery cable from the battery.
3. Disconnect the positive (+) battery cable and MerCathode controller positive wire from the battery.
4. Disconnect the battery isolator wires, if equipped.
5. Disconnect the gear lube monitor hose.



43559

a - Gear lube monitor hose assembly from transom
b - O-ring
c - Quick connect release
d - Gear lube monitor hose assembly from gear lube monitor
e - Connection secured

6. Remove the sterndrive. Refer to the **Mercury MerCruiser Bravo Sterndrive Service Manual**.
7. Disconnect the exhaust system hoses.
8. Disconnect the seawater inlet hose.
9. Disconnect the water heater lines, if equipped.
10. Disconnect the trim sender wire connections from the engine harness.
11. Disconnect the following connectors if applicable.
    a. Disconnect the boat harness from the engine harness. Turn the locking ring counterclockwise to release the thread engagement then pull the connection straight out.
    b. Disconnect the paddle wheel and tank level connector.
    c. Disconnect the power harness connector.
    d. Disconnect the transom harness connector.



44772

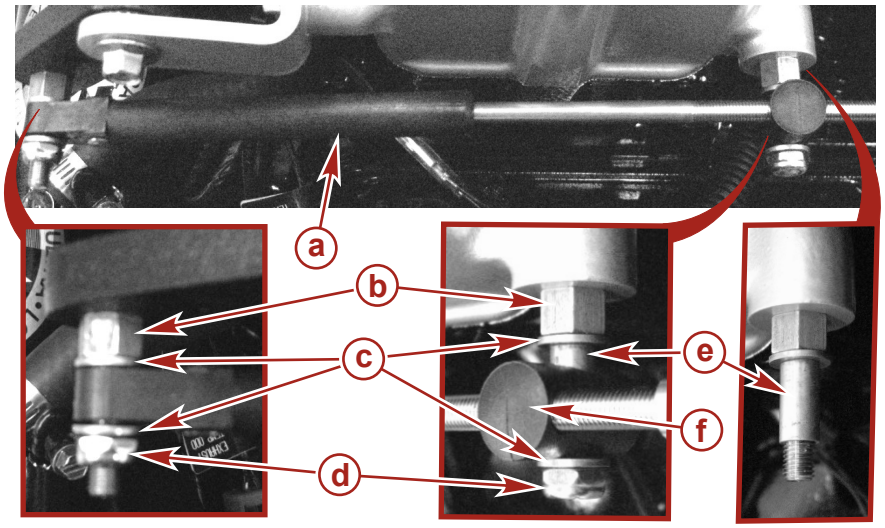
a - Paddle wheel and tank level connector
b - Diagnostic connector
c - Engine harness connector
d - Power harness connector
e - Transom harness connector

12. Close the fuel shut-off valve, if equipped.

⚠ WARNING

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

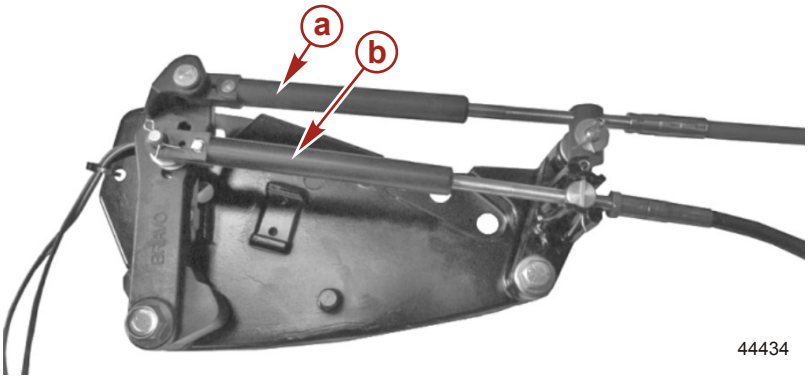
13. Disconnect and plug the fuel lines to prevent fuel from leaking into the bilge.
14. On non-DTS models, disconnect the throttle cable from the throttle body and retain the fasteners.



43159

a - Cable end guide
b - Hex spacer
c - Flat washer
d - Locknut
e - Sleeve
f - Barrel

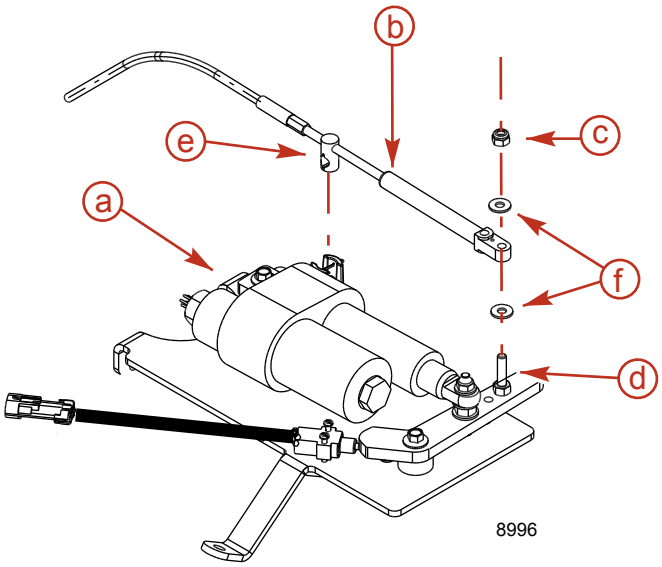
15. On non-DTS models, remove both of the shift cables from the shift plate. Retain the locknuts and hardware.



44434

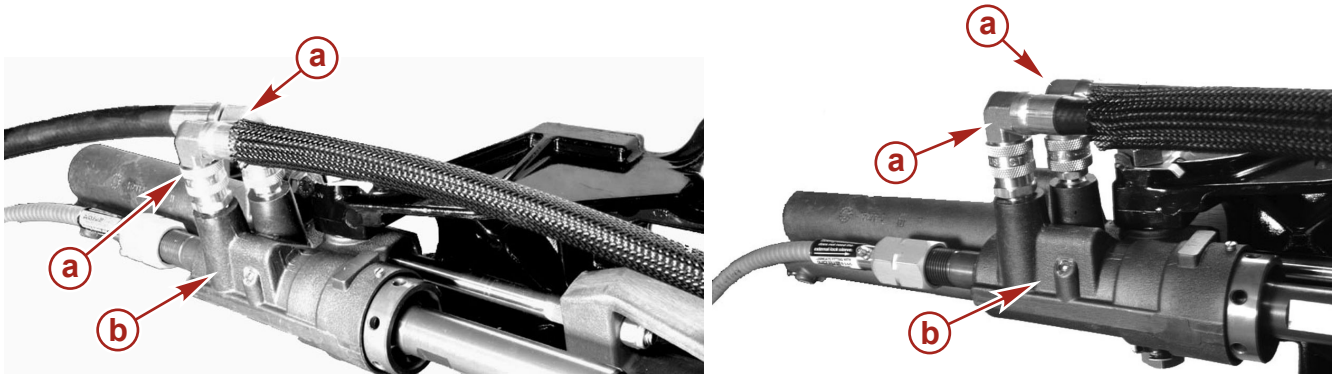
a - Remote control shift cable
b - Sterndrive intermediate shift cable

16. On DTS models, remove the sterndrive intermediate shift cable from the shift actuator on the engine. Retain the locknuts and hardware.



a - Shift actuator
b - Shift cable
c - Locknut
d - Shift cable stud
e - Shift cable barrel
f - Washers

17. Disconnect the power-assisted steering hydraulic hoses from the steering control valve and connect the hoses together to prevent leaking.



a - Hydraulic lines
b - Power-assisted steering control valve

18. If applicable, disconnect continuity wires and accessories that are connected to the engine.

⚠ CAUTION

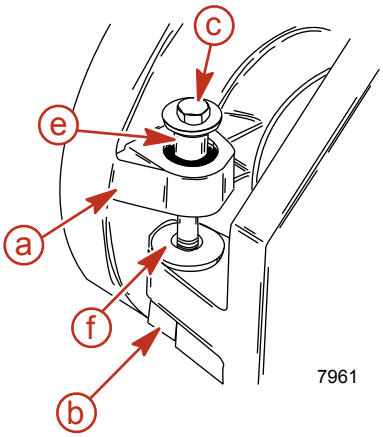
Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

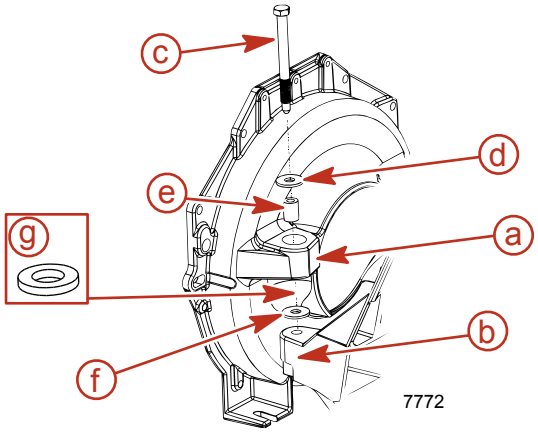
IMPORTANT: Do not allow the engine to rest on the oil pan.

19. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

a - Rear lifting eye
b - Front lifting eye

20. Remove and retain the rear engine mounting fasteners.

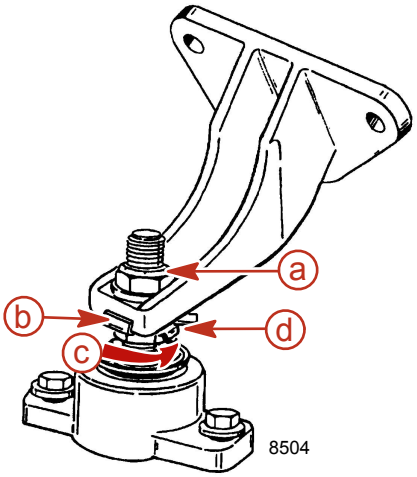




a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer
g - Stainless steel washer (optional spacer kit)

21. Remove and retain the starboard and port front engine mounting fasteners.

NOTE: *If the engine will be reinstalled you may want to leave the base on the stringer and only remove the top nut and locking washer.*



a - Nut and lockwasher
b - Tab washer
c - Direction (counterclockwise) to raise front of engine
d - Adjustment nut

22. Using an overhead hoist, carefully remove the engine. Do not damage the power-assisted steering control valve.

Emission-Related Instructions

Important Information

NOTICE
Failure to follow these instructions when installing a certified engine in a vessel violates U.S. federal law (40 CFR 1068.105[b]) and may result in fines or other penalties as described in the U.S. Clean Air Act.

Controlling Evaporative Emissions

Specific installation steps are required to control evaporative emissions. The installer and/or the vessel manufacturer must meet the requirements of EPA regulation 1045.112 and federal regulation 40 CFR part 1060.

Meeting Design Specifications

Other instructions to ensure that the engine will operate according to the manufacturer's design specifications are referenced in the Mercury MerCruiser installation manual provided with the product. Refer to:

1. **Section 3—Exhaust System.**
   - Important Information
   - Exhaust Recommendation
   - Exhaust Emissions
   - Measuring Exhaust Elbow Height
2. **Section 6—Drive System and Engine Mounting.**
   - Exhaust System Hose and Tube Connection

Emission Control Information Label

If you install the engine in a way that makes the engine's emission control information label difficult to read during normal engine maintenance, you must place a duplicate label on the vessel, as described in 40 CFR 1068.105.

Refer to **Section 1—Emission Control Information Label**.

Engine Installation

DTS System Installation Requirement

Due to updates on software and diagnostic tools we are not including this information in the service manual.

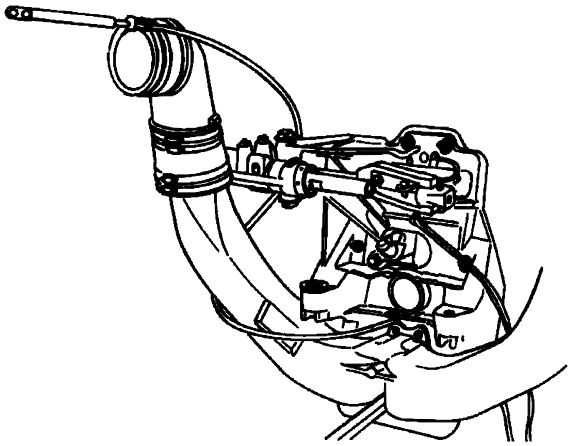
Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Shift Cable Routing

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.*

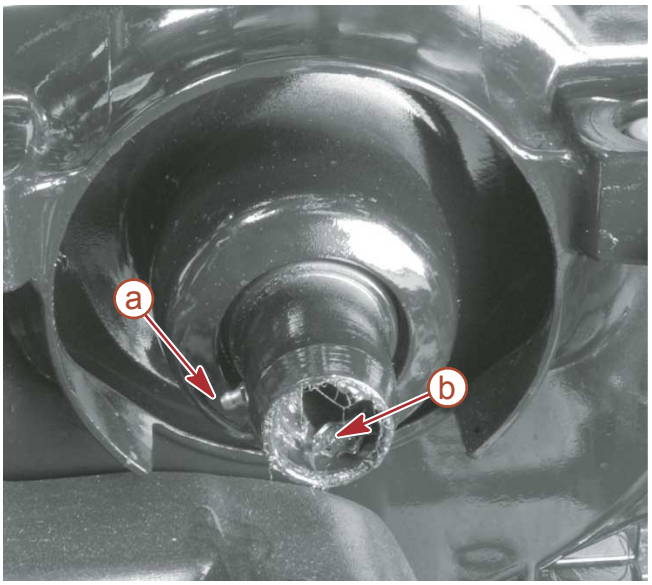


8995

Refer to **Section 8 - Remote Control**.

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.



12163

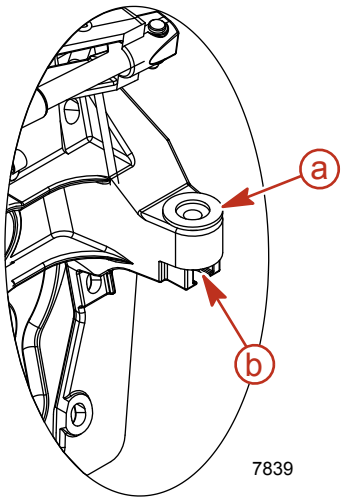
a - Grease fitting
b - Coupler splines

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Coupler splines	92-802869A 1

NOTICE

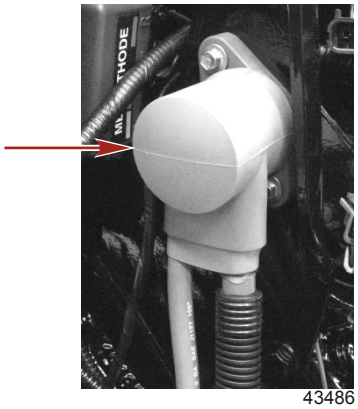
Mismatched flywheel housing mounts and inner transom plate mounting hardware will result in improper engine alignment and possible engine damage. Ensure that the flywheel housing mounts and the inner transom plate mounting hardware, port and starboard, are the correct parts and match before installing the engine.

3. Position rear engine mount attaching hardware on the inner transom plate mounts as shown.



a - Fiber washer (2)
b - Locknut (2)

4. Lay the battery cable over the top of the engine to prevent interference during installation.



IMPORTANT: Do not allow the engine to rest on the oil pan.

5. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

a - Rear lifting eye
b - Front lifting eye

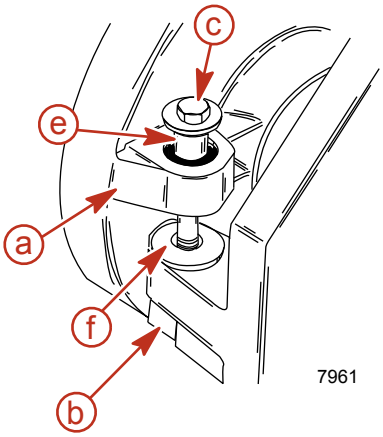
6. Lift the engine into position in the boat using an overhead hoist.
IMPORTANT: When lowering the engine into position. do not set the engine on the shift cable.
7. Ensure that the fiber washers and locknuts are on the inner transom plate mounts.
8. Align the rear engine mounts with the inner transom plate mounts, while simultaneously aligning the exhaust tube with the exhaust pipe bellows.
NOTE: *Do not use silicone on the exhaust tubes.*
9. To help with installation, apply lubricant into the exhaust tubes.

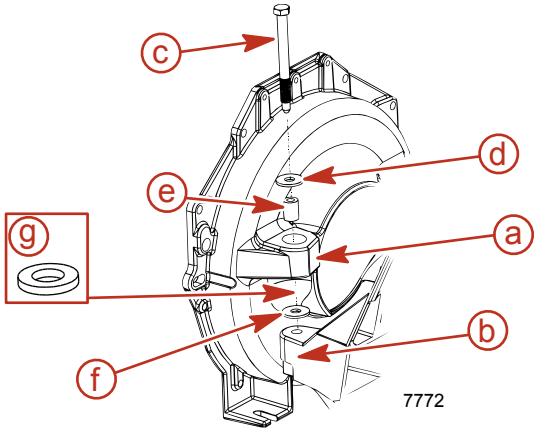
To help with installation, apply lubricant into the exhaust tubes.	Exhaust tubes	Part Number
Liquid Soap	Exhaust tubes	Obtain locally

10. Apply lubricant to the first 8 mm (1/4 in.) of the threads of the rear engine mounting bolts.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Rear engine mounting bolts	92-802865Q02

11. Install both rear engine mounting bolts and hardware. Relieve the hoist tension from the engine lifting eyes. Tighten the mounting bolts to specification.





a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer
g - Stainless steel washer (optional spacer kit)

Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	47	–	35

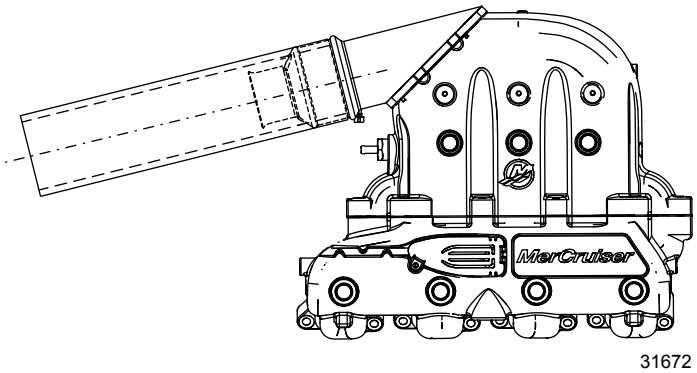
12. Set the engine on the front engine mounts and boat stringers.
13. Relieve the hoist tension.
14. Fasten both engine mounts to the boat stringers using the appropriate hardware.

NOTICE

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

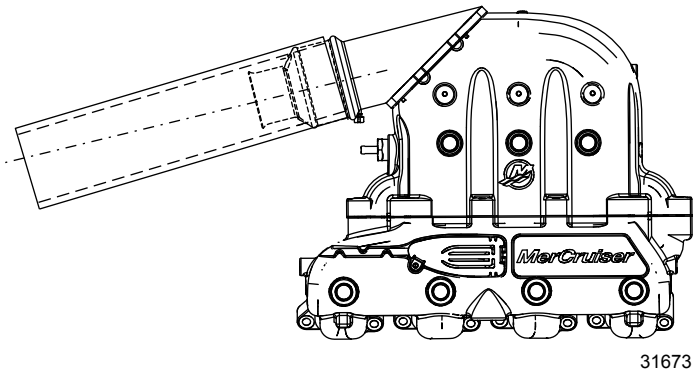
IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

15. Install the hoses on exhaust elbow outlets so the discharge water from the exhaust elbow flows around the entire inside diameter of the hose.



31672

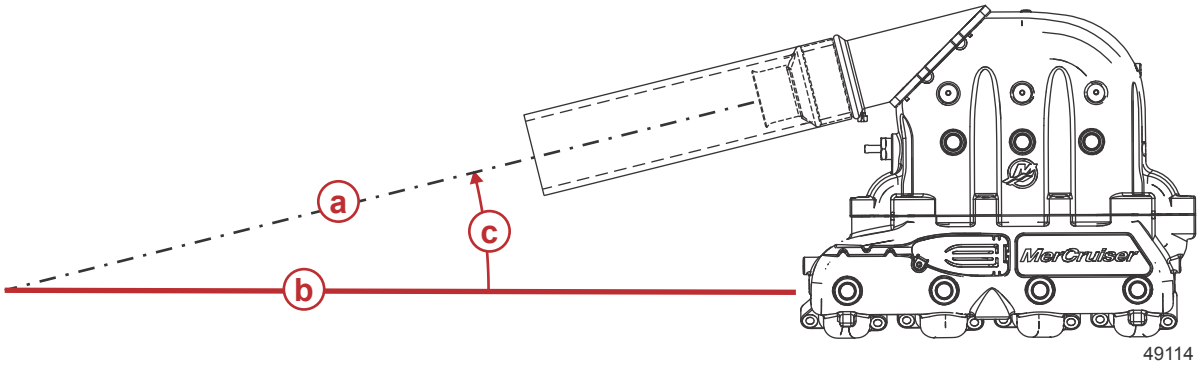
Correct alignment



31673

Incorrect connection

16. Install the exhaust hoses at the angle shown below. Doing so will avoid hot spots that can burn exhaust hoses.

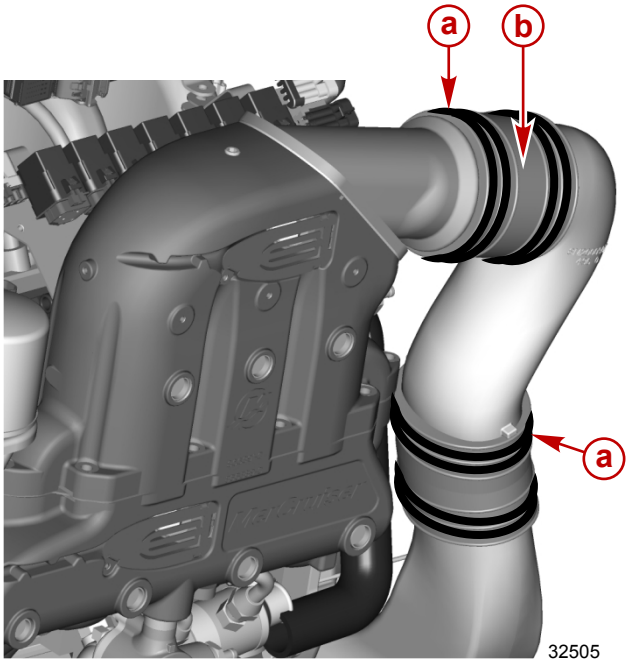


49114

a - Exhaust outlet centerline
b - Parallel with crankshaft centerline
c - Exhaust angle 14° ± 5°

17. Secure all exhaust hoses or tubes with at least two hose clamps. Tighten to specification.

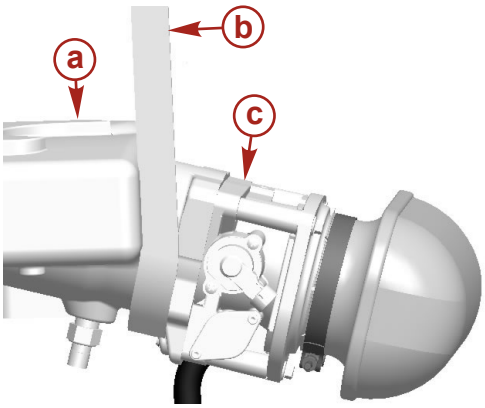
NOTE: The following example may not depict your model or installation.



a - Clamps
b - Exhaust tubes

Description	Nm	lb-in.	lb-ft
Exhaust hose clamps	3	28	–

18. Place a suitable polymer strap under the plenum behind the throttle body for assistance during engine alignment.



a - Plenum
b - Suitable polymer strap
c - Throttle body

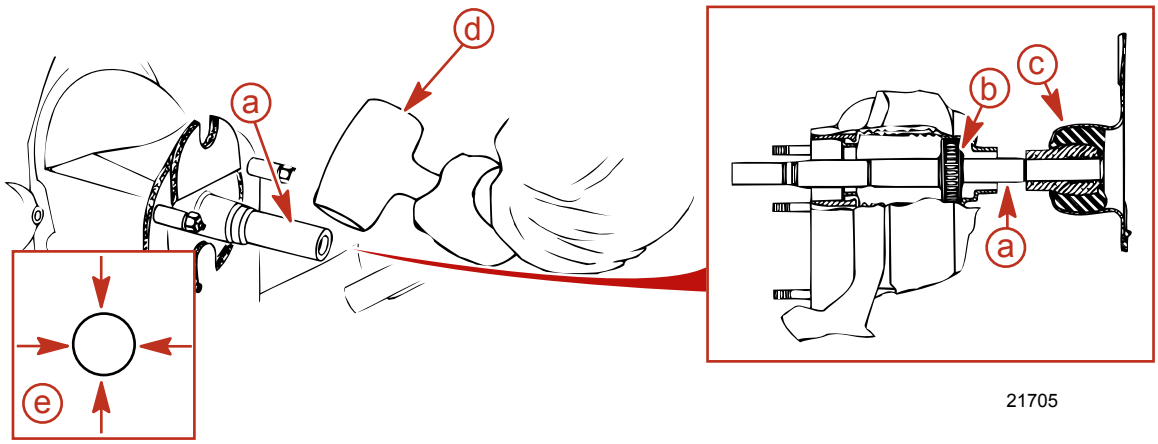
IMPORTANT: Alignment tools from other manufacturers may cause improper alignment and damage to the gimbal bearing or engine coupler. Use only the Quicksilver Alignment Tool.

NOTICE

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

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

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

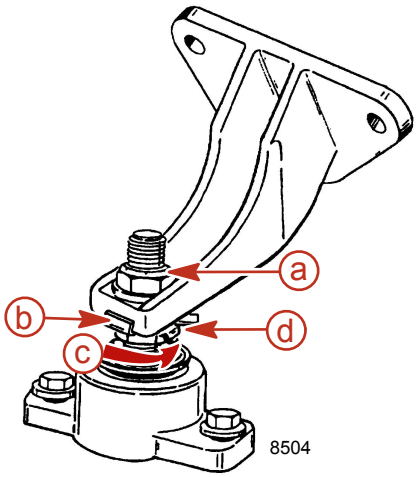


21705

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

Alignment Tool Assembly	91-805475A 1

21. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
22. 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.

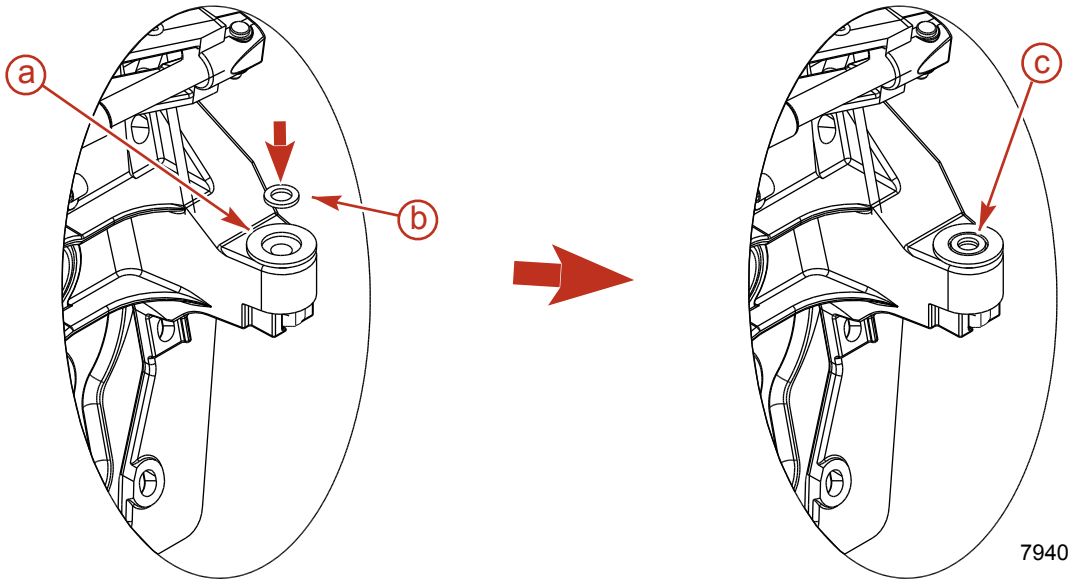


8504

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

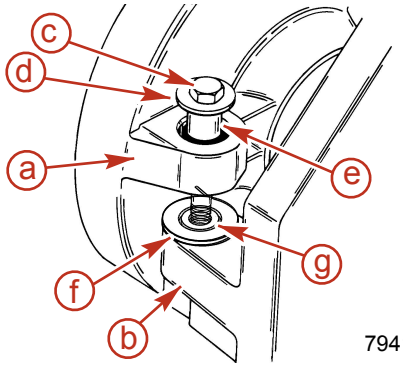
23. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
NOTE: *Spacer Kit (12-892619A01) is available to raise the rear of the engine. The kit is required only if alignment cannot be obtained with the normal adjustment. If the front or 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.*
24. On models where the front engine mounts cannot be lowered enough to allow for proper engine alignment:
    a. Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that the engine is level when suspended.
    b. Remove the rear engine mounting bolts and hardware.
    c. Using an overhead hoist, lift the engine enough to install a stainless steel washer inside the inner diameter of both fiber washers.

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



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

d. Install both rear engine mounting bolts with appropriate hardware as shown and tighten to specification.



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

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

e. Set the engine on the boat stringers.
f. Relieve the hoist tension.
g. Disconnect the sling from the engine lifting eyes.

25. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
26. 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.
27. Fasten the front mount assemblies to the boat stringers using the appropriate hardware (lag bolts or thru-bolts, and so on).
28. Tighten both front mount locking (jam) nuts to specifications.

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

29. 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.
30. Remove the alignment tool.
31. 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	92-34227Q02

Electrical Connections

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

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

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

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

Boat Harness and Instrumentation Connections

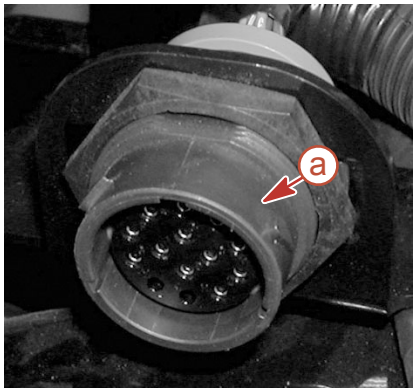
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses.

The four basic gauges that must be used with the engine are:

- Tachometer
- Oil pressure
- Water temperature
- Voltmeter

IMPORTANT: Maximum accessory load on the engine harness is 15 amps. If additional accessory load is needed, an accessory kit is available.

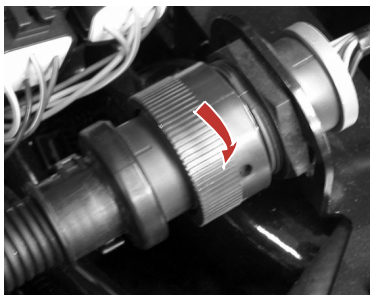
1. If an extension harness is required, connect the boat harness to the extension harness and connect the extension harness to the engine harness. Ensure that the harness does not rub or get pinched.
2. Fasten harnesses to boat at least every 46 cm (18 in.) using appropriate fasteners.



23135

Typical
a - Engine harness plug

3. Connect 14-pin harness to engine. Turn locking ring until firm snap is felt.



23136

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are engine rpm, coolant temperature, water pressure, battery voltage, fuel consumption, and engine operating hours. The Smartcraft instrument package will also aid in engine diagnostics.

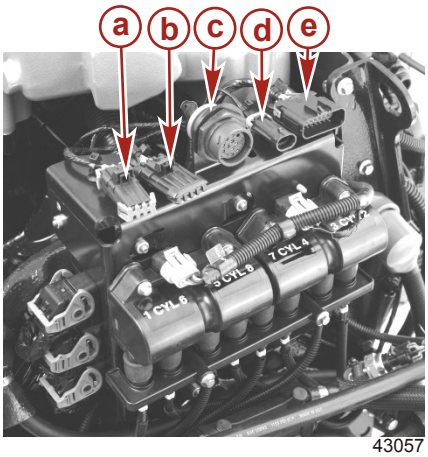
The SmartCraft instrument package will display critical engine alarm data and potential problems.

Refer to the Mercury SmartCraft Operator's Supplement (90-10229023) for the warning functions monitored and basic operation of the SmartCraft Instrument package. Refer to the instructions included with the instruments for installation instructions.

Engine Harness Connections

IMPORTANT: The 14 pin wiring harness can supply a maximum 15 amps of accessory power. An accessory relay and harness kit is available for higher accessory needs.

1. Route the instrumentation harness to engine. Do not allow the harness to rub or get pinched. If an extension harness is required, secure the connection properly.
2. Fasten the harnesses to the boat at least every 45.7cm (18 in.), using appropriate fasteners.
3. Connect the following:



43057

a - Paddle wheel and tank level connector
b - Diagnostic connector
c - 14-pin harness connector
d - Power harness connector
e - Transom harness connector

Continuity Wire Connection

IMPORTANT: Models equipped with 14-pin engine harness have the transom continuity circut incorporated into the transom harness.

Audio Warning System Connections

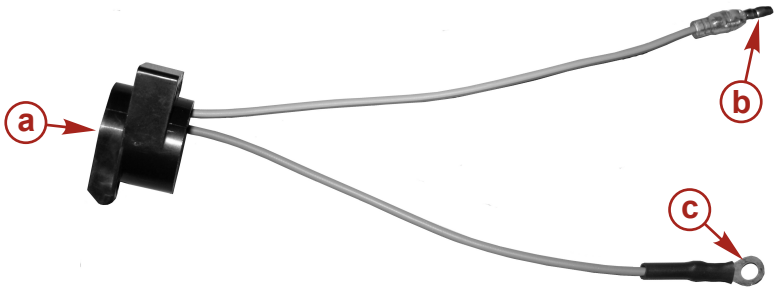
⚠ WARNING

Installing non-potted electrical components in explosive environments can result in serious injury or death from fire or explosion. Install all non-potted electrical components such as warning alarms away from environments where fuel or fuel vapor is present such as engine or fuel tank compartments.

1. Select a location for the audio warning alarm that meets all of the following:
   - Alarm can be easily heard, yet is out of sight
   - Alarm can be easily accessed for installation and maintenance
   - Alarm will remain dry
   - Alarm is within length limits of the 46 cm (18 in.) purple alarm wire that connects to the "I" terminal or 12 volt source on switched side of ignition switch.

   NOTE: *The terminal to which wire is attached must have no voltage when ignition switch is in the OFF position.*
2. Place the alarm in desired location and secure it to wire bundle with the tie strap provided.
3. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.

4. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or ignition switch. Tighten the connection securely.



45019

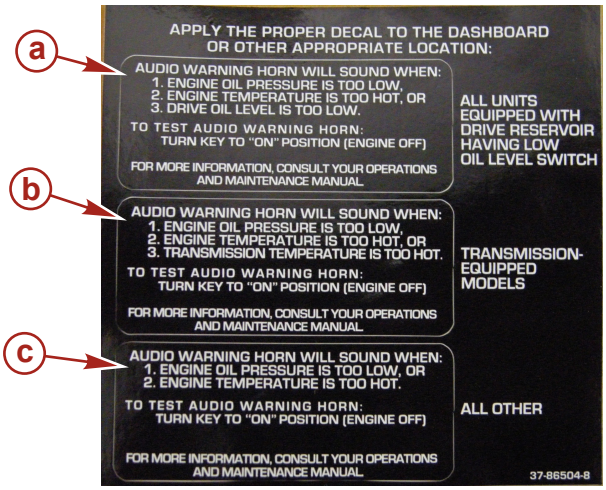
a - Alarm
b - TAN/ BLUE wire
c - PURPLE wire

5. Place the small transparent alarm decals on the bottom of the water temperature and the oil pressure gauges.

45021

Small transparent alarm decals

6. Choose the proper large decal for the engine package installed and place it on the instrument panel or other appropriate location easily viewed by the operator.



45020

a - Models equipped with a drive reservoir having low oil level switch
b - Models equipped with a transmission
c - All other models

7. Test the audio warning system as detailed.
   a. Turn the ignition switch to the "ON" position without cranking the engine.
   b. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

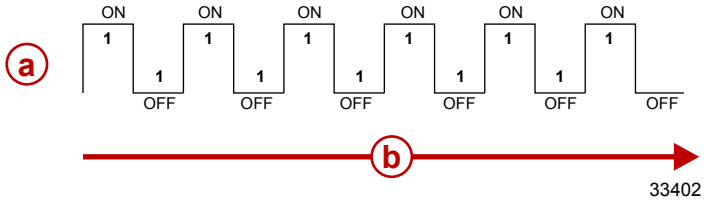
The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

There are two warning horn states:

- Caution
- Severe

Caution

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

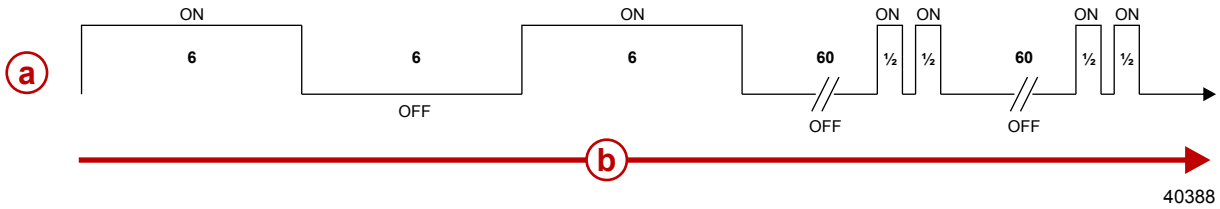
Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

Severe

IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Service Engine Light and OBD-M MIL Kit

Boats powered by Emissions Control Technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

47594

SC 1000 gauge and service engine light

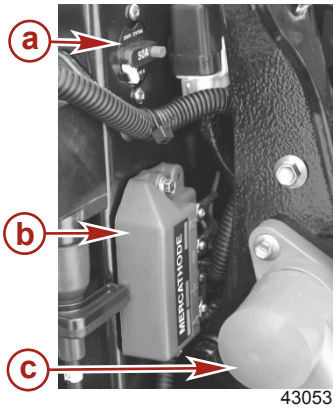
Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL light will remain illuminated for 4 seconds if the visual indication system is functioning correctly.

MerCathode Connections

The engine harness supports the MerCathode system. The engine harness has a MerCathode connector which connects to a MerCathode connector on the transom harness.

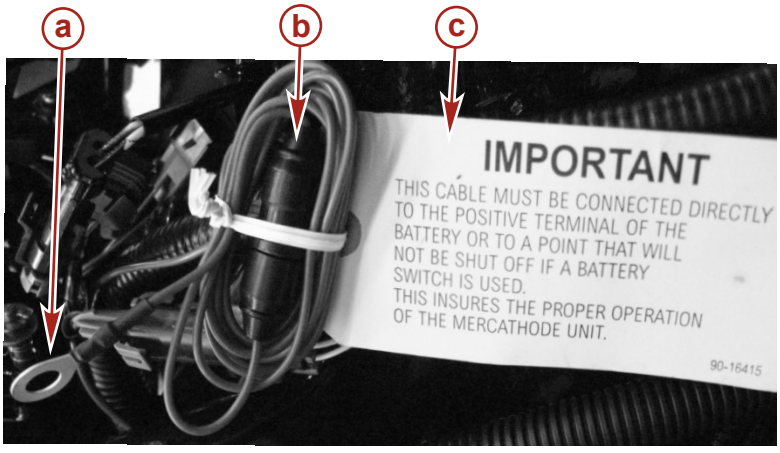
1. Locate the MerCathode controller assembly on the engine rear starboard.



43053

a - Circuit breaker
b - MerCathode controller
c - Remote battery connection

2. Connect the MerCathode positive (+) battery wire to the battery positive (+) terminal.

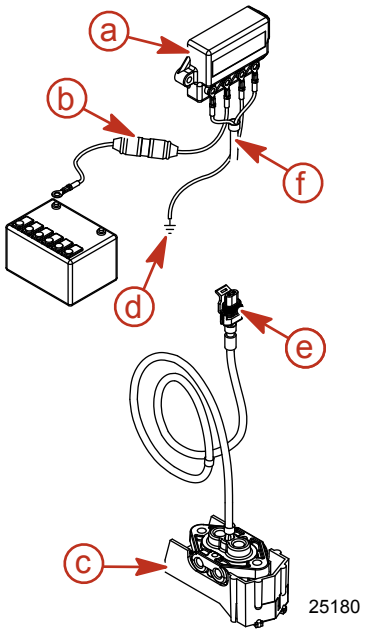


43556

MerCathode positive (+) battery wire

a - Connector
b - Fuse
c - Tag

IMPORTANT: Opposite end of RED/PURPLE wire must be connected directly to battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. MerCathode system must function continuously for proper corrosion protection.



- **a -** MerCathode controller
- **b -** RED/PURPLE wire - to positive (+) battery terminal
- **c -** Electrode on transom assembly
- **d -** Ground wire (in the engine harness, no hookup needed)
- **e -** Connector on the transom harness
- **f -** Engine harness to the MerCathode controller

Power Trim Electrical Connection

ABYC (American Boat and Yacht Council) installation recommends installing a battery switch in the positive conductor of any battery or battery bank with CCA rating greater than 800 amperes. (See ABYC for additional information)

ABYC further recommends, if a boat is equipped with a battery switch, the power trim pump may not be connected to the continuously energized circuit (battery). It must be connected to the switched side of the battery switch. Wire length requirements and location of circuit protection are also specified.

MerCruiser has developed three methods to facilitate compliance with ABYC recommendations. These come in the form of one standard production and two accessory kits.

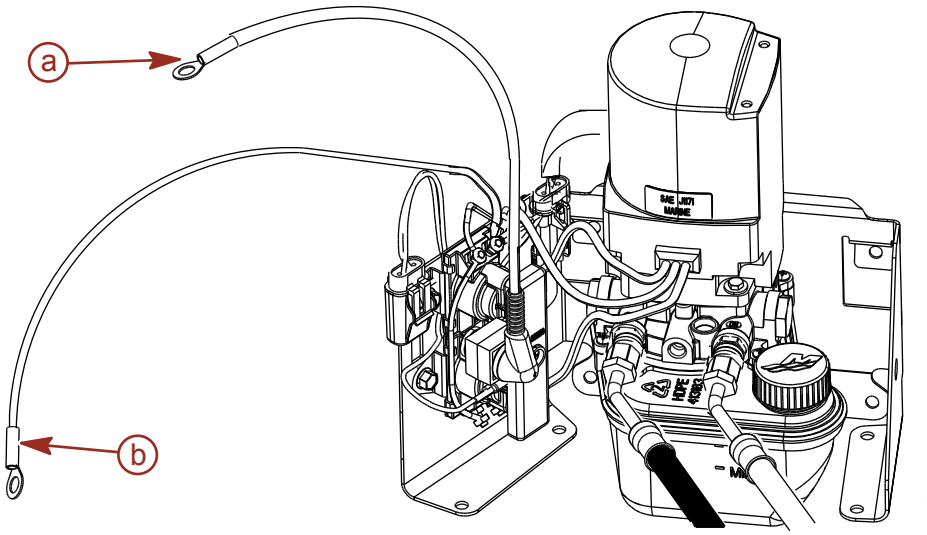
- Installations with the batteries (or battery banks) rated at less than or equal to 800 Cold Cranking Amps (CCA) and without battery switches: The trim pump may be installed using the wires supplied with the power trim pump and should be connected directly to the battery.
- Installations with batteries (or battery banks) rated at more than 800 CCAs (requiring a battery switch) or any boat with a battery switch:
  a. The red current conductor (for the trim pump) must be connected to the switched side of the battery switch and either:
     - provided with circuit protection within 7 inches of the power source or
     - Provided with circuit protection within 40 inches of the point of connection with the power source and sheathed the entire length of wire from the point of connection to the source and the circuit protection device. This will require the use of an Accessory cable kit.

Accessory Part Numbers

Part Number	Description	Color	Length	Type
8M2000587	Cable Assembly – Trim Pump	Red	72 inches	Fused
8M2000588	Cable Assembly – Trim Pump	Red	40 inches	Sheathed

Power Trim Pump Connections

1. Connect power trim pump BLACK (–) battery cable to negative (–) battery terminal and pump's RED (+) battery cable to positive (+) battery terminal or to the switched side of the battery switch.



a - Positive battery lead
b - Negative battery lead

Battery Cables Connection

IMPORTANT: Engine electrical system is negative (-) ground.

1. Connect engine positive (+) battery cable (usually RED) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually BLACK) to negative (–) battery terminal.
3. Install the power harness. Refer to **Section 7— Power Harness**.
4. Secure the battery cables and the power harness leads to the battery with hex nuts. Tighten the hex nuts to the specified torque.

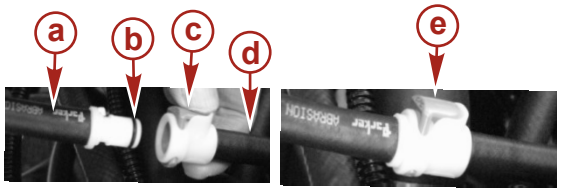
Description	Nm	lb-in.	lb-ft
Hex nut	13.5	120	–

5. Spray battery terminals with a battery connection sealant to help prevent corrosion.

Fluid Connections

Gear Lube Monitor Connection

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: Hose must not come in contact with steering system components, engine coupler, U-joint shaft, or drive shaft.
3. Fasten the quick connect.



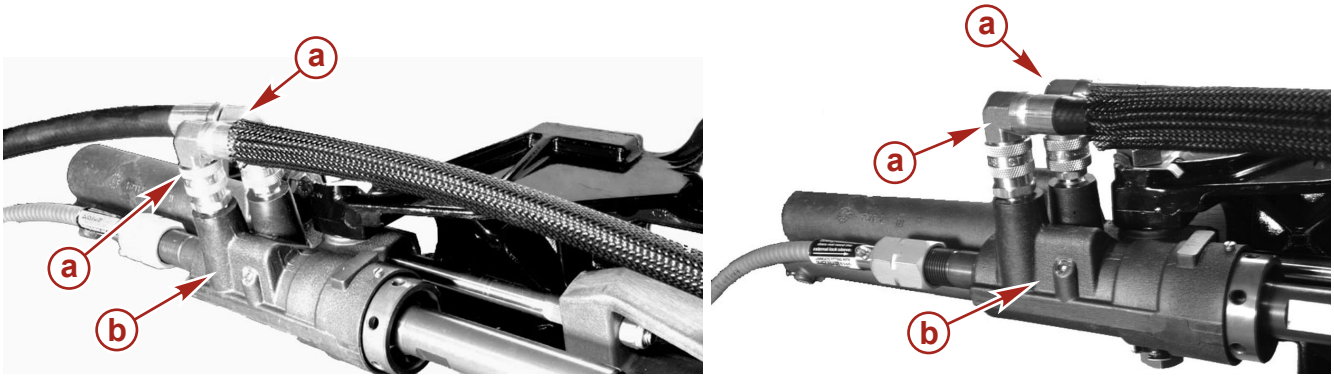
a - Gear lube monitor hose assembly from transom
b - O-ring
c - Quick connect release
d - Gear lube monitor hose assembly from gear lube monitor
e - Connection secured

Power-Assisted Steering Hoses

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

1. Disconnect the quick connect fittings on the power-assisted steering hoses.
2. Connect the power-assisted 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 hose to transom.



16225

a - Hydraulic lines
b - Power-assisted steering control valve

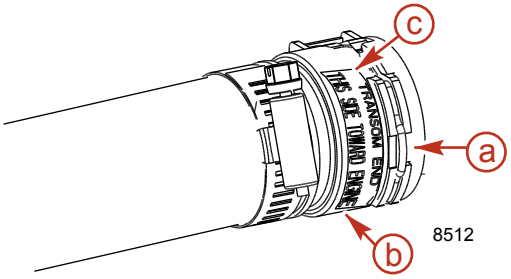
NOTE: *Steering Fluid can be added at this time if desired.*

Bravo Seawater Cooled Models Using Sterndrive Water Pickups

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

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

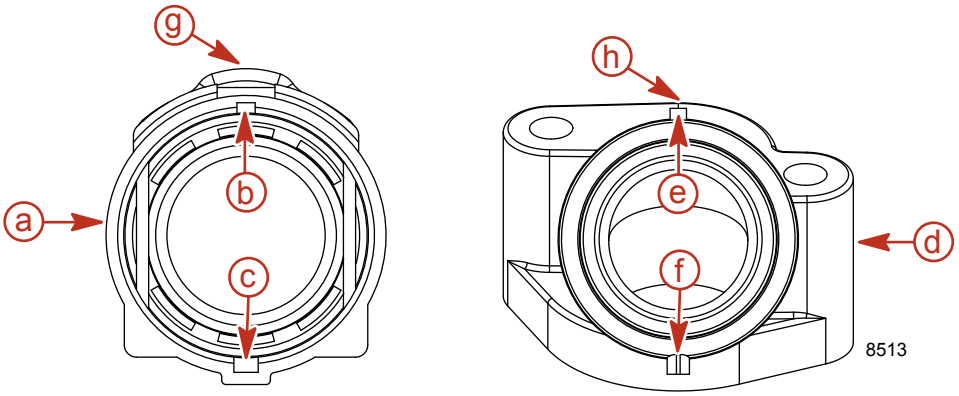
1. Install the seawater inlet hose assembly to the water inlet fitting.
   a. Position the retainer clip in the closed position.



8512

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.

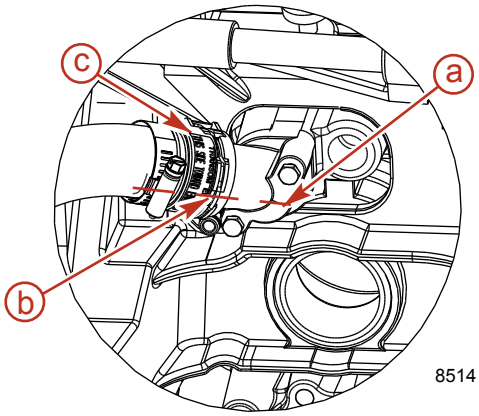


8513

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.

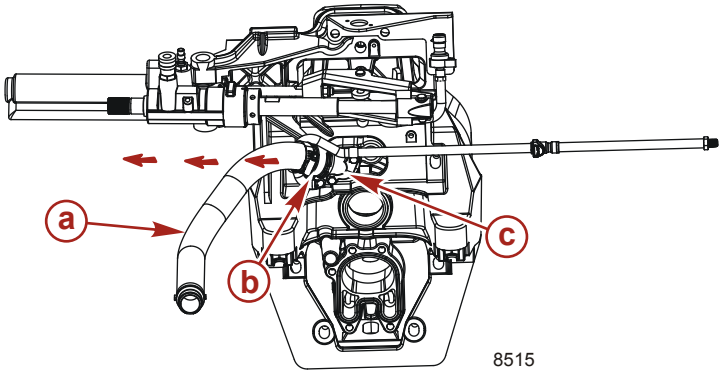
NOTE: *The retainer clip snaps into place and resumes the closed position when properly connected.*



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

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

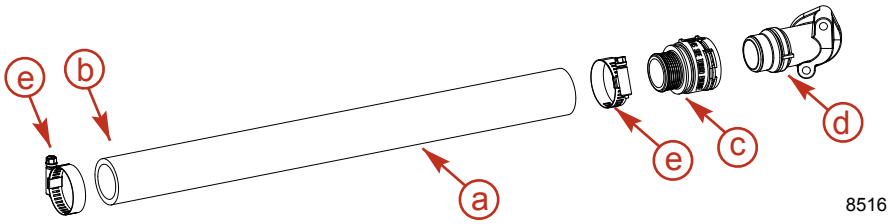
3. Perform a pull test on the water hose quick connection.
   a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 N (25 lbf). If the seawater inlet hose does not become separated from the seawater inlet fitting when force is applied, the seawater inlet hose is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



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.*

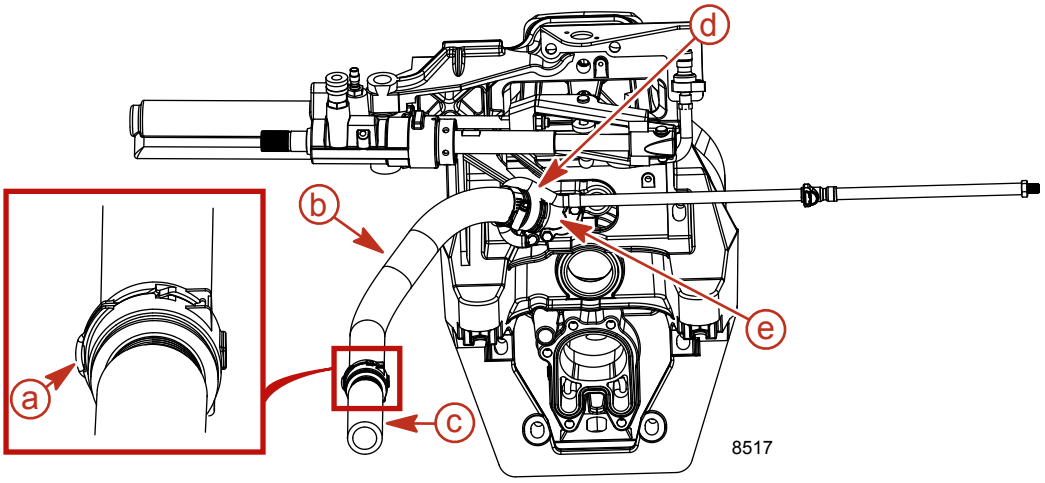


Seawater inlet hose assembly
a - Seawater inlet hose
b - To engine
c - Quick connect fitting
d - Seawater inlet fitting
e - Hose clamps

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.

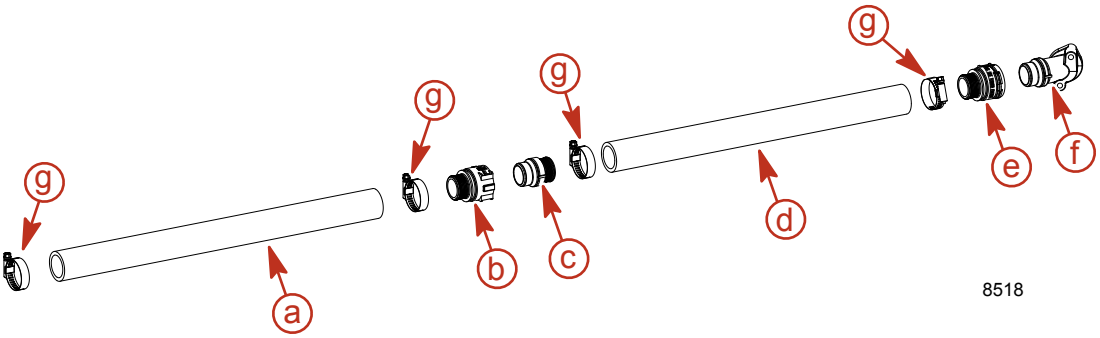


a - Retainer clip position (away from engine)
b - Seawater extension hose
c - Seawater inlet hose (to engine seawater pump)
d - Quick connect fitting (to seawater inlet fitting)
e - Seawater inlet fitting (to transom)

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

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

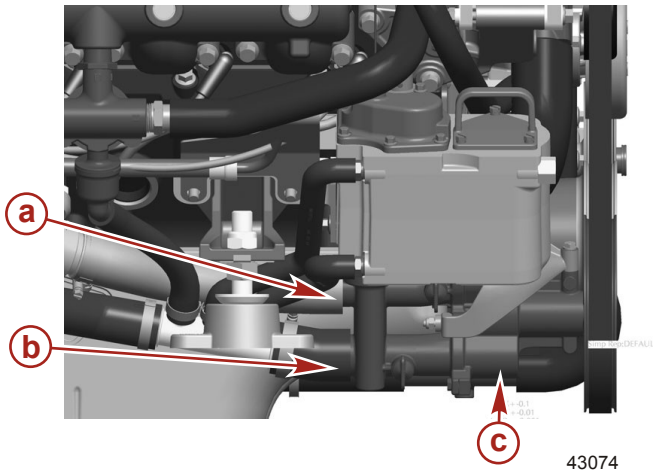
NOTE: *The seawater extension hose assembly connects to the transom and the seawater inlet hose.*



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

Seawater Pump Pickup Connection

1. Ensure the seawater inlet hose is connected to the upper hose fitting of the seawater pump.



43074

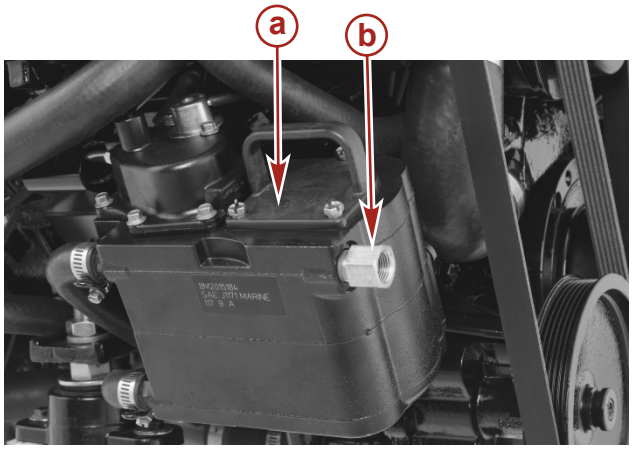
a - Seawater inlet hose
b - Seawater (out) hose to cooler
c - Seawater pump

Fuel Line Connection to Gen III Cool Fuel Module

Fuel Line Connection

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

1. Remove the shipping plug from the fuel fitting.
2. Connect the flexible fuel line to the fuel fitting.
   IMPORTANT: Hold fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.



43055

a - Gen III Cool Fuel Module
b - Fuel fitting

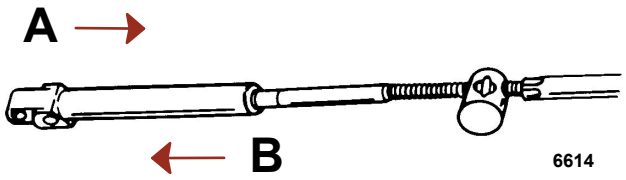
Bravo Model Shift Cable Installation

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.*

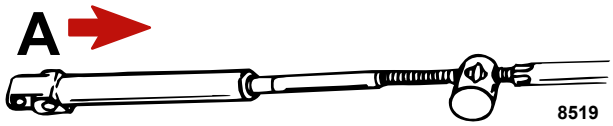
IMPORTANT: Sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.

- 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

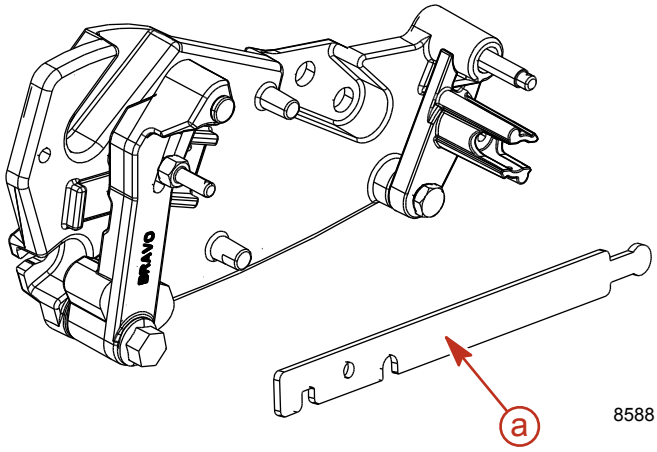
- Bravo Three - Front propeller on sterndrive unit is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction A, when control lever is placed in FORWARD gear position.



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

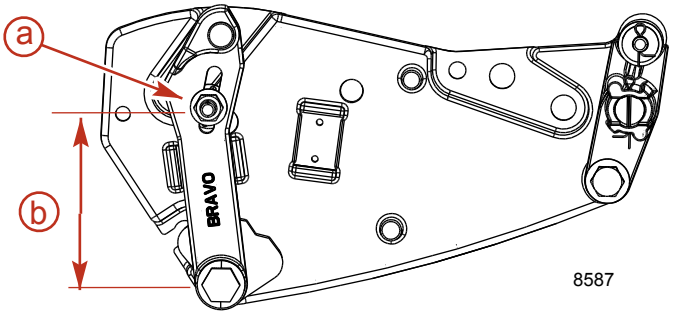
Bravo Models Shift Cable Adjustment

1. Remove the adjustment tool.



Typical Bravo shift bracket shown without switch
a - Adjustment tool

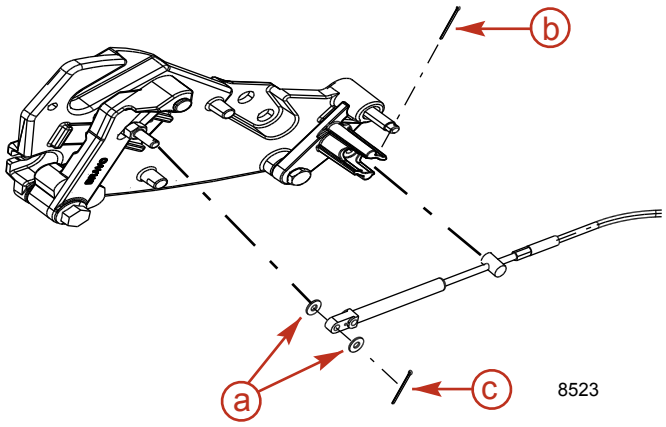
2. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud.



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 unit shift cable.
4. Install cotter pin.

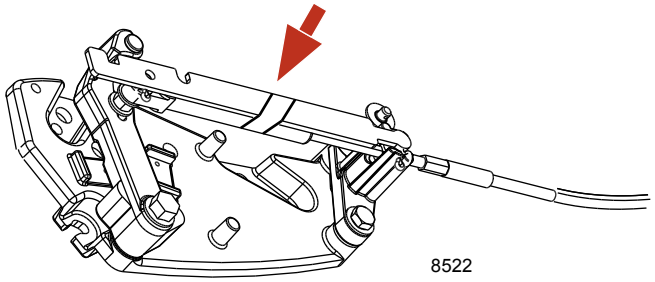
5. Insert cotter pin from top and spread ends fully.



Typical Bravo shift bracket shown without switch

a - Washers (2)
b - Long cotter pin
c - Short cotter pin

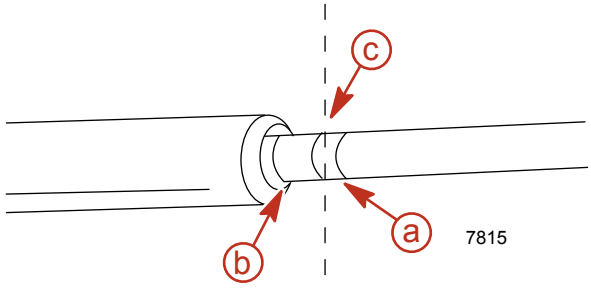
6. Place adjustment tool over sterndrive unit shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer.



Typical Bravo shift bracket shown without switch

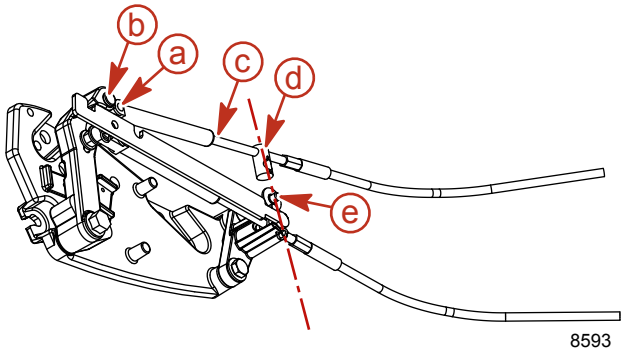
a - Adjustment tool
b - Sterndrive unit shift cable

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.
   a. Shift remote control to NEUTRAL.
   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."



8. Temporarily install control cable end guide into shift lever and insert anchor pin.
9. 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.

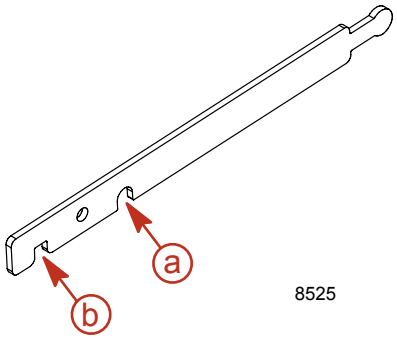
10. Remove control cable end guide from shift lever by removing clevis pin.



Typical Bravo shift bracket shown without switch

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

11. Install the control cable.
12. Install the washer and cotter pin to secure the barrel.
13. Install the clevis pin.
14. Install the cotter pin into the clevis pin from the top and spread the ends.
15. 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.

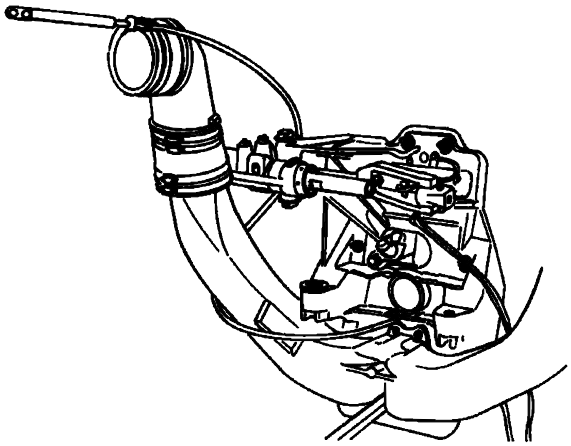
Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally

Shift Cable Installation for the 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.*

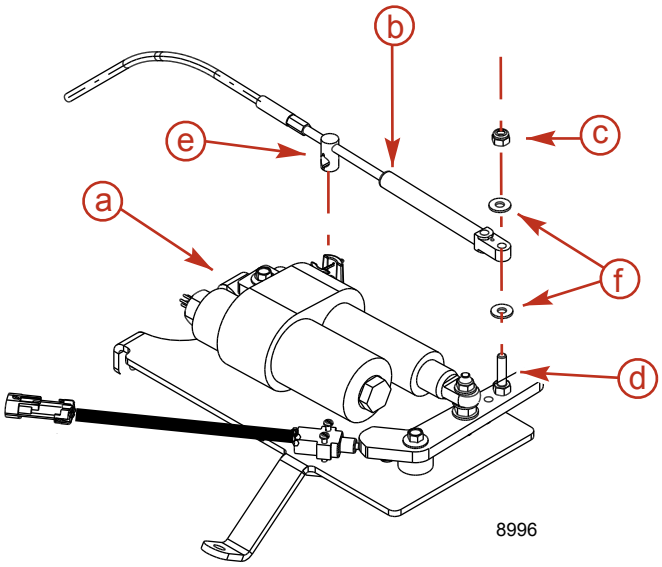


NOTE: *A final check of the adjustments should be made with the boat in the water and engine running. If this cannot be done or is not done at your manufacturing facility, arrangement should be made with the dealer to do this as part of the pre-delivery inspection.*

2. Apply lubricant to the threads of the shift cable stud.

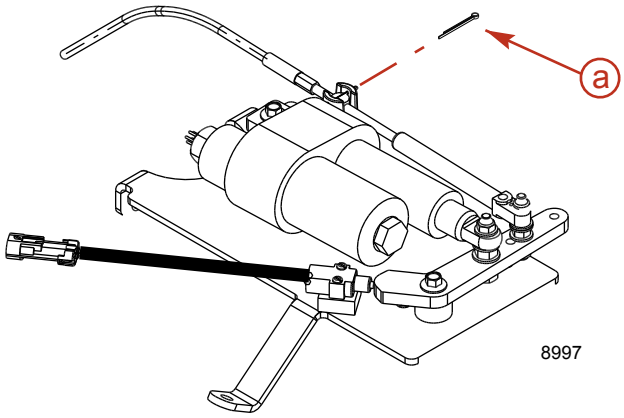
Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Shift cable stud	92-802865Q02

3. Install the intermediate shift cable to the shift actuator on the engine.
4. 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

5. Insert cotter pin from top and spread ends.



a - Cotter pin

DTS System Installation Requirement

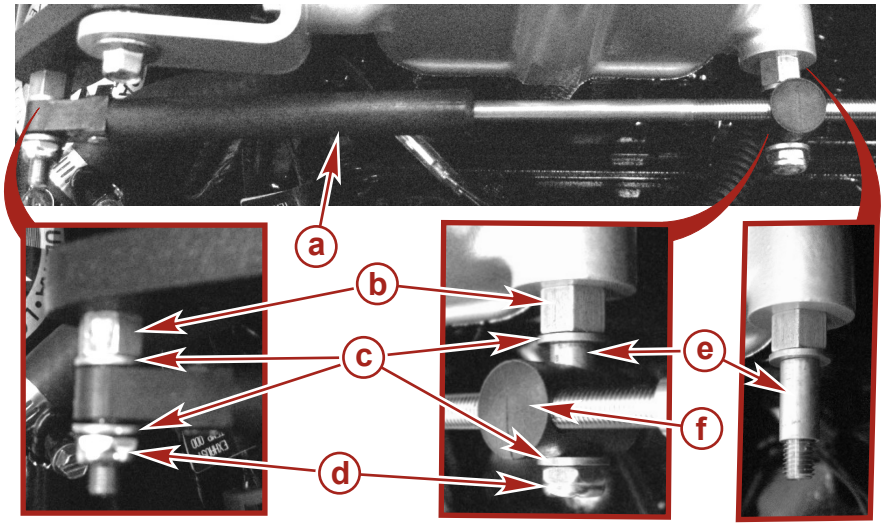
Due to updates on software and diagnostic tools we are not including this information in the service manual.

Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Throttle Cable Installation And Adjustment

1. Place the remote control handles in the neutral idle position.
   IMPORTANT: Ensure that the cable is routed to avoid sharp bends and/or 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. 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 anchor plate. Ensure that the hole in barrel positions the cable as shown.



a - Cable end guide
b - Hex spacer
c - Flat washer
d - Locknut
e - Sleeve
f - Barrel

3. Secure the throttle cable with the hardware as shown and tighten securely. Loosen locknut "a" 1/2 turn.
4. Place the remote control throttle level in the wide open throttle (WOT) position and ensure the throttle plates are completely open.
5. Return the remote control throttle lever to the idle position and ensure the throttle lever is completely closed.

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.

Engine Installation G3 Service Tool

Computer Diagnostic System (CDS) G3

Use the CDS G3 service tool for the following if applicable:

1. Configuration—Helm Configuration, CAN Pad Configuration, Drive Configuration, Compass Configuration, Import

47774

2. Active Test—Set Trailer Limit, Set Trim Limit, Set Engine Location, Set Tach Link

47775

Connecting the Computer Diagnostic System (CDS G3) Service Tool

NOTE: *The Computer Diagnostic System (CDS G3) procedural information is available in the help menu. If you have the CDS hardware, order the software and cable 8M0046124 from Mercury. The complete system is available from SPX.*

Computer Diagnostic System (CDS G3)	Order from SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124

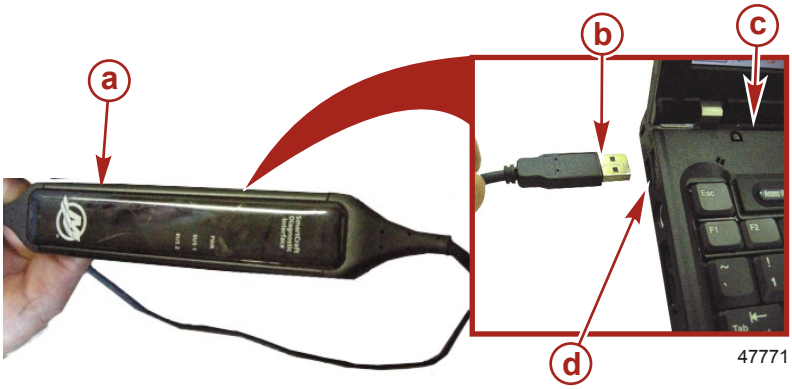
Models Equipped With a SmartCraft Diagnostic Port

1. Ensure all engine key switches and engines are off.
2. Locate the SmartCraft diagnostic port at the boat helm.

   NOTE: *The diagnostic port may not be mounted on the dashboard if space is limited, but may be mounted under the dashboard, or in the cabin at an inconspicuous, but accessible location.*
3. Remove the cover and insert the CDS G3 interface harness connection.

SmartCraft diagnostic port

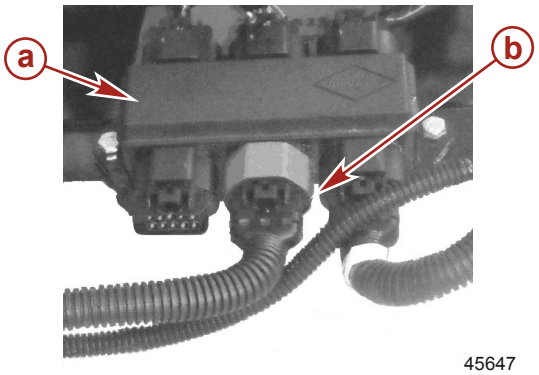
4. Connect the CDS G3 interface USB port connector to the USB port on the G3 service tool.



a - CDS G3 interfacetool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

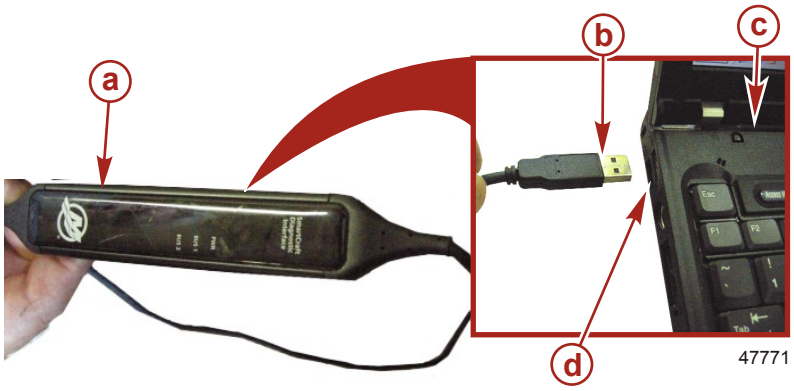
Models Equipped With a SmartCraft Diagnostic Junction Box

1. Ensure all engine key switches and engines are off.
2. Locate the standard junction box under the boat helm and connect the CDS G3 interface harness.



a - Junction box
b - CDS G3 interface harness connector

3. Connect the CDS G3 interface USB port connector to the USB port on the CDS G3 service tool.



a - CDS G3 interface tool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

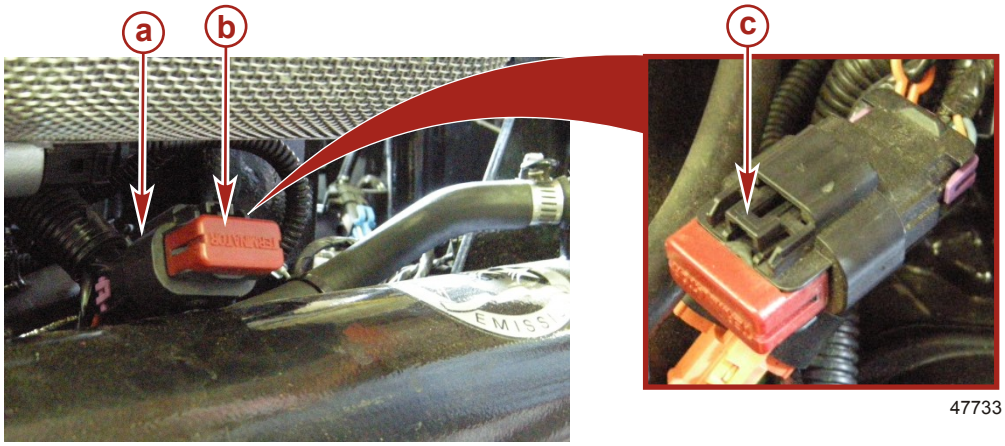
Models Not Equipped With SmartCraft Diagnostic Port or Junction Box

IMPORTANT: The CDS G3 termination harness is a terminal resistor. Only use it when connecting to the engine harness terminator connection. Do not connect the termination harness to the junction box or diagnostic port at the helm.

CDS G3 termination harness

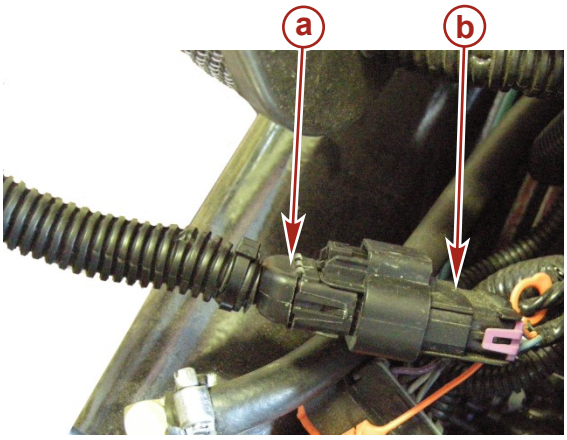
CDS G3 Termination Harness	84-8M0045065

1. Ensure all engine key switches and engines are off.
2. Locate the yellow or red terminator resistor on the engine harness and remove it by pushing the tab in while pulling the connections apart. Retain the yellow or red terminator resistor to reinstall after using the service tool.



Terminator resistor red or yellow
a - Terminator connection
b - Yellow or red terminator resistor
c - Tab

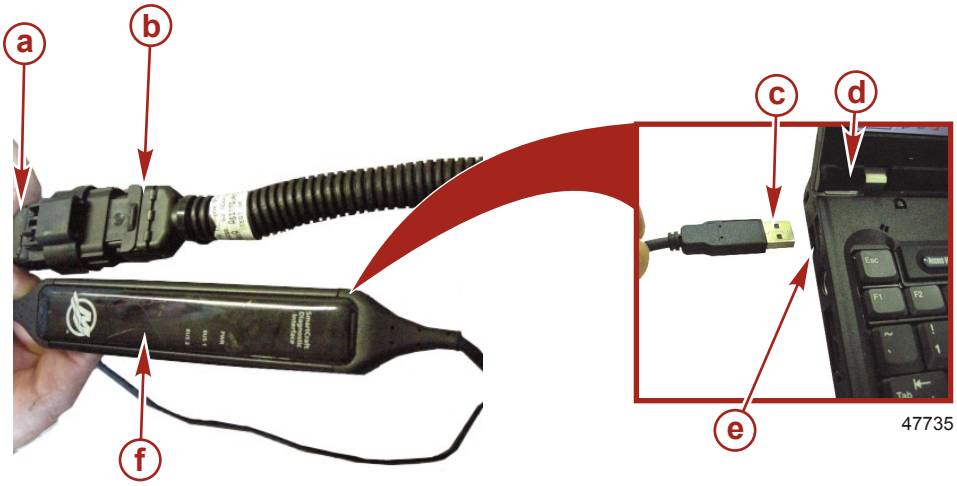
3. Connect the CDS G3 termination harness to the terminator connection on the engine.



47734

a - CDS G3 termination harness
b - Terminator connection

4. Connect the CDS G3 termination harness connector to the CDS G3 interface harness connector.
5. Connect the CDS G3 interface USB connector to the USB port on the CDS G3 service tool.

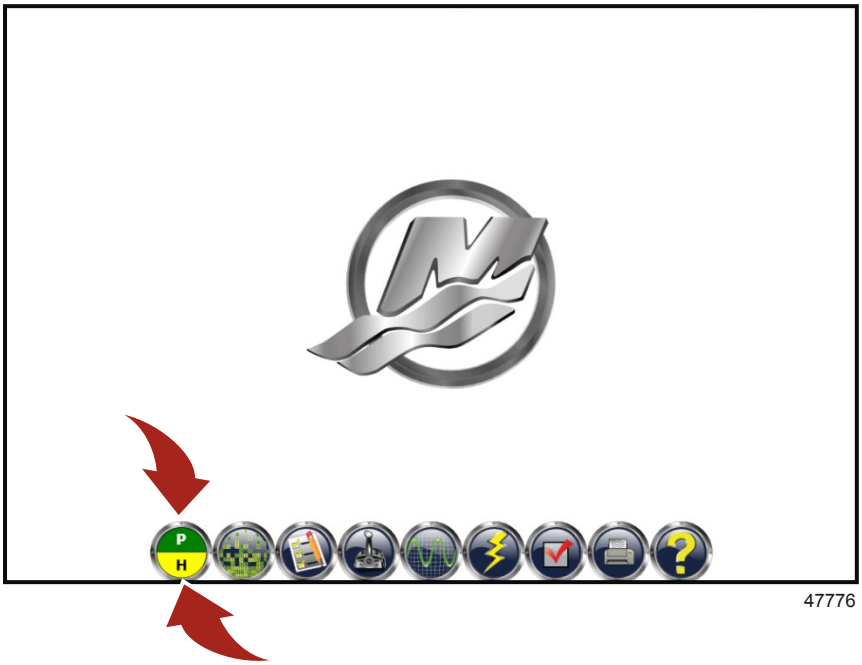


47735

a - CDS G3 interface harness connector
b - CDS G3 termination harness connector
c - CDS G3 interface USB connector
d - CDS G3 service tool
e - USB port on the CDS G3 service tool
f - CDS G3 interface tool

Mechanical Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the connection problem.

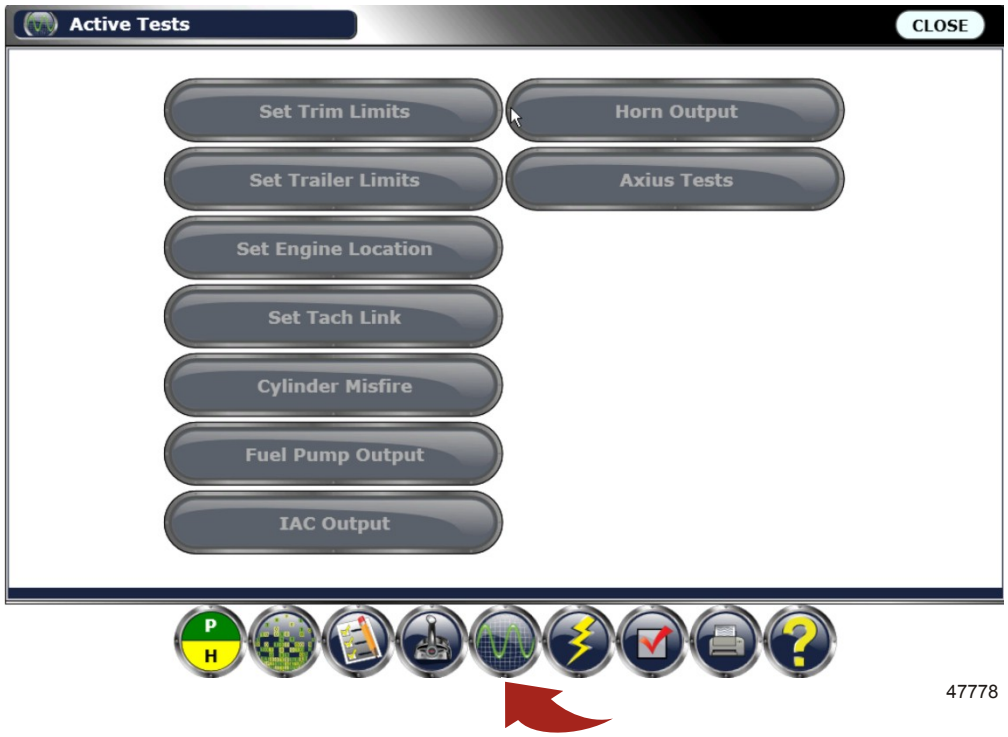


47776

2. Wait for the "Module Data" screen to appear.

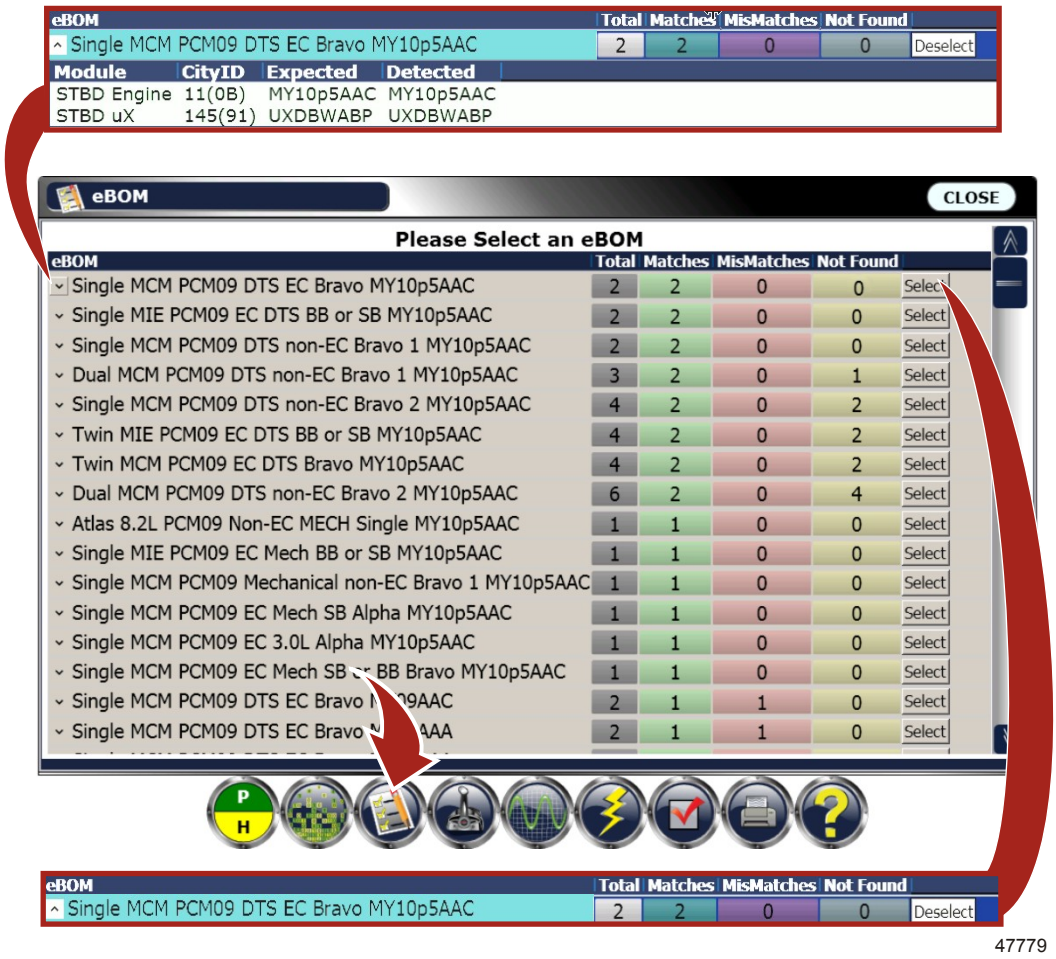
47777

3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

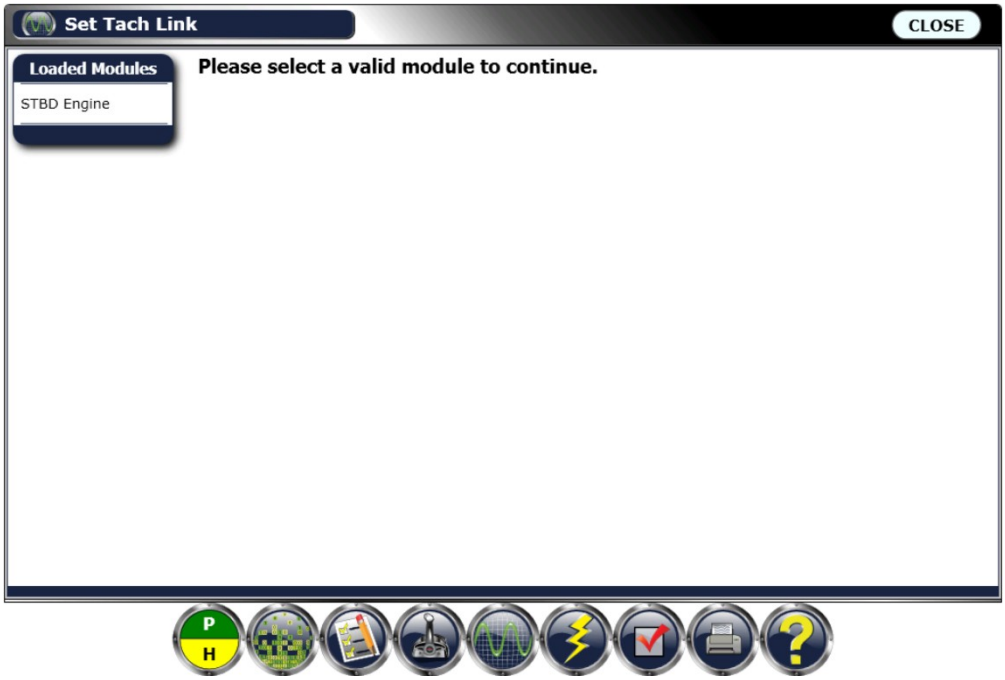
c. When you are finished, click on the Configuration icon to continue with the setup.

47782

6. Select "Active Tests."
7. Initiate the "Set Tach Link" procedure.

47788

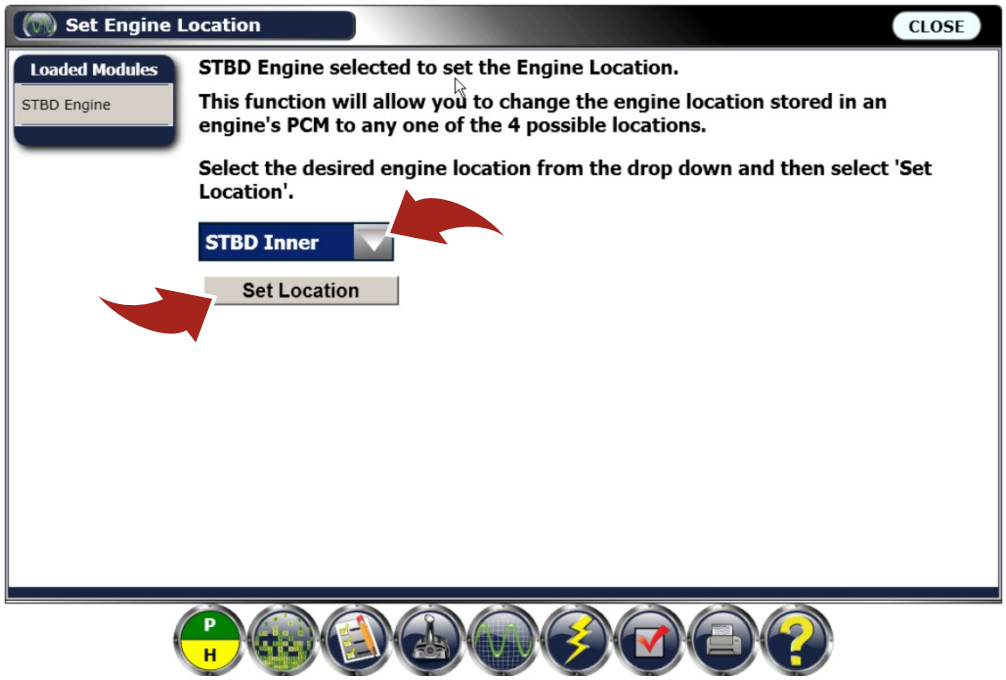
8. Select the appropriate engine.



9. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.

47790

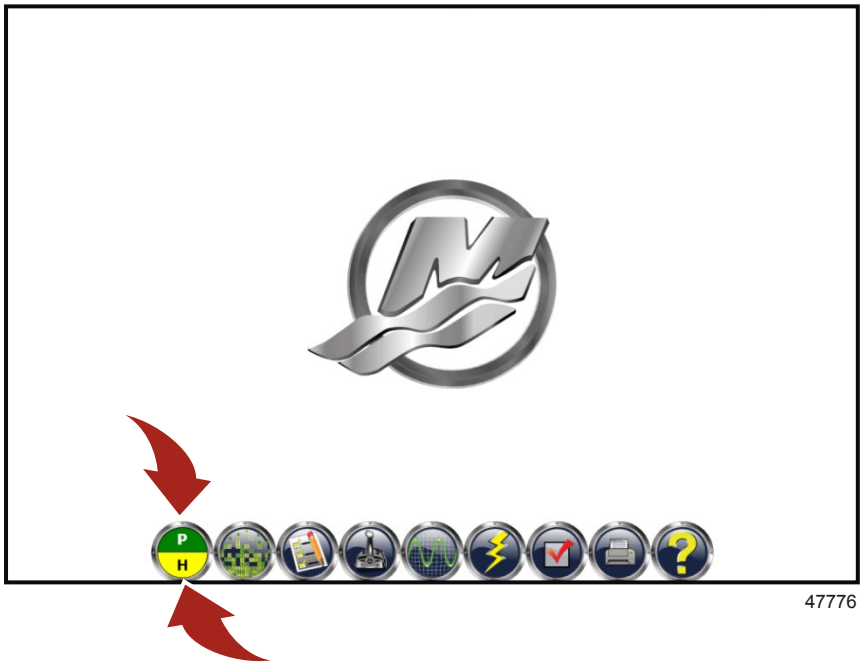
10. Use the drop-down box and "Set Location" button to change the engine location, if required.



47791

DTS Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the connection problem.

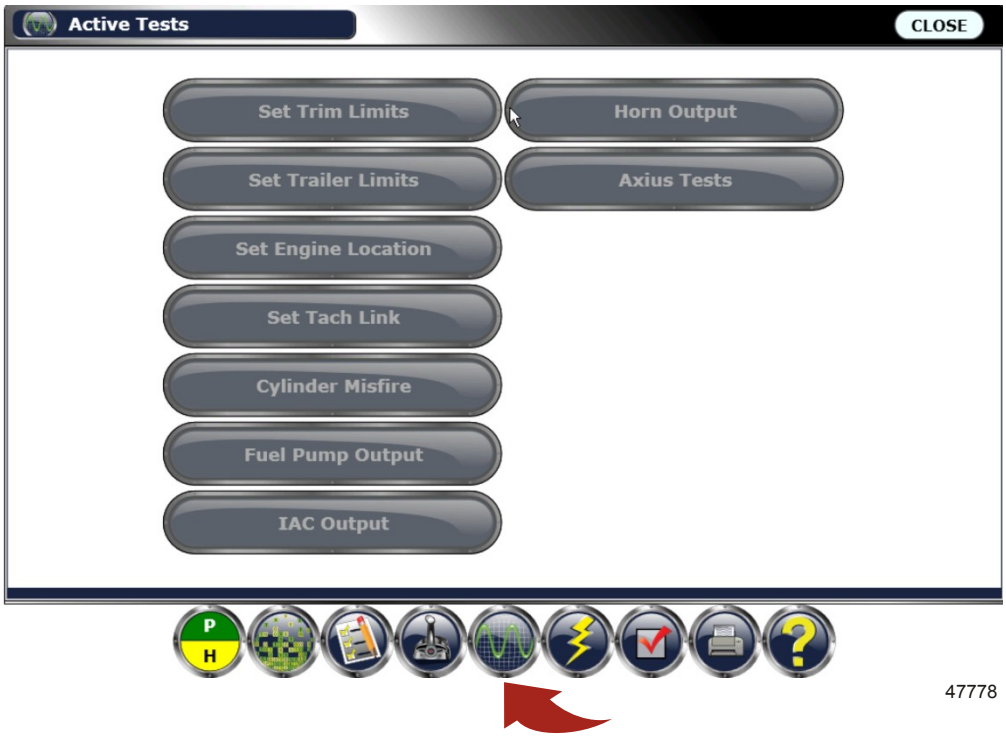


47776

2. Wait for the "Module Data" screen to appear.

47777

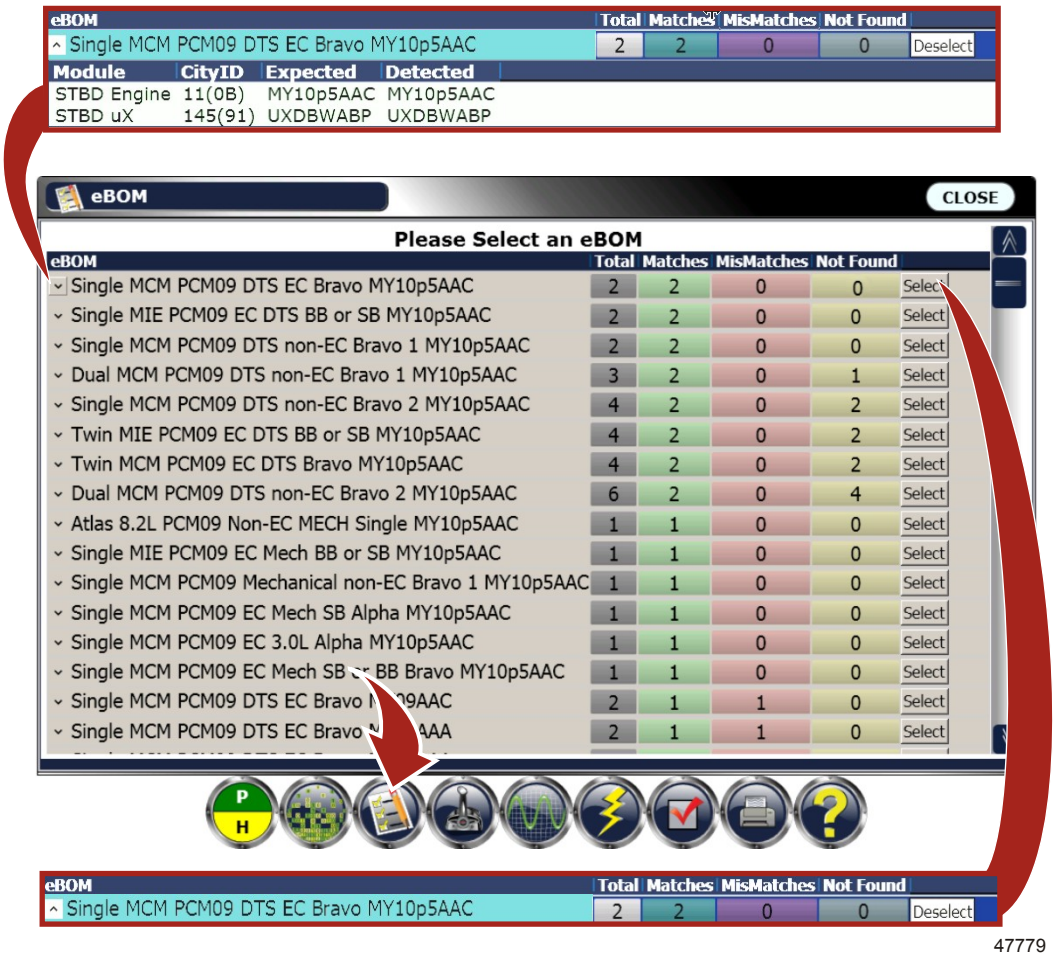
3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



47778

4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

c. When you are finished, click on the Configuration icon to continue with the setup.

47782

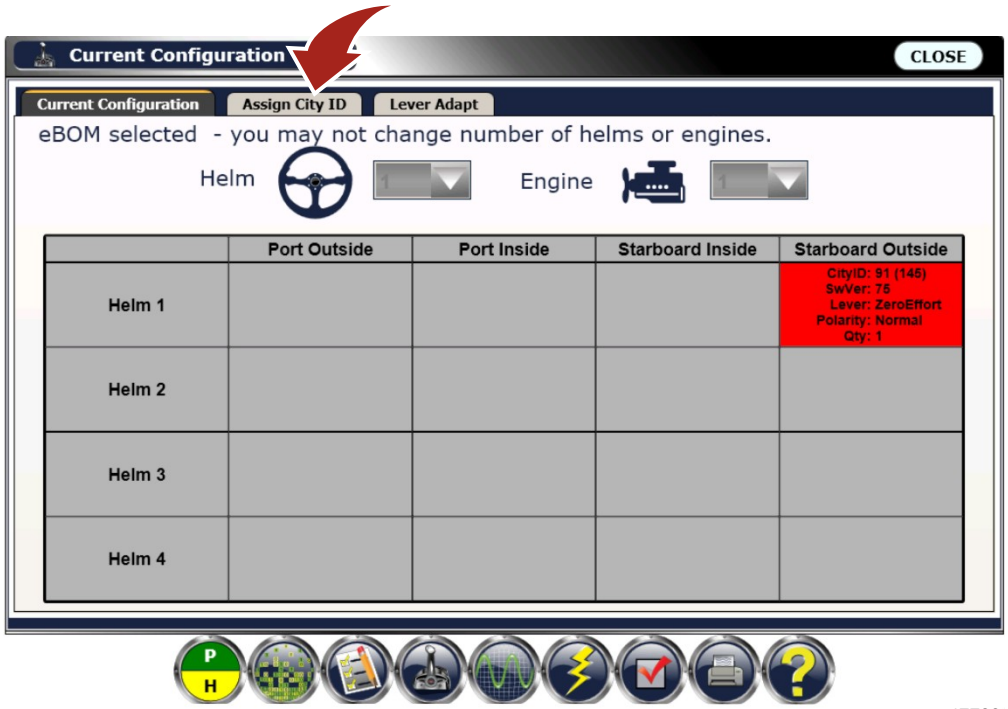
6. Select "Helm Configuration."

45499

7. Initiate "Helm Setup."

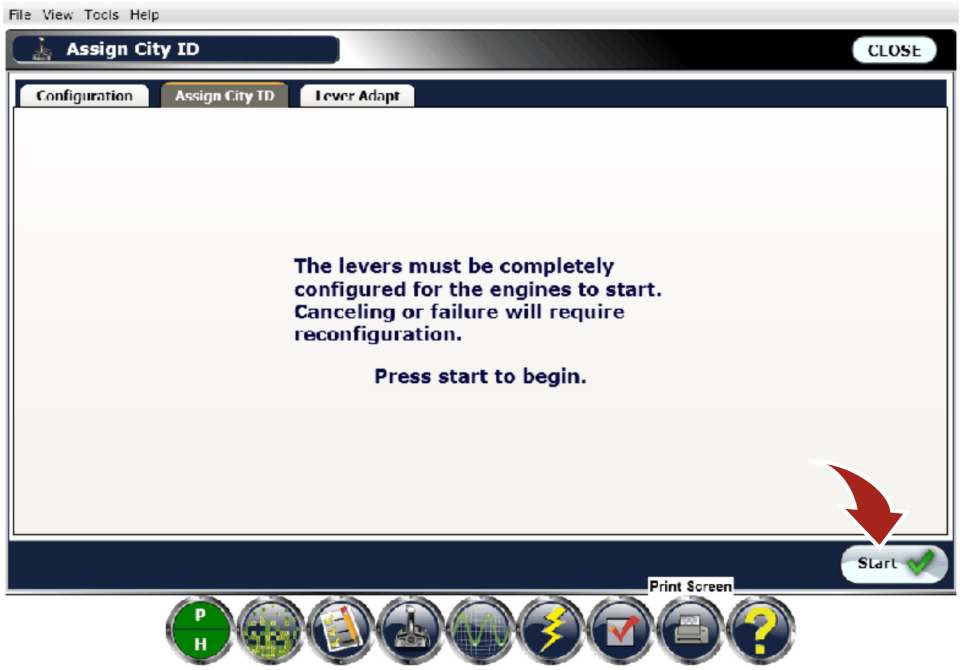
45500

8. Follow the on-screen directions presented by the G3 tool.
   a. Select the number of helms and engines to configure. You may need to wait a moment while the helm configuration is validated.
   b. Notice that the cell for the helm module will have a red background.
   c. Select "Assign City ID" to continue.



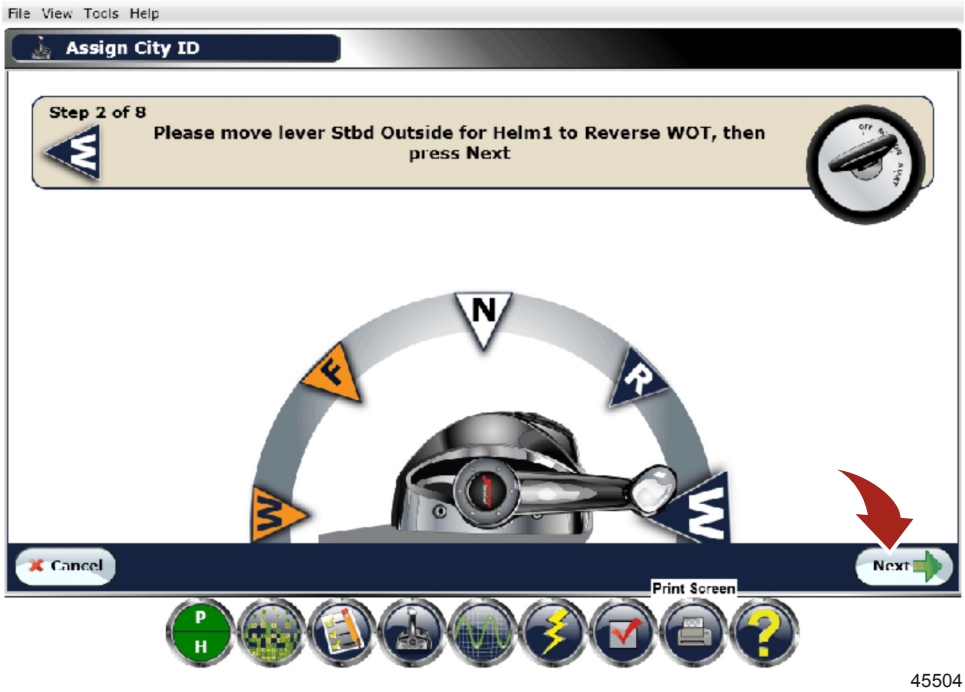
47780

9. Select "Start" to begin setup of the City ID.



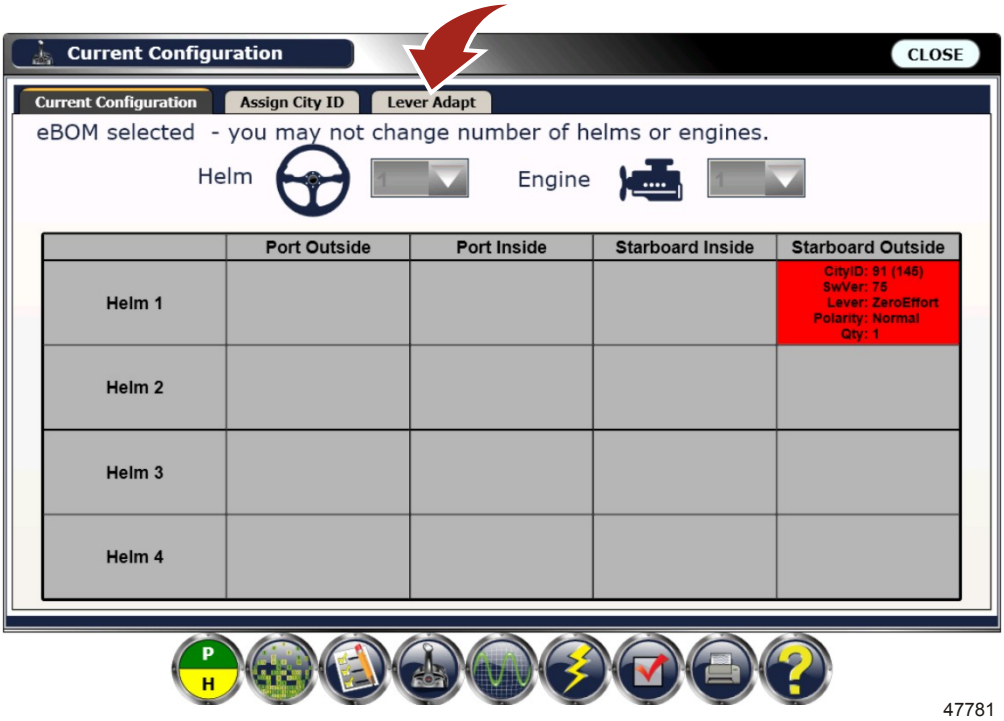
45503

10. Follow the on-screen directions, selecting "Next" to advance through the screens. When you reach the end of the on-screen directions, you may encounter a brief wait while the G3 tool updates the helm modules.



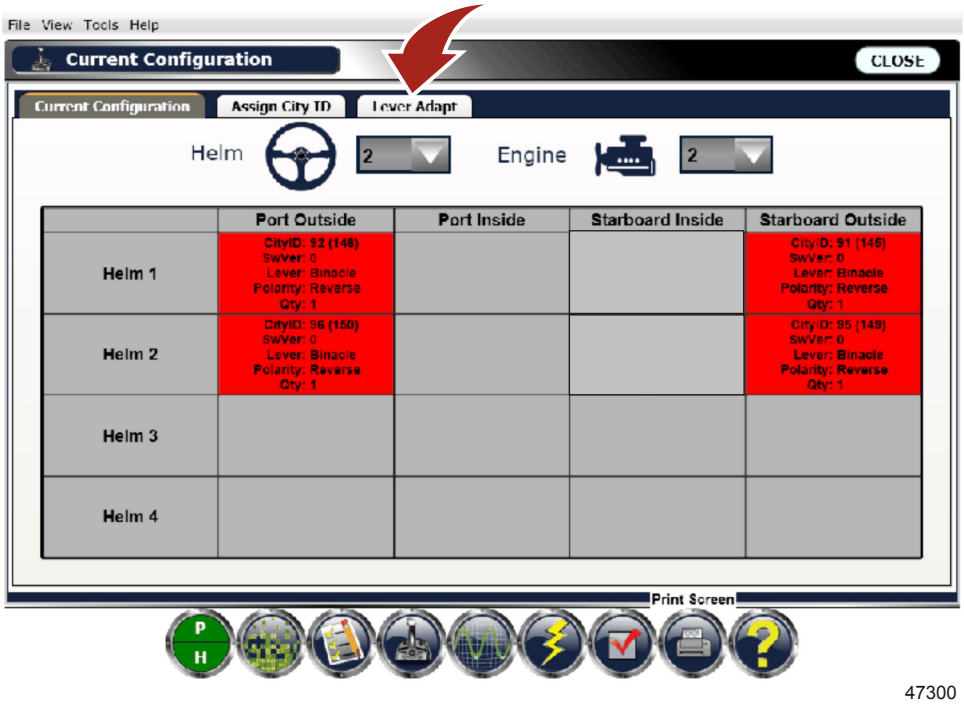
45504

11. The "Current Configuration" screen will display the City IDs assigned to all helm modules, although the cells will still have red backgrounds. You must select "Lever Adapt" to complete the helm configuration.



47781

Single engine example



47300

Multiple engine example

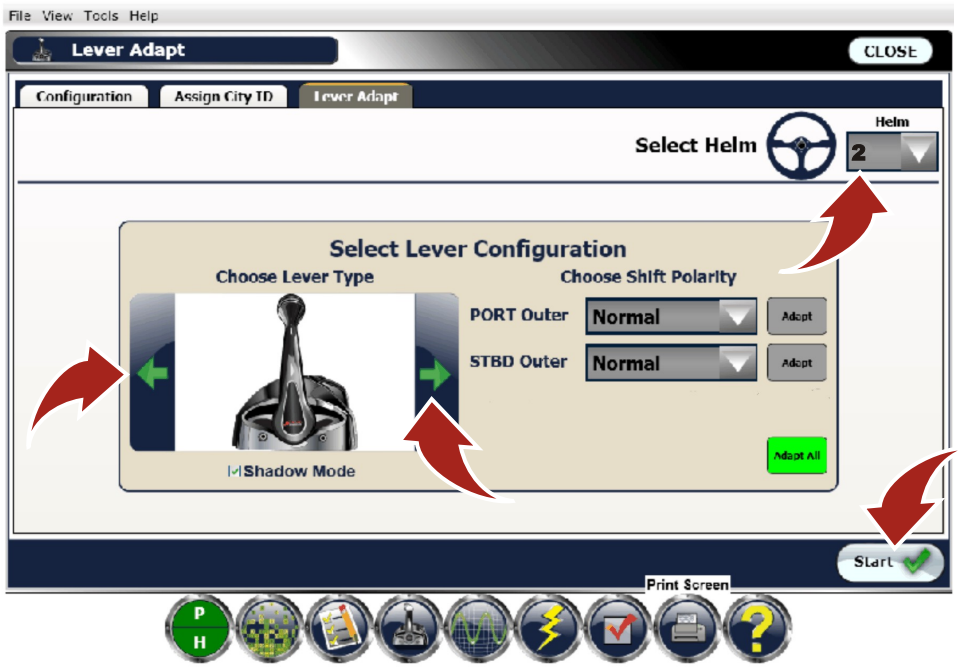
12. Select the helm to adapt, then choose the type of lever used at that helm. Click "Start" to begin the lever adaptation.

47301

13. Follow the on-screen directions, moving the control levers as instructed.

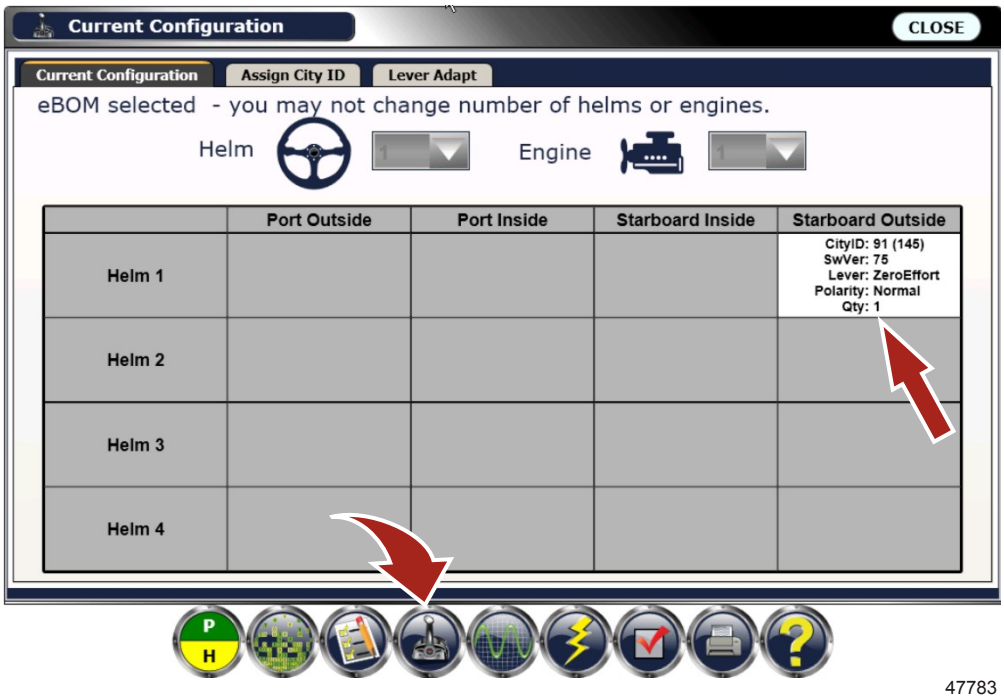
45507

14. Repeat the process for any additional helms. Be certain to select the helm number, choose the appropriate lever type for that helm, and follow the on-screen directions as before. Note that a slight wait may occur while the G3 tool updates the helm module.



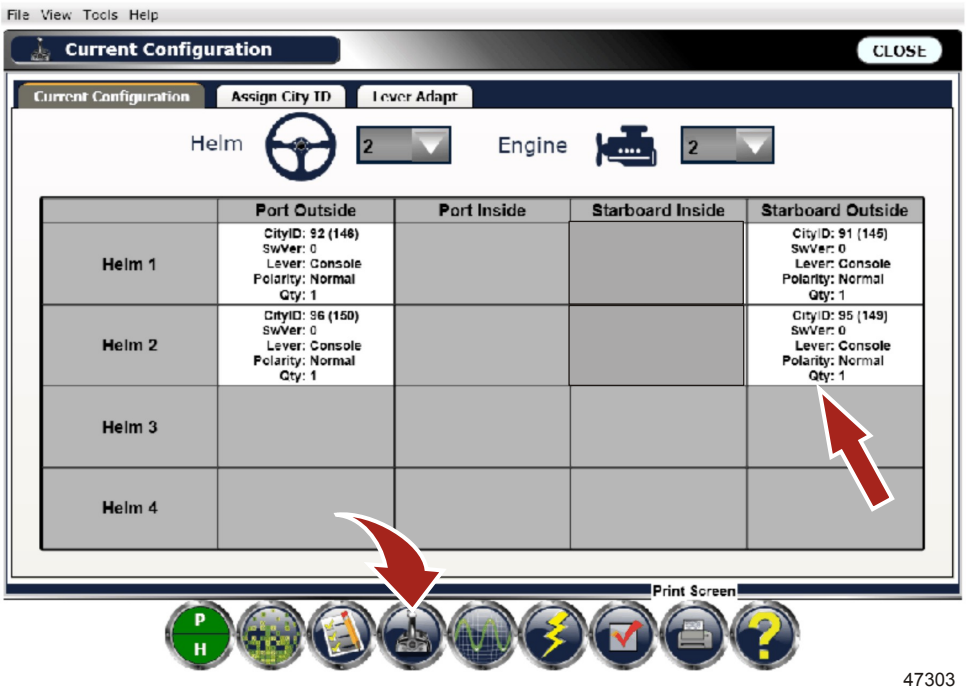
47302

15. After all levers have been adapted, the helm module cell backgrounds on the "Current Configuration" screen will be white. Select the Configuration icon to continue setup.



47783

Single engine example



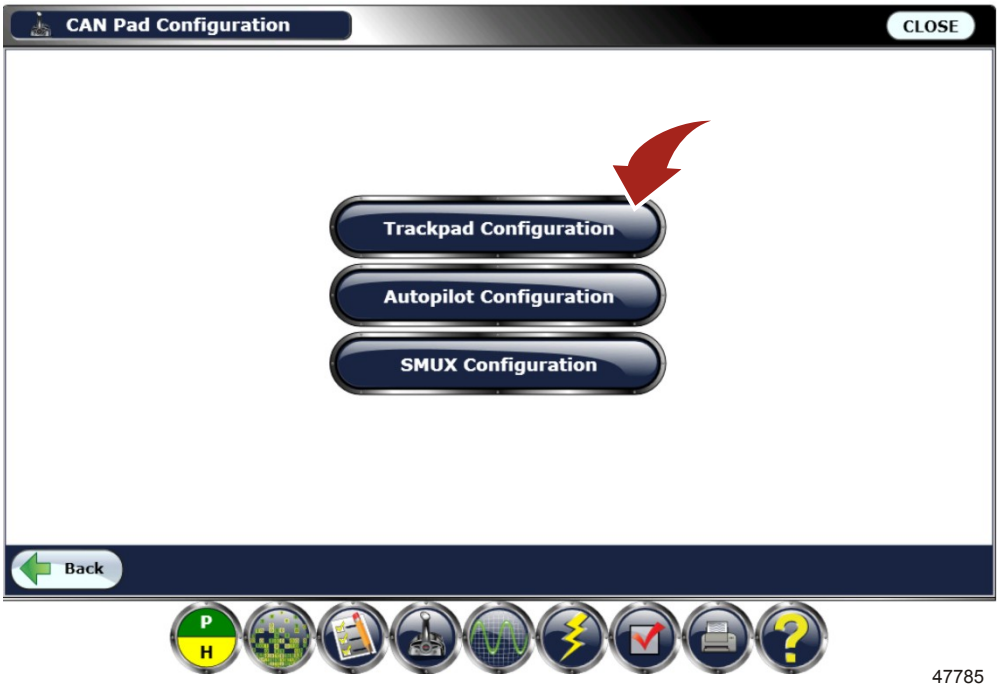
47303

Multiple engine example

16. Select "CAN Pad Configuration."

45550

17. Select "Trackpad Configuration," and follow the on-screen directions. The CAN pad must be installed for dual and multiple-engine applications.

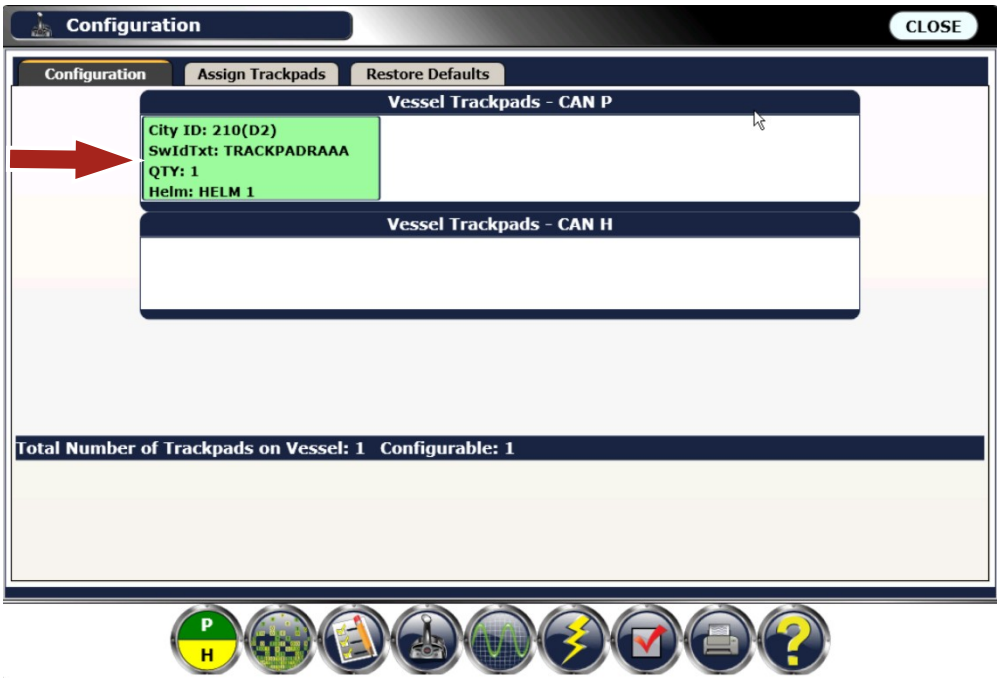


47785

18. Follow the directions in the G3 tool for assigning the City ID for the trackpads.
19. On the "Assign Trackpads" screen, select a helm and the number of trackpads at that helm; then click "Start" to begin. Complete the process for all applicable helms. Then click "Save" to save the configuration information.

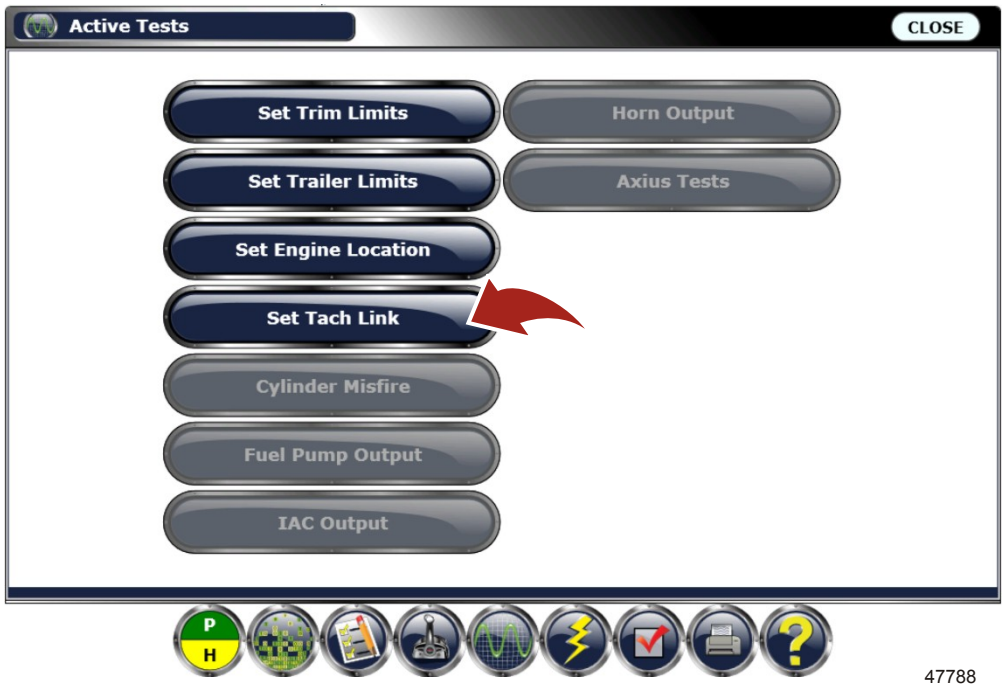
47787

20. When the trackpad assignment is complete, the trackpad City ID will turn green.



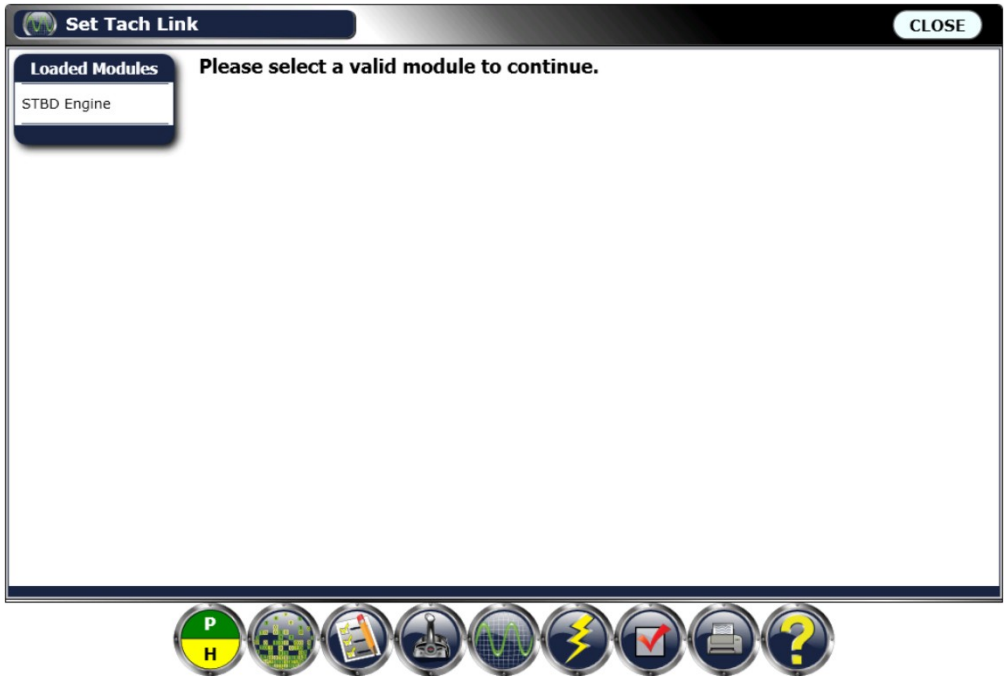
47786

21. If applicable, follow the same process for the DTS trackpads (CAN P).
22. Select "Active Tests."
23. Initiate the "Set Tach Link" procedure.

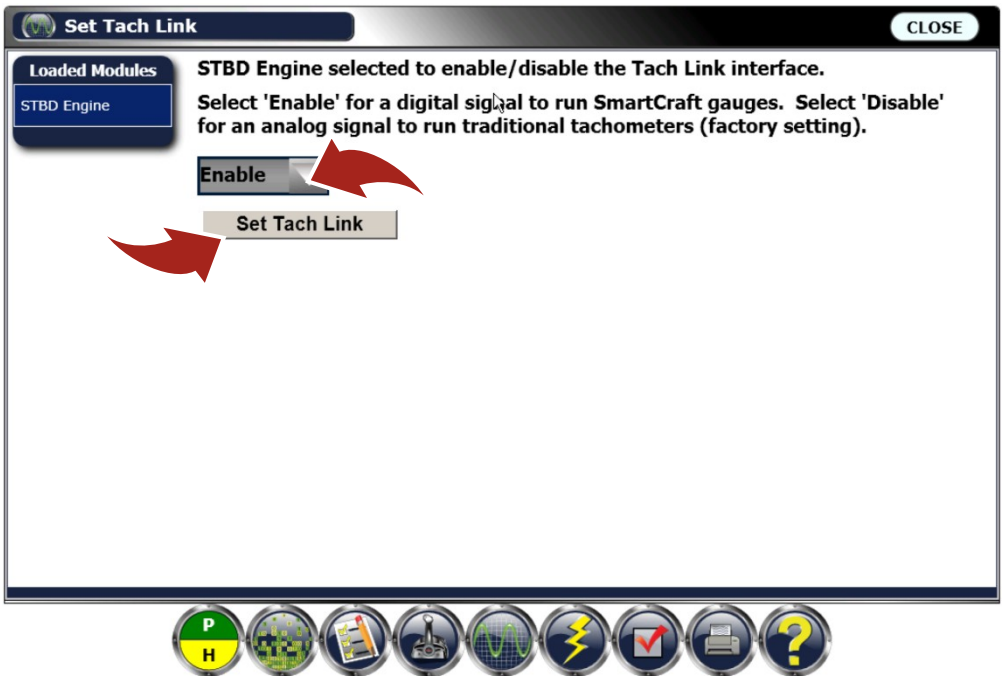


47788

24. Select the appropriate engine.

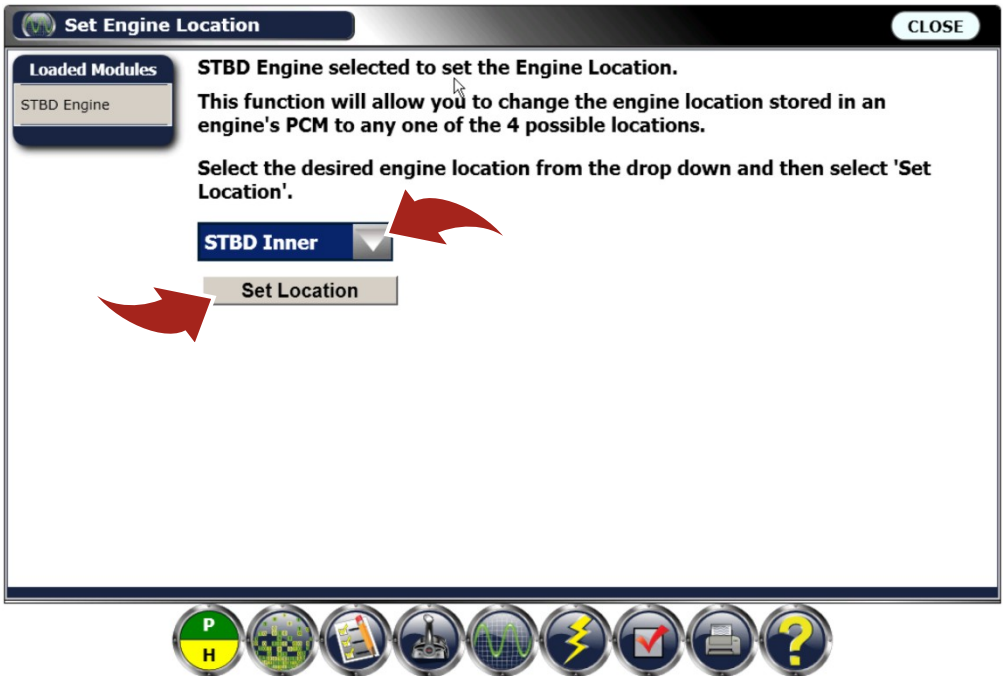


25. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.



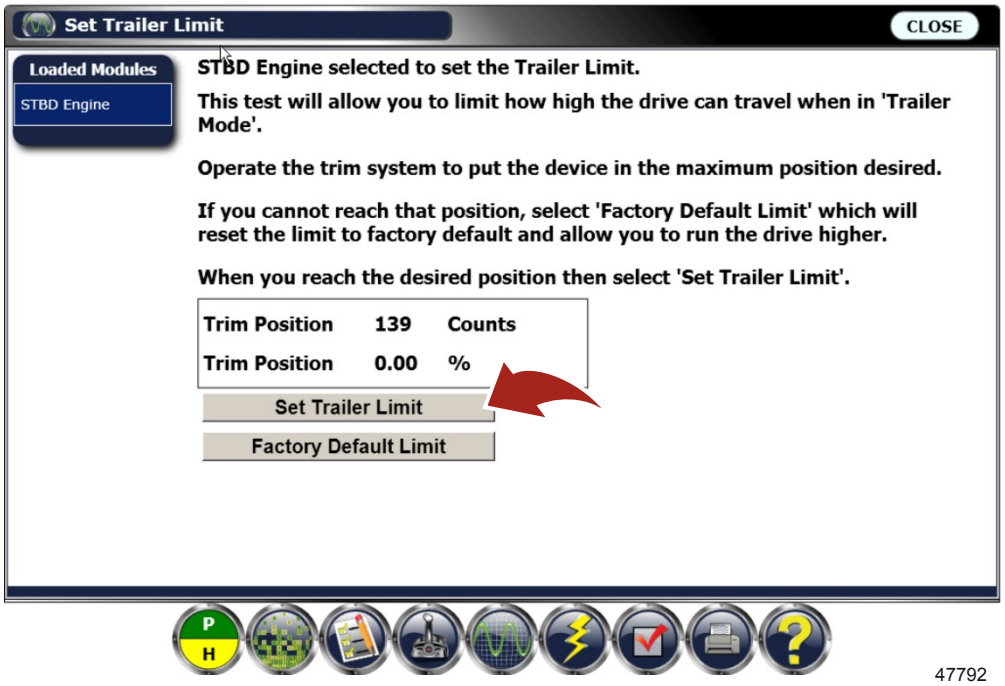
47790

26. Use the drop-down box and "Set Location" button to change the engine location, if required.



47791

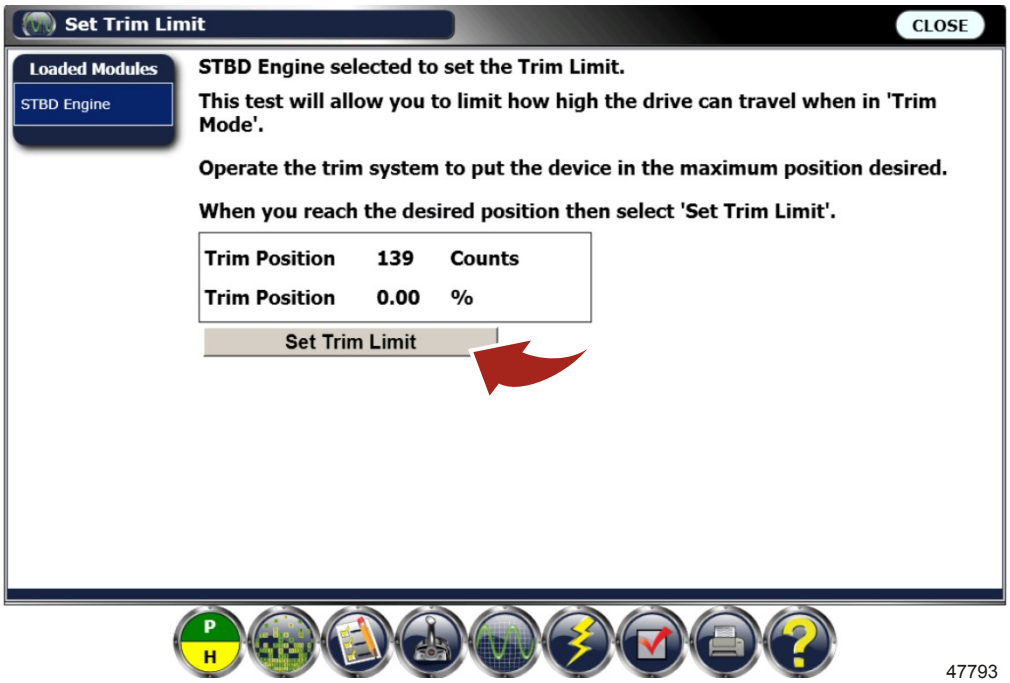
27. From the "Active Tests" screen, select "Set Trailer Limits," and follow the on-screen directions. The trailer limit must be set for boats equipped with a swim platform. The "Factory Default Limit" may be used if the drive can be trimmed without causing damage to the boat or equipment.



47792

28. From the "Active Tests" screen, select "Set Trim Limits" and follow the on-screen directions.

NOTE: It is necessary to measure the trim distance to ensure it does not exceed the 55.2 cm (21.75 in.) trim limit. This measurement is dependent on the position of the trim-in insert.



Removal and Installation

Section 2B - Inboard Models

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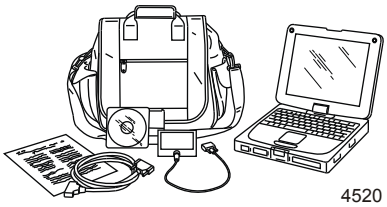
Lubricant, Sealant, Adhesives

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

Special Tools

Computer Diagnostic System (CDS G3)	Order from SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System G3 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

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

CDS G3 Termination Harness	84-8M0045065
 43351	Contains termination resistors to allow communication when G3 is connected to the engine's diagnostic connector.

Engine Removal

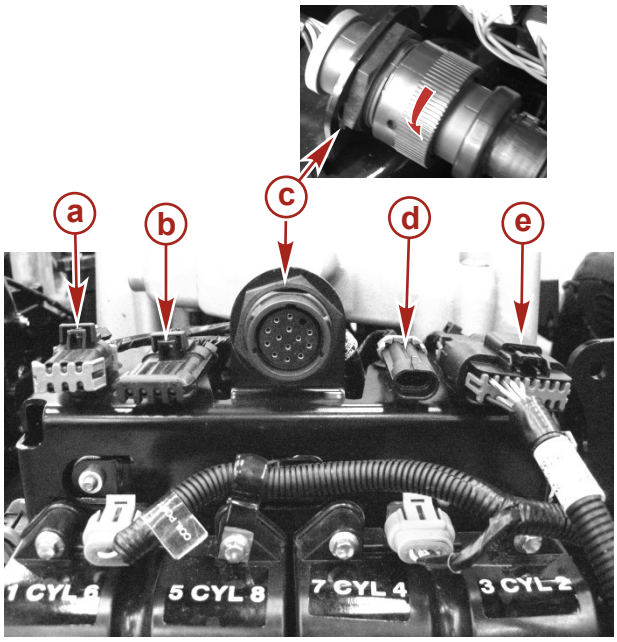
Removal

⚠ WARNING

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

1. Remove the boat from the water.
2. Disconnect the negative (–) battery cable from the battery.
3. Disconnect the positive (+) battery cable from the battery.
4. Disconnect the following connectors if applicable.
   a. Disconnect the boat harness from the engine harness. Turn the locking ring counterclockwise to release the thread engagement then pull the connection straight out.
   b. Disconnect the paddle wheel and tank level connector.
   c. Disconnect the power harness connector.

d. Disconnect the transom harness connector.



44777

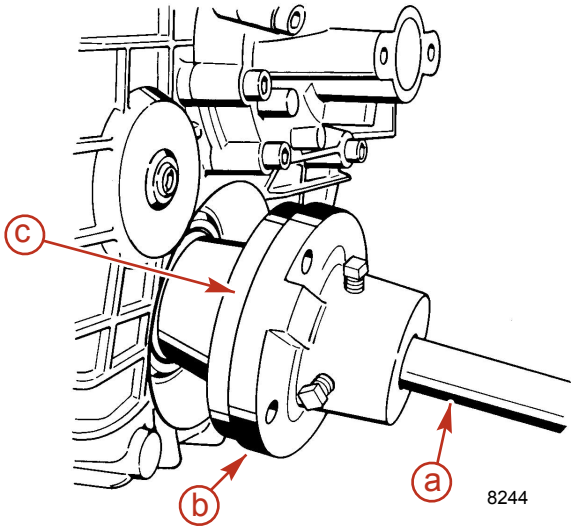
- **a -** Paddle wheel and tank level connector
- **b -** Diagnostic connector
- **c -** Engine harness connector
- **d -** Power harness connector
- **e -** Transmission harness connector

5. Close the fuel shut-off valve, if equipped.

⚠ WARNING

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

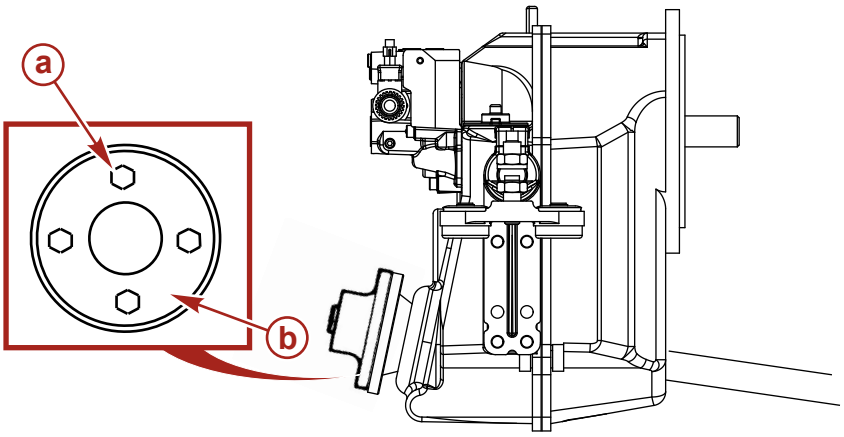
6. Disconnect and plug the fuel lines to prevent fuel from leaking into the bilge.
7. Disconnect the trim sender wire connections from the engine harness.
8. Disconnect the battery isolator wires, if equipped.
9. Disconnect the seawater inlet hose.
10. Disconnect the water heater lines, if equipped.
11. Disconnect the exhaust system hoses.
12. Disconnect the shaft-log-seal hose from the hose fitting on the exhaust manifold.
13. Remove the propeller shaft as follows:
    a. Remove and retain the bolts, lock-washers, and nuts from the propeller shaft coupler, and disengage the couplings.



8244

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

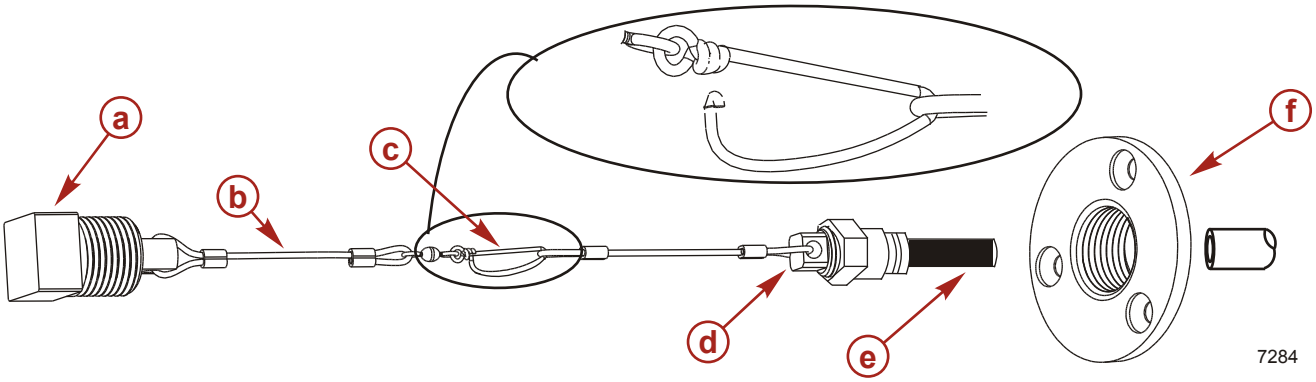
b. On V-drive models, remove the safety wire, set screws, and the propeller shaft flange from the propeller shaft.



a - Bolts
b - Transmission coupler

c. Slide the propeller shaft away from the transmission to create suitable clearance.

14. Remove and retain the boat drain plug.
15. Disconnect the oil drain hose lanyard from the boat drain plug.



a - Bilge drain plug
b - Tether
c - Clip
d - Oil drain hose plug
e - Oil drain hose
f - Bilge drain flange

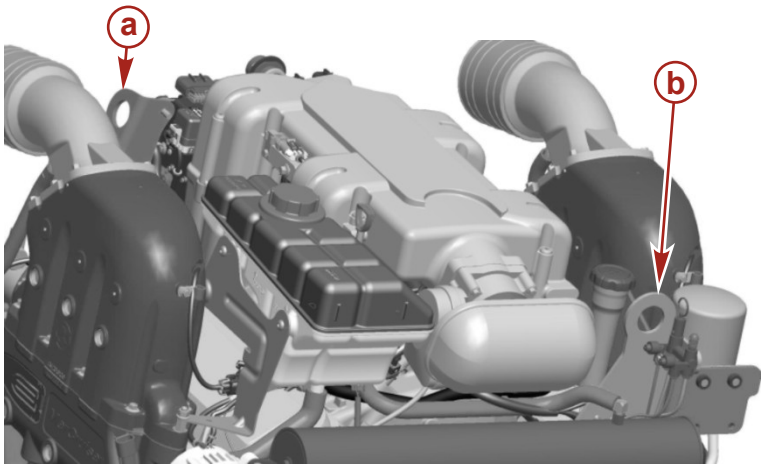
16. If applicable, disconnect continuity wires and accessories that are connected to the engine.

⚠ CAUTION

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

IMPORTANT: Do not allow the engine to rest on the oil pan.

17. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

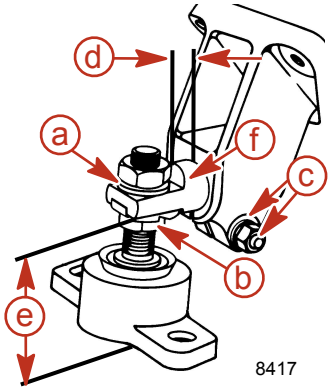


43746

a - Rear lifting eye
b - Front lifting eye

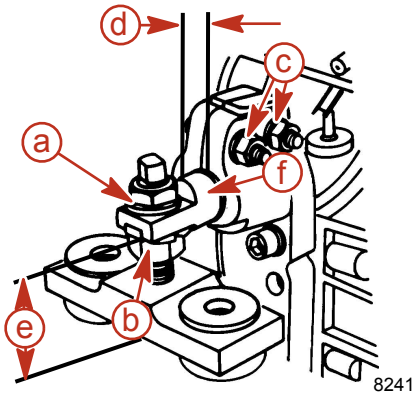
18. Remove and retain the port and starboard rear engine mounting fasteners.
19. Remove and retain the starboard and port front engine mounting fasteners.

NOTE: *If the engine will be reinstalled you may want to leave the base on the stringer and only remove the locking nut and locking washer.*



8417

Typical front mount



8241

Typical rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolts and nuts, with lock-washers
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

20. Using an overhead hoist, carefully remove the engine and the transmission. Do not damage the control valve assembly on the transmission.

DTS System Installation Requirement

Due to updates on software and diagnostic tools we are not including this information in the service manual.

Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Emission-Related Instructions

Important Information

NOTICE

Failure to follow these instructions when installing a certified engine in a vessel violates U.S. federal law (40 CFR 1068.105[b]) and may result in fines or other penalties as described in the U.S. Clean Air Act.

Controlling Evaporative Emissions

Specific installation steps are required to control evaporative emissions. The installer and/or the vessel manufacturer must meet the requirements of EPA regulation 1045.112 and federal regulation 40 CFR part 1060.

Meeting Design Specifications

Other instructions to ensure that the engine will operate according to the manufacturer's design specifications are referenced in the Mercury MerCruiser installation manual provided with the product. Refer to:

1. **Section 3—Exhaust System.**
   - Important Information
   - Exhaust Recommendation
   - Exhaust Emissions
   - Measuring Exhaust Elbow Height
2. **Section 6—Drive System and Engine Mounting.**
   - Exhaust System Hose and Tube Connection

Emission Control Information Label

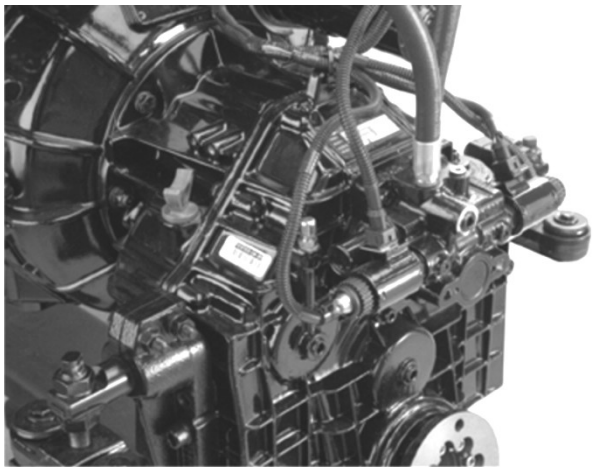
If you install the engine in a way that makes the engine's emission control information label difficult to read during normal engine maintenance, you must place a duplicate label on the vessel, as described in 40 CFR 1068.105.

Refer to **Section 1—Emission Control Information Label**.

Engine Preparation

ZF Marine Transmissions—DTS

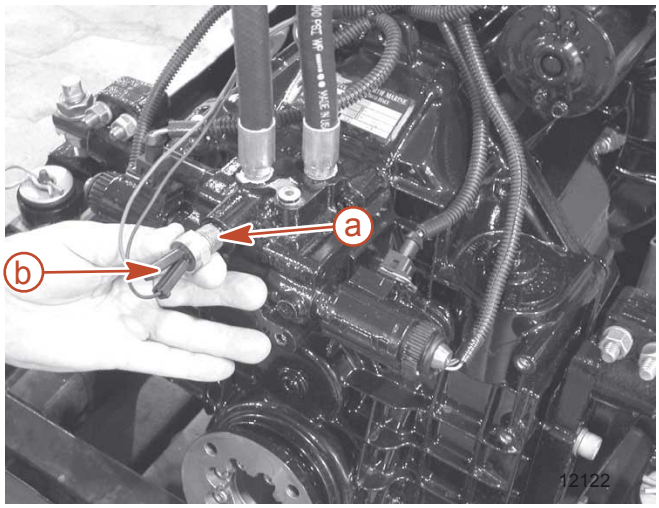
The oil temperature sensor for the ZF Marine transmissions with electronic shift is not installed at the factory. An allen plug is installed in the port for shipping. The oil temperature sensor is provided in a parts bag.



20418

ZF Marine transmission—DTS (oil temperature sensor not installed)

Remove the allen plug and install the oil temperature sensor. Connect the wire connections, of the harness, to the oil temperature sensor.



ZF Marine transmission—DTS (oil temperature sensor installed)

a - Oil temperature sensor
b - Oil temperature sensor wire connections

Positive (+) Connections on Engine

IMPORTANT: There is a fuse located at the starter solenoid. Do not remove this fuse.

1. Install the battery positive (+) cable directly to the positive (+) stud on the starter.
2. Tighten the nut to specification.

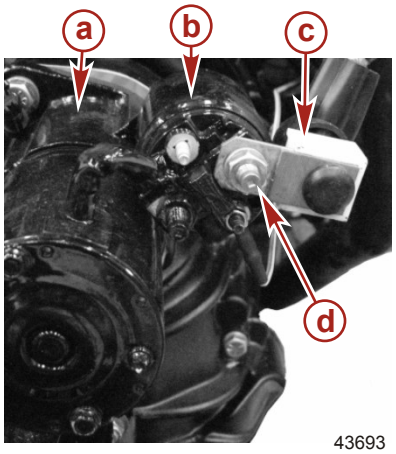


Image shown without battery cable attached

a - Starter
b - Starter solenoid
c - 90 amp fuse - do not remove
d - Positive (+) starter stud

Description	Nm	lb-in.	lb-ft
Positive battery cable on the starter stud	9.5	84	–

3. Apply a thin coat of sealant over the stud and the connection.

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

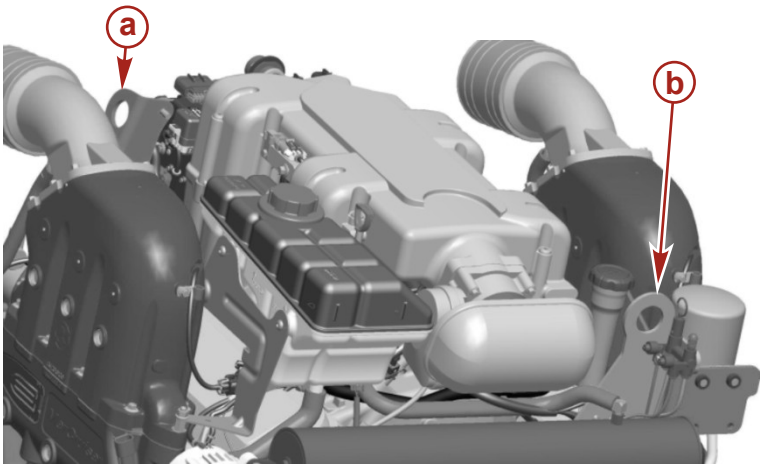
4. Drape the battery cable over the top of the engine to prevent interference during installation.

Engine Installation

Engine Mount Pre-Adjustment

1. Remove the hardware that secures the engine to the shipping pallet.

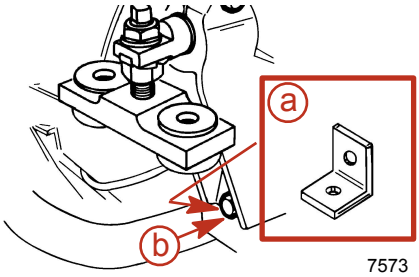
2. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended. Lift the engine with an overhead hoist.



43746

a - Rear lifting eye
b - Front lifting eye

3. Remove the L-shaped shipping brackets from both rear (transmission) mounts. Retighten the mount bracket attaching bolts.



7573

Typical
a - L-shaped bracket
b - Transmission mount bracket attaching bolt

Description	Nm	lb–in.	lb-ft
Mount bracket bolt	64	–	47

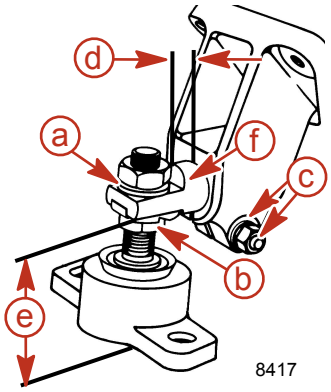
IMPORTANT: Engine mounts must be adjusted, as explained in steps 4 and 5, to center mount adjustment and establish a uniform height on all mounts.

4. 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 specified. If it is not, loosen the mount locking nut and turn the adjusting nut in the direction required to obtain the proper dimension; then retighten the locking nut.

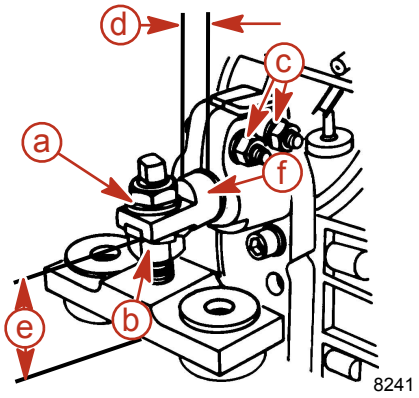
Description	Specification
Distance from the bottom of the mount to the bottom of the trunnion	67 mm + 2 mm (2-5/8 in. + 1/16 in.)

5. Loosen the clamping bolts and nuts on all four engine mount brackets.
   - Keep the bolts tight enough to prevent the trunnions from moving in or out during engine installation, yet loose enough to allow the engine position to be laterally adjusted.
   - Keep each mount trunnion equally extended.

- When the base of the engine mount is on the boat stringers, the mount trunnion must extend a minimum of 10 mm + 2 mm (3/8 in. + 1/16 in.) from the trunnion clamp.



Typical front mount



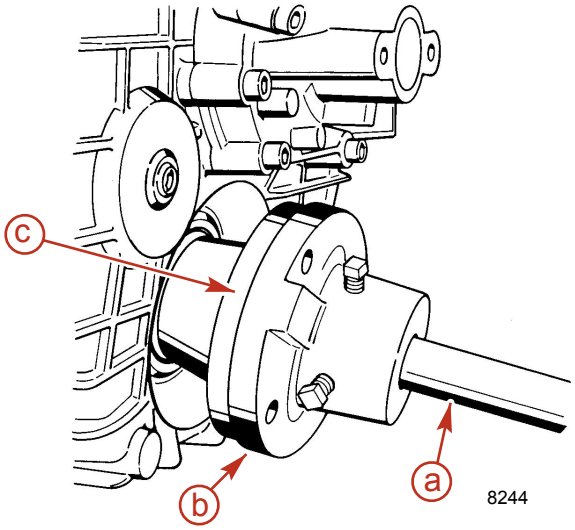
Typical rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolts and nuts, with lock-washers
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

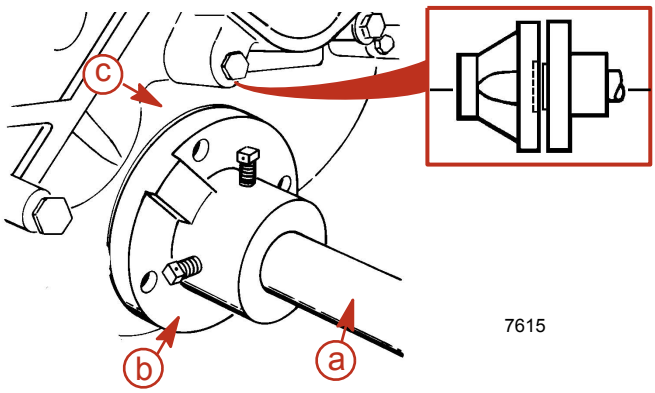
Models With 8 Degree Down Angle Transmissions

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



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 4 mounts after performing the initial alignment. This is necessary to allow for the final engine alignment.



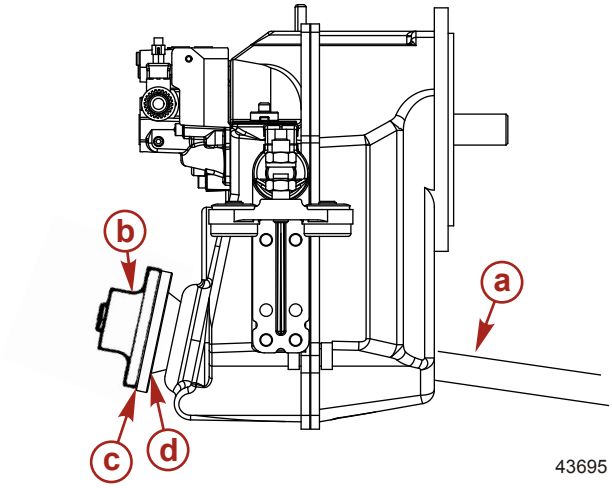
7615

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

2. Ensure that all 4 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 the lag bolts securely.
3. Disconnect the overhead hoist and remove the sling.

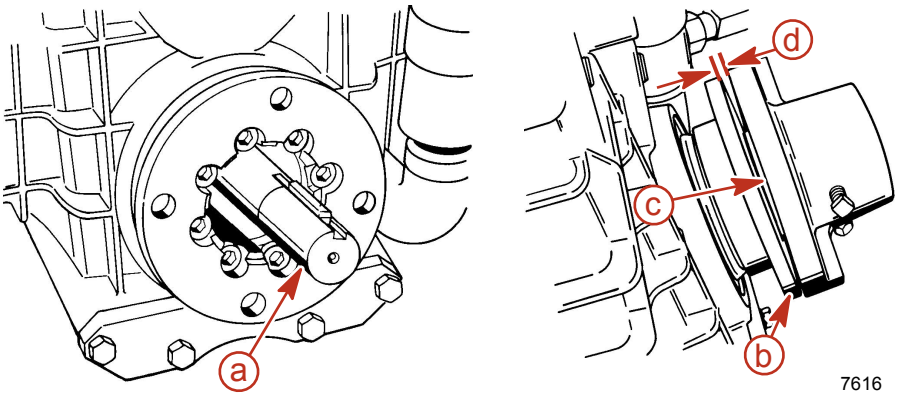
Models with V-Drive Transmissions

1. Lift the engine into the boat and position it so that enough propeller shaft protrudes through the transmission and the output flange for the propeller shaft coupler to be attached. Then install the coupler and position the engine (no visible gap between the coupling faces when butted together). Adjust the engine bed height if necessary to obtain the proper alignment. Do not use the mount adjustments to adjust the engine position at this time.
IMPORTANT: The engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all 4 mounts after performing the final alignment. This is necessary to allow for the final engine alignment.



43695

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



7616

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

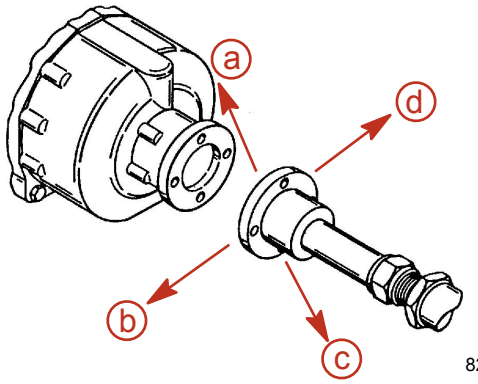
2. Ensure that all 4 mounts are positioned properly, then fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts (of sufficient length) and flat washers. Tighten the lag bolts securely.
3. Disconnect the overhead hoist and remove the sling.

Final Engine Alignment

IMPORTANT: The engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

The engine must be aligned so the transmission and the 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.

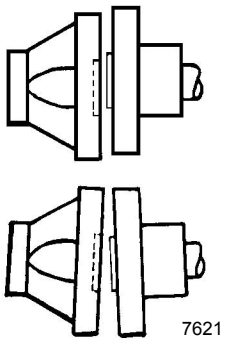
1. Check the mating faces on the transmission output flange and the propeller shaft coupler to ensure that they are clean and flat.
2. Center the propeller shaft in the shaft log as follows:
   a. Push down and then lift the shaft as far as it will move. Then place the shaft in the middle of the movement.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



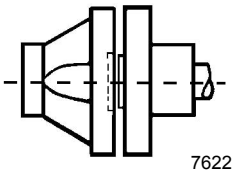
Typical down angle (V-drive similar)

- **a -** Up
- **b -** Port
- **c -** Down
- **d -** Starboard

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

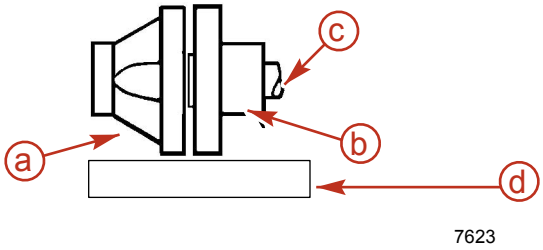


Incorrect



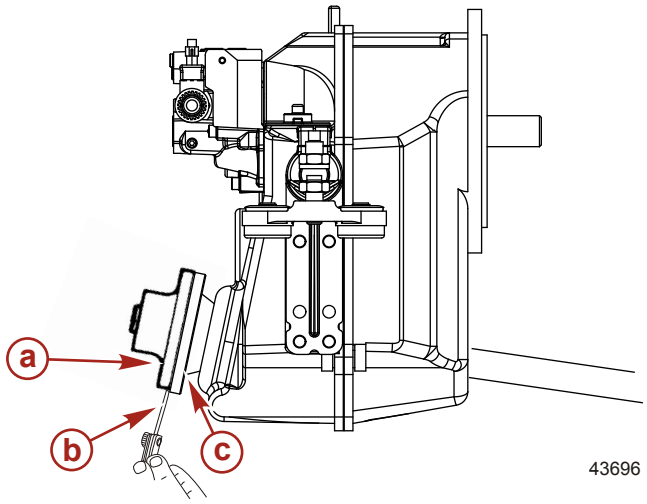
Correct

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

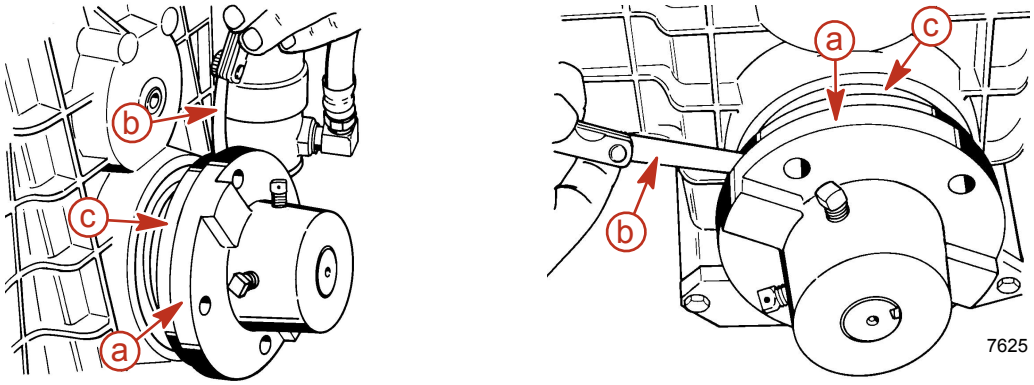


- **a -** Transmission output flange
- **b -** Propeller shaft coupler
- **c -** Propeller shaft
- **d -** Straight edge

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.



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



ZF Marine

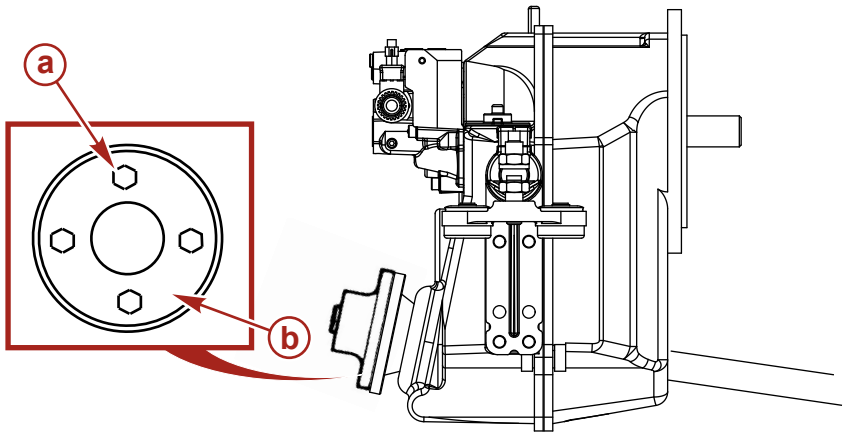
a - Propeller shaft coupler
b - Feeler gauge
c - Transmission output flange

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 mounts (or rear mounts) adjusting nuts must be turned equally to keep the engine level from side to side.
   NOTE: *Some rear mounts have 1 clamping screw and nut on each side.*
   b. To move the engine to the left or the right: Loosen the clamping bolts and nuts on all 4 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 the front end of some mounts. Loosen the lag bolts (which fasten mounts to 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. Tighten the clamping bolts and nuts on all 4 mount brackets to specification.

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

8. Tighten the locknut on all 4 mounts.
9. Bend one of the tabs on the tab washer down onto the flat of the adjusting nut.
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 coupling together with the bolts, lockwashers and nuts. Tighten the fasteners to specification.

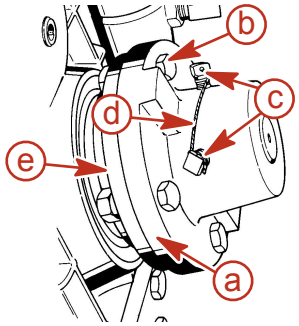


43697

a - Bolts
b - Transmission coupler

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

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



7627

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

Description	Nm	lb–in.	lb–ft
Coupling bolts and nuts	68	–	50

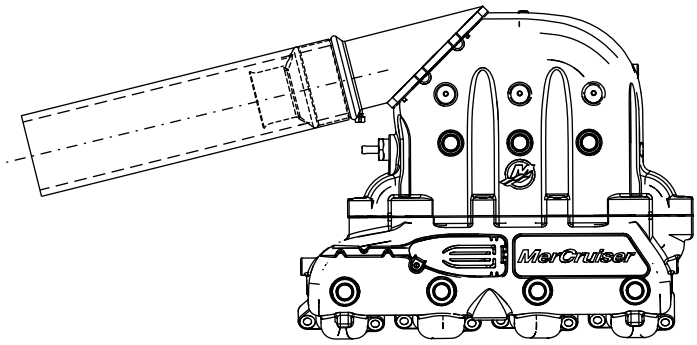
Exhaust System Hose and Tube Connection

NOTICE

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

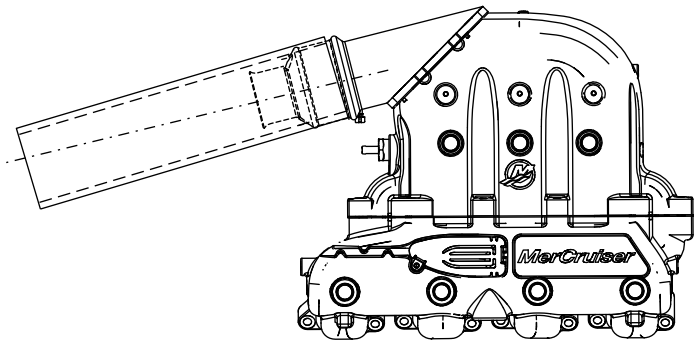
IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Install hoses on exhaust elbow outlets so discharge water from the exhaust elbow flows around the entire inside diameter of the hose.



31672

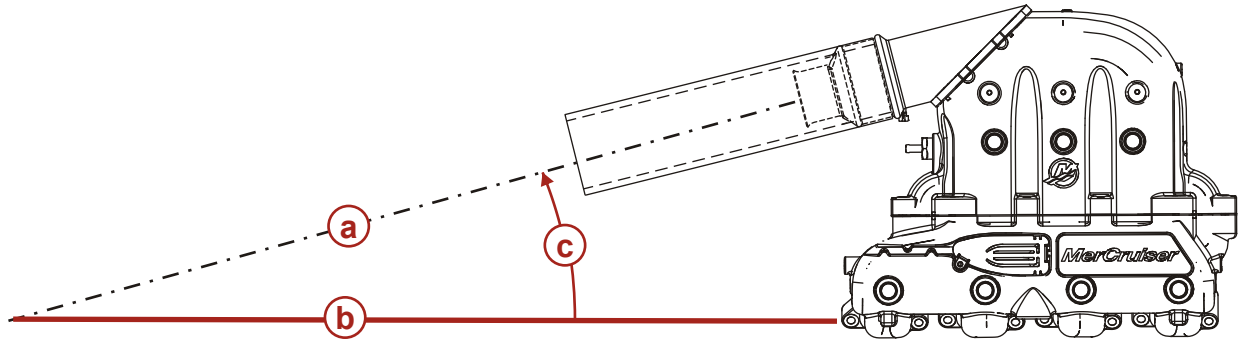
Correct alignment



31673

Incorrect connection

To avoid hot spots that can burn exhaust hoses, install the exhaust hoses at the angle shown below.

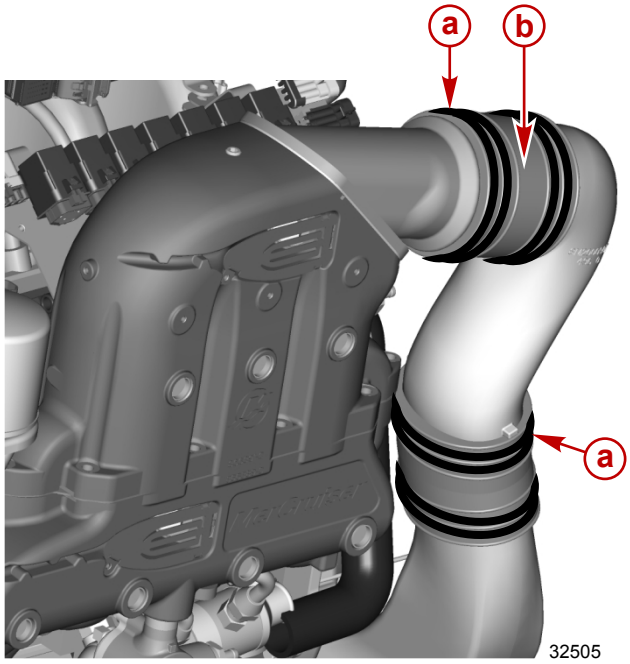


43665

a - Exhaust outlet centerline
b - Parallel with crankshaft centerline
c - Exhaust angle 14° ± 5°

Secure all exhaust hoses or tubes with at least two hose clamps. Tighten to specification.

NOTE: *The following example may not depict your model or installation.*

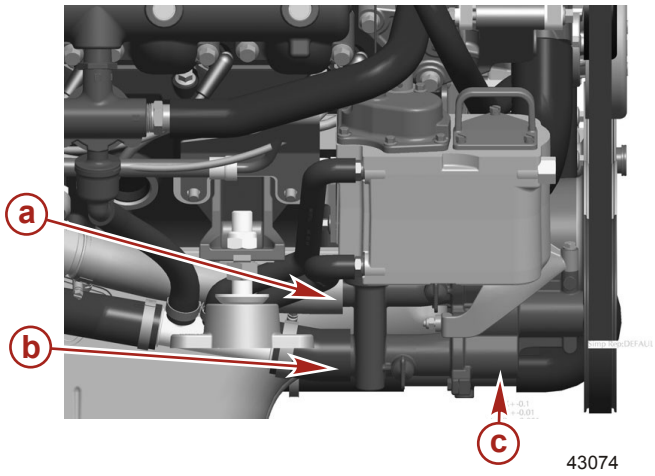


a - Clamps
b - Exhaust tubes

Fluid Connections Inboard Models

Seawater Pump Pickup Connection

1. Ensure the seawater inlet hose is connected to the upper hose fitting of the seawater pump. Connect the opposite end of the hose to the seawater inlet source.



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

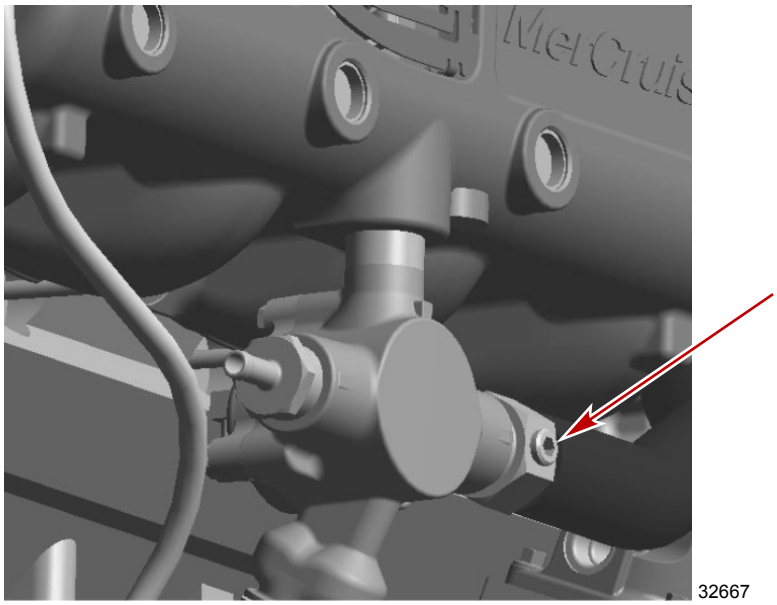
Shaft Log Seal Connection

NOTICE
Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.

1. Attach the shaft log seal cooling water hose fitting to the access port in the reducer fitting, located on the aft side of the poppet valve underneath the exhaust manifold.
   IMPORTANT: Do not remove the reducer fitting, even if you are not using the shaft log seal. The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system.

NOTICE

Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.



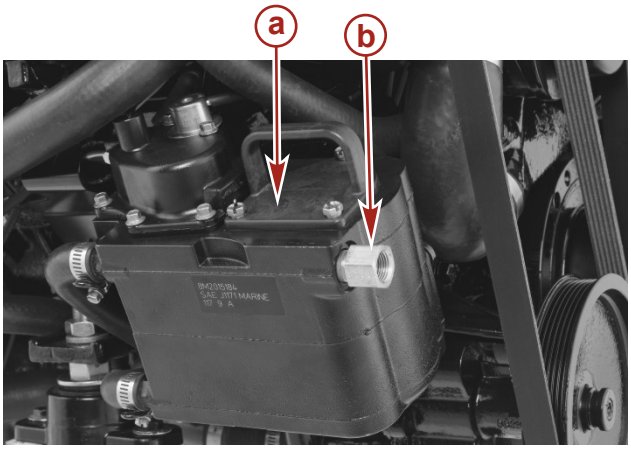
Shaft log seal access port

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

Fuel Line Connection

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

1. Remove the shipping plug from the fuel fitting.
2. Connect the flexible fuel line to the fuel fitting.
   IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.



a - Gen III Cool Fuel Module
b - Fuel fitting

Engine Electrical Connections

Electrical Connections

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

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

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

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

Boat Harness and Instrumentation Connections

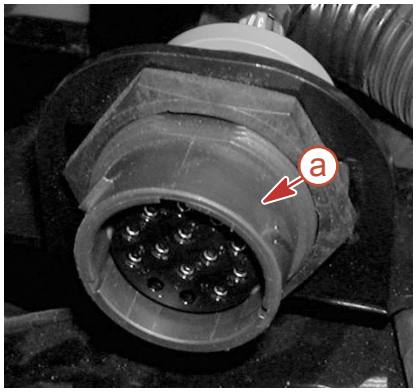
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses.

The four basic gauges that must be used with the engine are:

- Tachometer
- Oil pressure
- Water temperature
- Voltmeter

IMPORTANT: Maximum accessory load on the engine harness is 15 amps. If additional accessory load is needed, an accessory kit is available.

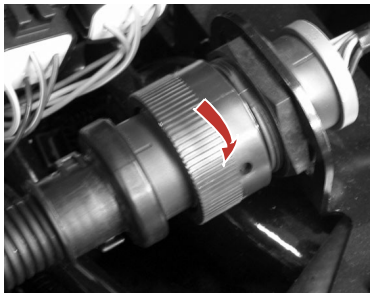
1. If an extension harness is required, connect the boat harness to the extension harness and connect the extension harness to the engine harness. Ensure that the harness does not rub or get pinched.
2. Fasten harnesses to boat at least every 46 cm (18 in.) using appropriate fasteners.



23135

Typical
a - Engine harness plug

3. Connect 14-pin harness to engine. Turn locking ring until firm snap is felt.



23136

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are engine rpm, coolant temperature, water pressure, battery voltage, fuel consumption, and engine operating hours. The Smartcraft instrument package will also aid in engine diagnostics.

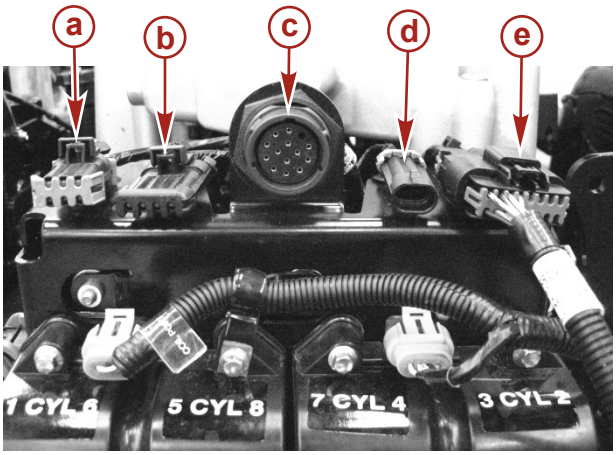
The SmartCraft instrument package will display critical engine alarm data and potential problems.

Refer to the Mercury SmartCraft Operator's Supplement (90-10229023) for the warning functions monitored and basic operation of the SmartCraft Instrument package. Refer to the instructions included with the instruments for installation instructions.

Engine Harness Connections

IMPORTANT: The 14-pin wiring harness can supply a maximum 15 amps of accessory power. An accessory relay and harness kit is available for higher accessory power needs.

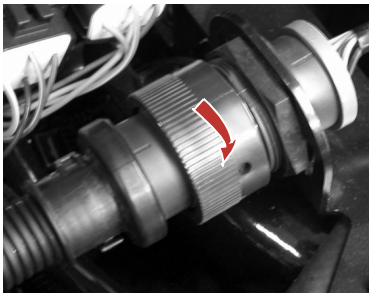
1. Route the instrumentation harness to the engine. Do not allow the harness to rub or get pinched. If an extension harness is required, secure the connection properly.
2. Fasten the harness to the boat at least every 45.7cm (18 in.), using appropriate fasteners.
3. Connect the following:



43698

a - Paddle wheel and tank level connector
b - Diagnostic connector
c - 14-pin harness connector
d - Power harness connector
e - Transmission connector

NOTE: *When connecting the 14-pin harness to the connector on the engine, turn the locking ring until a firm snap is felt.*



23136

NOTE: *Refer to Instrumentation Wiring Diagrams for specific wiring diagrams.*

Audio Warning System Connections

⚠ WARNING

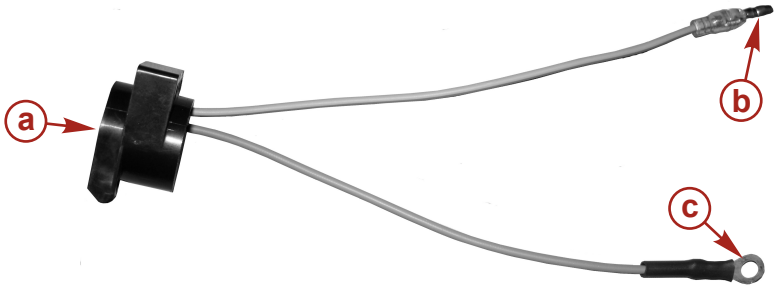
Installing non-potted electrical components in explosive environments can result in serious injury or death from fire or explosion. Install all non-potted electrical components such as warning alarms away from environments where fuel or fuel vapor is present such as engine or fuel tank compartments.

1. Select a location for the audio warning alarm that meets all of the following:
   - Alarm can be easily heard, yet is out of sight
   - Alarm can be easily accessed for installation and maintenance
   - Alarm will remain dry

- Alarm is within length limits of the 46 cm (18 in.) purple alarm wire that connects to the "I" terminal or 12 volt source on switched side of ignition switch.

NOTE: *The terminal to which wire is attached must have no voltage when ignition switch is in the OFF position.*

2. Place the alarm in desired location and secure it to wire bundle with the tie strap provided.
3. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.
4. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or ignition switch. Tighten the connection securely.



a - Alarm
b - TAN/ BLUE wire
c - PURPLE wire

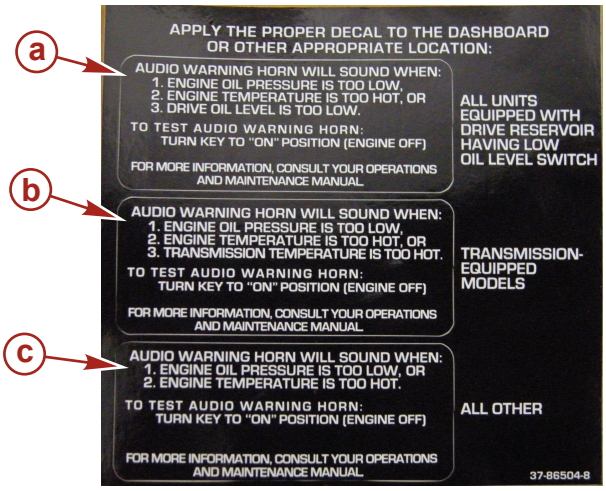
45019

5. Place the small transparent alarm decals on the bottom of the water temperature and the oil pressure gauges.

45021

Small transparent alarm decals

6. Choose the proper large decal for the engine package installed and place it on the instrument panel or other appropriate location easily viewed by the operator.



45020

a - Models equipped with a drive reservoir having low oil level switch
b - Models equipped with a transmission
c - All other models

7. Test the audio warning system as detailed.
   a. Turn the ignition switch to the "ON" position without cranking the engine.
   b. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

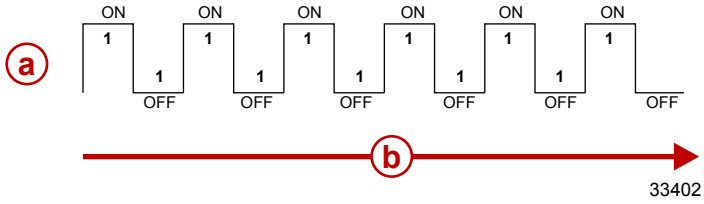
There are two warning horn states:

- Caution

- Severe

Caution

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

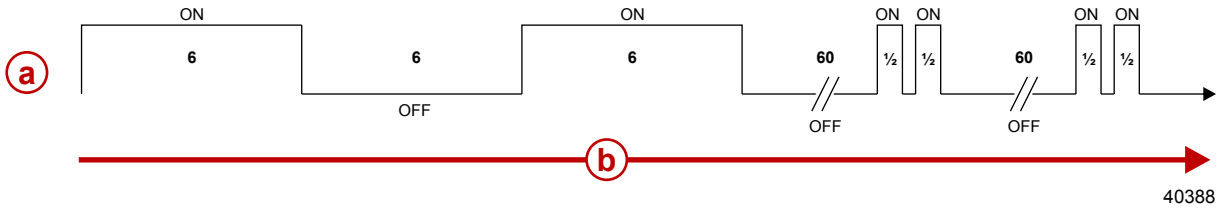
Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

Severe

IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Service Engine Light and OBD-M MIL Kit

Boats powered by Emissions Control Technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

SC 1000 gauge and service engine light

Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL light will remain illuminated for 4 seconds if the visual indication system is functioning correctly.

Battery Cables Connection

IMPORTANT: The engine's electrical system uses a negative (–) ground.

1. Connect the engine's positive (+) battery cable (usually RED) to the positive (+) battery terminal.
2. Connect the engine's negative (–) battery cable (usually BLACK) to the negative (–) battery terminal.
3. Install the power harness.
4. Secure the battery cables and the power harness leads to the battery with hex nuts. Tighten the hex nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Hex nut	13.5	120	–

5. Spray the battery terminals with a battery connection sealant to help prevent corrosion.

Engine Installation G3 Service Tool

Computer Diagnostic System (CDS) G3

Use the CDS G3 service tool for the following if applicable:

1. Configuration—Helm Configuration, CAN Pad Configuration, Drive Configuration, Compass Configuration, Import

47774

2. Active Test—Set Trailer Limit, Set Trim Limit, Set Engine Location, Set Tach Link

47775

Connecting the Computer Diagnostic System (CDS G3) Service Tool

NOTE: *The Computer Diagnostic System (CDS G3) procedural information is available in the help menu. If you have the CDS hardware, order the software and cable 8M0046124 from Mercury. The complete system is available from SPX.*

Computer Diagnostic System (CDS G3)	Order from SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124

Models Equipped With a SmartCraft Diagnostic Port

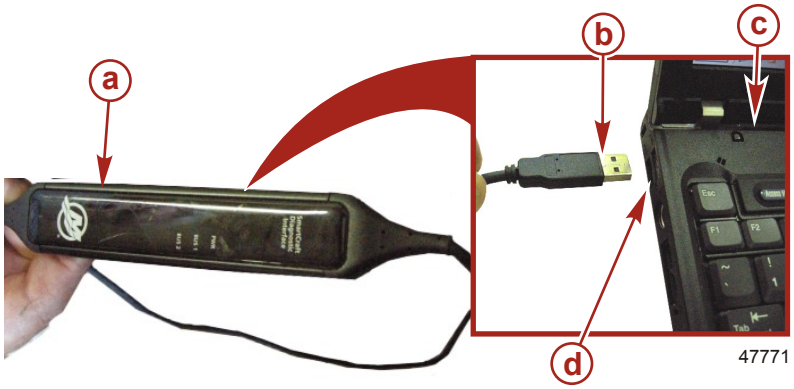
1. Ensure all engine key switches and engines are off.
2. Locate the SmartCraft diagnostic port at the boat helm.

   NOTE: *The diagnostic port may not be mounted on the dashboard if space is limited, but may be mounted under the dashboard, or in the cabin at an inconspicuous, but accessible location.*
3. Remove the cover and insert the CDS G3 interface harness connection.

47772

SmartCraft diagnostic port

4. Connect the CDS G3 interface USB port connector to the USB port on the G3 service tool.

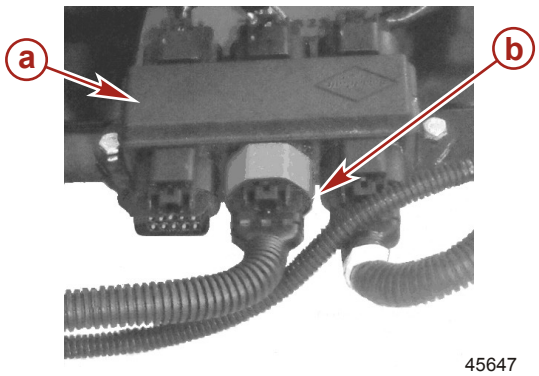


47771

a - CDS G3 interfacetool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

Models Equipped With a SmartCraft Diagnostic Junction Box

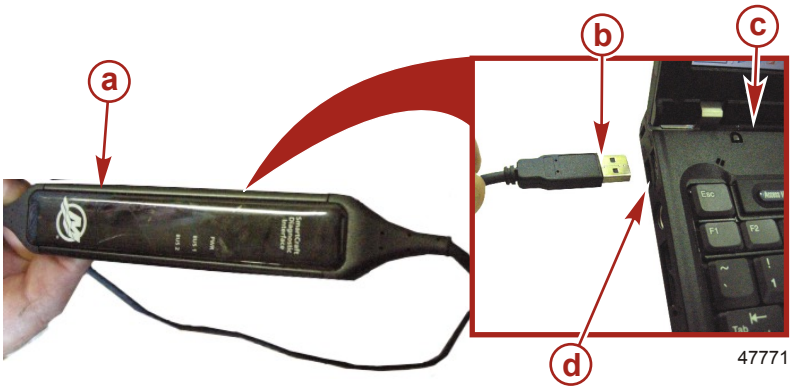
1. Ensure all engine key switches and engines are off.
2. Locate the standard junction box under the boat helm and connect the CDS G3 interface harness.



45647

a - Junction box
b - CDS G3 interface harness connector

3. Connect the CDS G3 interface USB port connector to the USB port on the CDS G3 service tool.



a - CDS G3 interface tool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

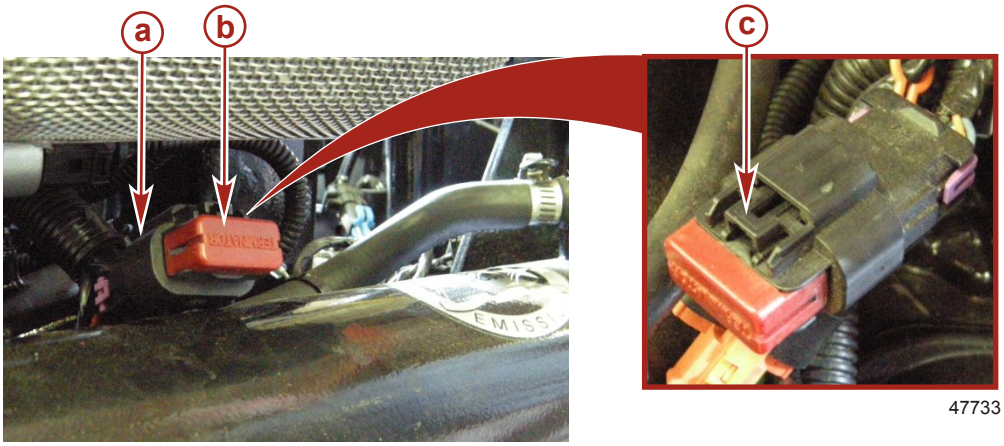
Models Not Equipped With SmartCraft Diagnostic Port or Junction Box

IMPORTANT: The CDS G3 termination harness is a terminal resistor. Only use it when connecting to the engine harness terminator connection. Do not connect the termination harness to the junction box or diagnostic port at the helm.

CDS G3 termination harness

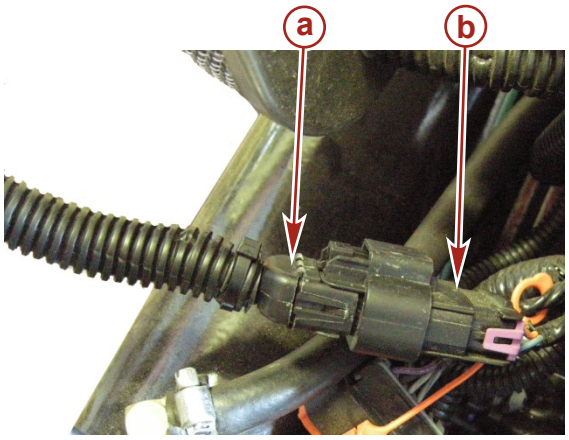
CDS G3 Termination Harness	84-8M0045065

1. Ensure all engine key switches and engines are off.
2. Locate the yellow or red terminator resistor on the engine harness and remove it by pushing the tab in while pulling the connections apart. Retain the yellow or red terminator resistor to reinstall after using the service tool.



Terminator resistor red or yellow
a - Terminator connection
b - Yellow or red terminator resistor
c - Tab

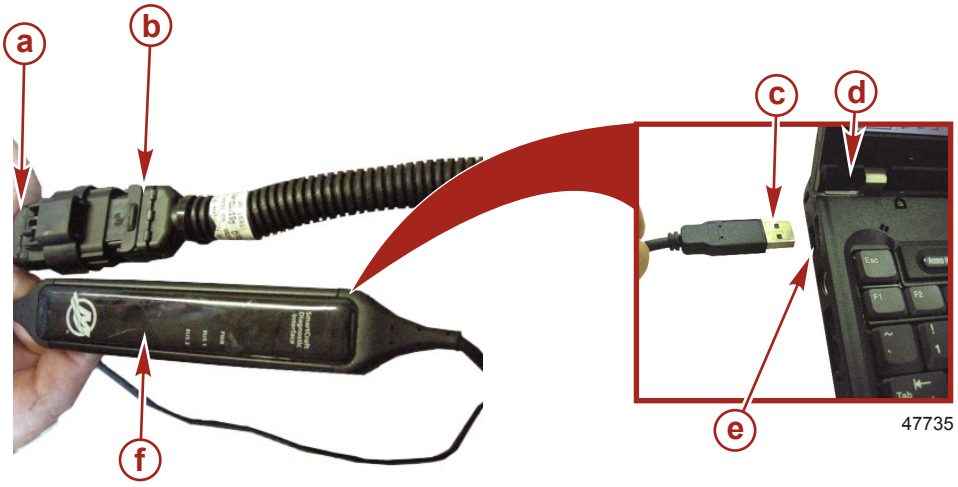
3. Connect the CDS G3 termination harness to the terminator connection on the engine.



47734

a - CDS G3 termination harness
b - Terminator connection

4. Connect the CDS G3 termination harness connector to the CDS G3 interface harness connector.
5. Connect the CDS G3 interface USB connector to the USB port on the CDS G3 service tool.

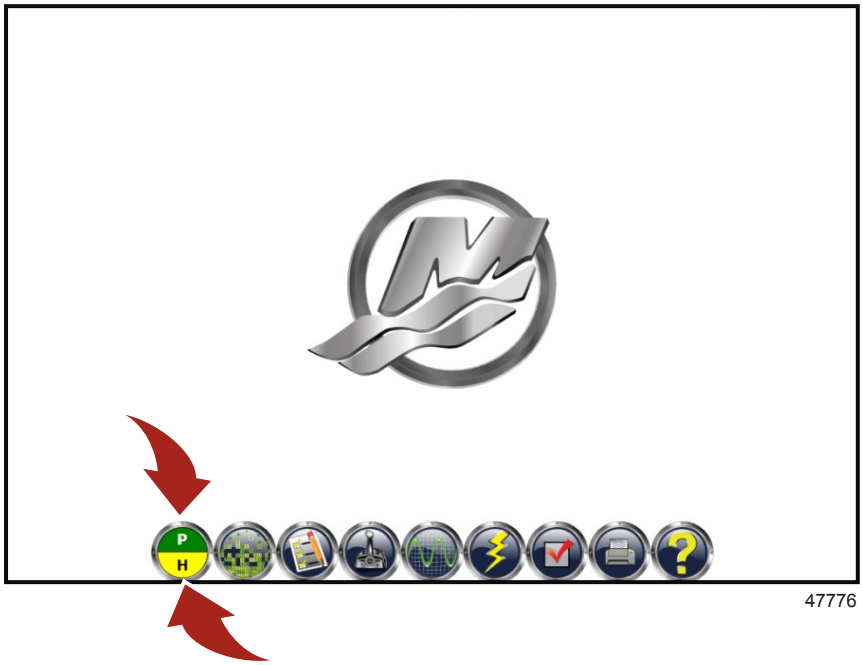


47735

a - CDS G3 interface harness connector
b - CDS G3 termination harness connector
c - CDS G3 interface USB connector
d - CDS G3 service tool
e - USB port on the CDS G3 service tool
f - CDS G3 interface tool

Inboard DTS Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the the connection problem.

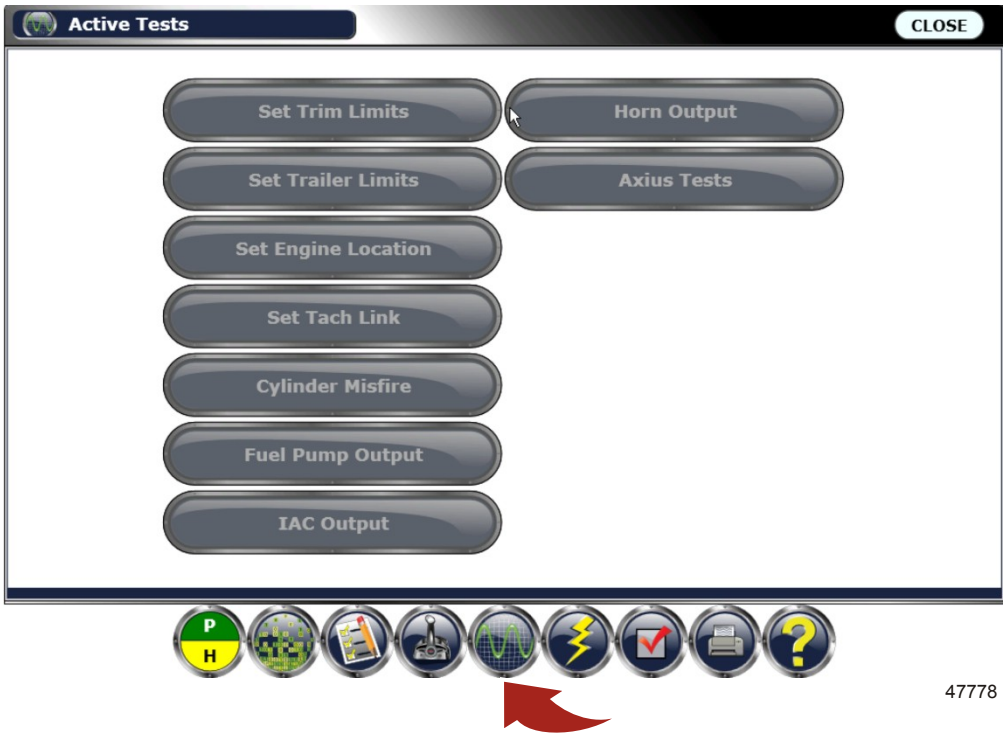


47776

2. Wait for the "Module Data" screen to appear.

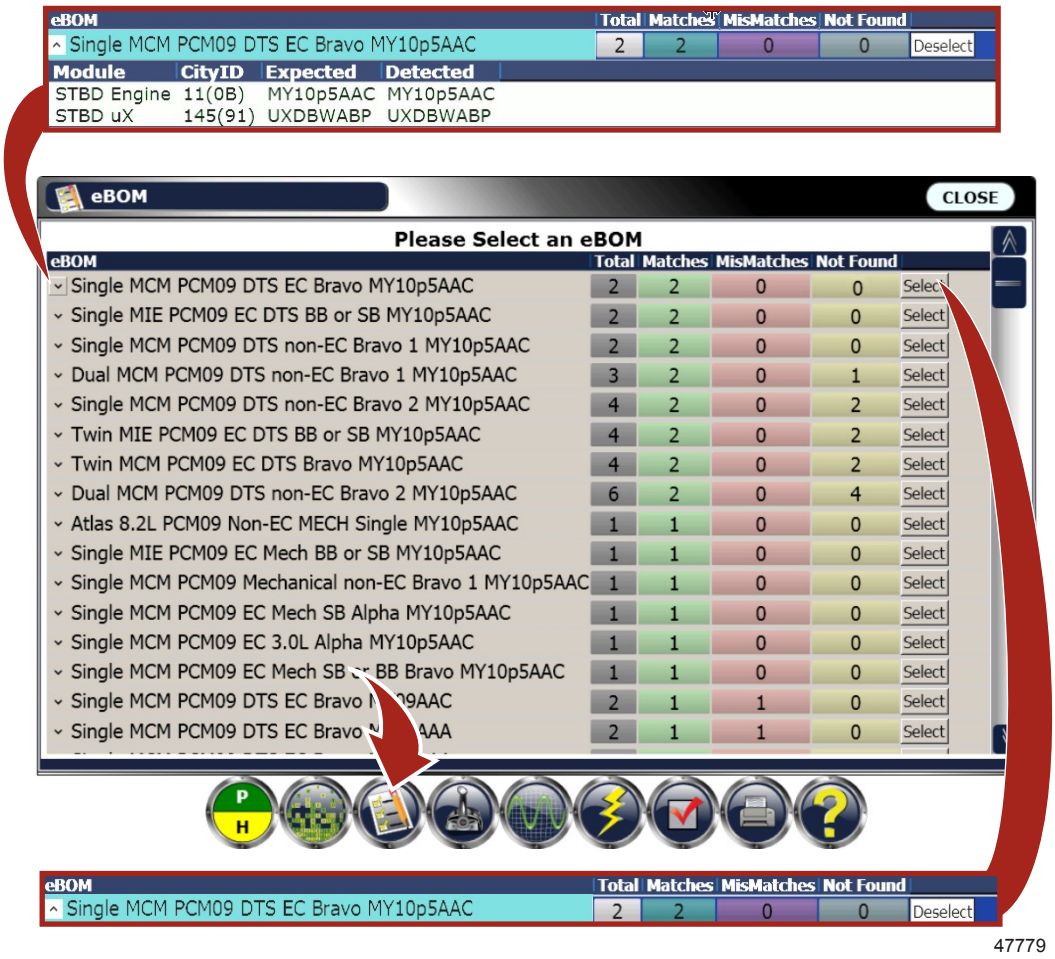
47777

3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

c. When you are finished, click on the Configuration icon to continue with the setup.

47782

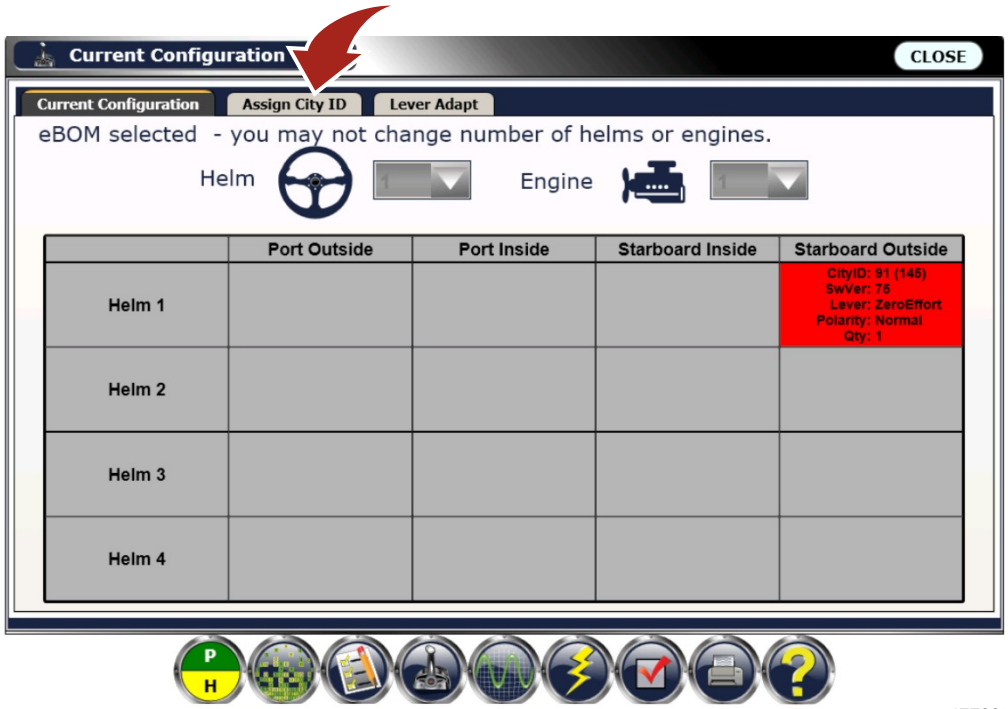
6. Select "Helm Configuration."

45499

7. Initiate "Helm Setup."

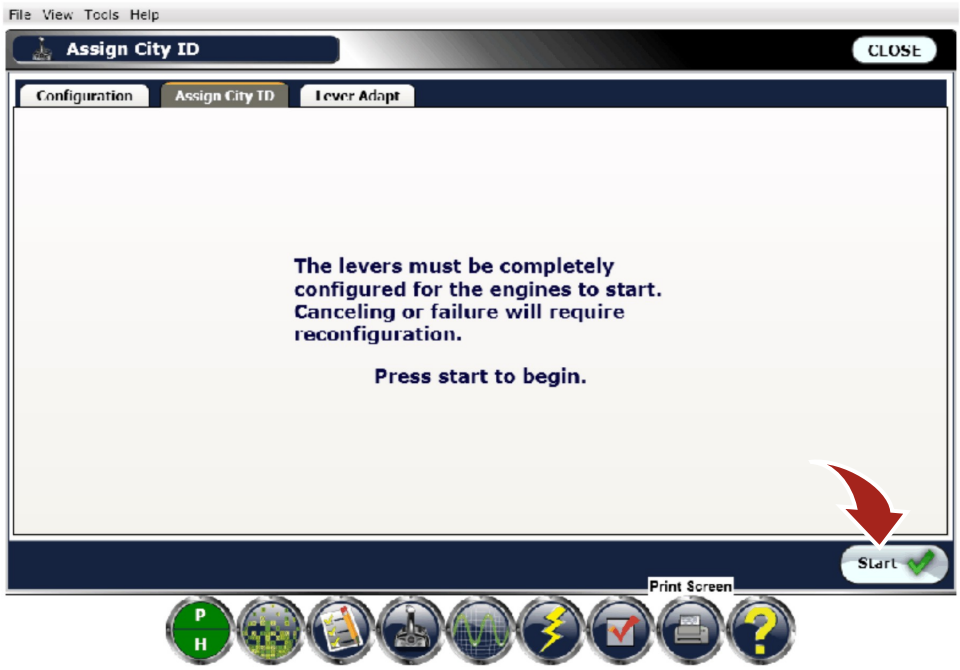
45500

8. Follow the on-screen directions presented by the G3 tool.
   a. Select the number of helms and engines to configure. You may need to wait a moment while the helm configuration is validated.
   b. Notice that the cell for the helm module will have a red background.
   c. Select "Assign City ID" to continue.



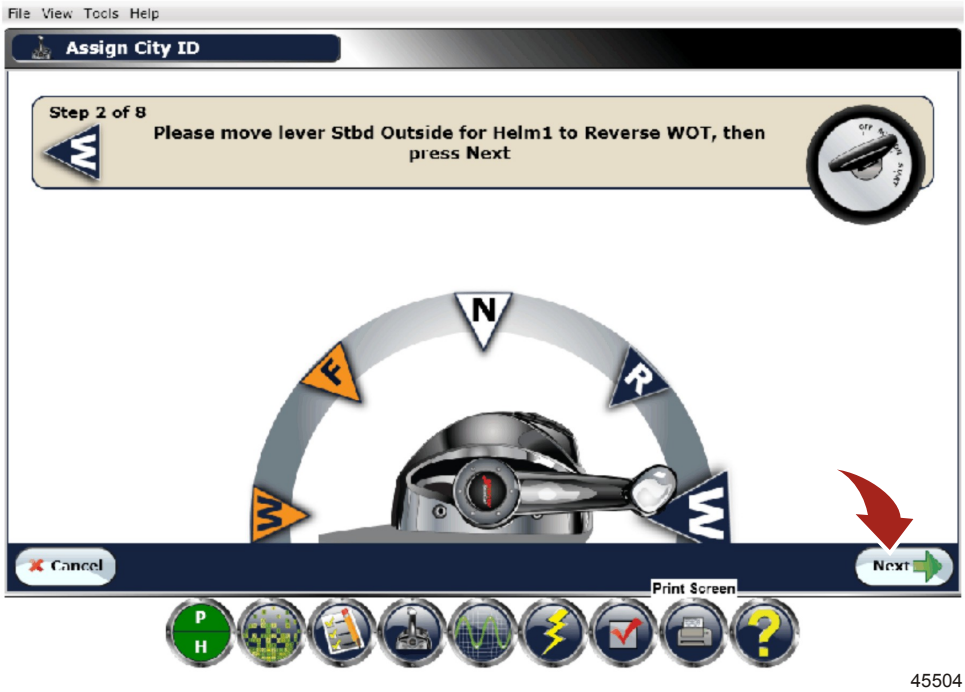
47780

9. Select "Start" to begin setup of the City ID.



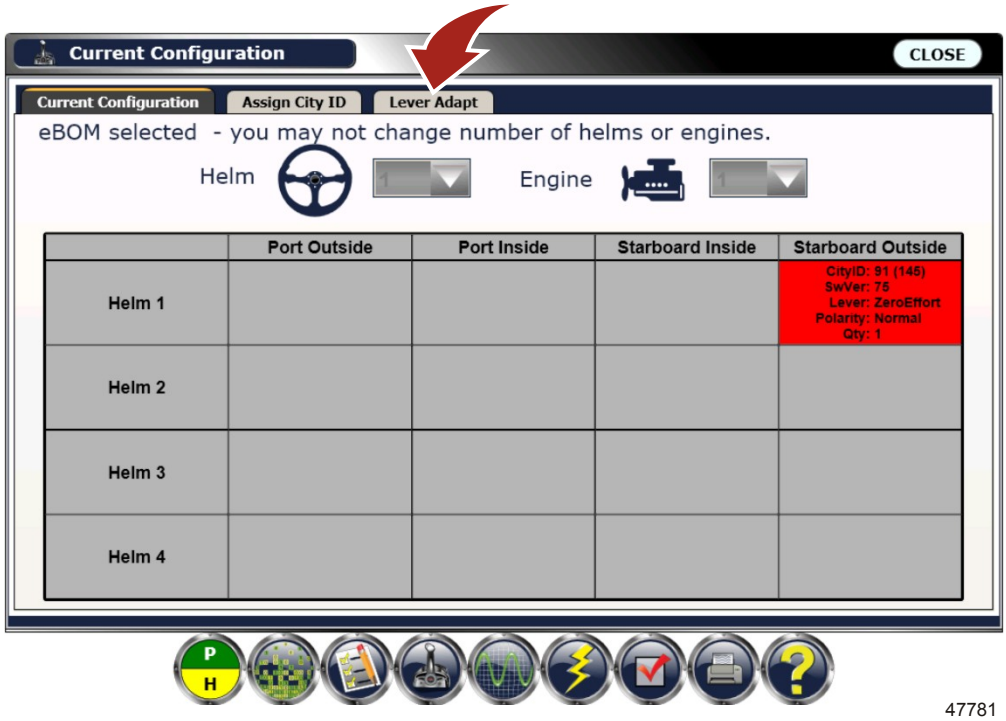
45503

10. Follow the on-screen directions, selecting "Next" to advance through the screens. When you reach the end of the on-screen directions, you may encounter a brief wait while the G3 tool updates the helm modules.



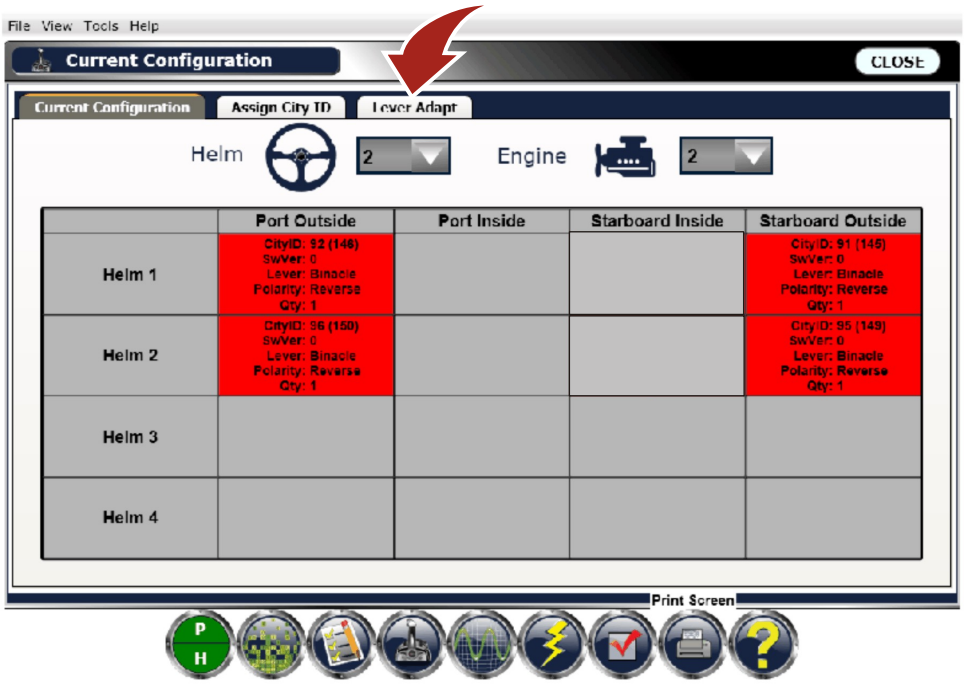
45504

11. The "Current Configuration" screen will display the City IDs assigned to all helm modules, although the cells will still have red backgrounds. You must select "Lever Adapt" to complete the helm configuration.



47781

Single engine example



47300

Multiple engine example

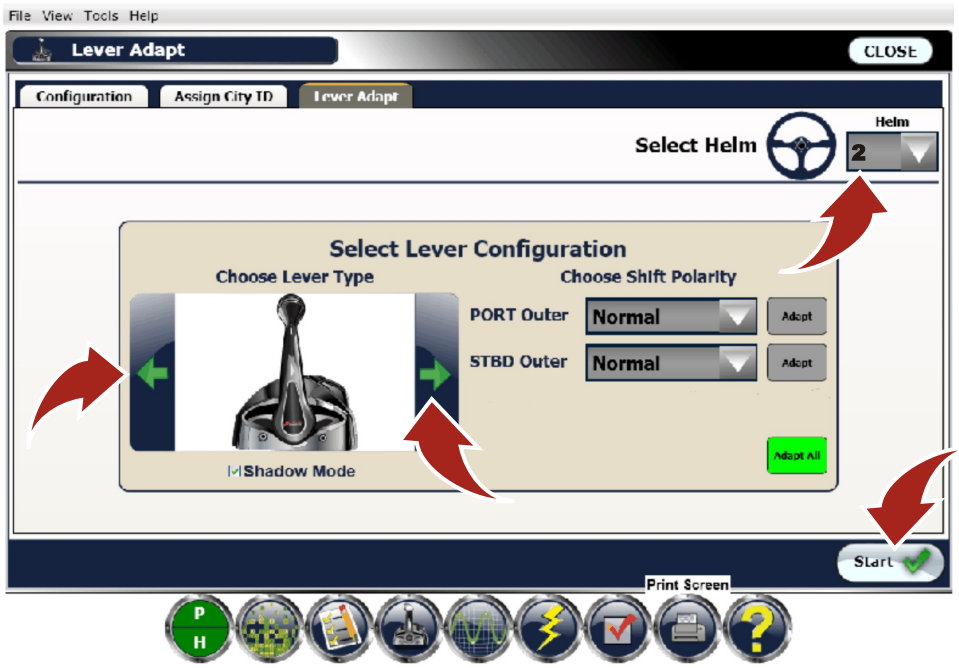
12. Select the helm to adapt, then choose the type of lever used at that helm. Click "Start" to begin the lever adaptation.

47301

13. Follow the on-screen directions, moving the control levers as instructed.

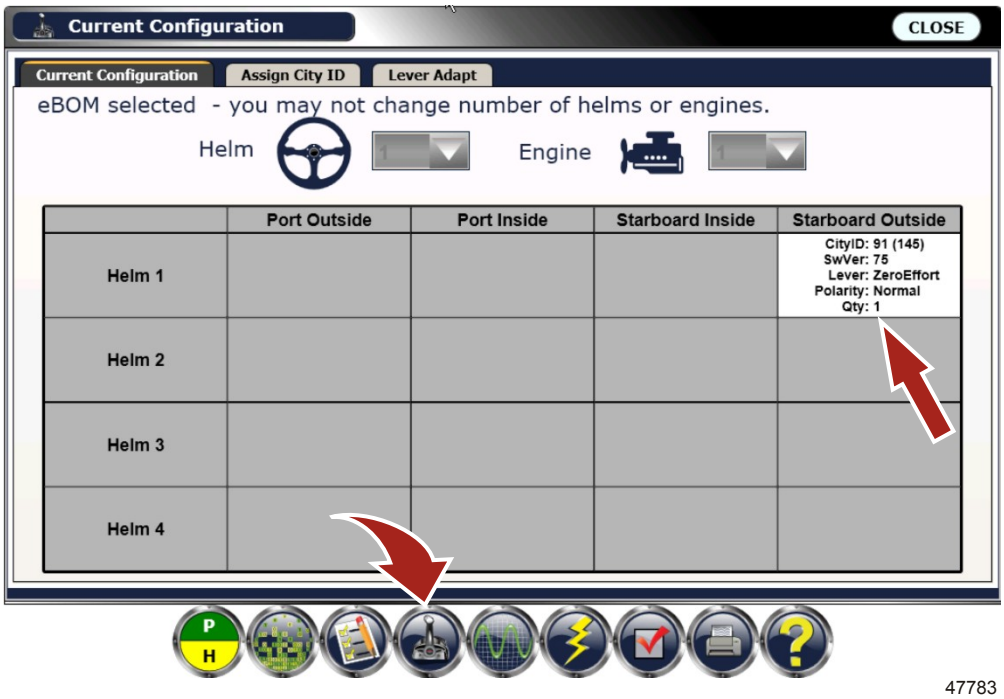
45507

14. Repeat the process for any additional helms. Be certain to select the helm number, choose the appropriate lever type for that helm, and follow the on-screen directions as before. Note that a slight wait may occur while the G3 tool updates the helm module.



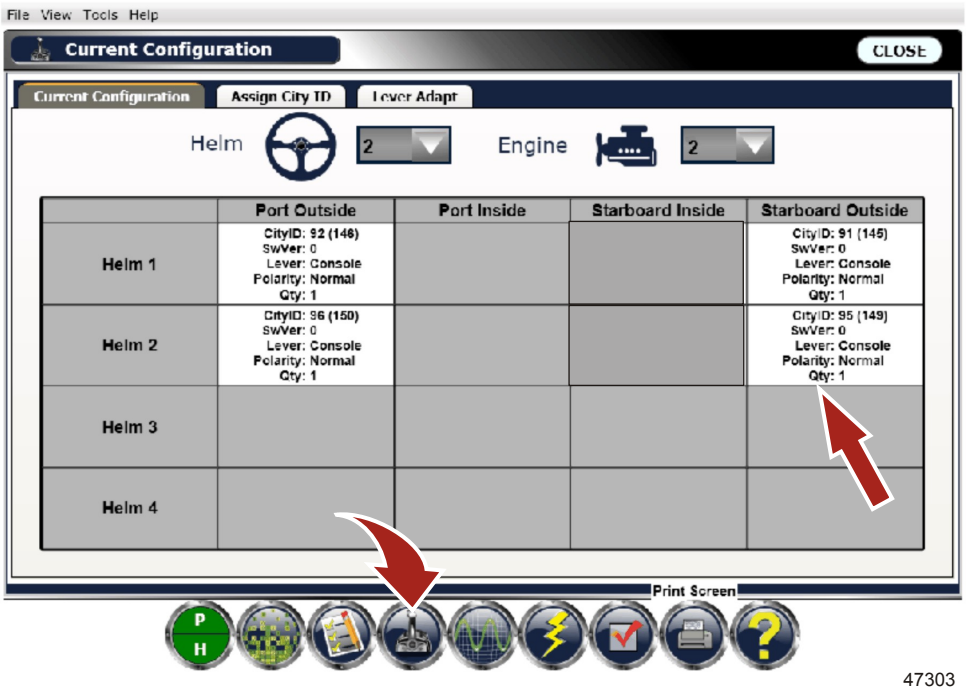
47302

15. After all levers have been adapted, the helm module cell backgrounds on the "Current Configuration" screen will be white. Select the Configuration icon to continue setup.



47783

Single engine example



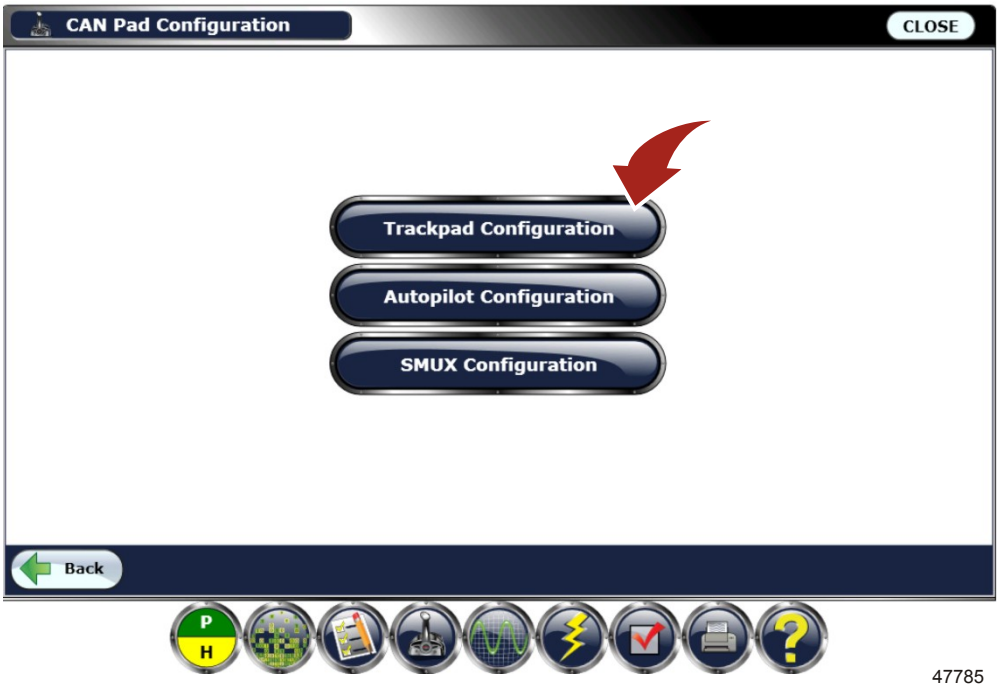
47303

Multiple engine example

16. Select "CAN Pad Configuration."

45550

17. Select "Trackpad Configuration," and follow the on-screen directions. The CAN pad must be installed for dual and multiple-engine applications.

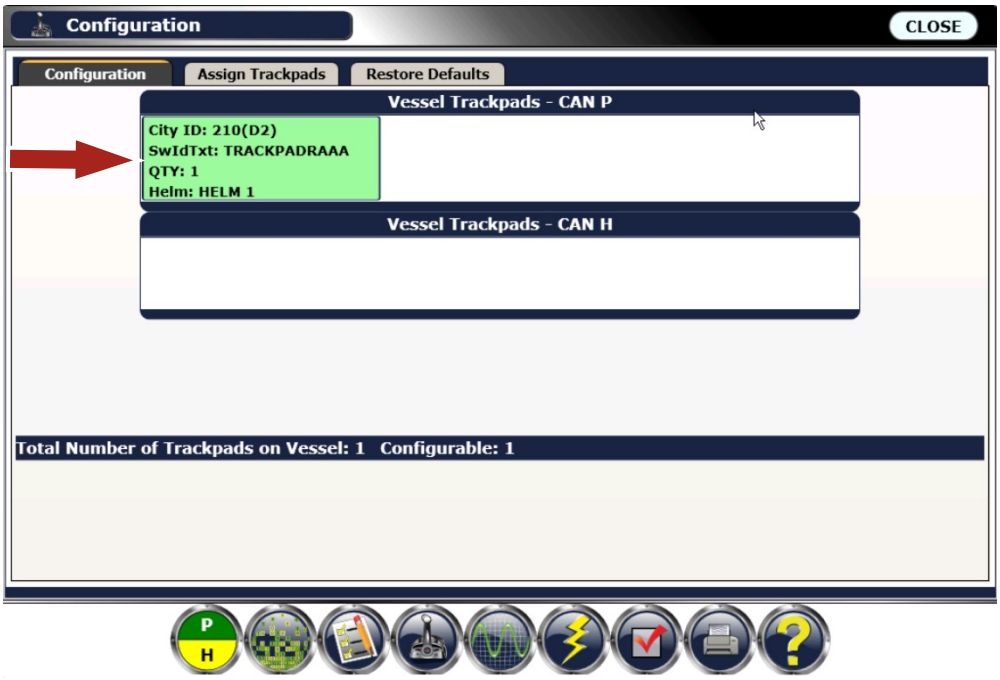


47785

18. Follow the directions in the G3 tool for assigning the City ID for the trackpads.
19. On the "Assign Trackpads" screen, select a helm and the number of trackpads at that helm; then click "Start" to begin. Complete the process for all applicable helms. Then click "Save" to save the configuration information.

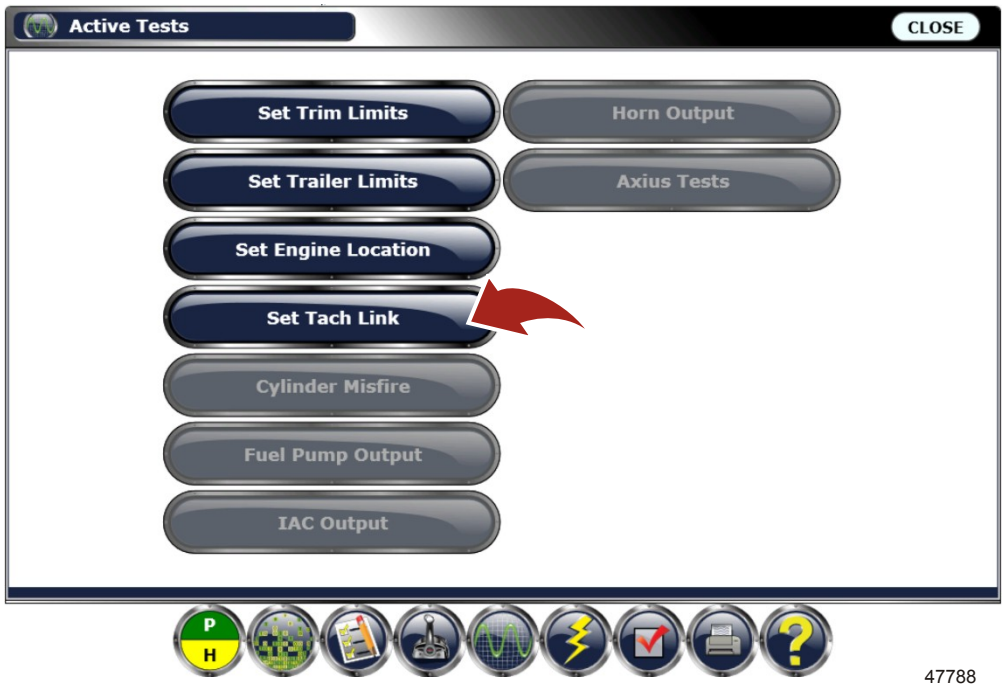
47787

20. When the trackpad assignment is complete, the trackpad City ID will turn green.



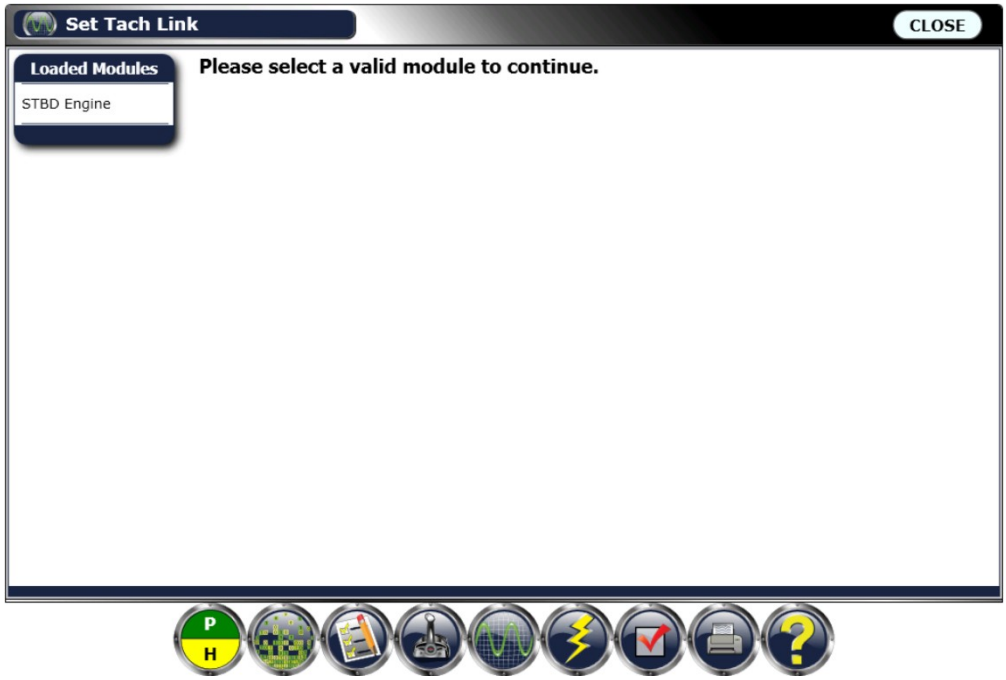
47786

21. If applicable, follow the same process for the DTS trackpads (CAN P).
22. Select "Active Tests."
23. Initiate the "Set Tach Link" procedure.

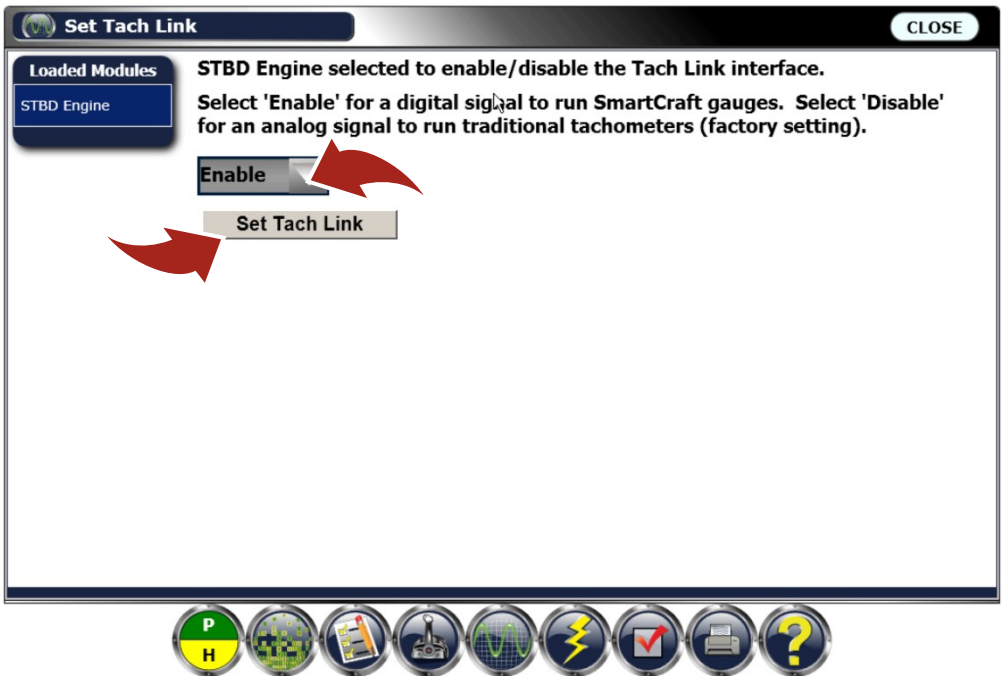


47788

24. Select the appropriate engine.

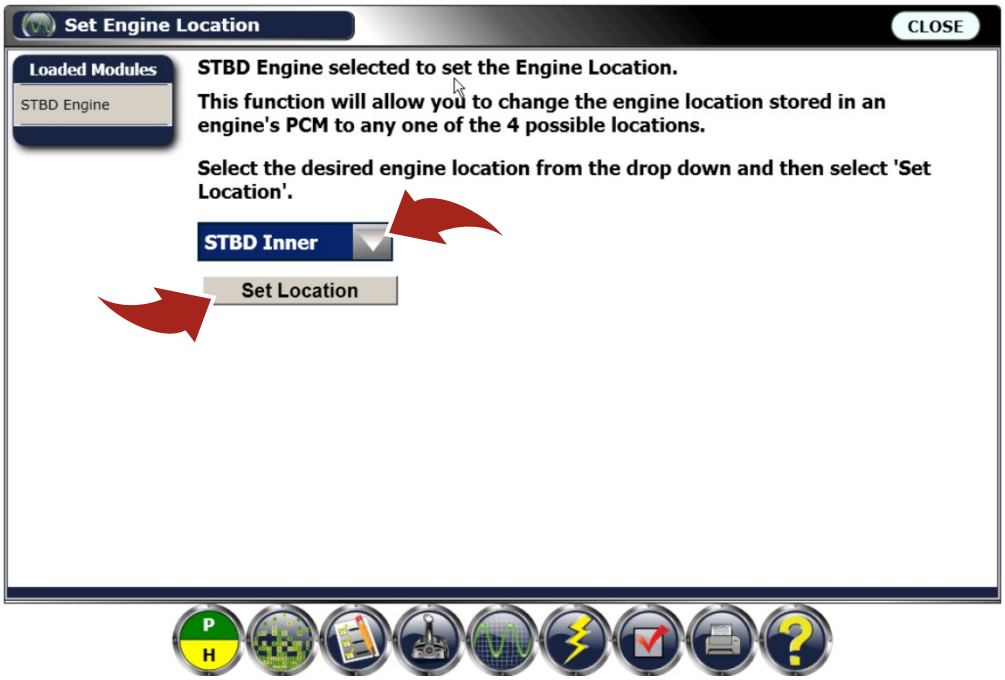


25. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.



47790

26. Use the drop-down box and "Set Location" button to change the engine location, if required.



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Notes:

Engine

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Cylinder head and valve cover surfaces Head gasket surfaces	Obtain Locally
9	Loctite 567 PST Pipe Sealant	Intake manifold bolts	92-809822
19	Perfect Seal	Cylinder head coolant passages Manifold gasket coolant passages Oil hose fitting	92-34227Q02
33	Loctite 680 Retaining Compound	Seal retainer mating surface Engine block/seal mating surface	92-809833
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Engine block end seal boss Rear main bearing cap sealing surface	92-809826
136	Lubriplate SPO 255	Valve lifters and camshaft lobes	Obtain Locally
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Cylinder head bolt thread, head, and washer Bearing surfaces and crankshaft journals Piston pin bore, piston pin, rod pin bore Connecting rod bearings Pistons, rings, cylinder walls Rod cap bearing surface Timing chain	92-858087K01

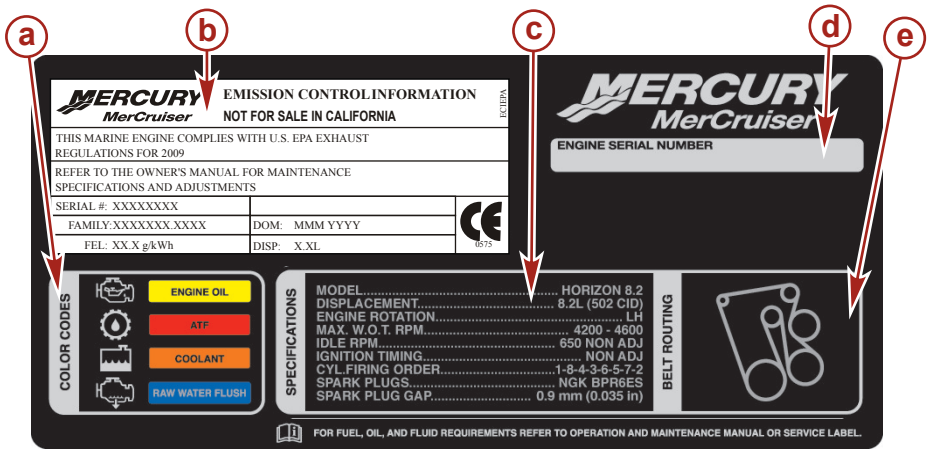
Replacement Parts Warning

⚠ WARNING

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

Information Decal

The information decal is located on the top starboard-side of the heat exchanger.

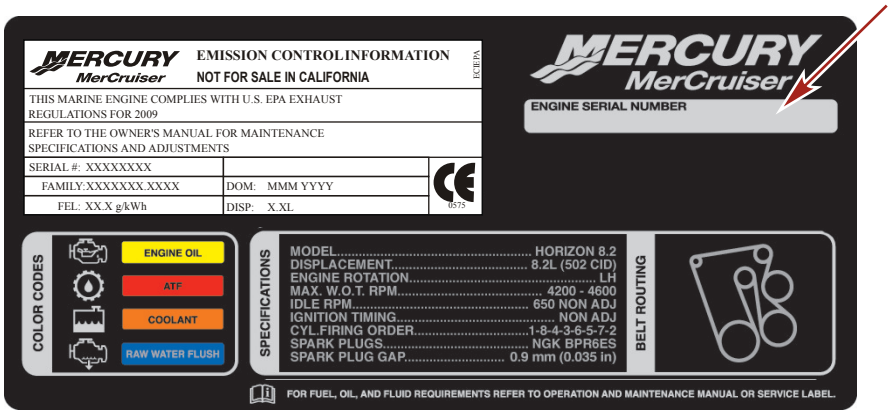


43688

a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Belt routing

Engine Serial Number Decal

The serial number decal is placed on the information decal.



43689

Engine serial number decal on heat exchanger

The engine serial number is also stamped in the engine block.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Engine Specifications

Description	8.2 MAG		8.2 MAG H.O.
Crankshaft horsepower	283 KW 380 HP at 4600 RPM		320 KW 430 HP at 5000 RPM
Peak crankshaft torque	667 Nm 492 lb. ft. at 3600 RPM		663 Nm 489 lb. ft. at 3600 RPM
Displacement L / cid	8.2 L 502 cid		
Bore	No. 1–6 cylinders	113.436 mm (4.4658 in.)	
	No. 7–8 cylinders	113.453 mm (4.6664 in.)	
Stroke	101.6 mm (4.0 in.)		
Compression ratio	8.75:1		
Maximum RPM at WOT	4400–4800 RPM		4600–5000 RPM
RPM rev limit	4950 RPM		5150 RPM
Idle speed in gear	650 RPM		
Idle speed in neutral	650 RPM		
Ignition system	Wasted spark control, PCM controlled (distributorless ignition with knock control)		
IAC duty cycle at idle RPM	Approximately 20%		
Fuel delivery system	EFI, sequential port fuel injection (cool fuel)		
Induction system	Normally aspirated		
Cooling system	Closed cooling with circulating pump; single-stage sea pump for raw water, coolant to raw water heat exchanger, Dex-Cool 50/50 mixture		
Thermostat	76 °C (169 ºF)		
Minimum allowable seawater pressure at WOT	115 kPa (17 psi)		
Maximum allowable seawater pressure at WOT	296 kPa (43 psi)		
Fuel pump pressure	281–305 kPa (40.8–44.2 psi)		
Compression pressure (engine at normal operating trempérature) —all cylinders should be within 20% of each other	965 kPa (140 psi)		
Firing order	1-8-4-3-6-5-7-2		
Electrical system	12 volt negative (–) ground		
Alternator rating	65 amps (847 Watts at 13.03 volts)		
Recommended battery rating	Minimum 750 CCA, 850 MCA or 180 amp / hrs.		

Oil Temperature and Pressure

NOTE: *The 8.2 engine does not have an oil temperature sensor. However, the oil temperature specifications are helpful for service and troubleshooting. To measure the oil temperature, temporarily install a thermocouple or sensor.º*

Peak Oil Temperature	Specification
Upstream of oil cooler at 4800-5000 RPM WOT (ie, sump oil temperature)	120–140º C (257–284º F)
Downstream of oil cooler at 4800-5000 RPM WOT (ie, main gallery oil temperature)	90–115º C (194–239º F)

Typical Oil Pressure	Specification
Engine at WOT (hot) (After running a minimum of 3 minutes at 4400-5000 RPM WOT)	280–460 kPa (41–67 psi)
Engine at idle (hot) (Within 30 sec following throttle chop from 4800-5000 RPM WOT to idle)	80–220 kPa (12–32 psi)
Engine at idle (warm)	220–320 kPa (32–46 psi)
Engine at idle (cold)	320–450 kPa (46–65 psi)

Cylinder Bore

Cylinder Bore		Specification
Diameter		No. 1–6 cylinders 113.424 - 113.442 mm (4.4655 - 4.4662 in.)
		No. 7–8 cylinders 113.444 - 113.462 mm (4.4663 - 4.4670 in.)
Out-of-round (production and service)		0.0254 mm (0.001 in.) max
Taper	Thrust side	0.0127 mm (0.0005 in.) max
	Relief side	0.0127 mm (0.0005 in.) max
	Service	0.0381 mm (0.0015 in.) over production

Piston

Piston		Specification
Clearance	No. 1–6 cylinders	0.044 - 0.076 mm (0.0017 - 0.0030 in.)
	No. 7–8 cylinders	0.064 - 0.096 mm (0.0025 - 0.0038 in.)

Piston Ring

Compression Ring		Specification
Groove side clearance	Top	0.02 - 0.085 mm (0.0008 - 0.0033 in.)
	2nd	0.01 - 0.058 mm (0.0004 - 0.0022 in.)
Gap	Top	0.28 - 0.43 mm (0.0110 - 0.0169 in.)
	2nd	0.40 - 0.65 mm (0.0157 - 0.0255 in.)

Oil Ring	Specification
Groove side clearance	0.008 mm (0.0003 in.) interference to 0.176 mm (0.0070 in.) clearance
Gap (rails / oil scrapers)	0.15 - 0.66 mm (0.0060 - 0.0260 in.)

Piston Pin

Pin	Specification
Diameter	22.997 - 23.000 mm (0.9054 - 0.9055 in.)
Clearance in piston	0.0040 - 0.0130 mm (0.00016 - 0.00051 in.)
Clearance in rod	0.0150 - 0.0280 mm (0.00059 - 0.00110 in.)

Crankshaft

Crankshaft			Specification
Main journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out-of-round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Main bearing clearance	Production and service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)
Crankshaft end play			0.152 - 0.254 mm (0.006 - 0.010 in.)
Connecting rod journal	Diameter		55.8546 - 55.8673 mm (2.1990 - 2.1995 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out-of-round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Rod bearing clearance		Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
		Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max
Rod side clearance			0.305 - 0.61 mm (0.012 - 0.024 in.)
Crankshaft runout at No.3 main bearing			0.088 mm (0.0035 in.) max

Cylinder Head

Cylinder Head	Specification
Gasket surface flatness	0.1016 mm (0.004 in.) overall; 0.0508 mm (0.002 in.) per 15.2 x 15.2 cm (6.00 x 6.00 in.) span/area
Valve guide diameter (intake and exhaust)	9.479 - 9.497 mm (0.3732 - 0.3739 in.)

Valve System

Valve System		Specification
Lifter		Hydraulic / Roller
Rocker arm ratio		1.7:1
Face angle (intake & exhaust)		45°
Seat angle (intake & exhaust)		45°
Seat runout (intake & exhaust)		0.0508 mm (0.002 in.)
Seat width	Intake	2.032 +/- 0.1524 mm (0.080 +/- 0.006 in.)
	Exhaust	3.175 +/- 0.1524 mm (0.125 +/- 0.006 in.)
Stem clearance	Intake	0.0178 - 0.061 mm (0.0007 - 0.0024 in.)
	Exhaust	0.0482 - 0.0914 mm (0.0019 - 0.0036 in.)
Stem diameter	Intake	9.436 - 9.461 mm (0.3715 - 0.3725 in.)
	Exhaust	9.406 - 9.431 mm (0.3703 - 0.3713 in.)
Valve margin	Intake	1.27 mm (0.050 in.)
	Exhaust	1.651 mm (0.065 in.)
Valve diameter ± 0.127 mm (0.005 in.)	Intake	57.15 mm (2.25 in.)
	Exhaust	47.78 mm (1.881 in.)

Valve Spring

Valve Spring			Specification
Inner valve spring (no stripe)	Free length		48.76 mm (1.92 in.)
	Force	Closed at 46.99 mm (1.85 in.)	147 - 165 N (33 - 37 lbf)
		Open at 31.1 mm (1.225 in.)	576 - 625 N (129.5 - 140.5 lbf)
	Installed height		43.18 mm (1.70 in.)
Outer valve spring (blue stripe)	Free length		52.78 mm (2.078 in.)
	Force	Closed at 45.72 mm (1.800 in.)	338 - 374 N (76 - 84 lbf)
		Open at 29.85 mm (1.175 in.)	1112 - 1201 N (250 - 270 lbf)
	Installed height		45.75 mm (1.80 in.)

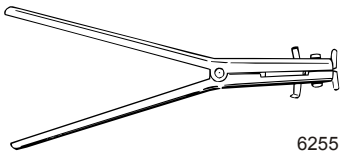
Roller Camshaft

Roller Camshaft		Specification
Lobe lift	Exhaust	8.327 mm (0.327 in.)
	Intake	7.569 mm (0.298 in.)
Duration (crank angle) 1.27 mm (0.050 in.) valve lift	Exhaust	254°
	Intake	236°
Journal diameter		49.479 - 49.522 mm (1.948 - 1.9497 in.)
Journal out-of-round		0.0508 mm (0.002 in.) max
Camshaft runout		0.0508 mm (0.002 in.) max
Timing chain deflection		12.7 mm (0.50 in.) from taut position

Flywheel

Flywheel	Specification
Runout	0.203 mm (0.008 in.) max

Special Tools

Piston Ring Expander	**91-24697**
Description: Removes and installs the piston rings.	 6255

Torque Specifications

Description	Nm	lb. in.	lb. ft.
Alternator bracket to engine	41	–	30
Alternator to mounting bracket (pivot)	27	–	20
Alternator to mounting bracket (anchor)	27	–	20
Coil to bracket	11	–	8
Electrical center bracket to cylinder head	54	–	40
Camshaft sprocket	27	–	20
Camshaft thrust plate	11	–	8
Connecting rod caps (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn		
Coupler/Flywheel (MCM)	48	–	35
Crankshaft pulley	48	–	35
Damper attaching bolt	244	–	180
Crossover to block	66	–	49
Cylinder head (follow 3 step procedure)	95	–	70
Exhaust manifold	47	–	35
Flame arrestor to throttle body	6	55	-
Flywheel	95	–	70
Flywheel housing to block	41	–	30
Flywheel housing cover	13	114	–
Heat exchanger to crossover	19	–	14
Lifter hold down	20	–	15
Intake manifold (follow 2 step procedure)	48	–	35
Plenum to intake	24	–	18
Main bearing caps (follow 2 step procedure)	149	–	110
Oil baffle nuts	35	–	26
Oil filter adapter	47	–	35
Oil pan bolts	20	–	15
Oil pan drain plug	27	–	20
Oil pump	95	–	70
Oil pump driver mechanism	20	–	15

Description	Nm	lb. in.	lb. ft.
Oil pump cover	11	–	8
Power steering pump brace to block	66	–	49 (large)
Power steering pump bracket	47	–	35 (small)
Engine mount	38	–	28
Remote oil connector (1/2 in. x 13)	34	–	25
Rocker adjusting lock set screw	34	–	25
Rocker arm studs	75	–	55
Remote oil filter adapter nut/fitting	27	–	20
Seawater pump brace to engine mount	41	–	30
Seawater pump bracket	66	–	49 (large)
	41	–	30 (small)
Spark plug	20	–	15
Starter motor	44	–	33
Throttle body to plenum	11	96 (DTS)	–
	14	120 (mech)	–
Timing cover	11	96	–
Valve cover nuts	14	120	–
Valve cover stud	13	112	–
Water circulating pump	47	–	35

Fuel Supply Connections

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

- Apply #592 Loctite Pipe Sealant with PTFE to threads of brass fitting or plug.
- Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.
- Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns. Do not overtighten.
- Install fuel line. To prevent over-tightening, hold brass fitting with a wrench and tighten fuel line connectors securely.

Service Precautions

IMPORTANT: The following information must be adhered to when working with the fuel system:

- Always keep a dry chemical fire extinguisher at the work area.
- Do not replace fuel pipe with fuel hose.
- Observe all Warnings and Cautions.

⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

NOTICE

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

Recommendations

IMPORTANT: Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing a fuel delivery system.

Valve Covers

Removal

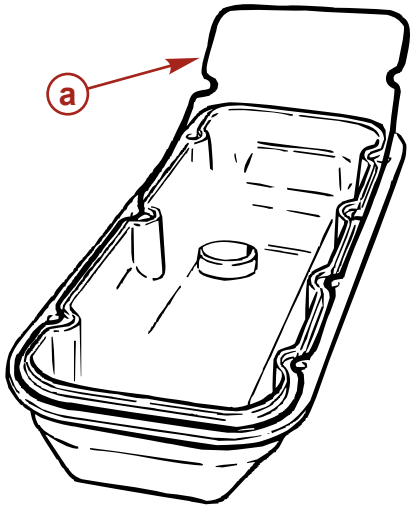
1. Disconnect the crankcase ventilation hoses.
2. Remove the coolant reservoir and bracket.
3. Remove the shift bracket or DTS shifter and bracket assembly.
4. If equipped, remove the gear lube bottle from the bracket.
5. If equipped, remove the oxygen sensors and EMCT sensors.
6. Remove the engine exhaust system or move it out of the way.
7. Remove the valve cover attaching nuts.
8. If applicable, remove the special stud.
9. Remove the valve cover.

Installation

1. Clean the sealing surfaces on the cylinder head and valve cover with a cleaner degreaser.

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Cylinder head and valve cover surfaces	Obtain Locally

2. Place the valve cover gasket in the groove of the valve cover.

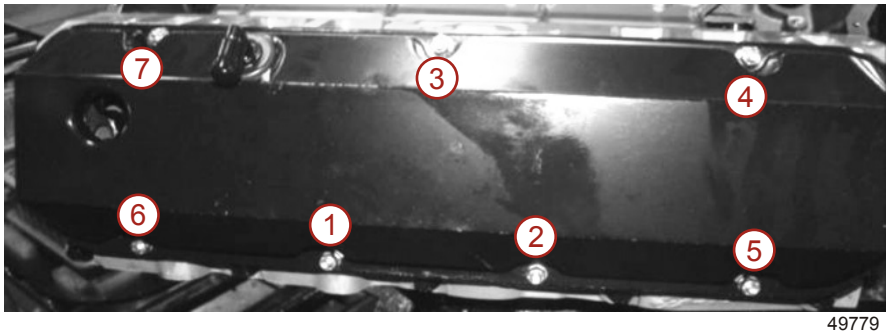


6257

a - Valve cover gasket

3. Align the valve cover with the studs and place the valve cover on the head.
4. If removed, install the special stud.
5. Place a washer and hand start a nut on each stud.

6. Tighten the valve cover nuts and special stud (if equipped) to specification.



49779

Valve cover torque pattern

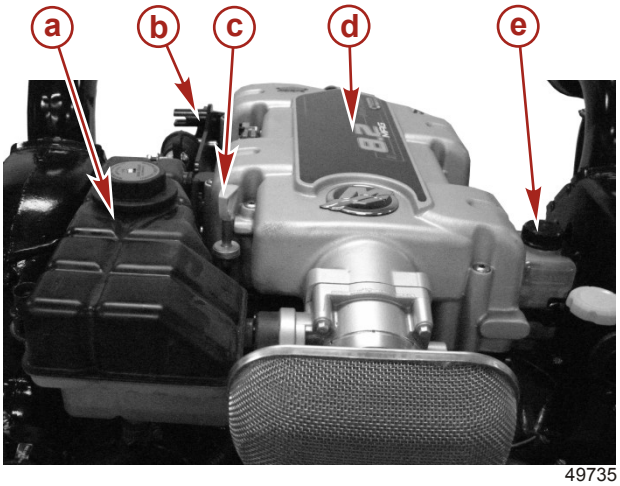
Description	Nm	lb. in.	lb. ft.
Valve cover nuts and special stud	14	120	–

7. Install the engine exhaust system.
8. Install items that were removed to allow access to the valve covers.
9. Connect the crankcase ventilation hoses to the valve covers.
10. Start the engine and check for oil leaks.

Intake Plenum and Manifold

Removal

1. Remove the engine block drain plugs and drain the closed cooling system.
2. Remove the coolant reservoir and bracket.
3. Remove the shift bracket or DTS shifter and bracket assembly.
4. If equipped, remove the gear lube bottle from the bracket and harness.



49735

a - Coolant reservoir
b - DTS shifter and bracket assembly
c - Oil dipstick
d - Intake plenum
e - Gear lube bottle

5. If equipped, disconnect sensors:
   - TPS
   - IAT
   - MAP
   - IAC
   - MAT
   - EMCT
   - Oxygen Sensor
   - Crankshaft position sensor
   - Camshaft position sensor

6. Disconnect the hoses from the PCV valve, crankcase ventilation hose, fuel pressure regulator, and fuel pump vent to the upper plenum.
7. Remove and retain the intake plenum bolts.
8. Remove the intake plenum. Refer to **Intake Plenum**.
9. It is optional to loosen the two nuts securing the electrical mounting bracket and allow the bracket with the components to tilt back out of the way.
10. Disconnect the fuel injector and fuel pressure switch electrical connectors.
11. Remove the stay straps securing the engine wiring harness and move the harness away from the intake manifold.

⚠ WARNING

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

13. Bleed the fuel pressure from the fuel rail at the shrader valve. Refer to **Relieving Fuel System Pressure**.
14. Remove the fuel inlet line from the fuel rail fitting. Refer to **Fuel Rail**.
15. Remove the PCV valve and vent line from the valve covers.
16. Remove the intake manifold bolts, and remove the intake manifold assembly.

Cleaning and Inspection

1. Remove the gasket material from all of the mating surfaces.
   IMPORTANT: When cleaning the cylinder head mating surface, do not allow the gasket material to enter the engine crankcase or intake ports.
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 build-up or other material. Clean as necessary.
4. Remove the formed seals from the intake manifold and clean the grooves.
5. Place new formed seals in the grooves of the intake manifold.

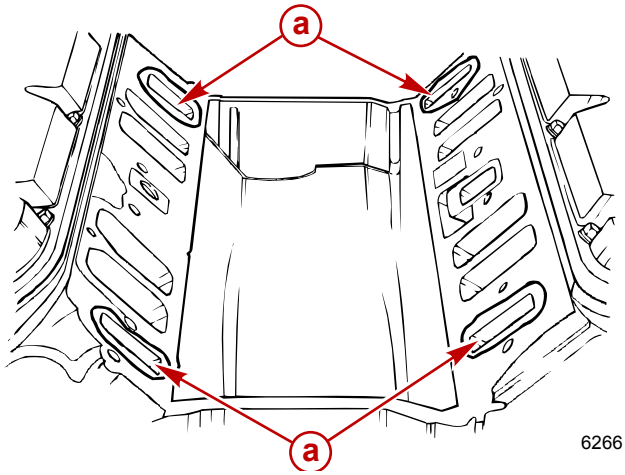
Installation

1. Apply a bead of sealant on the cylinder head around the coolant passages and to the edge of the casting.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Cylinder head coolant passages	92-34227Q02

IMPORTANT: Make sure the gasket is on the correct bank, see words "LEFT" and "TOP". Ensure the word "FRONT" is at the front of the engine.

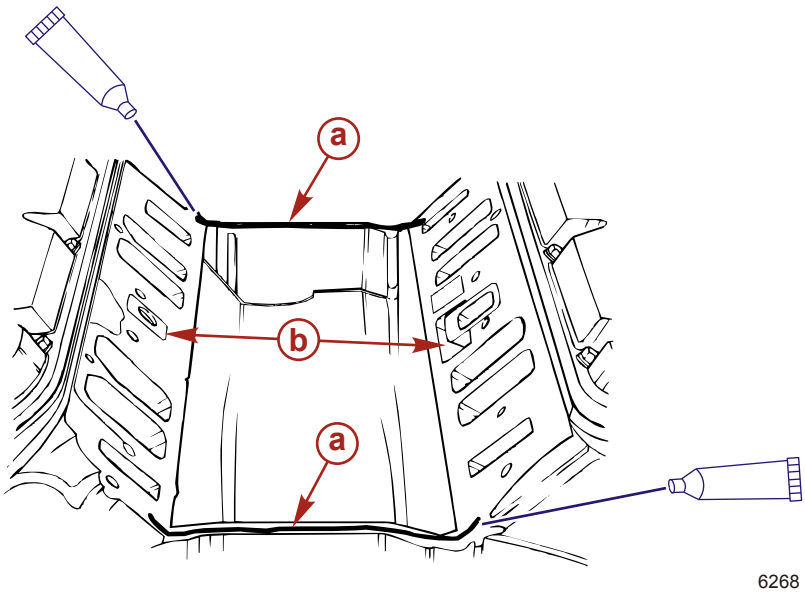
2. Place the gasket on cylinder head with the wording "front" toward the front of the engine. Slip the edge of the gasket under the clips.
3. Apply a bead of sealant on the gasket around the coolant passages and to the edge of the gasket.



a - Coolant passages

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Manifold gasket coolant passages	92-34227Q02

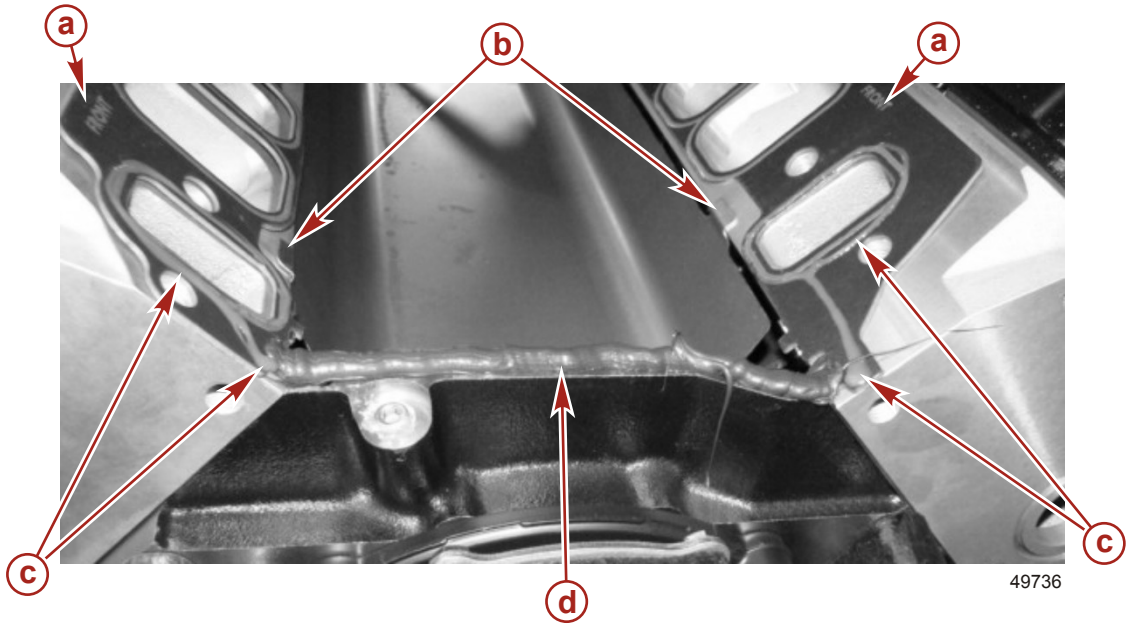
4. Apply a ¼ in. bead of sealant on the end seal boss of the engine block between the cylinder heads. The sealer should extend 12.7 mm (0.50 in.) onto the cylinder head.



a - End seal boss
b - Intake manifold gasket

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Engine block end seal boss	92-809826

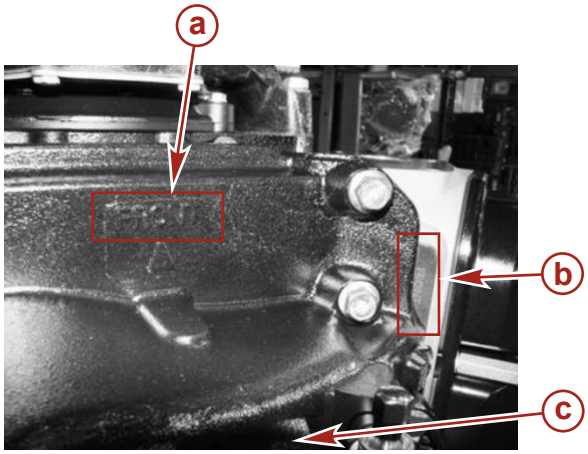
5. Ensure the wording "front" on the gasket is toward the front of the engine, the gasket is under the clips, and the sealant is applied correctly.



a - Gasket wording "front"
b - Clips
c - Coolant passages sealant
d - Sealant on end seal boss

IMPORTANT: The word "FRONT" on the intake manifold and the port and starboard gaskets face the front of the engine block.

6. Carefully install the manifold assembly with the word "FRONT" on the intake and the word "FRONT" on the gaskets at the front of the engine.



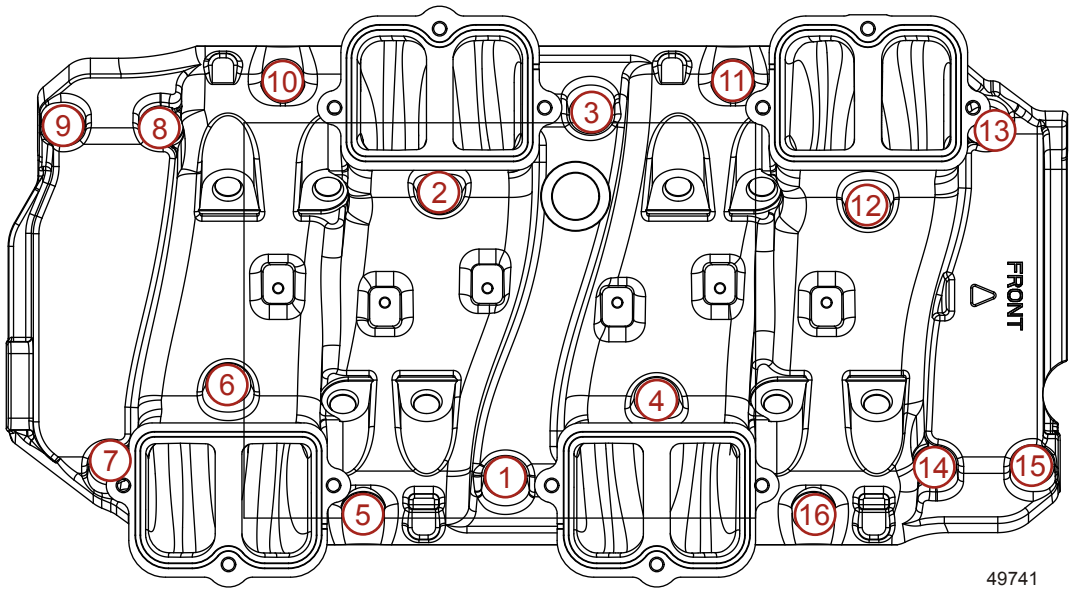
49780

a - "FRONT" on the intake
b - "FRONT" on the gasket
c - Front side of engine

7. Apply sealant to the threads of the intake manifold bolts.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Intake manifold bolts	92-809822

8. Hand start four short bolts at the corners of the intake manifold. Then hand start the remaining eight short bolts and four long bolts.
9. In two steps, tighten the bolts to specification in the sequence shown.



49741

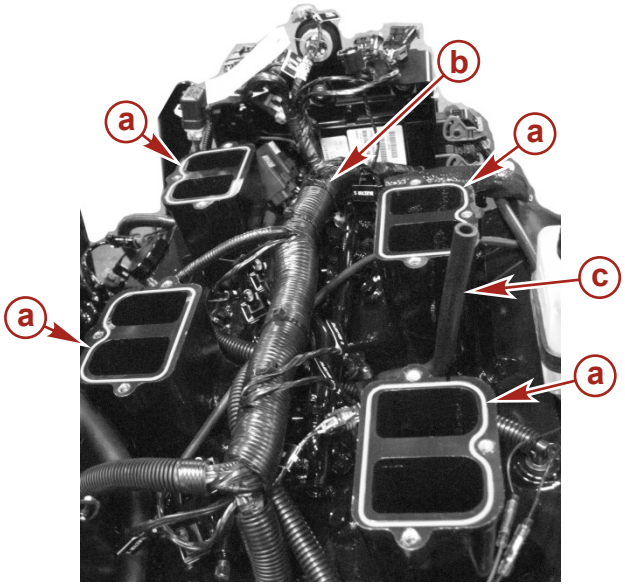
Intake manifold torque sequence

Description		Nm	lb. in.	lb. ft.
Intake manifold to cylinder head bolts	Step #1	27	–	20
	Step #2	48	–	35

IMPORTANT: Use dielectric compound on all of the electrical connector contact points.

10. Position the engine harness and install new stay straps to secure it's position.
11. Connect the fuel injector electrical leads. They are tagged to correspond to the engine cylinder number.

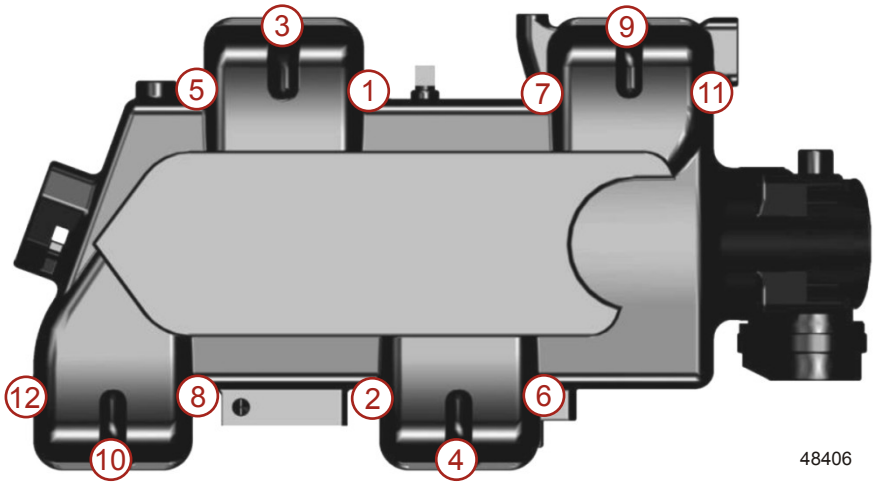
12. Install the fuel inlet line to the fuel rail fitting. Refer to **Fuel Rail**.
13. Connect the crankcase ventilation hoses to the rocker arm covers.
14. Ensure that the engine harness and components are positioned out of the way and the connections are easily accessible.



48821

a - Seal
b - Engine harness
c - Crankcase vent hose

15. Install the plenum. Refer to **Intake Plenum**.
16. In two steps, tighten the screws to specification in the sequence shown.



48406

Intake plenum torque sequence

Description		Nm	lb-in.	lb-ft
Intake plenum screw	Step #1	7	–	5
	Step #2	24	–	18

17. Install the shift bracket or DTS shifter and bracket assembly and connect to engine harness.

Description	Nm	lb-in.	lb-ft
Shift bracket to plenum screw	27	–	20
Shift bracket to lift bracket screw			

18. Install the gear lube bottle in the bracket and connect to engine harness.
19. If loosened, tighten the two nuts securing the electrical bracket.

Description	Nm	lb-in.	lb-ft
Electrical bracket to head nut	54	–	40

20. Connect the hoses to the flame arrestor, fuel pressure regulator, and fuel pump vent to plenum.
21. If equipped, ensure that the sensors are connected:
    - TPS
    - IAT
    - MAP
    - IAC
    - MAT
    - EMCT
    - Oxygen Sensor
    - Crankshaft position sensor
    - Camshaft position sensor
22. Install the coolant reservoir and bracket assembly.
23. Connect the throttle cable, if equipped.
24. Install the engine block drain plugs and refill the closed cooling system.
25. Start the engine and check the hose connections, gaskets and seals for leaks.
26. Inspect the fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

1. Remove the rocker arm covers.
2. Remove the rocker arm assemblies and push rods.
   IMPORTANT: Place rocker arm assemblies and push rods in a rack for re-assembly in their original locations.

Cleaning and Inspection

1. Clean all of the parts with solvent and dry them with compressed air.
2. Inspect all of the contact surfaces for wear. Replace any damaged parts.

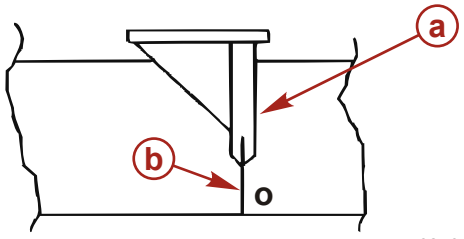
Installation

IMPORTANT: When installing the rocker arm components, coat the bearing surfaces with engine oil.

1. Install the push rods in their original locations. Ensure the push rods are seated in the lifter sockets.
2. Install the rocker arms in their original locations and adjust the valves.

Valve Adjustment

1. Remove the spark plugs. Using a wrench on the center bolt of the crankshaft pulley, turn the engine over in its normal direction of rotation while placing a finger over the "No. 1" cylinder spark plug opening. Compression will be felt at the spark plug opening as 0° TDC is approached. If not, the engine is in the "No. 6" firing position and should be rotated through one more revolution (360°) to reach the "No. 1" position 0° TDC.

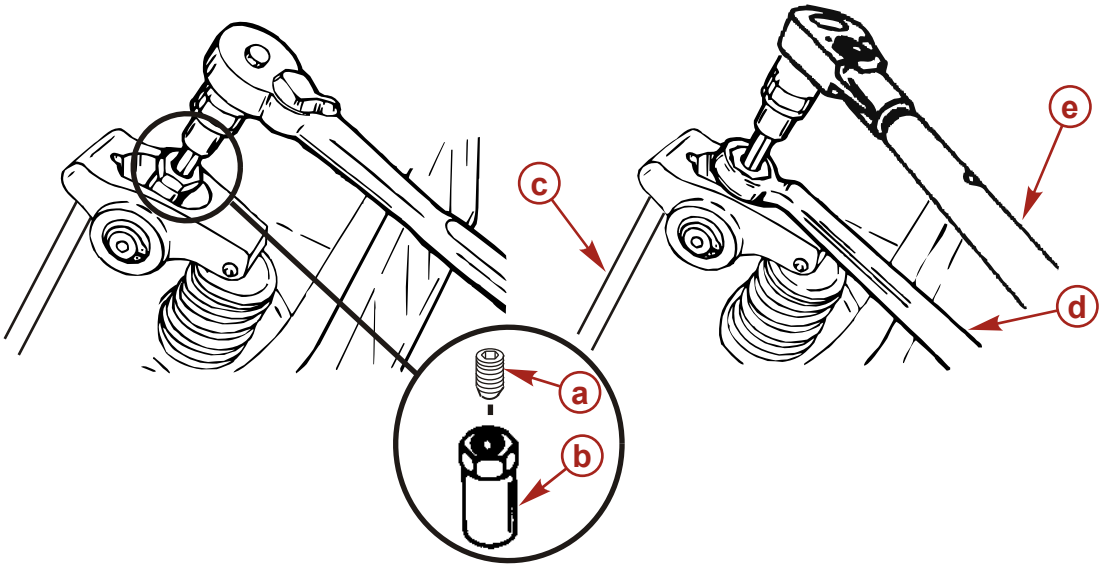


6276

a - Timing tab
b - 0° TDC torsional damper timing mark

2. When the engine is at the number one TDC position, adjust the following valves: Exhaust: 1-3-4-8, Intake: 1-2-5-7.
3. Loosen the allen head set screw.
4. Loosen adjusting nut until lash is felt at push rod, and then hand tighten adjusting nut until all lash is removed. Lash can be checked by rotating push rod while hand tightening adjusting nut until all play is removed.

IMPORTANT: If the lifter has not been pumped up with oil, the push rod could be rotated while the plunger in the lifter is being collapsed. Any resistance felt while rotating the push rod should be considered no lash. This can be checked by making sure there is no up and down movement of the push rod or zero clearance between the rocker arm and valve stem.



6281

- **a -** Allen head set screw
- **b -** Adjusting nut
- **c -** Push rod
- **d -** Box end wrench
- **e -** Torque wrench

5. Rotate the adjustment nut an additional, 3/4 turn (270°).
6. While holding the adjusting nut in position, torque the allen head set screw.

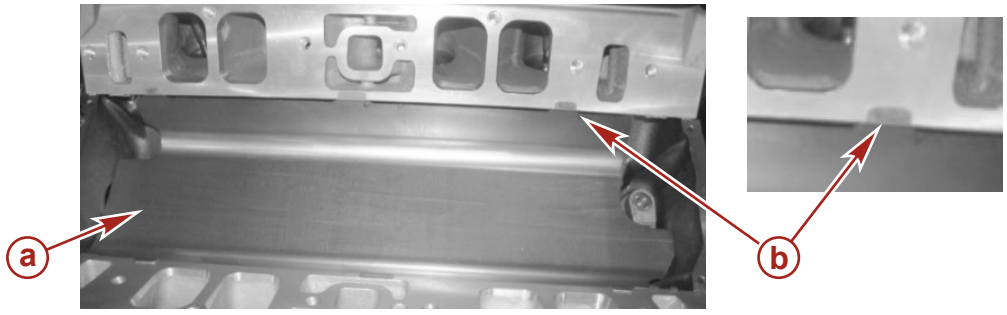
Description	Nm	lb. in.	lb. ft.
Allen head set screw	34		25

7. Using a wrench on the center bolt of the crankshaft pulley, turn the engine over in its normal direction of rotation while placing a finger over the "No. 6" cylinder spark plug opening. Compression will be felt at the spark plug opening as 0° TDC is approached. If not, the engine is in the "No. 1" firing position and should be rotated through one more revolution (360°) to reach "No. 6" position, 0° TDC.
8. When the engine is at the number six TDC position, adjust the following valves: Exhaust: 2-5-6-7, Intake: 3-4-6-8.

Hydraulic Valve Roller Lifters

Removal

1. Remove the rocker arm covers.
2. Remove the intake manifold.
3. Unclip and remove the oil splash shield.

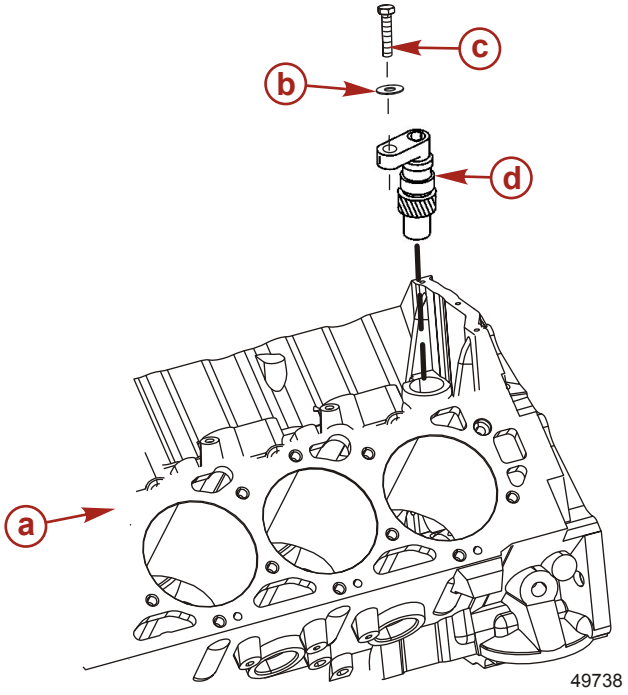


49798

- **a -** Splash shield
- **b -** Clip (4 places)

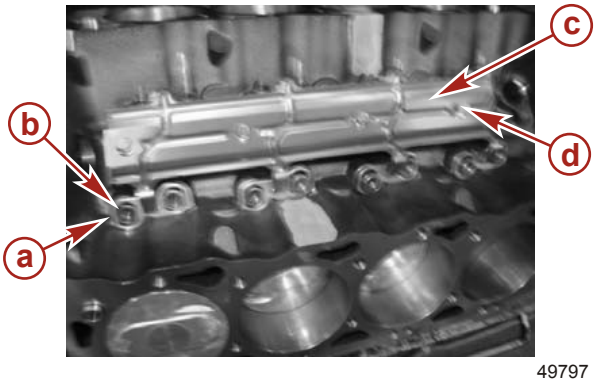
4. Remove the rocker arm assemblies and push rods.

5. Remove the oil drive mechanism.

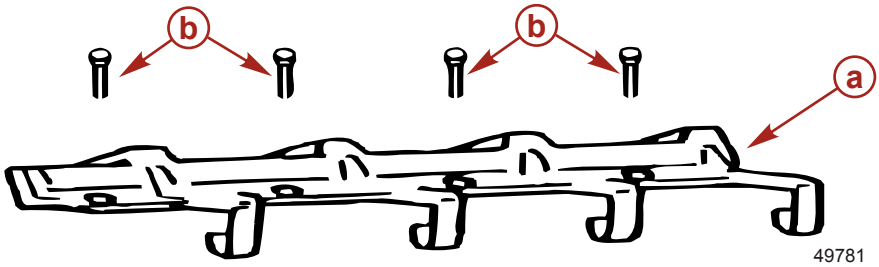


a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

6. Remove the lifter guide retainer.



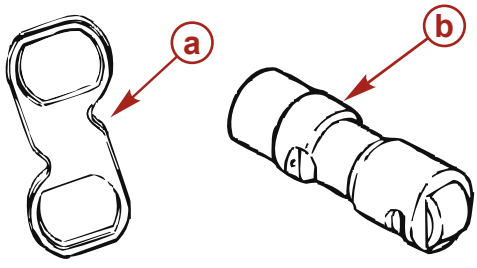
a - Guide
b - Lifter
c - Retainer
d - Screw (4)



a - Lifter guide retainer
b - Screw (4)

IMPORTANT: IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.

7. Remove the lifter guides and the valve lifters. Store the lifters in the upright position in order of removal.



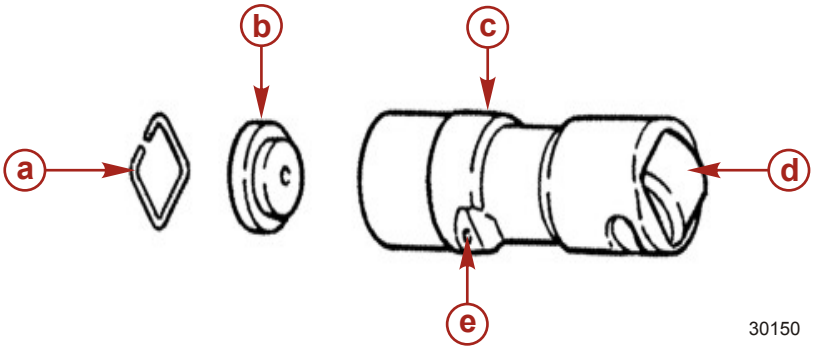
a - Lifter guide
b - Valve lifter

Cleaning

1. Except for the valve lifters, clean the parts with cleaning solvent.
2. Dry the parts with compressed air.
3. Keep the valve lifter upright, wipe with a clean, oil saturated, lint free cloth. Store valve lifters in the upright position.

Inspection

1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect the pushrod seat. If the seat is scuffed or worn, inspect the pushrod for warping or damage.
3. Inspect outer lifter body. If the lifter is scuffed or worn, inspect the engine block lifter bore.
4. Inspect the roller of valve lifter. If roller is scuffed or worn, inspect the camshaft lobe.
5. Ensure the oil hole is unobstructed.
6. Inspect all parts carefully. Replace any valve lifter assembly that is damaged or excessively worn.



Lifter inspection points

- **a -** Seat retainer clip
- **b -** Pushrod seat
- **c -** Valve lifter body
- **d -** Roller
- **e -** Oil hole

Installation

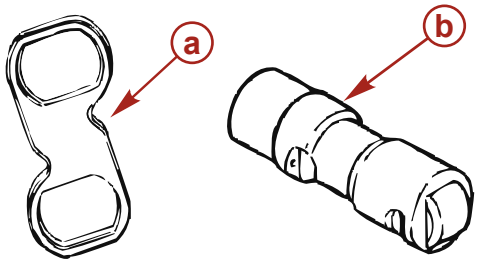
IMPORTANT: The engine oil must be changed and a new oil filter installed after servicing the valve lifters or the camshaft. Before installing the lifters, coat the bottom of the lifter with engine oil. If installing new lifters or a new camshaft, an additive containing EP lube (General Motors Cam and Lifter Pre-lube or equivalent) should be applied to the camshaft lobes before installing the lifters.
Coat the entire valve lifter with engine oil before installation.
New valve lifters must be installed with a new camshaft.

1. Before installing valve lifters, coat the camshaft lobes and valve lifters with engine assembly lube.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve lifters and camshaft lobes	Obtain Locally

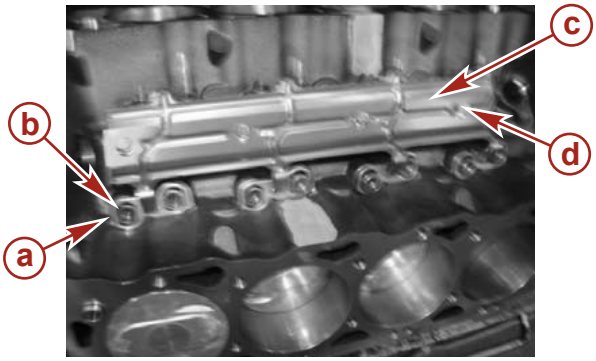
2. Install the valve lifters. Install the lifters in their original locations if being reused.
3. Install the lifter guides.

NOTE: *The flat side of the lifters matches the flats of the lifter guide.*



- **a -** Lifter guide
- **b -** Valve roller lifter

4. Install the lifter guide retainer. Tighten the four screws to specification.

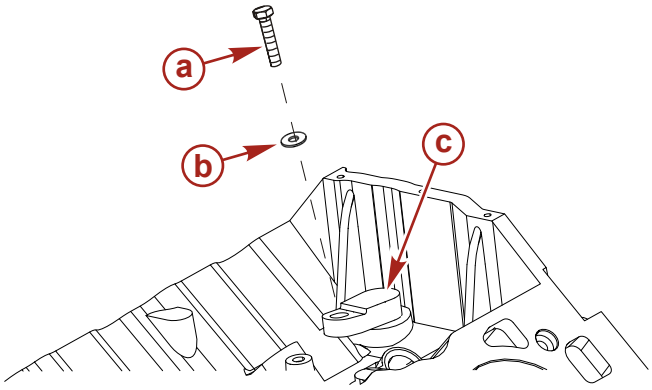


49797

a - Guide
b - Lifter
c - Retainer
d - Screw (4)

Description	Nm	lb-in.	lb-ft
Valve lifter guide retainer screw	16	144	–

5. Install the oil drive mechanism. Rotate the crankshaft to engage the oil drive mechanism with the oil pump.
IMPORTANT: The oil drive mechanism is not properly installed if it is not resting on the engine casting and engaged with the oil pump.
6. Ensure that the mechanism is resting on the engine casting as shown.
7. Install the washer and screw. Tighten the screw to specifications.

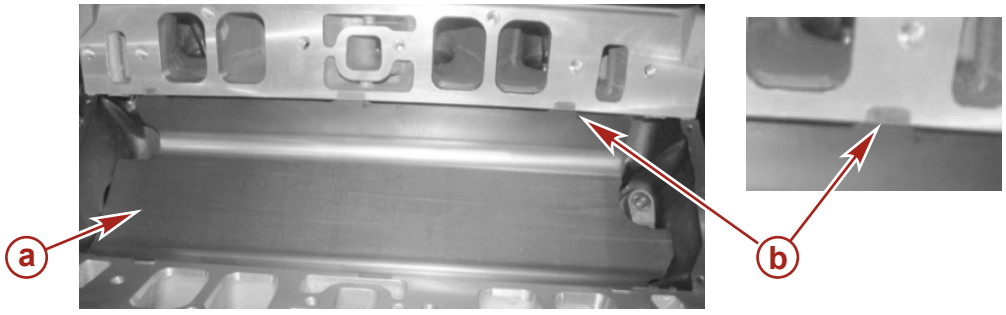


49740

a - Mounting bolt
b - Washer
c - Oil drive mechanism

Description	Nm	lb-in.	lb-ft
Oil drive mechanism screw	20	180	–

8. Clip the oil splash shield in position as shown.



49798

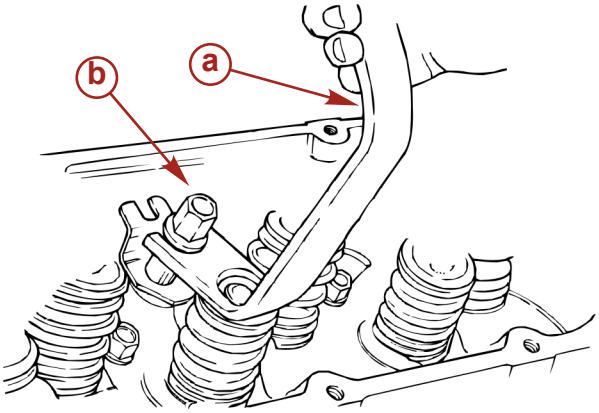
a - Splash shield
b - Clip (4 places)

9. Install the intake manifold.
10. Install and adjust the push rods and rocker arms.
11. Install the rocker arm covers.
12. Start the engine and check for leaks.

Valve Stem Seal and Valve Spring

Removal With Head Installed

1. Remove:
   a. Valve cover.
   b. Spark plug of affected cylinder.
   c. Rocker arm assembly.
2. Install an air line adapter tool in the spark plug opening and apply compressed air to hold the valves in place.
3. Use a valve spring compressor to compress valve spring and remove valve locks.
   IMPORTANT: Maintain air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

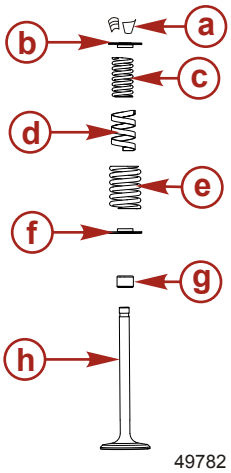


6290

a - Valve spring compressor
b - Nut

4. Slowly release the valve spring compressor. Remove the cap and valve spring.
5. Remove the push rod guides if required.

Valve Assembly—Exploded View



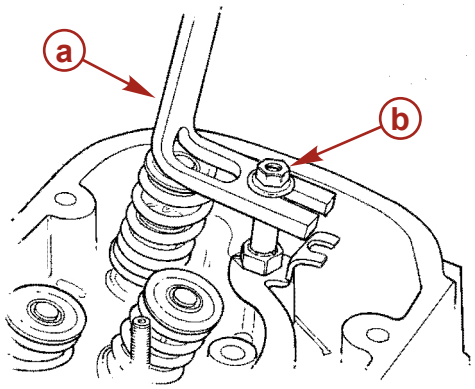
49782

a - Valve keeper
b - Upper spring seat
c - Inner spring
d - Damper
e - Outer spring
f - Lower spring seat
g - Seal
h - Valve

Valve Seal Installation—Head Installed

1. Install the push rod guides if removed.
2. Place a spring seat into the spring pocket.
   NOTE: *A spring seat must always be used underneath the valve spring.*
3. Install the new oil seals onto the valve guides of the cylinder head.
4. If taken apart, re-assemble the damper and valve spring.
5. Place the valve spring assembly in position against the spring seat.
6. Coat the valve stem and the new seal with engine oil.
7. Set the cap on the valve stem, and align the valve stem with the center of the cap.

8. Compress the valve spring using a valve spring compressor and install the valve locks (grease may be used to hold the valve locks in place). Slowly release the tool to prevent damaging the seal. Make sure the valve locks seat properly in the valve stem grooves.



6297

a - Valve spring compressor
b - Rocker arm nut

9. Turn off the compressed air and remove the air line adapter tool from the spark plug opening.
10. Install and adjust the push rods and the rocker arm assemblies.
11. Install the valve cover, than install the spark plug.

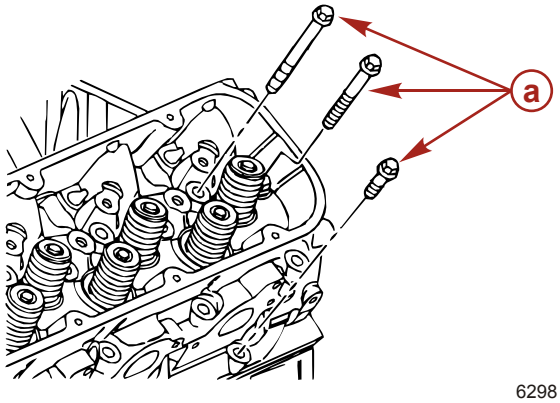
Description	Nm	lb. in.	lb. ft.
Valve cover nuts	14	120	–
Spark plugs	27	–	20

Cylinder Head and Valves

Cylinder Head and Valve Conditioning

Removal

1. Drain the closed cooling system.
2. Remove these components as outlined:
   a. Exhaust manifolds.
   b. Intake manifold assembly.
   c. Valve covers.
   d. Rocker arm assemblies.
   e. Any components attached to front or rear of cylinder head.
   f. Spark plugs.
   g. Head bolts.



6298

a - Head bolts

3. Remove the cylinder head.
4. Place the cylinder head on a bench on wooden blocks to prevent damaging the gasket surfaces.

Cleaning

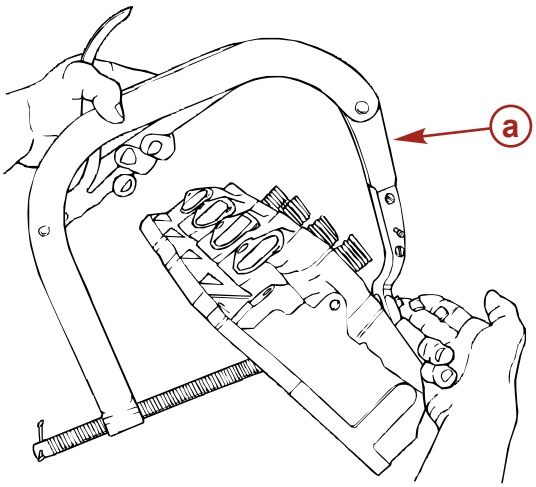
Clean the gasket material and sealer from the cylinder heads.

Inspection

1. Inspect the sealing surfaces for deep nicks and scratches.
2. Inspect for corrosion damage around the cooling passages, and inspect for evidence of cylinder head leakage.

Disassembly

1. Using a valve spring compressor, compress the valve spring and remove the valve keepers, then slowly release the tool.



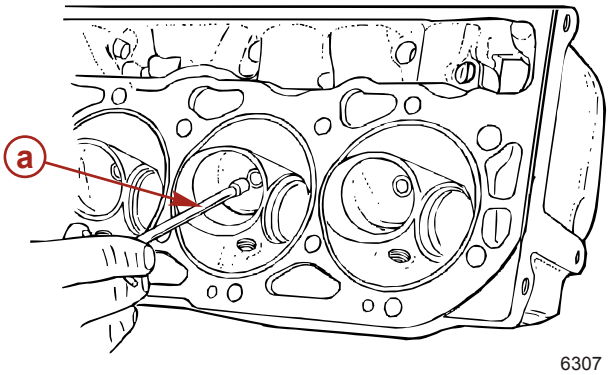
6301

a - Valve spring compressor

2. Remove the retainers and the valve springs.
   IMPORTANT: If the valve stem ends are not square anymore, then use a file to square the edges before removing the valves. This will prevent damaging the valve guides when removing the valves.
3. Carefully remove the valves from the cylinder head and mark them for re-assembly in their original locations.

Cleaning

1. Clean the push rods and rocker arm assemblies with a suitable solvent.
2. Clean the carbon from the valves using a wire wheel.
3. Remove the carbon from the combustion chambers and valve ports using plastic bead media under low pressure, 276 kPa (40 psi).
4. Clean the valve guides thoroughly with valve guide cleaner.



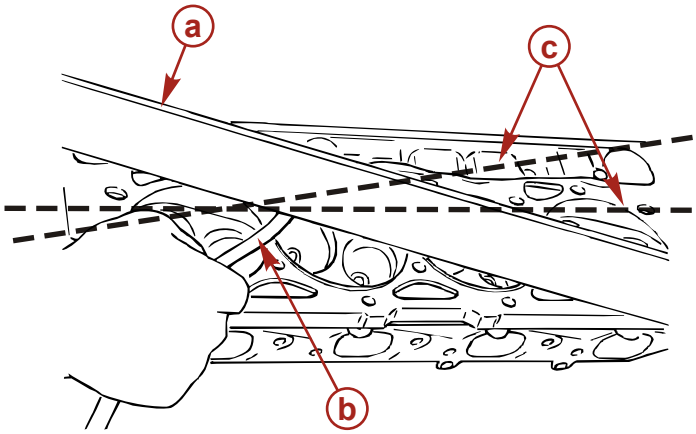
6307

a - Valve guide cleaner

Inspection

1. Inspect the cylinder heads for cracks in the exhaust ports, water jackets and combustion chambers (especially around the spark plug openings and valve seats). Replace the heads if any cracks are found.

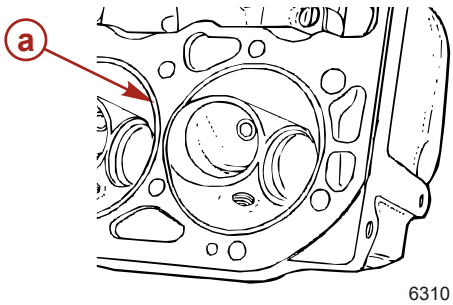
2. Inspect the cylinder head gasket surface for burrs, nicks or corrosion or other damage. Also, check the flatness of the cylinder head gasket surface using a machinist's straight edge and feeler gauges as shown. Take both measurements diagonally across the head (both ways) and straight down the center of the head, a 0.1016 mm (0.004 in.)difference (maximum) overall.



6309

a - Straight edge
b - Feeler gauge
c - Diagonal and straight measurements

3. Inspect the area between the combustion chambers for damage. If there is evidence of damage, check the area with a straight edge and a feeler gauge for flatness. No more than 0.0508 mm (0.002 in.) of a gap is allowed between the surface and the straight edge over a 15.24 cm (6 in.) span.

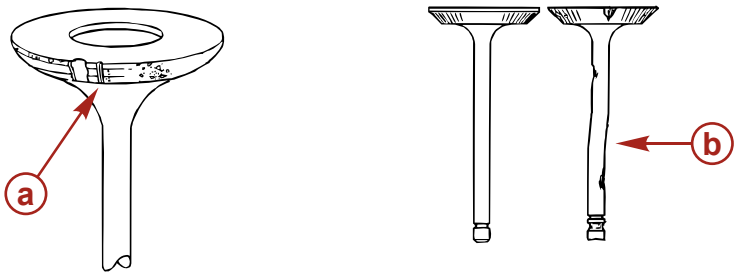


6310

a - Inspect

IMPORTANT: The cylinder head gasket surface should be re-surfaced if it is out of tolerance. When head re-surfacing is required, the intake manifold gasket surface on the cylinder head must be milled to provide for proper alignment between the intake manifold and the cylinder head.

4. Inspect the valves for heat damage, cracked faces or damaged stems.



6311

a - Cracked and pitted face
b - Damaged stems

5. Inspect the rocker arm assemblies and push rod guides for wear and damage.
IMPORTANT: Incorrect clearance between the valve stem and bore may cause excessive oil consumption, valve noise, and possible valve damage. Ensure that valve clearance is within specifications.
6. Measure the valve stem and compare the measurement with the table. If the valve stem is worn, replace the valve.

Valve System		Specification
Stem diameter	Intake	9.436 - 9.461 mm (0.3715 - 0.3725 in.)
	Exhaust	9.406 - 9.431 mm (0.3703 - 0.3713 in.)

7. Measure the valve guide with a dial bore gauge and subtract the valve stem measurement from the guide diameter. That measurement will be the stem clearance.
   a. If the clearance exceeds the specification, replace the valve guide.

Cylinder Head	Specification
Valve guide diameter (intake and exhaust)	9.479 - 9.497 mm (0.3732 - 0.3739 in.)

Valve System		Specification
Stem clearance	Intake	0.0178 - 0.061 mm (0.0007 - 0.0024 in.)
	Exhaust	0.0482 - 0.0914 mm (0.0019 - 0.0036 in.)

Valve Guide Replacement

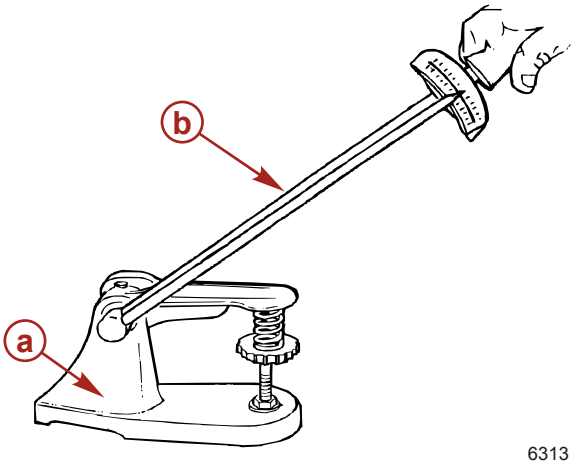
Any cylinder head requiring repair, other than valve and valve seat reconditioning, should be taken to a reputable cylinder head repair facility for repair.

Valve Guide Specifications		
Valve Guide Tool	**mm**	**in.**
Guide removal ream size[1]	11.11	0.4375
Drift to remove guide	11.11	0.4375
Guide installation tool[2]	9	0.355
Initial ream size	9.469-9.474	0.3728-0.3730
Hone	9.489	0.3736

Valve Spring Testing

IMPORTANT: The valve spring pressure must be checked with the inner and outer springs and the upper retainer in place.

Measure the valve spring length and pressure and compare with the table below. Replace any spring, keeper and retainer that does not meet the specifications.



6313

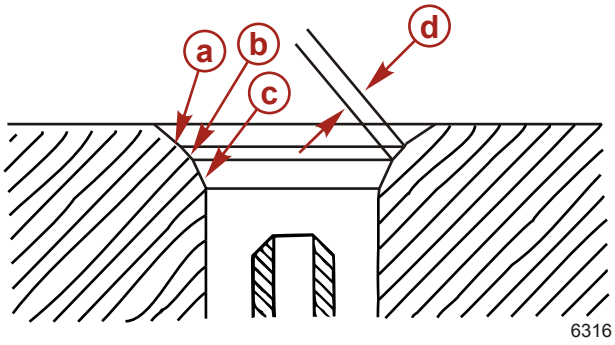
a - Valve spring tester
b - Torque wrench

Valve Spring			Specification
Inner valve spring (no stripe)	Free length		48.76 mm (1.92 in.)
	Force	Closed at 46.99 mm (1.85 in.)	147 - 165 N (33 - 37 lbf)
		Open at 31.1 mm (1.225 in.)	576 - 625 N (129.5 - 140.5 lbf)
	Installed height		43.18 mm (1.70 in.)
Outer valve spring (blue stripe)	Free length		52.78 mm (2.078 in.)
	Force	Closed at 45.72 mm (1.800 in.)	338 - 374 N (76 - 84 lbf)
		Open at 29.85 mm (1.175 in.)	1112 - 1201 N (250 - 270 lbf)
	Installed height		45.75 mm (1.80 in.)

1. Leave a step in the guide for the guide drift to work against when removing the guide.
2. Use Sunnen B-200 lubricant on outer surface of guide.

Valve Seat Repair

The tool manufacturer's recommendations should be followed carefully to attain proper results.

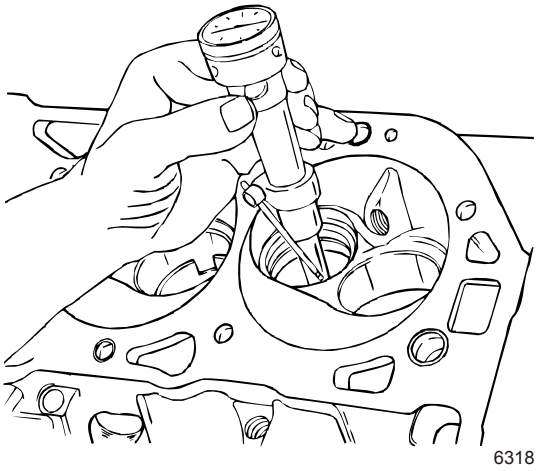


Typical "Three Angle" Valve Seat

- **a -** Top angle (30°)
- **b -** Seat angle (45°)
- **c -** Bottom angle (60°)
- **d -** Seat width

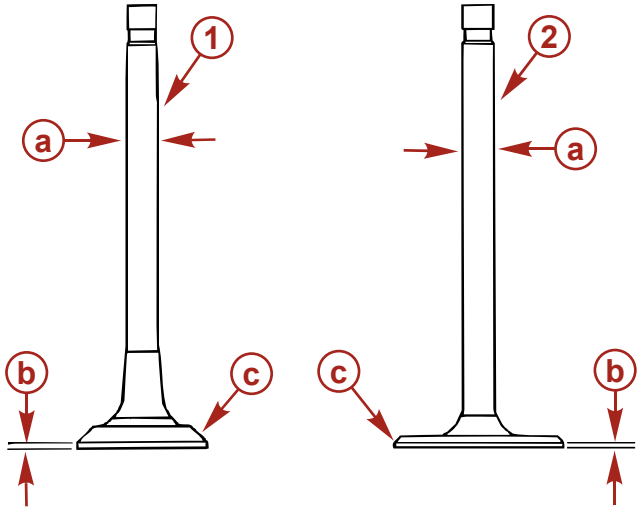
Valve System		Specification
Seat width	Intake	2.032 +/- 0.1524 mm (0.080 +/- 0.006 in.)
	Exhaust	3.175 +/- 0.1524 mm (0.125 +/- 0.006 in.)

IMPORTANT: It is essential that valve guide bores be free from carbon or dirt to achieve proper centering of the pilot in the valve guide to ensure concentricity.



Valve Grinding

Valves that are pitted must be re-faced to the proper angle. Valve stems that show excessive wear or valves that are warped must be replaced. When a warped valve is re-faced, 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 re-face it. 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 in.) after grinding, replace the valve.



1. **Exhaust**
   - **a.** 9.406 - 9.431 mm (0.3703 - 0.3713 in.)
   - **b.** 1.651 mm (0.065 in.)
   - **c.** 45°
2. **Intake**
   - **a.** 9.436 - 9.461 mm (0.3715 - 0.3725 in.)
   - **b.** 1.27 mm (0.050 in.)
   - **c.** 45°

Re-assembly

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. Verify the installed height.

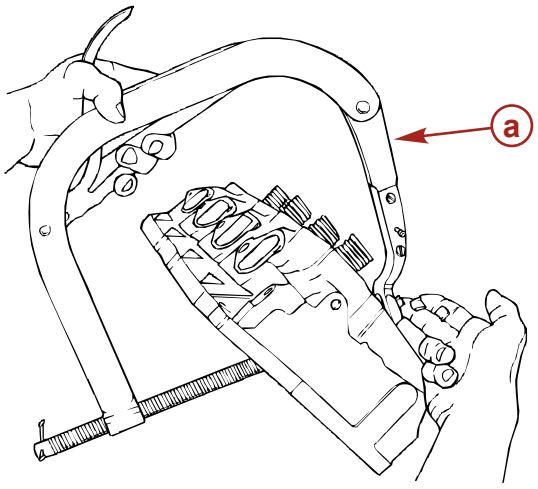
NOTICE

Serious engine damage can result if the valve springs bind. Do not shim valve springs to give an installed height less than the minimum specified.

Valve Spring		Specification
Inner valve spring (no stripe)	Installed height	43.18 mm (1.70 in.)
Outer valve spring (blue stripe)		45.75 mm (1.80 in.)

NOTE: *A spring seat must always be used underneath the valve spring assembly.*

3. Use a valve spring compressor to install the retainer and valve keepers. Use grease to hold keepers in place during assembly.



6301

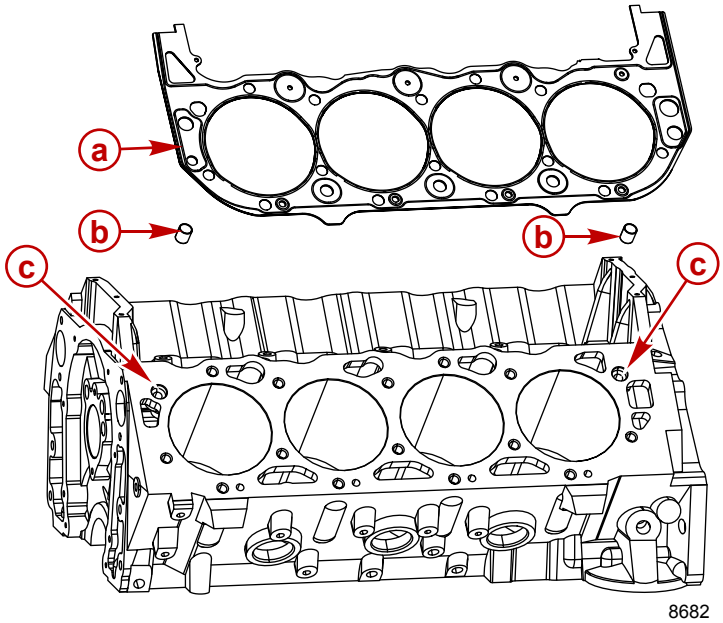
a - Valve spring compressor

Cylinder Head Gasket Installation

1. Clean the cylinder block and cylinder head gasket surfaces with a cleaner degreaser.

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Head gasket surfaces	Obtain Locally

2. Remove the split dowel pins from the cylinder block and install the dowel pins supplied with the kit.
3. Install the head gasket onto the cylinder block and install the cylinder head.



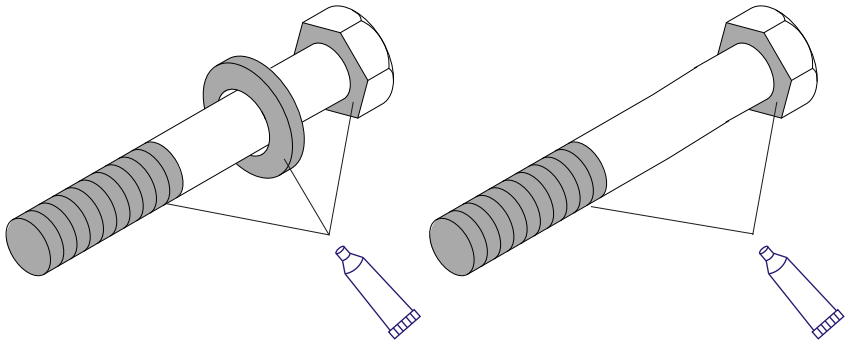
8682

Port shown, starboard similar

a - Head gasket
b - Dowel pin
c - Dowel pin location

IMPORTANT: Do not use washers with the head bolts on cast iron cylinder heads.

4. Generously lubricate the threads of the cylinder head bolt, under the head of the bolt, and on the washer (aluminum heads only).

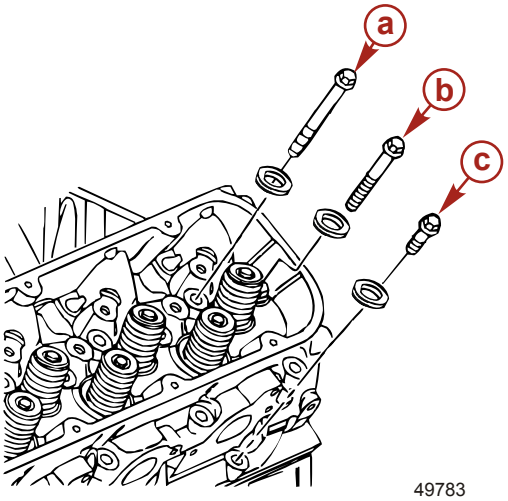


9262

Aluminum cylinder head bolt with washer lubrication area **Cast Iron cylinder bolt lubrication area**

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Cylinder head bolt thread, head, and washer	92-858087K01

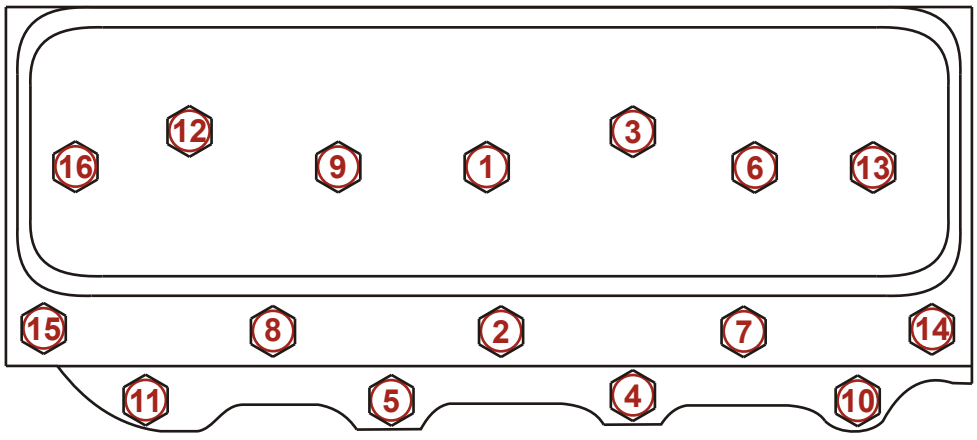
5. Install the head bolts with washers finger-tight.



49783

a - Long bolt with washer
b - Medium bolt with washer
c - Short bolt with washer

6. Tighten the head bolts in three steps, following the torque sequence for each step, and finish with a slow pull to the final torque. Repeat the final torque sequence.



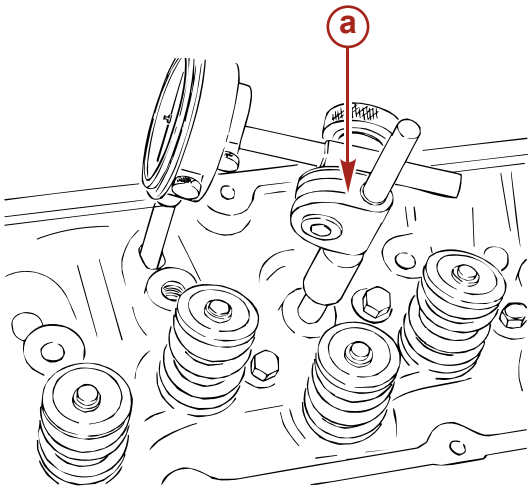
6339

Component		Nm	lb. in.	lb. ft.	Lubricants, Sealants, Adhesives
Aluminum Cylinder Head	Step #1	41	–	30	**Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated**Under the head and on the threads of the cylinder head bolt and on both sides of the washer
	Step #2	68	–	50	
	Step #3	95	–	70	

Camshaft

Measuring the Camshaft Lobe Height

1. Remove one of the rocker arm assemblies as previously outlined.
2. Install a dial indicator and tool as shown. Position the indicator with the ball socket adapter tool on the push rod. Ensure that the push rod is seated in the lifter cup.



6343

a - Dial indicator and tool

3. Rotate the torsional damper slowly in the direction of rotation until the lifter is on the base circle or "heel" of the cam lobe. At this point, the push rod will be in its lowest position.
4. Set the dial indicator to zero, then rotate the damper slowly until the push rod is in the fully raised position.
5. Compare the total lift to the specifications.

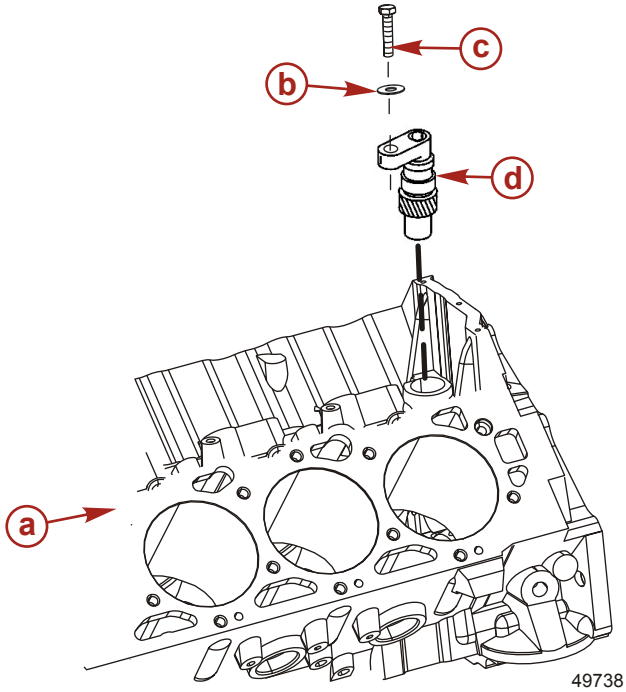
Roller Camshaft Lobe Lift	Specification
Exhaust	8.327 mm (0.327 in.)
Intake	7.569 mm (0.298 in.)

6. Continue to rotate the damper until the indicator reads zero. This will be a check on the accuracy of the original indicator reading.
7. If the camshaft lobe lift readings are not within the specifications, replace the camshaft.
8. Install and adjust the rocker arm(s).

Removal

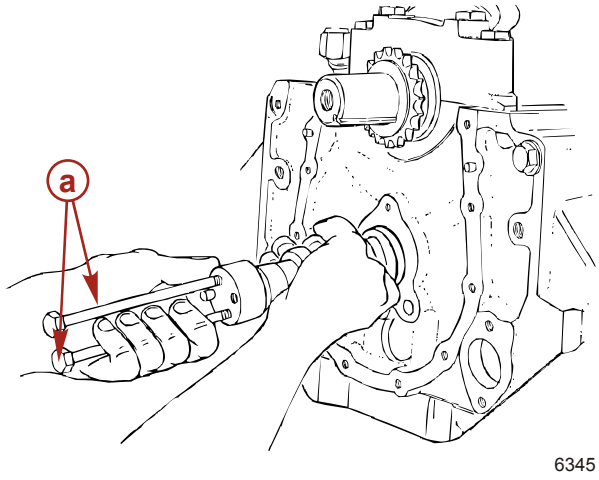
1. Remove the rocker arms, windage tray, push rods and the valve lifters.

2. Remove the oil drive mechanism.



a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

3. Remove the timing cover.
4. Remove the timing chain and sprocket.
5. Remove the cam retaining plate.
6. Install two 5/16-18 x 5 in. bolts in the camshaft bolt holes. These will be used as a handle for removing the camshaft.
7. Carefully remove the camshaft.

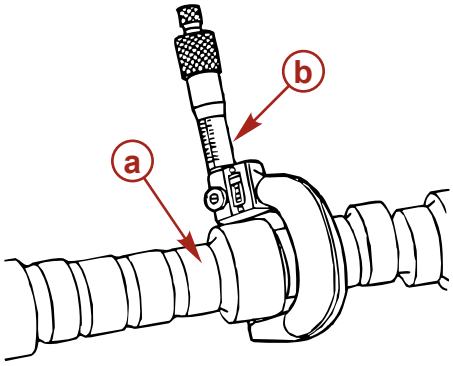


Removing the camshaft
a - 5/16 - 18 x 5 in. bolts

Inspection

1. Inspect the camshaft bearings, whenever the camshaft is removed. Refer to the **Camshaft Bearings** section of this manual.

2. Measure the camshaft bearing journals with a micrometer.

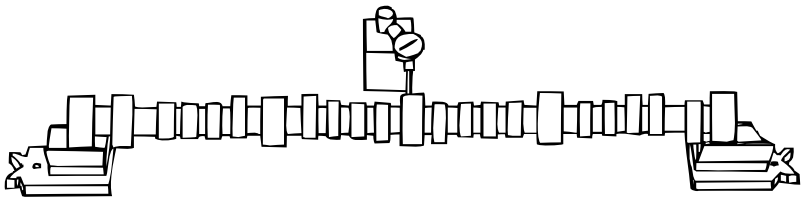


6346

a - Camshaft
b - Micrometer

Roller Camshaft	Specification
Journal diameter	49.479 - 49.522 mm (1.948 - 1.9497 in.)
Journal out of round	0.0508 mm (0.002 in.) max

3. If the journals measurement is above the out-of-round specification, the camshaft must be replaced.
4. Check the camshaft for excessive runout using V-blocks and a dial indicator.



6347

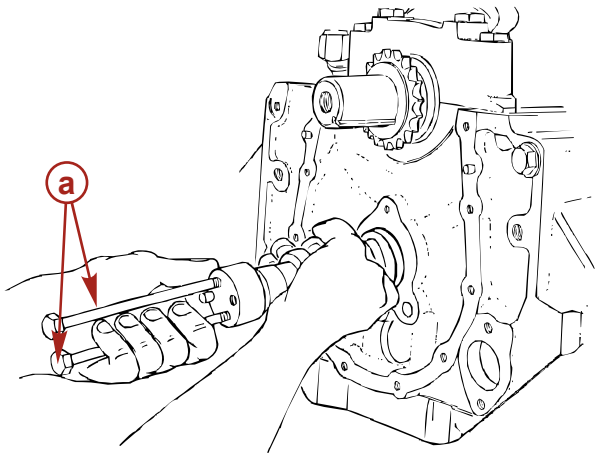
Checking camshaft alignment

Roller Camshaft	Specification
Camshaft runout	0.0508 mm (0.002 in.) max

5. If the runout is more than specification, the camshaft must be replaced.

Installation

1. Install two 5/16-18 x 5 in. bolts in the camshaft bolt holes.
2. Lubricate the camshaft journals with engine oil or assembly lube.
3. Install the camshaft into the camshaft bore. Be careful not to damage the camshaft's precision ground surfaces or the bearings by bumping the camshaft around in the boreline. Ensure that the camshaft rotates freely during and after installation.



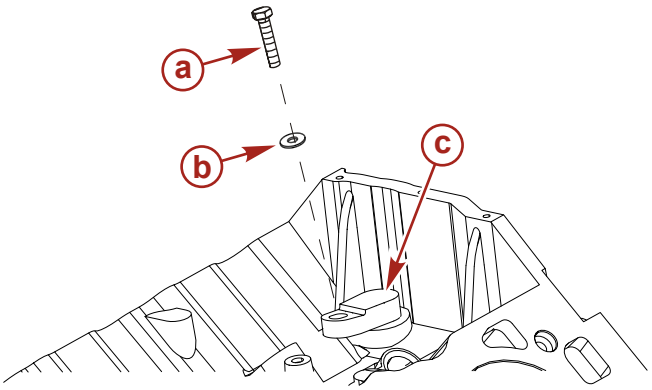
6345

Installing the camshaft
a - 5/16 - 18 x 5 in. bolts

4. Apply engine oil to both sides of the camshaft retainer plate. Secure with two screws and tighten to specification.

Description	Nm	lb-in.	lb-ft
Cam retainer to block screw	11	96	–

5. Apply Crane Camshaft Assembly Lube (supplied with the camshaft) or an equivalent (moly-based assembly lube) to the camshaft lobes in preparation for lifter installation.
6. Install the oil drive mechanism. Rotate the crankshaft to engage the oil drive mechanism with the oil pump.
IMPORTANT: The oil drive mechanism is not properly installed if it is not resting on the engine casting and engaged with the oil pump.
7. Ensure that the mechanism is resting on the engine casting as shown.
8. Install the washer and screw. Tighten the screw to specifications.



49740

a - Mounting bolt
b - Washer
c - Oil drive mechanism

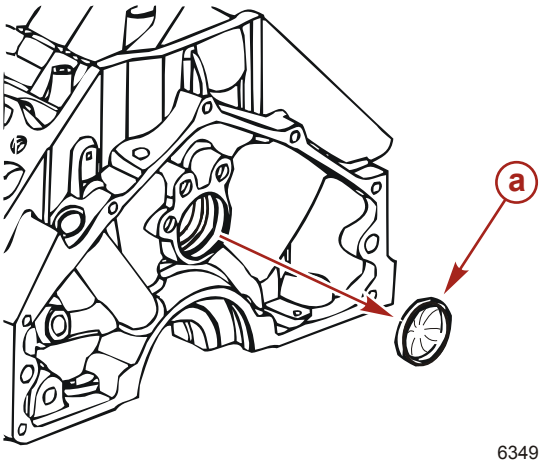
Description	Nm	lb-in.	lb-ft
Oil drive mechanism screw	20	180	–

9. Install the timing chain and timing cover.
10. Install the rocker arm assemblies, lifters, retainer, and windage tray.

Camshaft Bearings

Removal

1. With the camshaft and crankshaft removed, drive the camshaft rear plug from the cylinder block.

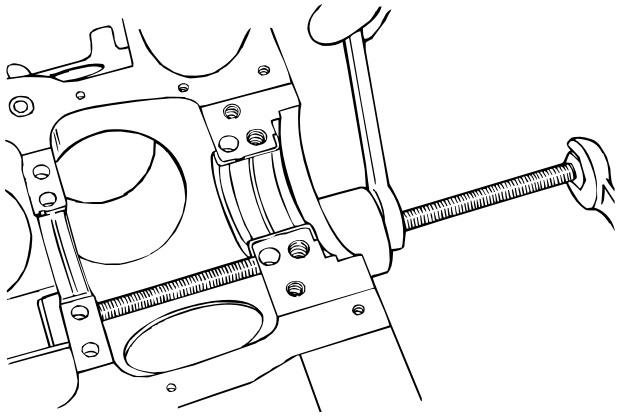


6349

a - Camshaft rear plug

NOTE: *Several tools are available to remove and install camshaft bearings, follow the instructions supplied with the tool to remove the bearings.*

2. Using a camshaft bearing remover and installer set, remove the camshaft bearings.



6350

Inspection

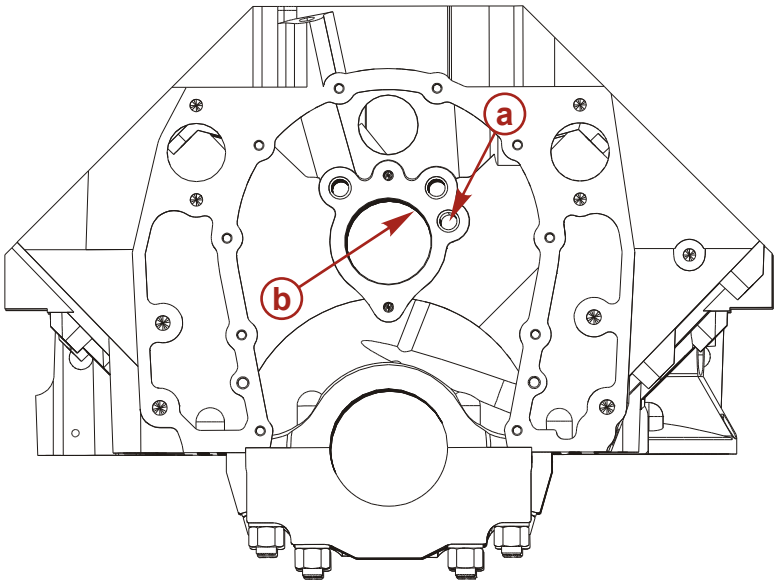
Clean the camshaft bearing bores with solvent and blow them out with compressed air. Ensure that the grooves and the drilled oil passages are clean.

Installation

IMPORTANT: If the new cam bearings are not supplied with instructions:The #1 cam bearing is narrower than the others. #3 and #4 cam bearings have the same outside diameter and #2 and #5 cam bearings have the same outside diameter.

NOTE: *Several tools are available to remove and install camshaft bearings, follow the instructions supplied with the tool to install the bearings.*

1. Lubricate the outer surface of the camshaft bearings with high pressure grease to aid in the bearing installation.
2. Install the camshaft bearings, as written in the following paragraphs, making sure that the camshaft rotates freely in the bearing as each bearing is installed and before installing the cam gear and cover.
3. Position the camshaft bearings as follows (directional references are clock positions from the front of the engine looking rearward):
   - The front bearing must be positioned so that the oil hole is at the "2:30" clock position, aligned with the oil gallery and the hole in the bore.
   - The rear, intermediate, and center bearings must be positioned so that the oil hole is at the two o'clock position and aligned with the hole in the block.



a - Front bearing alignment
b - Remaining bearing alignment

6351

IMPORTANT: The plug must be installed flush to 0.8 mm (1/32 in.) deep and it must be parallel with the rear surface of the cylinder block.

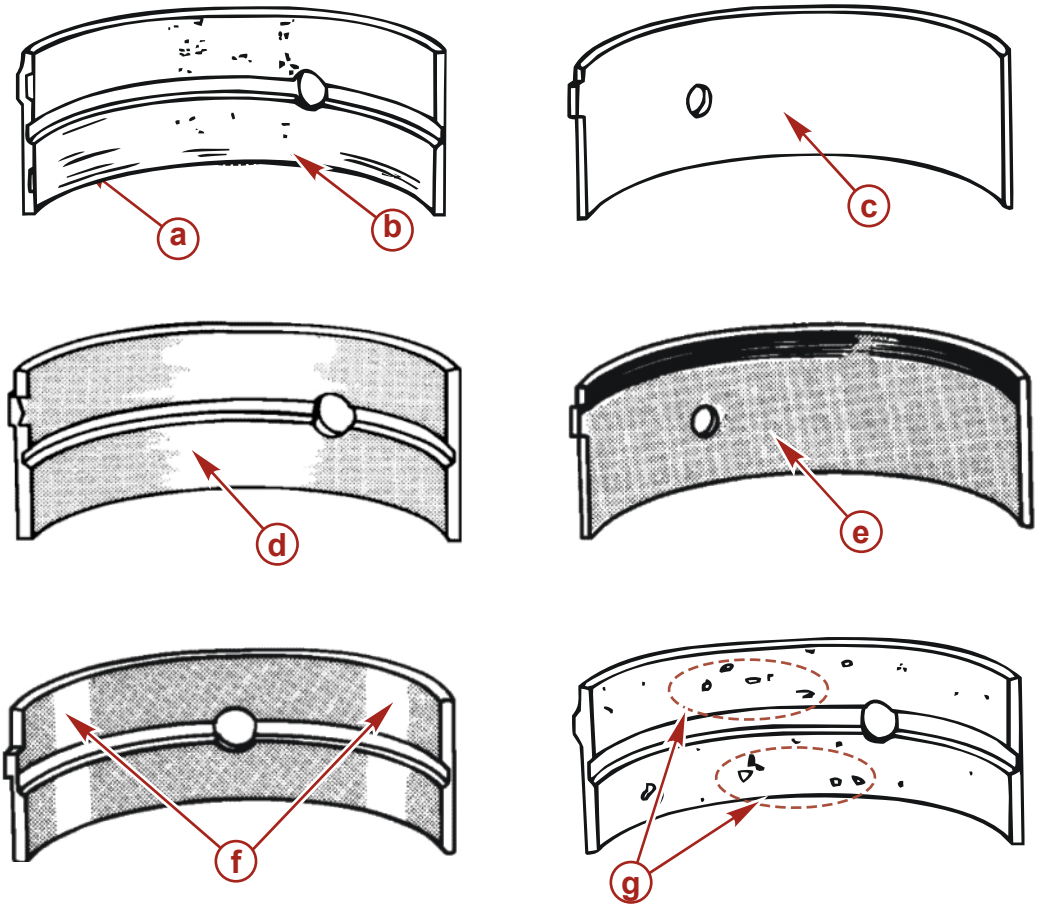
4. Install a new camshaft rear plug.
5. Install the crankshaft and camshaft.

Crankshaft and Main Bearings

Inspection of Main Bearings

In general, the lower half of the bearing (except bearing number one) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that 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.

The main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and 0.001 in., 0.002 in., 0.010 in. and 0.020 in. undersize.

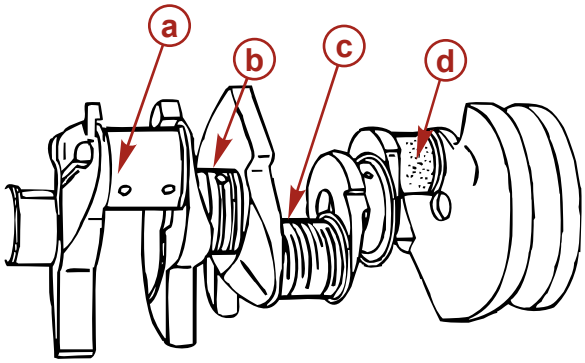


a - Scratched by dirt - scratches
b - Dirt embedded in bearing material
c - Tapered journal - overlay gone from entire surface
d - Lack of oil - overlay worn off
e - Radius ride - worn area
f - Improper seating - bright or polished sections
g - Fatigue failure - craters or pockets

Inspection of Crankshaft

1. Wash the crankshaft in solvent and dry it with compressed air.

2. Inspect the crankshaft.

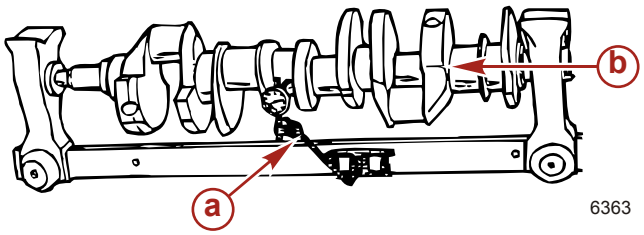


6362

a - Smooth surface
b - Grooves
c - Scratches or uneven surface
d - Pitted surface

NOTE: *The journal dimensions should be checked at two spots, 90° apart, don't take measurements near the oil galleries.*

3. Measure the main bearing journal dimensions with a micrometer and record the dimensions. Check for out-of-round, taper or undersize, see specifications.
4. Support the front and rear main bearing journals with V-blocks and check the crankshaft for runout, see specifications.



6363

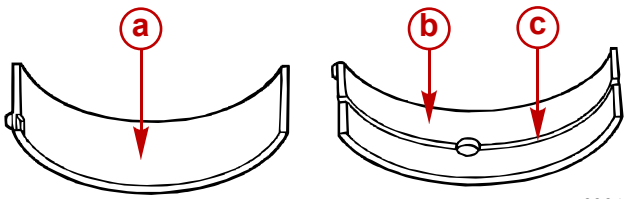
a - Dial indicator
b - Crankshaft

5. Replace or recondition the crankshaft if it is not within the specifications.

Crankshaft			Specification
Main journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out of Round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Crankshaft runout @ No.3 main bearing			0.088 mm (0.0035 in.) max

Measuring Main Bearings (Factory Method [Preferred])

1. Install main bearings in engine block as follows.

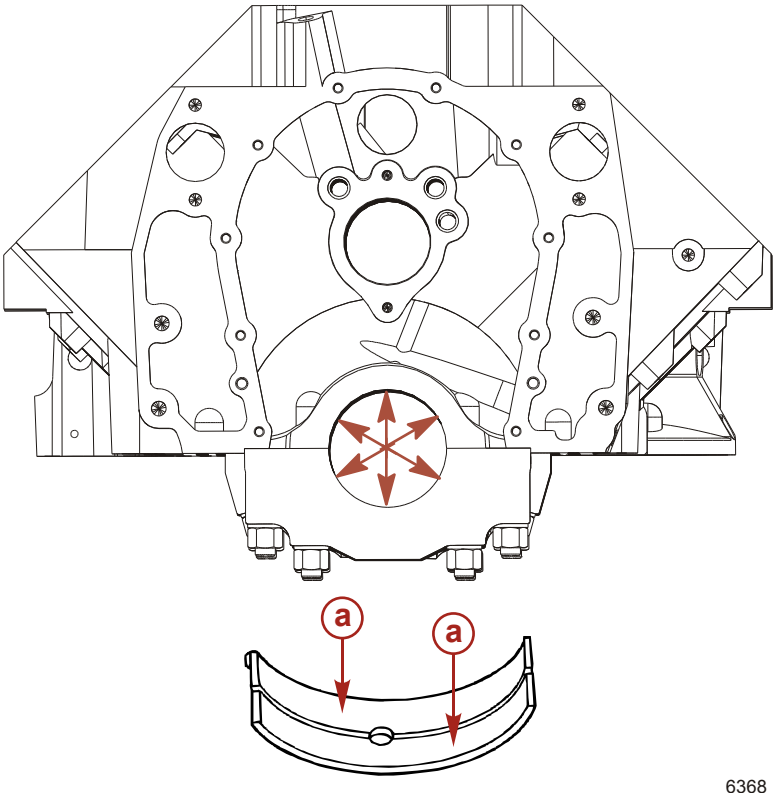


6364

Main Bearing Inserts
a - Lower bearing insert (install in cap)
b - Upper bearing insert (install in block)
c - Oil groove

2. Install the main bearing caps with the bearings installed and tighten them to specifications.

3. Using a dial bore gauge, measure the front and rear dimensions of the bearing and around the entire inside diameter of the bearing, record readings. All dimensions must be within clearance specifications, if not, replace bearing. This is your main bearing bore dimension.



6368

a - Front and rear of bearing

4. Subtract the journal diameter from the main bore diameter, this is the main bearing clearance.

Crankshaft			Specification
Main Bearing Clearance	Production and Service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)

5. If the clearance is not within specification, replace the bearing if it is used. A standard, or 0.025 mm (0.001 in.), undersize bearing may produce the proper clearance. if not, re-grind the crankshaft and install an undersized bearing. Mixing half-sizes or sanding the backside of a bearing to gain the proper clearance is also acceptable.

Installation

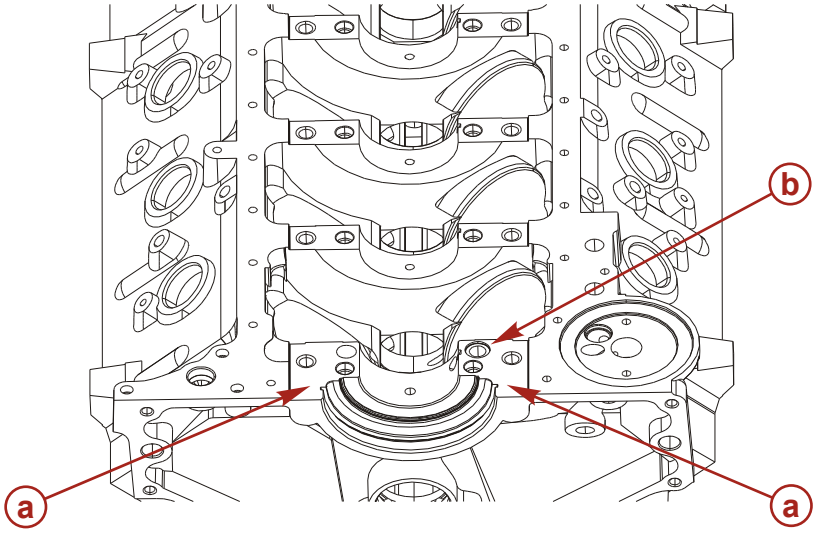
1. Apply engine oil to the bearing surfaces and crankshaft journals.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Bearing surfaces and crankshaft journals	92-858087K01

2. Apply a very thin coat of silicone to the rear sealing surface of the rear main bearing cap to prevent oil seepage between the cap and the block and be sure to install the cap before the sealant cures.

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Rear main bearing cap sealing surface	92-809826

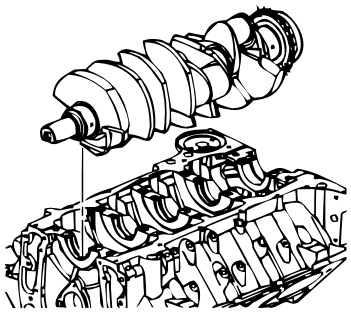
3. Install the o-ring.



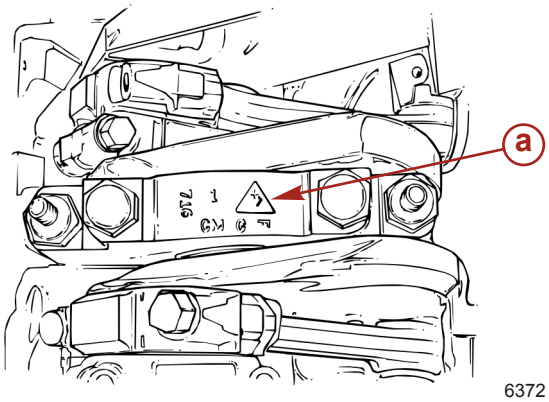
6370

a - Silicone sealant
b - O-ring

4. Carefully lower the crankshaft into position and install the main bearing caps in the proper order, "1" through "5" with arrows pointing toward front of engine.



6371



6372

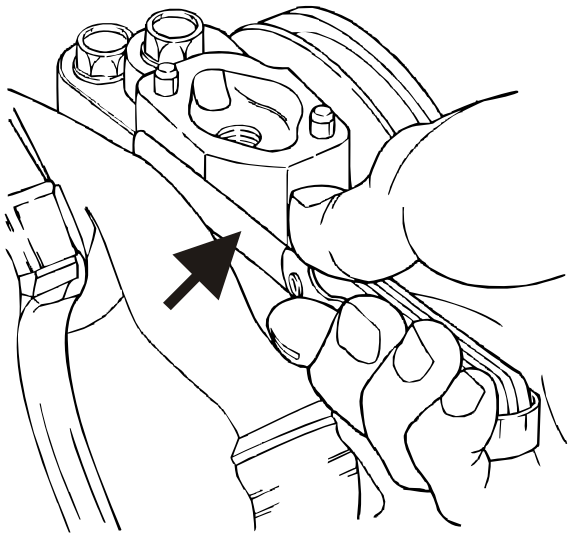
a - Bearing cap marking

NOTE: *Install the fasteners as received or as removed from the engine. Do not apply additional lubrication.*

5. Install and tighten the main bearing caps, "1,", "2," "3," and "4" to specifications.
6. Tighten the rear main bearing cap to specifications; then tap the end of the crankshaft, first rearward then forward with a lead or plastic hammer. This will line up the rear main bearing and the crankshaft thrust surfaces. Tighten the rear main bearing cap to specifications.

Description	Nm	lb. in.	lb. ft.
Main bearing cap torque "1" through "4"	149	–	110
Rear main bearing cap torque (first step)	14-16	–	10-12
Rear main bearing cap torque (second step)	149	–	110

7. Measure the crankshaft end play, see specifications, by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.



6373

Crankshaft	Specification
Crankshaft end play	0.152 - 0.254 mm (0.006 - 0.010 in.)

8. If the end play exceeds the specifications and the bearing is used, install a new bearing and re-check the main bearing clearance and end play. If the end play is still excessive, the crankshaft will either have to be re-worked or replaced.
9. If there is not enough end play, remove the rear main bearing and lightly and evenly sand the thrust surface and re-measure end play.
10. Rotate the crankshaft by hand feeling for excessive resistance, if the crankshaft cannot be rotated easily by hand, the cause must be found and fixed.
11. Check the piston rod big end clearances and re-install pistons and valve train.
12. Install as outlined:
    a. Timing chain and sprocket on camshaft align marks with crankshaft.
    b. Timing chain cover.
    c. Oil pump and baffle.
    d. Dipstick tube and oil pan.
    e. Spark plugs.
    f. Torsional damper and crankshaft pulley.
    g. Water pump.
    h. Belt(s).
    i. Flywheel / drive coupler/plate and flywheel housing.
    j. Starter.
13. Install a new oil filter and fill the crankcase with oil, refer to **Section 1B - Maintenance.**

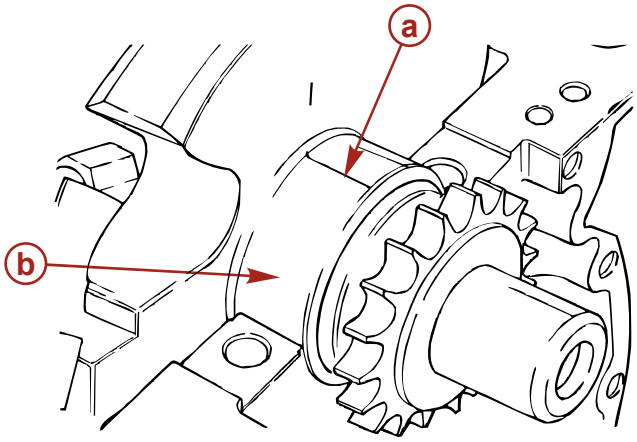
Crankshaft and Main Bearings (Plastic Gauging Method [Not Preferred])

To obtain accurate measurements while using Plastigage™ or its equivalent, the engine must be out of the boat and upside down so that the crankshaft will rest on the upper bearings. The total clearance can now be measured between the lower bearing and the journal.

IMPORTANT: To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, prior to checking the fit of the bearings, the surface of the crankshaft journal and bearing should be wiped clean.

1. With the oil pan and oil pump removed, wipe the oil from the journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.
3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap Must be tightened to specifications in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

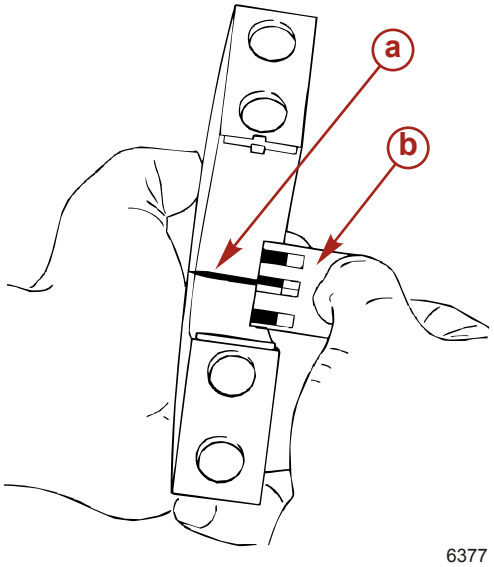
IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.



6376

a - Gauging plastic
b - Journal

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



6377

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 0.0254 mm (0.001 in.) maximum, be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter, and the journal is out of round 0.0254 mm (0 .001 in.), 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 0.0254 mm (0.001 in.) difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory.

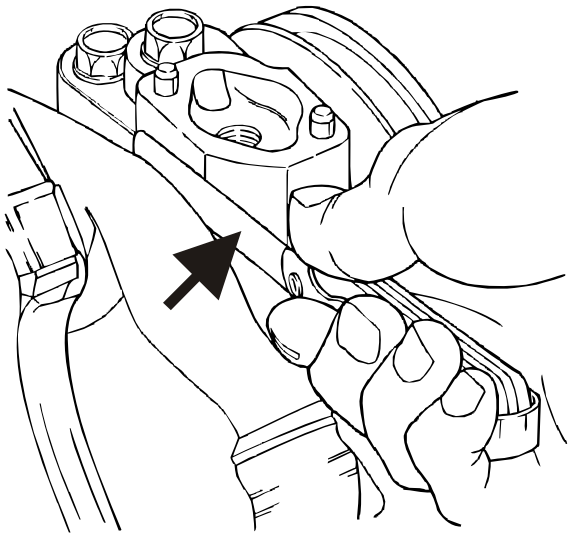
Crankshaft			**Specification**
Main Bearing Clearance	Production and Service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)

7. A standard, or 0.0254 mm (0.001 in.), undersize bearing or half of a over or undersize bearing may produce the proper clearance. If not, it will be necessary to re-grind the crankshaft journal for use with the next undersize bearing.

   NOTE: *After selecting a new bearing, re-check the clearance.*

8. Proceed to the next bearing. After all of the bearings have been checked, rotate the crankshaft to check for excessive drag. When checking the number one main bearing, loosen the accessory drive belts. The drive belt pulling on the crankshaft will distort the reading.

9. Measure the crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.

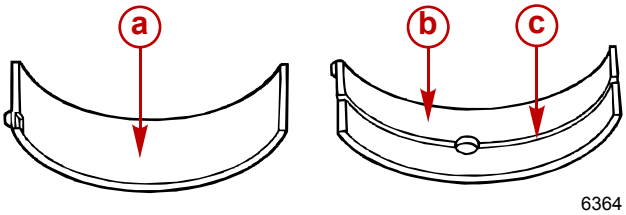


6373

Crankshaft	Specification
Crankshaft end play	0.152 - 0.254 mm (0.006 - 0.010 in.)

Replacement

NOTE: *The main bearings can be replaced with or without the crankshaft in place.*



6364

Main Bearing Inserts

a - Lower bearing insert (install in cap)
b - Upper bearing insert (install in block)
c - Oil groove

With Crankshaft Removed

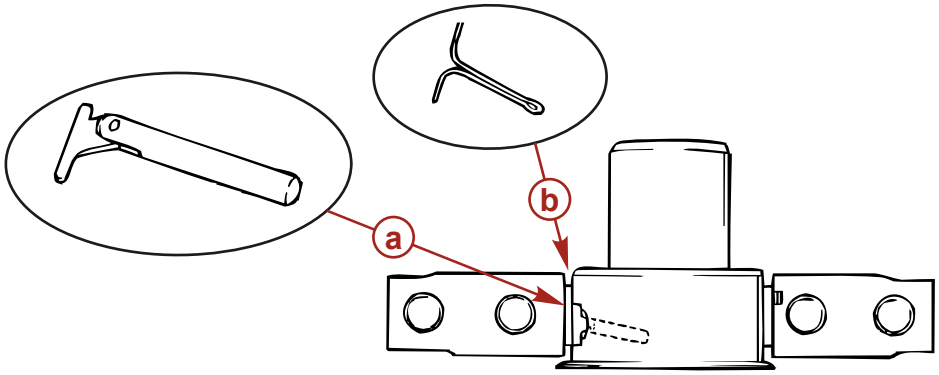
1. Remove and inspect the crankshaft as outlined.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

Without Crankshaft Removed

IMPORTANT: Inspect the bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before dis-assembly so that they can be re-installed in their original locations.

1. With oil pan, oil pump and spark plugs removed, make suitable marks on cap and remove cap on main bearing requiring replacement. Remove bearing from cap.

2. Install main bearing remover/installer in oil hole in crankshaft journal. If tool is not available, a cotter pin may be bent, as shown, to do the job.



6379

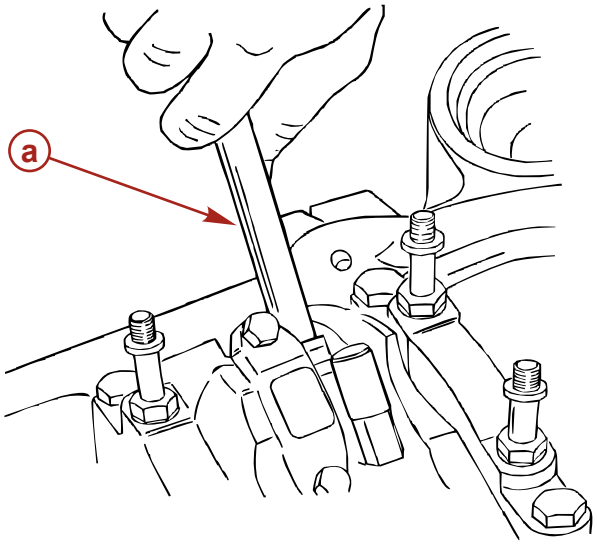
a - Main bearing remover/ installer
b - Cotter pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll the upper bearing out of the block.
4. Oil the new upper bearing and insert the plain (no notched) end between the crankshaft and the indented or notched side of the block. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
5. Oil the new lower bearing and install it in the bearing cap.
6. Install the main bearing, cap with marks made on dis-assembly or arrows if present, pointing toward the front of the engine.
7. Tighten the main bearing caps "1," "2," "3," and "4" to specifications.
8. Tighten the rear main bearing cap to specifications; then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Tighten the rear main bearing cap to specifications.

Description	Nm	lb. in.	lb. ft.
Main bearing cap torque "1" through "4"	149	–	110
Rear main bearing cap torque (first step)	14-16	–	10-12
Rear main bearing cap torque (second step)	149	–	110

9. Install the connecting rod bolt guide. Push the connecting rod and piston assembly out through the top of the cylinder block.

NOTE: *It will be necessary to turn the crankshaft slightly to disconnect and remove some of the connecting rod and piston assemblies.*

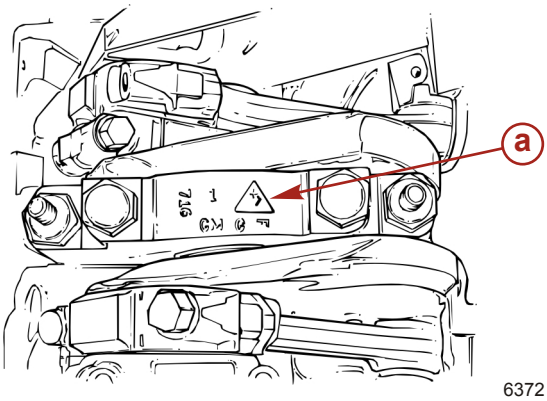


6381

a - Connecting rod bolt guide

NOTE: *The main bearing caps have arrows cast in them (facing forward) with the numbers "1" through "5" stamped on them.*

10. Remove each main bearing cap being careful to keep the bearing half with its respective cap.



a - Bearing cap marking

11. Carefully remove the crankshaft.

Pistons and Connecting Rods

IMPORTANT: Do not use an impact wrench.
Be sure to use soft jaws in the vise when clamping the rod and new piston.
Take precautions to avoid nicking the rod, cap, or bolts; they are highly stressed and susceptible to fatigue cracks that start with surface defects.

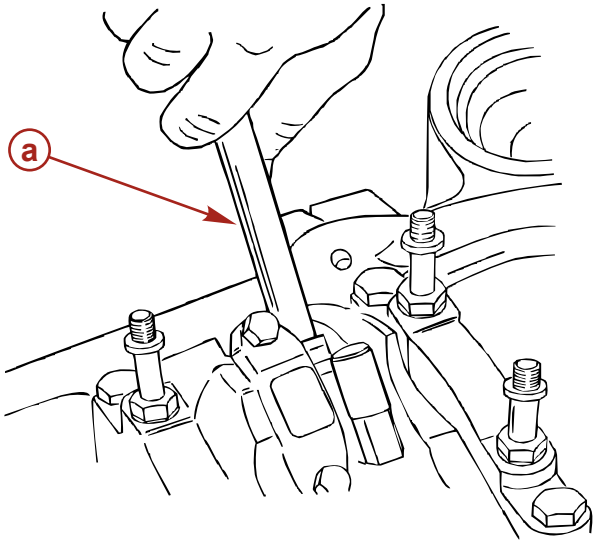
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. Never file rods or rod caps. If the clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersize for use with new and used standard size crankshafts, and in 0.010 in. and 0.020 in. undersize for use with reconditioned crankshafts.

Removal

1. Remove the engine.
2. Remove the coupling and flywheel and mount the engine on a suitable stand.
3. Remove the cool fuel system, engine mount and oil cooler.
4. Remove the starter and cylinder heads.
5. Remove the oil pan and torsional damper.
6. Remove the oil pump and baffle.
7. Remove the timing chain cover and timing chain.
8. Remove the camshaft.
9. Use a ridge reamer to remove any ridge or deposits from the top of the cylinder bore.
   IMPORTANT: Before the ridge and deposits are removed, rotate the crankshaft to position the piston at the bottom of the stroke and place a cloth on top of the piston to collect the cuttings. After the ridge and deposits are removed, rotate the crankshaft to position the piston at the top of the stroke, then remove the cloth and cuttings.

   NOTE: *The connecting rod caps and the connecting rods are matched by a process called cracked rod.*
10. Remove each connecting rod cap being careful to keep the bearing half with its respective cap.
11. Install the connecting rod bolt guide on the rods. Push the connecting rod and piston assembly out of the top of the cylinder block.

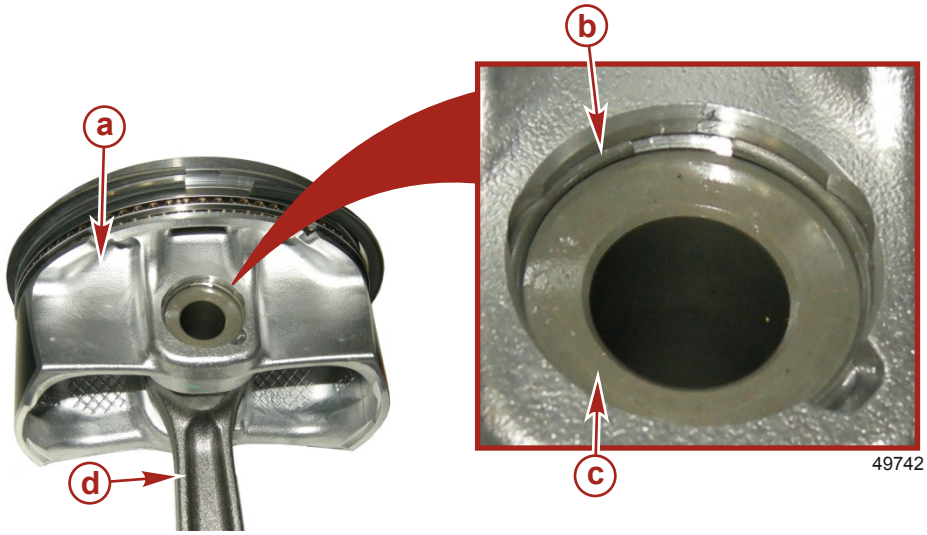
NOTE: It will be necessary to turn the crankshaft slightly to disconnect and remove some of the connecting rod and piston assemblies.



a - Connecting rod bolt guide

Disassembly and Inspection

1. Remove the retaining clip and remove the piston pin to disassemble the piston from the connecting rod.



a - Piston
b - Retaining clip
c - Piston pin
d - Connecting rod

2. Inspect the bearing surface for wear and damage.
3. Remove the oil film from the crank pin, and the upper and lower bearing shells.
4. Measure the crankpin for out-of-round or taper with a micrometer. If it is not within the specifications, replace or recondition the crankshaft. If it is within the specifications and a new bearing is to be installed, measure and record the maximum diameter of the crankpin to determine the new bearing size required.

Crankshaft			**Specification**
Main Journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) Max
		Service	0.0254 mm (0.001 in.) Max
	Out of Round	Production	0.0127 mm (0.0005 in.) Max
		Service	0.0254 mm (0.001 in.) Max

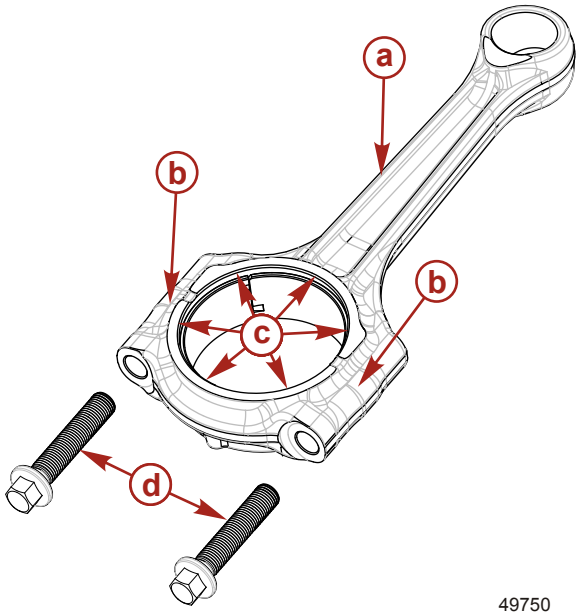
NOTICE

Attaching bearing cap bolts to a connecting rod that is secured in a vise can lead to product damage. When clamping rods in a vise, always use a soft-jawed vise and clamp at the crankshaft end of the rod, as close to the parting line of the bearing cap as possible.

5. Clamp the connecting rod into a vice with soft jaws.
6. Install the bearing caps with the bearings and tighten them to specifications.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

7. Using a dial bore gauge, measure and record the inside diameter of the bearing. Subtract the crank pin diameter from the rod bearing inside diameter to obtain clearance.



49750

a - Connecting rod
b - Parting area (cracked cap)
c - Inside diameter
d - Bolt

Crankshaft		Specification
Rod Bearing Clearance	Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
	Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max

8. If the clearance exceeds the specifications, select a new, correct size bearing and measure the clearance.

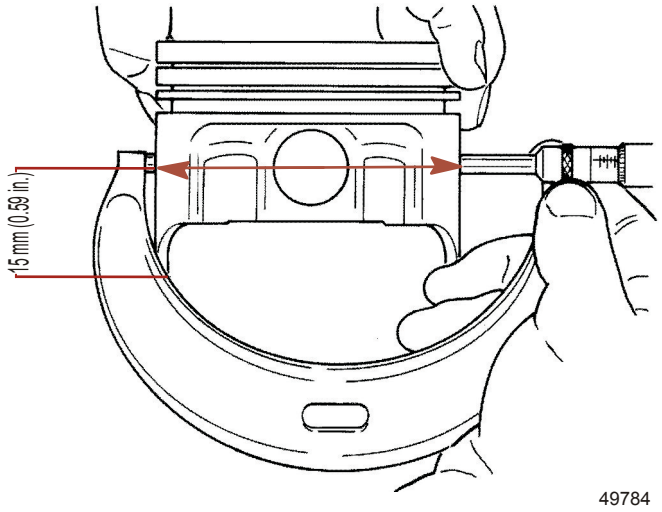
   NOTE: *Be sure to check the size of the bearing being removed in order to determine proper replacement size bearing. If the clearance cannot be brought to within the specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace the crankshaft.*

Cleaning

1. Remove the varnish from the piston skirts with a cleaning solvent. Do not use a wire brush to clean the piston. Clean the ring grooves with a groove cleaner and make sure the oil ring openings are clean.
2. Inspect the piston for cracked ring lands, skirts and pin bosses, wavy worn ring lands, scuffed or damaged skirts, and eroded areas at the top of piston. Replace the pistons that are damaged or show signs of excessive wear.
3. Inspect the ring grooves for nicks and burrs that might cause the rings to hang up.

Measuring

1. Measure the piston diameter at the skirt across the center line of the piston pin as shown. Find the piston centerline at 15 mm (0.59 in.) as shown.



   a. Subtract the piston diameter from the cylinder bore diameter to determine the piston-to-bore clearance.
   b. Determine if the piston-to-bore clearance is acceptable.

Piston		Specification
Clearance	No. 1–6 cylinders	0.044 - 0.076 mm (0.0017 - 0.0030 in.)
	No. 7–8 cylinders	0.064 - 0.096 mm (0.0025 - 0.0038 in.)

2. If a used piston is not satisfactory, determine if a new piston can be selected to fit the cylinder bore within an 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 the correct clearance (preferable range).
4. Mark the piston to identify the cylinder for which it was fitted.

   NOTE: *The cylinder bore and taper must be within the specifications before the pistons can be considered for re-use.*

Piston Pins

1. The piston pin clearance is designed to maintain an adequate clearance under all engine operating conditions.
2. Inspect the piston pin bores and the piston pins for wear. The piston pin bores and the piston pins must be free of varnish and scuffing when measured. Measure the piston pin with a micrometer and the piston pin bore with a dial bore gauge or inside micrometer. If the clearance is in excess of the 0.0130 mm (0.00051 in.) wear limit, replace the piston and piston pin assembly.

Piston Pin	Specification
Diameter	22.997 - 23.000 mm (0.9054 - 0.9055 in.)
Clearance in piston	0.0040 - 0.0130 mm (0.00016 - 0.00051 in.)
Clearance in rod	0.0150 - 0.0280 mm (0.00059 - 0.00110 in.)

Cylinder Block Cleaning

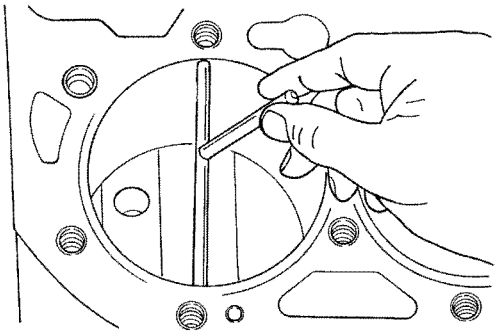
1. Wash the cylinder block thoroughly with a cleaning solvent and clean all of the gasket surfaces.
2. Remove the oil gallery plugs and clean all of the oil passages.
3. Remove the expansion plugs and clean the water passages in the cylinder block.

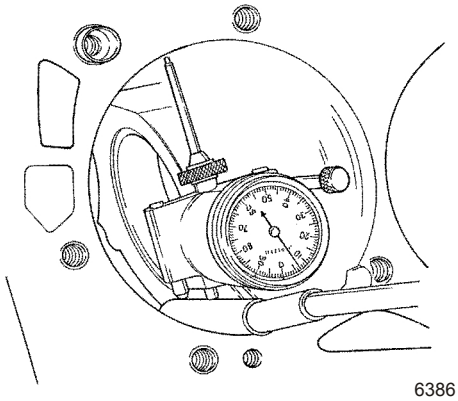
   NOTE: *These plugs may be removed with a sharp punch, or may be drilled and pried out.*

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 wall taper, runout and for an excessive ridge at the top of the ring travel. This should be done with a dial indicator or an inside micrometer. Carefully work the gauge up and down the cylinder to determine the taper and make sure to measure it at different points around the cylinder wall to determine the out-of-round condition. If the cylinders exceed the specifications, honing and boring or just honing may be necessary to bring the cylinder(s) back into specifications.





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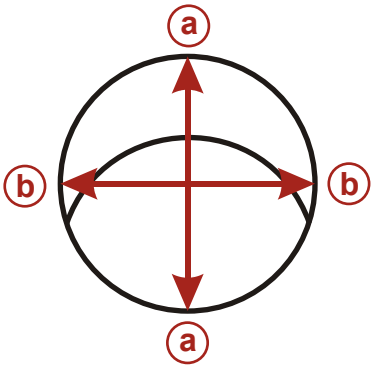
NOTE: *"Out of Round" equals the difference between the measurements "a" and "b" taken at both the top and bottom of the cylinder bore.*



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Cylinder Measurement

a - At right angles to centerline of engine

b - Parallel to centerline of engine

Cylinder Re-conditioning

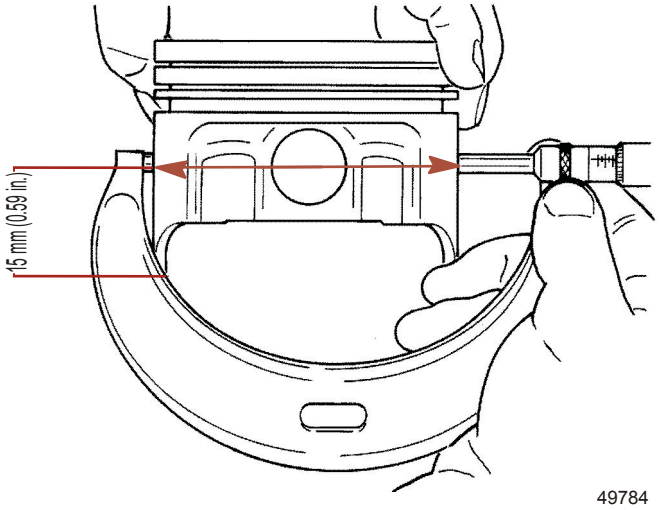
1. Whether or not the following operation is necessary depends upon the engine condition at the time of repair:
   a. If the cylinder block inspection indicates that the block is suitable for continued use (except for out-of-round or tapered cylinders), they can be re-conditioned by either honing or boring and honing.
   b. If the cylinders have less than 0.0127 mm (0.0005 in.) taper or wear, they can be conditioned with a hone and fitted with a standard size piston at the higher limit of the piston to bore clearance.

   NOTE: *A cylinder bore with more than 0.0127 mm (0.0005 in.) of wear or taper may not clean up entirely when fitted to a piston that's at the higher limit of the piston to bore clearance. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If there is more than 0.0127 mm (0.0005 in.) of taper or wear, bore and hone to the smallest oversize that will permit a complete resurfacing of all of the cylinders.*

Cylinder Boring

1. Before using any type boring bar, file off the top of the cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with the result that the bored cylinder wall is not at right angles to the crankshaft.

2. Measure the piston to be fitted with a micrometer, measuring at the center of piston skirt 15 mm (0.59 in.), and at right angles to the piston pin. Bore the cylinder to the same diameter as the piston and hone it to give the specified clearance.



Cylinder Honing

NOTE: *Follow the hone manufacturer's recommendations for using the hone and the cleaning and lubrication during the honing. Occasionally, during the honing operation, thoroughly clean the cylinder bore and check the piston for correct fit in the cylinder.*

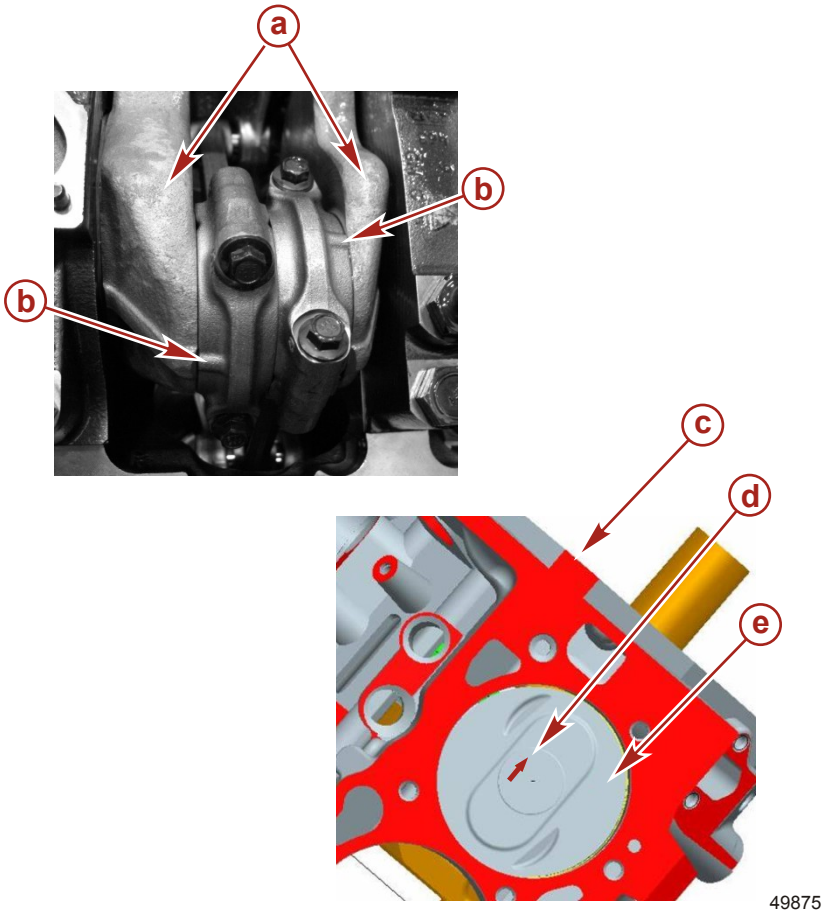
1. When finish-honing a cylinder bore to fit a piston, move the hone up and down at a sufficient speed to obtain the very fine uniform surface finish marks in a crosshatch pattern of approximately 22–32 degrees to the cylinder bore. The finish marks should be clean, but not sharp, and free from imbedded particles and torn or folded metal.
2. Permanently mark the piston (with the number of the cylinder it has been fitted to).
   IMPORTANT: Handle the pistons with care and do not attempt to force them through the cylinder until the cylinder is honed to the correct size, this type of piston can be distorted by careless handling.
3. Thoroughly clean the cylinder bores with hot water and detergent. Scrub them with a stiff bristle brush and completely rinse them with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in the cylinder bores, rings, the cylinder bores and bearings lubricated by the contaminated oil will wear rapidly. Swab the bores several times with a clean transmission fluid on a clean cloth, then wipe with a clean, dry cloth. The cylinder should not be cleaned with kerosene or gasoline. Clean the remainder of the cylinder block to remove any excess material spread during the honing operation.

Piston Reassembly

The cracked rod cap has a forged nub and the piston has an arrow to ensure correct orientation during assembly.

IMPORTANT: The forged nub on the rod caps assemble away from each other when correctly installed on each crankpin.
IMPORTANT: The laser etched arrow on each piston points toward the front of the engine when correctly installed.

1. Determine the correct position before assembly. Position the connecting rod to the piston so the arrow on top of the piston is pointing toward the front of the engine and the nub on the rod cap is against the crankshaft lobe when installed.

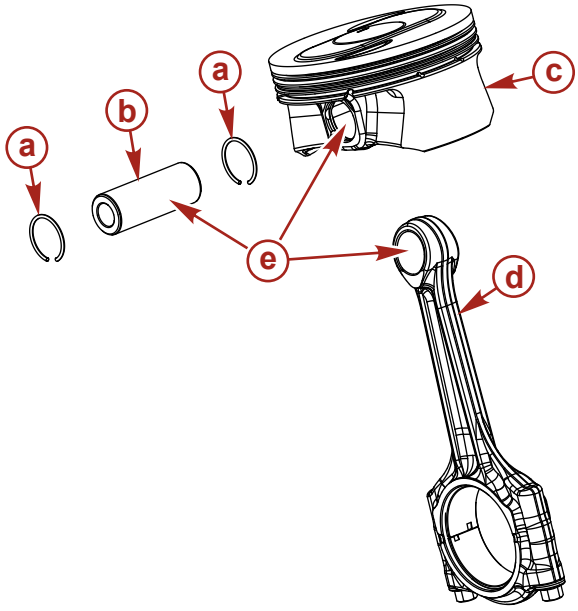


- **a -** Crankshaft lobe
- **b -** Nub on the rod cap
- **c -** Front of engine
- **d -** Arrow (etched on piston)
- **e -** Piston

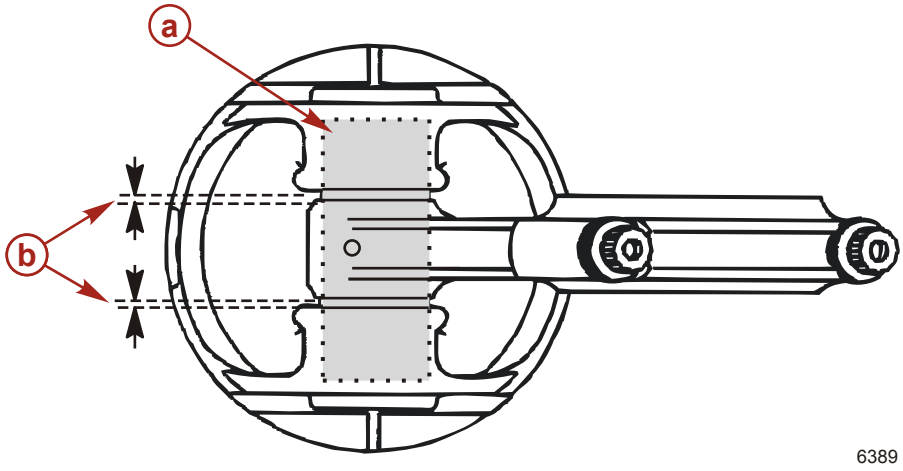
2. Apply a very light film of engine oil to the piston pin bore, the piston pin, and the rod pin bore.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Piston pin bore, piston pin, rod pin bore	92-858087K01

3. Slide the piston pin in the piston/rod assembly and install a retaining clip in each groove securing both ends of the pin.

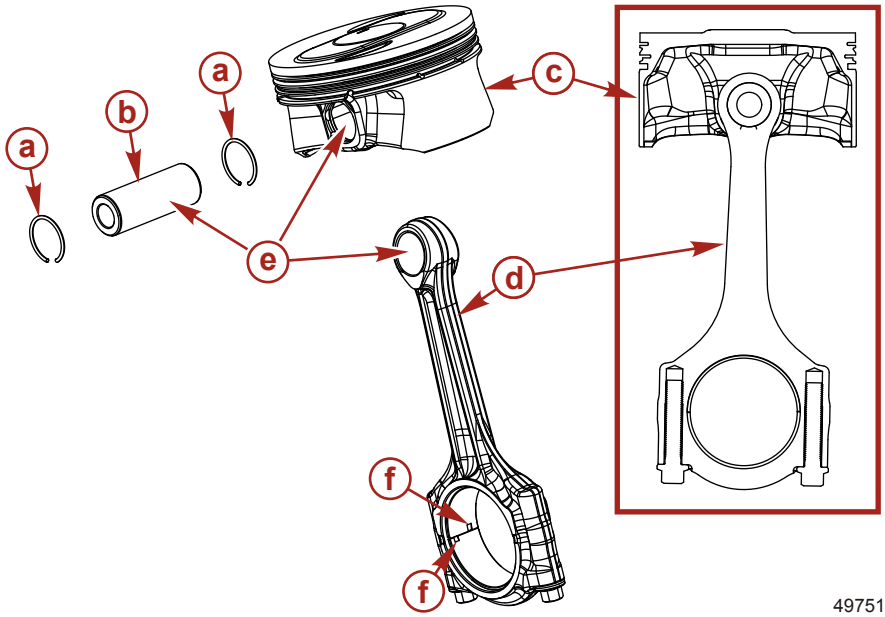


a - Retaining clip
b - Piston pin
c - Piston
d - Connecting rod
e - Lubrication area



a - Piston pin
b - Rod to piston clearance

4. Once assembled, check the piston for freedom of movement on the connecting rod (rod swing and lateral movement). The piston should move freely in all directions. If not, the piston pin bore is tight and should be disassembled to determine the cause.



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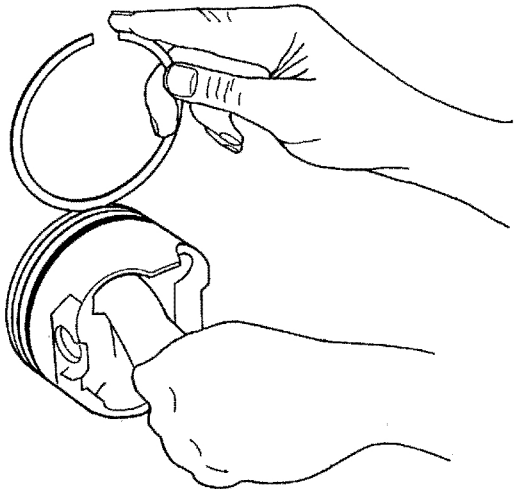
a - Retaining ring
b - Piston pin
c - Piston
d - Connecting rod
e - Light film of engine oil prior to assembly
f - Bearing tang notches in the rod

Piston Rings

1. 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 make sure that the ring is free as shown. If binding occurs at any point, determine the cause. If it is caused by a ring groove, remove the obstruction by dressing it with a fine cut file. If the binding is caused by a distorted ring, recheck it with another ring.



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2. The proper clearance of the piston ring in its piston ring groove is very important to provide the proper ring action and reduce the wear. Therefore, when fitting new rings, clearances between the ring and the groove surfaces should be measured.

6399

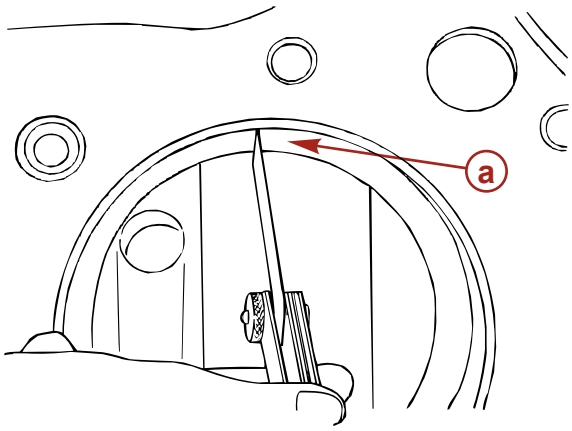
Compression Ring		Specification
Groove side clearance	Top	0.02 - 0.085 mm (0.0008 - 0.0033 in.)
	2nd	0.01 - 0.058 mm (0.0004 - 0.0022 in.)
Gap	Top	0.28 - 0.43 mm (0.0110 - 0.0169 in.)
	2nd	0.40 - 0.65 mm (0.0157 - 0.0255 in.)

Oil Ring	Specification
Groove side clearance	0.008 mm (0.0003 in.) interference to 0.176 mm (0.0070 in.) clearance
Gap (rails / oil scrapers)	0.15 - 0.66 mm (0.0060 - 0.0260 in.)

NOTE: *The top compression ring is marked with a dot on the top side. The second ring or scraper is not marked and installed with the scraper edge down.*

NOTE: *The oil control rings are a three-piece type, consisting of two rings and an expander*

3. Select the rings comparable in size to the cylinder bore and the piston size.
4. Slip the compression ring in the cylinder bore, then press the ring down into the cylinder bore about 6.4 mm (1/4 in.) (below the ring travel). Ensure that the ring is square with the cylinder wall.
5. Measure the gap between the ends of the ring with a feeler gauge as shown, record the measurements.

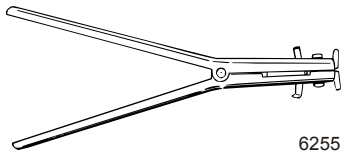


a - Piston ring

6400

6. Clean and inspect the pistons, if needed.

7. Install the piston rings as follows:
   a. Install the oil ring expander in the groove.
   b. Install the lower steel oil ring rail with the gap properly located.
   c. Install the upper steel oil ring rail with the gap properly located.
   d. Flex the oil ring assembly to make sure the ring is free. If binding occurs at any point, the cause should be determined and, if caused by the ring groove, remove the obstruction by dressing the groove with a fine cut file. If the binding is caused by a distorted ring, use a new ring.
   e. Install the lower compression ring with the scraper edge down, using a ring expander.
   f. Install the top compression ring with the dot and chamfer bevel up, using a ring expander.

Piston Ring Expander	91-24697
Description: Removes and installs the piston rings.	 6255

Installation

IMPORTANT: The cylinder bores must be clean before the piston installation. Clean them with a light honing, as necessary. Then clean them with hot water and detergent wash. After cleaning, swab bores several times with clean transmission fluid and a clean cloth, then wipe them with a clean dry cloth.

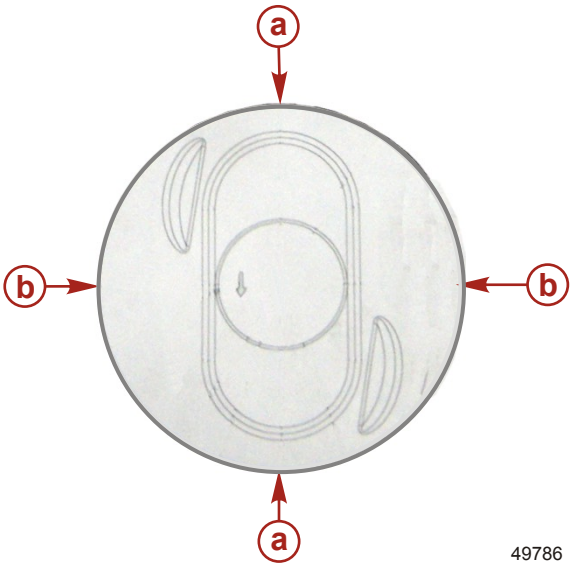
1. Install and lubricate the connecting rod bearings.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Connecting rod bearings	92-858087K01

2. Lightly coat the pistons, rings and the cylinder walls with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Pistons, rings, cylinder walls	92-858087K01

3. With the bearing caps removed, install the connecting rod guide on the connecting rod.
   IMPORTANT: Ensure that the ring gaps are properly positioned as shown.



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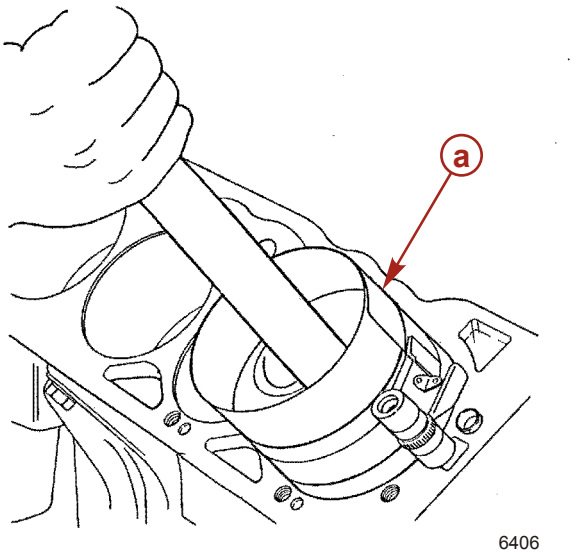
a - Oil ring expander
b - Top and bottom oil rings 180° apart: First and second compression rings 180° apart

4. Install each connecting rod and piston assembly in its respective bore. Install with the 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 guide. Use the hammer handle with light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all the piston rings have entered the cylinder bore. **IMPORTANT: Be sure to install the new pistons in the same cylinders for which they were fitted, and the used pistons in the same cylinder from which they were removed. Mark each connecting rod and bearing cap 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). The numbers on the connecting rod and bearing cap must be on the same side when they are installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, the new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**



a - Piston ring compressor

5. Remove the connecting rod guide. Coat the bearing surface with oil.

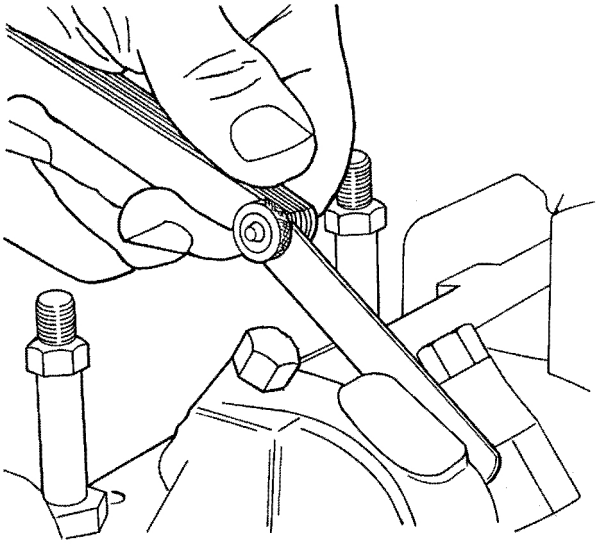
Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Rod cap bearing surface	92-858087K01

6. Install the rod bearing caps.
7. Evenly tighten the rod bolts to specification.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

8. When all of the connecting rod bearings have been installed, tap each rod lightly, parallel to the crankpin, to make sure there is clearance.

9. Measure all of the connecting rod side clearances between the connecting rod caps as shown.



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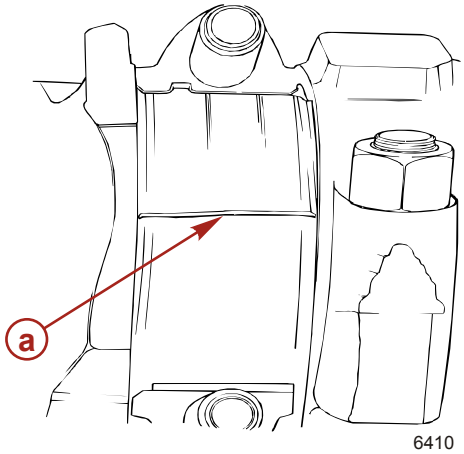
Crankshaft	Specification
Rod side clearance	0.305 - 0.61 mm (0.012 - 0.024 in.)

Using Plastic Gauging

The connecting rod bearings are of the precision insert type and do not use shims for adjustment. Do not file the rods or rod caps. If the clearances are found to be excessive, a new bearing will be required. Service bearings are available in a standard size and a 0.0254 mm (0.001 in.) and 0.051 mm (0.002 in.) undersize for use with the new and used standard size crankshafts, and in a 0.254 mm (0.010 in.) and 0.051 mm (0.020 in.) undersize for use with reconditioned crankshafts.

Inspection and Replacement

1. Inspect the bearing for wear and damage. Do not re-install a worn or damaged bearing.
2. Wipe both upper and lower bearing shells and crank pin clean of oil.
3. Measure the crankpin for an out-of-round or taper using a micrometer. If they are not within the specifications, replace or recondition the crankshaft. If they are within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine the new bearing size required.
4. If they are within specifications, measure the new or used bearing clearances with a gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit it to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round 0.0254 mm (0.001 in.), an interference between the bearing and the crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin 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 it is placed elsewhere.)



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a - Gauging plastic

b. Install and lubricate the connecting rod bearings.

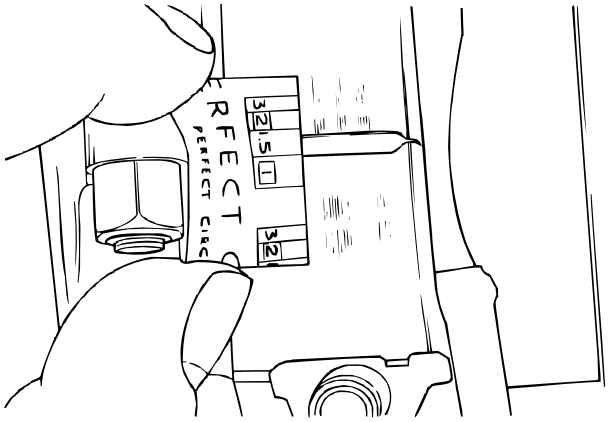
Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Connecting rod bearings	92-858087K01

5. Install the bearing caps and hand start the bolts.
6. Evenly tighten the rod bolts to specifications.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

a. When all the connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.

b. 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 rotate the crankshaft with the gauging plastic installed.



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7. If the clearance exceeds the specifications, select a new, correct size bearing and measure the clearance.

Crankshaft		Specification
Rod Bearing Clearance	Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
	Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max

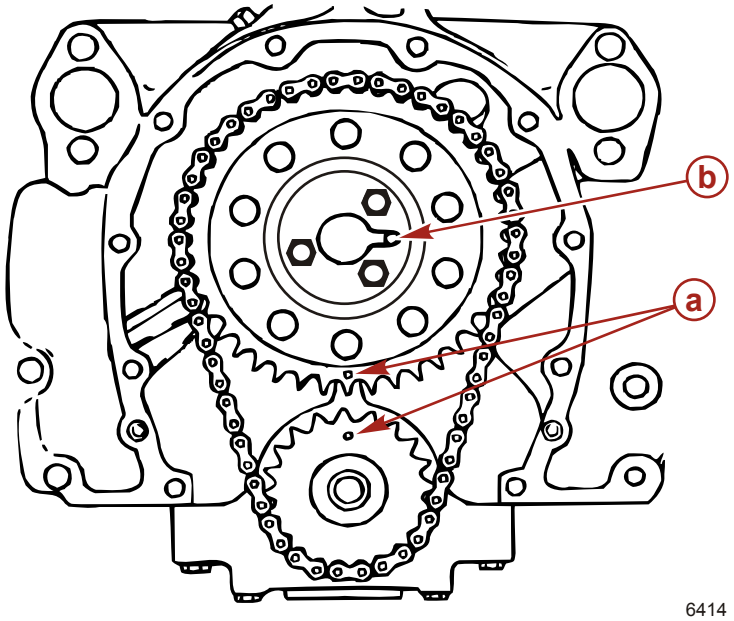
IMPORTANT: Be sure to check the size of the bearing being removed in order to determine the proper replacement size bearing. If the clearance cannot be brought to within the specifications, the crankpin will have to be ground undersize. If the crankpin is already at a maximum undersize, replace the crankshaft.

Timing Chain and Sprocket

Removal

1. Remove the torsional damper, oil pan and timing cover.

2. Turn the crankshaft until the timing marks on the crankshaft and camshaft sprockets are in alignment as shown.



a - Timing marks aligned
b - Locating pin

3. 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.
4. If the crankshaft sprocket requires replacement, remove it.

Cleaning and Inspection

1. Clean all the parts in solvent and dry them with compressed air.
2. Inspect the timing chain and sprockets for wear and damage.

Installation

1. If the crankshaft sprocket was removed, re-install as outlined in the **Crankshaft Sprocket** section of this manual.
2. 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.
3. Install the sprocket on the camshaft.
IMPORTANT: Do not attempt to force the sprocket onto the camshaft, or the welch plug at the rear of the engine could be dislodged.

Description	Nm	lb. in.	lb. ft.
Camshaft sprocket mounting bolts	27	–	20

4. Lubricate the timing chain with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Timing chain	92-858087K01

5. Install the timing cover, oil pan, and torsional damper.

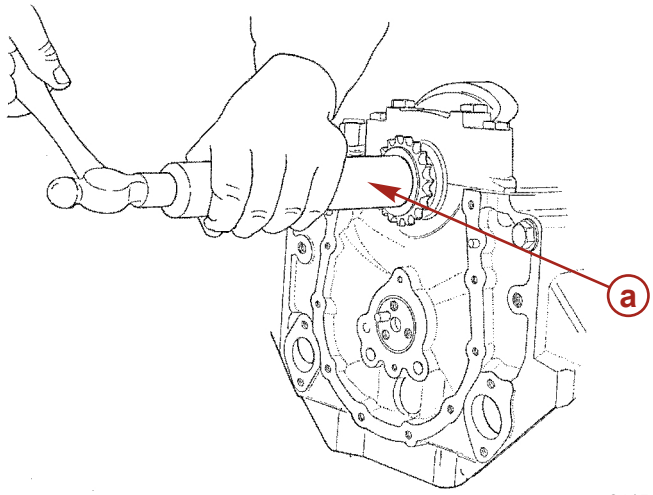
Crankshaft Sprocket

Removal

1. Remove the torsional damper and the crankcase front cover.
2. Remove the camshaft timing chain.
3. Remove the crankshaft sprocket using a crankshaft gear and sprocket puller.

Installation

1. Using a crankshaft gear and sprocket installation tool as shown, install the sprocket on the crankshaft.



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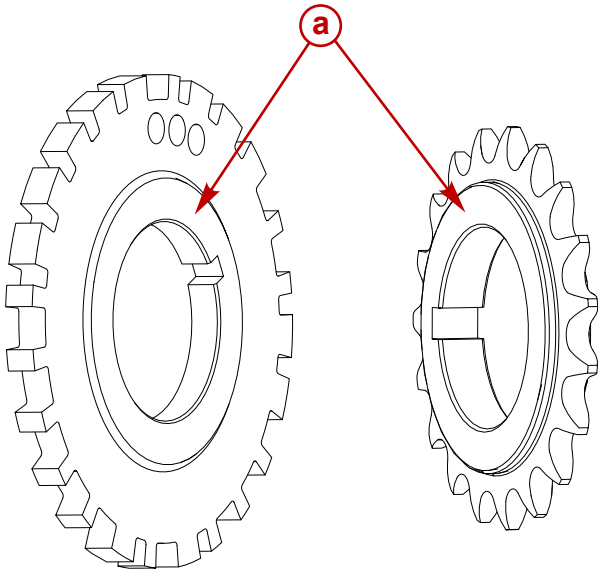
a - Crankshaft gear and sprocket installation tool

2. Install the timing chain as outlined.
3. Install the crankshaft sensor target wheel with the raised portion of the target wheel facing the raised portion of the crankshaft sprocket.



20763

a - Raised portion of target wheel and sprocket.

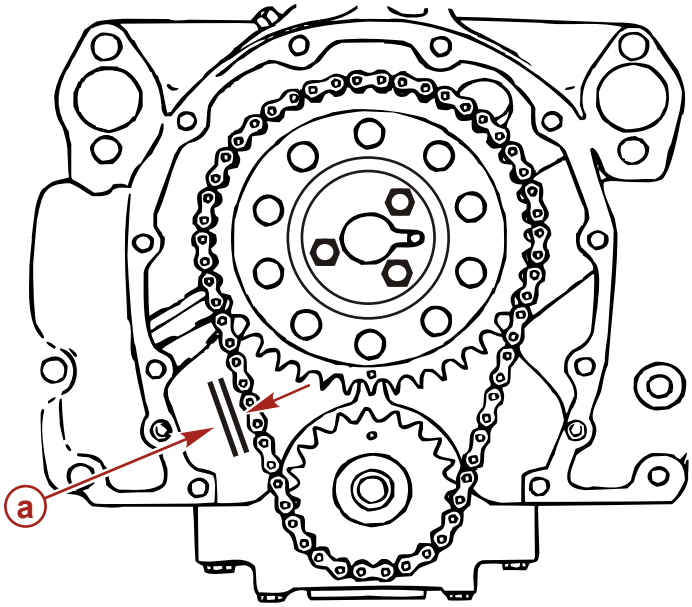
4. Install the crankcase cover and the torsional damper as outlined.

Checking Timing Chain Deflection

The timing chain and the sprockets must be replaced as a set. Check the timing chain deflection anytime the cover is removed and replace the set during every engine rebuild.

1. Rotate the camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate the camshaft in the opposite direction to remove the chain tension, then force the chain out with your fingers and again measure the distance between the reference point and the 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.



6418

a - Reference point

Roller Camshaft	Specification
Timing chain deflection	12.7 mm (0.50 in.) from taut position

5. Install the crankcase front cover and the torsional damper.

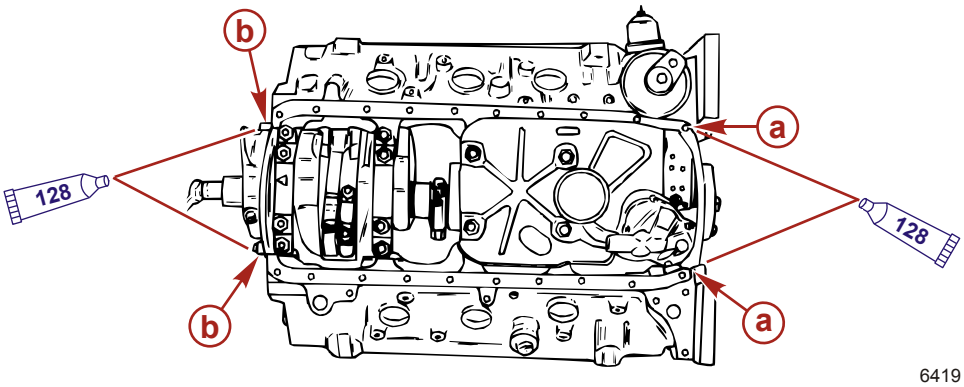
Oil Pan

Removal

1. Drain the crankcase oil.
2. Remove the dipstick.
3. Remove the oil pan.

Installation

1. Clean the sealing surfaces of the engine block and the oil pan.
   IMPORTANT: The sealer sets up in about 15 minutes. Be sure to complete the assembly process promptly.
2. Apply a small amount of sealer to the joints of the rear seal retainer and the joints of the front cover.

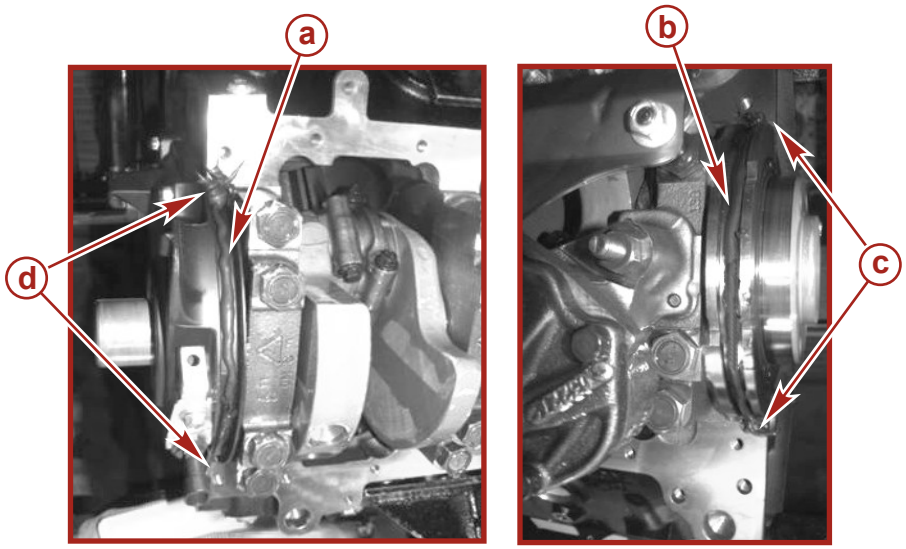


6419

a - Joints of rear seal retainer
b - Joints of front cover

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally

3. Apply a bead of sealer in the rear main bearing groove and the front cover groove where the oil pan gasket will nest.

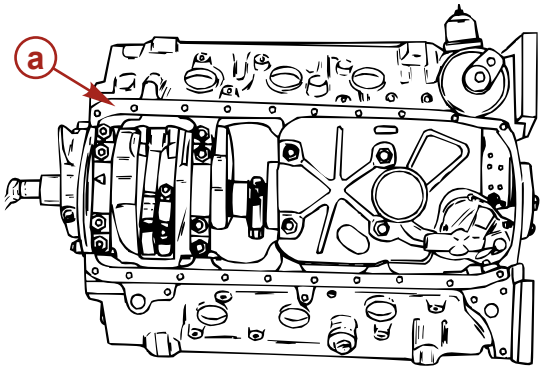


49790

a - Font cover groove
b - Rear main bearing groove
c - Joints of rear seal retainer
d - Joints of front cover

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally

4. Install the oil pan gasket in the position shown.



6421

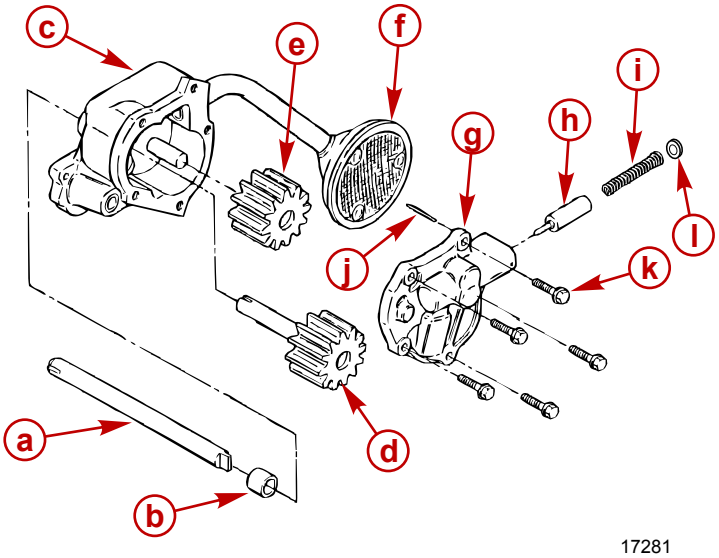
a - Oil pan gasket

5. Install the oil pan. Starting from the center and working outward in each direction, torque the mounting bolts to specifications.

Description	Nm	lb. in.	lb. ft.
Oil pan mounting bolts	20	–	15

6. Fill the crankcase with the required quantity of oil.

Oil Pump



17281

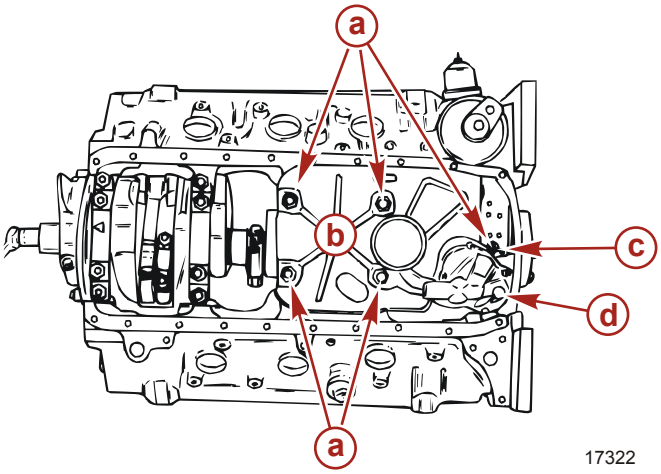
Oil pump assembly

- **a -** Extension shaft
- **b -** Shaft coupling
- **c -** Pump body
- **d -** Drive gear and shaft
- **e -** Idler gear
- **f -** Pickup screen and pipe
- **g -** Pump cover
- **h -** Pressure regulator valve
- **i -** Pressure regulator spring
- **j -** Retaining pin
- **k -** Screws
- **l -** Washer

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. The oil pump is driven by an extension shaft that is driven by a helical gear on the camshaft.

Removal

1. Remove the oil pan and its gasket.
2. Remove the baffle.

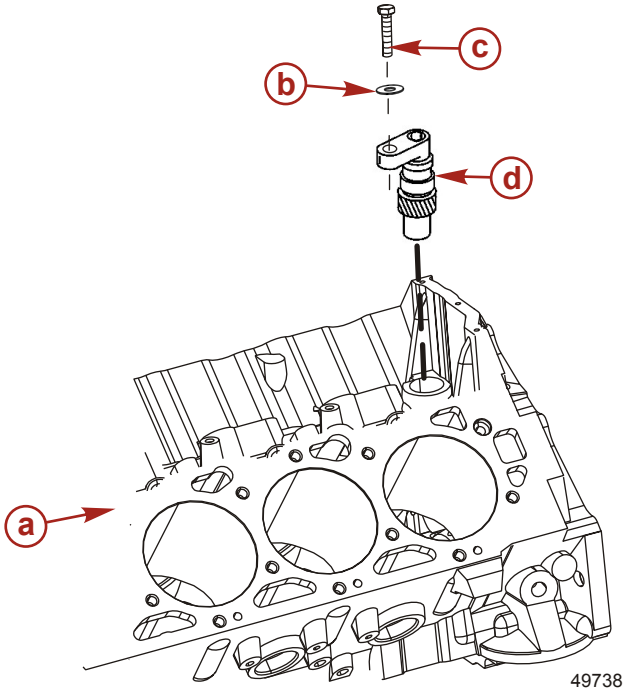


17322

- **a -** Baffle retaining nuts
- **b -** Oil deflector baffle
- **c -** Oil pump mounting bolt with baffle stud
- **d -** Oil pump

3. Remove the oil pump mounting bolt. Remove the oil pump and extension shaft.

4. If necessary, the oil drive mechanism can also be removed.



a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

Disassembly

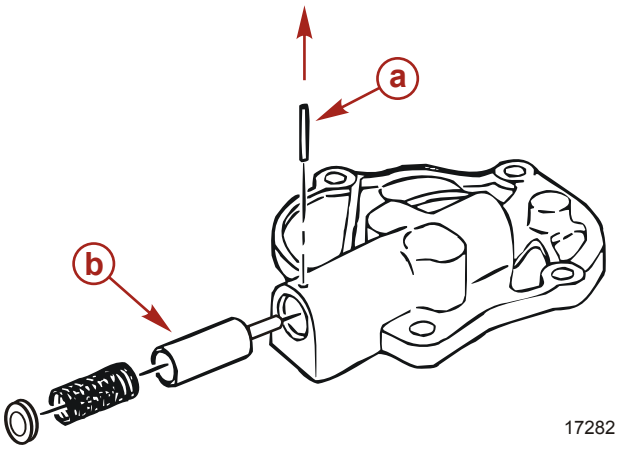
NOTE: *Refer to the exploded view shown previously.*

1. Remove the pump cover.
   IMPORTANT: Mark the gear teeth for reassembly with same teeth indexing.
2. Remove the idler gear and the drive gear from the pump body.

⚠ CAUTION

The pressure regulator valve is spring-loaded, retained by a snap ring. The force of the spring can cause injury during removal. Use caution when disassembling components and wear protective eye equipment.

3. Remove the retaining pin from the pump cover with a punch (remove in direction shown). The spring may release violently. Remove the pressure regulator valve from the pump cover.



a - Retaining pin
b - Pressure regulator valve

Cleaning

1. Wash all the parts in cleaning solvent and dry them with compressed air.
2. Inspect the pump body and the cover for cracks or excessive wear.
3. Inspect the pump gears for damage and excessive wear.
4. Check for a loose drive gear shaft in the pump body.

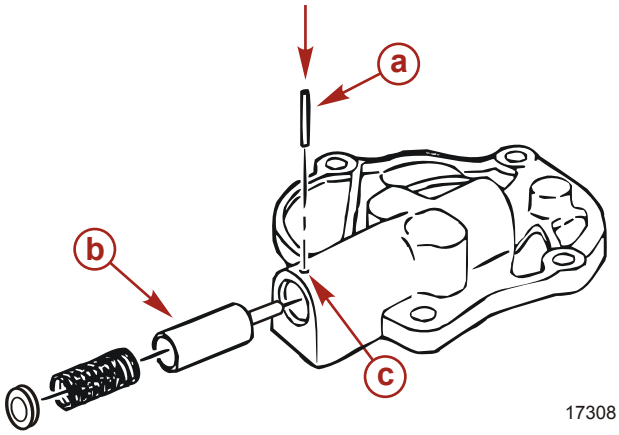
5. Inspect the inside of the pump cover for wear that would permit the oil to leak past the ends of the gears.
6. Inspect the pickup screen and the pipe assembly for damage to the screen and pipe.
7. Check the pressure regulator valve for fit.
   IMPORTANT: The oil pump is not serviceable. If any parts are worn or damaged, replacement of the entire pump assembly and pickup tube is necessary.

Reassembly

IMPORTANT: Oil the internal parts liberally with the specified engine oil before installation.

NOTE: *Refer to the oil pump exploded view shown previously.*

1. Install the pressure regulator valve and the related parts. Ensure that the retaining pin is tight, if not, install the pin and stake it with a punch and hammer to keep it tight in the housing.



17308

a - Retaining pin
b - Pressure regulator valve
c - Stake here with a punch and hammer

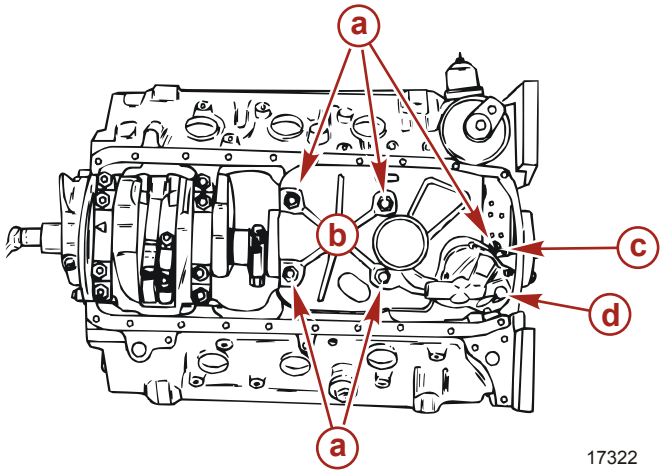
2. Install the drive gear in the pump body.
3. Install the idler gear in the pump body with the smooth side of the gear toward the pump cover opening. Align the marks made during disassembly.
4. Fill the gear cavity with the specified engine oil.
5. Install the pump cover and torque the attaching screws to specifications.

Description	Nm	lb. in.	lb. ft.
Oil pump cover attaching bolts	11	–	8

6. Turn the extension shaft by hand to check for smooth operation.

Installation

1. Install the pump, with the extension shaft, and the rear main bearing, aligning the extension shaft with the distributor drive shaft.
2. Install the baffle. Tighten the baffle nuts to specifications.
3. Tighten the oil pump mounting bolt to specifications.



17322

a - Baffle retaining nuts
b - Oil deflector baffle
c - Oil pump mounting bolt with baffle stud
d - Oil pump

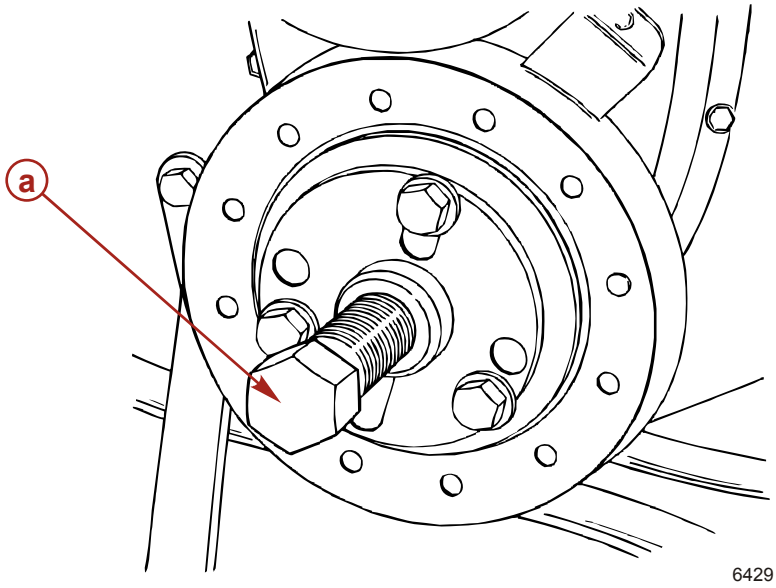
Description	Nm	lb. in.	lb. ft.
Oil baffle nuts	35	–	26
Oil pump mounting bolt	95	–	70

4. Install the oil pan as outlined in the **Oil Pan** section of this manual.

Torsional Damper

Removal

1. Remove the drive belt.
2. Remove the drive pulley and the water pump pulley.
3. Remove the torsional damper retaining bolt.
   IMPORTANT: Do not use a universal claw type puller to remove the torsional damper (in 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.
4. Remove the torsional damper.



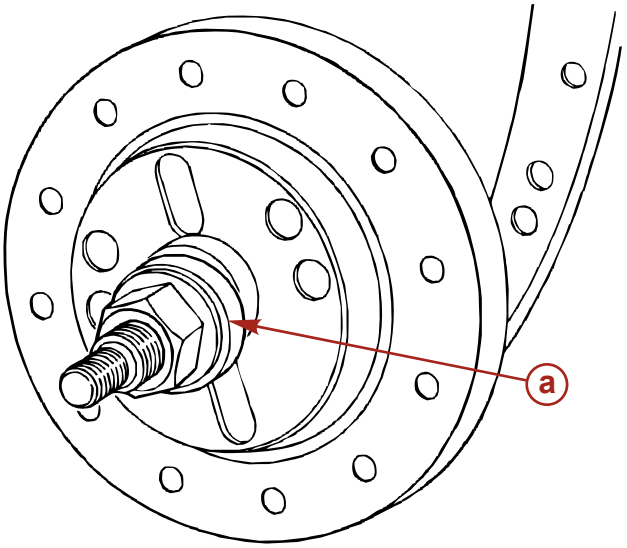
a - Torsional damper tool

Installation

IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace the key in the crankshaft if it is damaged.
2. Coat the interference surface of the torsional damper with a High Pressure Grease.

3. Install the torsional damper on the crankshaft, using a Torsional Damper tool.



6432

a - Torsional damper tool

   a. To prevent oil leakage, apply an RTV sealant to the keyway.
   b. Install the torsional damper bolt. Tighten it to specifications.
4. Install the drive pulley and the water pump pulley..
5. Install and adjust the drive belt.

Description	Nm	lb. in.	lb. ft.
Water pump pulley attaching bolts	24	–	18
Drive pulley attaching bolts	47	–	35
Torsional damper attaching bolt	244	–	180

Front Cover/Oil Seal

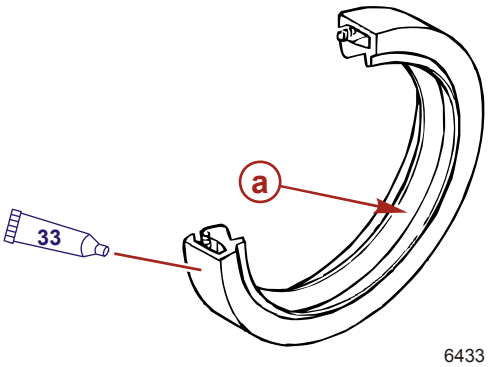
Oil Seal Replacement (Without Removing Front Cover)

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.

Installation

1. Apply Loctite 680 to the seal retainer mating surface and apply grease to the seal lips.

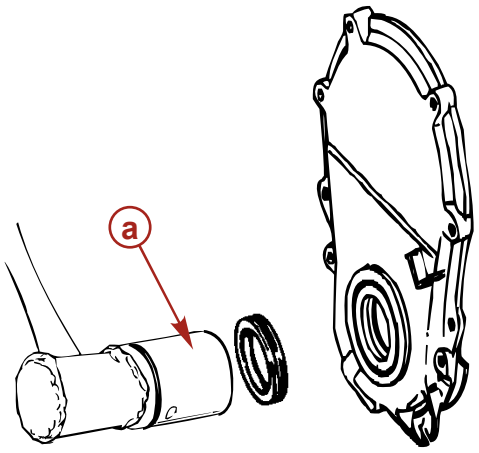


6433

a - Seal lip

Tube Ref No.	Description	Where Used	Part No.
33	Loctite 680 Retaining Compound	Seal retainer mating surface	92-809833

2. Install a new seal with the open end of the seal inward (lip of seal toward inside of engine), using a crankcase front cover seal installation tool. Drive the seal in until it seats. Do not use excessive force.



6434

a - Crankcase front cover seal installation tool

3. Re-install the torsional damper as outlined.

Front Cover

Removal

1. Remove engine from boat if necessary.
2. Remove the torsional damper, oil pan, water circulating pump and the front cover.
3. If damaged, drive the oil seal out of the front cover (from the rear) using a punch.

Cleaning

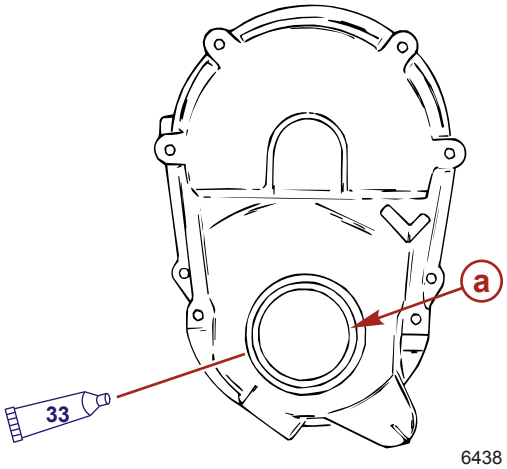
1. Clean the front cover in solvent and it dry with compressed air.
2. Remove the old sealer from the mating surfaces on the cover and the cylinder block.

Inspection

IMPORTANT: The front cover is cast aluminum and uses a molded o-ring style gasket that must be replaced if damaged. This gasket is retained in a cast groove.

Installation

1. Apply Loctite 680 to the outer edge of the seal and grease to the inner lip. Install the oil seal in the cover with the lip of the seal toward the inside of the engine using a seal driver. Support the cover around the seal area with an appropriate tool.



6438

a - Crankcase front cover seal

2. Coat both sides of the front cover gasket with Perfect Seal.
3. Install the front cover, making sure the holes in the cover align with the dowel pins in the block. Torque the front cover attaching bolts to **Specifications.**

Description	Nm	lb. in.	lb. ft.
Front cover attaching bolts	11		8

4. Install the oil pan, torsional damper, and water circulating pump.
5. Fill the crankcase with engine oil.
6. Re-install the engine in the boat (if necessary).

NOTICE

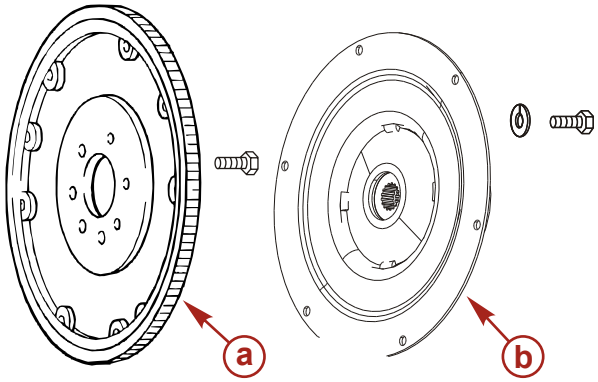
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. Start the engine and check for water and oil leaks.

Flywheel

Removal

1. Remove the engine from boat if necessary.
2. Remove the flywheel housing and related parts.
3. Remove the coupler.
4. Remove the flywheel.



a - Flywheel
b - Bravo coupler

Inspection

1. Inspect the splines in the drive plate or the coupler for wear.
2. Check the flywheel ring gear for worn and missing teeth.

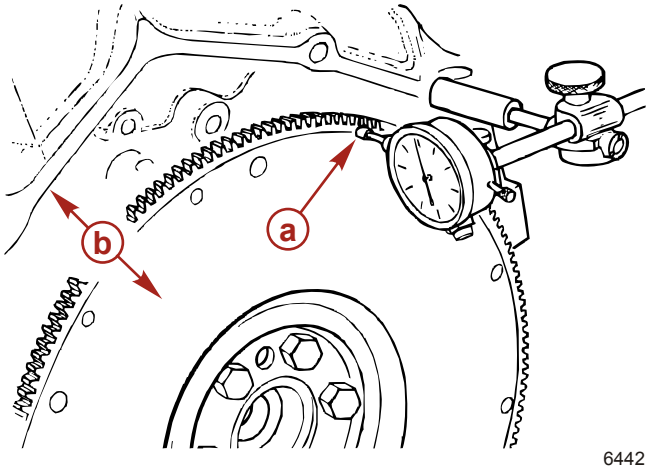
Installation

1. Clean the mating surfaces of the flywheel and the crankshaft until the metal is bare and remove any burrs.
2. Align the dowel hole in the flywheel with the dowel in the crankshaft and install the flywheel. Tighten the mounting bolts to specifications.

Description	Nm	lb. in.	lb. ft.
Flywheel mounting bolts	95	–	70

3. Check the flywheel runout as follows:
   a. Attach a dial indicator to the engine block.
   b. Take several readings around the outer edge of the flywheel. Push in on the flywheel to remove the crankshaft end play.

c. Maximum runout is 0.20 mm (0.008 in.).



6442

a - 0.20 mm (0.008 in.) maximum runout
b - Direction fore and aft

Description	Nm	lb. in.	lb. ft.
Drive coupler or drive plate mounting bolts	48	–	35
Flywheel housing mounting bolts	41	–	30
Flywheel housing cover mounting bolts	13	114	–
Transmission mounting bolts (V-Drive)	68	–	50

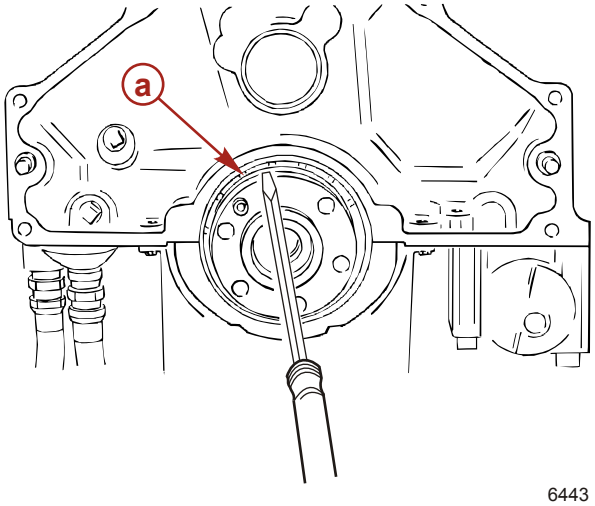
4. Install the drive coupler or drive plate. Tighten the mounting bolts to specifications.
5. Install the flywheel housing and related parts.
6. Install the flywheel housing cover.
7. Install the transmission if applicable.

Rear Main Oil Seal

The rear main crankshaft oil seal can be replaced without removing the oil pan or the rear main bearing cap from the engine.

Removal

Remove the seal by using a screwdriver to pry it out of the engine block as shown.



6443

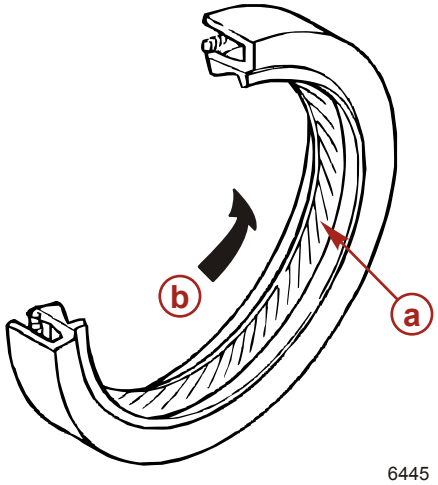
a - Rear main crankshaft oil seal

IMPORTANT: Do not nick or gouge the engine block or the rear main bearing cap sealing surface. Protect the crankshaft end of the crankshaft/seal running surface from damage.

Cleaning and Inspection

Clean the crankshaft/seal running surface and the seal retainer.

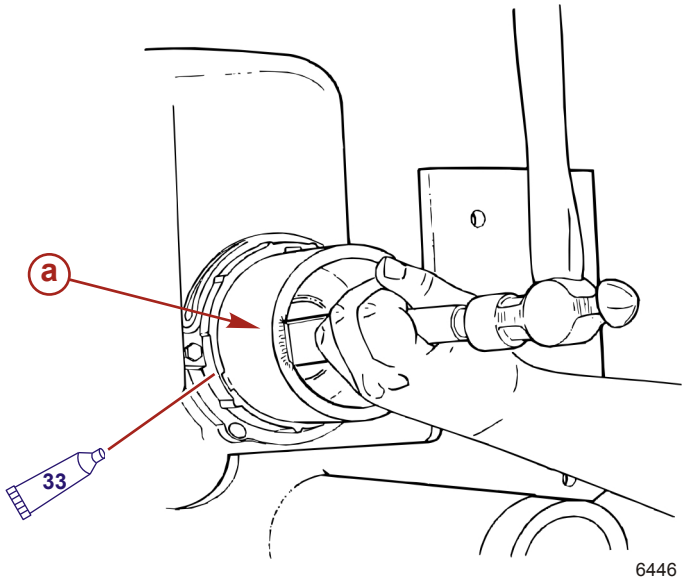
IMPORTANT: The correct rotation of the oil seal must be used to prevent oil leakage.



a - Rear seal with helical grooves - Seal lip toward inside of engine
b - Rotation of crankshaft as viewed from flywheel end looking forward

Installation

1. Apply Loctite 680 to the engine block/seal mating surface. Apply grease to the seal lips.
2. Install the seal using a rear main seal driver.



a - Suitable seal driver

Tube Ref No.	Description	Where Used	Part No.
33	Loctite 680 Retaining Compound	Engine block/seal mating surface	92-809833

Oil Filter Bypass Valves and Adapter

Inspection and Replacement

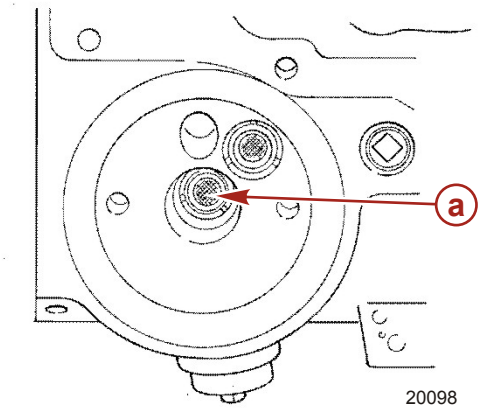
The oil bypass valve and adapter should be inspected whenever the engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

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	92-34227Q02

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

Notes:

Electrical System

Section 4A - Starting System

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4
A

Lubricants, Sealants, Adhesives

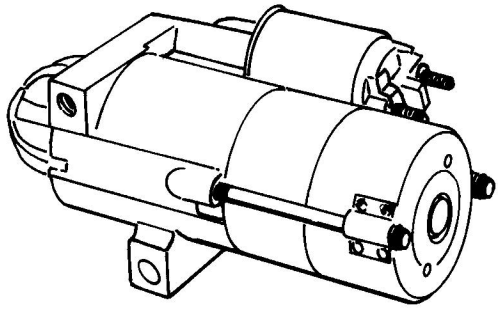
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter terminals	92- 25711 3

Finding Other Diagrams

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

Starter Motor

Identification



19724

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					

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. Tighten the starter mounting bolts to specification.

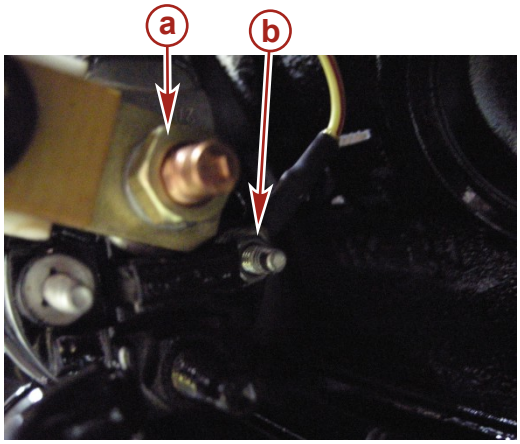
Description	Nm	lb. in.	lb. ft.
Starter mounting bolt	41	–	30

Starter Removal

⚠ WARNING

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

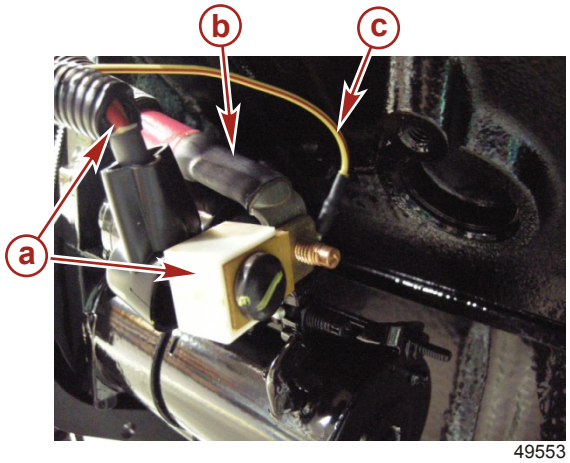
1. Disconnect the battery cables from the battery.
2. Remove and retain the nuts and washers from the solenoid terminals.



49555

a - Nut and washer on large terminal
b - Nut and washer on small terminal

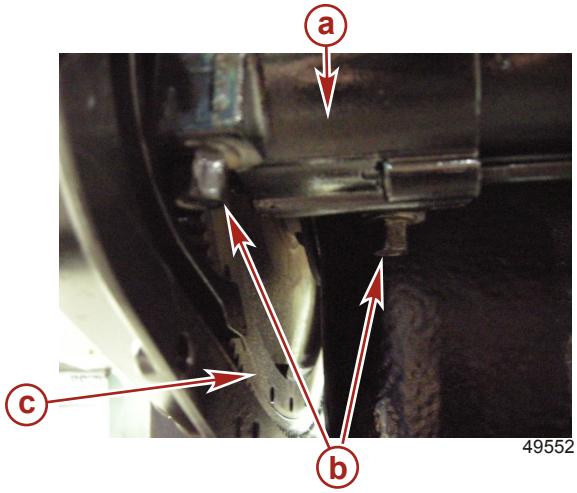
3. Remove and retain the wires from the solenoid terminals.



49553

a - ORANGE wire, RED wire, and fuse
b - Hot stud wire (RED power)
c - YELLOW/RED wire

4. Support the starter while removing the starter mounting bolts.



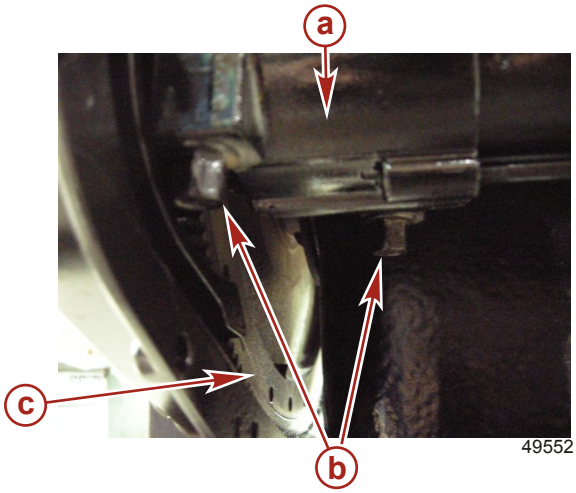
49552

a - Starter
b - Starter mounting bolt (2)
c - Flywheel

5. Pull the starter assembly away from the flywheel and remove it from the engine.

Installation

1. Place the starter motor in position and install the mounting bolts.
2. Tighten the bolts to specification.

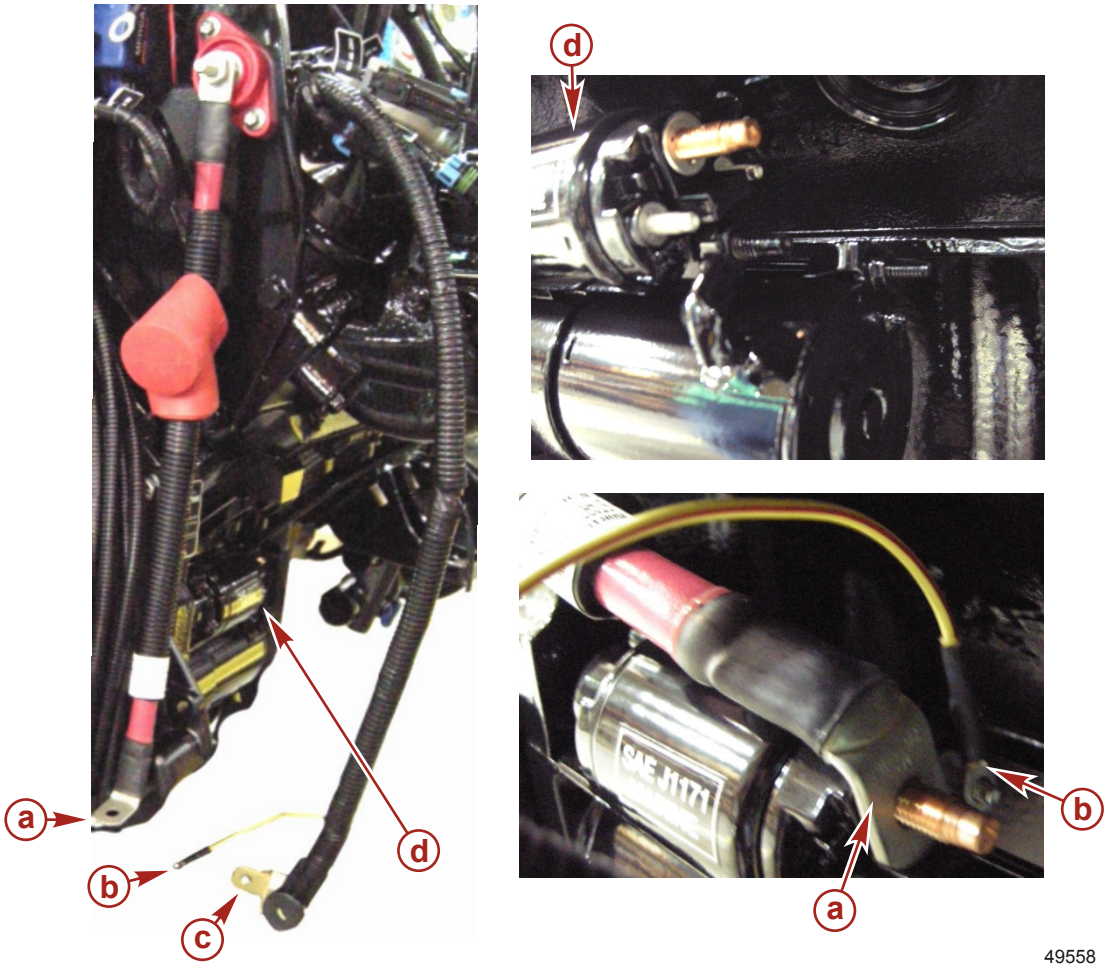


a - Starter
b - Starter mounting bolt (2)
c - Flywheel

Description	Nm	lb. in.	lb. ft.
Starter mounting bolts	41	–	30

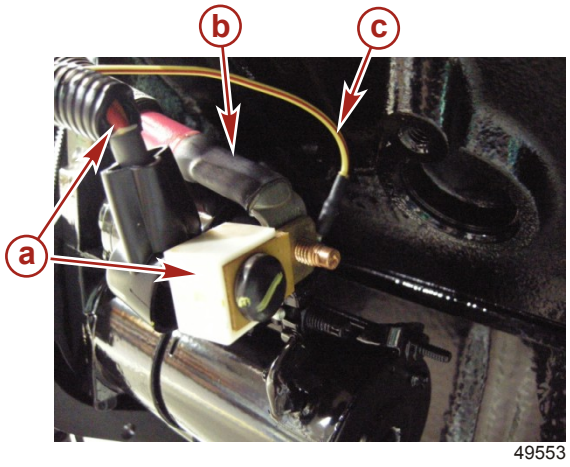
3. Connect the YELLOW/RED wire from the harness assembly to the upper solenoid terminal.

4. Connect the hot stud cable to the large terminal.



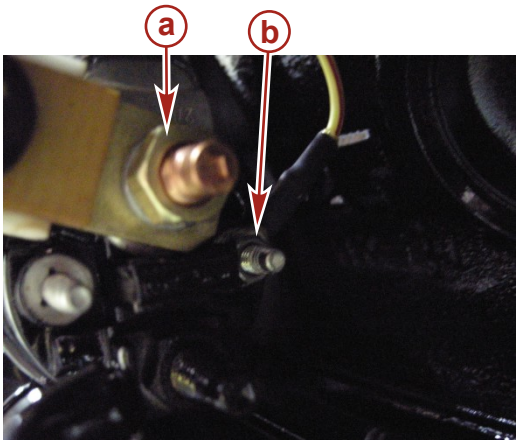
a - Hot stud cable
b - YELLOW/RED wire
c - ORANGE wire, RED wire, and fuse
d - Starter solenoid

5. Connect the ORANGE wire, RED wire, and fuse from the harness assembly to the large terminal over the hot stud wire.



a - ORANGE wire, RED wire, and fuse
b - Hot stud wire (RED power)
c - YELLOW/RED wire

6. Install washers and nuts on the large and small terminals to secure the wires. Tighten the nuts to specification.



49555

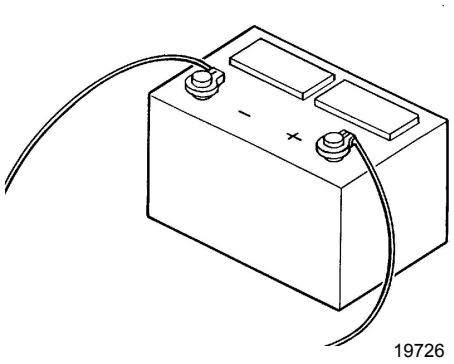
a - Nut and washer on large terminal
b - Nut and washer on small terminal

Description	Nm	lb-in.	lb-ft
Starter solenoid small terminal nut	2	20	–
Starter solenoid large terminal nut	7	50	–

7. Apply sealant to the starter terminals.

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

8. 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.



19726

Typical

Electrical System

Section 4B - Ignition System

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Finding Other Diagrams..... 4B-2
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EFI System Maintenance Precautions..... 4B-2
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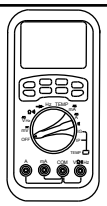
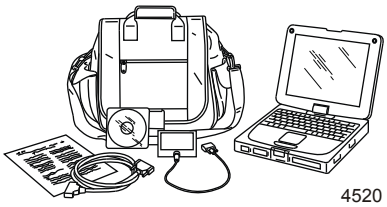
Ignition Coil..... 4B-6

4
B

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

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.)

Finding Other Diagrams

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

Ignition System Components

EFI System Maintenance Precautions

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

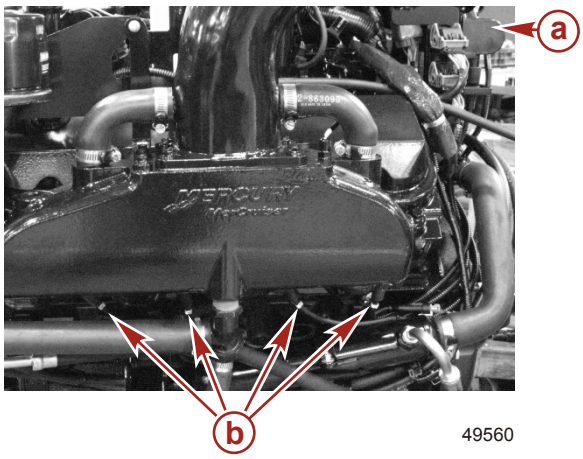
IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system.

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

Spark Plug

Checking

1. Disconnect the spark plug wires (high-tension leads) from the spark plugs.



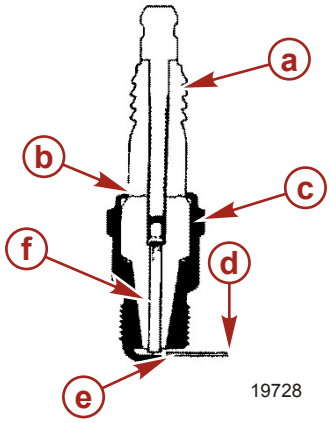
Non-ECT engine model shown, ECT models similar

- **a -** Coil pack
- **b -** Spark plug wires at spark plugs

NOTE: *Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot 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.

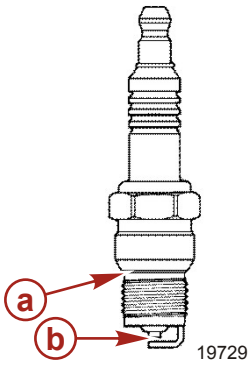
Description	Nm	lb. in.	lb. ft.
spark plugs	20	–	15

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 Wire—High-Tension Leads

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
Computer Diagnostic System (CDS)	Order through SPX

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.

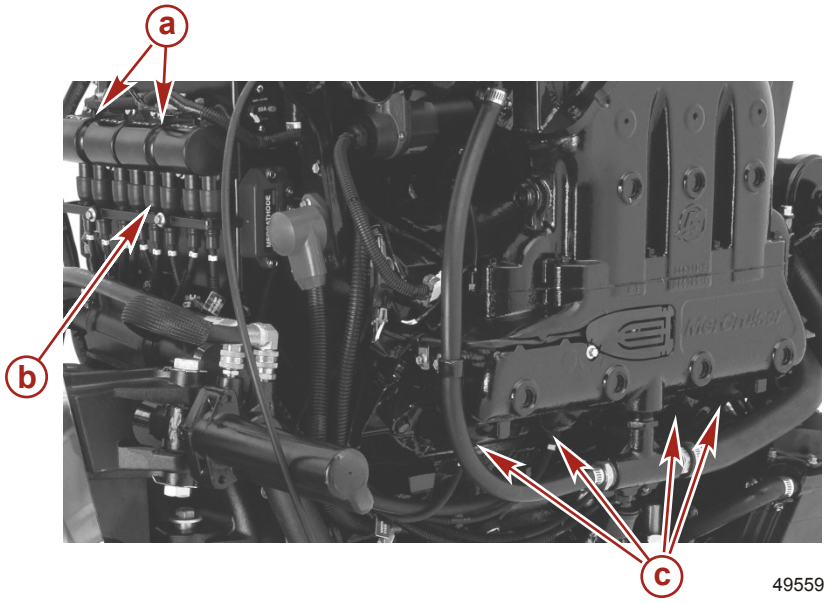
Replacing

IMPORTANT: Only use spark plug wires recommended for marine application.

NOTE: *Replace one spark plug wire at a time to reduce the risk of installation error.*

1. Disconnect individual spark plug wire from the spark plug.

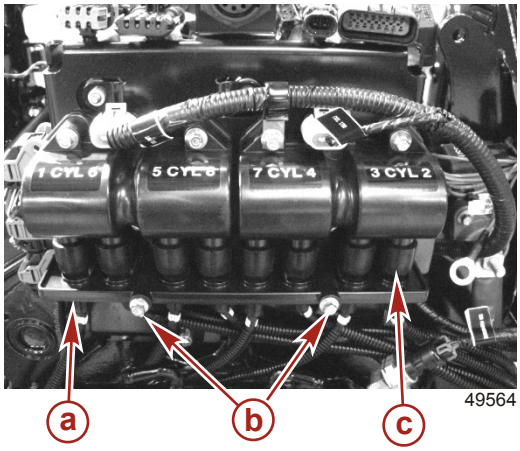
NOTE: Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot to remove the spark plug wire from the spark plug.



ECT engine model shown, non-ECT models similar

- **a -** Coil packs (2)
- **b -** Spark plug wires to coil (8)
- **c -** Starboard spark plug wires to spark plugs (4)

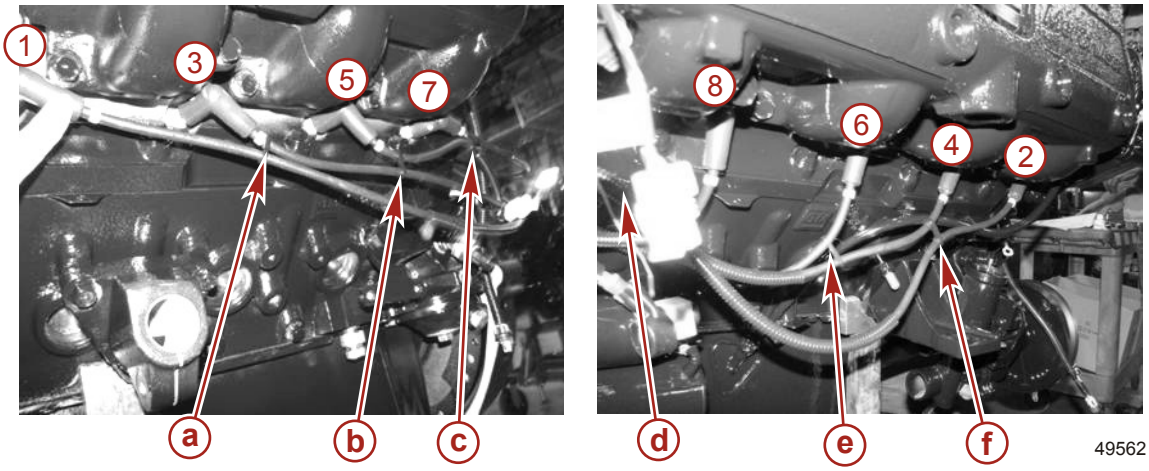
2. Remove the Spark plug wire retainer bracket.



- **a -** Spark plug retainer bracket
- **b -** Screw (2)
- **c -** Spark plug wire (8)

3. Pull the spark plugs wire from the coil.
4. 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.



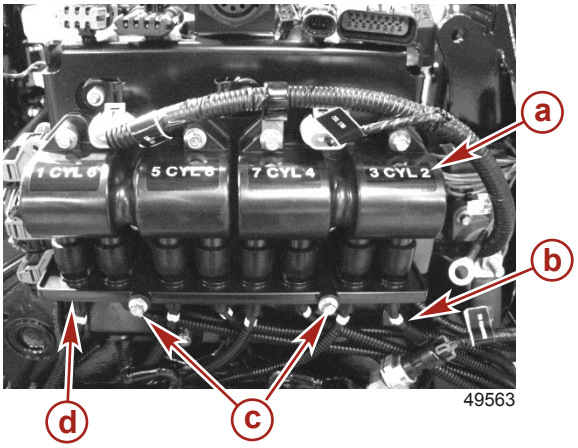
Engine parts removed for visual clarity

- **a -** Retainer clip on spark plug wires number 1 and 3
- **b -** Retainer clip on spark plug wires number 3 and 5
- **c -** Retainer clip on spark plug wires number 5 and 7
- **d -** Retainer clip on spark plug wires number 6 and 8
- **e -** Retainer clip on spark plug wires number 4 and 6
- **f -** Retainer clip on spark plug wires number 2 and 4

b. Attach the spark plug wires to the appropriate spark plug and coil pack. Each end must fit securely.

c. Install the spark plug retainer bracket and mounting screws.

d. Tighten the bracket mounting screws to specification.



- **a -** Cylinder numbers on coil (8)
- **b -** Cylinder numbers on spark plug wire (8)
- **c -** Screw
- **d -** Spark plug wire retainer bracket

Description	Nm	lb. in.	lb. ft.
Spark plug wire retainer bracket screw	11	96	–

Ignition Coil

NOTE: *For ignition coil troubleshooting* ***refer to the appropriate Mercury MerCruiser PCM Diagnostic Service Manual.***

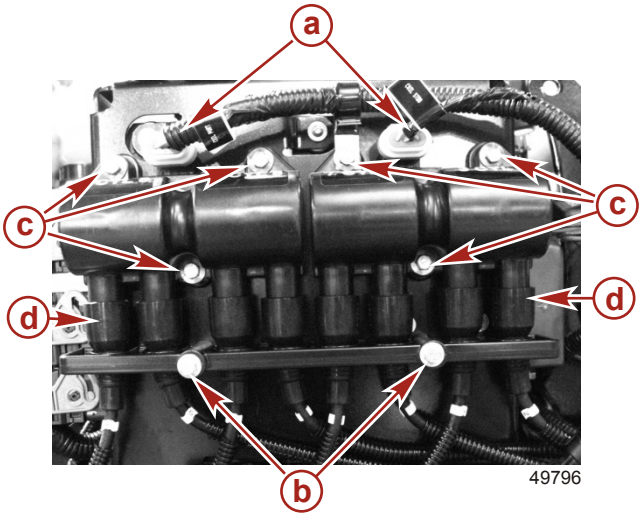
Removal

⚠ WARNING

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

1. Disconnect both battery cables from the battery.

2. Remove and retain the two screws securing the spark plug wire retainer bracket and remove the bracket.
3. Disconnect the spark plug wires at the ignition coils.
4. Disconnect the ignition coil harness connector.
5. Remove and retain the three ignition coil mounting screws.
6. Remove the ignition coil.



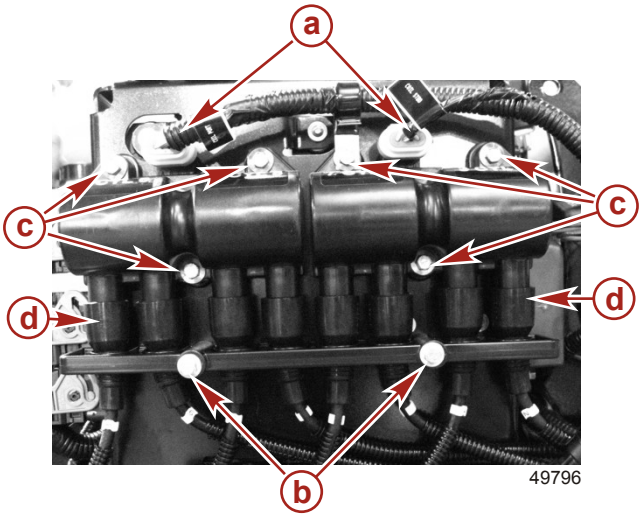
a - Ignition coil harness connector (starboard and port)
b - Retainer bracket screw (2)
c - Ignition coil mounting screw (3)
d - Spark plug wire (8)

Installation

1. Position the ignition coil packs onto the mounting bracket.
2. Install the ignition coil mounting screws and J-clip. Tighten the screws to specification.

Description	Nm	lb. in.	lb. ft.
Ignition coil screw	11	96	–

3. Connect the starboard and port ignition coil harness.
4. Connect the spark plug wires to the ignition coils.
5. Install the spark plug wire retainer bracket.
6. Install the retainer bracket mounting screws. Tighten the screws to specification.

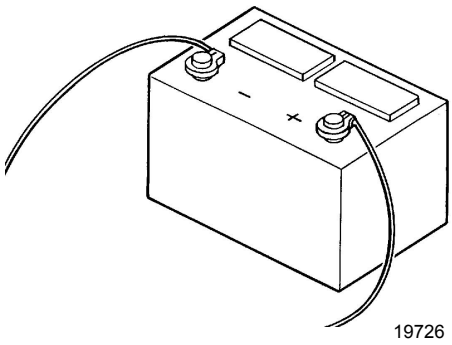


a - Ignition coil harness connector (starboard and port)
b - Retainer bracket screw (2)
c - Ignition coil mounting screw (3)
d - Spark plug wire (8)

Description	Nm	lb. in.	lb. ft.
Spark plug wire retainer bracket screw	11	96	–

7. 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.



Typical

Electrical System

Section 4C - Charging System

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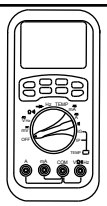
4C

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.

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

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

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

Charging System Components

The alternator system consists of the alternator, battery, the ignition switch, and the wiring that connects these components.

Periodic Maintenance

⚠ WARNING

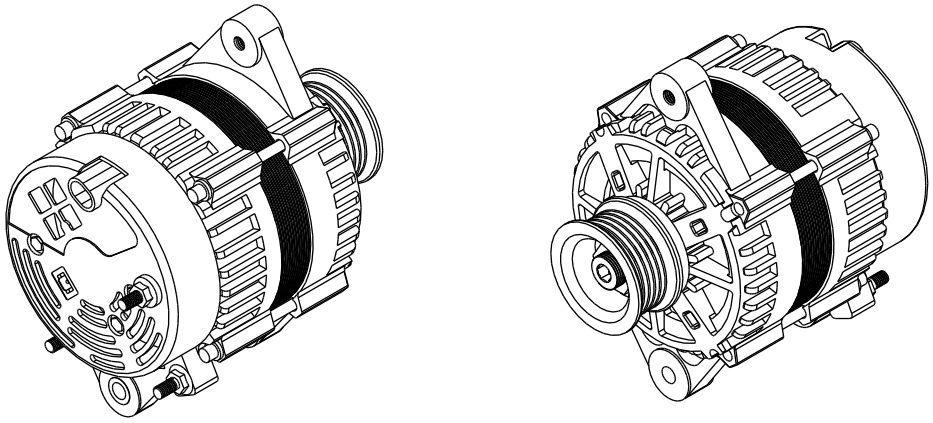
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

1. 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.

Alternator

Delco Alternator

Identification



23405

Delco 65-amp alternator

Replacement Parts Warning

⚠ WARNING

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

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****.*

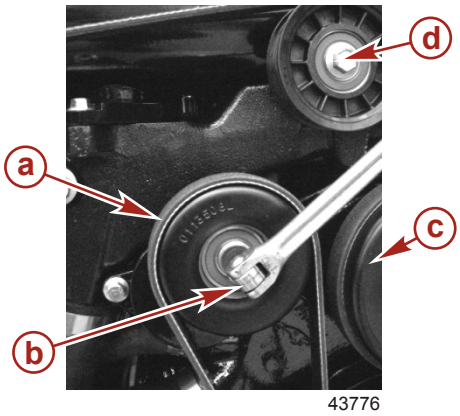
Tools

Description	Part Number
Multi-Meter / DVA Tester	91-99750A1
Ammeter (0–100 Amp)	Obtain locally

Removal

1. Use a breaker bar and appropriate socket to relieve the serpentine belt tensioner. Rotate the tensioner away from the belt until it stops.
   IMPORTANT: If a belt is to be reused, it should be reinstalled with the same direction of rotation.

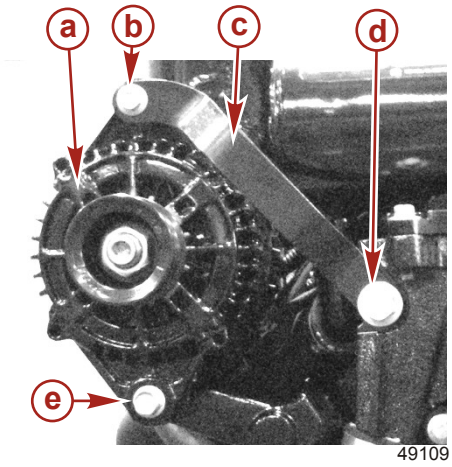
2. Remove the serpentine belt from the idler pulley; then slowly relieve the tension on the breaker bar and remove the belt.



43776

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

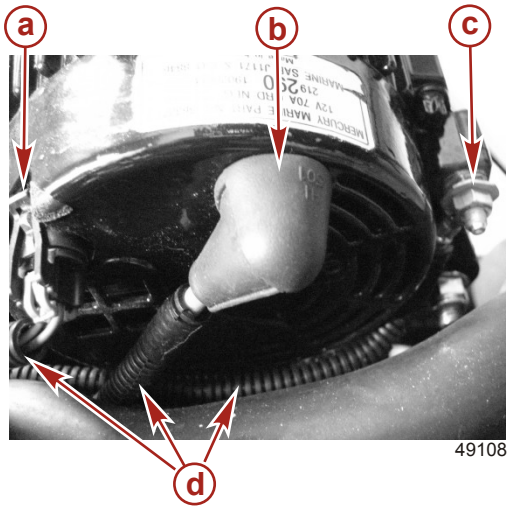
3. Loosen the alternator brace-to-crossover screw.



49109

- **a -** Alternator
- **b -** Upper alternator mounting screw
- **c -** Alternator brace
- **d -** Alternator brace-to-crossover screw
- **e -** Lower alternator mounting bolt

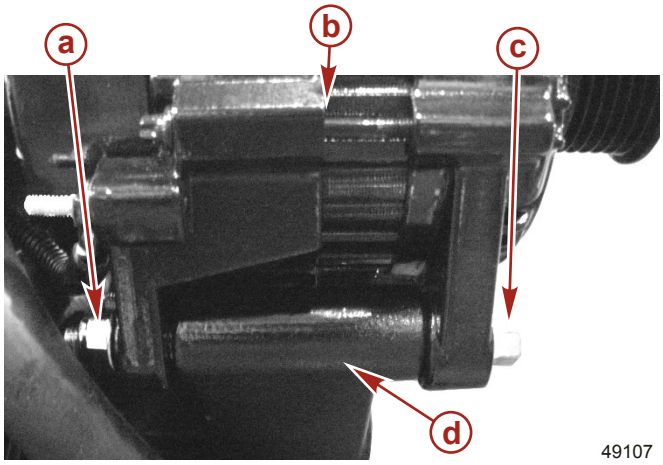
4. Remove the upper alternator mounting screw. Allow the brace to hang from the crossover screw.
5. Rotate the alternator away from the heat exchanger.
6. Remove the alternator wires.
   a. Disconnect the wiring harness from the alternator.
   b. Remove and retain the nut and the positive ORG wire from the alternator.
   c. Remove and retain the nut and the negative BLK wire from the alternator.
   d. Move the wires out of the way for alternator removal and installation. Do not pinch the wires.



49108

- **a -** Wiring harness connector
- **b -** Positive wire with boot
- **c -** Negative wire
- **d -** Wire routes

7. Remove the locknut from the lower alternator mounting bolt.

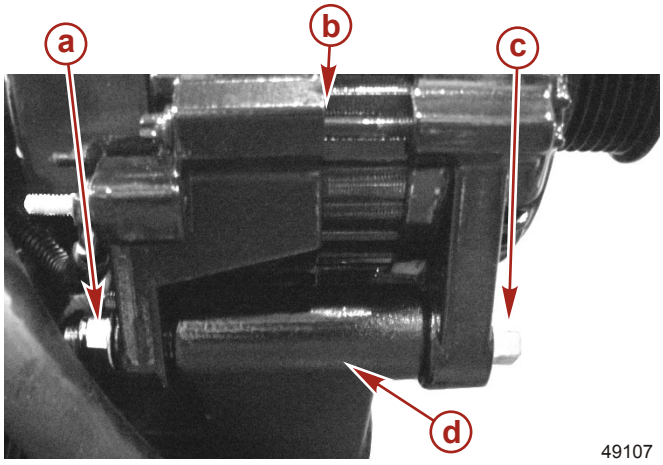


a - Locknut
b - Alternator
c - Bolt
d - Mounting bracket

8. Support the alternator and remove the bolt from the mounting bracket. Lift the alternator from the mounting bracket.

Installation

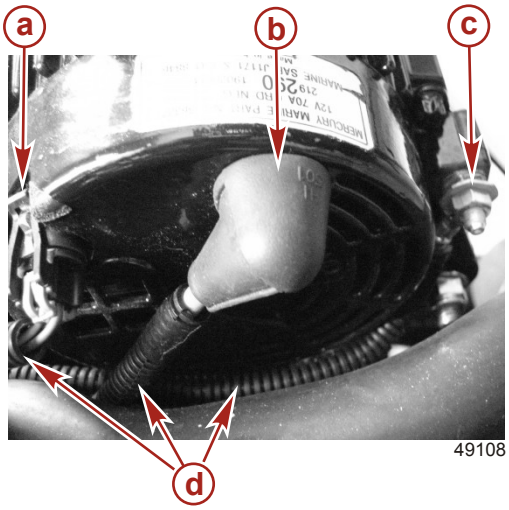
1. Position the alternator in the mounting bracket.
2. Install the lower alternator mounting bolt, and locknut.



a - Locknut
b - Alternator
c - Bolt
d - Mounting bracket

3. Route and connect the alternator wires. Do not pinch the wires.
   a. Connect the wiring harness to the alternator.
   b. Install the positive ORG wire to the alternator and hand-start the nut.
   c. Install the negative BLK wire to the alternator and hand-start the nut.

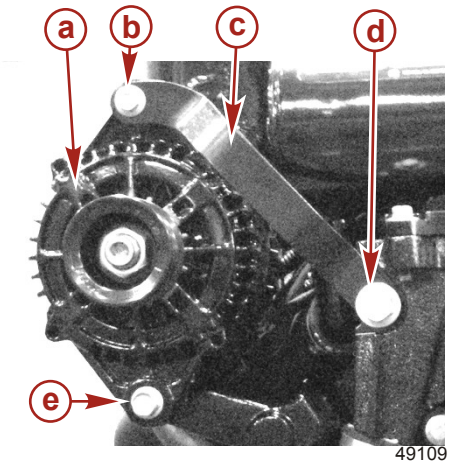
d. Tighten the nuts to specification and cover the positive connection with the boot.



a - Wiring harness connector
b - Positive wire with boot
c - Negative wire
d - Wire routes

Description	Nm	lb-in.	lb-ft
Alternator positive wire nut	2.8–4.5	25–40	–
Alternator negative wire nut	2.8–4.5	25–40	–

4. Install the alternator brace and the upper alternator mounting screw.



a - Alternator
b - Upper alternator mounting screw
c - Alternator brace
d - Alternator brace-to-crossover screw
e - Lower alternator mounting bolt

5. Tighten the lower alternator mounting bolt, and locknut to specification.

Description	Nm	lb-in.	lb-ft
Lower alternator mounting bolt, and locknut	91	–	72

6. Tighten the upper alternator mounting screw to specification.

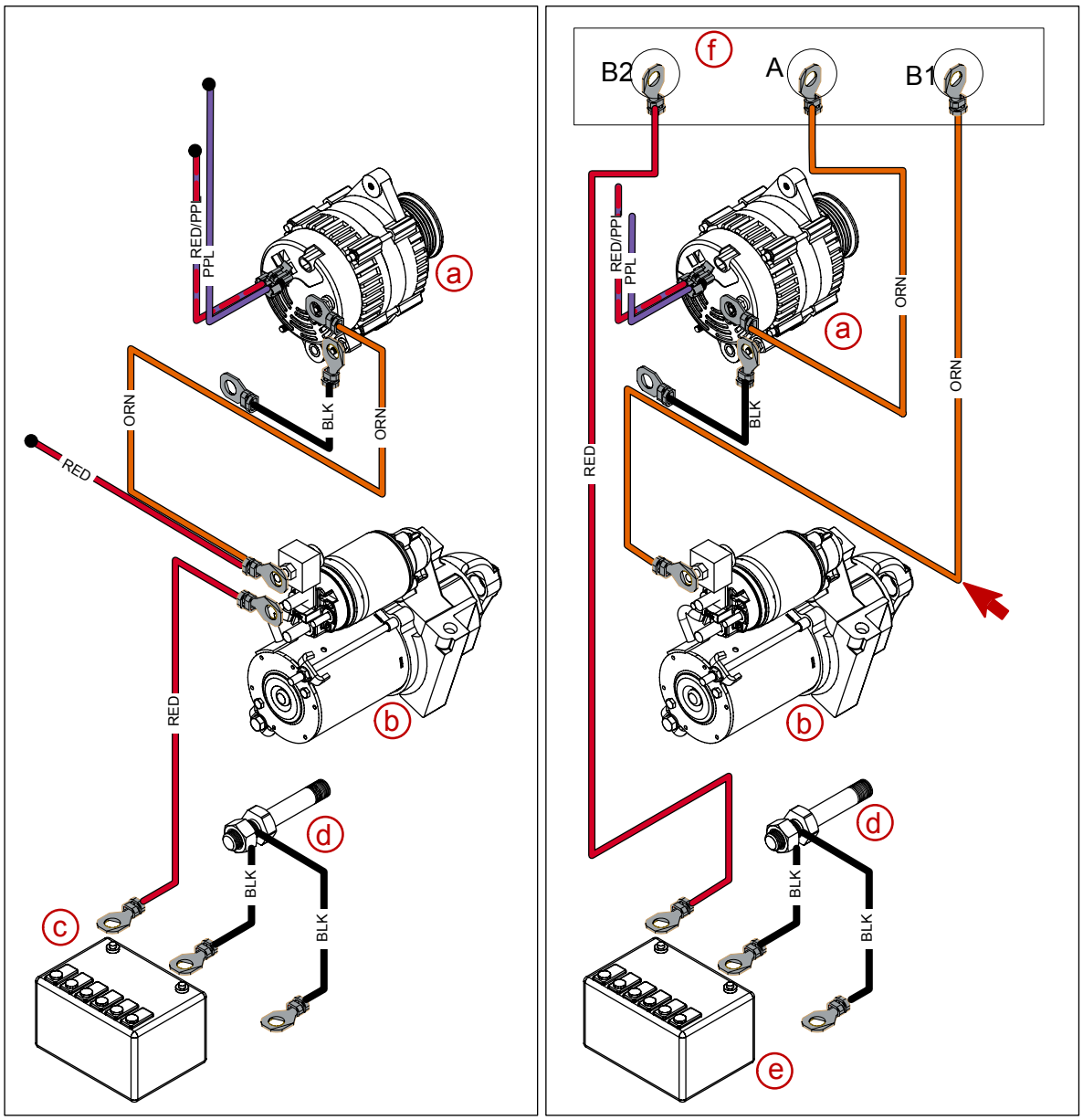
Description	Nm	lb-in.	lb-ft
Upper alternator mounting screw with brace	27	–	20

7. Tighten the alternator brace-to-crossover screw to specification.

Description	Nm	lb-in.	lb-ft
Alternator brace-to-crossover screw	27	–	20

8. Install the serpentine drive belt.
9. Connect the negative battery cable to the battery.

Battery Isolator Diagram



- **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.

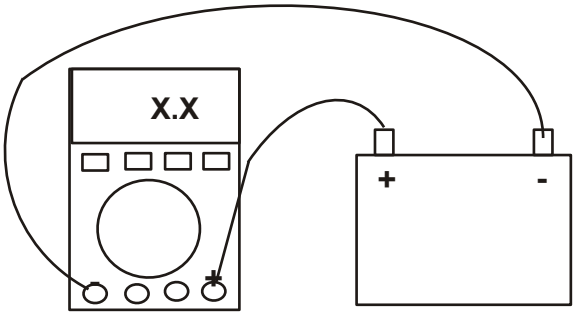
Troubleshooting Tests (Alternator on the Engine)

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

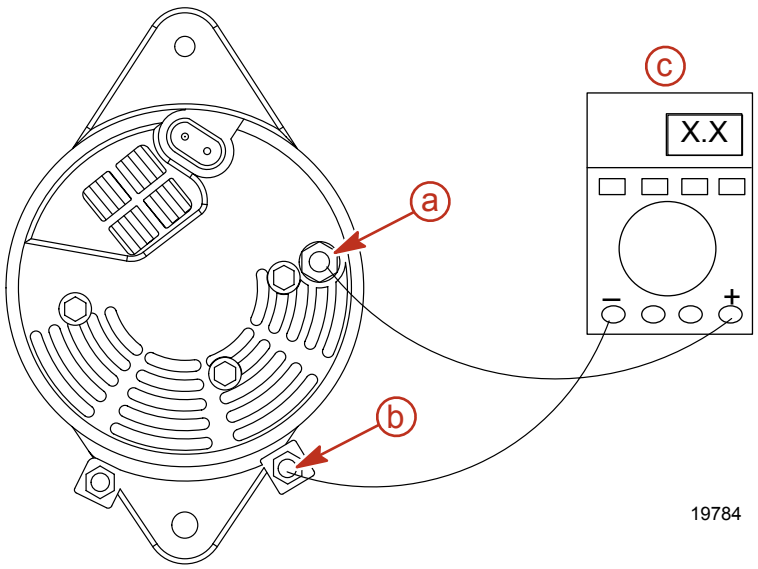
DMT 2004 Digital Multimeter	91-892647A01

NOTICE

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

2. 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.



19784

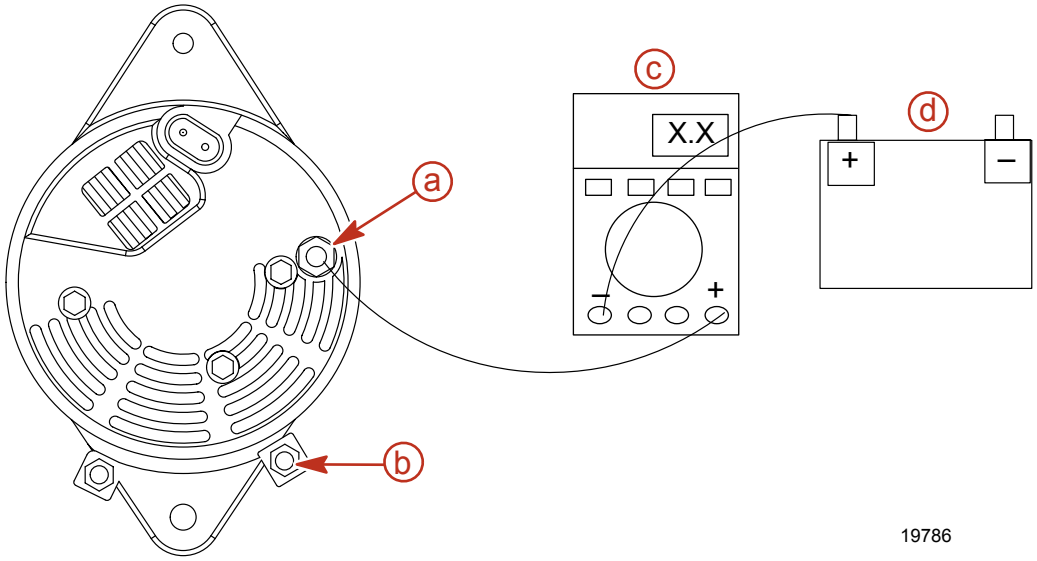
Typical
a - Output terminal
b - Ground terminal
c - Voltmeter

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.*



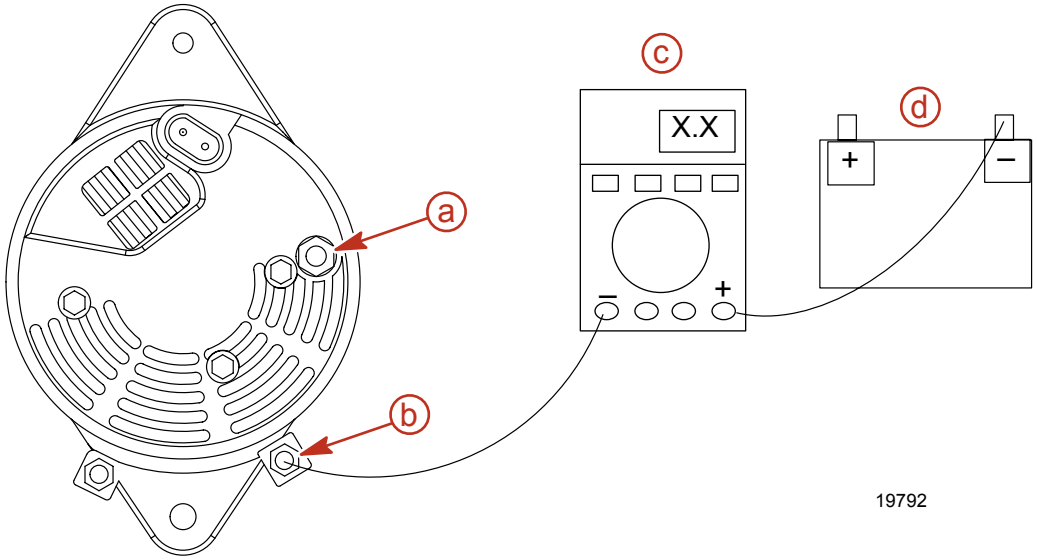
Typical

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.

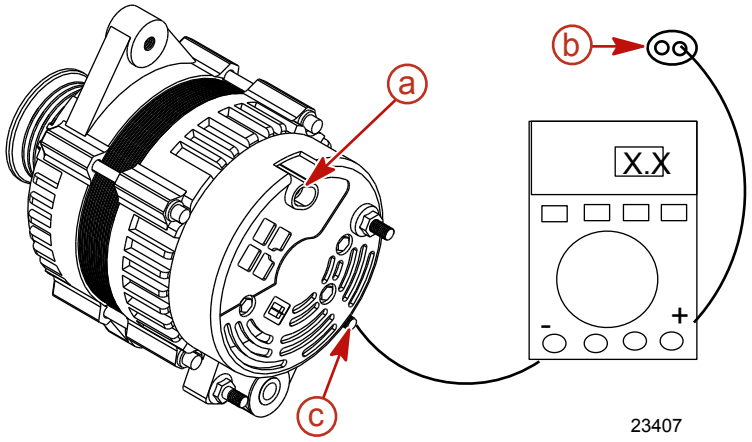
DMT 2004 Digital Multimeter	91-892647A01

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

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.

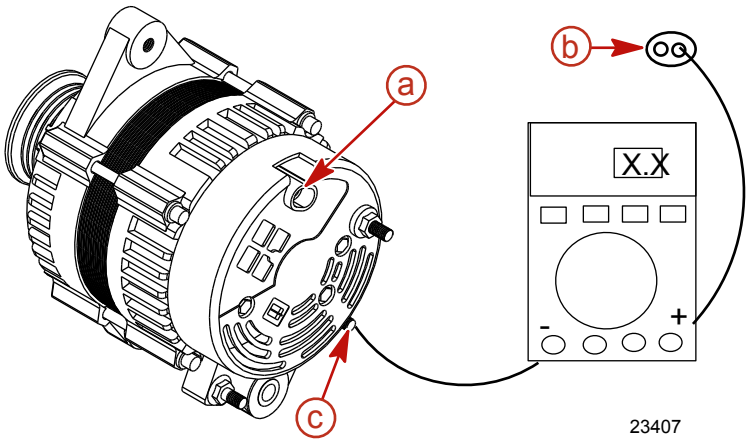


Typical

- **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.



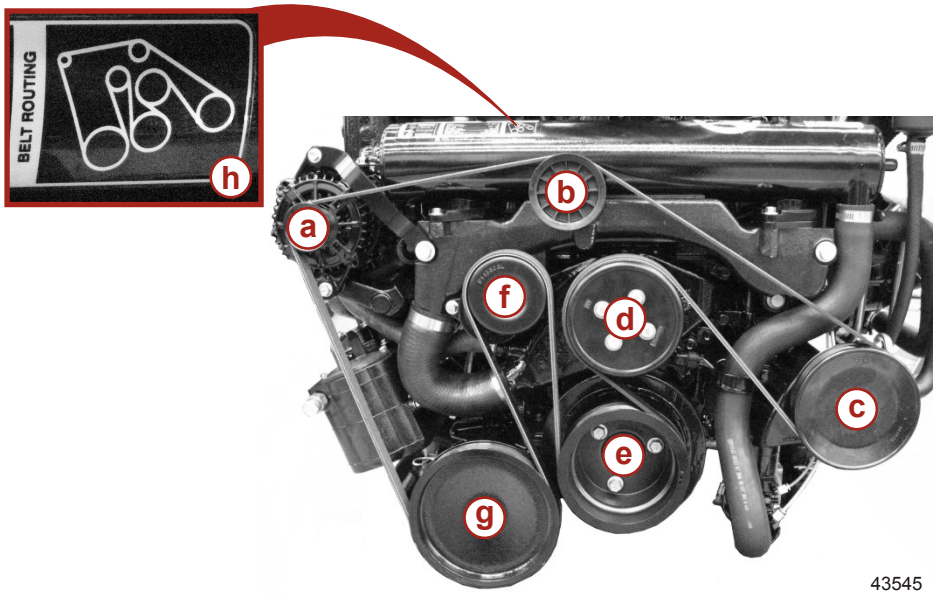
Typical
- **a -** Connector location
- **b -** PURPLE and RED / PURPLE connector
- **c -** Ground

Serpentine Drive Belt—Sterndrive Models

Inspection

⚠ WARNING

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



- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram

Checking

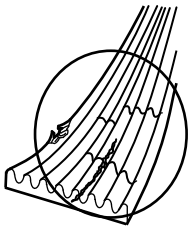
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

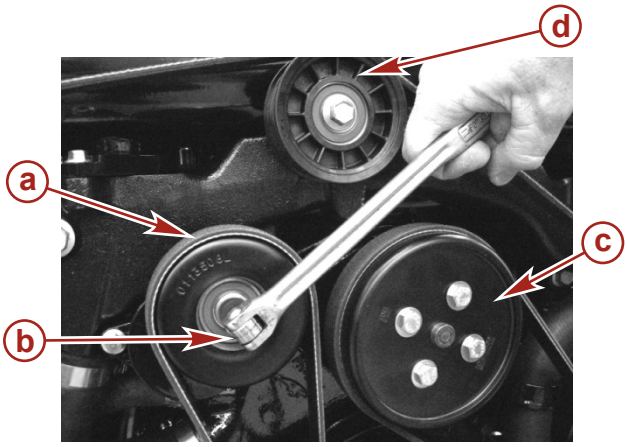
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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



43546

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

Description	
Deflection[1]	13 mm (½ in.)

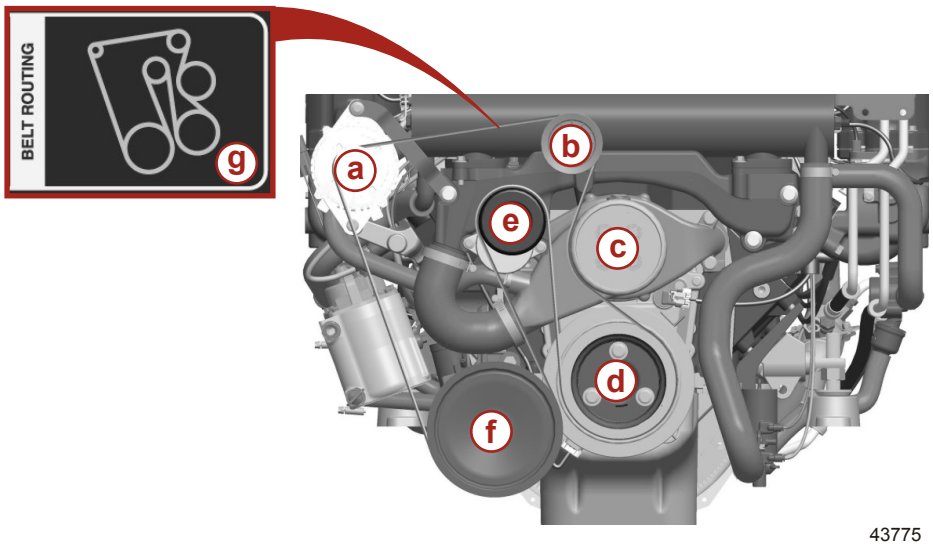
1. Use moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

Serpentine Drive Belt—Inboard Models

Inspection

⚠ WARNING

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



43775

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

Checking

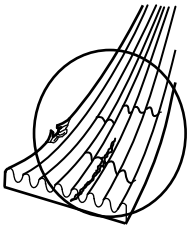
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

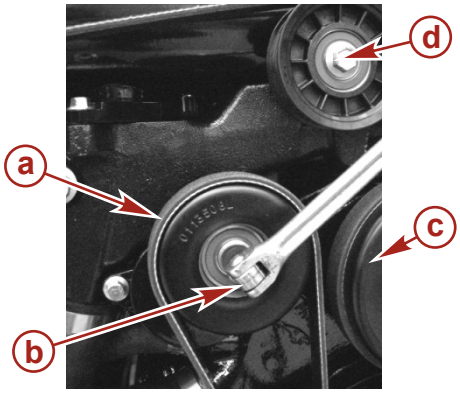
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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

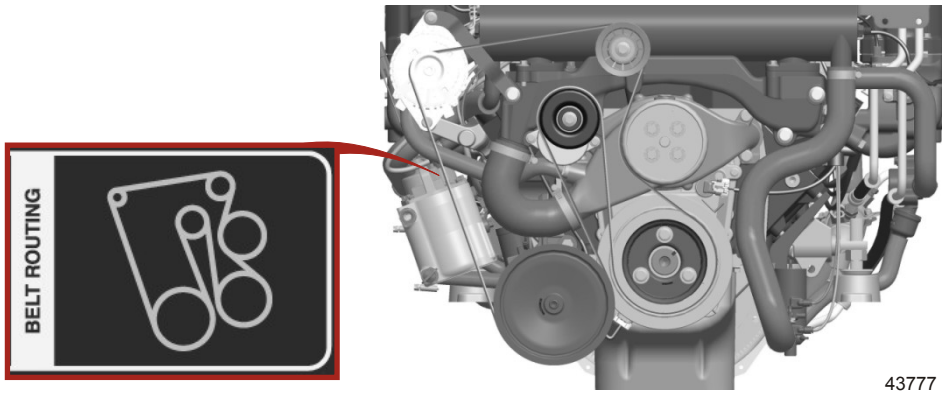


43776

a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

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



43777

Description	
Deflection	13 mm (½ in.)

Electrical System

Section 4D - Audio and Visual Warning System

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4
D

Engine Guardian Strategy

Engine Guardian reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Engine Guardian monitors the following:

- Oil pressure
- Coolant temperature
- Seawater pressure
- Engine overspeed
- Exhaust manifold temperature

The Guardian strategy also reduces power to 90% of maximum if any sensor on the power package fails. The PCM stores the fault for diagnostics.

For example, if the water inlet becomes partially blocked, Guardian reduces the available power level of the engine to help prevent damage from decreased water flow to the engine. If the debris passes through, and full water flow is restored, Guardian restores engine power to normal.

To avoid possible recurrence of the problem, we suggest boat owners contact an authorized dealer. The PCM stores the fault and with this information the technician will be able to more rapidly diagnose problems.

Transmission Guardian Strategy

IMPORTANT: Boat speed could be reduced to idle and may not respond to the throttle.

Transmission Guardian is a MerCruiser DTS feature that protects transmissions from clutch damage. Transmission Guardian monitors the clutch pack pressure in forward and reverse gears. If the transmission fluid pressure drops below a predetermined level, Transmission Guardian lowers the engine torque and speed to prevent clutch slippage.

To avoid possible recurrence of the problem, we suggest boat owners contact an authorized dealer. The PCM stores the fault and with this information the technician will be able to more rapidly diagnose problems.

Audio Warning System

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

There are three warning horn states:

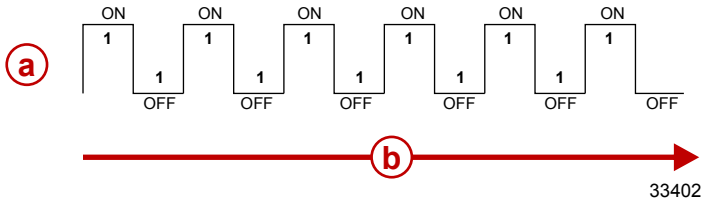
- Caution
- Severe
- Onboard Diagnostic Marine (OBDM) fault (not available for non-emissions controlled engines))

Caution

Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

Severe

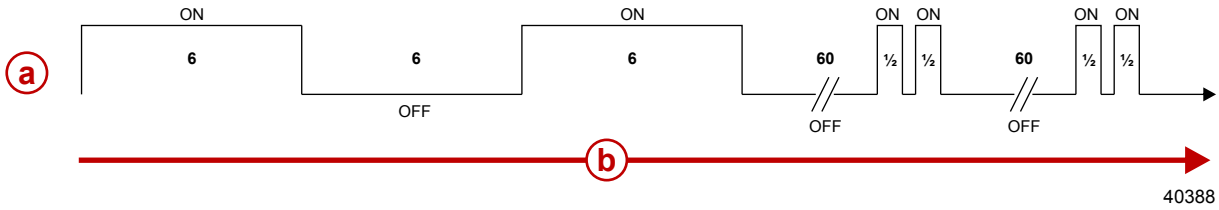
IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

- Transmission pressure is low

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

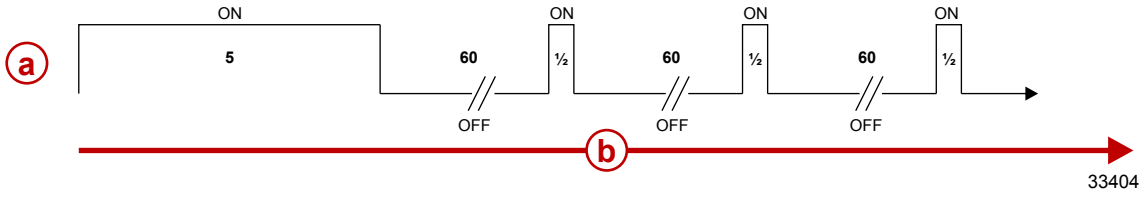
OBDM—Emissions Controled Engines

NOTE: *The OBDM fault is not available for non-emissions controlled engines.*

Below are some examples of a OBDM fault:

- Emissions too hot
- Fuel too hot

If an OBDM fault is detected, the audio warning system sound with one five-second horn, then one short, ½-second horn every 60 seconds for certain faults related to the emissions or fuel system. Owners are advised to contact an authorized Mercury MerCruiser dealer for assistance.



a - Horn (on or off)
b - Time (in seconds)

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Visual Warning System—Emissions Control Engines

Notice to Installer—Malfunction Indicator Lamp (MIL)

A malfunction indicator lamp (MIL) must be installed with this engine to be compliant with EPA and CARB regulations.

47769

OBDM Malfunction Indicators For Engine Serial Numbers

Models Covered	Serial Number Or Year
8.2 Emissions Controlled	1A352945 and below—ending build 05/19/2011

Engines are equipped with an OBDM warning horn for faults related to emissions or fuel systems. The horn will sound an audio warning while the fault is active.

If an OBDM malfunction indicator light kit is installed, the malfunction indicator light (MIL) will remain illuminated while the fault is active. In addition, the OBDM horn is deactivated and the fault will not sound an audio warning horn.

Models Covered	Serial Number Or Year
8.2 Emissions Controlled	1A352946 and above—starting build 05/20/2011

IMPORTANT: A malfunction indicator lamp (MIL) must be installed with this engine to be compliant with EPA and CARB regulations.
IMPORTANT: If the MIL light is not connected, the boat operator will not receive any warnings pertaining to the emissions control or fuel system.

Engines are equipped with an OBDM malfunction indicator light (MIL). The light will remain illuminated while the fault is active.

There is no OBDM horn for this calibration.

OBDM Malfunction Indicator Light (MIL) Options

The OBDM light provides a visual indication of a malfunction with the engine emissions control system and will remain illuminated while the OBDM fault is active.

Use a service engine icon or MIL such as a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light.

Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

47594

SC 1000 gauge and service engine light

Installation Information

⚠ WARNING

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

⚠ CAUTION

Avoid injury or product damage. Obstructions, such as braces and wiring, may be unseen when looking at the front of the dashboard. Before drilling or cutting any holes in the dashboard, check the area behind the dashboard for obstructions. Do not drill or cut when obstructions are present.

NOTE: *Emissions Control [EC]) engines built before 5/20/2011 may require software updates for OBDM light operation. Contact a MerCruiser Customer Service for information on software updates when installing this kit on a boat that is powered by MerCruiser EC engines with serial numbers 1A352945 and below.*

NOTE: *Some engines may not be equipped with an OBDM light connector. Adaptor Harness 8M2100233 must be used on engines that do not have the OBDM light helm harness connector.*

Description	Part Number
OBDM Malfunction Indicator Light kit (Emissions Control (EC) Engines)	8M0046481

Dashboards

IMPORTANT: Some dashboards may already be equipped with a precut hole.
Panels must be 0.76–4.75 mm (0.03–0.19 in.) thick.

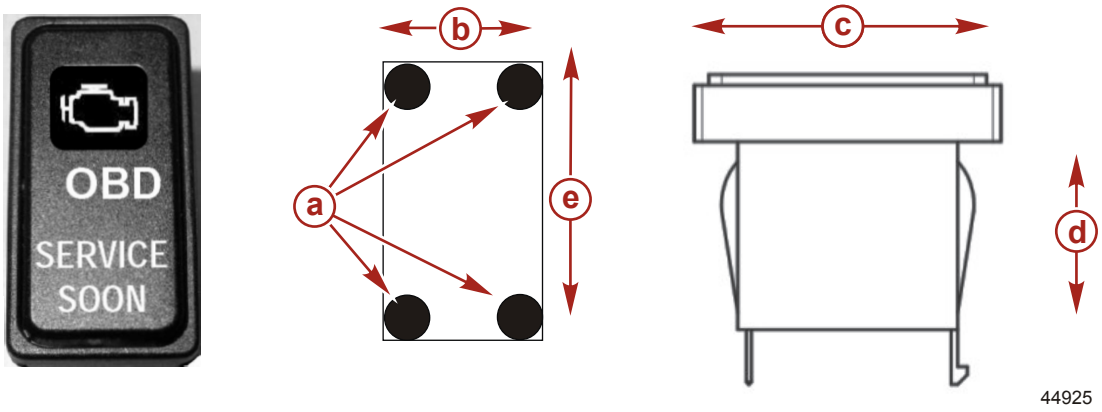
Before cutting any holes, check area behind dashboard for obstructions (braces, cables, wiring, etc.). When cutting the dashboard for the OBDM light installation, follow these cutting tips:

- Fiberglass—Apply masking tape to the area that will be cut to prevent the dashboard from cracking.
- Vinyl covered—Remove vinyl from area to be cut with a razor blade to keep the vinyl from tearing.

Installing the OBDM Light

1. Disconnect both battery cables from the battery or batteries
2. Select a location with unobstructed visibility for the OBDM light using the dimensions shown below.
3. Prepare the selected area with masking tape and remove vinyl as necessary.
4. Remove the four corners of the selected area using an appropriate size drill.
5. Cut a 21.1 mm (0.83 in.) x 36.8 mm (1.45 in.) rectangular opening for the OBDM light with a reciprocating saw.

6. Dress cutout with a flat file if necessary and install the OBDM light into the dashboard.



OBDM light cutout

- **a -** Holes (4)
- **b -** 21.1 mm (0.83 in.)
- **c -** 48.5 mm (1.91 in.)
- **d -** 29.5 mm (1.16 in.)
- **e -** 36.8 mm (1.45 in.)

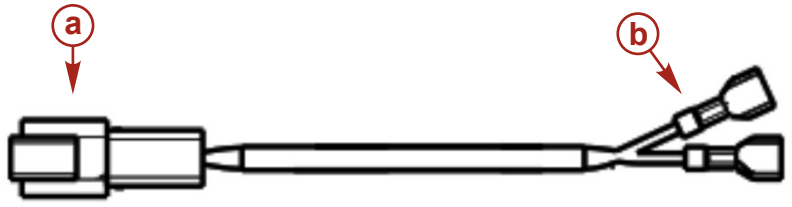
NOTE: *Drawing is not to scale. Use drawing as a dimensional reference only.*

Installing a Single Station Helm Harness for the OBDM Light

NOTE: *Harness must be ordered separately.*

Description	Part Number
3.0 m (10 ft) OBDM helm harness	8M0048049
4.6 m (15 ft) OBDM helm harness	8M0048054
6.1 m (20 ft)OBDM helm harness	8M0048055
7.6 m (25 ft) OBDM helm harness	8M0048056
9.2 m (30 ft) OBDM helm harness	8M0048057
12 m (40 ft) OBDM helm harness	8M0048058
15 m (50 ft) OBDM helm harness	8M0048059

1. Connect the two spade connectors on the helm harness to the spade terminals on the OBDM light.
2. Route the OBDM helm harness from the dashboard to the engine. Secure the OBDM helm harness with cable-ties or non-metallic clamps every 45 cm (18 in.).
3. Connect the OBDM helm harness to the connector on the engine labeled OBDM light. (The connector on the engine will be located near the engine 14-pin data harness.)



OBDM helm harness

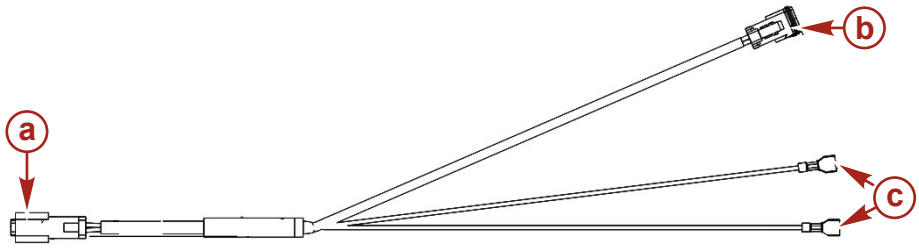
- **a -** Connector (to engine harness)
- **b -** Spade terminals (to OBDM light)

Installing a Dual-Station Helm Harness for the OBDM Light

NOTE: *Harness must be ordered separately.*

Description	Part Number
3.0 m (10 ft) dual-station OBDM helm harness	8M0048040
4.6 m (15 ft) dual-station OBDM helm harness	8M0048043
6.1 m (20 ft) dual-station OBDM helm harness	8M0048044
7.6 m (25 ft) dual-station OBDM helm harness	8M0048045
9.2 m (30 ft) dual-station OBDM helm harness	8M0048046
12 m (40 ft) dual-station OBDM helm harness	8M0048047
15 m (50 ft) dual-station OBDM helm harness	8M0048048

1. Connect the two spade connectors on the dual-station OBDM helm harness to the spade terminals on the OBDM light.
2. Route the dual-station OBDM helm harness from the dashboard to the engine and secure with cable ties or non-metallic clamps every 45 cm (18 in.).
3. Connect the dual-station OBDM helm harness to the connector on the engine labeled OBD-M light. The connector on the engine will be located near the engine 14-pin data harness.
4. Connect the dual-station helm harness to the second-station helm harness.
5. Route the second-station OBDM helm harness to the back of the second-station dash panel. Connect the OBDM helm harness spade connectors to the spade terminals on the second-station OBDM light.



45063

Dual station OBDM helm harness

- **a -** Connector (to engine harness)
- **b -** Connector to second-station OBDM helm harness
- **c -** Spade connectors (OBDM light at lower station)

Testing the OBDM Light

1. Turn the ignition switch to the on position. Do not start the engine.
2. The OBDM light will remain illuminated for four seconds if the system is functioning correctly.

Notes:

Electrical System

Section 4E - Components

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Coolant Temperature Sensor Replacement..... 4E-15
Exhaust Manifold Coolant Temperature (EMCT)..... 4E-15
Idle Air Control (IAC) Valve..... 4E-16
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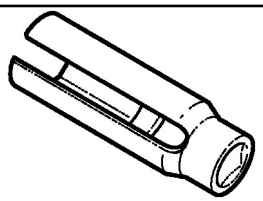
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Sensor threads	92-809822
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821
		MAP sensor retaining screw	
		Screw threads	
		IAC screw	
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Seal on MAP sensor	92-858087K01

Special Tools

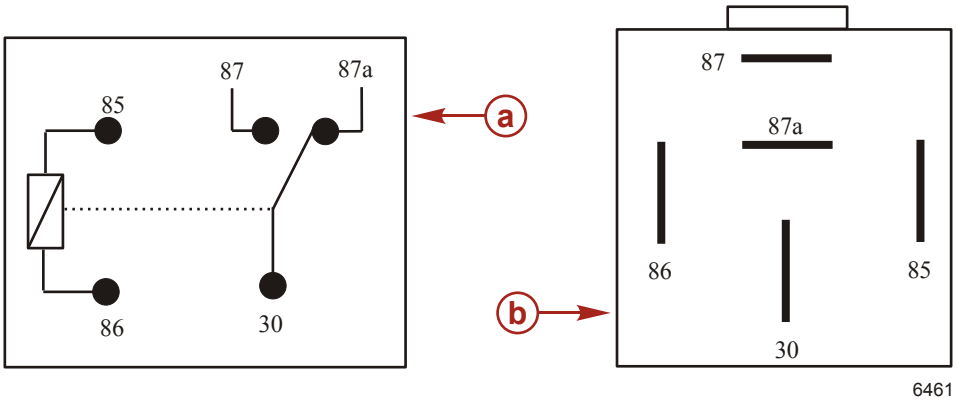
Terminal Test Probe Kit	SPX P/N MM- 46523
7915	Test probes adapt test meter leads to harness connections without damaging harness terminals. May be used with Computer Diagnostic System (CDS).

Kent-Moore Oxygen Sensor Socket	KN-46577
 32314	Kent-Moore socket (or equivalent 7/8 in. automotive oxygen sensor socket) Aids in the removal and installation of oxygen sensors on products equipped with Emissions Control.

Relays

The relays used for the Main Power C7 and C8, fuel pump C5 circuits are de-energized to connect terminals 87a and 30 and energized to connect terminals 87 and 30.

The resistance across terminals 85 and 86 is 75-95 Ohms, if not, replace the relay.



6461

a - Relay circuit schematic
b - Relay terminal identification

Each relay is listed below with it's respective terminal connections and wire colors:

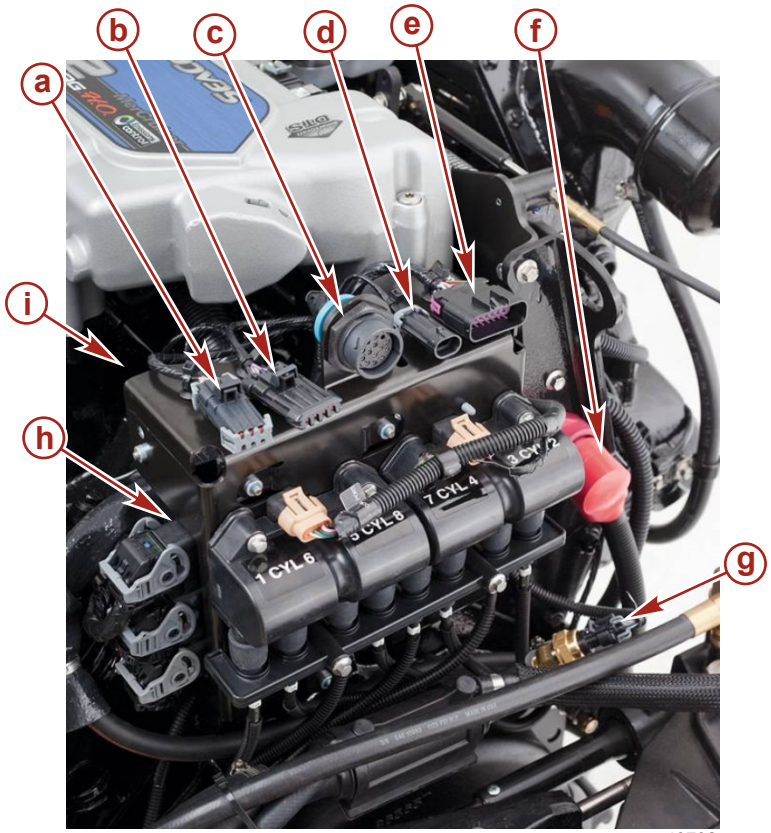
Relay	Terminal 85	Terminal 86	Terminal 30	Terminal 87	Terminal 87a
Main Pwr C7	RED/BLU	YEL/PPL	RED	RED/GRN	N/A

Relay	Terminal 85	Terminal 86	Terminal 30	Terminal 87	Terminal 87a
Main Pwr C8	RED/BLU	YEL/PPL	RED	RED/GRN	N/A
Fuel Pump C5	YEL/BLK	RED/BLU	RED	RED/GRN	N/A

Engine Electrical Connections

IMPORTANT: The opposite end of the RED/PPL power wire must be connected directly to the battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. The MerCathode system must function continuously for proper corrosion protection.

1. **Engine Mounted MerCathode** RED/PPL Lead - Connect to the positive (+) battery terminal.



49792

- **a -** Fuel tank/paddle wheel connector
- **b -** Data link connector (DLC)
- **c -** 14-Pin harness connector
- **d -** DTS clean power harness connector
- **e -** Transom harness connector (driveline packages have the extension harnesses attached to the engine)
- **f -** Hot stud, positive battery cable terminal
- **g -** Sea pump pressure sensor
- **h -** PCM
- **i -** Fuse holders (behind bracket)

Fuse Locations

Four fuses protect the main power, fuel pump, ignition, and accessory circuits. Four 10 amp fuses protect the Oxygen sensors. These are located on the top of the engine in the electrical center near the PCM and plenum.

Fuse Pack C-16 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
RED/BLK - RED/PNK	20	A, B	Fuel pump
RED/BLU - RED/GRN	20	C, D	IAC,
RED/GRN - RED/YEL	20	E, F	Coil packs, PCM
RED/WHT - RED/GRN	25	G, H	Fuel injectors

Fuse Pack C-17 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
RED/GRN - RED/ORN	5	A, B	Hour meter
RED/PPL - RED	20	C, D	Relay switched power
REDL/BLU -RED	20	E, F	Constant power

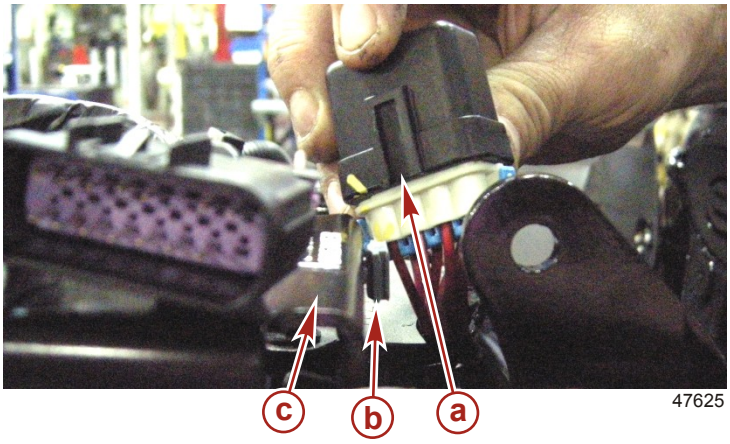
Fuse Pack C-17 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
PPL/WHT - PPL	5	G, H	Accessories

Propulsion Control Module (PCM)

IMPORTANT: The PCM is a sensitive electrical device, subject to electrostatic damage. Do not touch the connector pins when removing or installing the module.

Removal

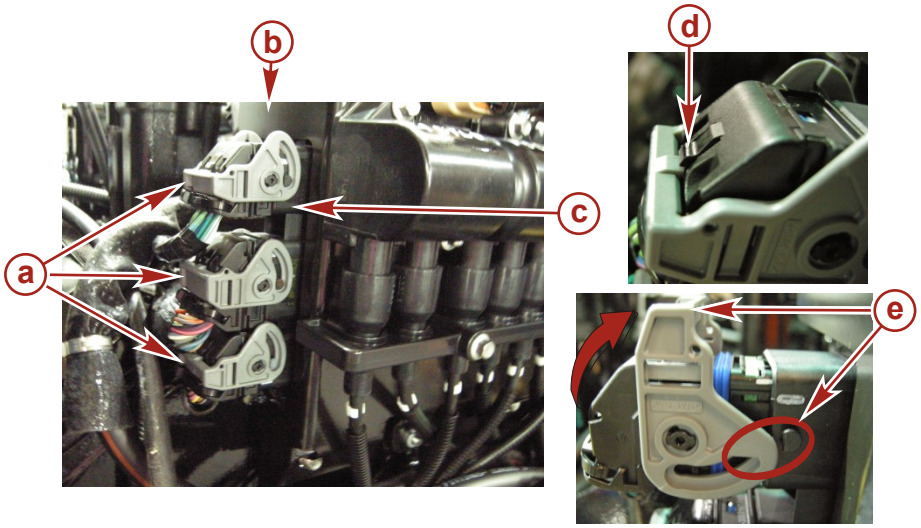
1. Slide the fuse connector up and remove it from its mount on the electrical bracket.



47625

a - Fuse connector
b - Fuse connector mount
c - Electrical bracket

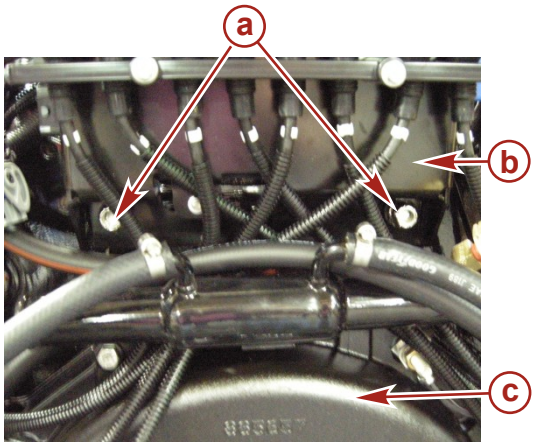
2. Remove the electrical connectors from the PCM.



47626

a - Electrical connectors
b - Electrical bracket
c - PCM
d - Locking tab
e - Latch and latch pin

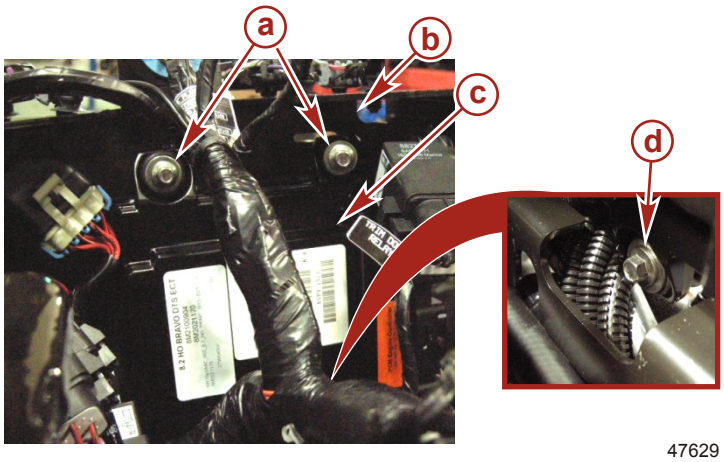
3. Remove and retain the nuts and washers from the electrical bracket on the flywheel side of the engine.



47627

a - Nut and washer
b - Electrical bracket
c - Engine flywheel housing

4. Slide the electrical bracket away from engine to gain access to the PCM fasteners.
5. Remove and retain the bottom and top screws holding the PCM to the bracket.



47629

a - Top screw
b - Electrical bracket
c - PCM
d - Bottom screw

6. Remove the PCM.

Cleaning and Inspection

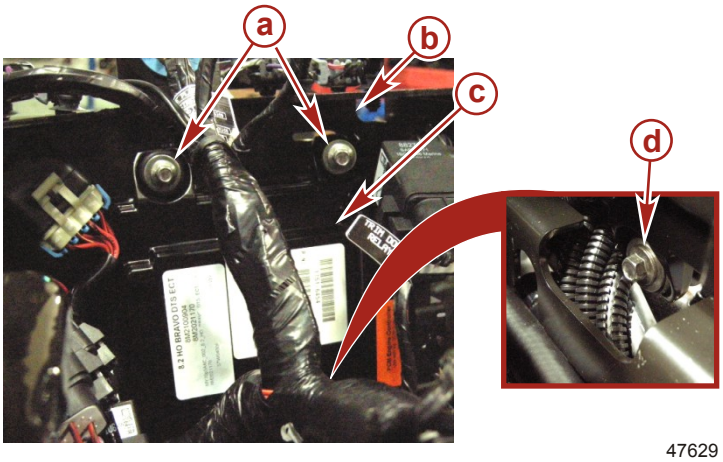
1. Clean the exterior of the PCM with a dry cloth, being careful to avoid contact with connector pins.
2. Inspect the outer surfaces for any obvious damage.
3. Visually inspect the electrical pins on the PCM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: *The PCM is a sealed electrical component. Do not use a damaged PCM.*

Installation

1. Place the PCM on the bracket and secure it to the bracket using the screws previously removed.

2. Tighten the PCM screws to specification.

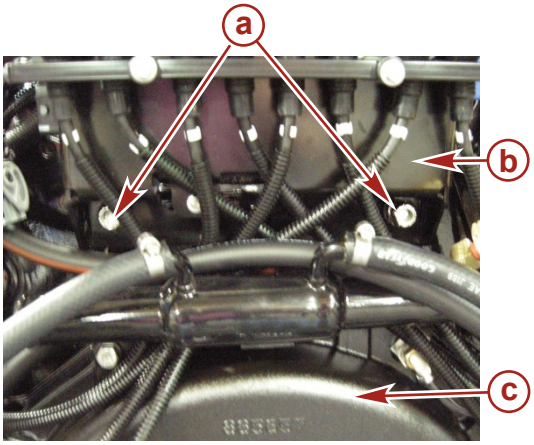


47629

a - Top screw
b - Electrical bracket
c - PCM
d - Bottom screw

Description	Nm	lb-in.	lb-ft
Screws, PCM to electrical bracket	6	40	–

3. Push the Electrical bracket all the way back on the studs and secure it with the washers and nuts previously removed.
4. Tighten the nuts to specification.

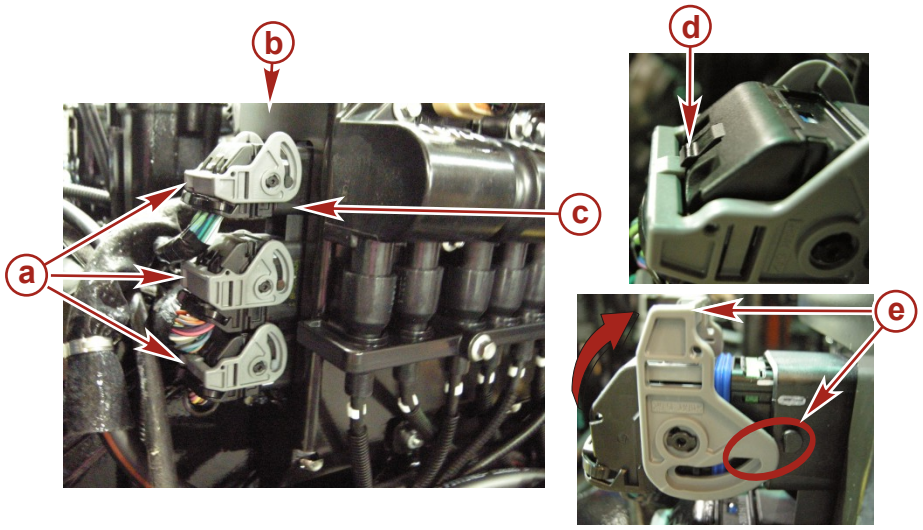


47627

a - Nut and washer
b - Electrical bracket
c - Engine flywheel housing

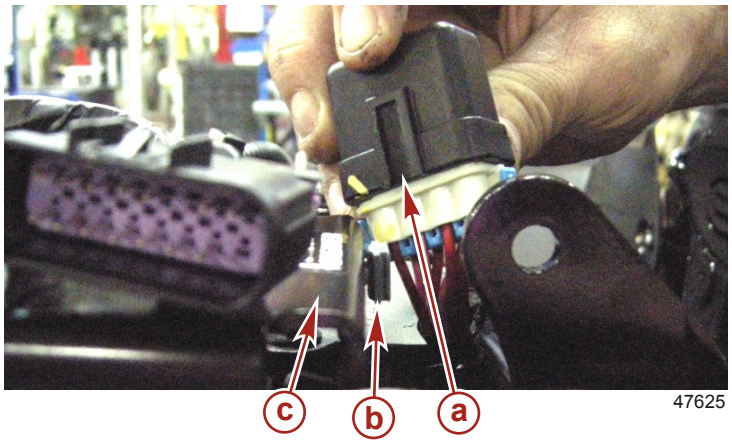
Description	Nm	lb-in.	lb-ft
Nut, electrical bracket to engine	54	–	40

5. Install the electrical connectors to the PCM.



a - Electrical connectors
b - Electrical bracket
c - PCM
d - Locking tab
e - Latch and latch pin

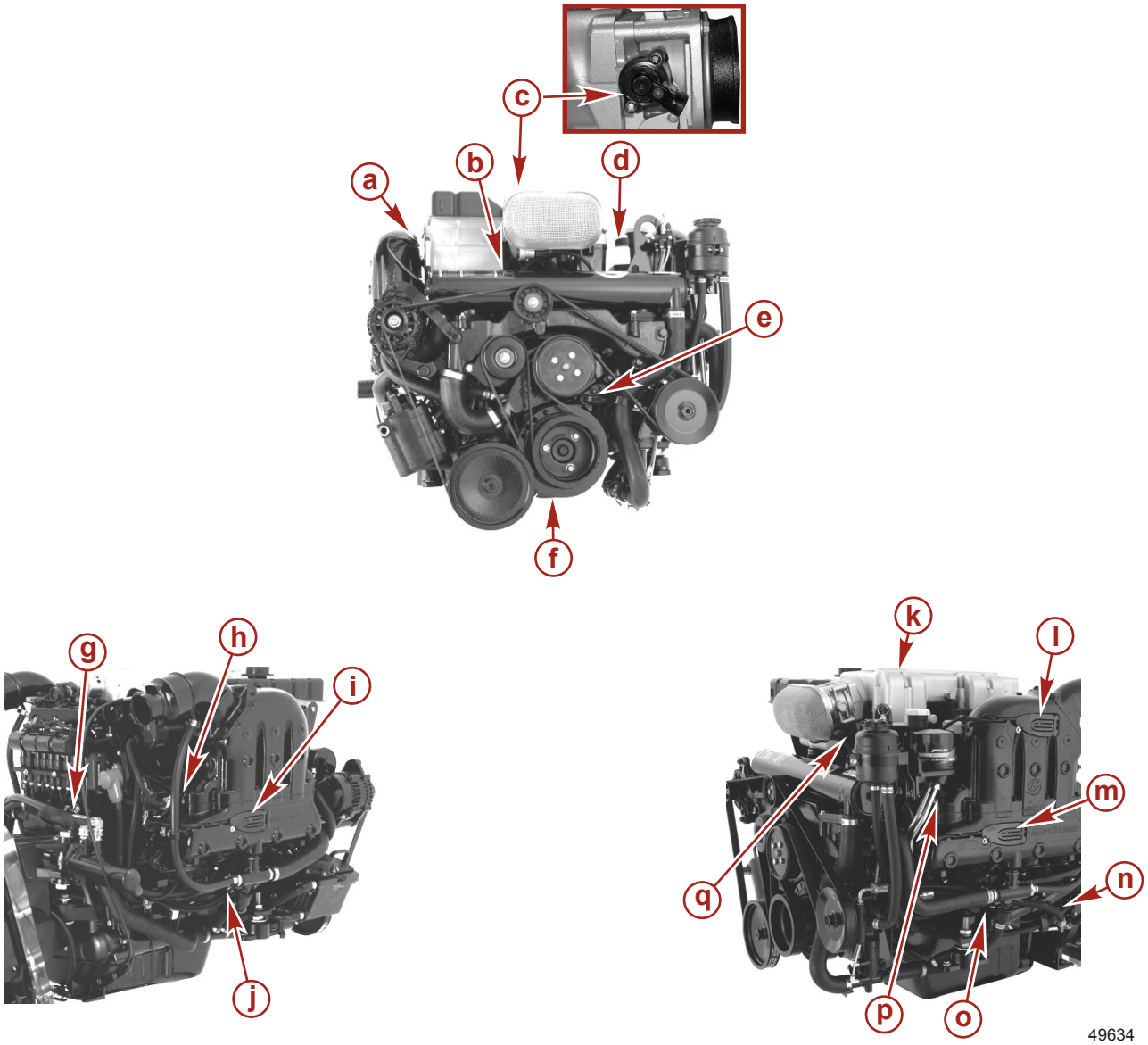
6. Slide the fuse connector in its mount on the electrical bracket.



a - Fuse connector
b - Fuse connector mount
c - Electrical bracket

Sensors

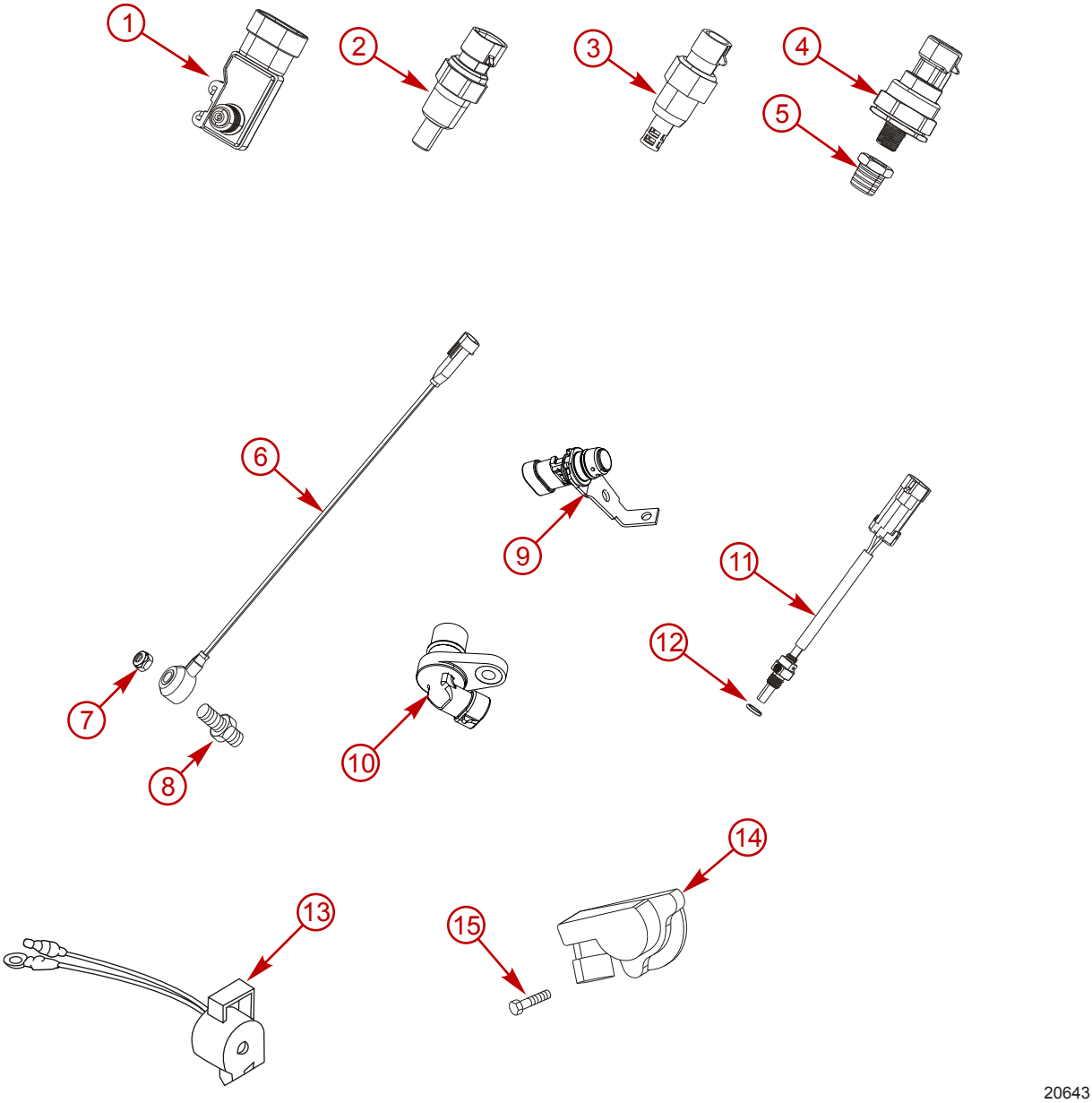
Sensor Locations



- **a -** Oxygen sensor (post starboard)
- **b -** Coolant temperature sensor
- **c -** Throttle position sensor (mechanical shift)
- **d -** Gear lube bottle sensor
- **e -** Camshaft sensor
- **f -** Crankshaft position sensor
- **g -** Sea pump pressure sensor
- **h -** Exhaust manifold coolant temperature (EMCT) sensor starboard
- **i -** Oxygen sensor (pre starboard)
- **j -** Knock sensor (starboard)
- **k -** Manifold air pressure sensor (MAP)
- **l -** Oxygen sensor (post port)
- **m -** Oxygen sensor (pre port)
- **n -** Oil pressure sensor
- **o -** Knock sensor (port)
- **p -** Exhaust manifold coolant temperature (EMCT) sensor port

q - Manifold air temperature sensor (MAT)

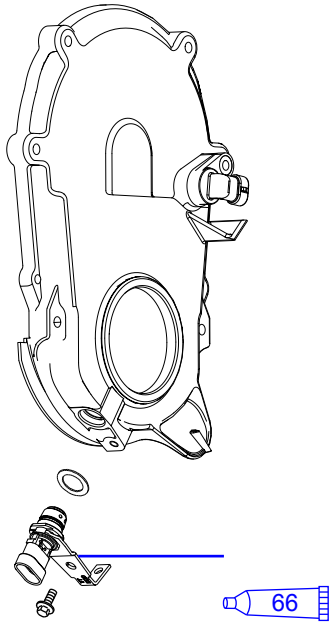
Electrical Senders and Sensors



REF.	QTY.	Description
1	1	SENSOR (MAP)
2	1	SENSOR (Coolant Temperature)
3	1	SENSOR (MAT)
4	1	SENSOR (Oil Pressure)
	1	SENSOR (Fuel Pressure)
	1	SENSOR (Water Pressure)
5	1	REDUCER **(Used With Oil Pressure Sensor)**
6	2	SENSOR ASSEMBLY (Knock)
7	2	NUT (M10)
8	2	STUD **(Knock Sensor Assembly Mounting)**
9	1	SENSOR ASSEMBLY (Crankshaft Position)
10	1	SENSOR ASSEMBLY (Camshaft)
11	1	SENSOR ASSEMBLY (coolant temperature) (EMCT)
12	1	O-RING
13	1	ALARM KIT (Audio Warning)
14	1	SENSOR (Throttle Position)
15	2	SCREW (#8-32 x 0.500)

Crankshaft Position Sensor

1. Install the sensor with spacer and tighten the mounting bolt to specification.

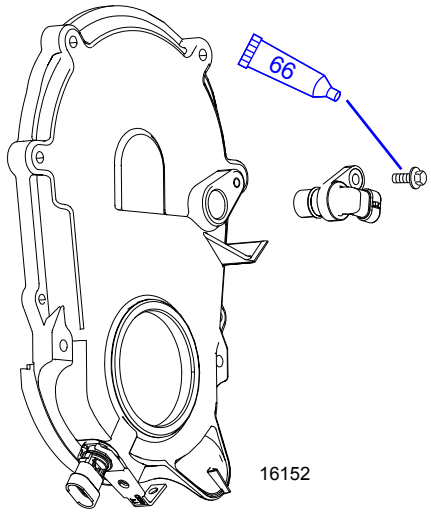


Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821

Description	Nm	lb. in.	lb. ft.
Crankshaft sensor mounting bolt	11	–	8

Camshaft Position Sensor

1. Install the camshaft sensor and tighten the mounting bolt to specification..



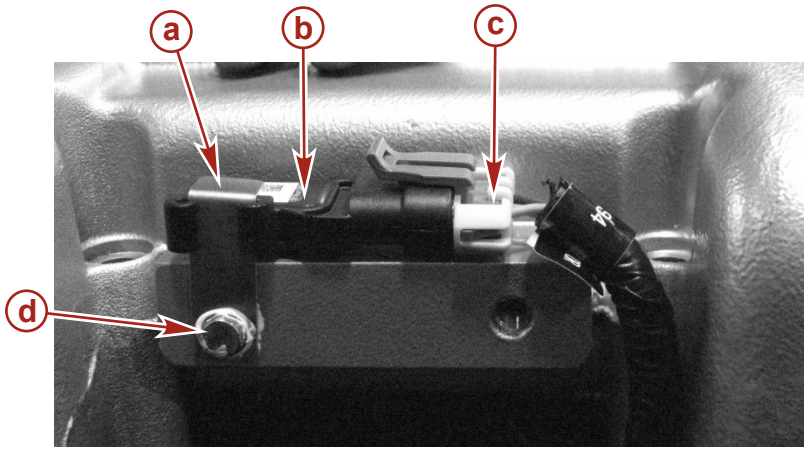
Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821

Description	Nm	lb. in.	lb. ft.
Mounting bolt	11	–	8

Manifold Absolute Pressure Sensor (MAP)

Removal

1. Remove the engine harness connection at the MAP connector.
2. Remove screw and bracket retaining the MAP sensor.

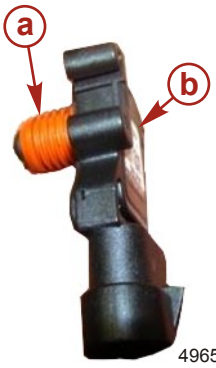


a - Bracket
b - MAP connector
c - Engine harness connection
d - Screw

3. Pull the sensor straight up from the plenum.

Installation

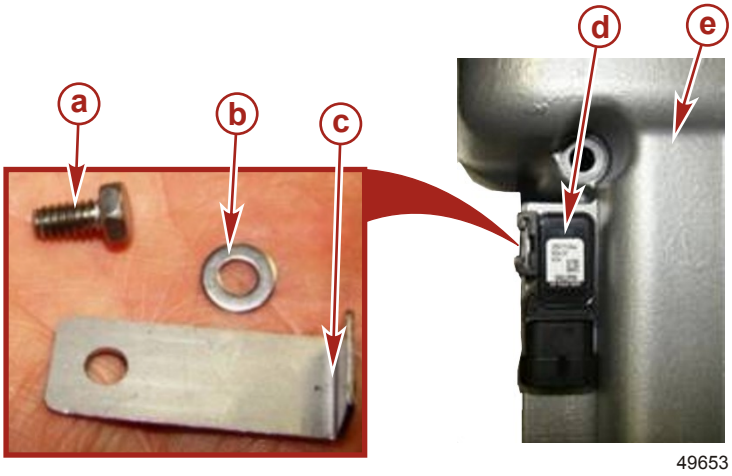
1. Lubricate the seal.



a - Seal
b - MAP sensor

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Seal on MAP sensor	92-858087K01

2. Install the MAP sensor and be careful not to damage the seal. (The sensor should lie flat on the mounting surface.)
3. Apply Loctite #242 to the threads of the retaining screw, install the retaining bracket and tighten the screw to Specification.

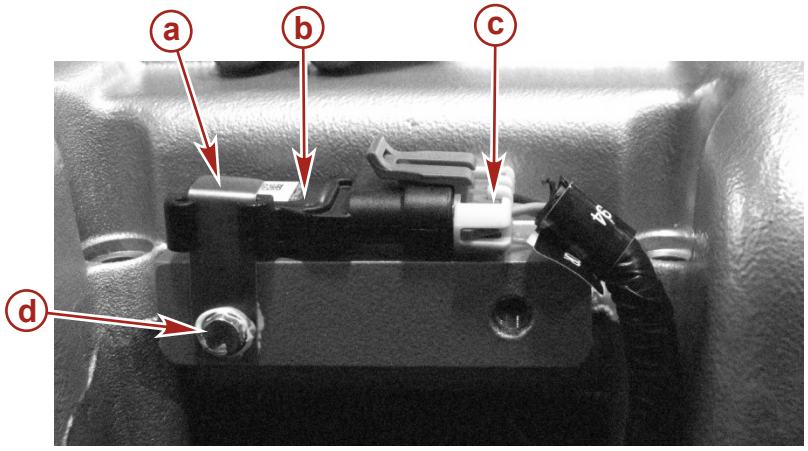


a - Screw
b - Washer
c - Bracket
d - MAP sensor
e - Plenum

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	MAP sensor retaining screw	92-809821

Description	Nm	lb. in.	lb. ft.
MAP sensor retaining screw	6	50	–

4. Connect the electrical harness to the MAP sensor.



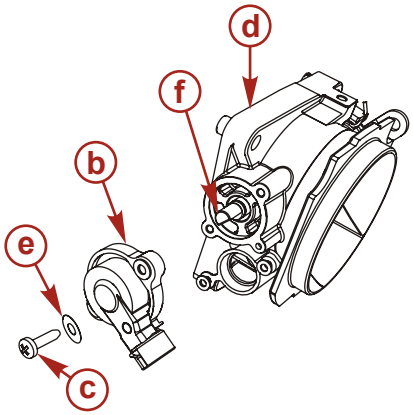
49651

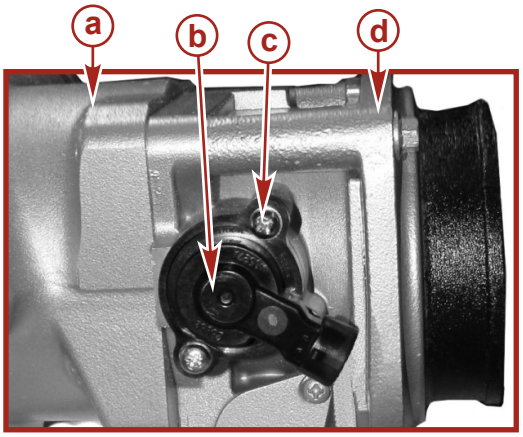
a - Bracket
b - MAP connector
c - Engine harness connection
d - Screw

Throttle Position Sensor (TPS)

Removal

1. Disconnect the electrical connector from the TPS sensor.
2. Remove the two retaining screws and the TPS sensor from the throttle body.





49791

a - Plenum
b - TPS sensor
c - Screw
d - Throttle body
e - Throttle shaft

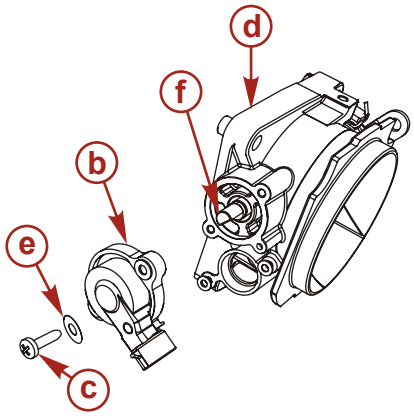
Installation

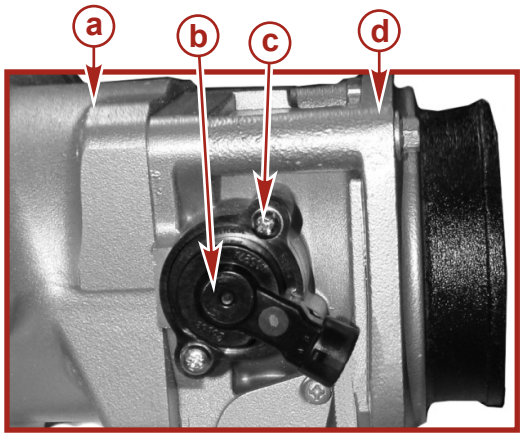
1. Apply adhesive to the screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Screw threads	92-809821

2. Install the TPS sensor on the throttle shaft and secure it to the throttle body with screws with washers.

3. Tighten the screws to specification.





49791

a - Plenum
b - TPS
c - Screw
d - Throttle body
e - Throttle shaft

Description	Nm	lb-in.	lb-ft
TPS sensor screw	2.7	24	–

Manifold Intake Air Temperature Sensor (MAT)

Removal

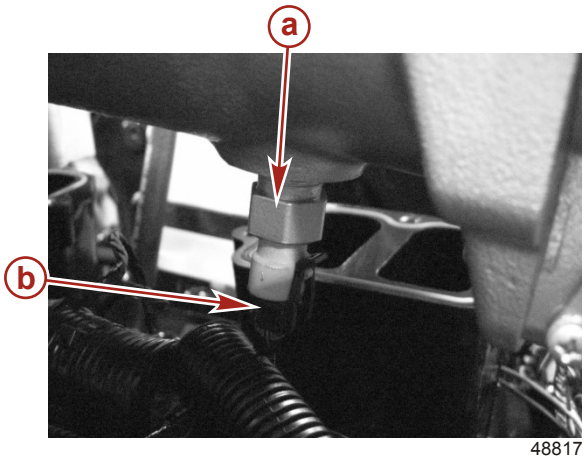
1. Remove the plenum. Refer to **Intake Plenum**.
2. Remove the sensor from the plenum.

Installation

1. If pre-applied sealant is not visible on the threads, apply pipe sealant to the threads of the sensor.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Sensor threads	92-809822

2. Install the sensor in the plenum. Tighten two and a half turns maximum.
3. Install the plenum. Refer to **Intake Plenum** and follow installation instructions.
4. Install the engine harness connection to the Air Temp sensor.

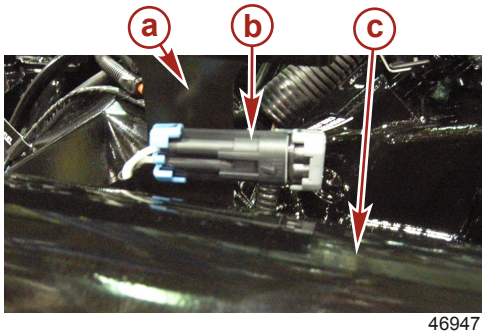


48817

a - Air Temp sensor
b - Engine harness connection

Coolant Temperature Sensor Replacement

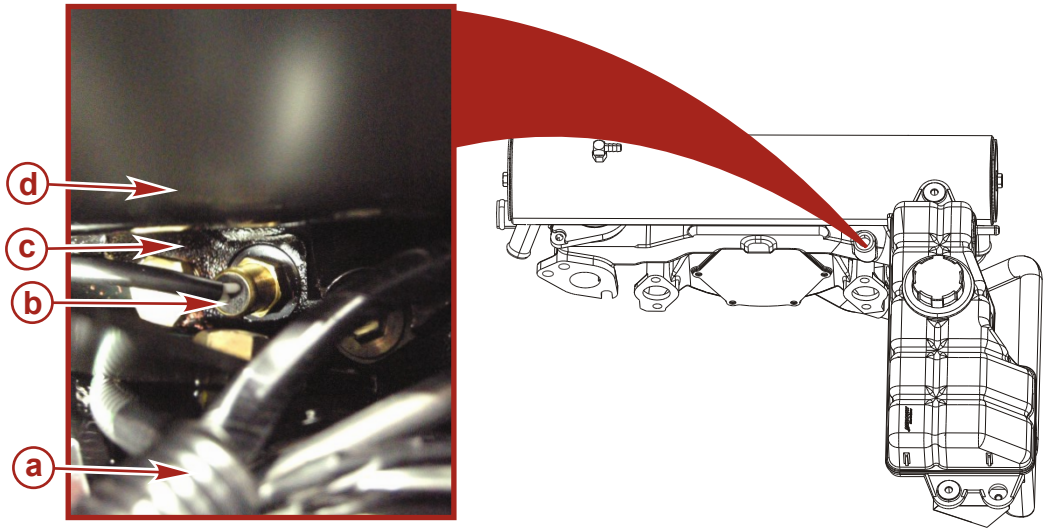
1. Disconnect the coolant temperature sensor from the engine harness.



46947

a - Reservoir bracket
b - Coolant temperature sensor
c - Heat exchanger

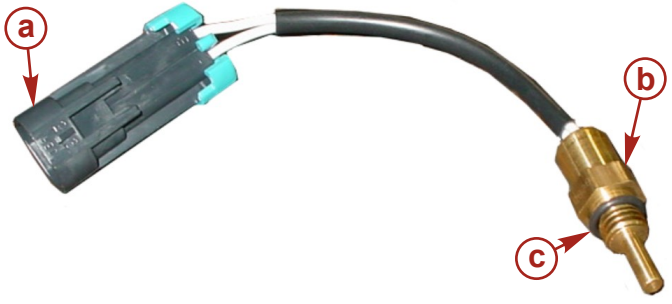
2. Remove the sensor.



49794

a - Engine harness
b - Sensor mounting location
c - Crossover
d - Heat exchanger

3. Verify that the O-ring is on the sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

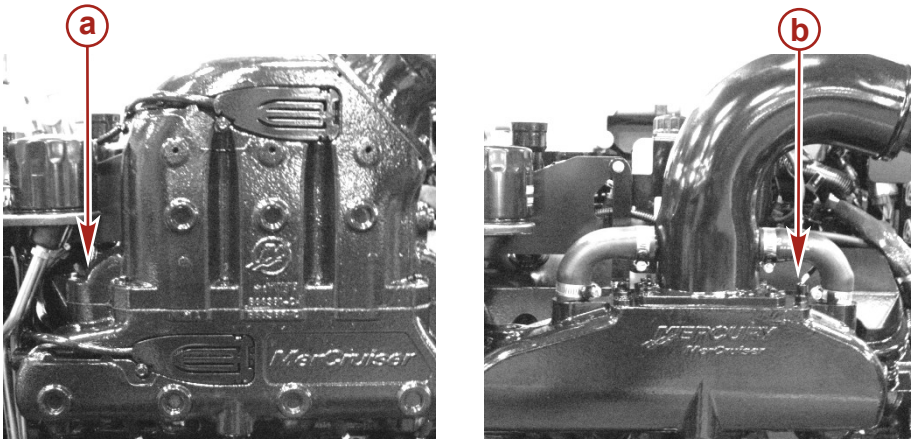
4. Install the sensor finger tight. Tighten the sensor to specification.

Description	Nm	lb-in.	lb-ft
Coolant temperature sensor	5	47	–

Exhaust Manifold Coolant Temperature (EMCT)

1. Remove the EMCT sensor connector from the engine harness.

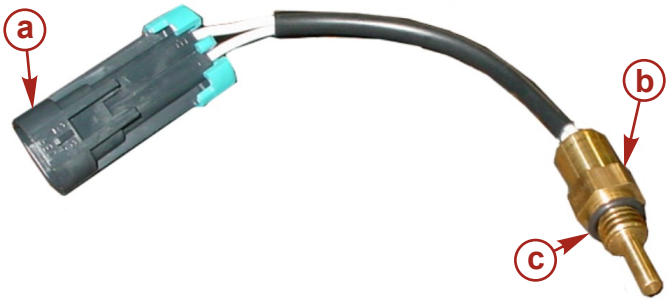
2. Remove the EMCT sensor from the manifold.



48675

a - EMCT sensor location on emission controlled engine
b - EMCT sensor location on non-emission controlled engine

3. Verify that the O-ring is on the EMCT sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

4. Hand-start the EMCT sensor in the manifold.
5. Tighten the sensor to specification.

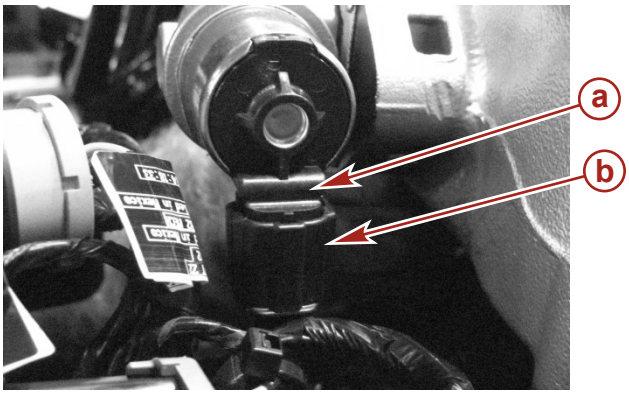
Description	Nm	lb-in.	lb-ft
EMCT sensor	8	–	6

6. Connect the EMCT sensor to the engine harness.

Idle Air Control (IAC) Valve

Removal

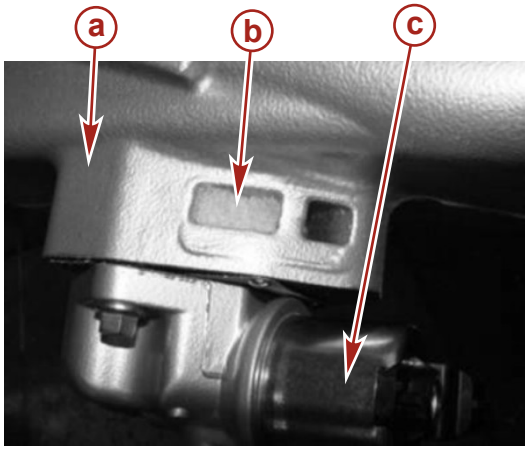
1. Disconnect the engine harness connection from the Idle air control (IAC) valve.



48815

a - IAC connector
b - Engine harness connection

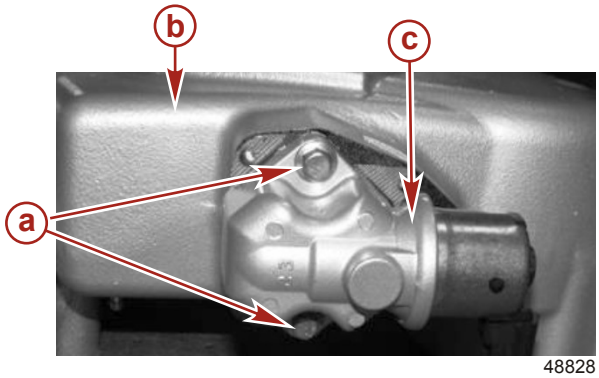
2. Remove the muffler.



48829

a - Plenum
b - Muffler
c - IAC valve

3. Remove the retaining screws and the IAC valve from the plenum.

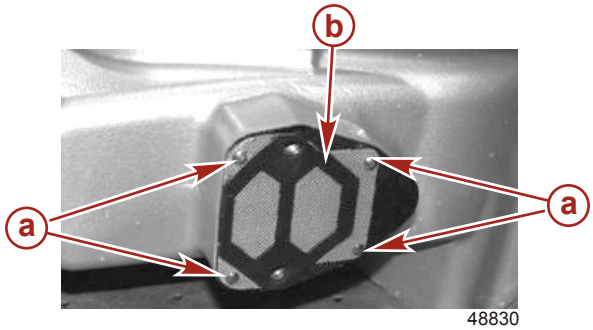


48828

a - Screw
b - Plenum
c - IAC valve

Installation

1. Clean the gasket surface.
2. Install a new gasket and four new rivets.



48830

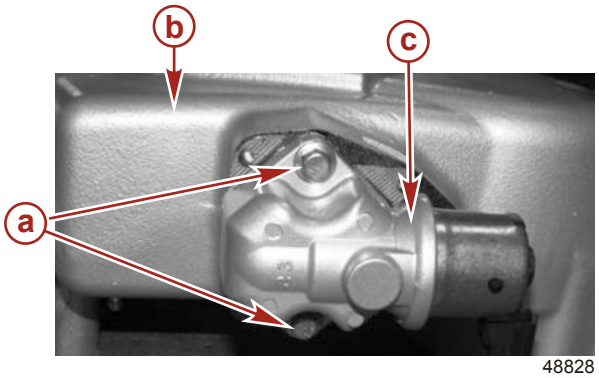
a - Rivets
b - Gasket

3. If not applicable, apply sealant to the screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	IAC screw	92-809821

6

4. Install the IAC valve onto the gasket and secure it with two screws.

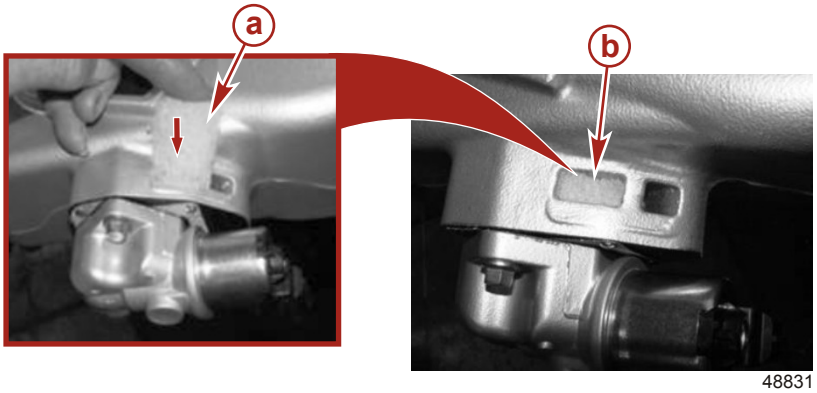


48828

a - Screw
b - Plenum
c - IAC valve

Description	Nm	lb. in.	lb. ft.
IAC mounting screw	11	100	–

5. Install a clean muffler.



48831

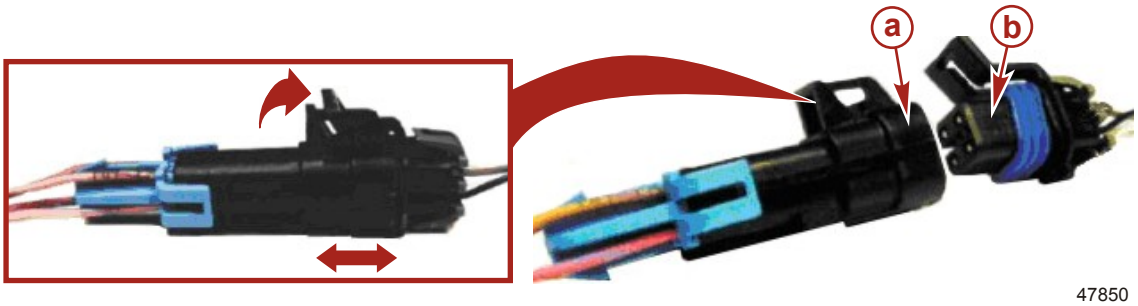
a - Muffler
b - Muffler installed

Oxygen Sensor

Inspecting the Oxygen Sensor Connectors

IMPORTANT: If light to moderate corrosion is present on any engine harness connector or sensor, and cannot be removed with the cleaning process. Replace the sensor or wiring harness as needed.

1. Disconnect two post and two pre-exhaust oxygen sensors from the engine wiring harness, being careful not to damage the locking tabs.



47850

Pre-exhaust and post-exhaust oxygen sensor

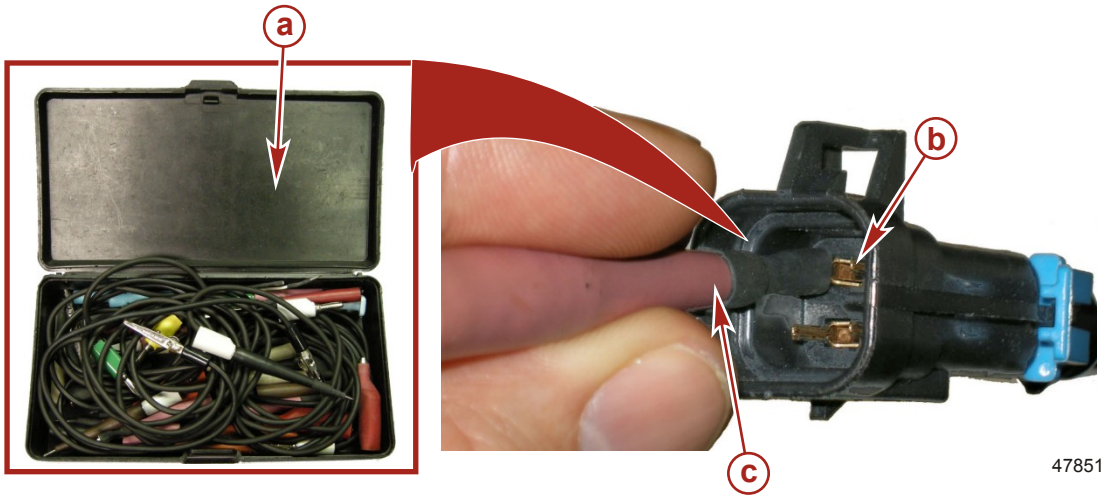
a - Engine harness connector (male)
b - Oxygen sensor connector (female)

2. Inspect each sensor and engine harness connector for evidence of condensation (moisture), corrosion, or damaged terminals and sockets. See image below.
3. If condensation is present, carefully use low-pressure compressed air to dry out both the male and female connectors.
4. Clean the pins and sockets using rubbing alcohol and a standard Q-tip (obtained locally) and then air dry.
5. Carefully inspect each pin and socket for corrosion or damage.

6. If damage is present, replace the sensor or harness as necessary.
7. If corrosion is present on any sensor pin, replace that oxygen sensor.
8. If light to moderate corrosion is present on any oxygen sensor connector, it can be removed as follows:
   a. Locate the pink female terminal adapter (J-35616-5) from the CDS Terminal Adapter kit (SPX P/N MM-46523)

Terminal Test Probe Kit	SPX P/N MM- 46523

   b. Using rubbing alcohol, slide the adapter on and off of each male pin until the corrosion has been removed. See image below.
   c. When finished cleaning all four pins, dry the connector with low pressure compressed air.



a - CDS Terminal Adapter kit
b - Pink female terminal adapter
c - Male pin (4)

9. Reconnect each oxygen sensor to the engine harness as you complete the inspection/cleaning process.
10. If the corrosion was not removed during the cleaning process, replace the sensor or wiring harness as needed.
11. Use the CDS-G3 service tool to clear any faults.

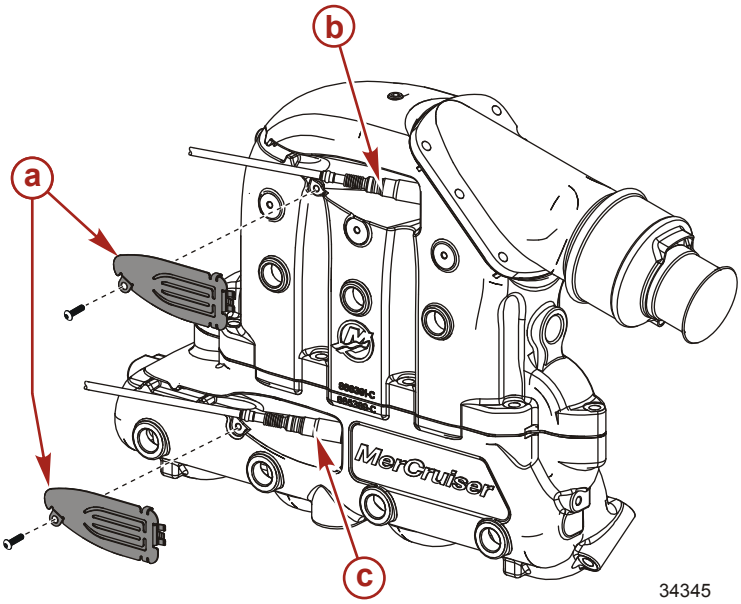
Replacing the Oxygen Sensor

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the oxygen sensor from the engine harness.

2. Loosen the screw securing the oxygen sensor cover to the collector and remove the cover.



a - Oxygen sensor cover
b - Post-catalyst oxygen sensor
c - Pre-catalyst oxygen sensor

3. Remove the oxygen sensors, as needed.

Kent-Moore Oxygen Sensor Socket	KN-46577

4. Use the oxygen sensor tool to install the oxygen sensor. Tighten the sensor to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	37

5. Install the oxygen sensor cover so it is flush against the collector. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor cover screw	3.5	31	–

6. Connect the oxygen sensor connector to the engine harness.

Fuel System

Section 5A - Fuel Delivery System

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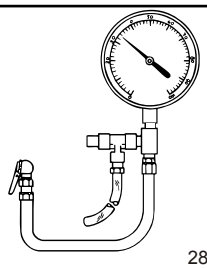
5A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting adapter Fuel line inlet fitting to adapter.	92-809822
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector o-ring Fuel injector O-rings Fuel line O-ring	92-858087K01

Special Tools

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Specifications

Description	Specifications
Fuel pump pressure	296 kPa (43 psi)

Torque Specifications

Description	Nm	lb. in.	lb. ft.
Cool fuel module top cover screw	14	124	–
Cool fuel module pressure regulator screw	14	124	–
Cool fuel module brackets to module screw	23	–	17
Cool fuel module support bracket to engine block screw	66	–	49
Hose clamp	3	26	–
Fuel line retainer screw	9	80	–
Throttle body screw to plenum	14	120	–
ECT throttle body screw to plenum	11	96	–
J-clip nut on flywheel housing	48	–	36
Fuel rail mounting bolts	12	105	–
Plenum to intake screw	24	–	18
Flame arrestor clamp	6	55	–
Shift bracket assembly to plenum	18	–	14
Rear lift brace screw to plenum	18	–	14
Sheild on engine mount nut	37	–	27
Fuel inlet fitting adapter	22	–	16

Replacement Parts Warning

⚠ WARNING

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

Service Precautions

IMPORTANT: The following information must be adhered to when working with the fuel system:

- Always keep a dry chemical fire extinguisher at the work area.
- Do not replace fuel pipe with fuel hose.
- Observe all Warnings and Cautions.

⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

NOTICE

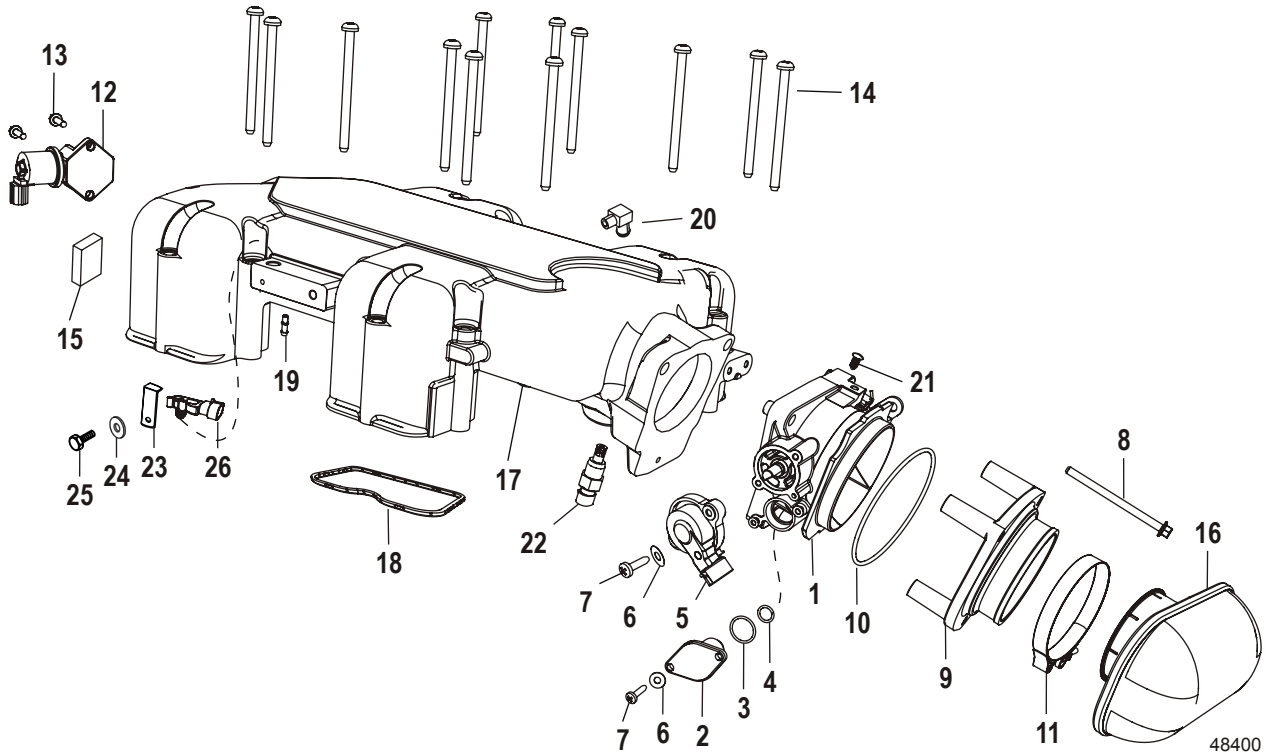
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Recommendations

IMPORTANT: Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing a fuel delivery system.

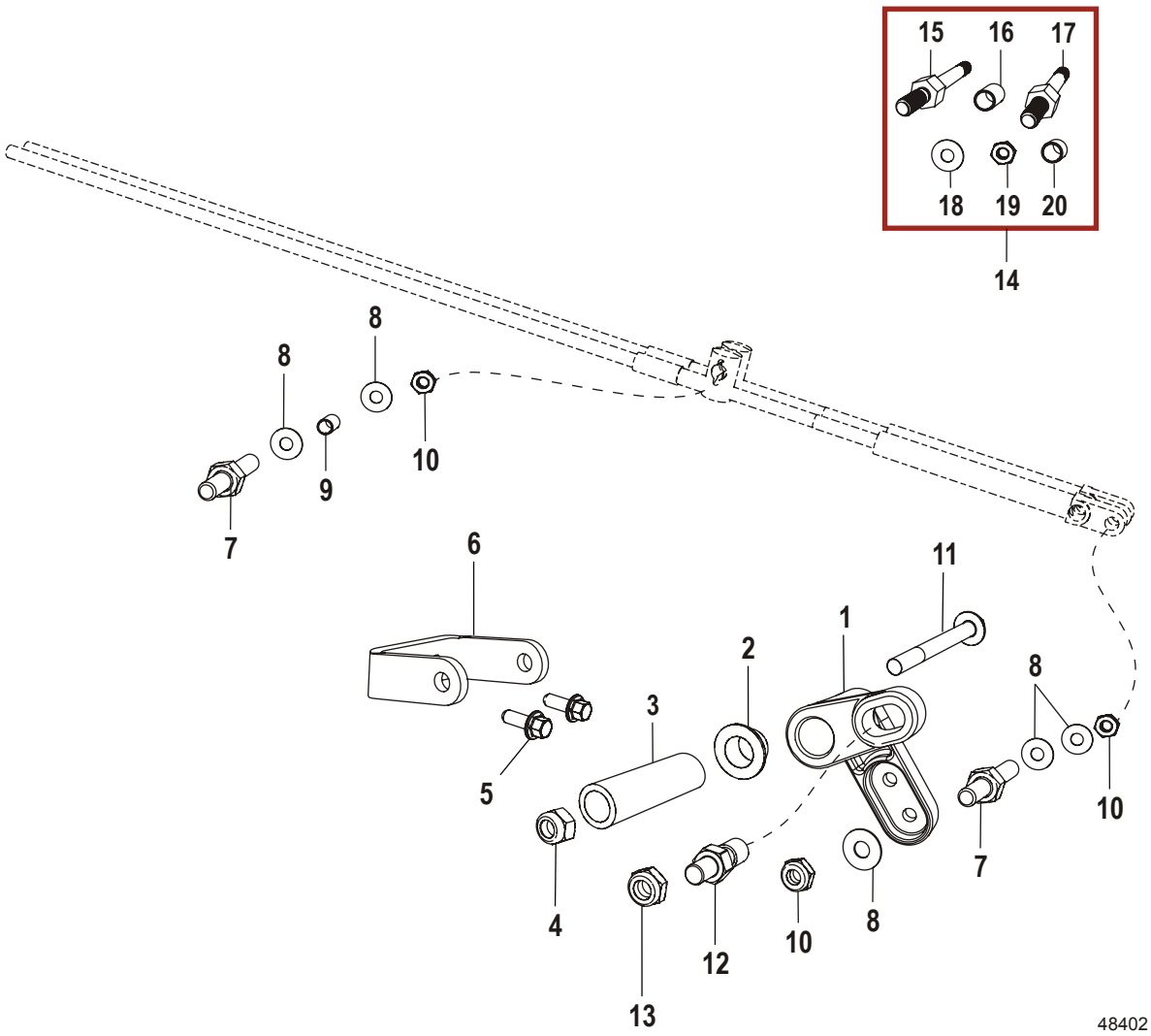
Intake Plenum and Throttle Body

Intake Plenum and Throttle Body—Mechanical Throttle and Shift



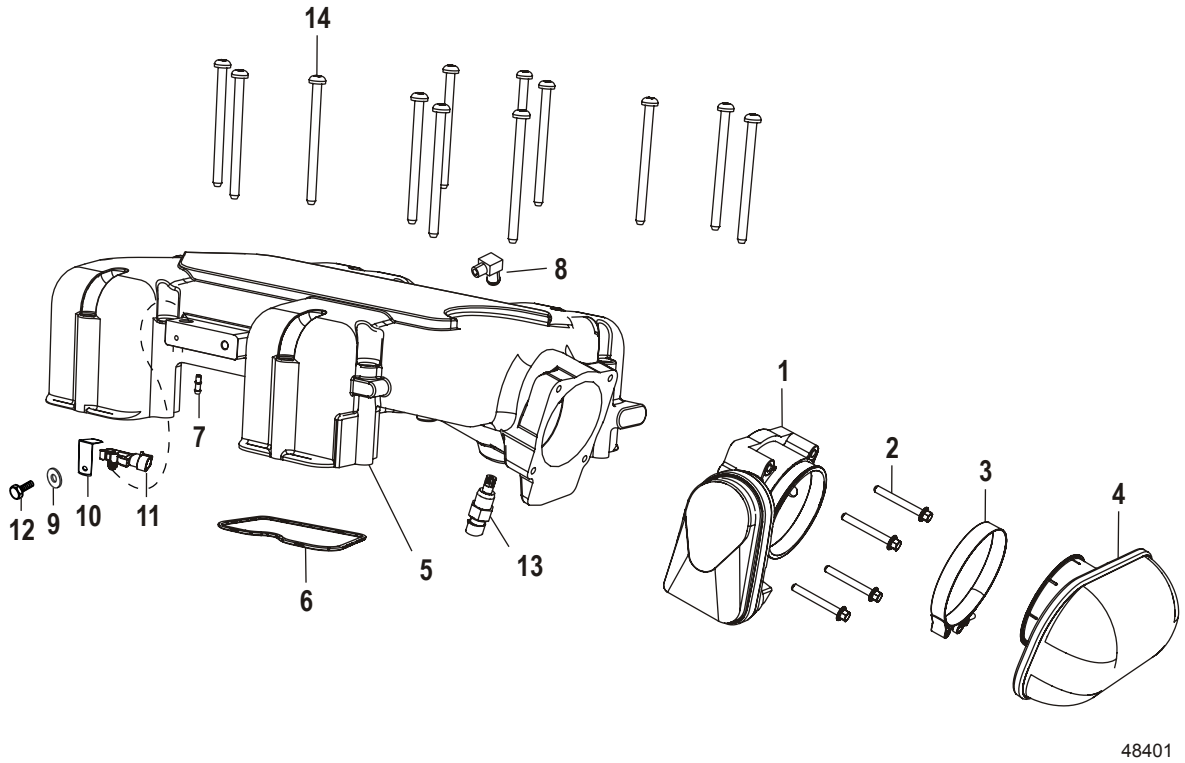
1 - Throttle body assembly with seal
2 - Plug
3 - O-ring
4 - O-ring
5 - Throttle position sensor (TPS)
6 - Washer
7 - Screw (3)
8 - Screw (stainless steel)
9 - Adaptor (HO or Base separate)
10 - O-ring
11 - Clamp
12 - Idle air control valve (IAC)
13 - Screw (stainless steel)
14 - Screw (12)
15 - Filter
16 - Flame arrestor
17 - Plenum assembly
18 - Seal (4) (intake manifold)
19 - Barb fitting
20 - 90º fitting
21 - Screw
22 - Intake air temperature sensor
23 - MAP sensor mount
24 - Washer (stainless steel)
25 - Screw
26 - Manifold air pressure sensor (MAP)

Throttle Lever Assembly—Mechanical Throttle and Shift



1 - Throttle lever assembly
2 - Bushing
3 - Bushing
4 - Nut
5 - Screw (2)
6 - Bracket
7 - Throttle cable stud
8 - Washer
9 - Spacer
10 - Nut
11 - Screw
12 - Throttle roller assembly
13 - Nut
14 - Dual station kit
15 - Stud
16 - Spacer
17 - Stud
18 - Washer
19 - Nut
20 - Spacer

Intake Plenum and Throttle Body—Digital Throttle and Shift



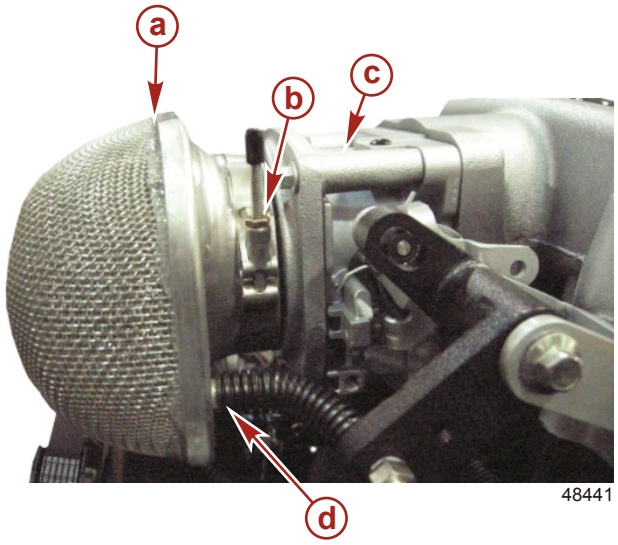
1 - Throttle body assembly with seal
2 - Screw (4)
3 - Clamp
4 - Flame arrestor
5 - Plenum assembly
6 - Seal (4) (intake manifold)
7 - Barb fitting
8 - 90º fitting
9 - Washer (stainless steel)
10 - MAP sensor mount
11 - Manifold air pressure sensor (MAP)
12 - Screw
13 - Intake air temperature sensor
14 - Screw (12) (stainless steel)

Flame Arrestor

Removal

1. Remove the vent hose.
2. Loosen the clamp nut.

3. Pull the flame arrestor from the throttle body.



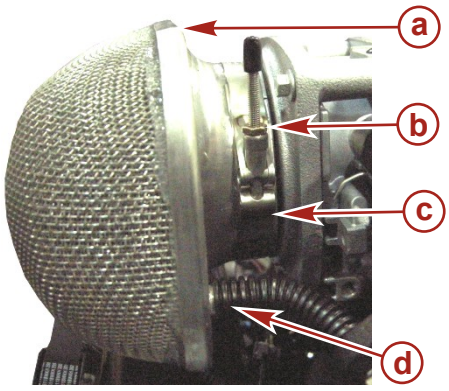
a - Fame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

Inspection

1. Inspect the flame arrestor for cuts or dents.
2. Clean the flame arrestor with soapy water and air dry with compressed air.
3. Inspect the clamp for damage that could affect the clamp load.

Installation

1. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
2. Push the flame arrestor onto the throtte body.
3. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.
4. Tighten the clamp to specification. Do not overtighten the clamp.



a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

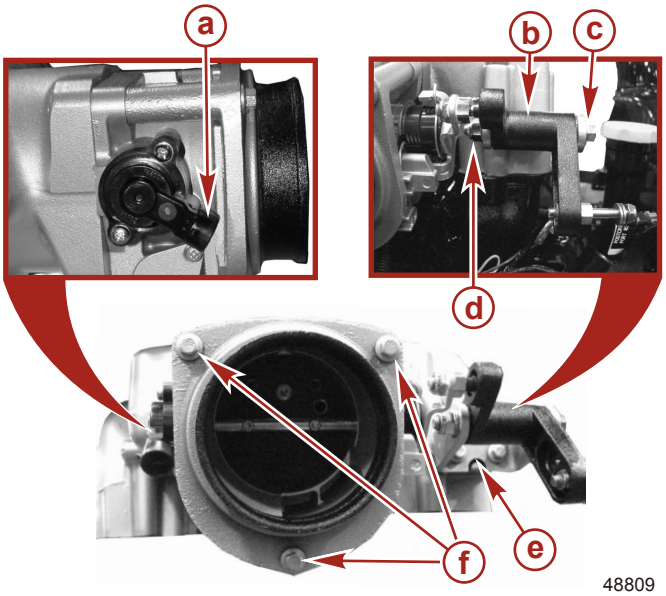
5. Install the vent hose to the bib fitting.

Throttle Body

Removal

1. Remove the flame arrestor, refer to **Flame Arrestor**.
2. On mechanical throttle and shift models:
   a. Remove the engine harness connection from the TPS connector.

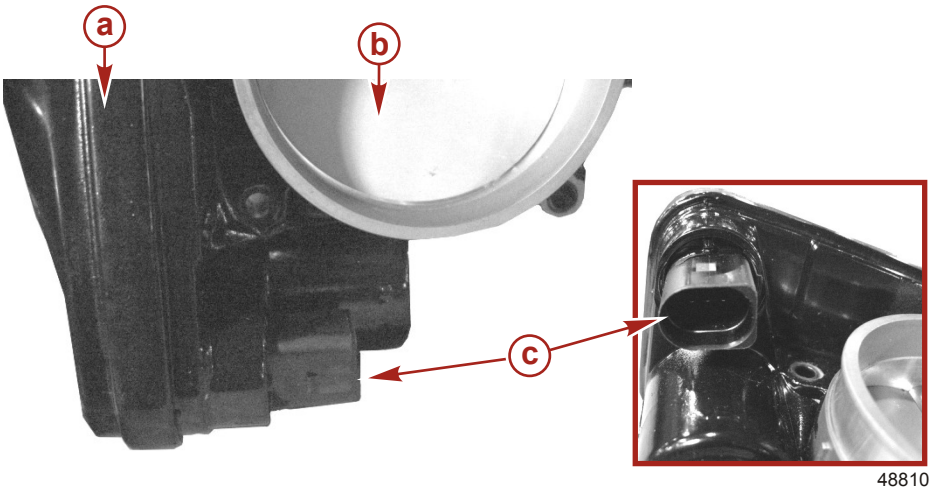
b. Remove the throttle cable from the throttle lever assembly.
c. Remove the nut and bolt securing the throttle lever assembly to the bracket.
d. Remove the throttle lever assembly from the bracket.



48809

a - TPS
b - Throttle lever assembly
c - Bolt
d - Nut
e - Bracket
f - Screws

3. On digital throttle and shift models (ETC), remove the engine harness connection from the ETC connector.



48810

a - ETC
b - Throttle body
c - ETC connector

4. Remove the throttle body retaining screws and remove the throttle body assembly. Some assemblies are equipped with an adapter. Refer to **Intake Plenum and Throttle Body**.
IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

Cleaning and Inspection

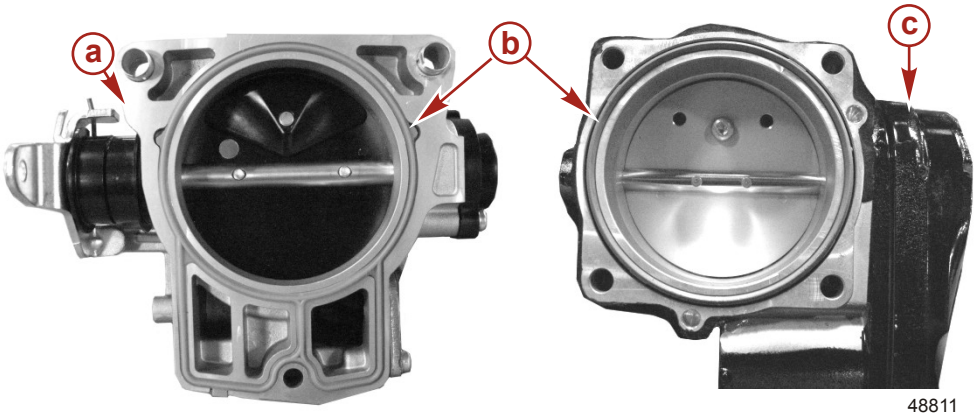
IMPORTANT: Do not use cleaners containing methyl ethyl ketone. They are not necessary for cleaning throttle bore and valve deposits.
IMPORTANT: Do not allow the throttle position sensor (TPS) to come into contact with solvent or cleaner.
IMPORTANT: Do not allow the electronic throttle control (ETC) to come into contact with solvent or cleaner.
IMPORTANT: Use care when removing gasket material from the intake manifold and throttle body.

1. Remove the sealing O-ring from the throttle body.
2. Inspect the sealing O-ring for cuts, or other imperfections that could affect seal.
3. Thoroughly clean the throttle body. Ensure that all passages are free of dirt and burrs.
4. Inspect mating surfaces for damage that could affect sealing.
5. Inspect the throttle body for cracks in the casting.
6. Inspect the throttle bore for marks that were made by the throttle plate rubbing against it. Replace the throttle body if such marks exist.

7. Inspect the throttle plates, linkage, return springs, etc., for damage, wear and foreign material.

Installation

1. Position the seal in the grove of the throttle body.



48811

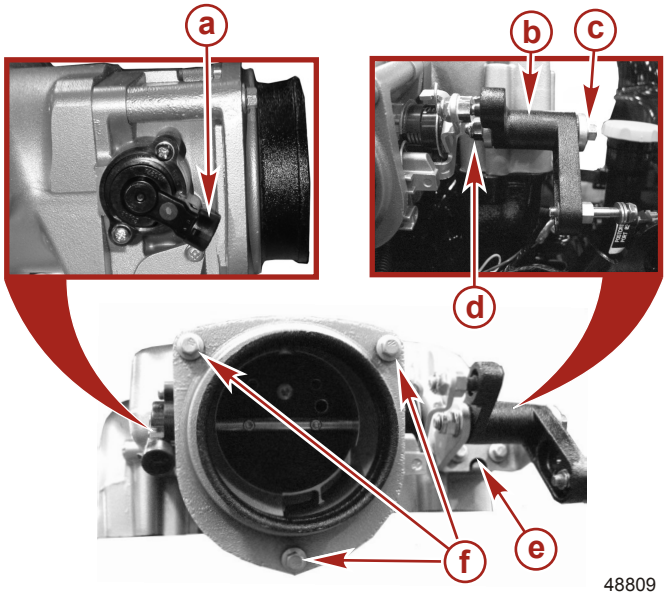
a - Mechanical throttle body
b - Seal
c - Electronic throttle body

2. If removed, place the adapter on the throttle body.
3. Install the throttle body assembly to the intake plenum and secure with screws. Refer to **Intake Plenum and Throttle Body**.

   NOTE: *The mechanical throttle body use three retaining screws, the electronic throttle body use four retaining screws, and the plemuns are specific to each.*
4. Tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Throttle body screw to plenum	14	120	–
Electronic throttle control (ETC) to plenum	11	96	–

5. On mechanical throttle and shift models:
   a. Connect the engine harness connector to the TPS.
   b. Install the throttle lever assembly to the bracket.
   c. Install the bolt through the throttle lever assembly and the bracket.
   d. Install the nut and tighten to specification.



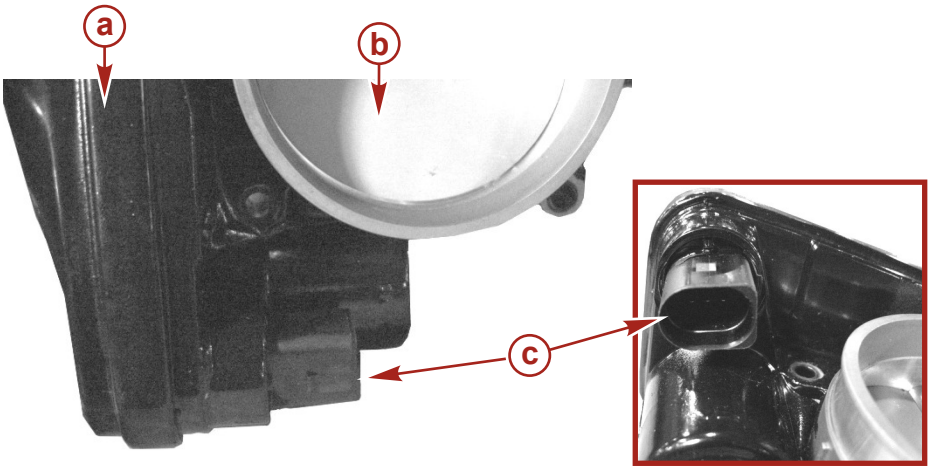
48809

a - TPS connector
b - Throttle lever assembly
c - Bolt
d - Nut
e - Bracket
f - Screws

Description	Nm	lb-in.	lb-ft
Throttle lever nut	24	–	18

   e. Connect the throttle linkage to the throttle body stud and install the throttle cable.

6. On digital throttle and shift models (ETC), conncect the engine harness to the ETC.



48810

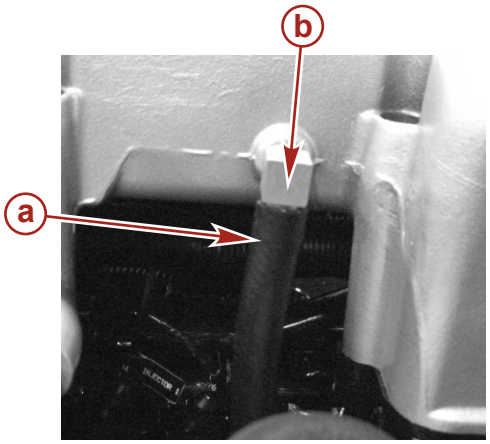
a - ETC
b - Throttle body
c - ETC connector

7. Install the flame arrestor, refer to **Flame Arrestor**.

Intake Plenum

Removal

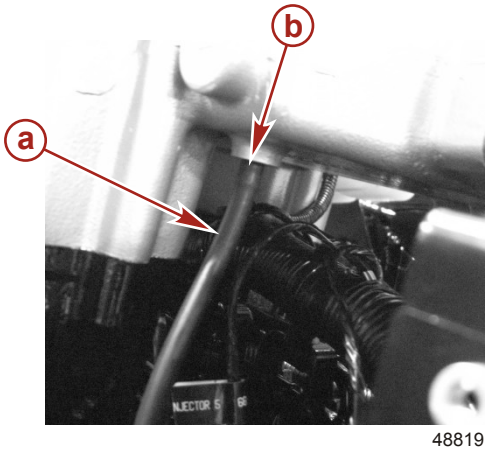
1. Remove the flame arrestor, refer to **Flame Arrestor**.
2. Remove the vacuum hose from the 90°fitting.



48818

a - Vacuum hose
b - 90° fitting

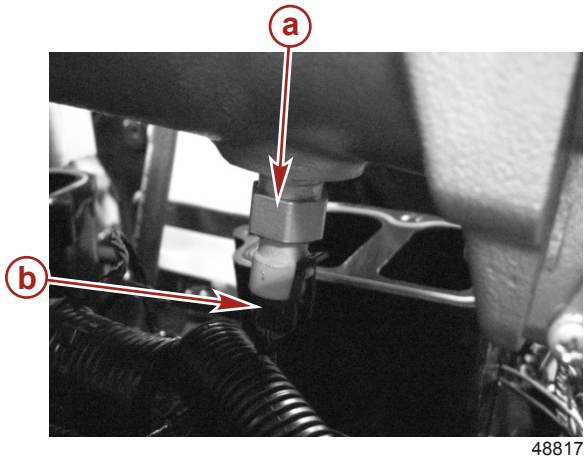
3. Remove the fuel vent hose from the barbed fitting.



48819

a - Fuel vent hose
b - Barbed fitting

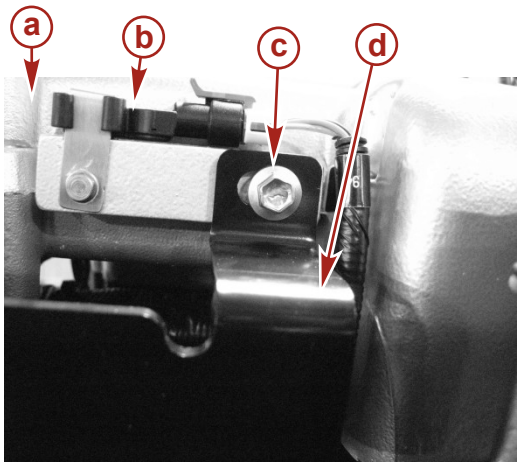
4. Remove the engine harness connections at Air Temp sensor.



48817

a - Air Temp sensor
b - Engine harness connection

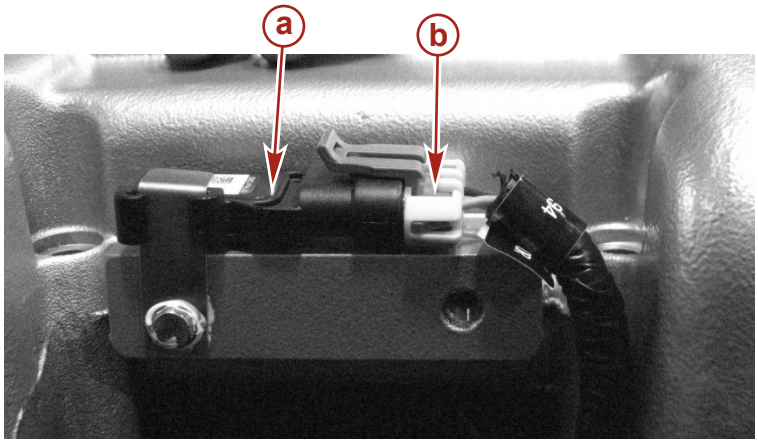
5. Remove and retain the screw securing the bracket on the plenum.



48813

a - Plenum
b - MAP
c - Screw
d - Bracket

6. Remove the engine harness connection at the MAP connector.

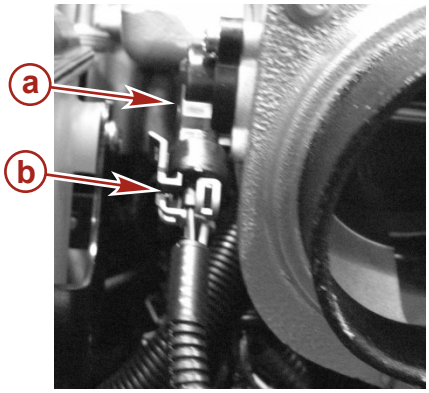


48816

a - MAP connector
b - Engine harness connection

7. Mechanical throttle and shift models:

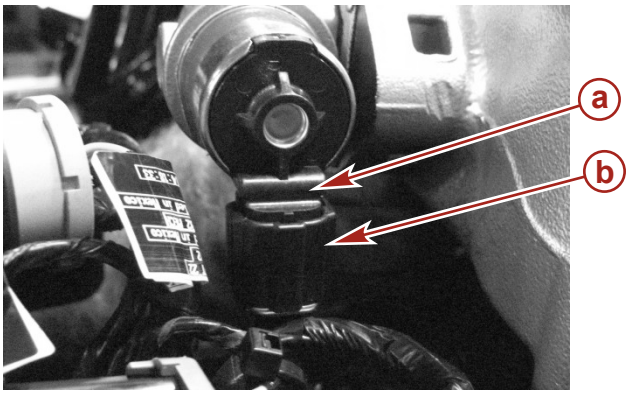
a. Remove the engine harness connection at the TPS connector.



48814

a - TPS connector
b - Engine harness connection

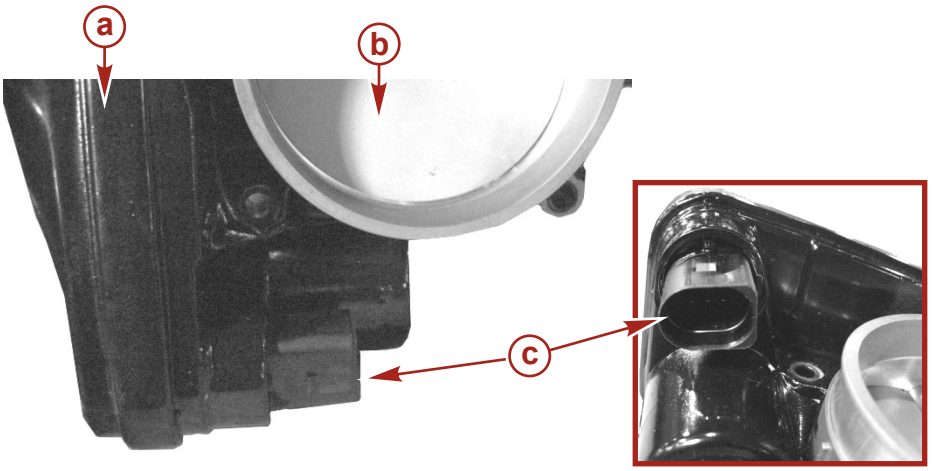
b. Remove the engine harness connection at the IAC connector.



48815

a - IAC connector
b - Engine harness connection

8. Digital throttle and shift models, remove the engine harness connection at the ETC connector.

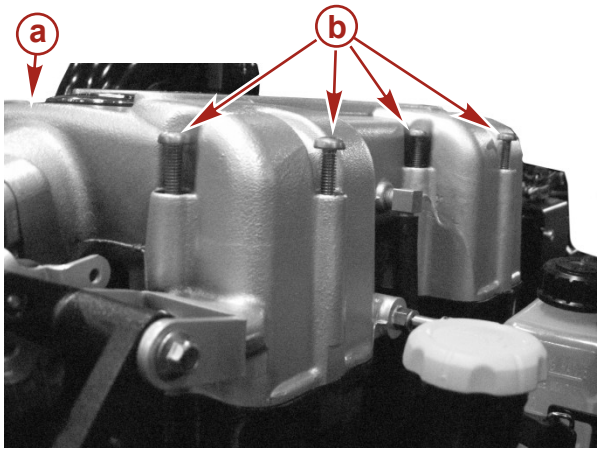


48810

a - ETC
b - Throttle body
c - ETC connector

9. If applicable, remove the throttle body, refer to **Throttle Body**.

10. Remove and retain the plenum screws and lift the plenum straight up.



48820

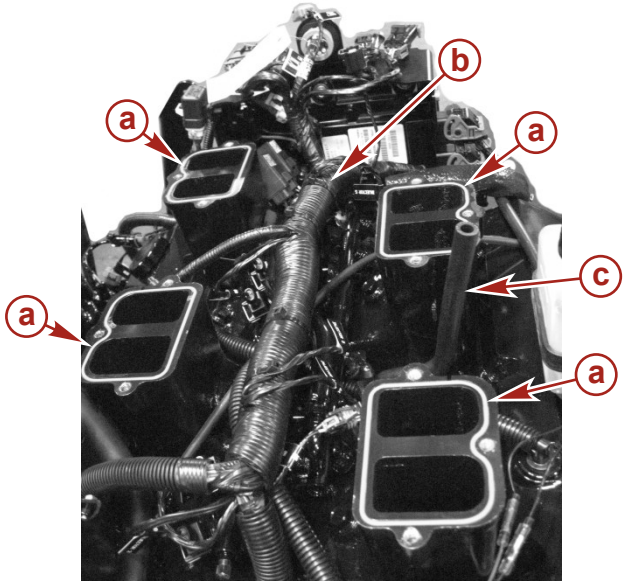
a - Plenum
b - Screw (12)

Cleaning and Inspection

1. Inspect the plenum for cracks in the casting.
2. Inspect the seals on the intake manifold for cuts or flat spots.
3. Inspect the mating surfaces for gashes, cuts, or other imperfections that could affect the seal.
4. Wash the casting with soapy water.

Installation

1. If removed, install the throttle body. Refer to **Throttle Body**.
2. Place a seal in the grove on each intake port on the intake manifold.
3. Ensure that the engine harness and components are positioned out of the way and the connections are easily accessible.

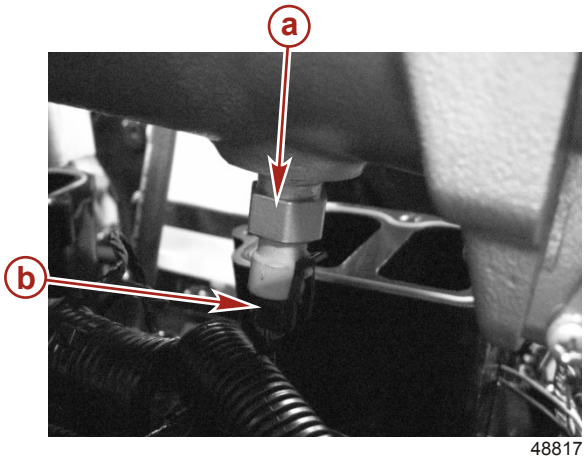


48821

a - Seal
b - Engine harness
c - Vacuum hose

4. Place the plenum on the seals on top the intake manifold.

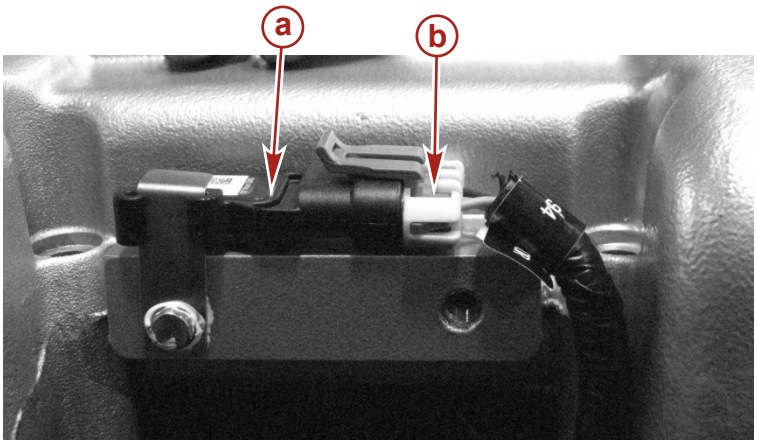
5. Install the engine harness connection to the Air Temp sensor.



48817

a - Air Temp sensor
b - Engine harness connection

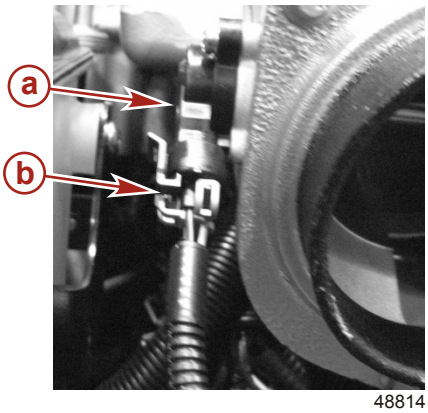
6. Install the engine harness connection to the MAP connector.



48816

a - MAP connector
b - Engine harness connection

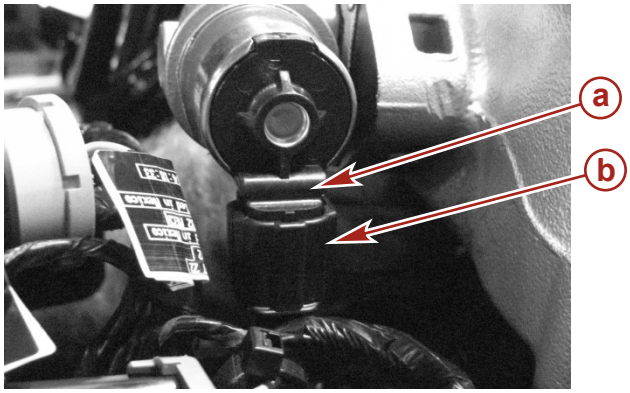
7. Mechanical throttle and shift models:
   a. Install the engine harness connection to the TPS connector.



48814

a - TPS connector
b - Engine harness connection

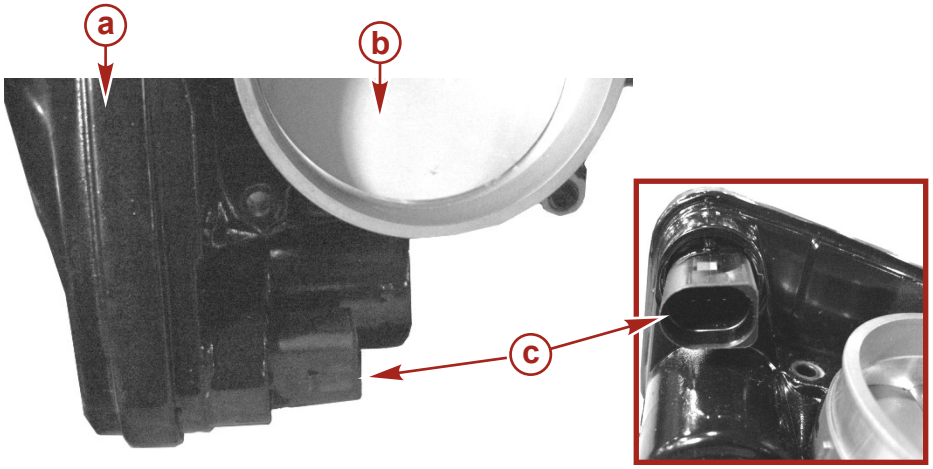
b. Install the engine harness connection to the IAC connector.



48815

a - IAC connector
b - Engine harness connection

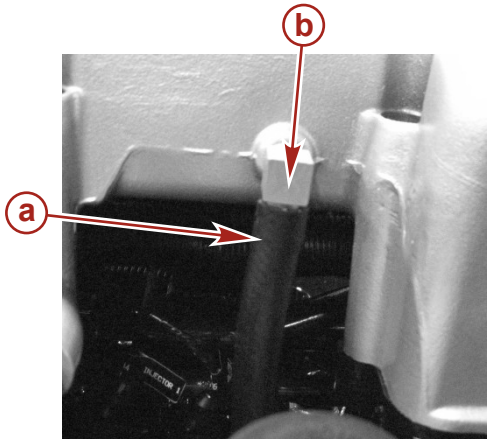
8. Digital throttle and shift models, install the engine harness connection to the ETC connector.



48810

a - ETC
b - Throttle body
c - ETC connector

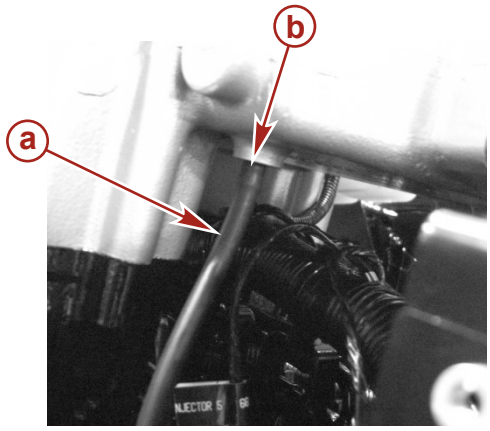
9. Push the vacuum hose onto the 90°fitting.



48818

a - Vacuum hose
b - 90° fitting

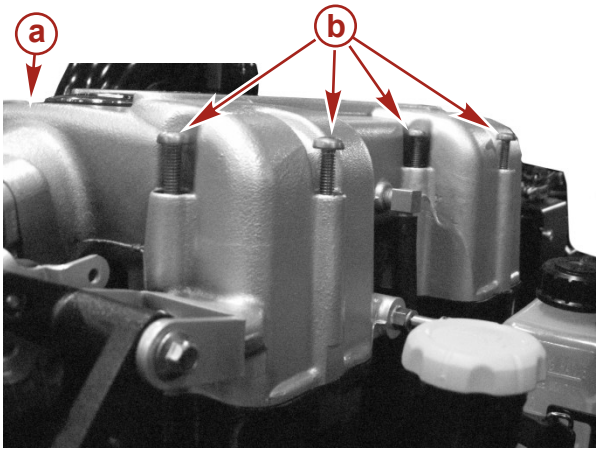
10. Push the fuel vent hose onto the barbed fitting.



48819

a - Fuel vent hose
b - Barbed fitting

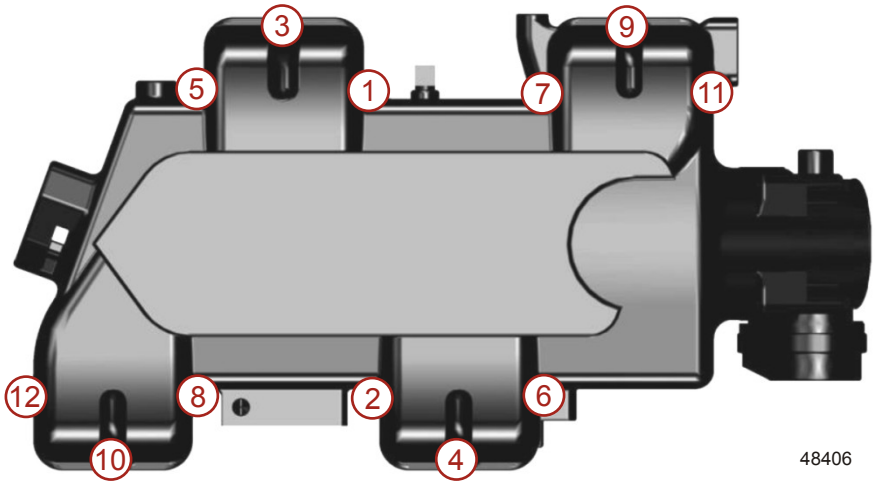
11. Install and hand start the screws.



48820

a - Plenum
b - Screw (12)

12. Tighten the screws to specification in the sequence shown.



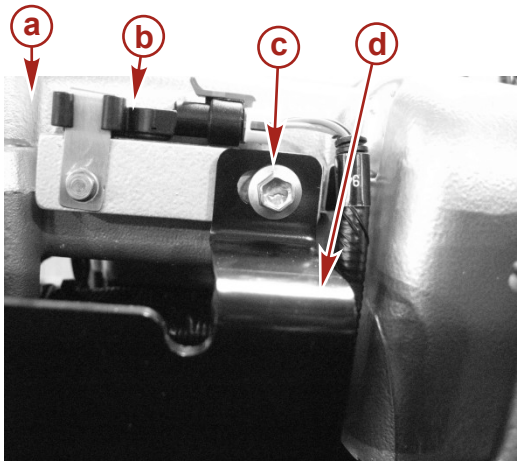
48406

Intake plenum torque sequence

Description	Nm	lb-in.	lb-ft
Intake plenum screw	24	–	18

13. Use the screw previously removed to install the bracket on the plenum.

14. Tighten the screw to specification.



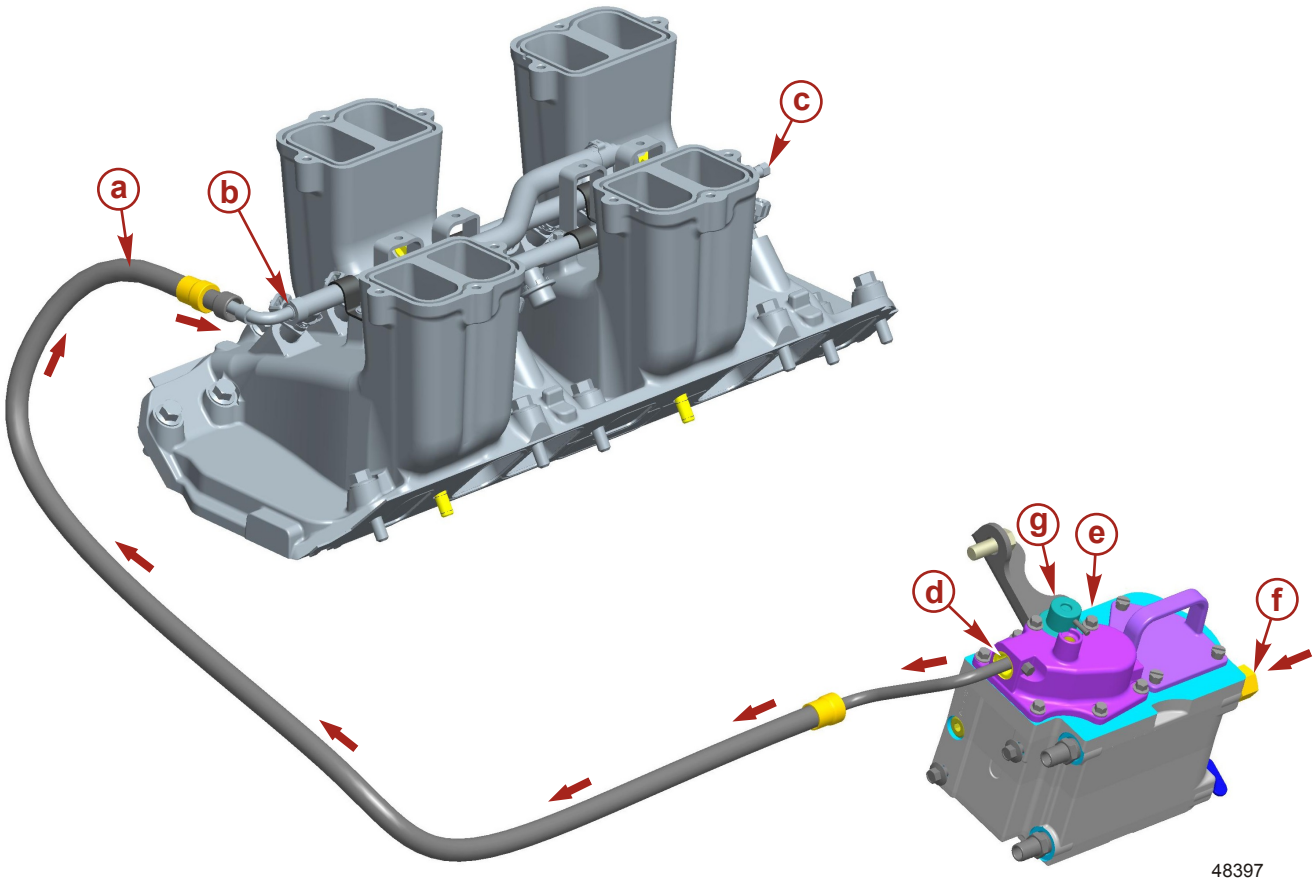
48813

a - Plenum
b - MAP
c - Screw
d - Bracket

Description	Nm	lb-in.	lb-ft
Bracket to plenum screw	19	–	14

Fuel Rail and Fuel Injectors

Fuel System Flow Diagram



- **a -** Fuel line with insulator
- **b -** Fuel line to fuel rail connection
- **c -** Fuel rail shrader valve cap
- **d -** Fuel line to Gen III Cool Fuel module connection
- **e -** Gen III Cool Fuel module
- **f -** Fuel inlet fitting
- **g -** Pressure regulator

Relieving Fuel System Pressure

⚠ CAUTION

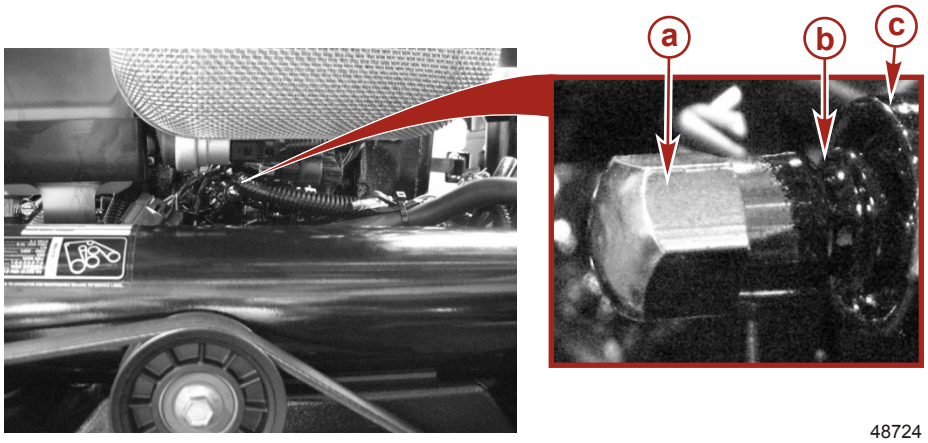
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

IMPORTANT: 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.

1. Shut off fuel supply.
2. Disconnect the negative (-) battery cable from the battery (usually black).
3. Disconnect the positive (+) battery cable from the battery (usually red).

   NOTE: *The schrader valve is accessible at the front of the engine under the flame arrestor.*
4. Relieve the fuel system pressure at the schrader valve:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the Schrader valve.

Fuel Pressure Gauge Kit	91-881833A03



48724

a - Cap
b - Schrader valve
c - Fuel rail

c. Place the fuel pressure gauge relief line into a suitable container.
d. Open the fuel pressure gauge relief valve to relieve pressure.

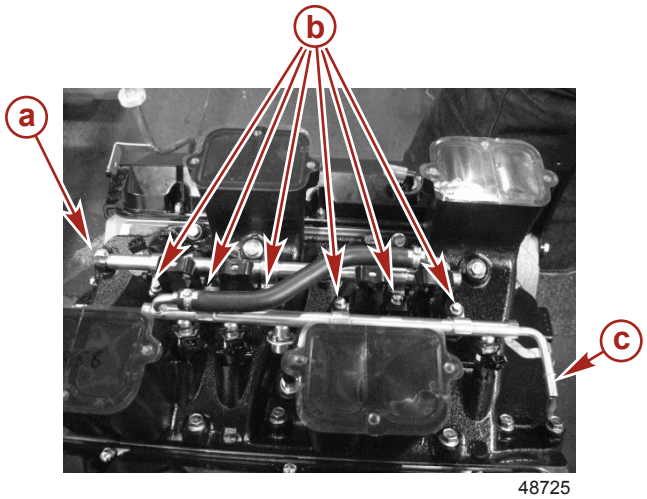
Fuel Rail

⚠ WARNING

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

Removal

1. Bleed the fuel pressure prior to disassembly of the fuel rail system, see Fuel Pressure Relief Procedure in this section.
2. Remove the plenum assembly.
3. Disconnect the electrical connector at each fuel injector.
4. Remove fuel inlet line from fuel rail fitting.
5. Remove the six fuel rail mounting screws.



48725

a - Schrader valve
b - Screw (6)
c - Inlet fuel line connection

6. Remove the port fuel rail by pulling evenly on the fuel rail to unseat all four of the injectors from the intake manifold.
7. Remove the starboard fuel rail by pulling evenly on the fuel rail to unseat all four of the injectors from the intake manifold and remove the fuel rail and injector assembly.

Cleaning and Inspection

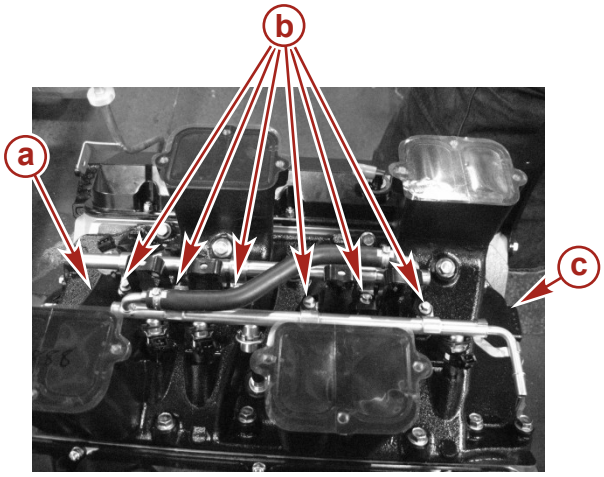
Replace the fuel rail if the injector seating area has pitting, nicks, burrs or irregularities.

Installation

NOTE: Before installing the fuel injectors, lubricate the new fuel injector o-rings with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector o-ring	92-858087K01

1. Install the fuel rail assembly onto the intake manifold.
2. Install the fuel rail mounting screws and tighten them to specification.



48765

a - intake manifold
b - Fuel rail mounting screw
c - Engine flywheel

Description	Nm	lb. in.	lb. ft.
Fuel rail mounting screw	11	96	–

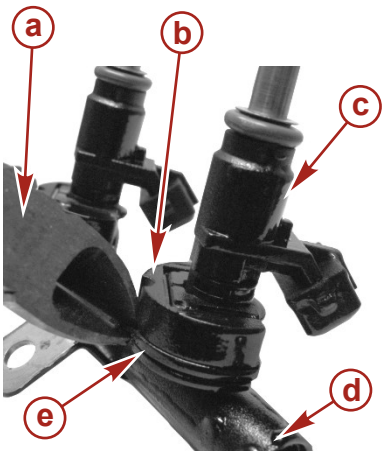
3. Connect and tighten securely the fuel inlet line to the elbow at the rear of the fuel rail.
4. Connect the electrical connectors to each fuel injector.
5. Install the plenum assembly.

Fuel Injector

Removal

IMPORTANT: Do not soak the fuel injector in any liquid cleaner or solvent.

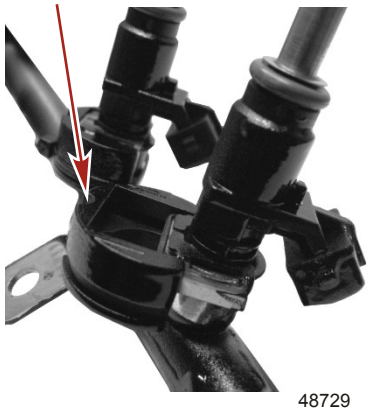
1. Remove the plenum and fuel rail as outlined in this section.
2. To remove the fuel injector housing.
   a. Cut the cable tie and remove it from the collar.



48728

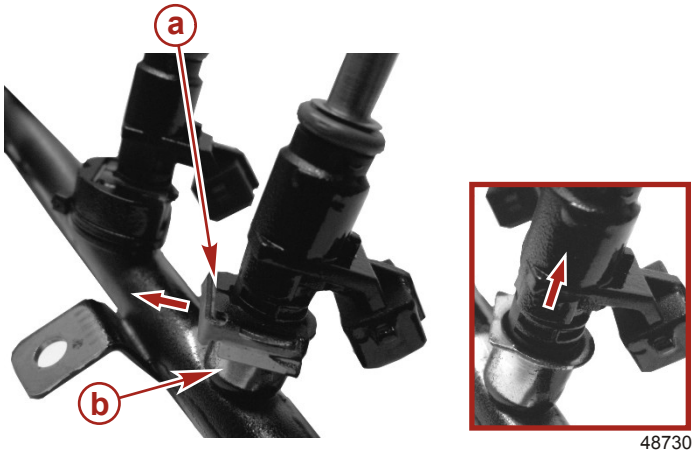
a - Tool
b - Collar
c - Fuel Injector housing
d - Fuel rail
e - Cable tie

b. Slide the collar off the assembly.



48729

c. Pull the retainer clip straight back to remove it from the groves in the injector housing.
d. Pull the injector straight up to remove it from the fuel rail housing.



48730

a - Retainer clip
b - Fuel rail housing

Installation

IMPORTANT: Always use genuine replacement parts. Other injectors may look identical but have different flow characteristics.

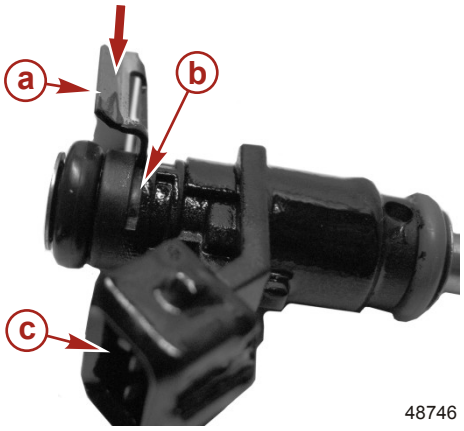
1. If replacing the O-rings, lubricate the O-rings and install on the fuel injector.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector O-rings	92-858087K01

2. To install the fuel injector to the fuel rail housing.
   a. Lightly lubricate the O-rings with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector O-rings	92-858087K01

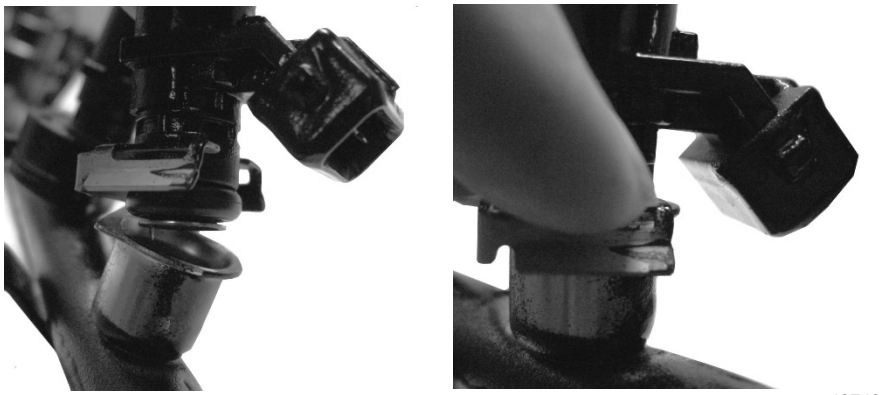
b. Place the retaining clip in the fuel injector grooves.



48746

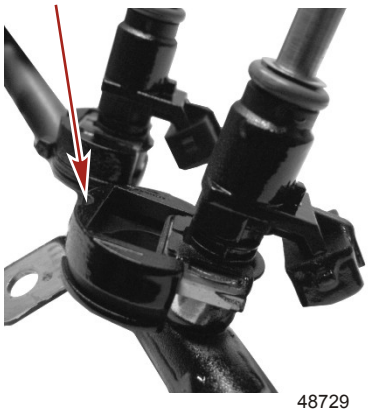
a - Retaining clip
b - Injector groves
c - Harness connector

c. Align the retaing clip and injector in the fuel rail housing and push the retaner clip down until it snapes in place on both sides of the retainer clip.



48749

d. Slide the collar over the retaining clip.



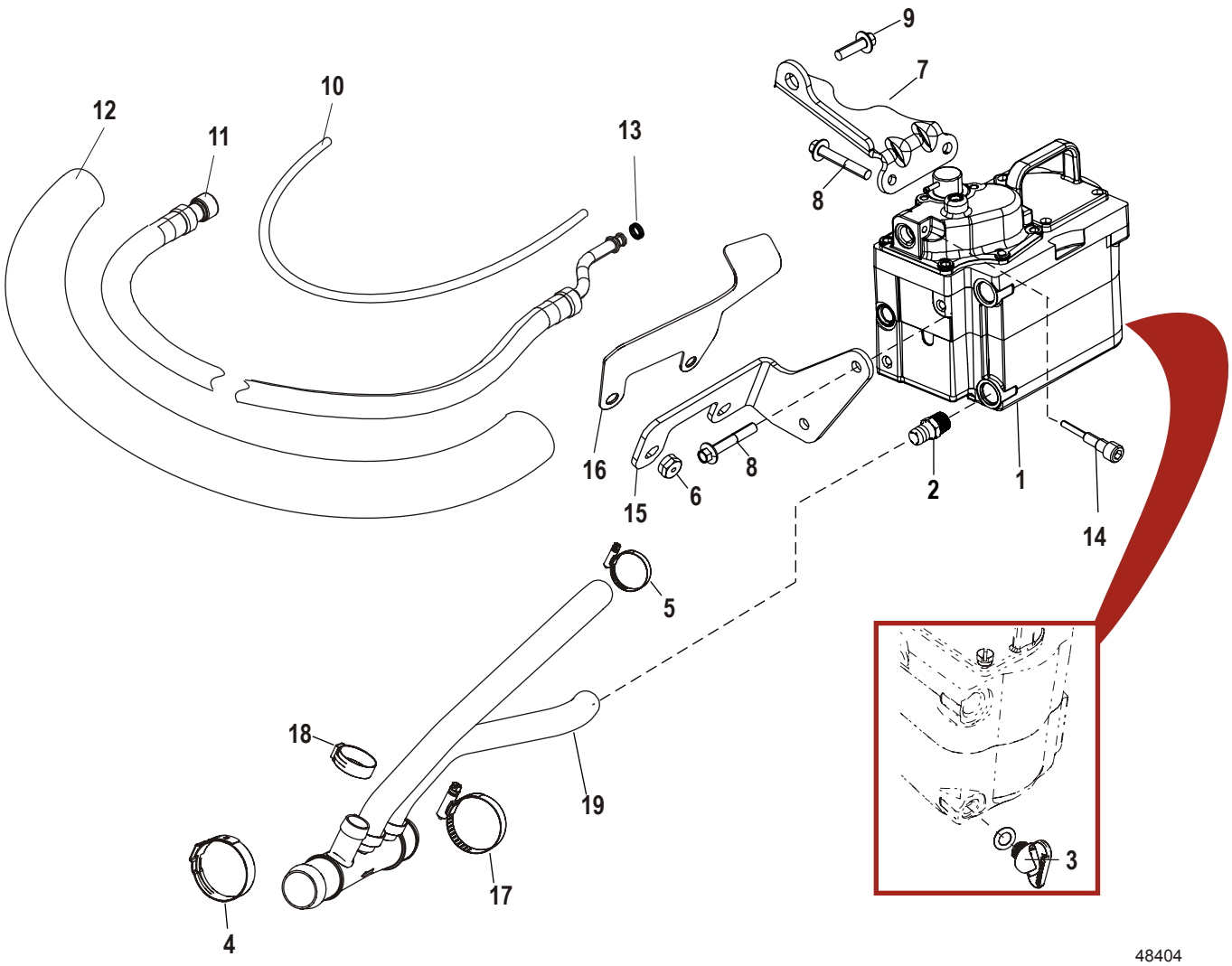
48729

e. Install a cable tie to secure the collar.

3. Install the fuel injectors, fuel rail, and plenum assembly.

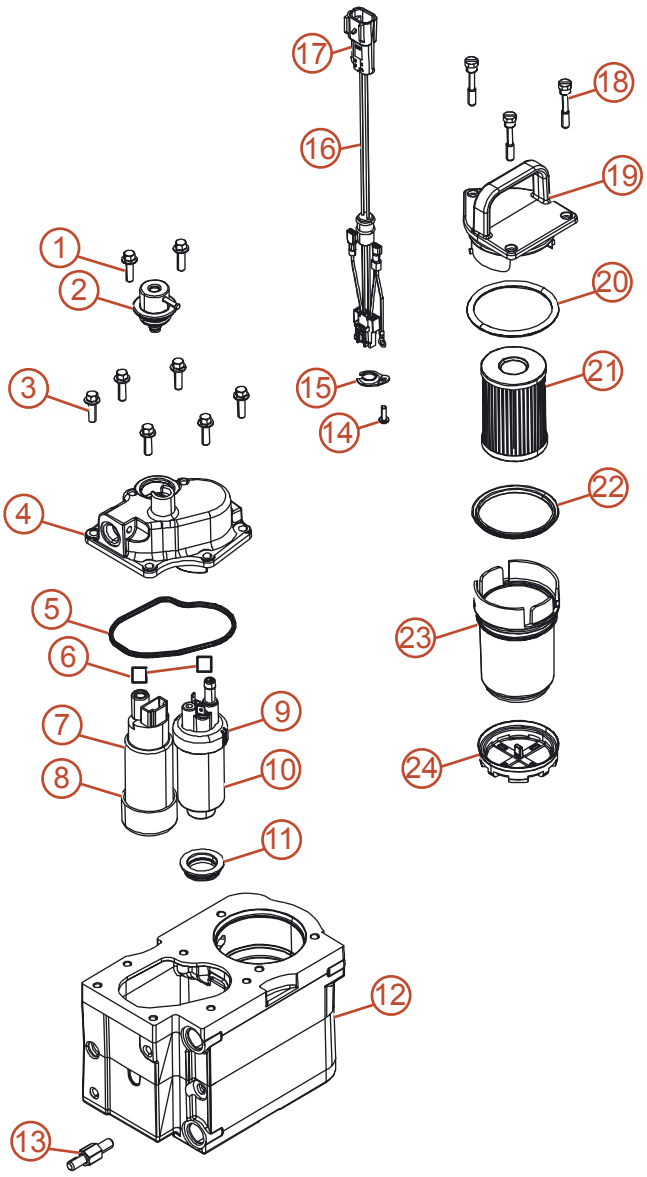
Gen III Cool Fuel

Gen III Cool Fuel System Exploded View



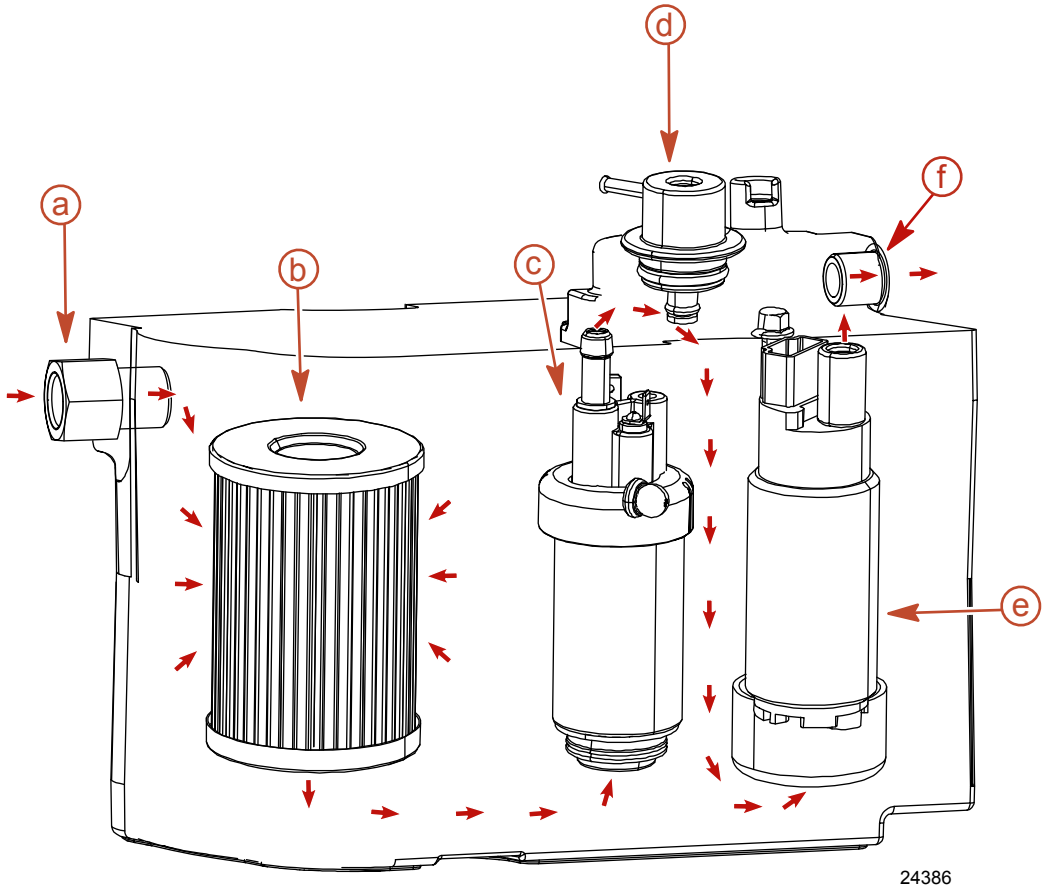
1 - Gen III Cool Fuel Module
2 - Fitting (2)
3 - Blue plug with O-ring
4 - Clamp
5 - Clamp
6 - Nut (2)
7 - Fuel module support bracket
8 - Screw (4)
9 - Screw
10 - Hose
11 - Fuel line (fuel module to fuel rail)
12 - Fuel line insulator sleeve
13 - Quad ring seal
14 - screw
15 - Bracket
16 - Shield (fuel line)
17 - Clamp
18 - Clamp
19 - Hose assembly (3-bib orifice meter)

Gen III Cool Fuel Module Exploded View



1 - Pressure regulator screws
2 - Pressure regulator
3 - Screws, top cover
4 - Top cover
5 - Seal, top cover
6 - Fuel pump outlet seal
7 - High-pressure fuel pump
8 - Isolator, high-pressure fuel pump
9 - Isolator, low-pressure fuel pump
10 - Low-pressure fuel pump
11 - Inlet seal, low-pressure fuel pump
12 - Cool Fuel Module housing
13 - Stud
14 - Screw, wire harness retainer
15 - Wire harness retainer
16 - Wire harness
17 - 2-pin electrical connector (plug)
18 - Screws, filter cap
19 - Filter cap
20 - O-ring
21 - Fuel filter
22 - Seal, filter cup
23 - Filter cup
24 - Filter disc

Gen III Cool Fuel Module Fuel Flow Diagram



a - Fuel inlet adapter fitting
b - Fuel filter element
c - Low-pressure fuel pump
d - Fuel pressure regulator
e - High-pressure fuel pump
f - Fuel outlet

Changing Water Separating Fuel Filter Element

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

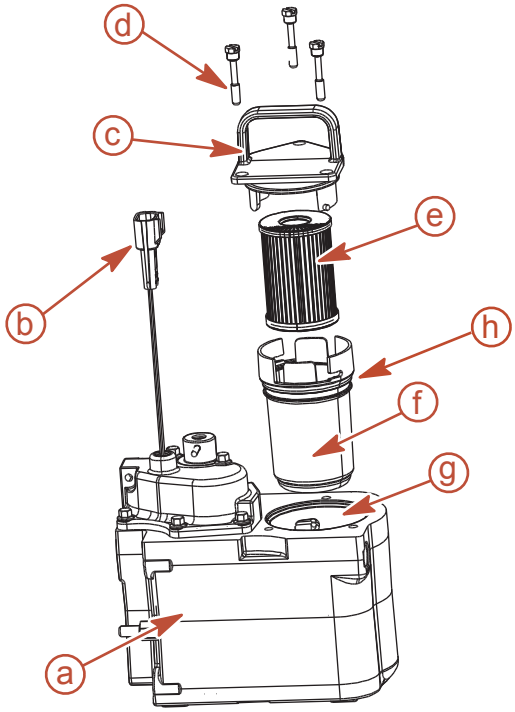
⚠ WARNING

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

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

   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to 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 5 seconds to relieve fuel system pressure.
5. Turn key switch to off position.

6. 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.
7. Loosen each filter assembly retaining screw until the screw is disengaged from the Cool Fuel Module. Do not remove the filter assembly retaining screws from the filter cap.



8837

a - Cool Fuel Module
b - Cool Fuel Module harness
c - Filter cap
d - Filter assembly retaining screw
e - Fuel filter element
f - Filter cup
g - Cool Fuel Module filter reservoir
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 in a clockwise direction 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 that may be 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 new O-ring on the filter cup.
14. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction 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.
17. Open fuel supply valve, if equipped.

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

18. Reconnect the Cool Fuel Module harness to the engine wiring harness.
19. Supply cooling water to the engine.
20. Properly ventilate the engine compartment.

⚠ WARNING

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

21. Run the engine and check for any leaks. Stop the engine immediately if any leak exists, and correct before continuing.

Fuel Line

Removing the Fuel Line

⚠ WARNING

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

⚠ WARNING

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

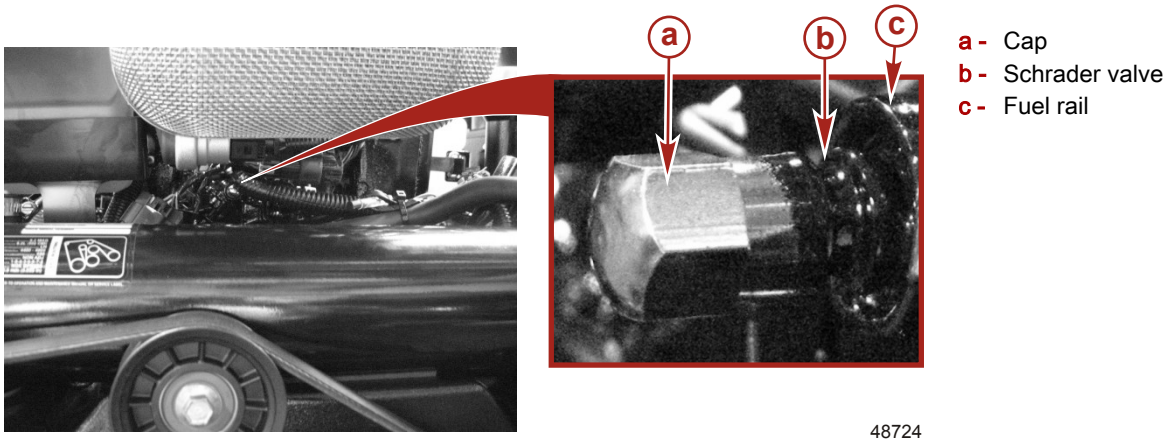
⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

IMPORTANT: 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.
IMPORTANT: Allow the engine to cool for at least 12 hours before removing the fuel line.

1. Shut off the fuel supply.
2. Disconnect the negative (-) battery cable from the battery (usually black).
3. Disconnect the positive (+) battery cable from the battery (usually red).
4. Place a shop towel or other suitable material under the fuel line fittings and connections to catch any fuel drips.
   NOTE: *The schrader valve is accessible at the front of the engine under the flame arrestor.*
5. Relieve the fuel system pressure:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the schrader valve.

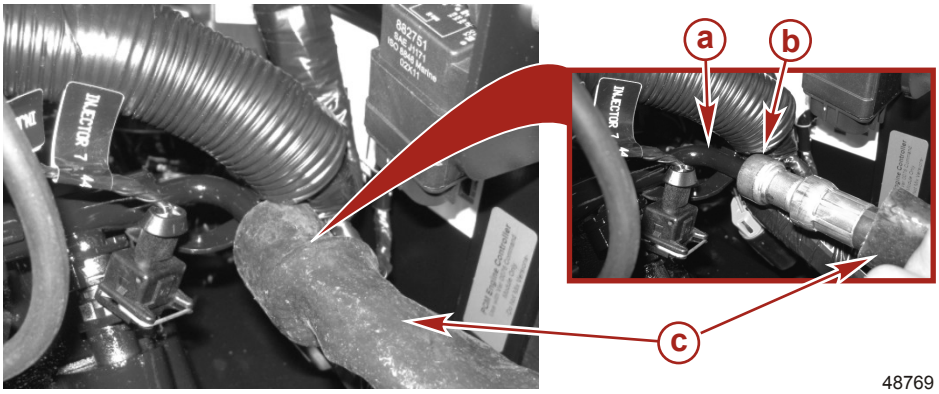
Fuel pressure gauge kit	**91-881883A2**



a - Cap
b - Schrader valve
c - Fuel rail

   c. Place the fuel pressure gauge relief line into an approved container.
   d. Open the fuel pressure gauge relief valve to relieve pressure.
6. Disconnect the fuel line from the fuel rail fitting:

a. Pull the heat-resistant sleeve back to expose the connection.

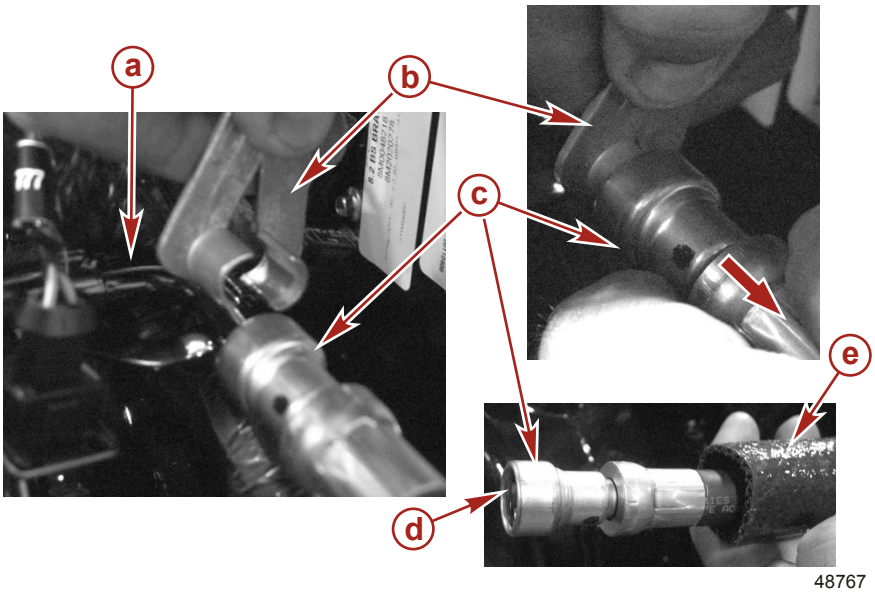


a - Fuel rail
b - Fuel line fitting
c - Heat-resistant sleeve

b. Position the fuel line disconnect tool at the fuel rail fuel line connection.

c. Squeeze the tool and push it into the fuel line fitting to release the quick connect and pull the fuel line straight backward to remove it from the fuel rail.

d. Drain any fuel remaining in the fuel line into a suitable container.

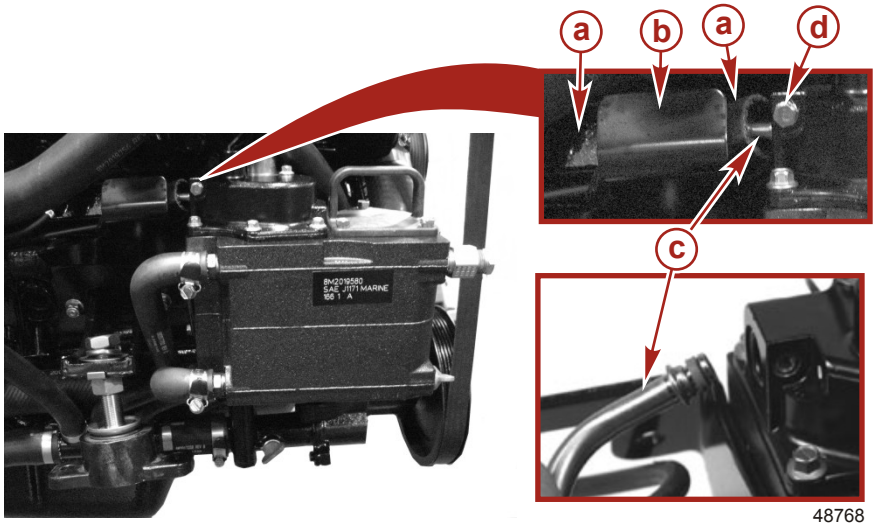


a - Fuel rail
b - Fuel line disconnect tool
c - Fuel line
d - Quick connect fitting
e - Heat-resistant sleeve

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

7. Disconnect the fuel line from the Gen III Cool Fuel Module:
   a. Remove the fuel line retainer screw.

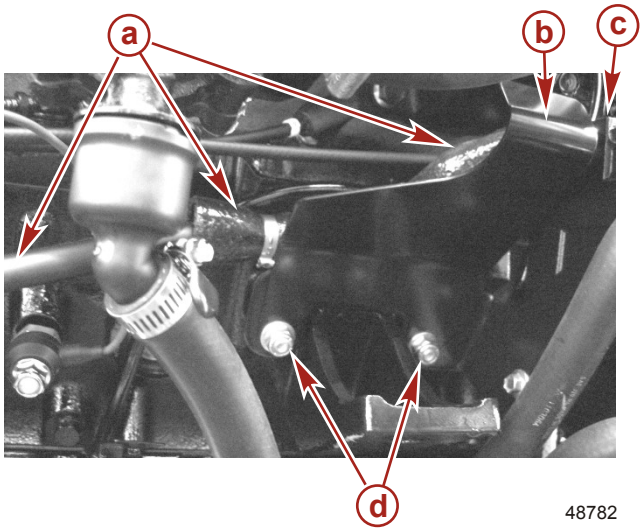
b. Carefully pull the fuel line straight out from the module and plug the line.



48768

a - Heat-resistant sleeve
b - Shield
c - Fuel line
d - Fuel line retainer screw

c. Remove the nuts at the engine mount and remove the shield.



48782

a - Fuel line
b - Shield
c - Fuel module
d - Nut

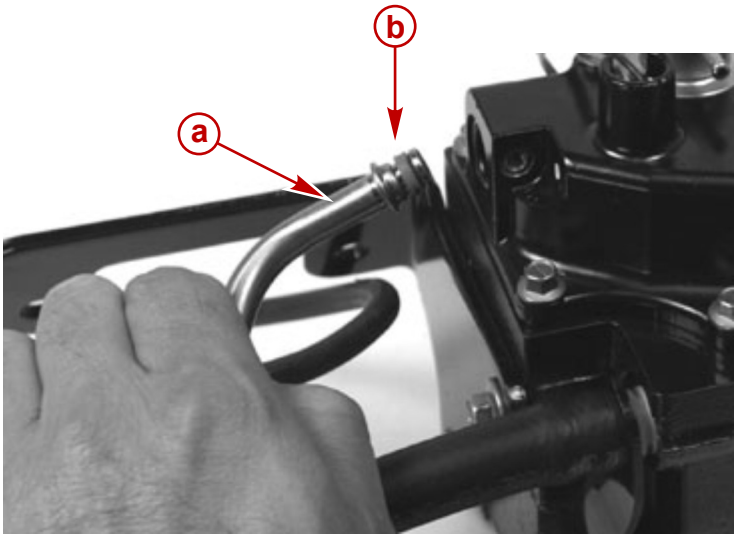
d. Following the fuel line and remove J-clips as necessary to remove the fuel line from the engine. Retain fasteners, note the routing, and clamp positions for installing the fuel line.

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.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel line O-ring	92-858087K01

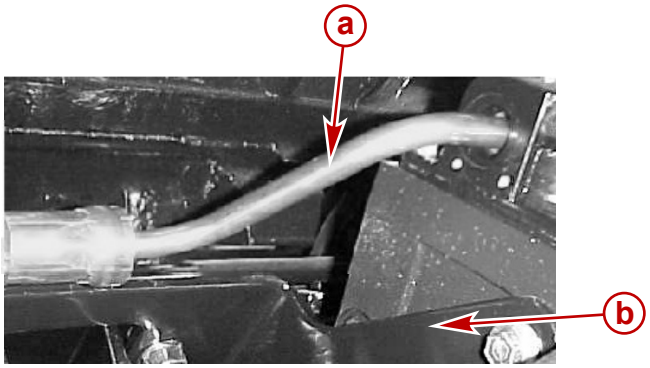
3. Install the O-ring on the fuel line connector as shown.



24580

a - Fuel outlet line
b - O-ring

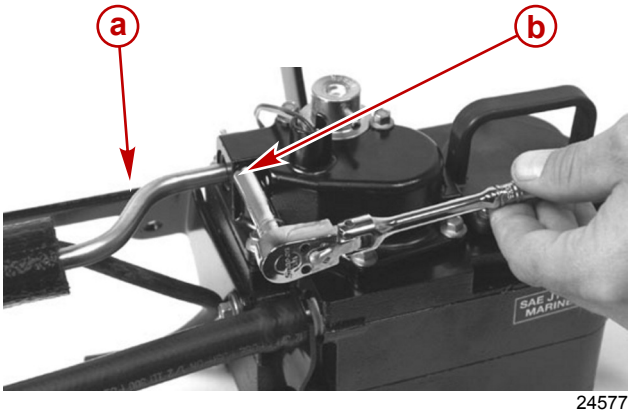
4. Carefully insert the fuel line into the Gen III Cool Fuel Module.
5. Rotate the fuel line toward the engine block as shown in the following photograph.



24390

Heat-resistant sleeve removed for visual clarity
a - Fuel line
b - Bracket

6. Install the fuel line retainer screw.
7. Tighten the screw to specification.



24577

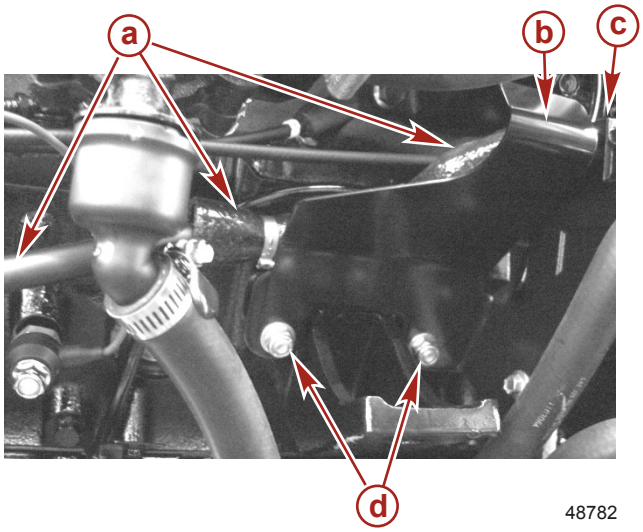
a - Fuel line
b - Screw

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.

8. Pull the heat-resistant sleeve over the fuel line to within 6 mm (1/4 in.) of the Gen III Cool Fuel Module.

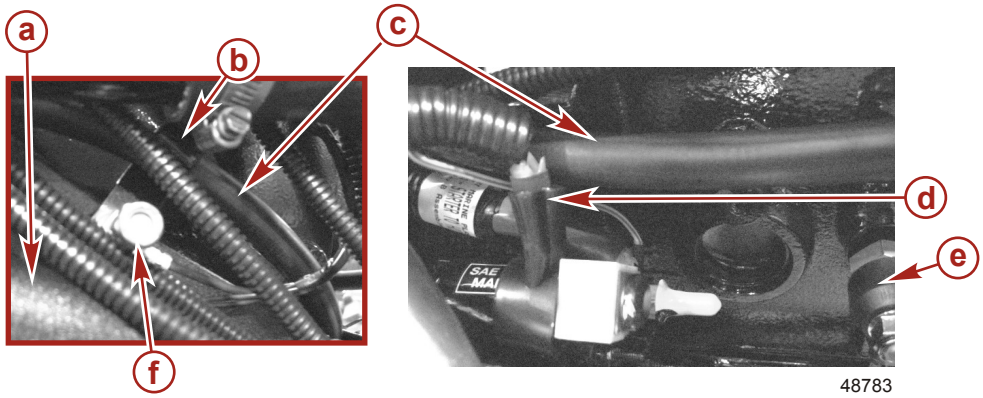
9. Install the shield to the engine mount. Ensure the heat-resistant sleeve and fuel line are properly positioned and line is not pinched when the nuts are tightened.
10. Tighten the nuts to specification.



a - Fuel line
b - Shield
c - Fuel module
d - Nut

Description	Nm	lb-in.	lb-ft
Sheild to engine mount nut	37	–	27

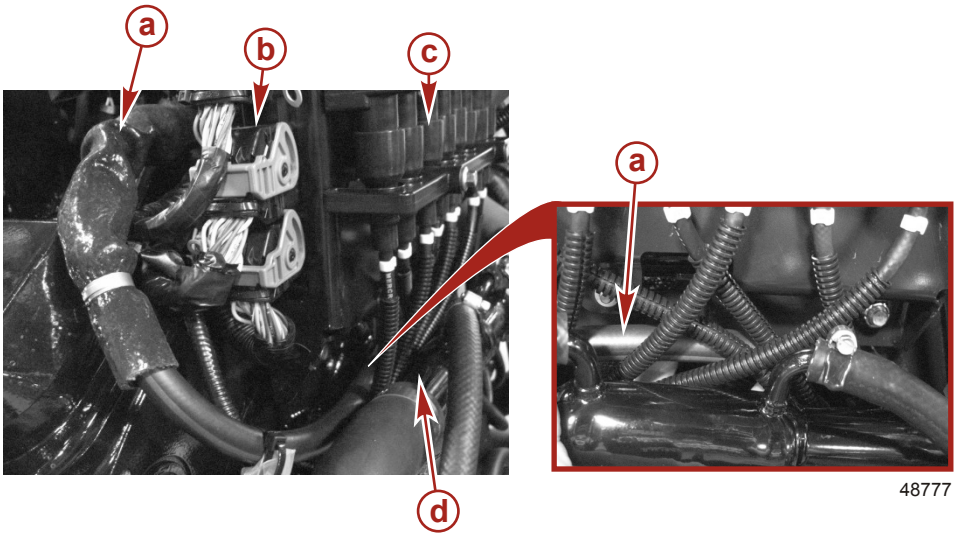
11. Route the fuel line along the block toward the top of the flywheel housing cover.
12. Secure the fuel line with the J-clip on the flywheel housing cover.



a - Flywheel housing cover
b - Jay clip
c - Fuel line
d - Hot stud wire on starter
e - Knock sensor
f - Nut

Description	Nm	lb. in.	lb. ft.
J-clip nut	48	–	36

13. Slide the fuel line behind the harness leads between the oil cooler and the coil pack then up to the fuel rail.

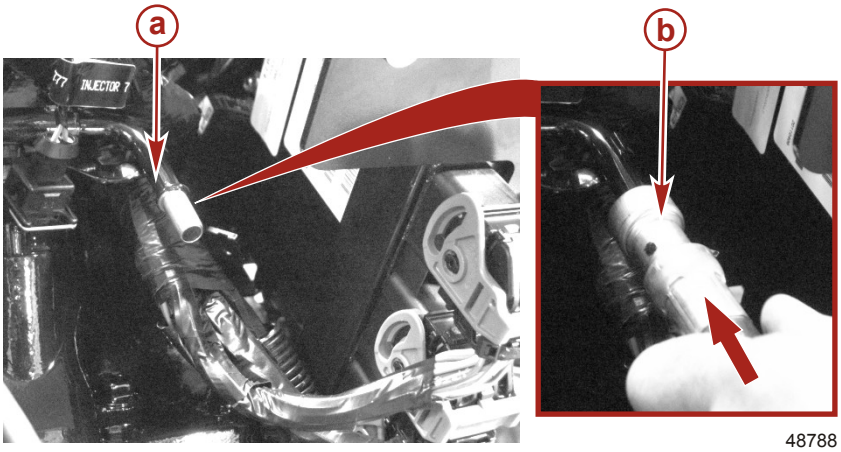


48777

a - Fuel line
b - ECM harness connectors
c - Coil pack
d - Oil cooler

Connecting the Fuel Line to the Fuel Rail

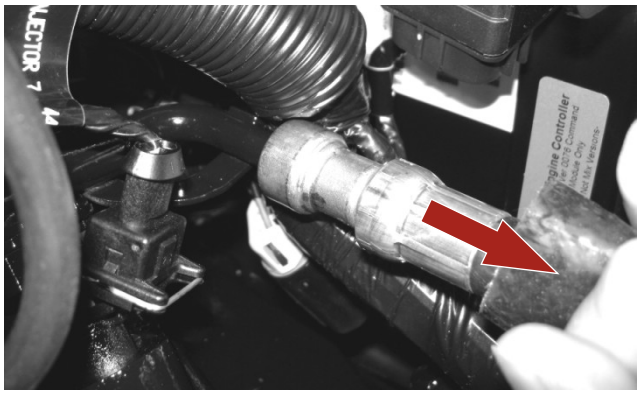
1. Ensure the fuel line is routed under the electrical harnessing and has no restrictions, compressions, or contact with sharp edges.
2. Push the fuel line fitting onto the fuel rail. Listen for a snap.



48788

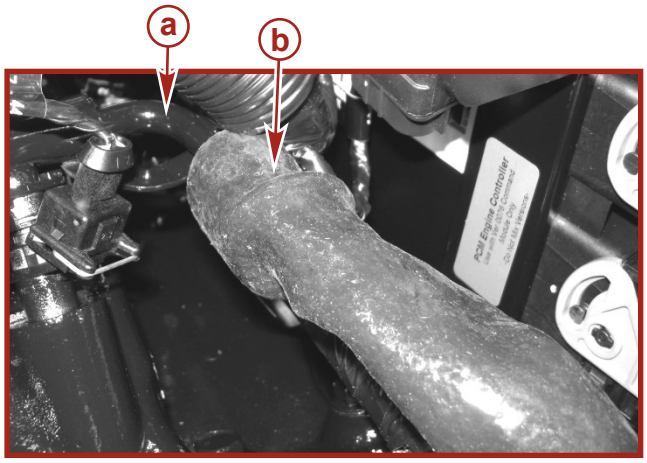
a - Fuel rail
b - Fuel line fitting

3. Test that the fuel line is properly seated by tugging firmly on the line.



48789

4. Pull the heat-resistant sleeve over the connection.



48790

a - Fuel rail
b - Heat-resistant sleeve

5. Ventilate the engine compartment.
6. Connect the positive (+) battery cable to the battery (usually red).
7. Connect the negative (-) battery cable to the battery (usually black).
8. 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.

Gen III Cool Fuel Module Removal

⚠ WARNING

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

⚠ WARNING

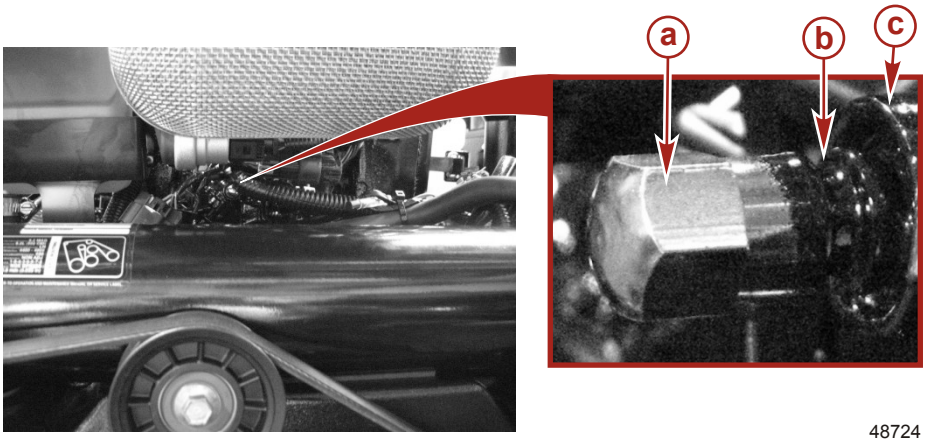
Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

1. Close the fuel supply valve (if equipped).
2. Close the seacock.
3. Disconnect the negative (-) battery cable from battery (usually black).
4. Disconnect the positive (+) battery cable from battery (usually red).
5. Relieve the fuel system pressure:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the schrader valve.

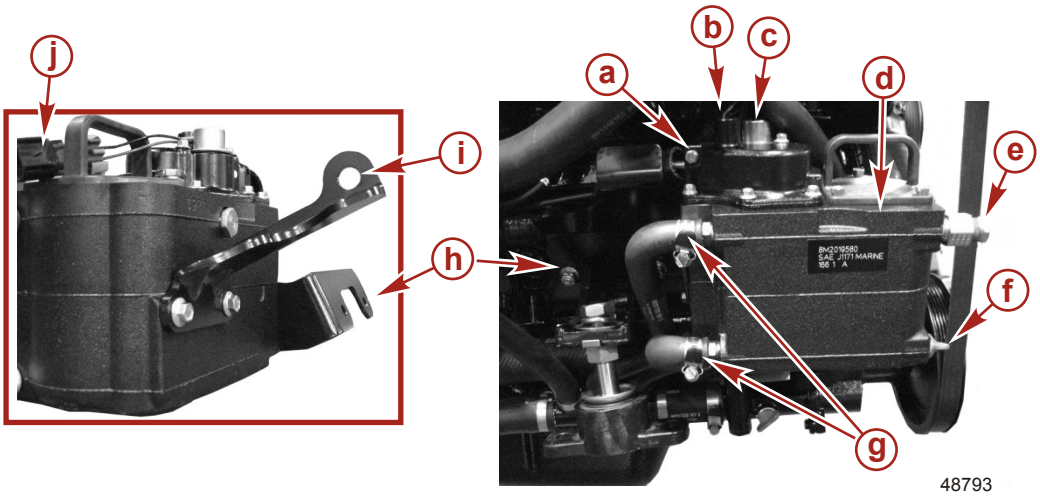
Fuel pressure gauge kit	91-881883A2



a - Cap
b - Schrader valve
c - Fuel rail

c. Place the fuel pressure gauge relief line into an approved container.
d. Open the fuel pressure gauge relief valve to relieve pressure.

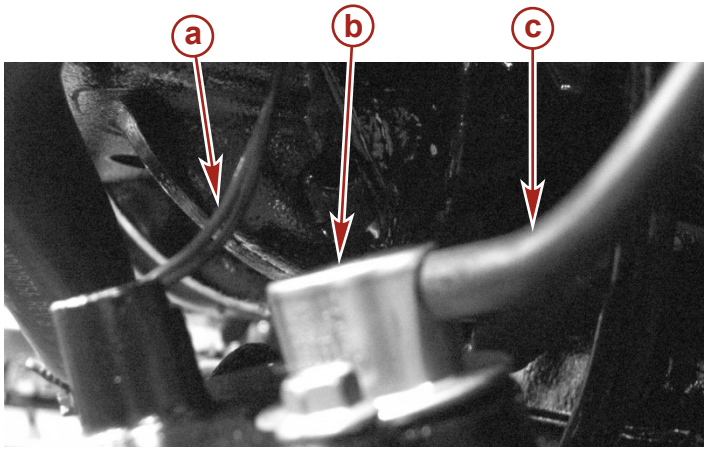
6. Locate the Gen III Cool Fuel Module.



a - Fuel outlet line retainer screw
b - Harness connector wires
c - Fuel pressure regulator
d - Gen III Cool Fuel Module
e - Fuel supply (inlet) fitting
f - Drain plug
g - Cooling hose
h - Mounting bracket to engine mount
i - Mounting bracket to front engine block
j - Harness connector

7. Disconnect the Gen III Cool Fuel Module 2-pin harness connector.

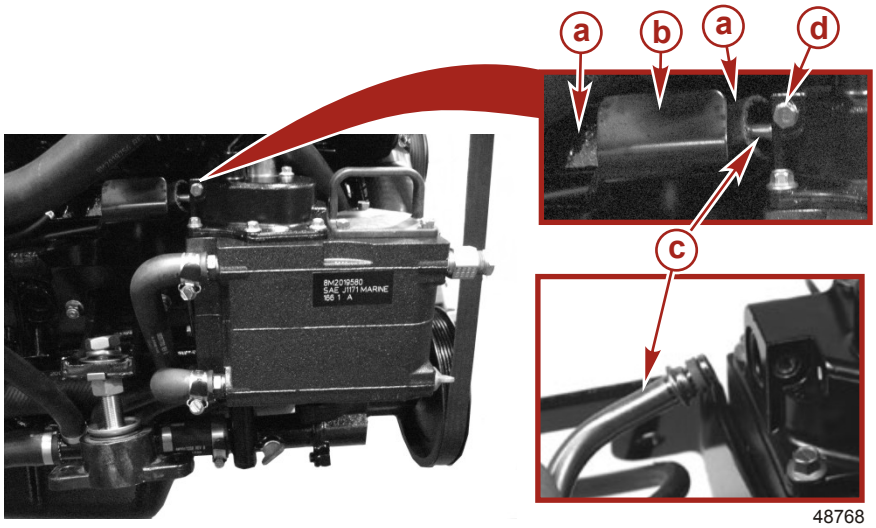
8. Remove the vacuum hose at the fuel pressure regulator on the Gen III Cool Fuel Module.



48799

a - Harness connector wires
b - Fuel pressure regulator
c - Vacuum hose

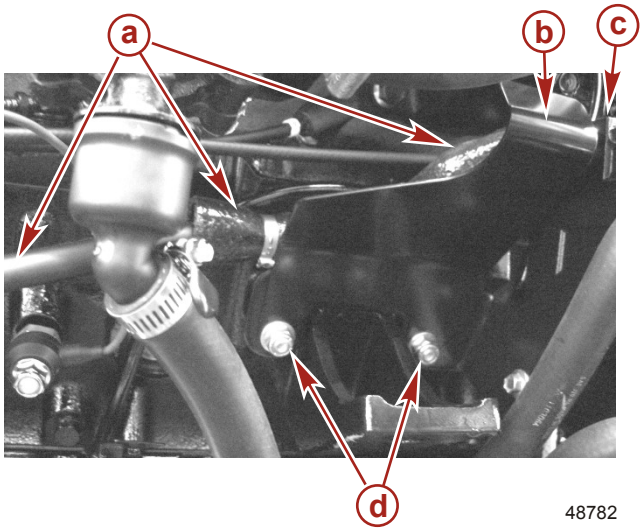
9. Disconnect the fuel supply (inlet) hose and plug the hose.
10. Disconnect the fuel line from the Gen III Cool Fuel Module:
    a. Remove the fuel line retainer screw.
    b. Carefully pull the fuel line straight out from the module and plug the line.



48768

a - Heat-resistant sleeve
b - Shield
c - Fuel line
d - Fuel line retainer screw

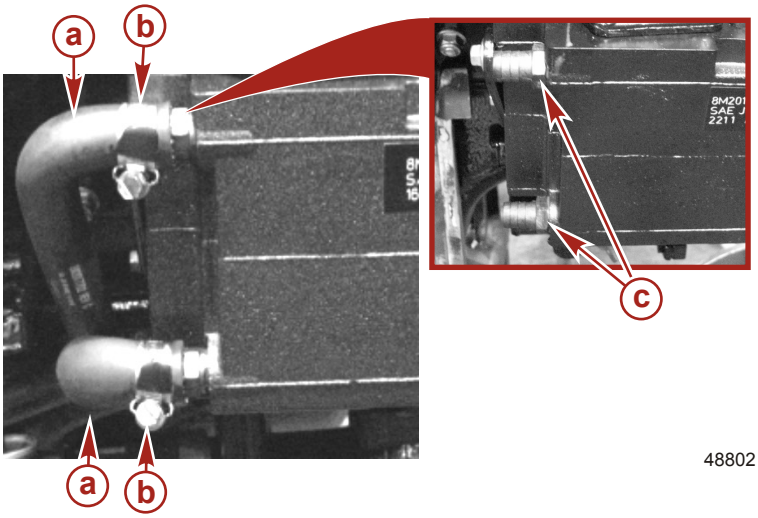
    c. Remove the nuts at the engine mount and remove the fuel line shield.



48782

a - Fuel line
b - Fuel line shield
c - Fuel module
d - Nut

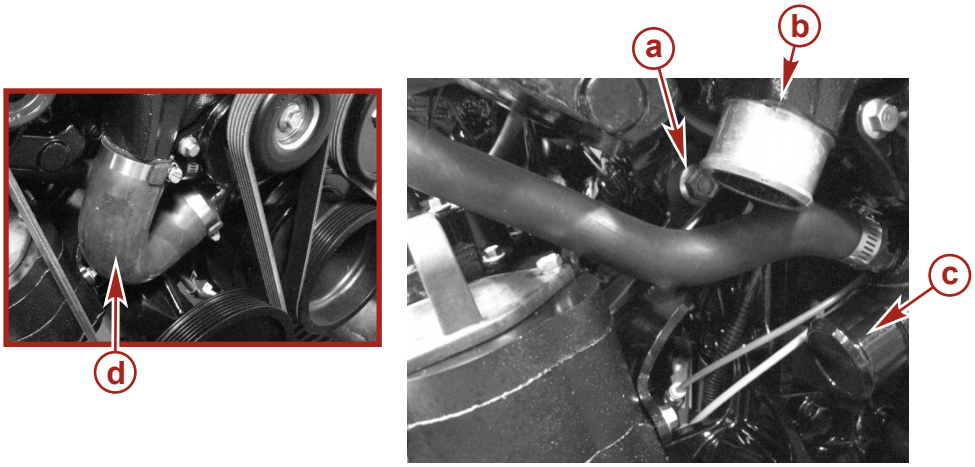
11. Loosen the hose clamps and remove the cooling hoses from the Gen III Cool Fuel Module.



a - Cooling hoses
b - Hose clamp
c - Hose fitting

48802

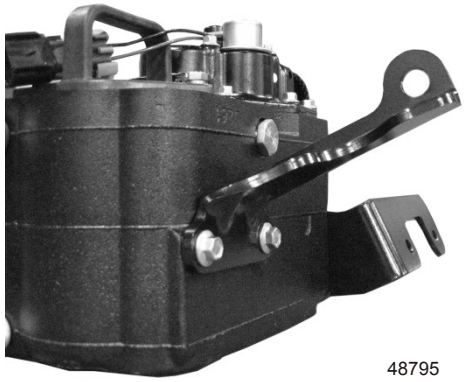
12. Remove the front bracket mounting screw from the front of the engine block. If this is not possible, drain the water from the engine and remove the coolant hose to gain access to the screw.



a - Screw
b - Crossover hose fitting
c - Engine circulation pump hose fitting
d - Coolant hose

48794

13. Carefully remove the Gen III Cool Fuel Module with its mounting brackets from engine.



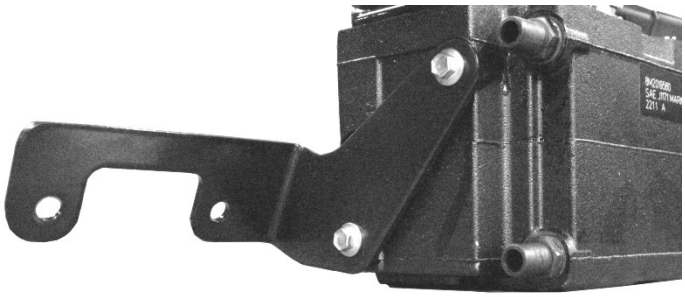
48795

Gen III Cool Fuel Module Disassembly

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

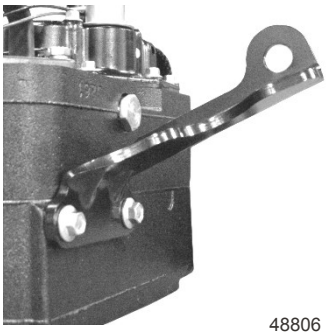
1. Remove the Gen III Cool Fuel Module from engine. Refer to **Gen III Cool Fuel Module Removal**.

2. Remove the primary mounting bracket from the Gen III Cool Fuel Module.



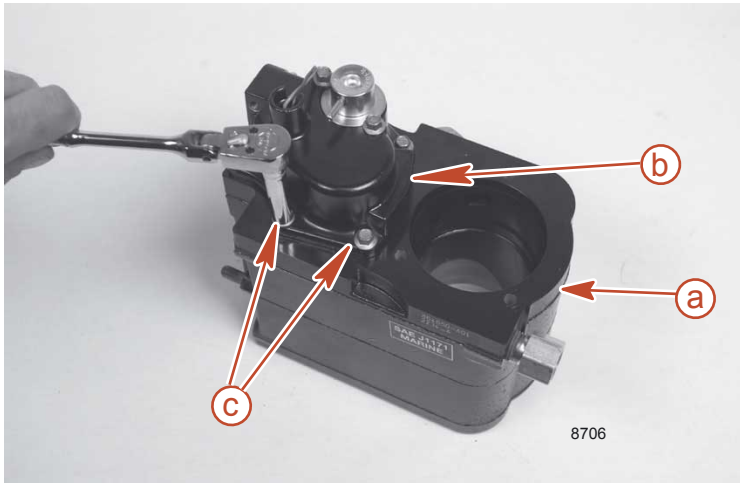
Primary Bracket

3. Remove the support bracket from the Gen III Cool Fuel Module.



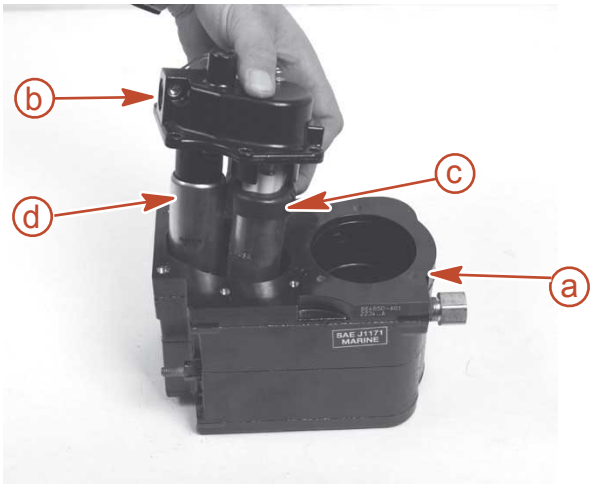
Support Bracket

4. Remove the filter assembly. Refer to **Changing Water Separating Fuel Filter Element**.
5. Remove the six screws holding top cover.



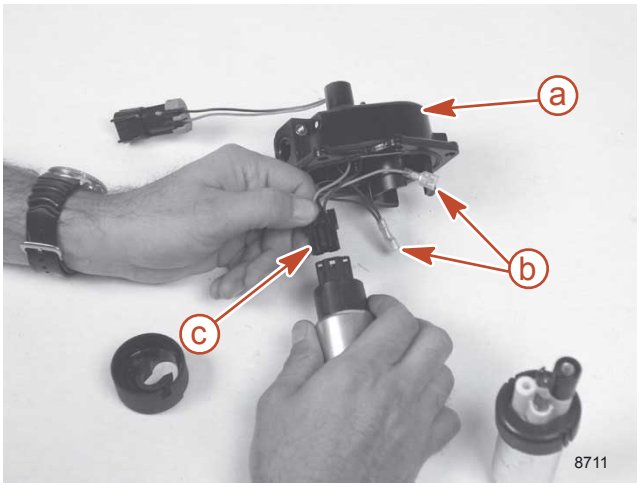
a - Gen III Cool Fuel Module
b - Top cover
c - Top cover screws (not all shown)

6. Pull top cover straight up.



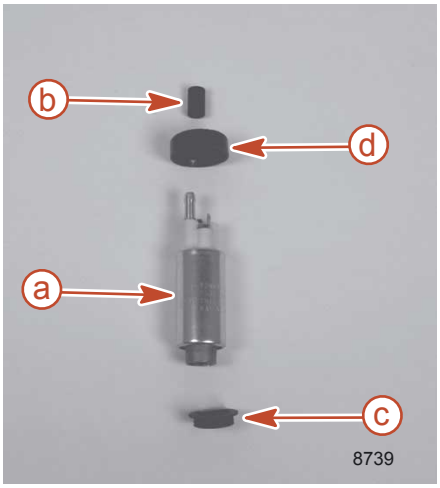
a - Gen III Cool Fuel Module
b - Top cover
c - Low-pressure fuel pump
d - High-pressure fuel pump

7. Disconnect electrical connections from the low-pressure and high-pressure pumps and remove the pumps from the top cover.

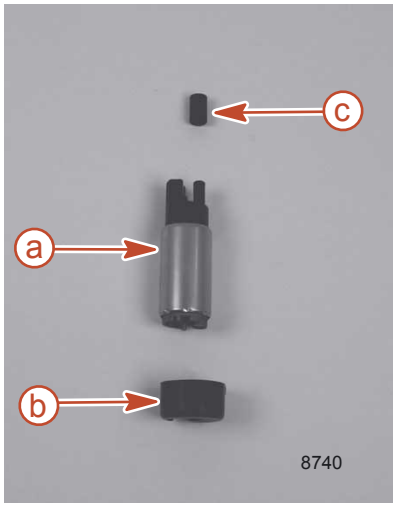


a - Top cover
b - Low-pressure fuel pump electrical connections
c - High-pressure fuel pump electrical connector

8. Remove seals and isolators from fuel pumps.



Low-pressure Fuel Pump
a - Low-pressure fuel pump
b - Outlet seal
c - Inlet seal
d - Isolator



High-pressure Fuel Pump

a - High-pressure fuel pump
b - Isolator
c - Outlet seal

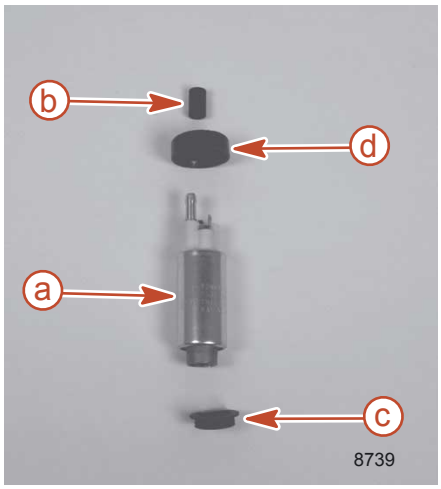
NOTE: *Fuel inlet seal for low-pressure pump may not come out with the pump when pump is removed from the Gen III Cool Fuel Module housing. Be sure to remove the seal from the housing before low-pressure fuel pump installation.*

9. Drain fuel from Gen III Cool Fuel Module into an approved container.

Gen III Cool Fuel Module Assembly

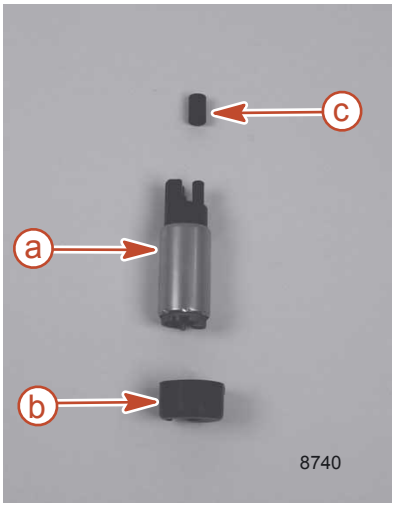
Top Cover and Fuel Pumps

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 Gen III 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

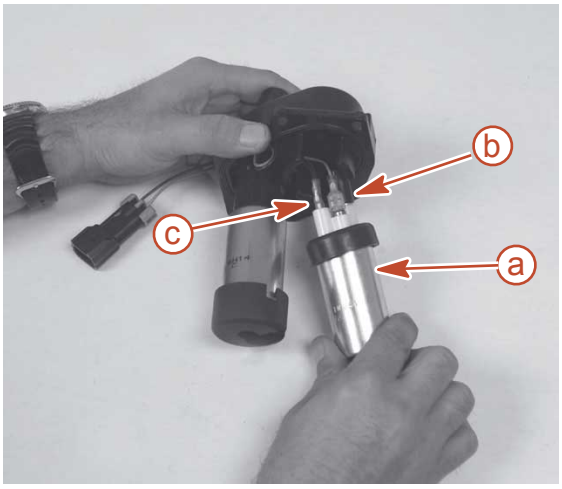
a - Low-pressure fuel pump
b - Outlet Seal
c - Inlet seal
d - Isolator



High-pressure fuel pump (low-pressure fuel pump removed for visual clarity)

- **a -** High-pressure fuel pump
- **b -** Isolator
- **c -** Outlet seal

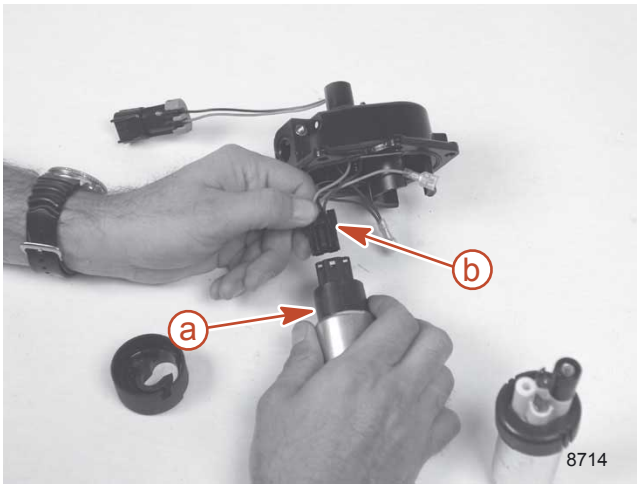
3. Connect the electrical connectors to the low-pressure pump. Red wire to positive terminal. Black wire to negative terminal. The fuel pump is marked (+) positive and (-) negative on the top of the pump. Spade connection sizes are matched to the appropriate connection as well.



Low-pressure fuel pump

- **a -** Low-pressure fuel pump
- **b -** Positive (+) electrical connection
- **c -** Negative (-) electrical connection

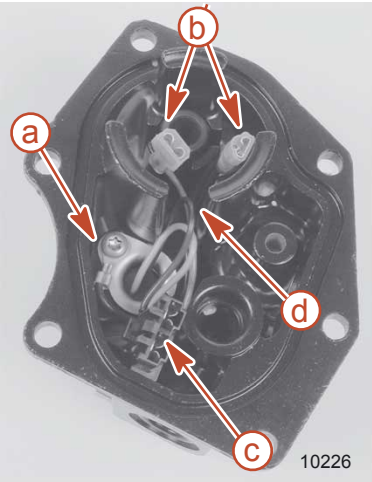
4. Connect the electrical connector to the high-pressure fuel pump.



High-pressure fuel pump (low-pressure pump disconnected for clarity)

- **a -** High-pressure fuel pump
- **b -** Electrical connector

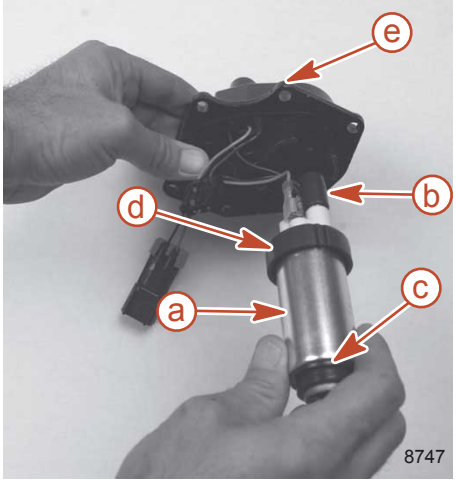
5. Route the wires as shown. Ensure that the ground wire terminal at the harness end is positioned against the outer wall of the casing. Low-pressure pump wiring must be routed through the slot and above the fuel pump. High-pressure pump wiring must also be routed above the fuel pump. Ensure that the wiring is not bound or pinched.



Fuel pumps not shown for visual clarity

- **a -** Ground wire terminal
- **b -** Low-pressure pump electrical connectors
- **c -** High-pressure pump electrical connector
- **d -** Slot (low-pressure pump wire routing)

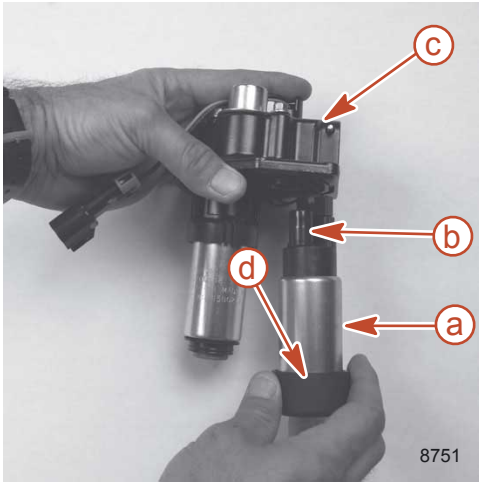
6. Insert the low-pressure pump into the top cover.



Low-pressure fuel pump installation

- **a -** Low-pressure fuel pump
- **b -** Outlet seal
- **c -** Inlet seal
- **d -** Isolator
- **e -** Top cover

7. Insert the high-pressure pump into the top cover.

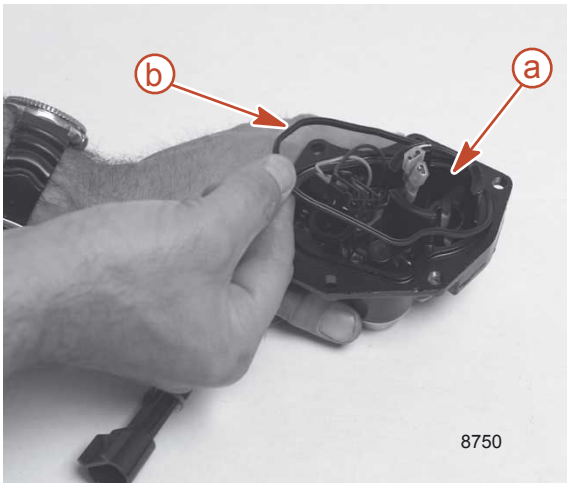


High-pressure fuel pump installation

- **a -** High-pressure fuel pump
- **b -** Outlet seal
- **c -** Top cover
- **d -** Isolator

8. Verify that the top cover seal is not damaged. Replace if necessary.

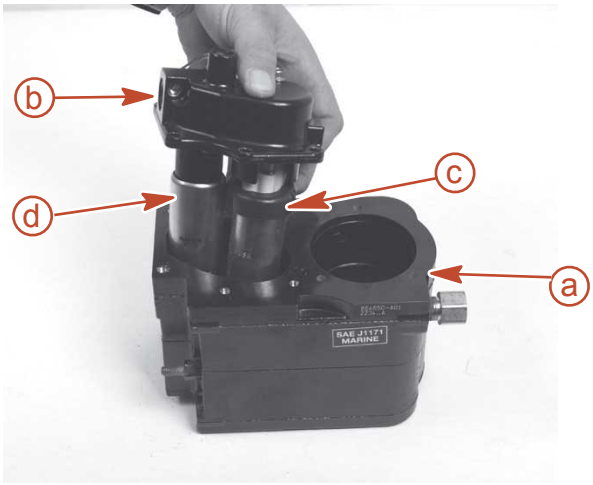
9. Place the top cover seal into the groove in the top cover.



Fuel pumps not shown for visual clarity

a - Gen III Cool Fuel Module top cover
b - Top cover seal

10. ***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 Gen III Cool Fuel Module housing.



a - Gen III Cool Fuel Module housing
b - Top cover
c - low-pressure pump
d - High-pressure pump

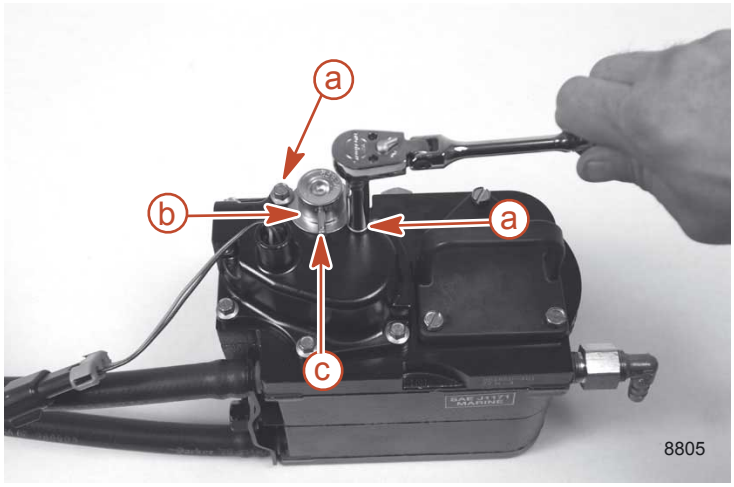
11. Install the top cover screws and hand-tighten.
12. Verify that the top cover is not bound and pull the cover gently into place with the top cover screws.
IMPORTANT: Be sure to tighten the top cover screws evenly when pulling the top cover down into place.
13. Torque top cover screws.

Description	Nm	lb. in.	lb. ft.
Top cover screws	14	124	–

14. Instal the filter assembly. Refer to **Changing Water Separating Fuel Filter Element**.

Fuel Pressure Regulator

1. Insert the fuel pressure regulator into the top cover with the hose barb facing the outboard side of the Gen III Cool Fuel Module.



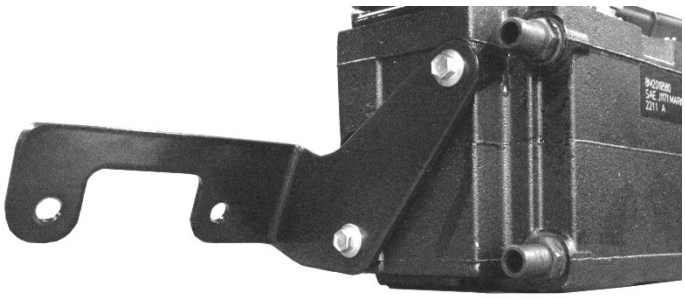
a - Fuel pressure regulator screws (2)
b - Fuel pressure regulator
c - Fuel pressure regulator vacuum hose barb

2. Install the (2) pressure regulator screws and torque to specification.

Description	Nm	lb. in.	lb. ft.
Pressure regulator screws	14	124	–

Mounting Brackets

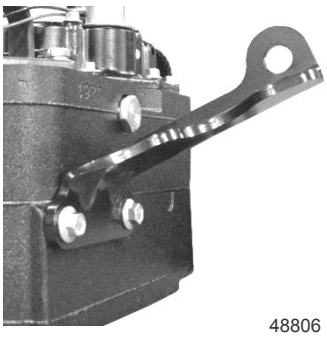
1. Install the primary mounting bracket to the Gen III Cool Fuel Module using the screws removed previously.
2. Tighten the screws to specification.



Primary bracket

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module primary bracket screws	23	–	17

3. Install the support mounting bracket to the Gen III Cool Fuel Module using the screws removed previously.
4. Tighten the screws to specification.

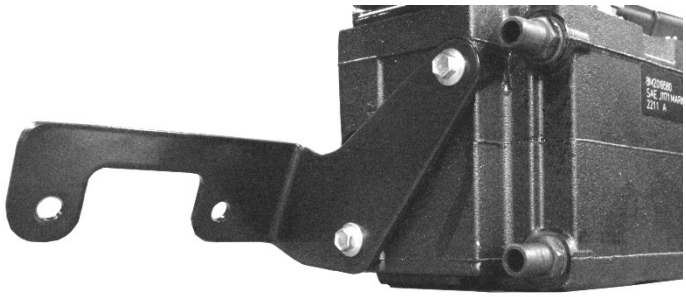


Support bracket

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module support bracket screws	23	–	17

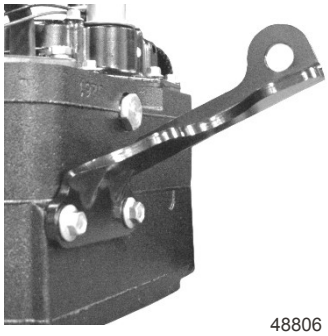
Gen III Cool Fuel Module Installation

1. Slide the Gen III Cool Fuel Module primary bracket over the studs on the engine mount.



Primary bracket

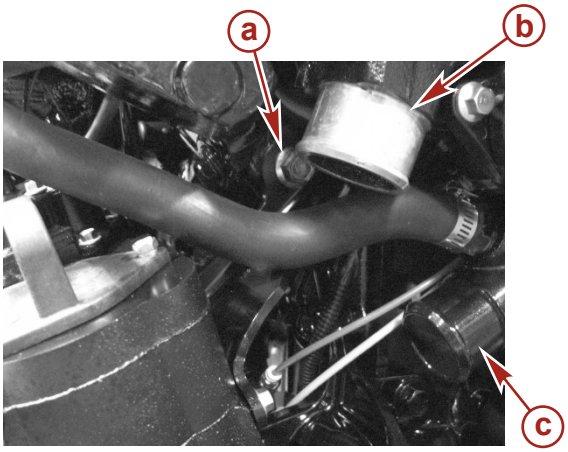
2. Install the mounting screw in the support bracket and into the front engine block.



48806

Support bracket

3. Tighten the screw to specification.



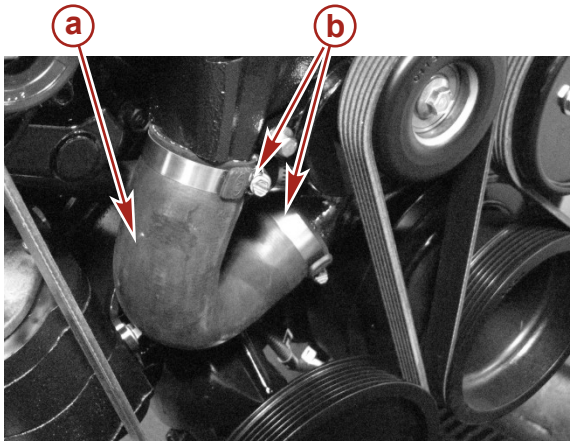
48800

a - Screw
b - Crossover hose fitting
c - Engine circulation pump hose fitting

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module support bracket screw	66	–	49

4. If removed, install the coolant hose and secure with hose clamps.

5. Tighten the hose clamps to specification.

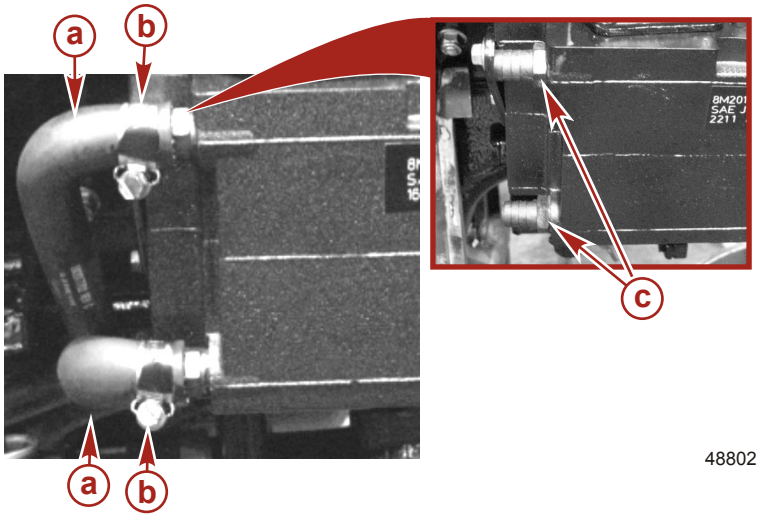


48801

a - Coolant hose
b - Hose clamps

Description	Nm	lb-in.	lb-ft
Hose clamp	3	26	–

6. Route the cooling hoses behind the engine mount and push the hose ends onto the hose fittings on the Gen III Cool Fuel Module.
7. Tighten the hose clamps to specification.



48802

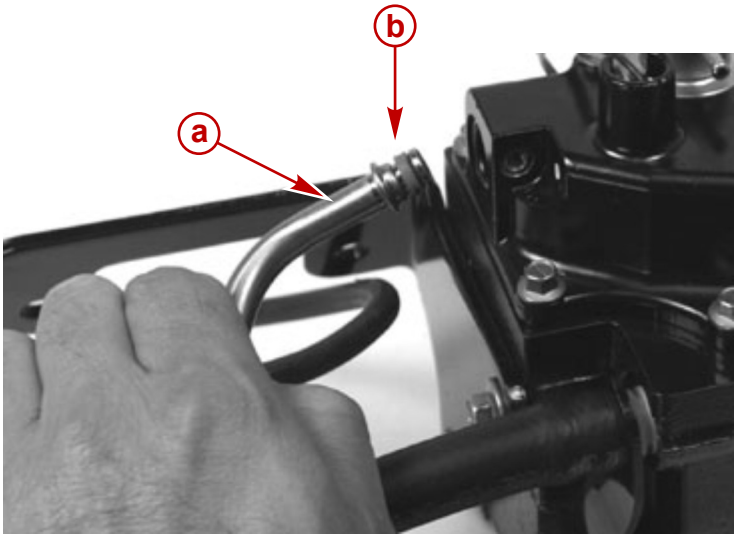
a - Cooling hoses
b - Hose clamp
c - Hose fitting

Description	Nm	lb-in.	lb-ft
Hose clamp	3	26	–

8. Install the fuel line as follows.
   a. Inspect the fuel line O-ring. Replace if damaged.
   b. Apply a thin layer of oil to the O-ring.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel line O-ring	92-858087K01

c. Install the O-ring on the fuel line connector as shown.

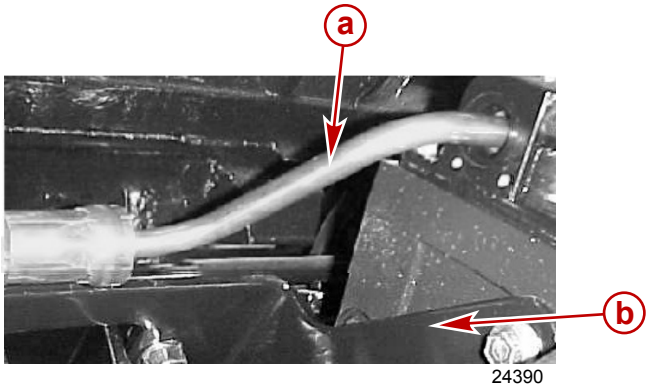


24580

a - Fuel outlet line
b - O-ring

d. Carefully insert the fuel line into the Gen III Cool Fuel Module.

e. Rotate the fuel line toward the engine block as shown in the following photograph.

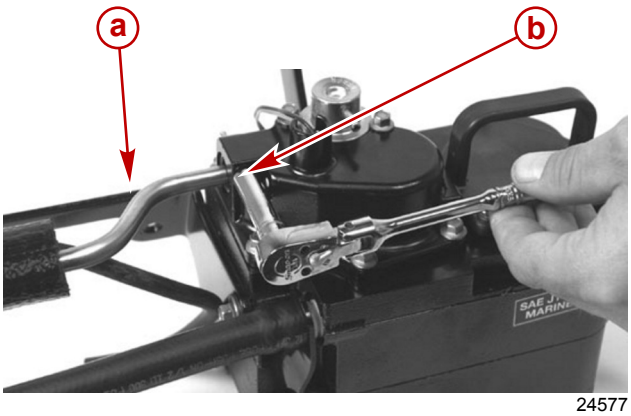


24390

Heat-resistant sleeve removed for visual clarity
a - Fuel line
b - Bracket

f. Install the fuel line retainer screw.

g. Tighten the screw to specification.



24577

a - Fuel line
b - Screw

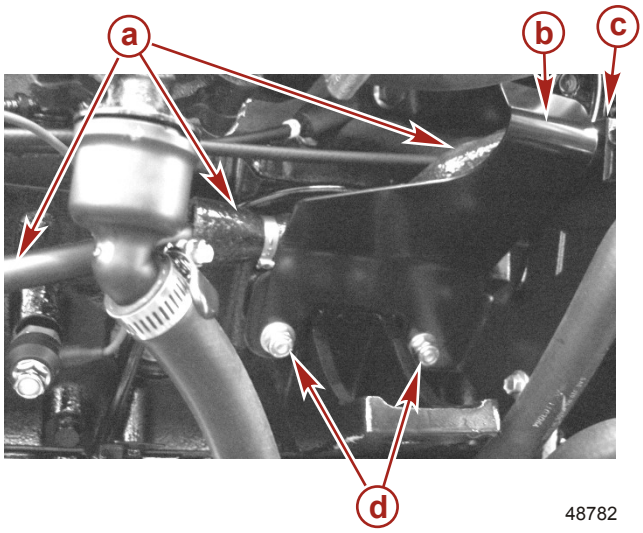
Description	Nm	lb. in.	lb. ft.
Fuel line retainer screw	9	80	–

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.

h. Pull the heat-resistant sleeve over the fuel line to within 6 mm (1/4 in.) of the Gen III Cool Fuel Module.

i. Install the fuel line shield to the engine mount. Ensure the heat-resistant sleeve and fuel line are properly positioned and line is not pinched when the nuts are tightened.

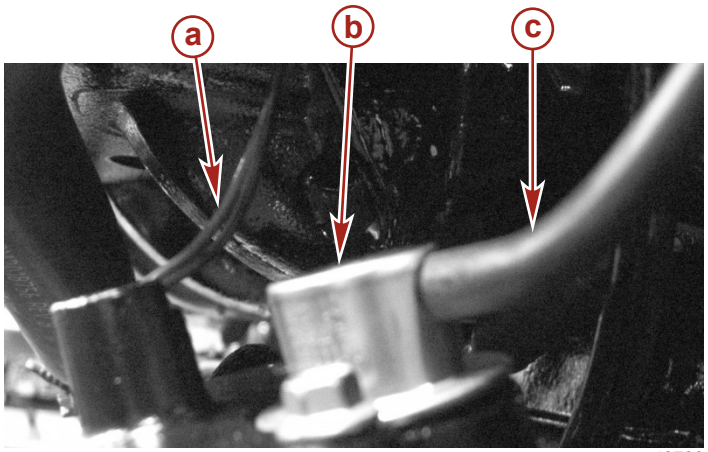
j. Tighten the nuts to specification.



a - Fuel line
b - Fuel line shield
c - Fuel module
d - Nut

Description	Nm	lb-in.	lb-ft
Shield to engine mount nut	37	–	27

9. Install a fuel supply line. Refer to **Fuel Supply Connection**.
10. Connect the Gen III Cool Fuel Module 2-pin harness connector to the engine harness.
11. Install the vacuum hose onto the fuel pressure regulator.



a - Harness connector wires
b - Fuel pressure regulator
c - Vacuum hose

12. Connect the positive (+) battery cable to the battery (usually red).
13. Connect the negative (-) battery cable to the battery (usually black).
14. Open the seacock, if equipped.
15. Open the fuel supply valve, if equipped.
16. Run the engine and check for any leaks. Stop the engine immediately if any leak exists and correct before continuing.

Fuel Supply Connection

⚠ WARNING

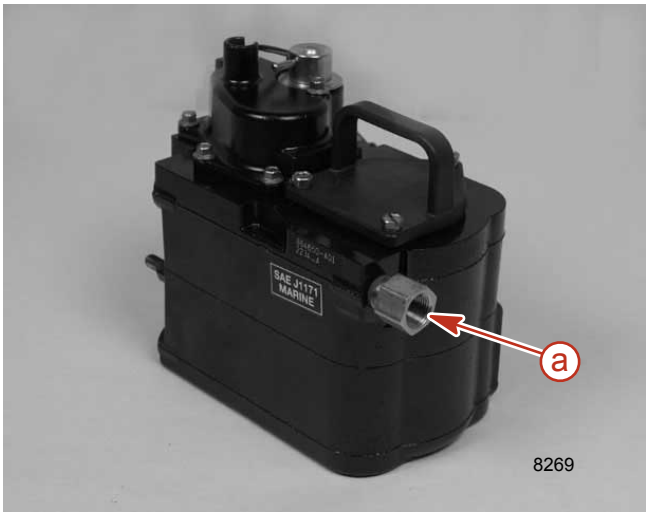
Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

1. Install the fuel inlet adapter fitting:
   a. If the threads of the fuel inlet adapter fitting are not coated with pre-applied sealant, apply sealant to the threads.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting adapter	92-809822

b. Hand start the adapter fitting into the cool fuel module.

c. Tighten the adapter fitting to specification.



a - Fuel inlet adapter fitting

Description	Nm	lb. in.	lb. ft.
Fuel inlet adapter fitting	22	–	16

2. Install a fuel supply line fitting:

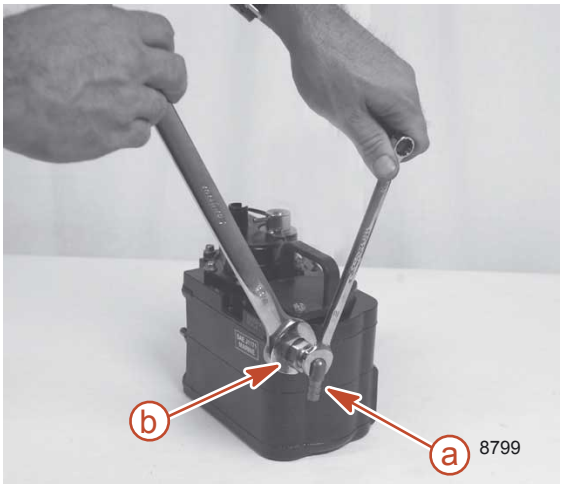
a. Apply sealant to the fuel supply line inlet fitting

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel line inlet fitting to adapter.	92-809822

b. Install the fuel line inlet fitting by hand, finger-tight.

c. While holding the fuel inlet adapter fitting securely, tighten the fuel line inlet fitting 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 fitting.



Typical

a - Fuel line fitting (typical 90-degree hose barb)

b - Fuel inlet adapter fitting

Cooling System

Section 6A - Closed Cooling System

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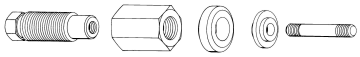
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bolt threads	92-809819
9	Loctite 567 PST Pipe Sealant	Connector threads Crossover mounting bolts Circulating pump mounting bolts	92-809822
19	Perfect Seal	Both sides of the poppet valve gasket O-rings	92-34227Q02
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821
68	Loctite 609	Retainer/seal	Obtain Locally
80	SAE Engine Oil 30W	Outer diameter of the bearings Seawater pump shaft	Obtain Locally
142	Loctite 598 RTV Sealant	Actuator housing wear plate	Obtain Locally

Special Tools

Pulley Pusher Installer	91-93656A1
 10047	Installs the pulley onto the power steering pump.

Power Steering Pump Pulley Remover	Kent Moore J-21239
 25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.

Pressure Cap and Cooling System Tester	Stant 12026
 48944	Adapter fits on the heat exchanger and aids in testing the pressure cap and cooling system

Belt Tension Gauge	Kent Moore BT-33-73-F
 39451	Measures serpentine belt deflection.

Specifications

Closed-Cooling System Capacity

All Models	Capacity	Fluid Type
Closed-cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water

Thermostat

All Models	Specification
Closed-cooling system thermostat	76° C (170° F)

Pressure Cap Rating

All Models	Specification
Closed-cooling system pressure cap	103 kPa (15 psi)

General Information

The 8.2 engine is fitted with a closed cooling system designed to keep the engine operating temperature at approximately 79º C (175º F) for optimum performance, fuel economy and durability. The Mercury MerCruiser closed cooling systems are sometimes called fresh water-cooling and use a combination of fresh water (antifreeze and water) and seawater for cooling. Refer to the cooling system flow diagram at the end of this section.

To monitor the cooling system, a temperature sensor is incorporated into the audio warning system, which alerts the operator of an abnormal condition if the temperature exceeds approximately 93º C (200º F).

NOTE: *This engine is not equipped with an analog temperature sender. When using analog gages an AGI box is required.*

The cooling system must receive a sufficient amount of seawater under all operating conditions to operate properly. The design and installation of the seawater supply system is the boat manufacturer's responsibility. Cooling system components must be constructed, sized, and installed in accordance with the following guidelines.

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

Seawater Supply System

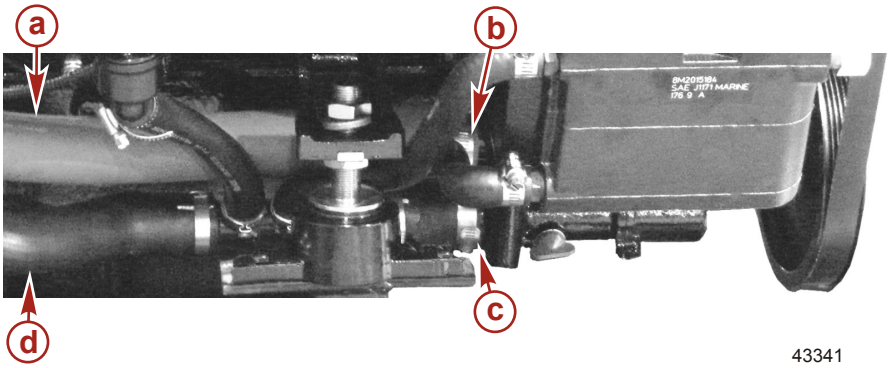
Seawater Supply Hose Specifications

Description	Hose and Connection	Vacuum
Seawater inlet hose	32 mm (1-1/4 in.) I.D. low restriction routing and connections	Able to support 34 kPa (10 in. Hg) (5 psi) of vacuum without collapsing hose
Seawater pickup		
Seacock (ABYC requirement)		
Sea strainer (optional)		

Seawater Inlet Hose

- A reinforced hose capable of supporting 34 kPa (10 in. Hg) (5 psi) vacuum must be used to prevent the seawater inlet hose from collapsing from pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible with the least number of bends to minimize restriction.
- All connections must be secured with hose clamps.

- Fasten the hose as appropriate to maintain proper routing and to prevent chafing or contact with other moving parts.



43341

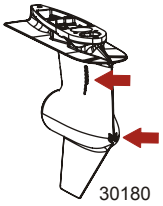
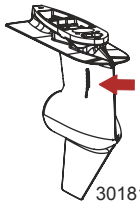
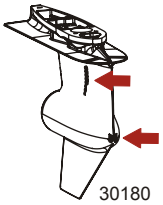
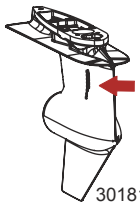
a - Seawater inlet hose
b - Hose clamp connection to pump inlet
c - Seawater outlet hose
d - Hose clamp connection to pump outlet

Sterndrive Seawater Supply

The 8.2 Bravo engine packages do not require additional seawater pickups if:

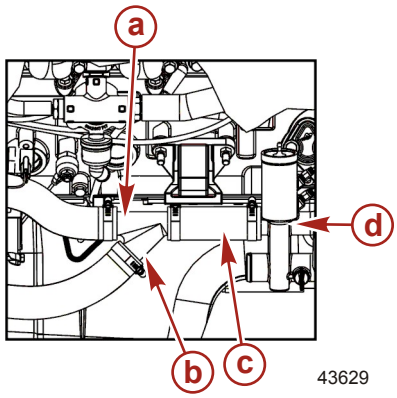
- The sterndrive gearcase has dual water pickups.
- The boat is capable of 64 km/h (40 mph) fully loaded and operated within the specified operating range.

The 8.2 Bravo Two sterndrive packages must have a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive side water pickups. Install the Y-fitting at the engine's seawater pump inlet. See **Installing the Y-Fitting**.

Seawater Pickups Required for 8.2 Engine Models with Bravo Sterndrive			
Boat speed with the maximum load operating within the specified range	**SeaCore Bravo has side water pickup**	**SeaCore Bravo has dual water pickup**	**Through-the-hull or through-the-transom seawater pickup**
64 km/h (40 mph) or greater		 30180	Not required, see **Installing the Seawater Supply Hose**
Less than 64 km/h (40 mph)	 30181	 30180	Required, see **Installing the Y-Fitting**
64 km/h (40 mph) or greater	 30181		Required, see **Installing the Y-Fitting**

Installing the Y-Fitting

All 8.2 engine models with Bravo Two sterndrive require a through-the-hull or through-the-transom seawater pickup and a Y-fitting at the engine seawater pump inlet port. The Y-fitting directs the seawater from the sterndrive and through-the-hull or through-the-transom seawater pickup to the engine's seawater pump to meet the minimum flow specifications.



- **a -** Y-fitting port to water inlet from sterndrive
- **b -** Y-fitting port to water inlet from through-the-hull or through-the-transom seawater pickup
- **c -** Hose 101.6 mm (4 in.) from seawater pump inlet to Y-fitting
- **d -** Engine seawater pump

NOTE: *The 8.2 engine models are not factory equipped with a Y-fitting, refer to* ***Mercury Parts Catalog, Closed Cooling Systems (Bravo)*** *to order one Y-fitting 864727, 3 hose clamps 815504222, and seawater supply bulk hose that meets MerCruiser specifications.*

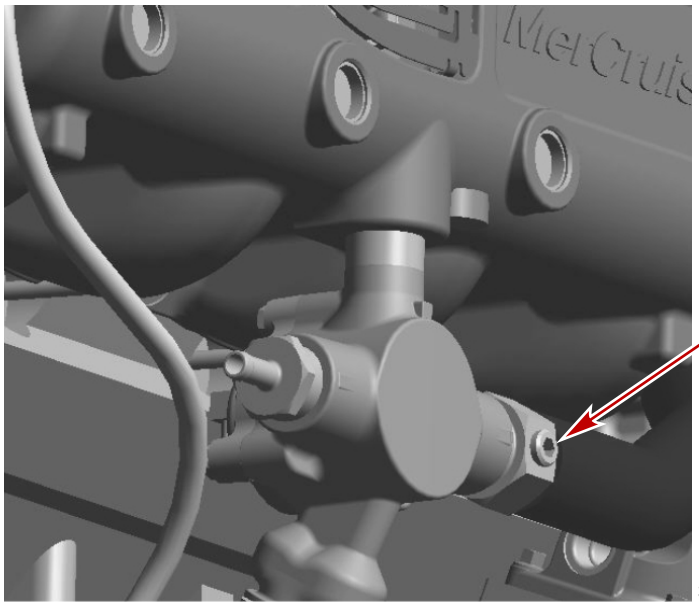
1. Cut a 101.6 mm (4 in.) length piece of the supply hose and install it to the seawater pump inlet and the Y-fitting.
2. Install a seawater supply hose to the Y-fitting and the sterndrive's water inlet at the transom. Cut off any excess hose as needed.
3. Install a seawater supply hose to the Y-fitting and the through-the-hull or through-the-transom seawater pickup. Cut off any excess hose as needed.
4. Properly secure all hoses to all fittings to prevent water leaking into the boat.

Propeller Shaft Log Seal Connection

NOTICE
Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.

1. Attach the shaft log seal cooling water hose to the access port in the reducer fitting, located on the poppet valve underneath the exhaust manifold. There are reducing fittings on the port and starboard manifolds.

IMPORTANT: Do not remove the reducer fitting, even if you are not using the shaft log seal. The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system.



Shaft log seal access port

2. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows to prevent a siphoning action when the engine is not running
3. Fasten the hose securely to keep it properly positioned.

Installing the Hot Water Heater

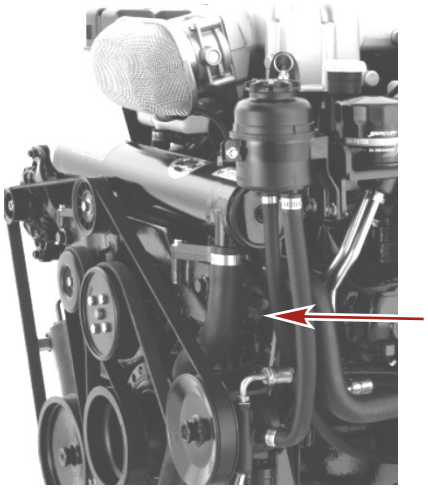
IMPORTANT: Hot water heater supply and return hoses must not exceed specification.

Hot Water Heater Hose Specification	
Supply hose	16 mm (5/8 in.)ID
Return hose	

When connecting a cabin heater or hot water heater:

- Use specified hot water heater supply and return hoses.
- Make the engine connections for the hot water heater only at the locations described in **Hose Connections**.
- Refer to the heater manufacturer's instructions for complete installation information and procedures.
- Do not reposition the engine temperature switch; it must remain where installed by the factory.
- Inspect the complete system for leaks after the heater is connected to the cooling system.

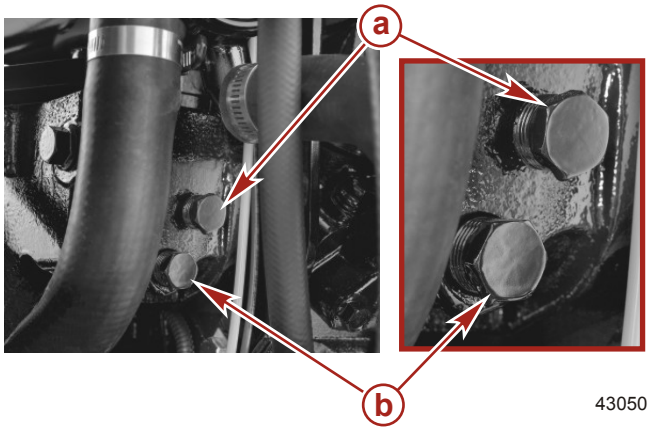
- Monitor the engine coolant temperature after the heater is connected.



43135

Location of the hot water heater connections

Connecting Hoses



43050

a - Heater supply (pipe plug)
b - Heater return (pipe plug)

NOTICE

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

1. Place a 4-liter (1 US gal) fluid catch container under the pipe plugs.
2. Remove the pipe plug from the heater supply and return locations on the engine. Properly dispose of the coolant.
3. Apply sealant to the threads of each hose connector and install. Tighten 1 to 2 turns beyond hand-tight.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Connector threads	92-809822

4. Install the supply and return heater hose to the appropriate connector and secure with a hose clamp.
5. Add clean coolant to the full level in the coolant reservoir. Secure the coolant pressure cap.

NOTICE

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

NOTICE

Blocking the coolant flow at the heater can cause reduced engine performance or overheating. Check for continuous coolant flow from the engine to the water circulating pump.

6. Supply cooling water to the engine.
7. If applicable, supply cooling water to the sterndrive.
8. Start the engine and check for leaks and adequate coolant flow.
9. Allow the engine to reach normal operating temperature. Ensure that engine temperature remains normal and that no leaks are present.

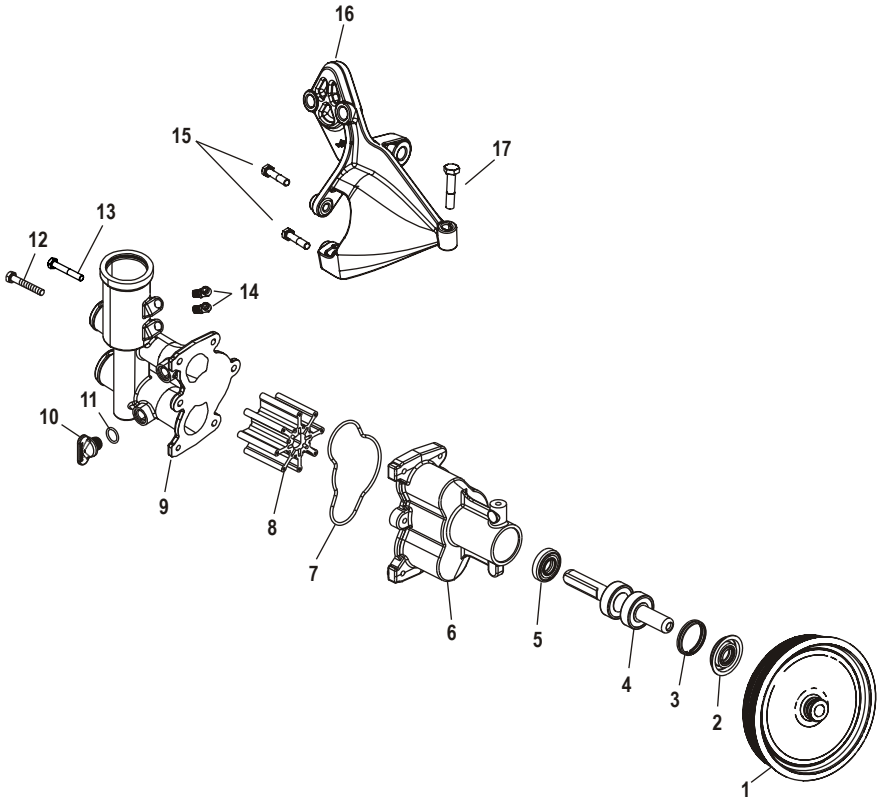
⚠ CAUTION

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

10. Stop the engine. If necessary, add new coolant to the full level in the coolant reservoir.

Seawater Pump Maintenance

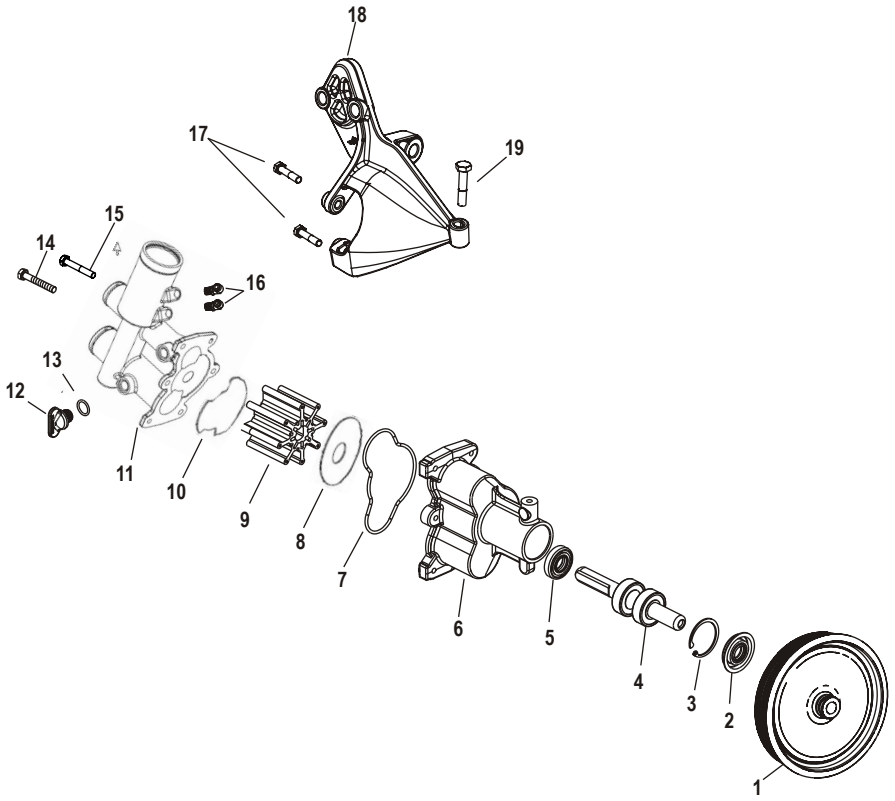
Seawater Pump Assembly



Seawater pump with air actuator

1 - Pulley
2 - Retainer seal
3 - Retainer ring
4 - Bearing shaft assembly
5 - Rear oil seal
6 - Seawater pump impeller housing
7 - O-ring
8 - Impeller
9 - Seawater pump actuator housing
10 - Drain plug
11 - O-ring
12 - Screw (M6 x 16)
13 - Screw (M6)
14 - Fitting (orange and gray)
15 - Screw (M6)
16 - Seawater pump bracket
17 - Screw (M6)

Seawater Pump Assembly With Wear Plate

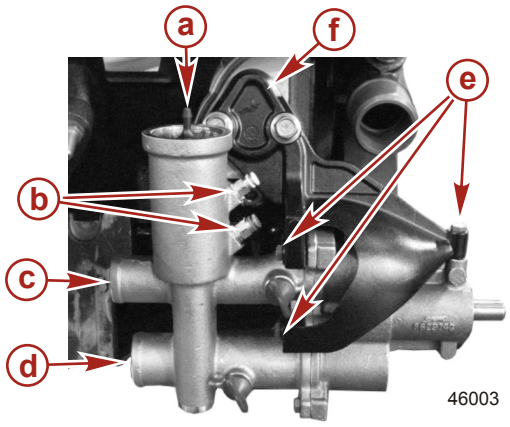


46198

1 - Pulley
2 - Retainer seal
3 - Retainer ring
4 - Bearing shaft assembly
5 - Rear oil seal
6 - Seawater pump impeller housing
7 - O-ring
8 - Impeller housing wear plate (if equipped)
9 - Impeller
10 - Actuator housing wear plate
11 - Seawater pump actuator housing
12 - Drain plug
13 - O-ring
14 - Screw (M6 x 16)
15 - Screw (M6)
16 - Fitting (orange and gray)
17 - Screw (M6)
18 - Seawater pump bracket
19 - Screw (M6)

Removal

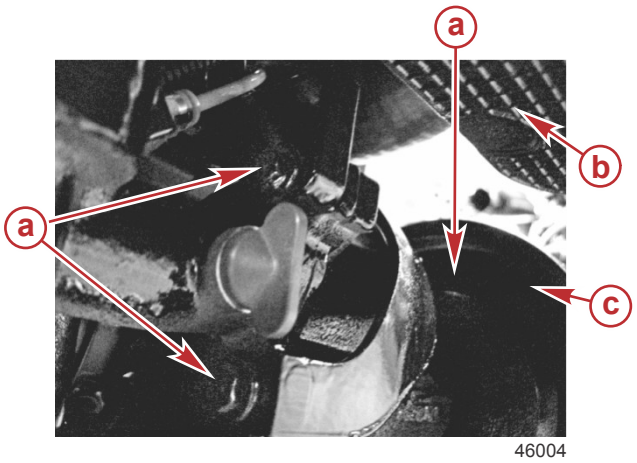
1. Drain the seawater section of the cooling system.
2. Remove the seawater inlet and outlet hoses from the aft side of the seawater pump.
3. Disconnect the vent hose from the top of the drain valve.
4. Disconnect the air hoses from the drain valve by pushing in and holding the plastic ring around the 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.
5. Remove the serpentine drive belt. Mark the direction of travel if the belt will be reused.
6. Remove the dual idler pulley bracket or the automatic tensioner bracket from the front of the engine.
   NOTE: *The seawater pump bracket mounts to the engine, sealing an opening on the engine block. The bracket should remain mounted to the engine whenever you are removing or installing the seawater pump.*
7. Remove the three screws securing the seawater pump to the bracket.
8. Remove the seawater pump from the bracket. Do not remove the bracket from the engine.



46003

Engine components and seawater pump pully removed for visual clarity

a - Drain valve vent hose fitting
b - Drain valve air hose fitting
c - Seawater inlet hose fitting
d - Seawater outlet hose fitting
e - Screw (seawater pump to bracket)
f - Seawater pump bracket on engine



46004

Seawater pump and pulley on the engine

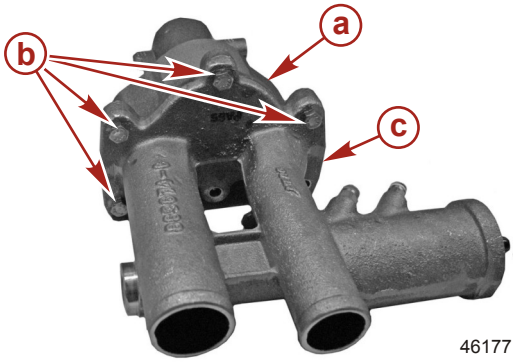
- **a -** Screw (seawater pump to bracket)
- **b -** Gen III fuel pump
- **c -** Seawater pump pulley

Disassembly

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the seawater pump pulley using an appropriate puller.
2. Remove the screws, and separate the impeller housing from the actuator housing.

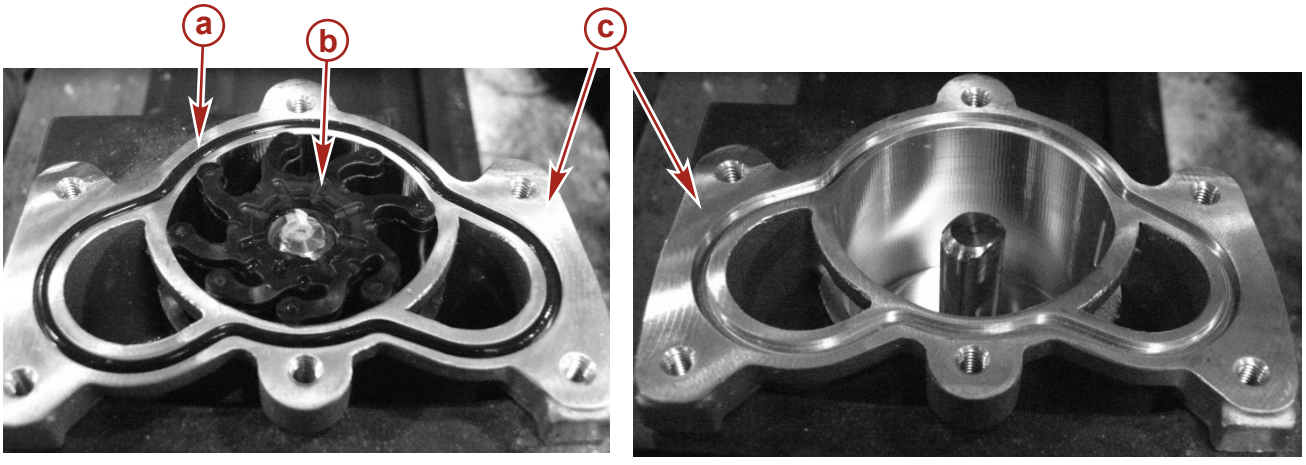


46177

Seawater pump assembly

- **a -** Impeller housing
- **b -** Screws
- **c -** Actuator housing

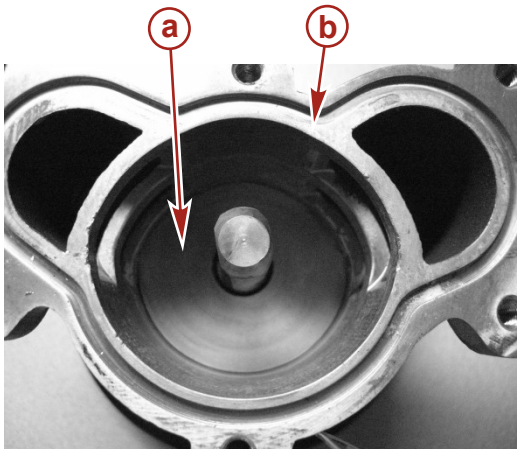
3. Remove the O-ring and the impeller.



46178

- **a -** O-ring
- **b -** Impeller
- **c -** Impeller housing

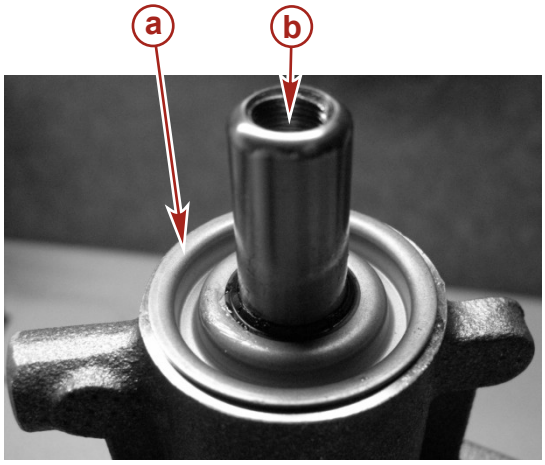
4. If equipped, remove the stainless steel plate.



46181

a - Stainless steel plate
b - Impeller housing

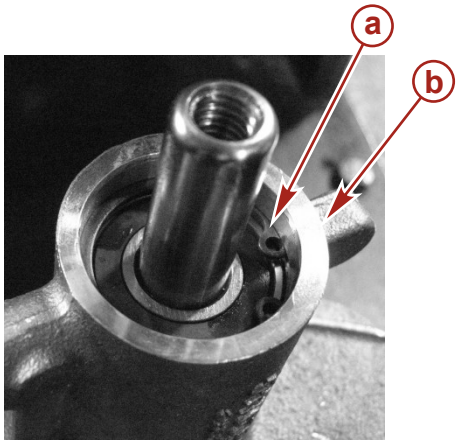
5. Remove the retainer seal.



46180

a - Retainer seal
b - Pulley end of bearing shaft

6. Remove the retainer ring.



46179

a - Retainer ring
b - Housing

7. Press the shaft and bearing assembly out of the housing from the impeller side.
8. Remove the rear oil seal.

Cleaning and Inspection

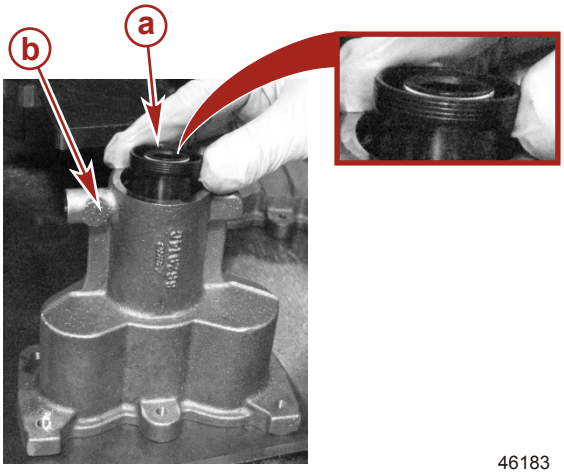
⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

1. Clean the metal parts in solvent, and dry them with compressed air.
2. Clean all gasket material and sealant from the sealing surfaces.
3. Inspect the bearing housing. Examine its 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 damage or leaks.
5. Rotate the bearing shaft in the bearing housing. Replace the bearing shaft and bearing assembly if bearings feel rough or if either end of the shaft wobbles.
6. Inspect the impeller housing surfaces where the impeller rides. Replace the impeller housing if significant grooves exist.
7. Inspect the 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

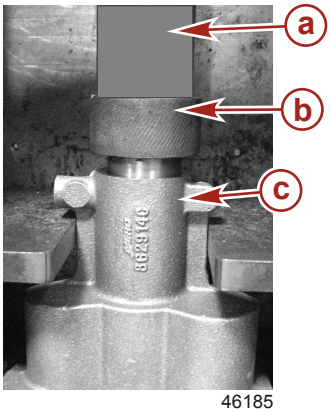
1. Install the rear seal with the spring toward the bearing shaft assembly.



46183

a - Spring on seal
b - Housing

2. Using a suitable mandrel, press the seal to seat it in the housing.



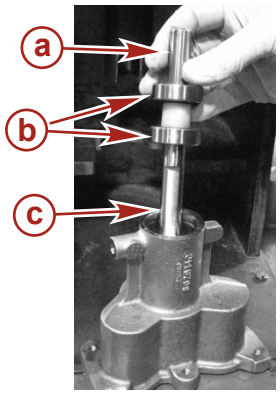
46185

a - Press
b - Suitable mandrel
c - Housing

3. **IMPORTANT: The bearing shaft assembly should slip easily into the bearing housing, using only minimal force.**
4. Lubricate the outer diameter of the bearings on the bearing shaft assembly.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Outer diameter of the bearings	Obtain Locally

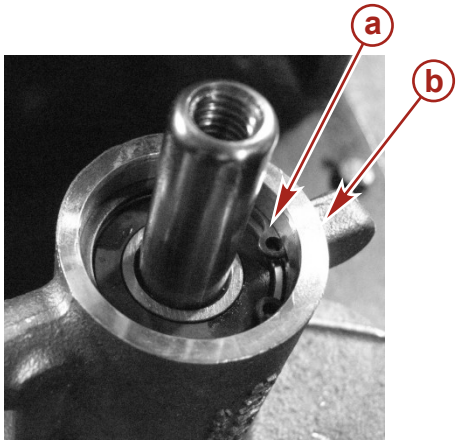
5. Install the bearing shaft assembly into the impeller housing. The end of the shaft with flat surfaces should extend into the impeller cavity. Clean any assembly lube or oil from the forward end of the impeller housing.



46186

a - Bearing shaft assembly
b - Outer diameter of the bearings
c - Shaft flat surfaces

6. Insert the retainer ring into the impeller housing.



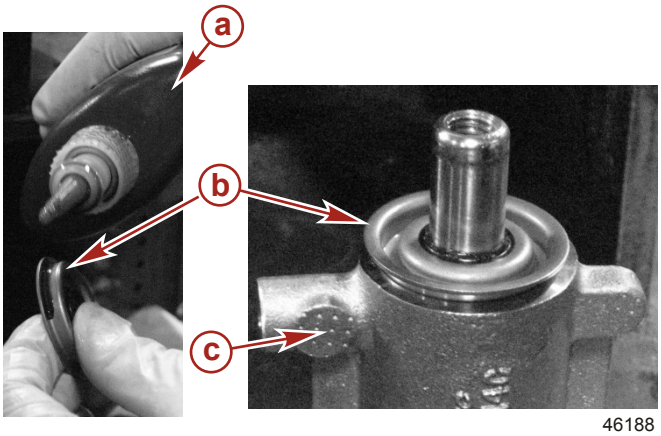
46179

a - Retainer ring
b - Housing

7. Apply adhesive to the outer diameter of the 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

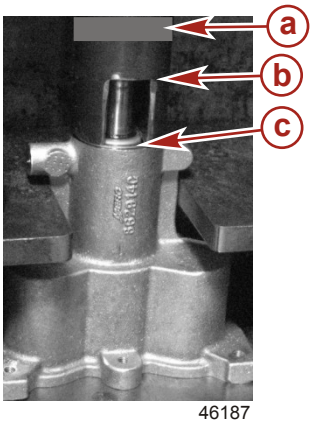
8. Install the retainer seal onto the bearing shaft assembly and slide it down until it contacts the end of the impeller housing.



46188

a - Sealant
b - Retainer seal
c - Housing

9. Press the retainer seal into place. Wipe away excess adhesive.

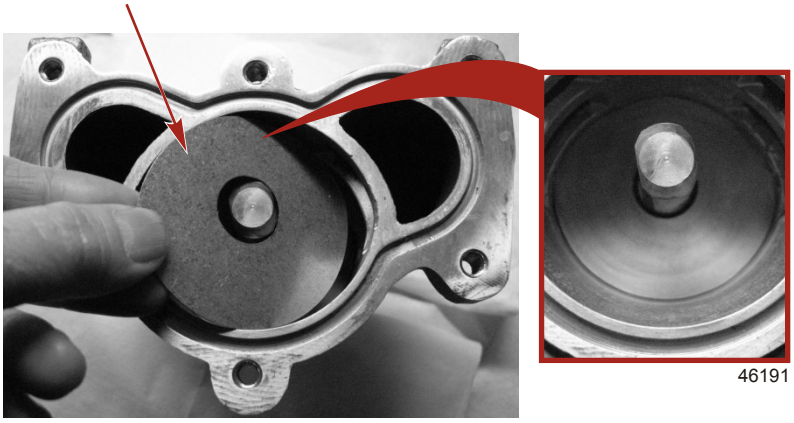


46187

a - Press
b - Suitable mandrel
c - Retainer seal

IMPORTANT: Only use the 0.030 in. inner wear plate in conjunction with the 0.030 in. shorter impeller. This impeller is marked orange on alternate vanes. The plate and shorter impeller come as a set when a new impeller is ordered.

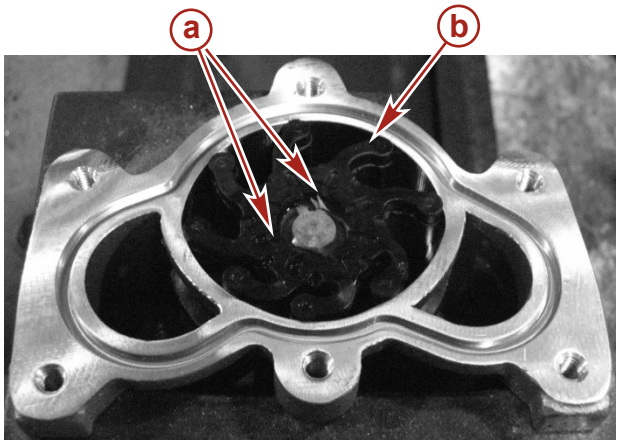
10. If equipped, install the stainless steel plate into the impeller cavity.



46191

Stainless steel 0.030 in. inner wear plate

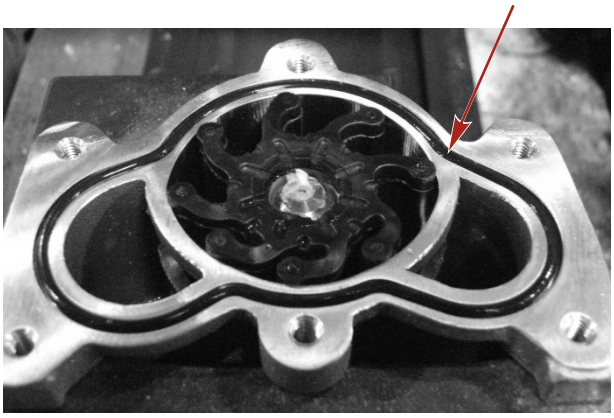
11. Lubricate the impeller with soapy water. Align the flat surfaces of the impeller hub and bearing shaft and install the impeller into the impeller cavity.



46189

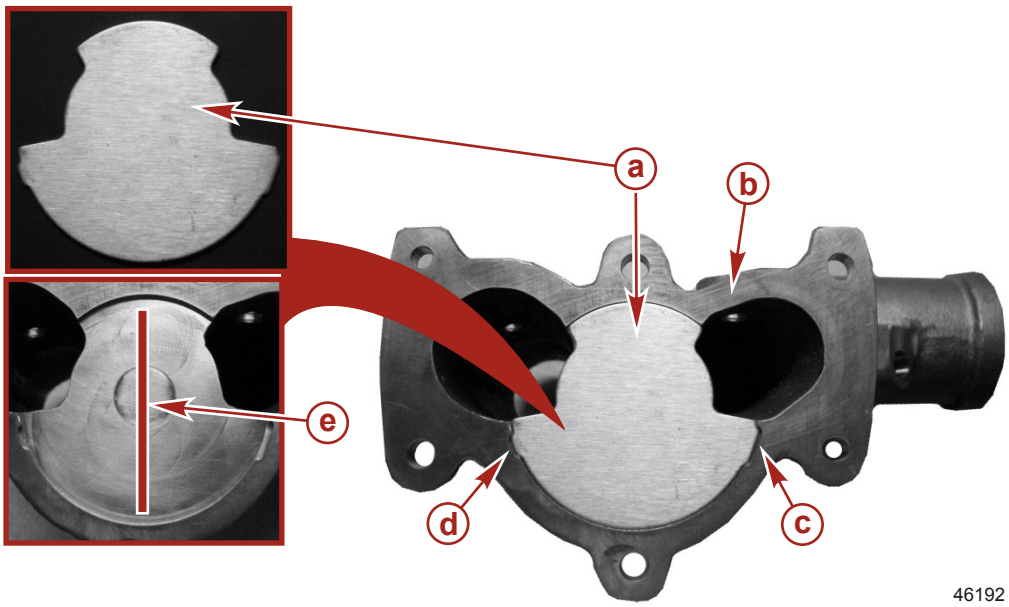
a - Flat surfaces
b - Impeller

12. Install the O-ring into the groove in the impeller housing rear face.



46190

13. If you have the design shown below, apply a 1/8-inch wide bead of adhesive across the actuator housing; then place the stainless steel wear plate on the housing with the tabs aligned. Bolt the assembly to the pump within five minutes.



a - Stainless steel wear plate
b - Actuator housing
c - Large tab
d - Small tab
e - Adhesive on housing

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Actuator housing wear plate	Obtain Locally

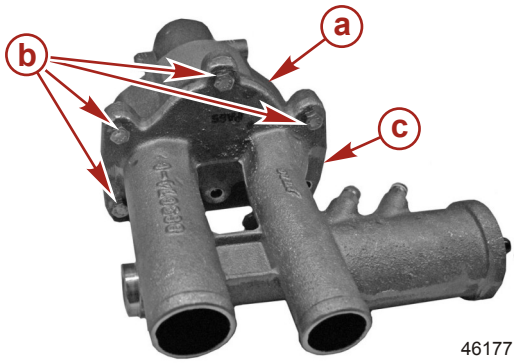
IMPORTANT: The following actuator housing styles will mate with both impeller styles.

a - Actuator housing style with milled even surface
b - Actuator housing style with wear plate

14. Align and install the actuator housing on the impeller housing assembly.
15. Screws that are reused may require loctite. Apply adhesive to the threads of the screws as necessary.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

16. Install the four screws and tighten to specification.



Seawater pump assembly
- **a -** Impeller housing
- **b -** Screws
- **c -** Actuator housing

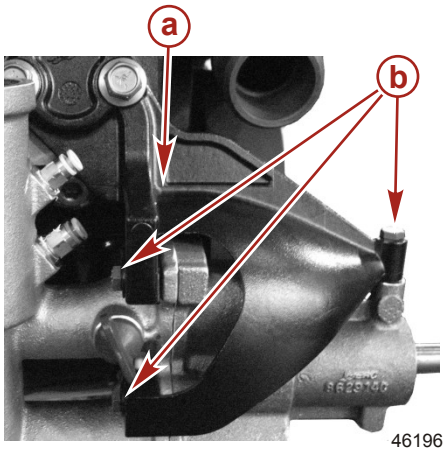
Description	Nm	lb. in.	lb. ft.
Impeller housing cover or the seawater pump actuator housing screw	10	88	–

Installation

1. Screws that are reused may require loctite. Apply adhesive to the threads of the three seawater pump bracket screws as necessary.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

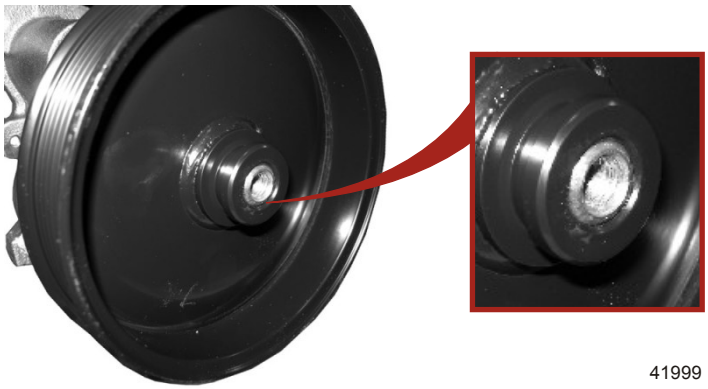
2. Install the seawater pump assembly onto the bracket on the engine. Hand-start two screws through the bracket and into the seawater pump assembly. Hand-start the screw that attaches the seawater pump bracket to the top of the seawater pump assembly.
3. Tighten the three screws to specification.



- **a -** Bracket
- **b -** Screw

Description	Nm	lb. in.	lb. ft.
Seawater pump bracket screws	10	88	–

4. Lubricate the seawater pump shaft and install the seawater pump pulley onto the shaft using an appropriate pulley installer. Ensure that the end of the shaft is even with the face of pulley hub.



Seawater pump pulley installed

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Seawater pump shaft	Obtain Locally

Pulley Pusher Installer	91-93656A1
Power Steering Pump Pulley Remover	Kent Moore J-21239

5. If removed, install the blue drain plugs in the seawater pump cover or actuator housing.
6. Install the dual idler pulley bracket or idler/tensioner bracket onto the studs in front of the cylinder block using the nuts previously removed.
7. Tighten the nuts to the specified torque.

Description	Nm	lb. in.	lb. ft.
Idler pulley bracket or idler/tensioner bracket	50	–	37

8. Install the seawater inlet and outlet hoses. Tighten the hose clamps securely.
9. 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.*
10. 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 the engine serpentine belt is to be reused, it should be installed in the same direction of rotation as before.
11. Install the serpentine drive belt.

NOTICE

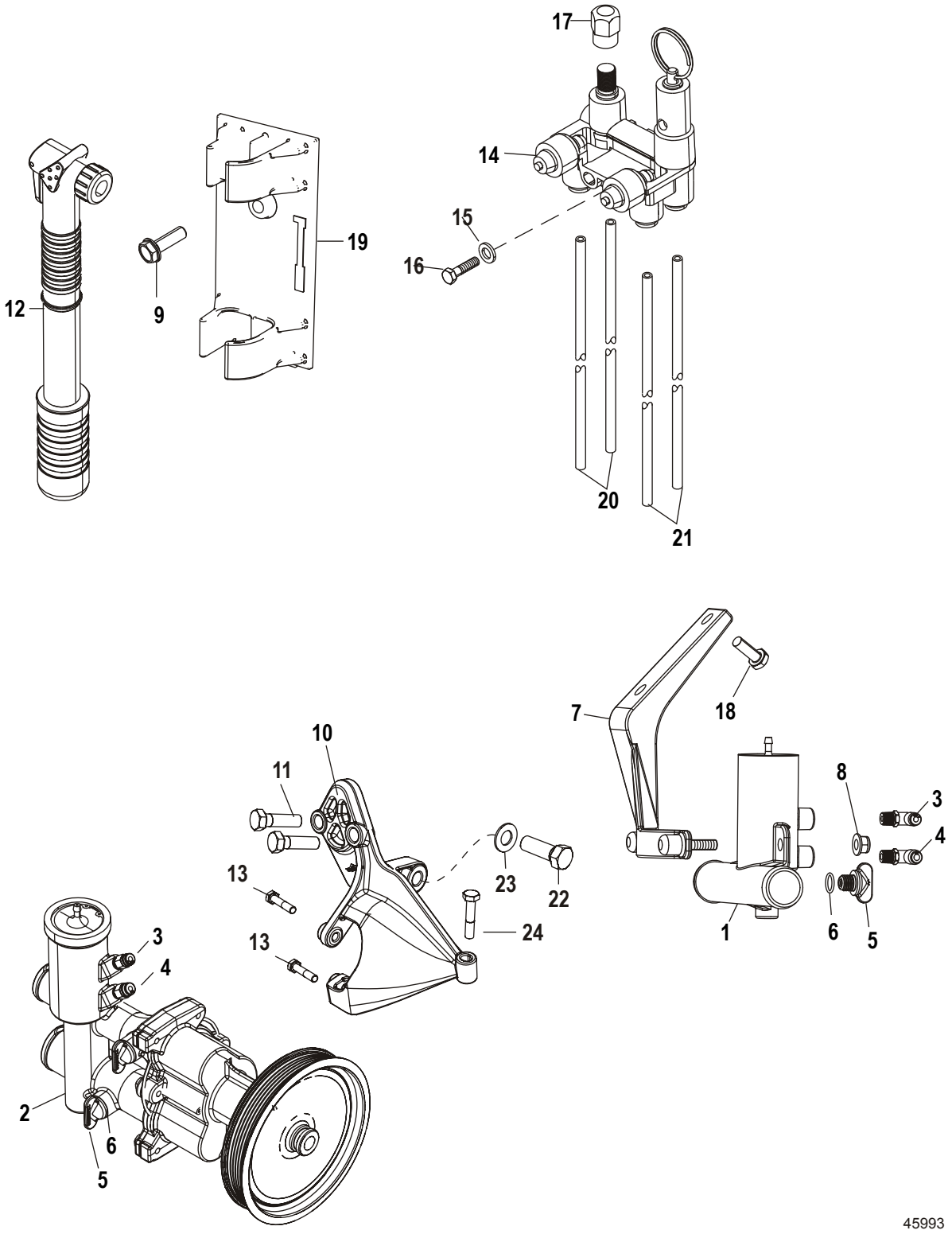
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

12. Supply cooling water.
13. Start the engine and check for leaks.

Notes:

Air-Actuated Drain System

Air-Actuated Drain System Exploded View



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	Screw (#12-11 x .750)
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	Washer
16	2	Screw
17	1	Service point cap
18	1	Screw
19	1	Air pump bracket
20	2	Green air line
21	2	Gray air line
22	1	Screw (.437 - 14 x 1.250)
23	1	Washer (.453 x .875 x .060)
24	1	Screw

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

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

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the boat from the water.
2. Using the hand pump or other air source, pump air into the system until both of the green indicators extend and the manual release valve opens to relieve excess pressure. If one or both of the green indicators have not extended when the relief valve opens, the corresponding air-actuated drain valve has not opened and may be seized.
3. Release the compressed air from 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

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

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

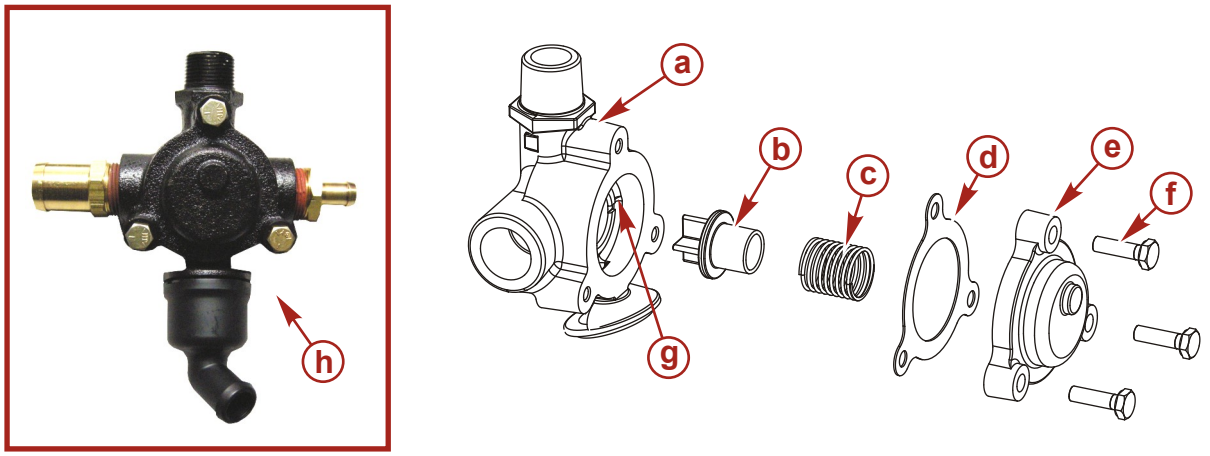
Connect the vent hose to top of drain valve. Route the vent hose the same as it was before removal.

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 Poppet Valve

Disassembly

1. Drain the water from the engine's seawater cooling passages.
2. Disconnect the hoses from the poppet valve housing.
3. Remove the screws and thermostat cap.
4. Remove the spring, gasket, and poppet.



a - Poppet valve housing
b - Poppet
c - Spring
d - Poppet cover gasket
e - Thermostat cap
f - Screw
g - Bypass slot
h - Poppet valve assembly

5. Discard the existing gasket.

Inspection

1. Inspect the bypass slot. If the passage is clogged, clean it. If the passage is rusted, replace the valve.
2. Check all parts for excessive wear. Replace as necessary.

Assembly

Different engine models use different, color-coded springs. Ensure that you install the correct spring.

Model	Spring Color
8.2 models	Silver

1. Remove all gasket material from the mating surfaces on the housing.
2. Coat both sides of a new gasket with Perfect Seal.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Both sides of the poppet valve gasket	92-34227Q02

3. Install the new components. Tighten the screws to specification.
4. Connect the inlet and outlet hoses. Tighten the hose clamps to specification.

Description	Nm	lb-in.	lb-ft
Poppet valve cap screws	11	8	–
Hose clamps	3	26	–

5. Start the engine and check for leaks.

Exhaust Manifold Drain Check Valve

General Information

Some engine models are equipped with drain check valves located on the port and starboard exhaust manifolds. The drain check valve is a non-serviceable item.

47230

Closed Cooling

Description

Closed cooling is a standard feature on some models and is available as an accessory or a factory installed option on others. When closed cooling is used, a mixture of antifreeze and water is circulated through the water jackets in the engine block, cylinder heads, and—on some applications—the exhaust manifolds to dissipate the heat. Refer to Water Flow Diagrams. This coolant is then passed though a heat exchanger. Here the coolant rejects heat to seawater (water in which the boat is being operated), which is simultaneously being passed through the exchanger. The heat is then carried away by the seawater and discharged overboard via the exhaust elbows. The design of the heat exchanger allows for the transfer of heat, while ensuring that the two coolants are separated. In this manner, the expensive engine components are never exposed to seawater, which can be corrosive in salty, polluted, or mineral laden water areas.

Mercury MerCruiser's closed cooling systems are developed by the same people who design our engines to ensure compatibility and the same high quality standards. Our systems employ several exclusive features to provide unsurpassed cooling efficiency and durability. An exclusive double-acting thermostat is used on V6 and V8 models, which provides increased coolant velocity through the engine and heat exchanger to prevent hot spots and improve performance. Mercury MerCruiser's heat exchangers also incorporate several state-of-the-art designs to enhance the heat transfer between the coolants for an additional margin of cooling capacity. Features like these allow our systems to continually operate at WOT in water temperatures up to 38 °C (100 °F), where most after-market systems fall short of this mark. This additional cooling capacity translates into longer cooling system life with fewer problems regardless of where the boat is operated. Contact your sales representative to order your closed cooling systems factory installed or refer to the Mercury Precision Parts and Accessories Guide to obtain the part numbers for the accessory kits.

Antifreeze Recommendations

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Factory installed closed cooling systems come filled with an extended life antifreeze. This coolant allows for a service interval of 5 years or 1000 hours (whichever occurs first), versus 2 years or 400 hours for standard antifreeze. When adding coolant to these systems (i.e. when filling coolant recovery bottle, installing hot water heater), we recommend that only an extended-life antifreeze be used. Mixing this coolant with even a small amount of regular antifreeze will require that the service interval be reduced 2 years. If you are installing closed cooling kits at your facility, we would also encourage you to use the extended Life coolant to allow your customer to take advantage of the reduced maintenance costs.

Pre-mixed extended life coolant is available from Quicksilver or can be purchased at most automotive stores and other locations where antifreeze is sold. Extended-life coolant is available from Texaco under the name Havoline Extended Life Dex Cool. Prestone also offers a version of this antifreeze called Extended Life 5/100. Only coolants that state that they are compatible with Dex Cool should be used. Extended-life coolants can be identified by their orange color (vs. green for standard coolant) and their corresponding orange cap on the container.

All antifreeze should be mixed 50/50 with pure water (Quicksilver coolant is already pre-mixed). If installing closed cooling kits at your facility, be sure to observe the special filling procedure in the installation instructions.

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

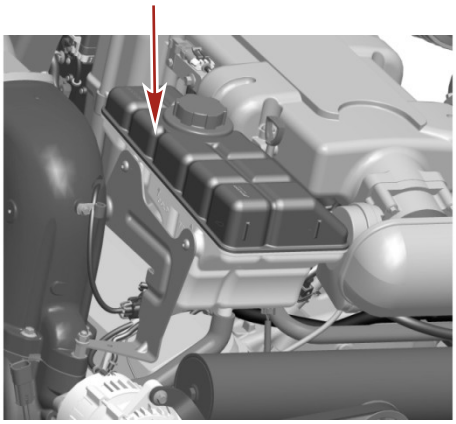
Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Coolant Recovery System

All Mercury MerCruiser systems with closed cooling are equipped with a coolant recovery system that must be installed by the boat manufacturer. The coolant recovery bottle mounting location must meet these requirements:

- Install within approximately 122 cm (4 ft.) of the heat exchanger filler neck to allow connection with tubing provided.
- Install so the bottle is even with or slightly above the heat exchanger filler neck.

- The recovery bottle must be accessible for observing level and servicing coolant.



43691

Coolant recovery bottle

Changing Coolant

Coolant Recommendations

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

NOTE: *The closed cooling system comes filled with Extended Life 5/100 Coolant. This antifreeze requires draining and replacing every five years or every 1000 hours of operation, whichever comes first. Mixing coolants that do not meet the same specification will require more frequent replacement intervals.*

Draining

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the coolant into a suitable container.

Cleaning and Flushing

The closed-cooling system should be cleaned at least once every five years or whenever decreased cooling efficiency is experienced.

NOTE: *The five-year time frame is based on using Extended Life Coolant. Refer to the coolant manufacturer's change intervals when other coolants are used.*

An automotive cooling system cleaning solution may be used to remove the rust, scale or other foreign material. Always follow the manufacturer's instructions supplied with the cleaner.

Flush in the opposite direction of the normal coolant flow to flush out the deposits that are lodged in the coolers or the heat exchanger. Refer to the instructions that accompany the flushing device.

Filling

⚠ CAUTION

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

NOTE: *The closed cooling system comes filled with Extended Life 5/100 Coolant. This antifreeze requires draining and replacing every five years or every 1000 hours of operation, whichever comes first. Mixing coolants that do not meet the same specification will require more frequent replacement intervals.*

1. Remove the pressure cap from the coolant reservoir.
2. Fill the reservoir to the "FULL" mark with the recommended coolant solution.

All Models	Capacity	Fluid Type
Closed-cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

3. Replace the pressure cap.

NOTICE

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

4. With the engine running:
   - ☐ Check the hose connections, fittings, and gaskets for leaks.
   - ☐ Monitor the engine coolant temperature. If the coolant temperature exceeds the normal operating temperature of 76° C (170° F), stop the engine immediately and determine the cause.

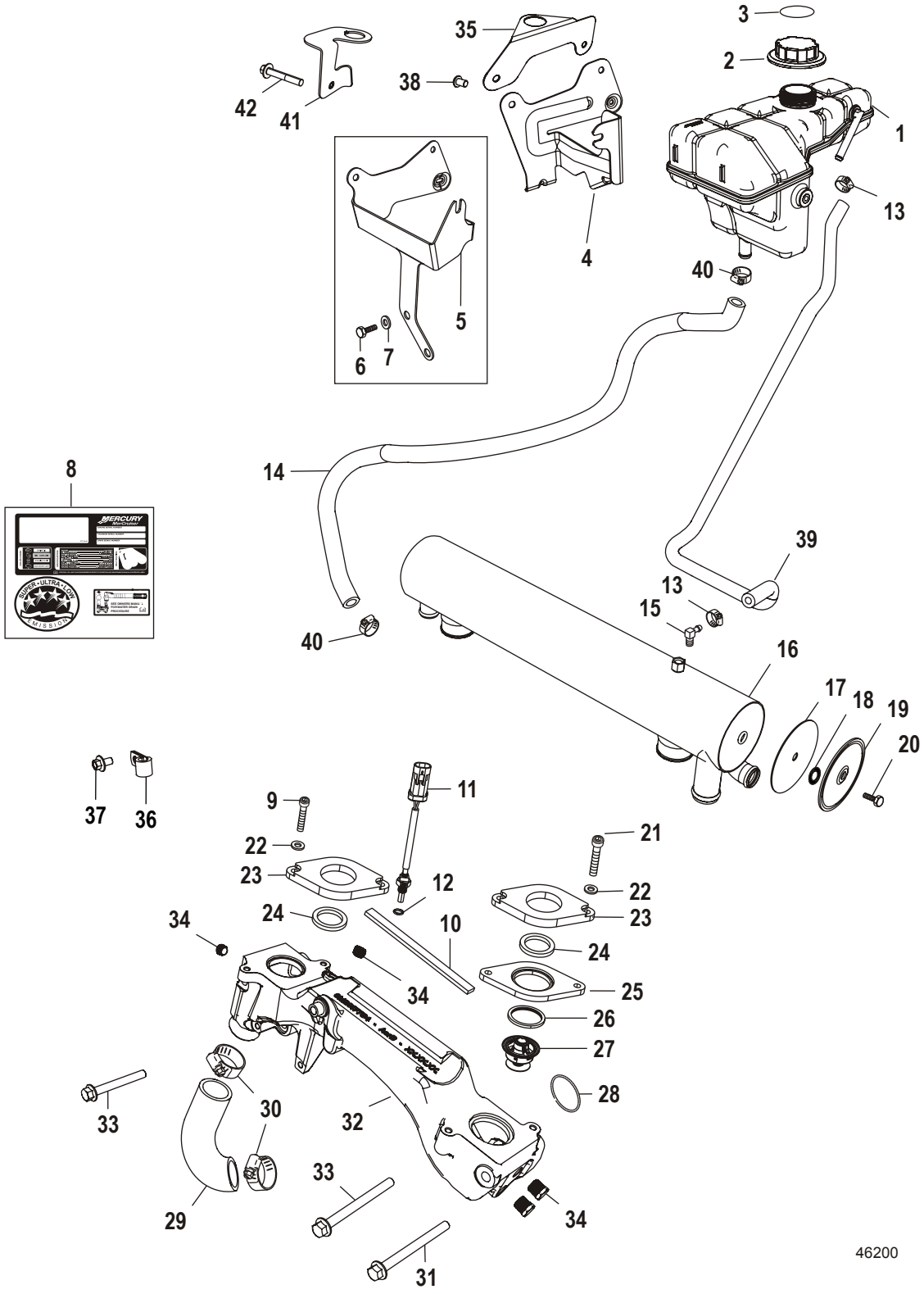
⚠ CAUTION

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

5. Stop the engine and add coolant to bring the coolant level to the "FULL" mark, if necessary.

Closed Cooling System

Closed-Cooling System Exploded View



Ref. No.	Qty.	Description
1	1	Coolant reservoir
2	1	Coolant reservoir cap
3	1	Engine coolant decal
4	1	Coolant reservoir bracket (SN 1A351717 and below)
5	1	Coolant reservoir bracket (SN 1A351718 and above)
6	2	Screw
7	2	Washer
8	1	Decal set
9	2	Screw
10	2	Foam strip
11	1	Coolant temperature sensor
12	1	O-ring
13	2	Worm gear clamp
14	1	Reservoir-to-circulating-pump hose
15	1	Heat exchanger
16	1	90-degree elbow fitting
17	1	Heat exchanger
18	1	O-ring
19	1	Cover
20	1	Screw (0.375-16 x 0.750)
21	2	Screw (M8 x 30)
22	4	Washer
23	2	Heat exchanger plate
24	2	Quad ring
25	1	Heat exchanger plate
26	1	Thermostat seal
27	1	Thermostat
28	2	O-ring
29	1	Crossover to water circulating pump hose
30	2	Worm gear hose clamp
31	1	Screw
32	1	Coolant crossover
33	2	Lower crossover screw
34	4	Brass pipe plug
35	1	Flush mount bracket
36	1	Clip
37	1	Stainless steel screw (M6 x 12)
38	1-3	Screw (M8 x 1.25)
39	1	Coolant bleed hose
40	2	Worm gear clamp
41	1	Flush mount bracket (MIE V-drive)
42	1	Flush mount bracket screw (M8 x 20) (MIE V-drive)

Closed-Cooling System Tests

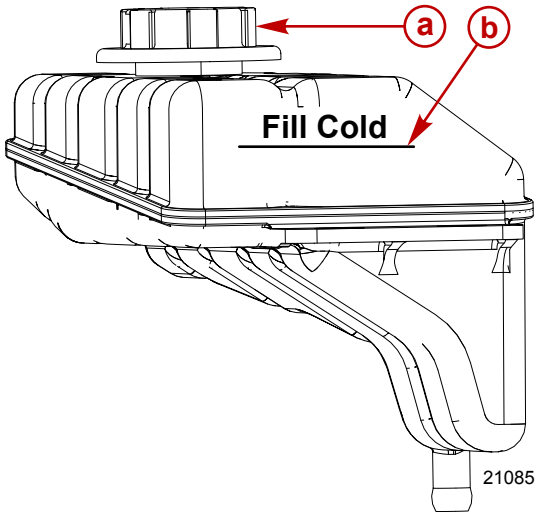
Pressure Test

The pressure cap is designed to maintain 103 kPa (15 psi) of pressure in the closed-cooling system. A pressurized system forces coolant into otherwise hard-to-reach areas of the engine. The pressure cap must be cleaned and inspected periodically to ensure proper operation of the cooling system.

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir. Wash the cap with clean water to remove any deposits or debris. Inspect the cap for cuts, cracks, or other signs of deterioration. Replace the cap if necessary.
2. Clean the sealing surfaces on the coolant reservoir. Inspect the surfaces for any damage or deposits that may prevent the cap from sealing properly.
3. Adjust the coolant level to the "FULL" mark on the coolant reservoir.



a - Pressure cap
b - Fill line

4. Attach a suitable pressure tester to the reservoir and pressurize the system to the amount specified in the following table.

Pressure Cap and Cooling System Tester	Stant 12026

NOTE: *An automotive radiator tester can be used to pressurize the closed-cooling system. Follow the instructions in the tester kit.*

Pressure cap rating	Test pressure
103 kPa (15 psi)	131 kPa (19 psi)

5. Monitor the gauge reading for approximately two minutes. If the pressure decreases, complete the following steps to locate the source of the leak.
6. While maintaining the specified pressure on the closed-cooling system, visually inspect the cooling system hoses, gaskets, drain plugs, petcocks, core plugs, and circulating pump seals for leaks. A bubbling or hissing sound may be heard at the source of the leak.
7. If there is no visual indication of a leak, the engine is leaking internally, and normally it is the result of one or more of the following:
   - A loose cylinder head bolt or a damaged head gasket
   - A loose intake manifold bolt or a damaged manifold gasket
   - A cracked, warped, or porous cylinder head or block
   - A cracked or porous exhaust manifold
8. To locate the source of the internal leak:
   a. Start the engine. Repressurize the system to the previously specified amount while monitoring the pressure gauge on the tester. If the gauge needle vibrates, the compression or combustion pressure is leaking into the closed cooling system from the combustion chamber.

b. Stop the engine. Remove and examine each spark plug. A spark plug that is perfectly clean or has a milky appearance indicates the presence of coolant.

c. Drain the oil from the engine. The oil will appear milky if there is coolant present. If any coolant is present, the engine will have to be disassembled and inspected.

Coolant Alkalinity Test

⚠ CAUTION

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

The coolant in the closed-cooling system should be changed according to the **Maintenance Schedule** recommendations, and the coolant 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 need not be replaced.
4. If the pink litmus paper remains pink, the coolant is not alkaline and must be replaced, refer to **Changing Coolant.**

Heat Exchanger and Crossover Assembly

Heat Exchanger

Internal Leaks

An internal leak will cause the coolant to enter the seawater system when the pressure in the closed-cooling system is greater than the pressure in the seawater system.

1. Remove a seawater hose from the heat exchanger. Do not drain the heat exchanger.
2. Pressurize the closed-cooling system with a suitable pressure tester.

   NOTE: *An automotive radiator tester can be used to pressurize the closed-cooling system.*

Pressure Cap Rating	Test Pressure
103 kPa (15 psi)	131 kPa (19 psi)

3. If seawater begins to flow from the hose fitting, one or more of the tubes inside the heat exchanger is leaking and the heat exchanger needs to be replaced.

Water Blockage

⚠ CAUTION

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

IMPORTANT: The seawater flows through the tubes in the heat exchanger and the coolant flows around the tubes.
One way to determine whether the closed-cooling side of the heat exchanger is blocked is to feel the heat exchanger during the engine warm-up period. As the engine reaches normal operating temperature, the thermostat will open and start to direct the coolant from the port side of the heat exchanger across to the starboard side of the heat exchanger. The temperature change can be felt approximately 76 mm (3 in.) inboard from either end of the heat exchanger.

1. Remove the end caps and visually inspect the tubes for a blockage. If the tubes are corroded or blocked, clean the water passages by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
2. Disconnect the closed-cooling system hoses from the heat exchanger and inspect the tubes just inside the hose fitting.

   NOTE: *If the tubes are coated with mineral deposits, the deposits will act as an insulator and reduce the cooling efficiency of the heat exchanger. This may be the result of not changing the antifreeze at the proper intervals or diluting the antifreeze with water that was not de-ionized or distilled.*
3. The closed-cooling side of the heat exchanger cannot be thoroughly inspected. The heat exchanger must be replaced if it is suspected of being blocked or if the cooling efficiency is compromised.

Heat Exchanger and Crossover

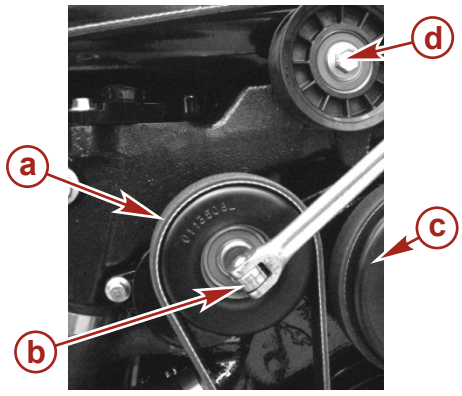
Removal

⚠ CAUTION

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

IMPORTANT: The heat exchanger is removed with the crossover as an assembly.

1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts. Drain the coolant into a suitable container.
3. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner away from the belt until it stops.
   IMPORTANT: If a belt is to be reused, it should be reinstalled with the same direction of rotation.
4. Remove the serpentine belt from the idler pulley; then slowly relieve the tension on the breaker bar and remove the belt.



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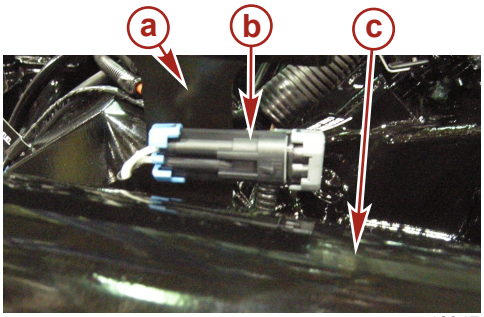
a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

5. Disconnect the coolant temperature sender connector from the engine harness.

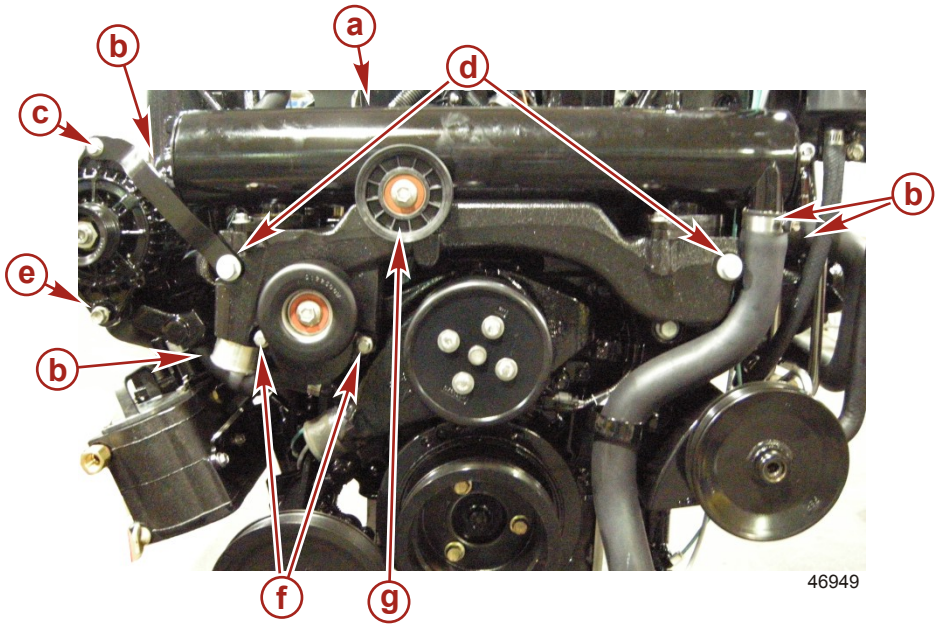


46947

a - Reservoir bracket
b - Coolant temperature sender connector
c - Heat exchanger

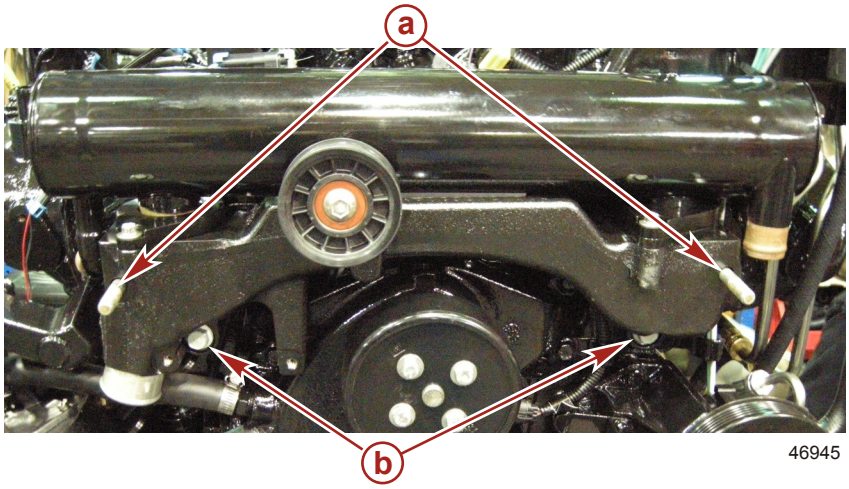
6. Remove the harness connections from the alternator.
7. Loosen the top and bottom alternator mounting bolts.
8. Remove the upper bolts securing the crossover to the cylinder heads, and install suitable alignment studs to temporarily secure the assembly during removal.
9. Rotate the alternator away from the heat exchanger.
10. Disconnect all of the hoses connected to the heat exchanger and the crossover.
11. If you are replacing the crossover, remove the idler pulley from the crossover.

12. Remove the tensioner pulley mounting bolts and tensioner pulley from the crossover.



a - Coolant temperature sender
b - Hose
c - Upper alternator bolt
d - Upper crossover bolt
e - Bottom alternator bolt
f - Tensioner pulley bolt
g - Idler pulley

13. Remove the lower mounting bolts securing the crossover.
14. Pull the crossover and heat exchanger assembly from the engine.



a - Alignment stud
b - Lower mounting bolt

Assembly and Mating Surface Inspection

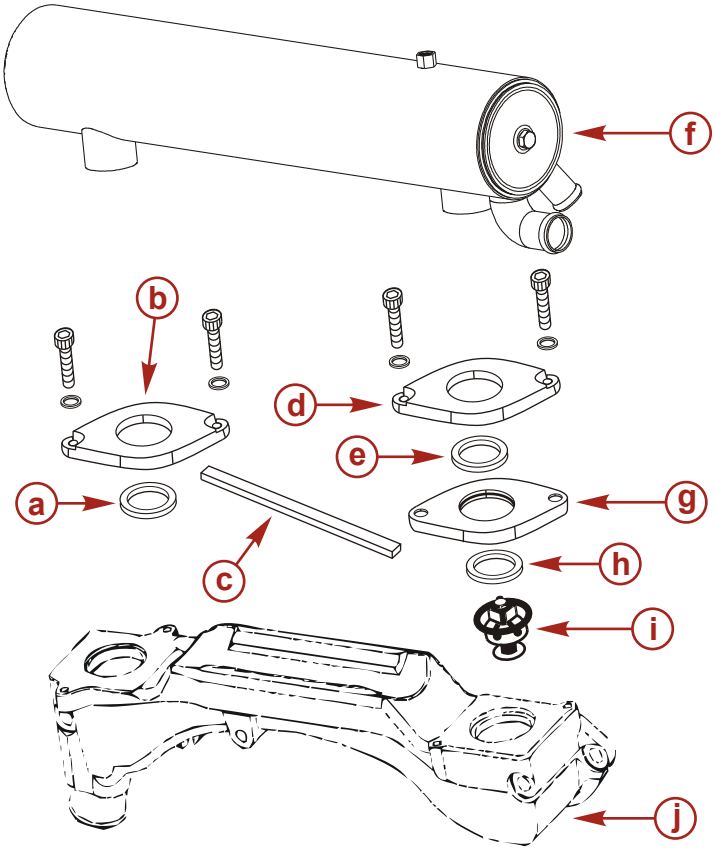
1. Clean the seal grooves with acetone or equivalent and inspect sealing surfaces for cracks or pitting.

   NOTE: *If any leak in the seal area resulted from a cracked or pitted seal surface, the cylinder head or crossover will have to be replaced.*
2. Inspect pipe plugs for cracks.
3. Inspect hose connections for wear and debris, clean or repair as needed.

Heat-Exchanger-to-Crossover Disassembly

1. Remove the heat exchanger retainer bolts.

2. Lift the heat exchanger off of the crossover and remove the thermostat assembly.

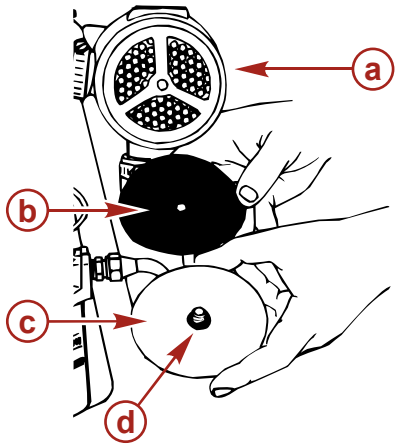


6746

a - Starboard heat exchanger seal
b - Starboard plate
c - Foam strip
d - Port upper plate
e - Port heat exchanger seal
f - Heat exchanger
g - Port lower plate
h - Thermostat seal
i - Thermostat
j - Crossover

Hear Exchanger Inspection, Cleaning, and Repair

1. Remove the end plates attached to each end of the heat exchanger.
2. Discard the O-rings and gaskets.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - O-ring

3. Inspect the tubes for damage.
   IMPORTANT: Clean the seawater section once every two years or whenever decreased cooling efficiency is suspected.
4. Clean the seawater section.
   a. Remove any gasket material from the end plates and heat exchanger.
   b. Clean each water passage with a suitable size wire brush.
   c. Remove the loose particles from the water passages with compressed air.
5. If applicable, repair a leaking tube.

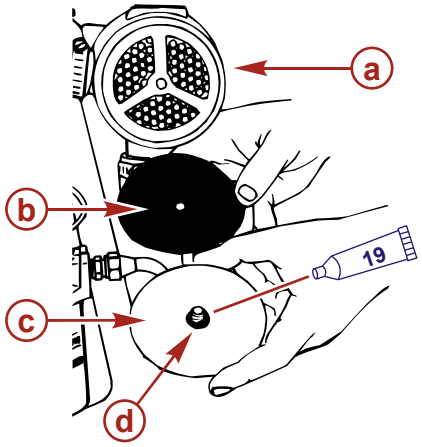
IMPORTANT: Repairing a leaking tube in the heat exchanger is a short term fix. Replace the heat exchanger as soon as practical. Do not close more than three tubes.

a. Clean and air dry the surface.
b. Protect the other joints in the vicinity of the repair.
c. Braze the tube shut at both ends with BCUP 2 rod or silver solder.

IMPORTANT: Always install new seals whenever the end covers have been removed from the heat exchanger.

6. Apply sealant to both sides of the O-ring.
7. Assemble the bolt, end plate, and O-ring as shown.

NOTE: *Be sure to install the O-ring between the end plate and the gasket.*



6748

a - Heat exchanger
b - Gasket
c - End cap
d - O-ring

8. Install the gasket between the heat exchanger and end plate assembly.
9. Hand-start the bolt and tighten to specification.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bolt threads	92-809819
19	Perfect Seal	O-rings	92-34227Q02

Description	Nm	lb. in.	lb. ft.
End plate bolts	6	54	–

Thermostat Testing

NOTE: *If coolant flow is restricted or fails to occur, repeatedly insert a wire into the drain holes to ensure that there are no obstructions in the passages.*

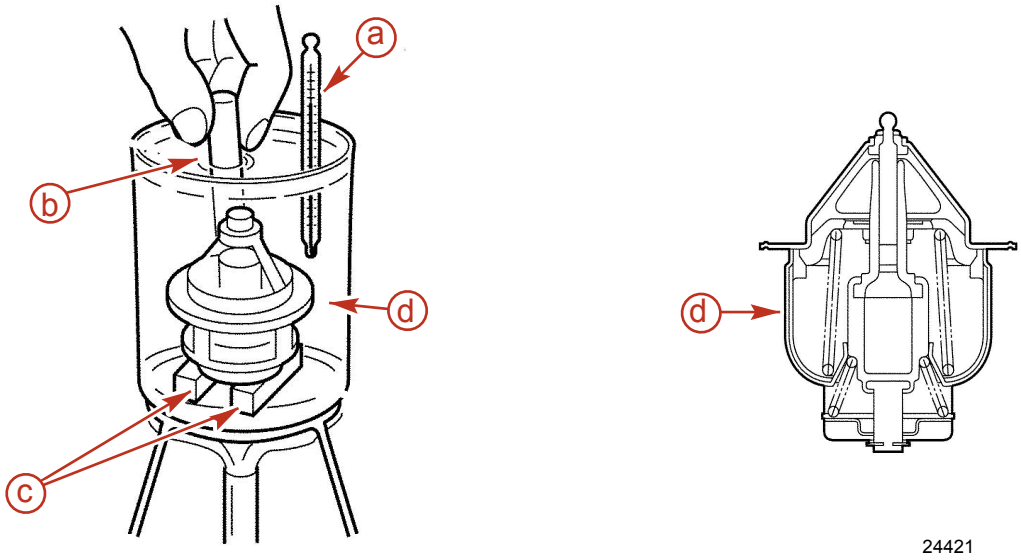
Cleaning and Inspection

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
c - Wooden blocks
d - Thermostat

Heat Exchanger to Crossover Assembly

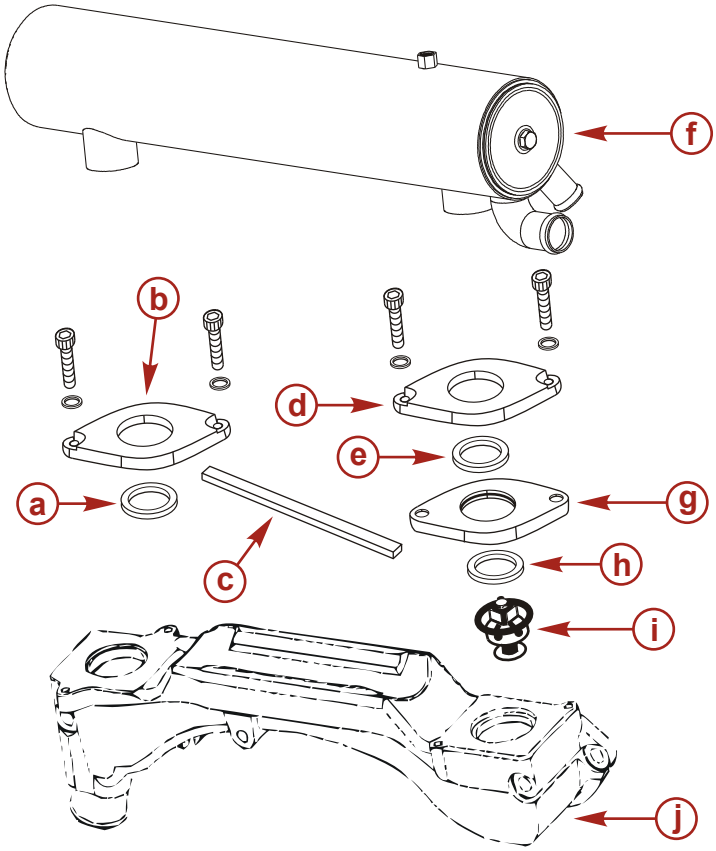
IMPORTANT: Always install a new thermostat and new seals whenever the heat exchanger has been removed from the crossover.

1. Generously lubricate the inner and outer diameters of the port and starboard heat exchanger seals with Parker SuperLube.

Description	Where Used	Part No.
Parker SuperLube	Heat exchanger seals	Obtain locally

2. Inspect the foam strips that are located on the raised supports of the crossover. If they are missing or damaged, replace them before installing the heat exchanger.
3. Install a new split-ring seal around the perimeter of the thermostat and position the thermostat into the port seal groove of the crossover. Place the lower port plate over the thermostat. The lower port plate has a seal groove on both sides.
4. Place the port and starboard upper plates onto the stems of the heat exchanger with the seal grooves facing away from the heat exchanger. Place the seals onto the stems, make sure that the seals are within the recessed area of the stem.
5. Place the heat exchanger into crossover fittings. Be careful not to pinch any wiring or hoses that are routed between the heat exchanger and the intake manifold.
6. Install and evenly tighten the heat exchanger retainer bolts.

Description	Nm	lb. in.	lb. ft.
Allen head retaining bolts	20	–	15



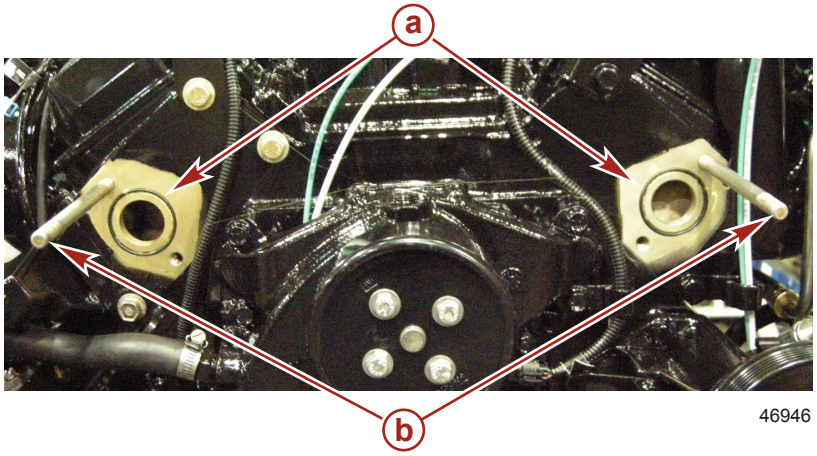
6746

a - Starboard heat exchanger seal
b - Starboard plate
c - Foam strip
d - Port upper plate
e - Port heat exchanger seal
f - Heat exchanger
g - Port lower plate
h - Thermostat seal
i - Thermostat
j - Crossover

Installation

IMPORTANT: The heat exchanger is installed with the crossover as an assembly.
IMPORTANT: Always use new seals when you are installing the crossover.

1. Install the alignment studs if removed.
2. Coat one side of the crossover-to-cylinder head O-rings with bellows adhesive and position them in the seal grooves.



46946

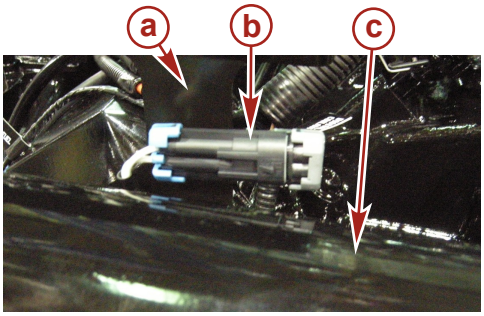
a - O-rings
b - Alignment studs

3. Carefully slide the assembly over the alignment studs and hand-start the bottom two bolts in the crossover.
4. Remove the alignment studs and install the upper mounting bolts.
5. Tighten all crossover mounting bolts to specification.

Description	Nm	lb. in.	lb. ft.
Crossover mounting bolts	66	–	49

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Crossover mounting bolts	92-809822

6. Connect the engine harness to the coolant temperature sender.



46947

a - Reservoir bracket
b - Coolant temperature sender connector
c - Heat exchanger

7. Connect all the hoses. Tighten all hose clamps securely.
8. Align the tensioner assembly to the mount holes in the crossover and hand-start the two bolts previously removed. Push the tensioner upward and hold it in place while tightening the bolts to specification.

Description	Nm	lb-in.	lb-ft
Tensioner assembly to crossover	19	–	14

9. Install the tensioner pulley onto the shaft of the tensioner and hand-start the bolt.
10. Install the idler pulley onto the upper shaft on the crossover and hand-start the bolt.
11. Tighten the idler and tensioner pulley bolts to specifications.

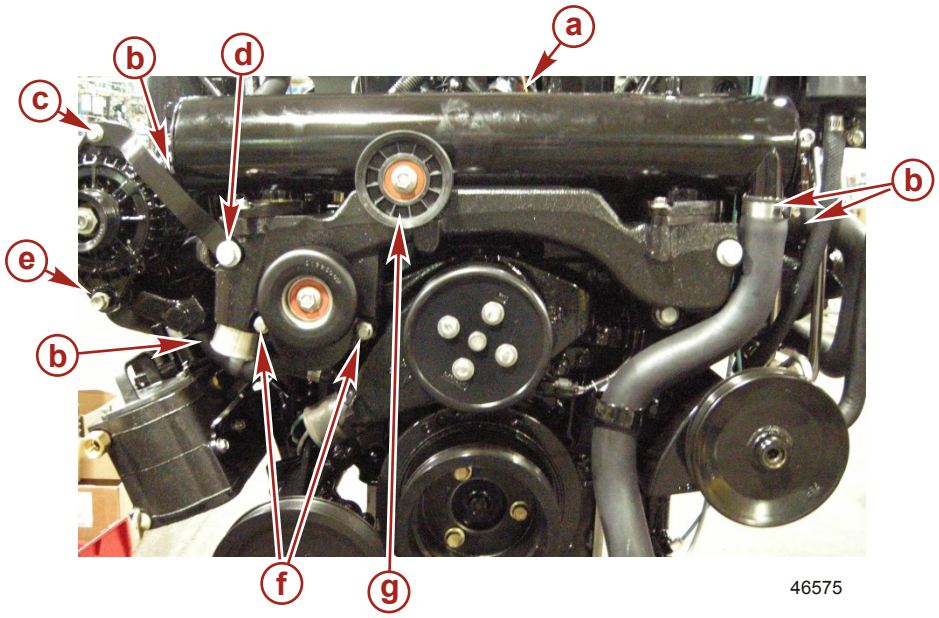
Description	Nm	lb-in.	lb-ft
Bolt on idler pulley	35	–	26
Bolt on tensioner pulley			

12. Install the bolt securing the alternator brace to the crossover and tighten to specification.

Description	Nm	lb-in.	lb-ft
Bolt on alternator to crossover	27	–	20

13. Tighten the bolts securing the alternator to specification.

Description	Nm	lb-in.	lb-ft
Alternator to bracket bolts	27	–	20



a - Coolant temperature sender
b - Hose
c - Bolt top alternator
d - Bolt alternator brace
e - Bolt bottom alternator
f - Tensioner pulley assembly
g - Idler pulley

14. Install the serpentine belt. Refer to **Serpentine Belt Routing and Tension Adjustment.**
15. Refill the closed cooling system.

NOTICE

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

16. Start the engine and check for leaks.

Circulating Pump and Serpentine Belt

Circulating Pump

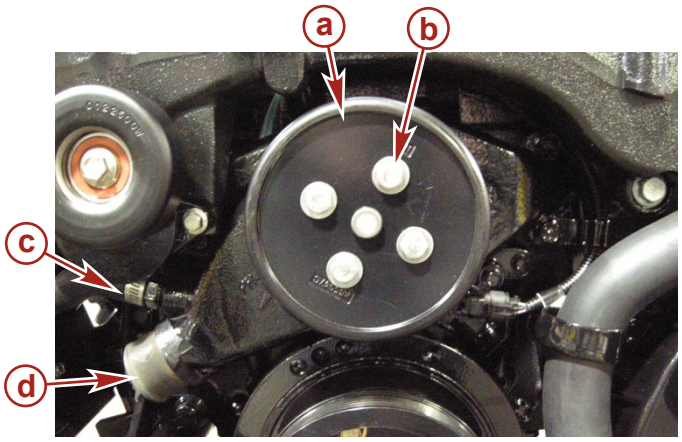
Removal

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the coolant into a suitable container and dispose of the coolant according to the local recycling regulations.
4. Loosen the bolts securing the circulating pump pulley.
5. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner away from the belt until it stops.
6. Remove the belt and return the tensioner to its original position.

7. Remove the pulley bolts and pulley from the pump.



46576

a - Pulley
b - Bolts
c - Sensor
d - Circular pump hose fitting

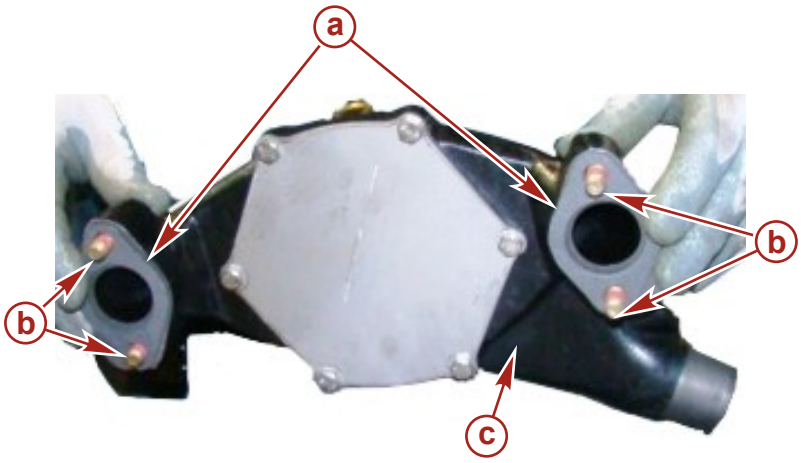
8. Remove the heat exchanger and crossover assembly. Refer to **Heat Exchanger and Crossover Assembly**.
9. Disconnect the reservoir hose at the pump.
10. Remove the pump mounting bolts.
11. Remove the pump and the gaskets.

Cleaning and Inspection

1. Clean the gasket surfaces on the water pump and engine block.
2. Inspect the pump pulley for damage. Replace the pulley if damaged.
3. Replace the circulating pump if the passages are blocked, the impeller is cracked or eroded, or if the impeller shaft or bearings have any side play.

Installation

1. Place the bolts in the pump mount holes. Add the J-clip in the location it was removed from.
2. Align the gaskets on the pump.

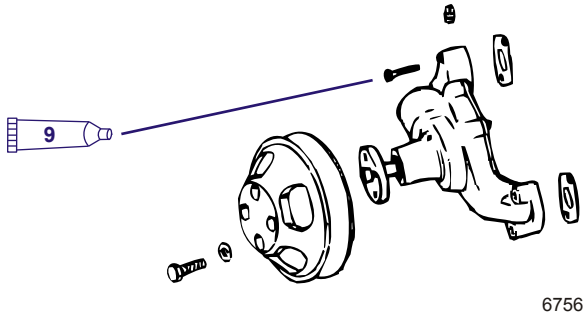


46577

a - Gasket
b - Bolt
c - Back side of circulating pump

3. Position the gaskets and circulating pump on the cylinder block.
4. Insert the bolts and tighten them to specification.

NOTE: *Circulating pump mounting bolts that are not precoated with sealant require sealant on threads before installation.*



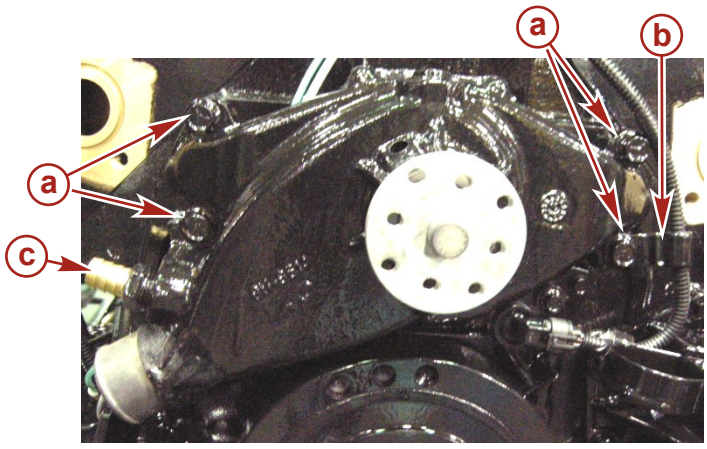
6756

Typical

Description	Nm	lb. in.	lb. ft.
Circulating pump mounting bolts	41	–	30

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Circulating pump mounting bolts	92-809822

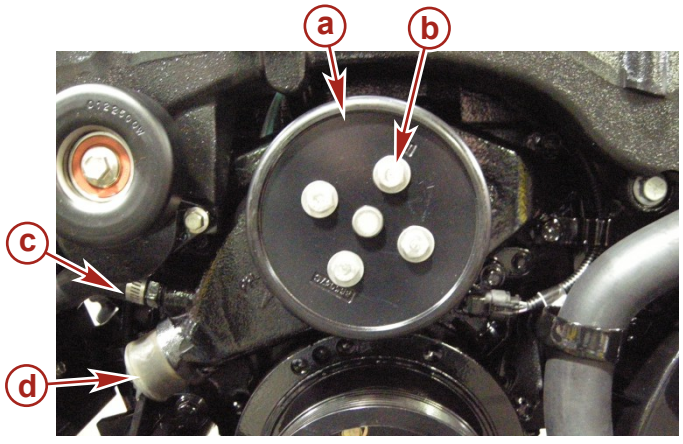
5. If applicable, remove the brass hose fitting from the pump that was removed and install it to the new replacement pump.
6. Install the reservoir hose on the hose fitting on the pump.



46578

a - Circulating pump mounting bolt
b - J-clip
c - Hose fitting

7. Install the heat exchanger and crossover assembly. Refer to **Heat Exchanger and Crossover Assembly**.
8. Install all hoses previously removed and tighten the hose clamps.
9. Install the pump pulley and bolts. Tighten the bolts to specification.



46576

a - Pulley
b - Bolts
c - Sensor
d - Circular pump hose fitting

Description	Nm	lb-in.	lb-ft
Circulating pump pulley bolts	47	–	35

10. Install the serpentine belt. Refer to **Serpentine Belt Routing and Tension Adjustment**.

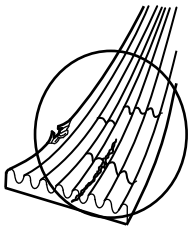
Serpentine Belt Routing and Tension Adjustment

⚠ WARNING

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

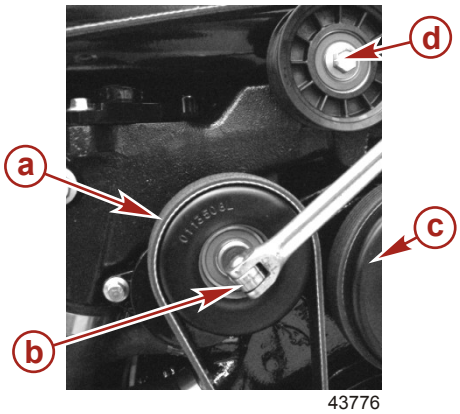
1. inspect the drive belt for:
   - Excessive wear
   - Proper tension
   - Fraying
   - Glazed surfaces
   - Cracks

   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.*



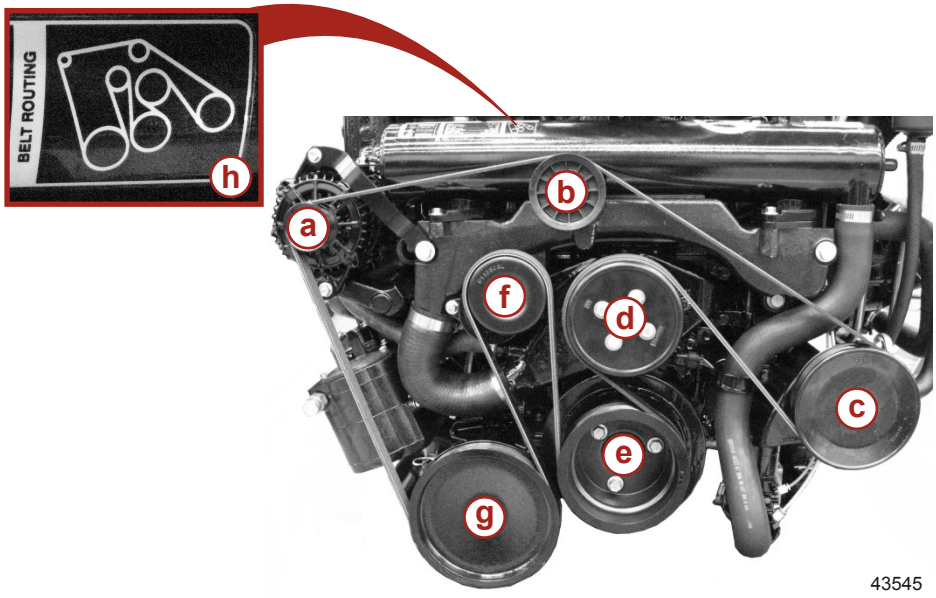
21062

2. Route the serpentine belt according to the belt routing diagram.
3. Use a breaker bar and appropriate socket to rotate the tensioner away from the belt until it stops.
4. Route and install the belt on the idler pulley and slowly relieve the tension on the breaker bar. Ensure that the belt stays positioned properly.



43776

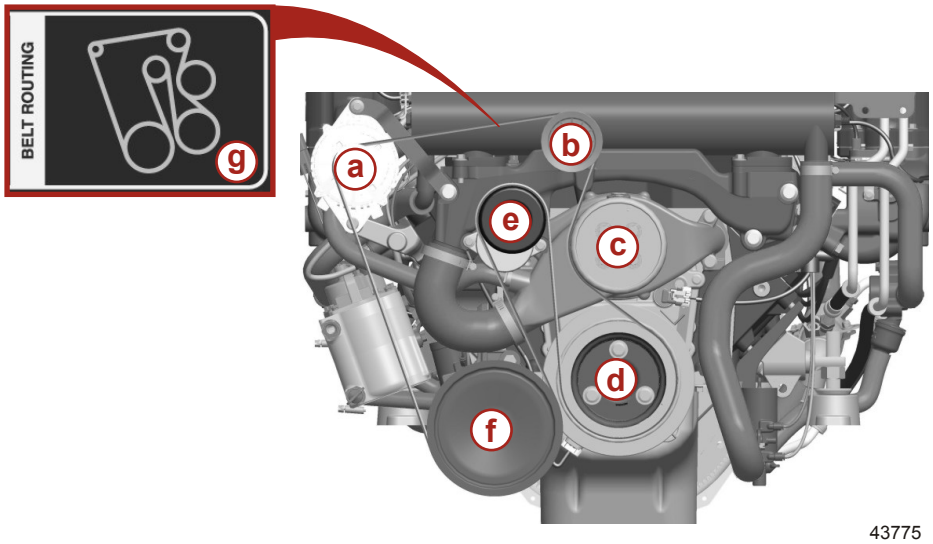
a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley



43545

MCM Models

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram



43775

MIE Models

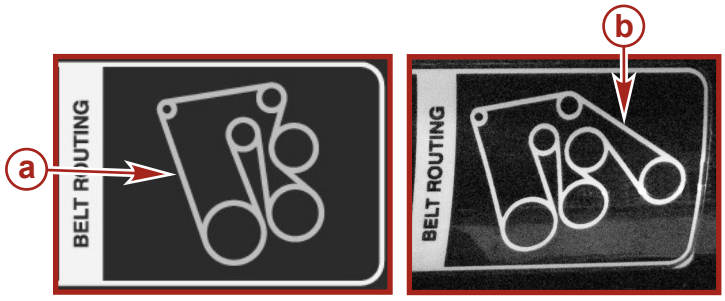
- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

5. Check the belt tension.

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

Belt Tension Gauge	Kent Moore BT-33-73-F

Description	
Deflection	13 mm (1/2 in.)



47236

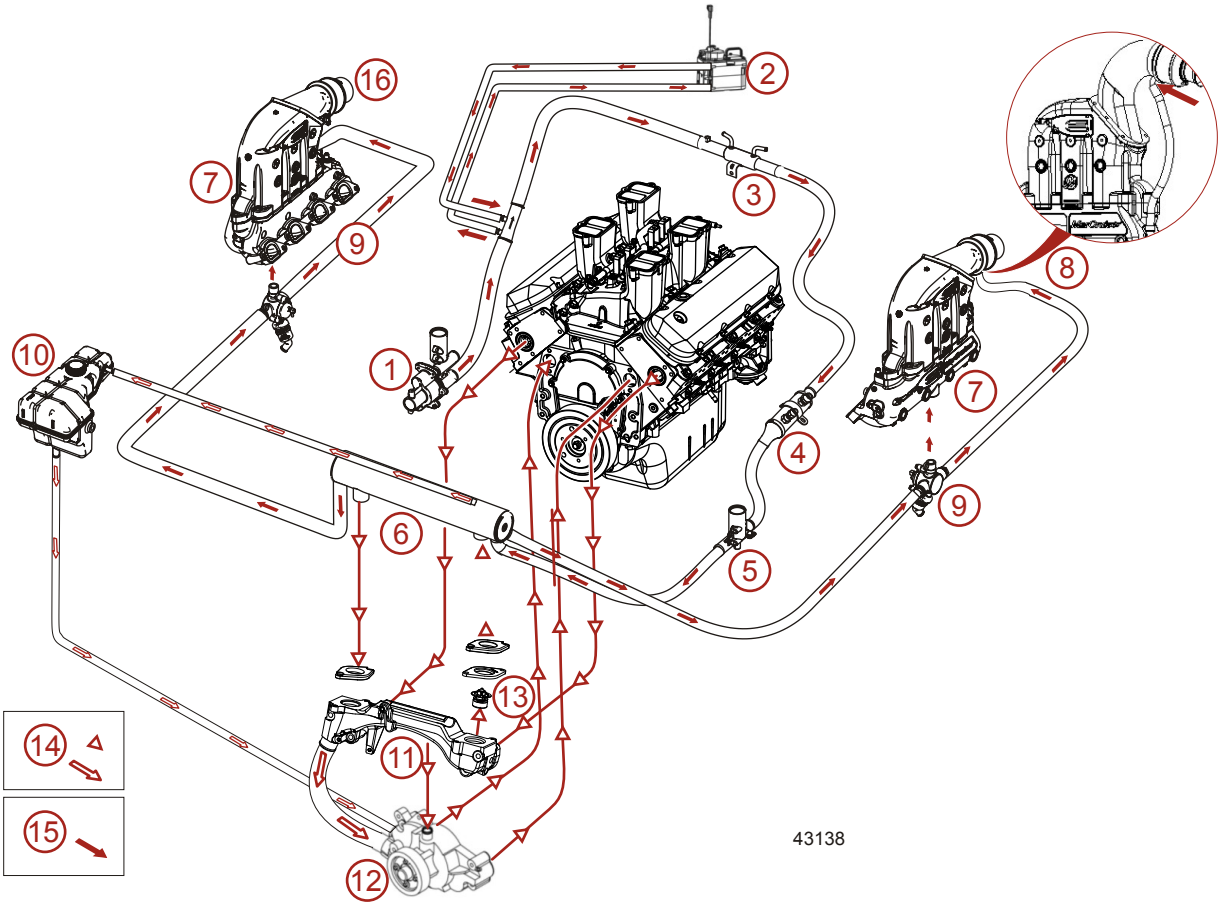
Measure deflection

- **a -** MIE models
- **b -** MCM models

Water Flow Diagram

8.2 Sterndrive Models—Water Flow Diagram

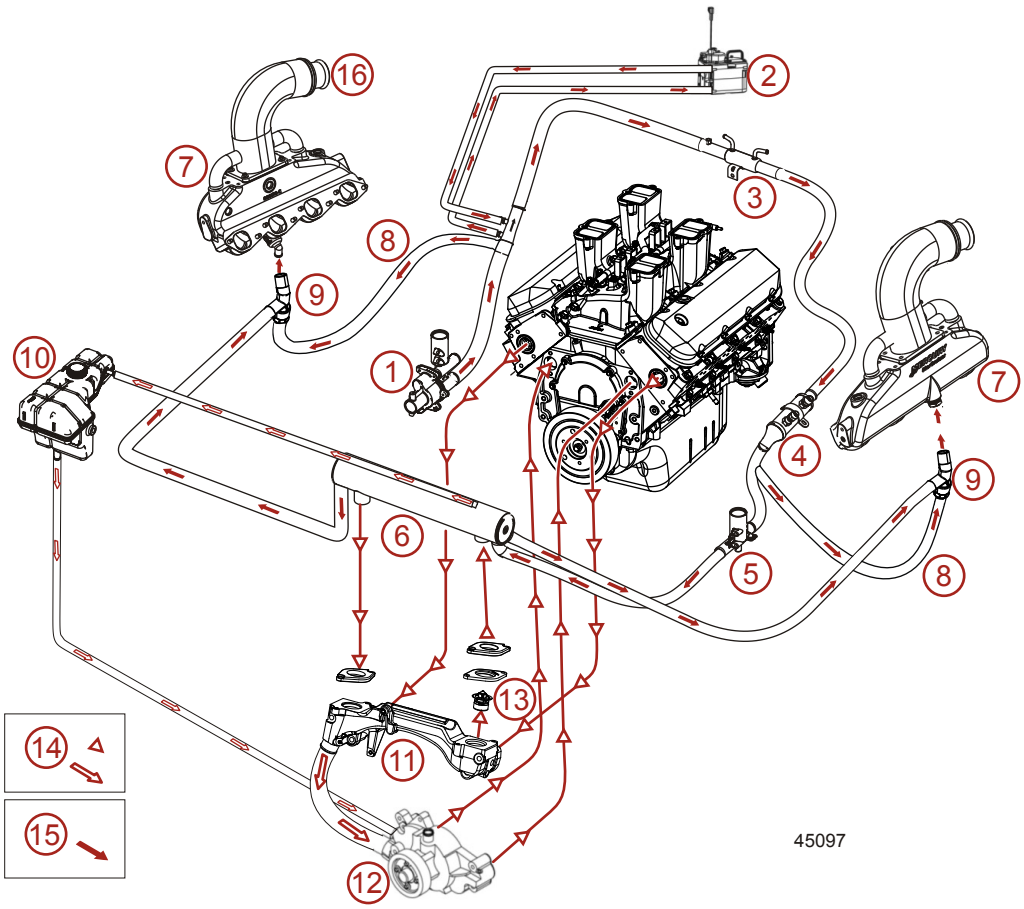
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Power steering cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Water Flow Diagram—8.2 Mag and 8.2 Mag H.O. Models

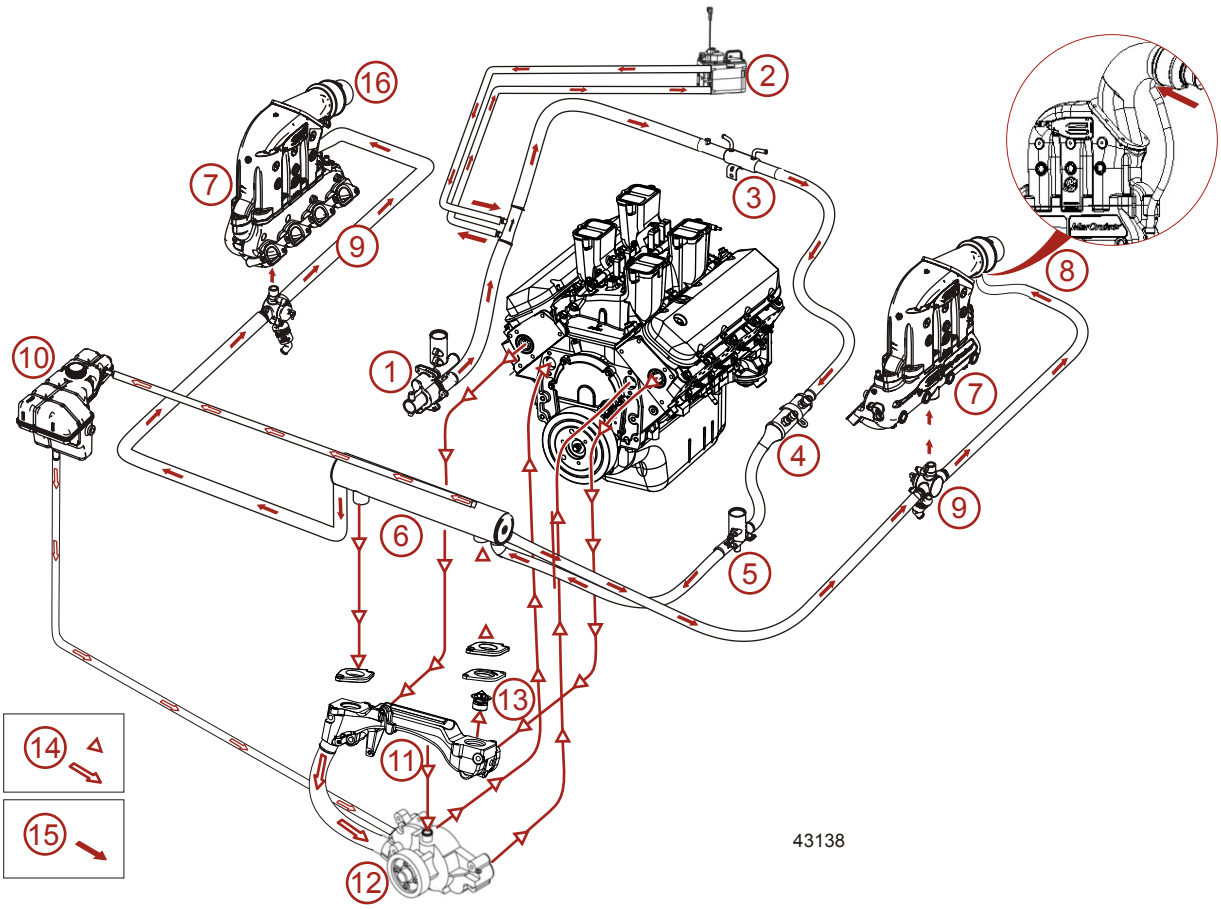
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and starboard water drain valve
2 - Fuel supply module
3 - Steering fluid cooler
4 - Oil cooler
5 - Port seawater drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Exhaust water drain hose (only functions during seawater drain)
9 - Check valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Ethylene coolant flow
15 - Seawater flow
16 - Exhaust outlet

Water Flow Diagram—8.2 H.O. and Horizon 8.2 Models With Emissions Control

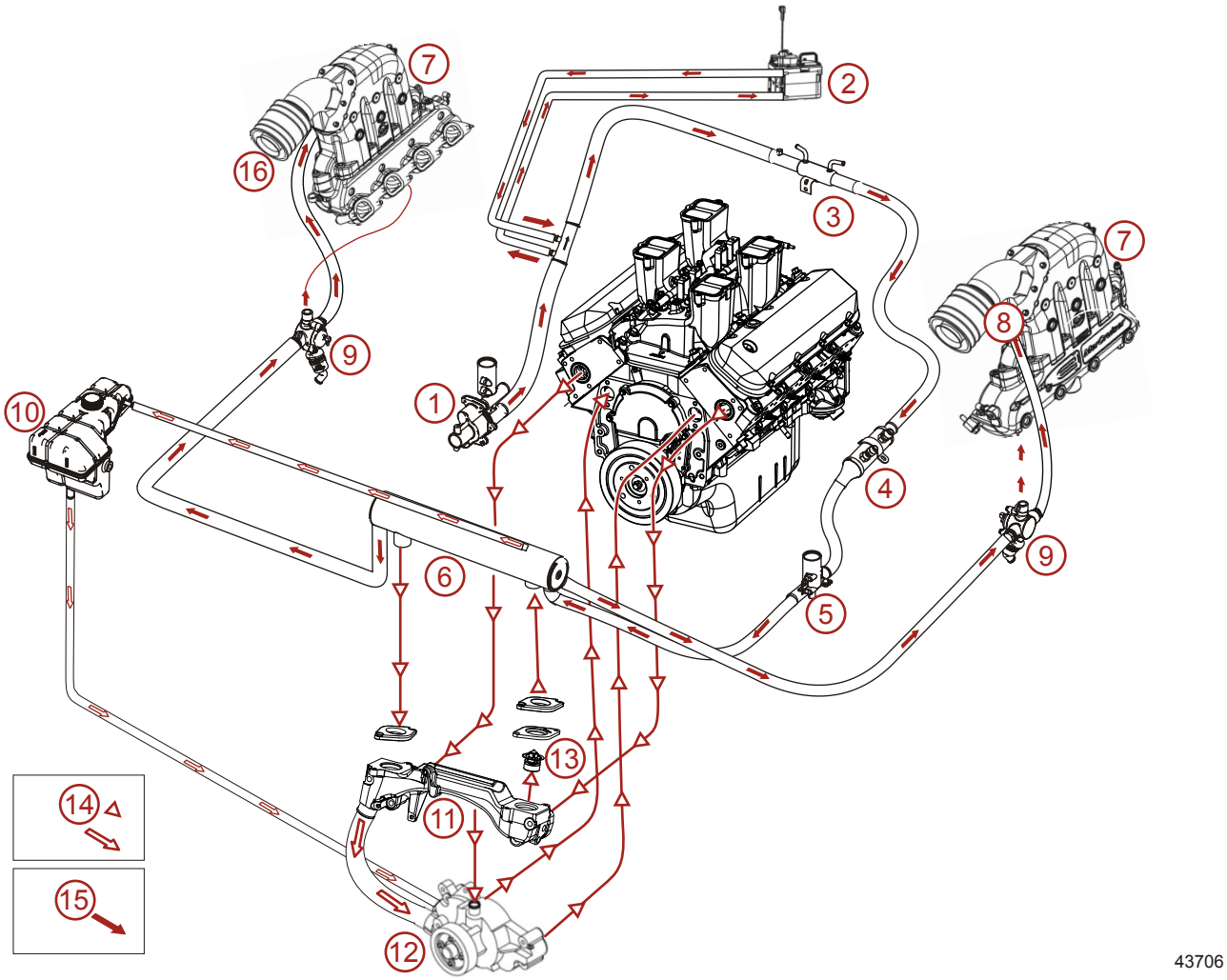
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Transmission cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Water Flow Diagram—8.2 V-Drive Models With Emissions Control

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Transmission cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Notes:

Exhaust System

Section 7A - Models With Emissions Control

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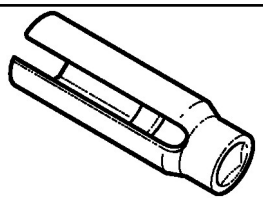
7A

Special Tools

Kent-Moore Oxygen Sensor Socket	KN-46577
 32314	Kent-Moore socket (or equivalent 7/8 in. automotive oxygen sensor socket) Aids in the removal and installation of oxygen sensors on products equipped with Emissions Control.

General Information

Exhaust System Caution

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boat builder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Exhaust Emissions Sampling

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

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

45323

Access area for exhaust gas sampling

Preventing Contamination of the Emissions Control System

Catalyst and oxygen sensors can become contaminated, leading to component failure. Phosphorus, found in some marine-grade oils, and other compounds will damage or destroy a catalyst's ability to clean the exhaust. Catalyst-friendly oil, like Mercury Full Synthetic MerCruiser Engine Oil, prevents this damage. Approved synthetic oils must be used in MerCruiser engines with Emissions Control.

NOTICE

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

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

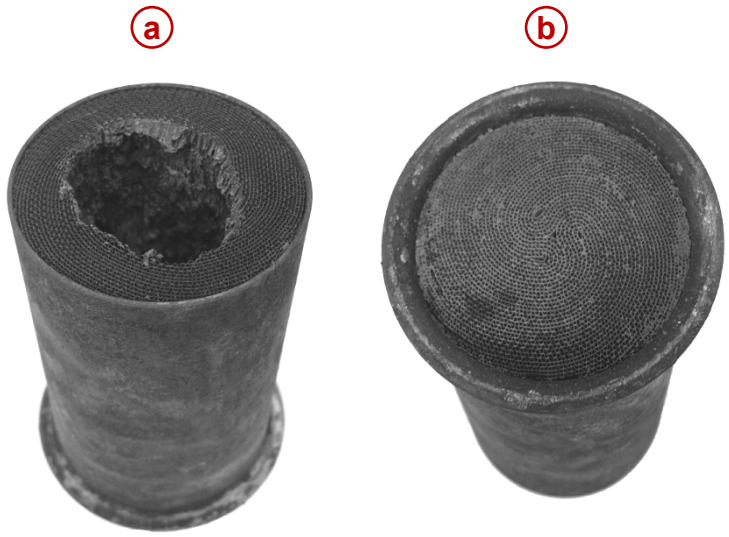
Determining Catalyst Health

Inspect the catalyst for damage whenever disassembling the exhaust system or if computer diagnostic software determines that an oxygen sensor's values are out of range. Examples of damaged catalysts are shown below.

When inspecting catalysts for damage, be aware of the following:

- In many cases, the damage may not be apparent on the upstream end. Check both the upstream and downstream sides of the catalyst.
- Replace the catalyst if it appears damaged in any way.

Damaged Catalysts

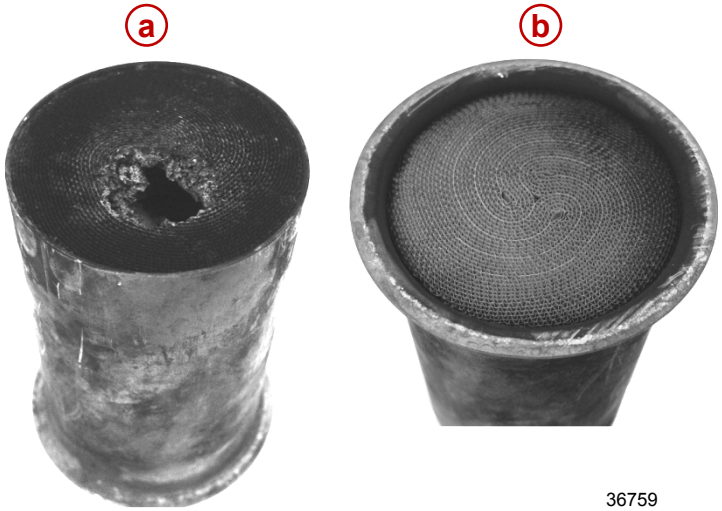


36757

Catalyst damage due to a faulty coil

a - Upstream side of catalyst

b - Downstream side of catalyst

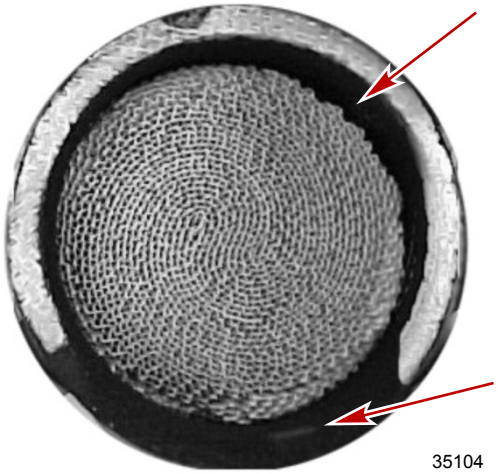


36759

Catalyst damage due to a faulty coil wire

a - Upstream side of catalyst

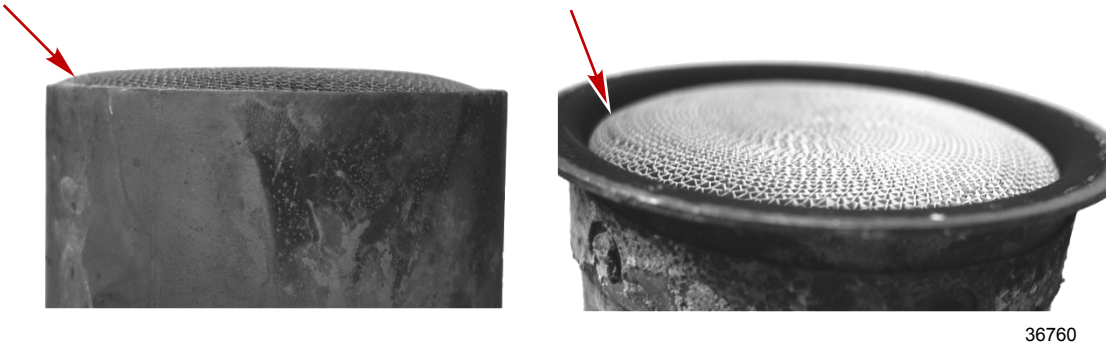
b - Downstream side of catalyst



Catalyst damage due to running out of fuel

Normal Conditions

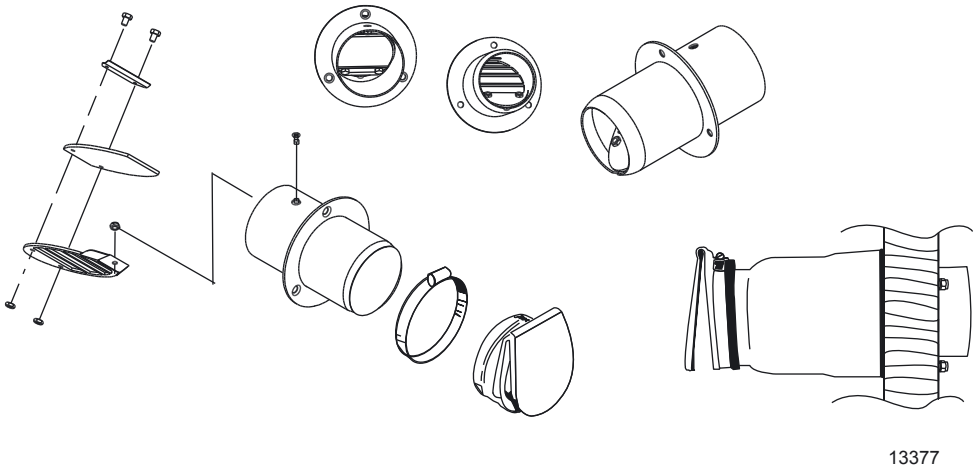
Catalysts that have experienced substantial run times may exhibit a raised substrate, as shown below. This is a normal condition called "crowning", and it does not indicate a damaged catalyst.



Crowning (normal)

Through-Hull Exhaust Fittings

Exhaust fittings (flanges, outlets) must be equipped with an internal shutter and external flapper to prevent water intrusion problems. This is a requirement on all applications except water lift mufflers, where it is still recommended. A variety of fittings are available through the Mercury Precision Parts and Accessories Guide.



Reference Note

Refer to the appropriate **Mercury MerCruiser Product Applications Manual** for more in depth diagnosis and set up installation of the exhaust systems.

Measuring Exhaust Elbow Height

General Information

Install exhaust elbows within specification to prevent water intrusion. Install exhaust elbow risers as needed to obtain the proper exhaust elbow height and exhaust angle. Risers must not exceed 203 mm (8 in.). Take all measurements with the boat in the water and loaded to simulate the maximum loading conditions for normal operation.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not the water line outside of the boat. Refer to Water Lift Muffler for instructions.
IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boat builders must communicate any load distribution conditions that affect the exhaust system, such as maximum occupancy of the swim platform, to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Model	Minimum Exhaust Elbow Height
8.2 Sterndrive Models	33 cm (13 in.)
8.2 Inboard Models	38 cm (15 in.)

Model	Minimum Exhaust Hose Slope within 46 cm (18 in.) of engine	Minimum Exhaust Hose Slope Remainder of system (if applicable)
8.2	10°	3°

If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to Mercury Precision Parts' **Accessories Guide** for part numbers.

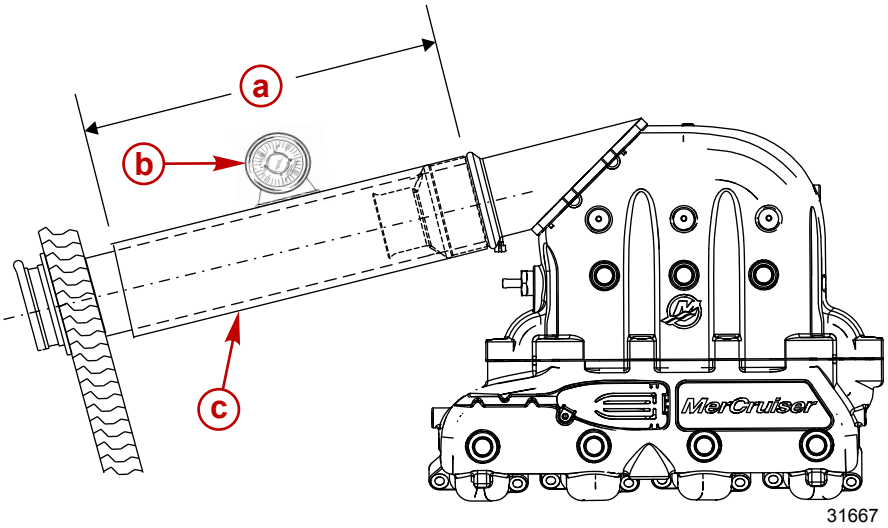
The maximum exhaust riser height is specified in the table below.

Maximum Exhaust Riser Height			
Model	**Low**	**Medium**	**High**
8.2	51 mm (2 in.)	102 mm (4 in.) 152 mm (6 in.)	203 mm (8 in.)

Model	Exhaust Hose or Tube length
8.2 Sterndrive Models	30 cm (12 in.)
8.2 Inboard Models	46 cm (18 in.)

Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet, continuing along each section to the exhaust exit point of the boat. Perform all exhaust angle measurements with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. See **Loading Requirements**.



Typical Exhaust

- **a -** Length of exhaust hose or tube
- **b -** Inclinometer
- **c -** Exhaust hose or tube

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on non-production boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**
- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**
- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boat builder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at OEM boat builders must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long that do not have a maximum rated swim platform weight capacity, must add181.45 kg (400 lb) to the swim platform .

c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.

d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity must add 226.80 kg (500 lb) to the swim platform.

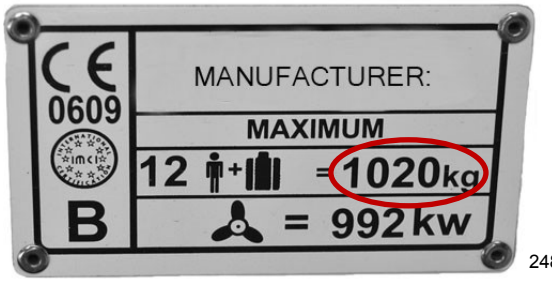
Loading the Boat (Boats with a Capacity Plate)

For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lb. Persons, Gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb.) per person. This gives the whole number and remainder of 74.84 kg (165 lb.) persons to load onto the boat.
3. Put the remainder of a person in the next available seat. See **Boat loading diagram**.



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CE Capacity Plate

24861

USCG Capacity Plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.

9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: *The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.*

NOTE: *The following example is provided as a reference.*

Example

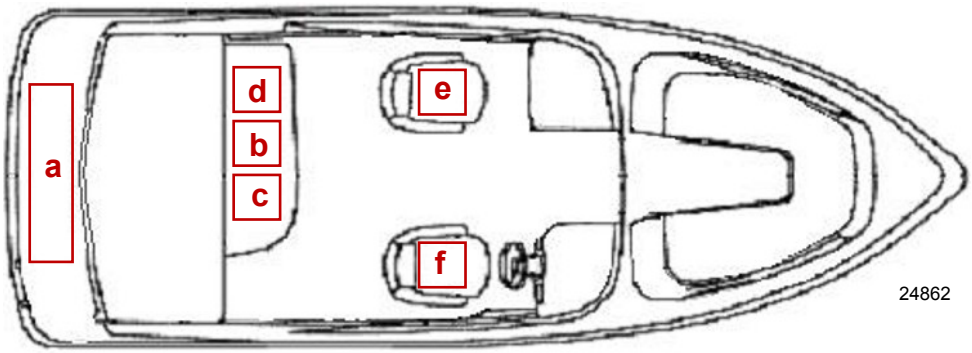
NOTE: *This example uses a boat that is less than 8.84 m (29 ft.) long, not including a boat that is 8.84 m (29 ft.) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 Kg (400 lb.) to the swim platform*

NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb. – 400 lb. = 700 lb.
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat
   - 700 lb. ÷ 165 lb. = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight
   - 0.24 × 165 lb. = 40 lb.

   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
5. Using the totals in this example, load four 165-lb. persons and one 40-lb. person onto boat seating with 400 lb. on the swim platform.

- 400 lb. + 165 lb. = 565 lb.
- 565 lb. + 165 lb. = 730 lb.
- 730 lb. + 165 lb. = 895 lb.
- 895 lb. + 165 lb. = 1060 lb.
- 1060 lb. + 40 lb. = 1100 lb.



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats Without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb. per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb. (MerCruiser person weight) = XXXX lb. maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb. per person. This gives the number of 165-lb. persons to load onto the boat. Round up to next whole number. See **Example 3**.
   IMPORTANT: To account for cargo, add a weight of 25 lb. per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb. by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

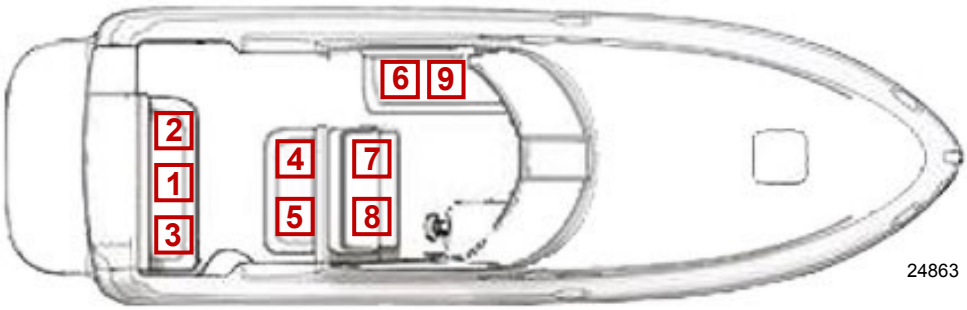
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: *The following example is provided as a reference.*
This example uses a boat that is 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 Kg (500 lb.) to the swim platform .

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



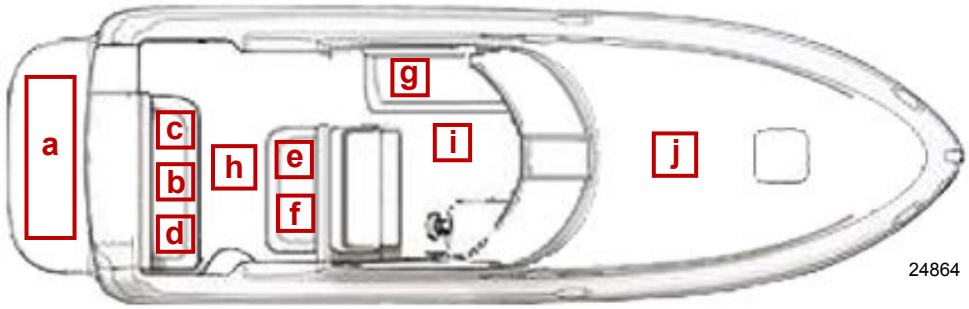
Designated Seating Diagram

This example uses 9 persons as the maximum passenger load.

NOTE: Use 0.50 lb. as the break point to round up or down to obtain a whole pound.

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb. = 225 lb.
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%
   a. 225 lb. × 50% = 112.50 lb.
   b. 112.50 lb. rounded up = 113 lb.
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%
   - 225 lb. × 25% = 56.25 lb.
   - 56.25 lb. rounded down = 56 lb.
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb. (MerCruiser person weight) to get a 1485 lb. (total passenger load)
   - 9 passengers × 165 lb. = 1485 lb.
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb. – 500 lb. = 985 lb.
7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb. ÷ 165 lb. = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb. cargo in the aft storage, 113 lb. cargo in the center storage, and 56 lb. cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb. passengers, onto the boat with 500 lb. on the swim platform.

- 500 lb. + 225 lb. = 725 lb.
- 725 lb. + 165 lb. = 890 lb.
- 890 lb. + 165 lb. = 1055 lb.
- 1055 lb. + 165 lb. = 1220 lb.
- 1220 lb. + 165 lb. = 1385 lb.
- 1385 lb. + 165 lb. = 1550 lb.
- 1550 lb. + 165 lb. = 1715 lb.

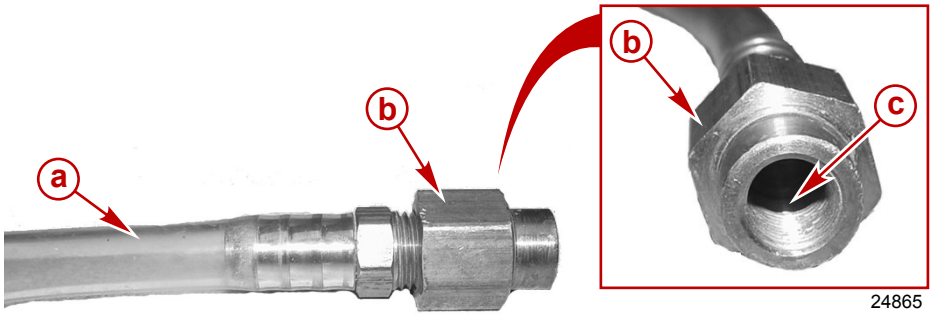


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

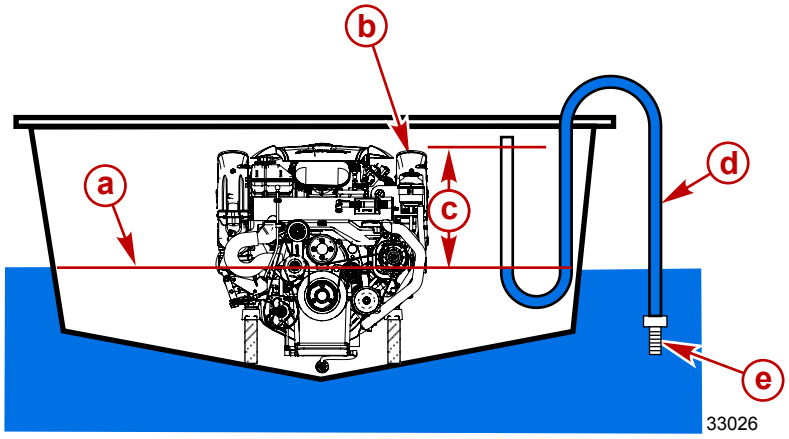
1. Obtain an 8–10 mm (5/16–3/8 in.) inner diameter (ID) clear hose approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.
4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust manifold collector and elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



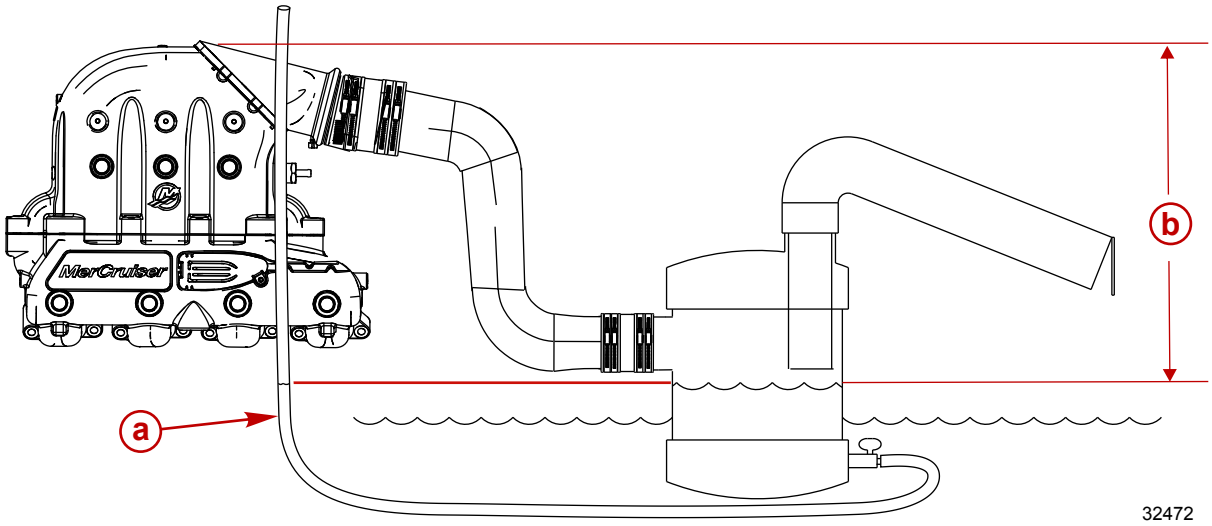
a - Waterline
b - Top of exhaust elbow
c - Waterline to top of exhaust elbow measurement
d - Clear hose
e - Weight

Clear Hose Measurement Method From Seacock or Muffler Drain

IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.
IMPORTANT: The engine must have been operated previously to fill the muffler with water.
IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.

7. Slowly take the finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep the hose close to the exhaust elbow and as vertical as possible.
8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height. The maximum riser height is 20.3 cm (8 in.) on 8.2 models.

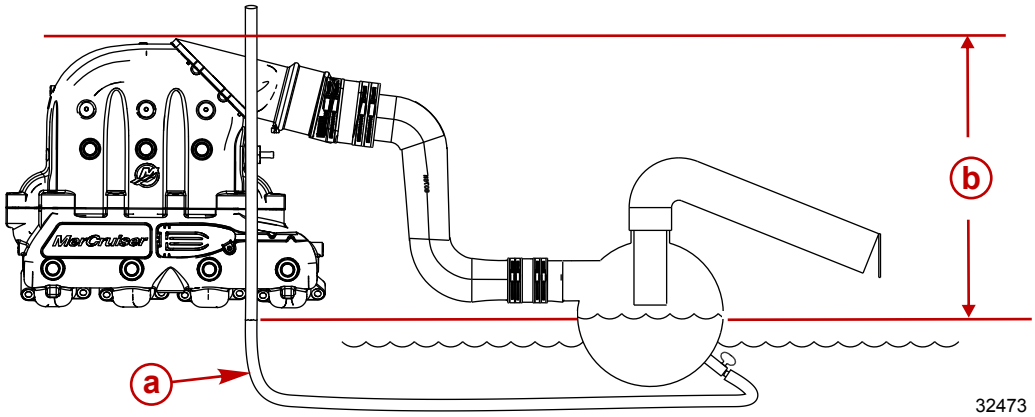


Typical vertical water lift muffler

a - Clear hose for measuring waterline

b - Minimum exhaust elbow height with maximum load

IMPORTANT: Horizontal waterlift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



Typical horizontal water lift muffler

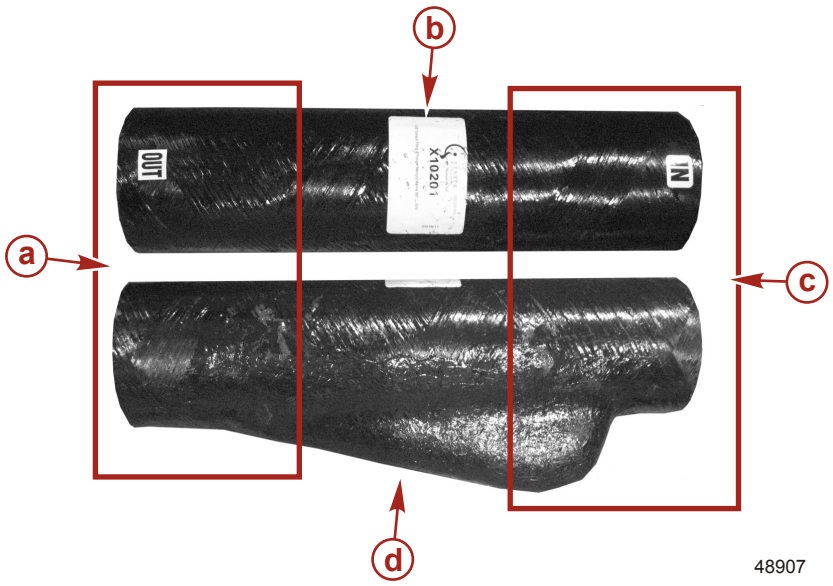
a - Clear hose for measuring waterline

b - Minimum exhaust elbow height with maximum load

Exhaust Diverter Tube on 8.2 Inboard

IMPORTANT: MerCruiser specifies a minimum distance of 457 mm (18 in.) from the exhaust elbow to the exhaust hose.

IMPORTANT: To function properly, the end of the tube marked "IN" is positioned toward the engine exhaust elbow with the deepest portion of the diverter tube facing straight down. Do not cut or modify the diverter tube.



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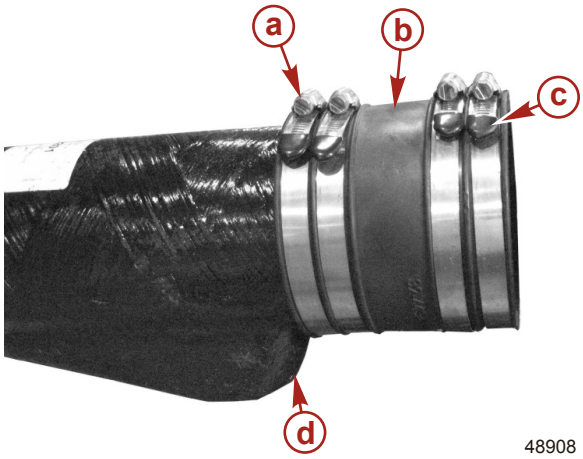
- **a -** End of diverter tube marked "OUT"
- **b -** Top view of diverter tube
- **c -** End of diverter tube marked "IN"
- **d -** Side view of diverter tube

1. Install the exhaust tube on the inlet side of the diverter tube.
   a. Place four hose clamps on the exhaust tube with the screw heads facing the same direction.
   b. Install a hose clamp cover on the hose clamps.
   c. Push the exhaust tube onto the end of the diverter tube marked "IN".



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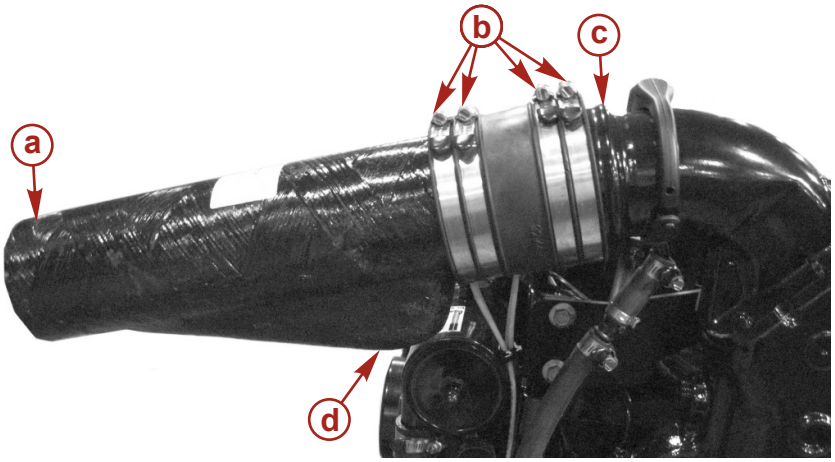
- **a -** Hose clamp (4)
- **b -** Exhaust tube
- **c -** Rubber tips
- **d -** End of diverter tube marked "IN"

2. Install the exhaust tube and diverter tube assembly on the exhaust elbow on the engine. Position the deepest portion of the tube facing straight down.
3. Ensure that the screw head on the hose clamps are facing toward the outside of the engine and the exhaust tube is against the ridge on the exhaust elbow.

4. Tighten the hose clamps to specification.



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Side view

- **a -** End of diverter tube marked "OUT"
- **b -** Hose clamp (4)
- **c -** Ridge
- **d -** Correct straight down position of deepest portion

Description	Nm	lb-in.	lb-ft
Hose clamp	4	35	–

Inboard and Service Exhaust Elbow

This elbow is installed on the 8.2 inboard models at the factory and will supersede all exhaust elbows for 8.2 service replacement parts, including the 8.2 sterndrive models.

The elbow is not installed on the 8.2 sterndrive models at the factory but is used as a replacement part through the service department.

49547

8.2 Inboard and service exhaust elbow

Risers on Emission Controlled Models

Additional Parts Required—Intermediate Exhaust Elbow Kit

IMPORTANT: Standard sterndrive applications with through-the-propeller exhaust systems require intermediate exhaust elbow kits. See the following table for your specific application.

NOTE: *The exhaust elbow riser kit 0 mm (0 in.) is only available for the 8.2 L Inboard V-drive models.*

Riser Extension Height	Exhaust Elbow Riser Kit	Required Intermediate Exhaust Elbow Kit (Order Separately)
0 mm (0 in.)	8M0062050 (Inboard V-drive models)	–
54 mm (2 in.)	8M0062051	44267A05
108 mm (4 in.)	8M0062052	44267A06
161 mm (6 in.)	8M0062053	44267A07
215 mm (8 in.)	8M0062054	44267A08

Parts List

These kits contain two of each listed riser, hose, and gasket.

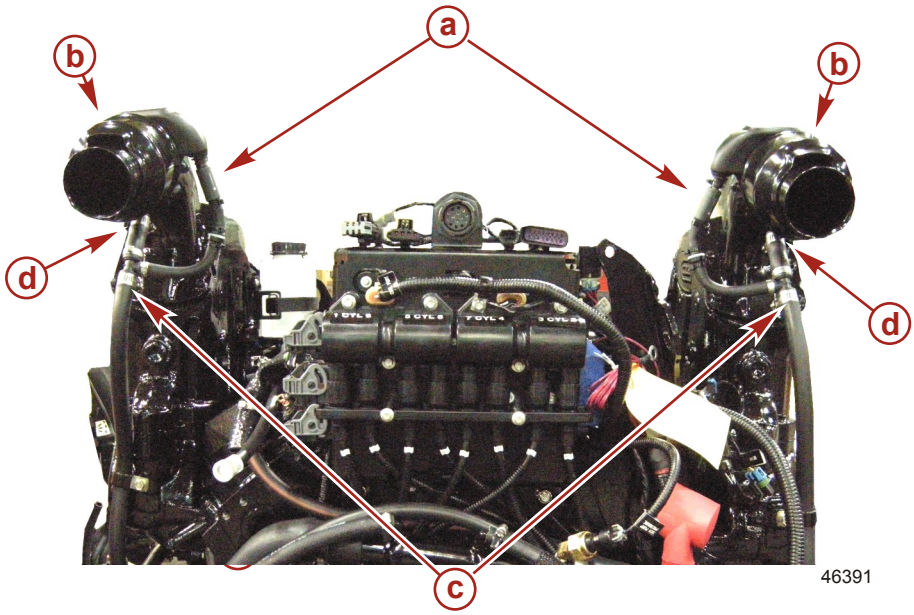
Kit Number	Riser Extension Height	Riser Part Number	Hose Part Number	Riser Gasket Part Number
8M0062050	0 mm (0 in.)	8M8027561	32-807498400	27-8M2003931
8M0062051	51 mm (2 in.)	8M8027562	32-807498400	27-8M2003931
8M0062052	108 mm (4 in.)	8M8027564	32-807498400	27-8M2003931
8M0062053	161 mm (6 in.)	8M8027566	32-8M2012906	27-8M2003931
8M0062054	215 mm (8 in.)	8M8027568	32-8M2012906	27-8M2003931

Vent Valve

IMPORTANT: The vent valve and vacuum breaker valve on each exhaust elbow must be replaced once every three years or every 300 hours of operation.

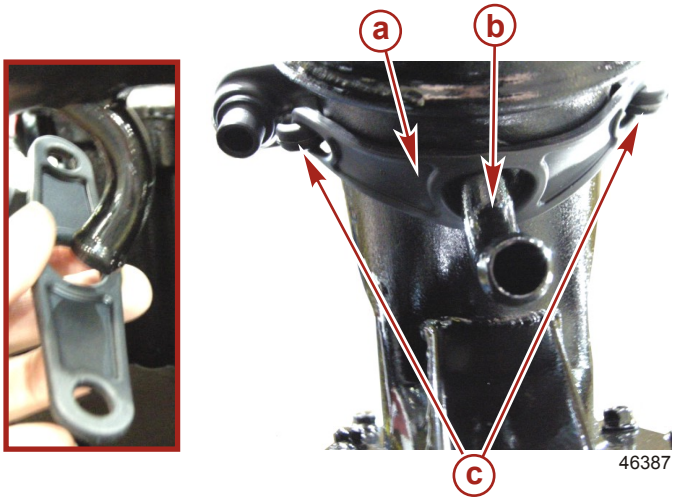
Removal

1. Remove the worm-gear hose clamp and hose at the T-fitting and the water fitting on the exhaust elbow.



a - Vacuum breaker valve
b - Air inlet hole
c - Worm-gear hose clamp at T-fitting
d - Worm-gear hose clamp at the water fitting

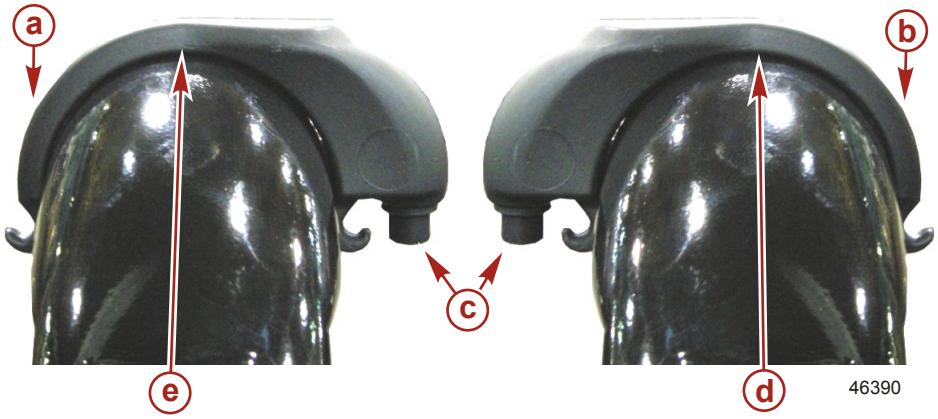
2. Remove the rubber strap from the water fitting on the exhaust elbow and the reservoir hooks.



a - Rubber strap
b - Water fitting
c - Reservoir hook

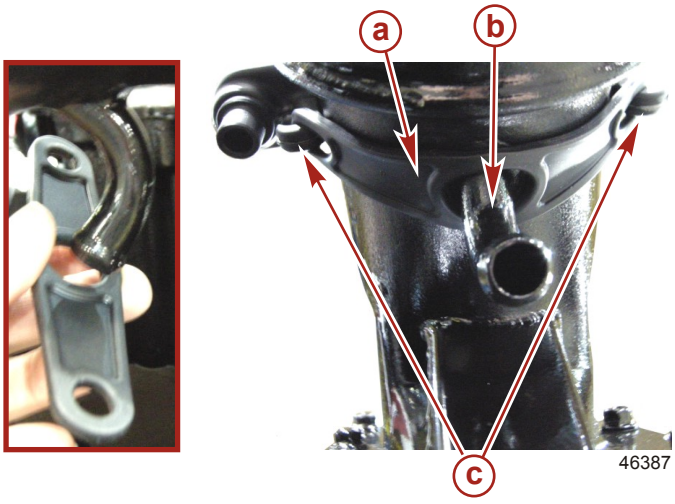
Installation

1. Push the reservoir onto the exhaust elbow with the air inlet hole toward the outside of the engine. Position the reservoir above the water fitting on the exhaust elbow.



a - Air inlet hole starboard
b - Air inlet hole port
c - Grommet
d - Reservoir port
e - Reservoir starboard

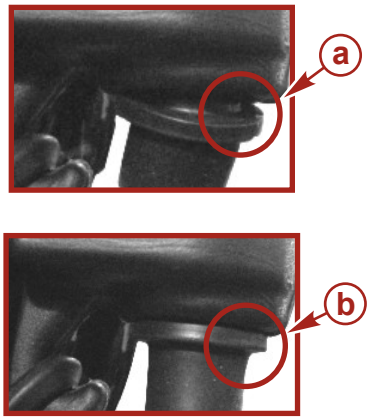
2. Place the center hole of the rubber strap over the water fitting on the exhaust elbow, stretch the strap around the bottom side of the exhaust elbow, and attach it to the reservoir hooks.



a - Rubber strap
b - Water fitting
c - Reservoir hook

3. Insert the vacuum breaker valve fitting into the grommet until the valve is seated against the grommet.
4. With a hose clamp on the hose assembly, push the hose end of the vent assembly over the water fitting on the exhaust elbow. Position the T-fitting to face inboard and slightly forward.

5. Inspect the grommet-to-reservoir area to ensure that there is no side-load pulling on the grommet. The grommet should be relaxed and fully seated against the reservoir. Position the T-fitting portion of the assembly as necessary to ensure proper assembly.



a - Incorrect assembly
b - Correct assembly

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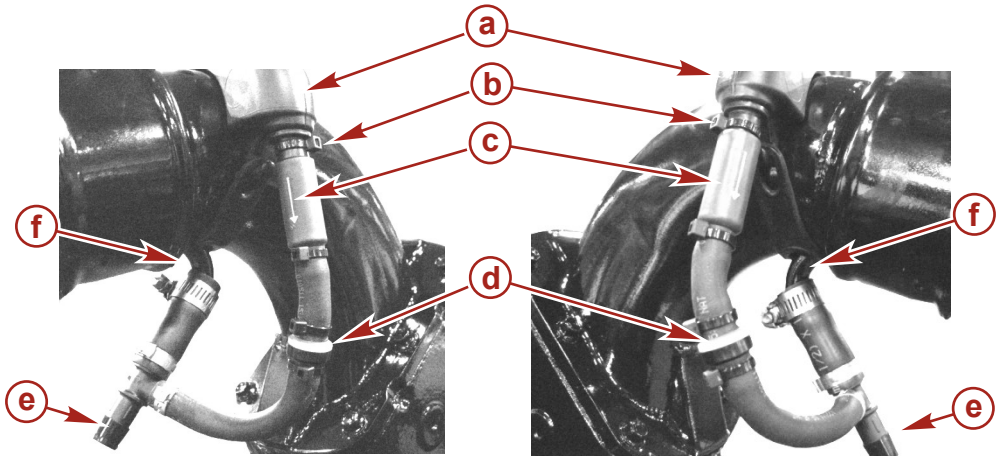
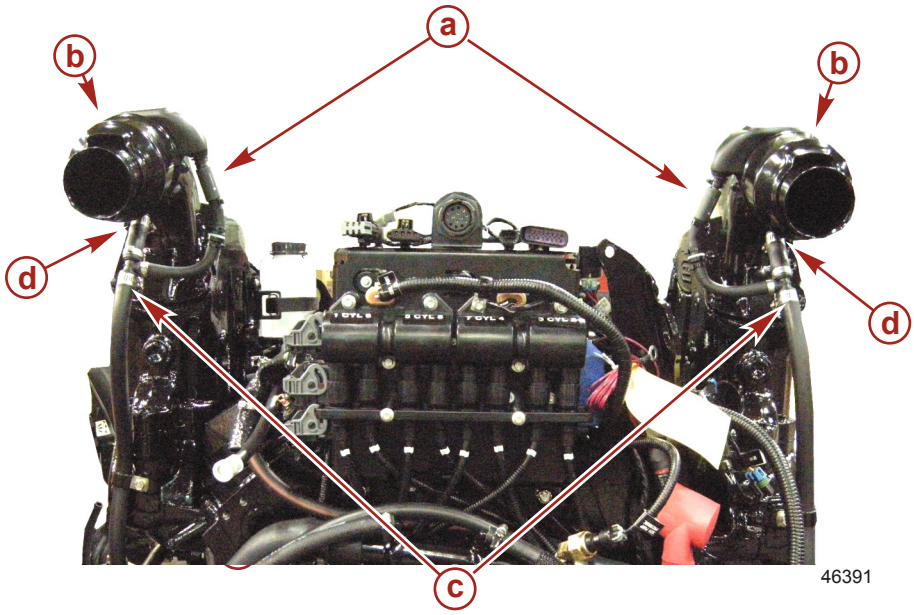
6. Install the cable tie over the grommet at the vacuum breaker valve fitting.



a - Reservoir
b - Cable tie
c - Vacuum breaker valve
d - Check valve
e - T-fitting
f - Water fitting on exhaust elbow

46386

7. With the hose clamp on the bypass hose, insert the T-fitting into the bypass hose.
8. Tighten the worm-gear hose clamps to specification at the T-fitting and at the water fitting on the exhaust elbow.



a - Vacuum breaker valve
b - Air inlet hole
c - Worm-gear hose clamp at T-fitting
d - Worm-gear hose clamp at the water fitting

46391

Description	Nm	lb-in.	lb-ft
Worm-gear hose clamp	4	35	–

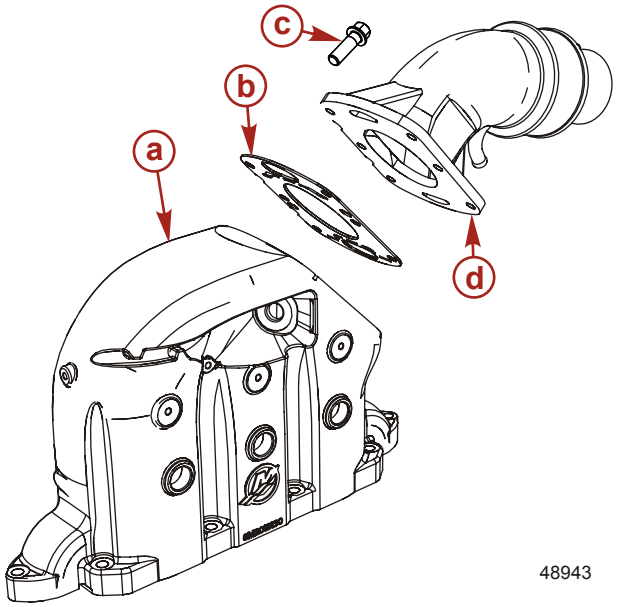
9. Install the cover on the hose clamp.

Riser Removal

⚠ WARNING

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

1. Turn off the engine and allow it to cool.
2. Remove the negative battery cable.
   IMPORTANT: Some water may remain in the exhaust manifold. Drain the exhaust elbow risers prior to removing components.
3. Drain any remaining water from the exhaust collector, exhaust elbow, and exhaust elbow riser assembly.
4. Remove the exhaust bellows from the exhaust elbow riser.
5. Remove and retain the six screws securing the exhaust elbow riser.
6. Remove the exhaust elbow riser.

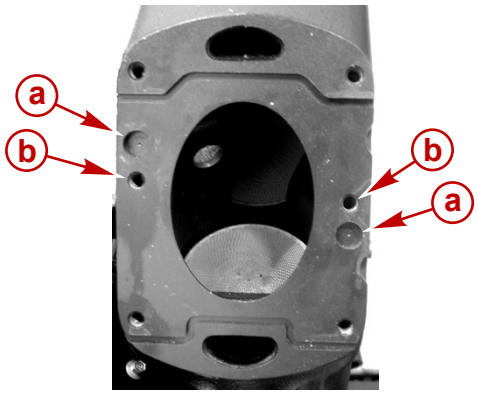


a - Exhaust collector
b - Gasket
c - Screw (6)
d - Exhaust elbow riser

Riser Installation

IMPORTANT: Foreign material on hot catalysts can damage the catalysts and their ability to work properly. Prevent material from falling into the exhaust collector. If material does fall into the exhaust collector, use care when removing the material to prevent damaging the catalysts.

1. Remove the gasket. Discard the gasket and clean the mating surface of the exhaust collector.

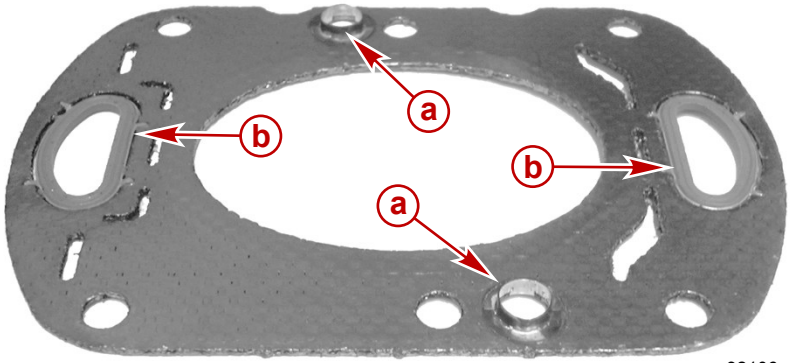


32108

ECT exhaust collector mating surface

a - Dowel holes
b - Fastener holes

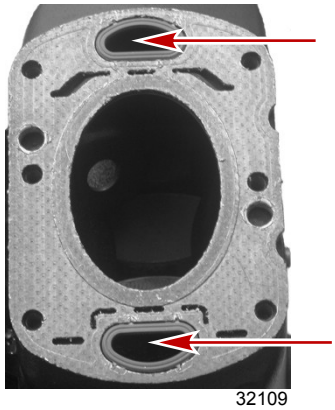
2. Insert the exhaust gasket dowels into the dowel holes on the exhaust collector mating surface.



32106

a - Dowels
b - Water port gaskets

3. With the dowels fully seated in the dowel holes, the water ports on the exhaust collector align with the water port gaskets. If misaligned, rotate the gasket 180°.

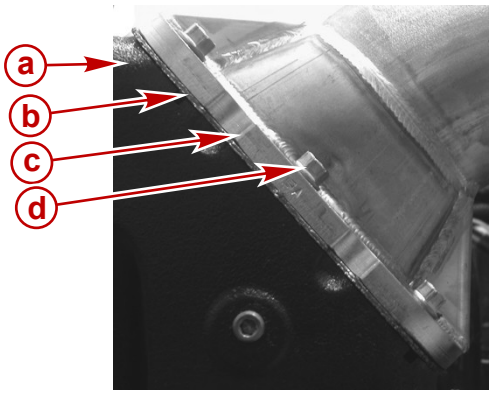


32109

Water ports

4. Align the new riser with the screw holes and install the six screws.

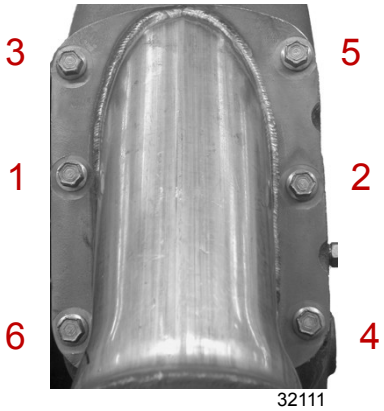
IMPORTANT: Always use the correct screws to achieve the required clamp load.



32110

a - Exhaust collector
b - Exhaust gasket
c - Exhaust riser
d - Screw

5. Tighten the screws to specifications in the following numbered sequence.



32111

Description	Nm	lb. in.	lb. ft.
Exhaust riser screw	30	–	22

6. On standard sterndrive applications with through-the-propeller exhaust:
   a. Install the new intermediate exhaust elbow components, ordered separately.
   b. Install exhaust bellows onto the exhaust riser and new intermediate exhaust elbow. Torque both hose clamps on each joint.
   c. Install exhaust bellows onto the exhaust pipe and new intermediate exhaust elbow. Torque both hose clamps on each joint.
7. On exhaust systems with waterlift or through-the-hull exhausts, reconnect the exhaust system. Torque both hose clamps on each joint.

Description	Nm	lb. in.	lb. ft.
Hose clamps	4	35	–

8. Install additional hoses on the exhaust riser, if applicable.
9. Connect the negative battery cable. Tighten securely.

NOTICE

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

10. Supply water to the engine. Start the engine and check for fuel, exhaust, or water leaks.

Collectors

Removal

⚠ CAUTION

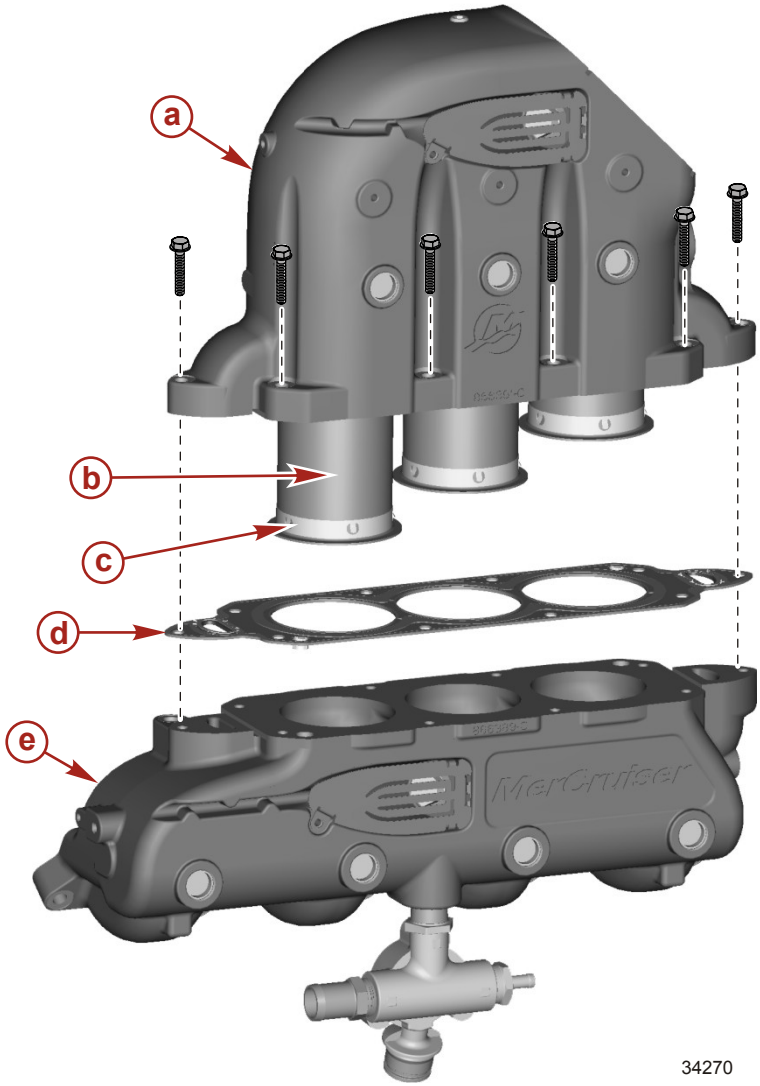
A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

NOTICE

Exposing the catalyst to foreign materials such as silicone, oils, or fiberglass can chemically alter the precious metal coating of the catalyst and compromise its ability to convert exhaust gases. Handle catalyst components in a clean environment only.

1. Remove the negative battery cable.
2. Turn the engine off and allow it to cool.
3. Remove the exhaust tip or riser as described in **Risers**.
   IMPORTANT: Some water may remain in the exhaust manifold. Drain the exhaust tips prior to removing components.
4. Drain any remaining water from the exhaust collector, exhaust elbow, and exhaust tip assembly.
5. Disconnect the temperature sensor and the two oxygen sensors from the engine harness.
6. Disconnect the cooling water inlet hose from the aft end of the collector.
7. Remove the 10 bolts securing the collector to the manifold.
   IMPORTANT: The catalyst retaining rings use friction to keep the catlyst in the collector during installation and removal. Over time, the clamping force of these rings may weaken, causing the catalysts to fall from the collector during assembly or disassembly. Take care not to drop the catalysts and replace the retaining rings before installation.

8. Lift the exhaust collector carefully to prevent the catalysts from falling due to loose retaining rings.



Port exhaust manifold and collector

- **a -** Exhaust collector
- **b -** Catalyst
- **c -** Retaining ring
- **d -** Gasket
- **e -** Exhaust manifold

9. Discard the gasket and current retaining rings.
10. Repeat this procedure for the other manifold as necessary.

Installation

NOTICE

Exposing the catalyst to foreign materials such as silicone, oils, or fiberglass can chemically alter the precious metal coating of the catalyst and compromise its ability to convert exhaust gases. Handle catalyst components in a clean environment only.

1. Remove any gasket material from all mating surfaces on the manifold and collector.
2. Install a new gasket.
   IMPORTANT: The catalyst retaining rings use friction to retain the catlyst in the collector for assembly. Over time, the interference fit of these rings may weaken, causing the catalysts to fall from the collector. Take care not to drop the catalysts during assembly or disassembly and replace the retaining rings before installation.
3. Replace any worn or loose catalyst retaining rings.
4. Secure the catalysts into the collector. The retaining rings should prevent the catalysts from falling.
5. Install the collector onto the manifold and gasket. Tighten the 10 retaining bolts to specification.

Description	Nm	lb-in.	lb-ft
Exhaust collector bolts (10)	27	–	20

6. Repeat this procedure for the other manifold as necessary.

7. To install the risers, refer to **Risers**.
8. Connect the negative battery cable. Tighten securely.

NOTICE

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

9. Supply water to the engine. Start the engine and check for fuel, exhaust, or water leaks.

Manifold

Removal

⚠ WARNING

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

1. Remove the exhaust elbow riser as described in **Risers**.
2. Remove the collector as described in **Collectors**.
3. Disconnect any cooling hoses from the manifold.
4. Remove any other components that are mounted to the exhaust manifold.
5. Disconnect the oxygen sensor from the engine harness.
6. Disconnect the temperature sensor from the engine harness.
7. Remove two bolts at opposite ends of the exhaust manifold and install an alignment pin in each bolt hole.
8. Remove the remaining exhaust manifold bolts.
9. Remove the exhaust manifold assembly.
10. Remove and discard the current gasket.

Cleaning and Inspection

IMPORTANT: Exhaust gaskets are not reusable.

1. Clean any gasket material from all surfaces.
2. Check the water passages for foreign material. The passages must be clean for efficient cooling.
3. Inspect all parts for damage or wear. Repair or replace as necessary.
4. To test the exhaust manifold, use block-off plates, plugs, or short hoses with plugged ends. One block-off plate must have a threaded hole for attaching a compressed air hose. Use new gaskets when installing block-off plates. Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water. Air bubbles indicate a leak.
5. Inspect all sealing surfaces carefully. Machined surfaces must be clean and free of all marks and deep scratches or exhaust leaks may result.
6. Ensure that all mating surfaces are flat.

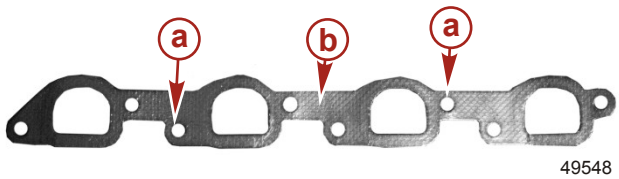
Description	Maximum overall difference
Surface flatness	0.13 mm (0.005 in.) with not more than a 0.02 mm (0.002 in.) difference within 25 mm (1 in.)

NOTE: *The maximum material that can be removed is 0.25 mm (0.01 in.) to flatten a gasket surface.*

7. Inspect the condition of the metal around the exhaust outlet in the casting. Inspect for damage caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser, if equipped. Replace all damaged parts.

Installation

1. Hand -tighten two alignment pins (if available) into the cylinder head. You may use the manifold location holes matching the gasket shown.



a - Alignment pin position
b - Gasket

2. Place the new exhaust manifold gasket on the cylinder head. Allow the alignment pins to hold the gasket in place.
3. Install the exhaust manifold onto the cylinder head. Tighten the bolts to specification.

Description	Nm	lb-in.	lb-ft
Exhaust manifold bolts (8)	47	–	35

4. Install any components previously removed.
5. Install the collector as described in **Collectors**.
6. Install the riser or tip as described in **Risers**.
7. Install all coolant and exhaust hoses.
8. Connect the oxygen sensor to the engine harness.
9. Connect the battery cables to the battery. Tighten securely.
10. Start the engine and check for fuel, exhaust, and water leaks.

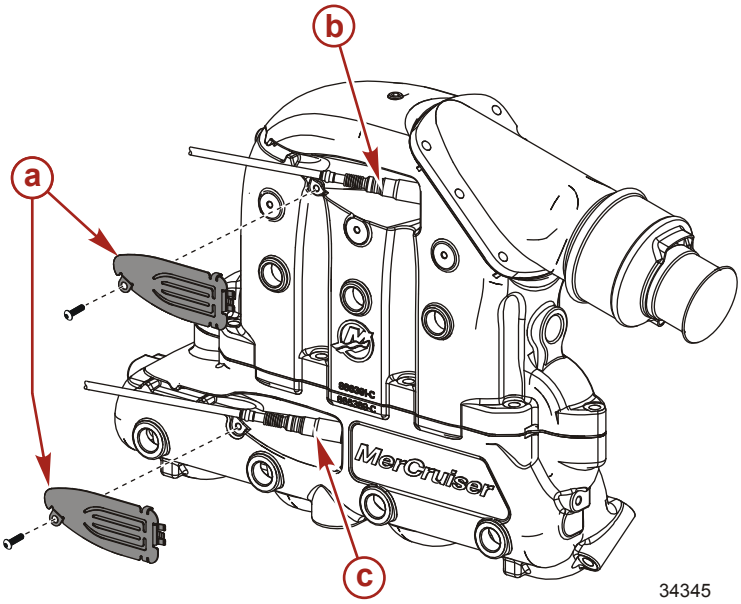
Oxygen Sensor

Removal

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the sensor from the engine harness.
2. Loosen the screw securing the oxygen sensor cover to the collector, and remove the cover.



a - Oxygen sensor cover
b - Post-catalyst oxygen sensor
c - Pre-catalyst oxygen sensor

3. Remove the oxygen sensors, as needed.

Kent-Moore Oxygen Sensor Socket	KN-46577

Installation

1. Use the oxygen sensor tool to install the oxygen sensor. Tighten the sensor to specification.

Kent-Moore Oxygen Sensor Socket	KN-46577

2. Install the oxygen sensor cover so it is flush against the collector. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	37
Oxygen sensor cover screw	3.5	31	–

3. Connect the sensor to the engine harness.

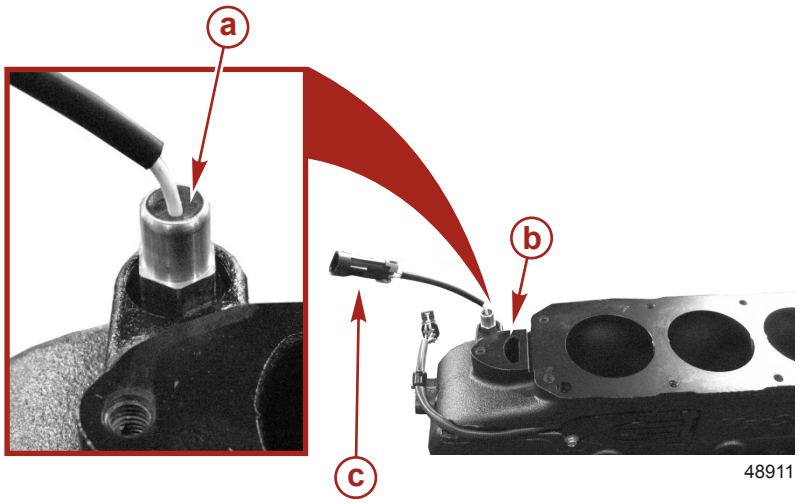
Exhaust Manifold Coolant Temperature (EMCT) Sensor

Removal

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the EMCT sensor connector from the engine harness.
2. Remove the EMCT sensor from the exhaust manifold.



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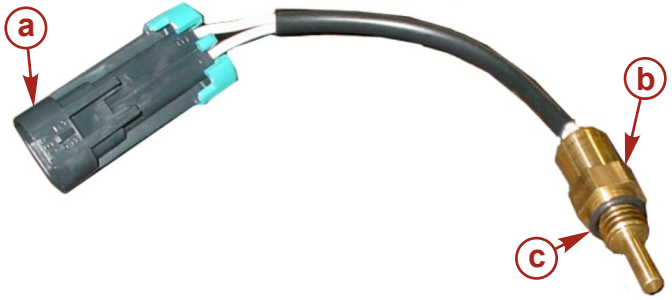
a - Sensor
b - Exhaust manifold
c - EMCT sensor connector

Installation

1. Verify that the O-ring is on the EMCT sensor.

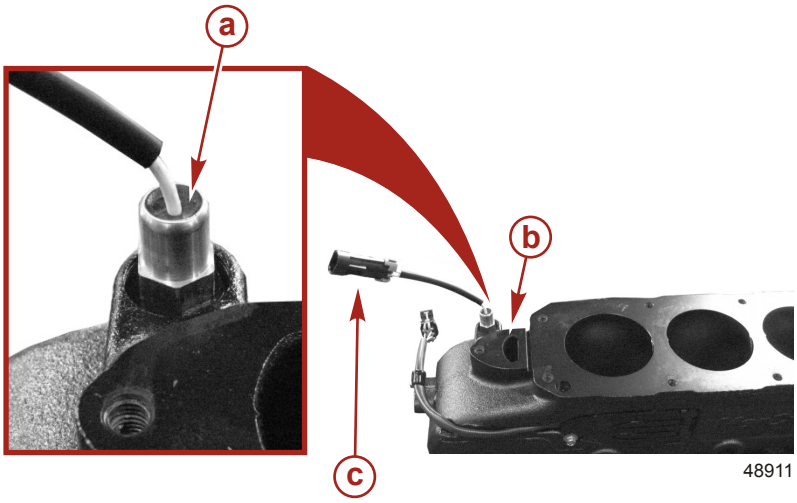


48912

a - EMCT sensor connector
b - EMCT sensor
c - O-ring

2. Hand-start the EMCT sensor into the exhaust manifold.

3. Tighten the EMCT sensor to specification.



a - Sensor
b - Exhaust manifold
c - EMCT sensor connector

Description	Nm	lb-in.	lb-ft
Sensor	8	–	6

4. Connect the EMCT sensor connector to the engine harness.

Exhaust System

Section 7B - Models Without Emissions Control

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7
B

Exhaust System

Exhaust System Caution

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boat builder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

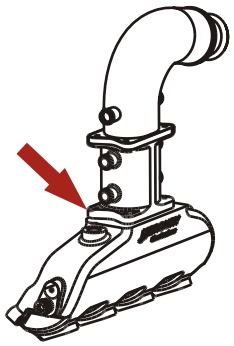
Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Exhaust Emissions Sampling

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

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



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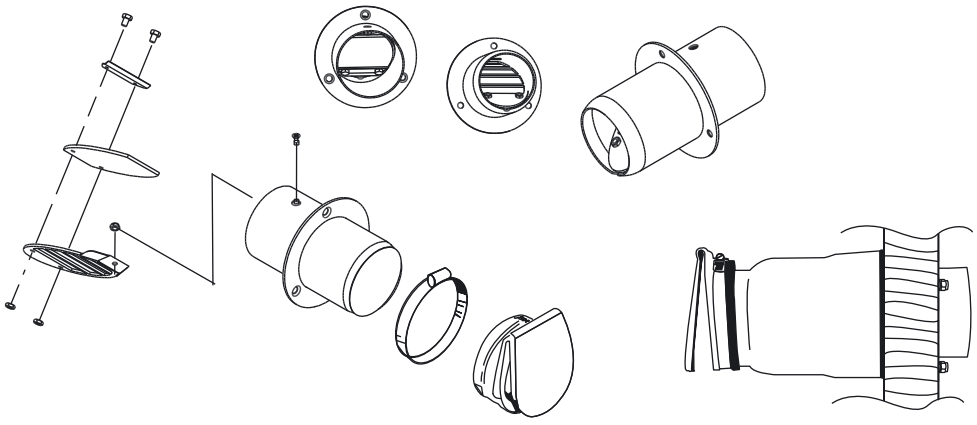
Access area for exhaust gas sampling—Non-Emission Controlled 8.2 MAG and 8.2 MAG H.O. Models

Through-Hull Exhaust Fittings

Exhaust fittings (flanges, outlets) must be equipped with an internal shutter and external flapper to prevent water intrusion problems. This is a requirement on all applications except water lift mufflers, where it is still recommended. A variety of fittings are available through the Mercury Precision Parts and Accessories Guide.



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Reference Note

Refer to the appropriate **Mercury MerCruiser Product Applications Manual** for more in depth diagnosis and set up installation of the exhaust systems.

Measuring Exhaust Elbow Height

General Information

Install exhaust elbows within the specified height dimensions to prevent water intrusion. Install exhaust elbow risers as needed to obtain the proper exhaust elbow height and exhaust angle. Risers cannot exceed 203.2 mm (8 in.) . Take all measurements with the boat in the water and loaded to simulate the maximum loading conditions for normal operation.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not the water line outside of the boat. Refer to Water Lift Muffler for instructions.
IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boat builders must communicate any load distribution conditions that affect the exhaust system such as maximum occupancy of the swim platform to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Model	Minimum Exhaust Elbow Height
8.2	381 mm (15 in.)

Model	Minimum Exhaust Hose Slope within 45.7 cm (18 in.) of engine	Minimum Exhaust Hose Slope Remainder of system (if applicable)
8.2	10°	3°

If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to the appropriate **Mercury Precision Parts and Accessory Guide** for part numbers.

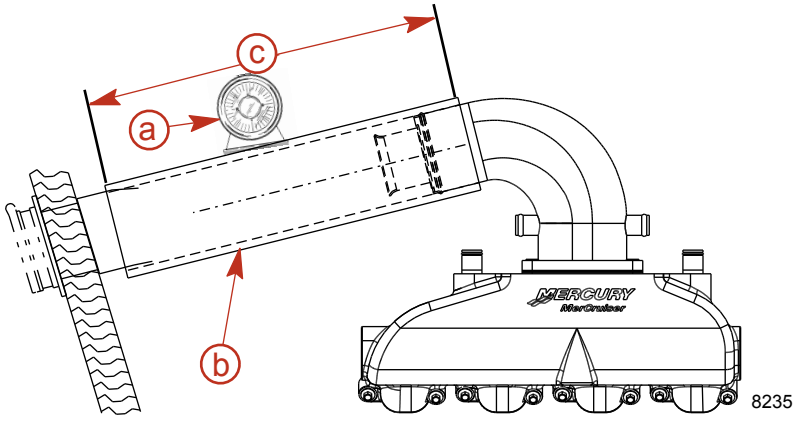
The maximum exhaust riser height is specified in the table below.

Maximum Exhaust Riser Height			
Model	**Low**	**Medium**	**High**
8.2	51 mm (2 in.)	152 mm (6 in.)	203 mm (8 in.)

Model	Exhaust Hose or Tube length
8.2 Sterndrive Models	30 cm (12 in.)
8.2 Inboard Models	46 cm (18 in.)

Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet continuing along each section to the exhaust exit point of the boat. Perform all exhaust angle measurements with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. See **Loading Requirements**.



a - Inclinometer
b - Exhaust hose or tube
c - Length of exhaust hose or tube

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on non-production boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**
- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**
- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boat builder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at OEM boat builders must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long that do not have a maximum rated swim platform weight capacity, must add181.45 kg (400 lb) to the swim platform .
   c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity must add 226.80 kg (500 lb) to the swim platform.

Loading the Boat (Boats with a Capacity Plate)

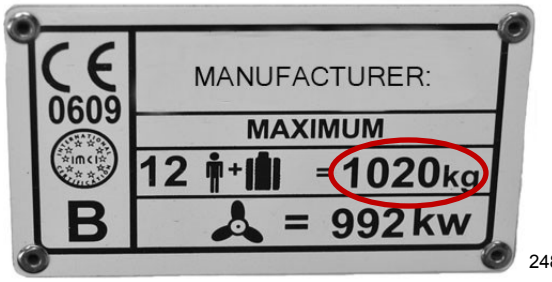
For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lb. Persons, Gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb.) per person. This gives the whole number and remainder of 74.84 kg (165 lb.) persons to load onto the boat.

3. Put the remainder of a person in the next available seat. See **Boat loading diagram**.



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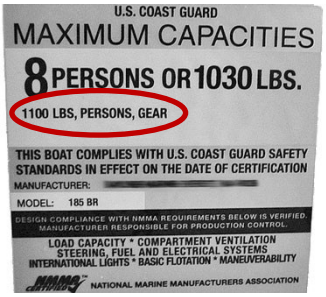
CE Capacity Plate



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USCG Capacity Plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: *The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.*

NOTE: *The following example is provided as a reference.*

Example

NOTE: *This example uses a boat that is less than 8.84 m (29 ft.) long, not including a boat that is 8.84 m (29 ft.) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 Kg (400 lb.) to the swim platform*

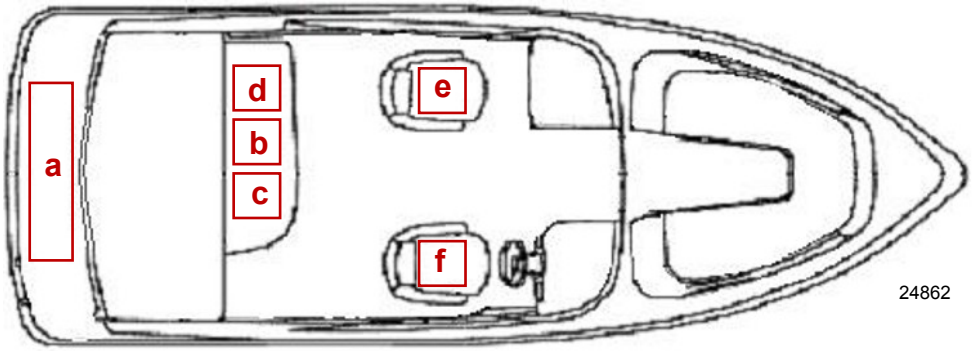
NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb. – 400 lb. = 700 lb.
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat
   - 700 lb. ÷ 165 lb. = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight
   - 0.24 × 165 lb. = 40 lb.

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.

5. Using the totals in this example, load four 165-lb. persons and one 40-lb. person onto boat seating with 400 lb. on the swim platform.

- 400 lb. + 165 lb. = 565 lb.
- 565 lb. + 165 lb. = 730 lb.
- 730 lb. + 165 lb. = 895 lb.
- 895 lb. + 165 lb. = 1060 lb.
- 1060 lb. + 40 lb. = 1100 lb.



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats Without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb. per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb. (MerCruiser person weight) = XXXX lb. maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb. per person. This gives the number of 165-lb. persons to load onto the boat. Round up to next whole number. See **Example 3**.
   IMPORTANT: To account for cargo, add a weight of 25 lb. per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb. by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

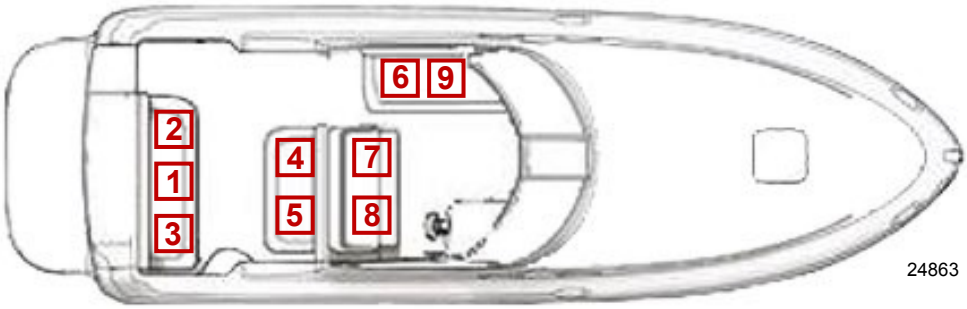
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: *The following example is provided as a reference.*
This example uses a boat that is 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 Kg (500 lb.) to the swim platform .

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



Designated Seating Diagram

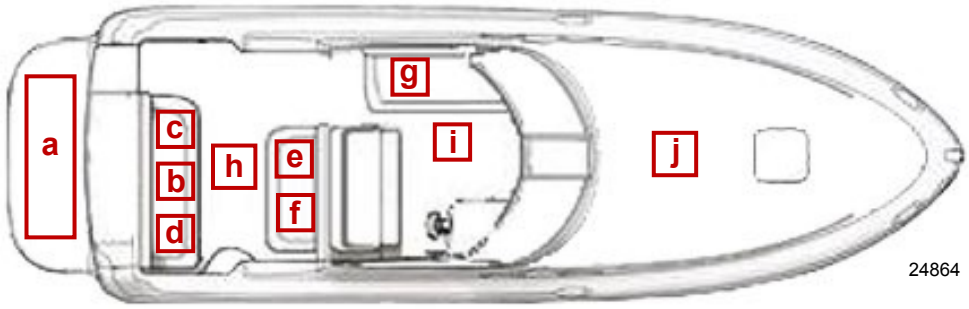
This example uses 9 persons as the maximum passenger load.

NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb. = 225 lb.
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%
   a. 225 lb. × 50% = 112.50 lb.
   b. 112.50 lb. rounded up = 113 lb.
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%
   - 225 lb. × 25% = 56.25 lb.
   - 56.25 lb. rounded down = 56 lb.
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb. (MerCruiser person weight) to get a 1485 lb. (total passenger load)
   - 9 passengers × 165 lb. = 1485 lb.
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb. – 500 lb. = 985 lb.

7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb. ÷ 165 lb. = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb. cargo in the aft storage, 113 lb. cargo in the center storage, and 56 lb. cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb. passengers, onto the boat with 500 lb. on the swim platform.

- 500 lb. + 225 lb. = 725 lb.
- 725 lb. + 165 lb. = 890 lb.
- 890 lb. + 165 lb. = 1055 lb.
- 1055 lb. + 165 lb. = 1220 lb.
- 1220 lb. + 165 lb. = 1385 lb.
- 1385 lb. + 165 lb. = 1550 lb.
- 1550 lb. + 165 lb. = 1715 lb.

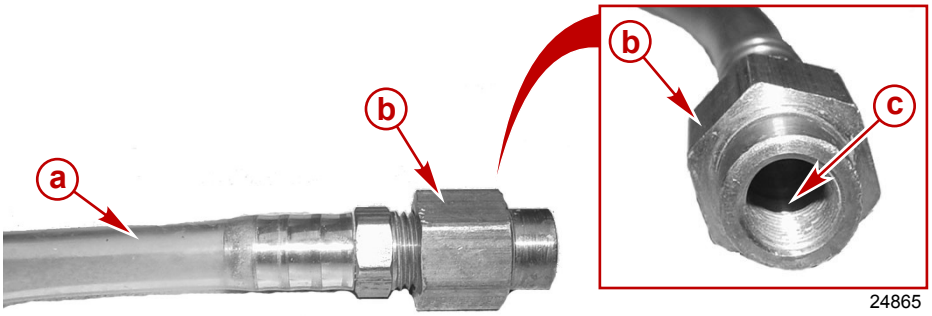


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

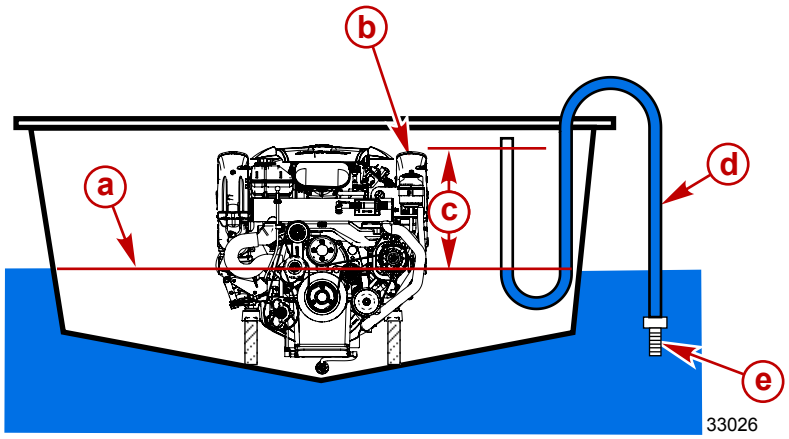
1. Obtain an 8–10 mm (5/16–3/8 in.) inner diameter (ID) clear hose approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.
4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust manifold collector and elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



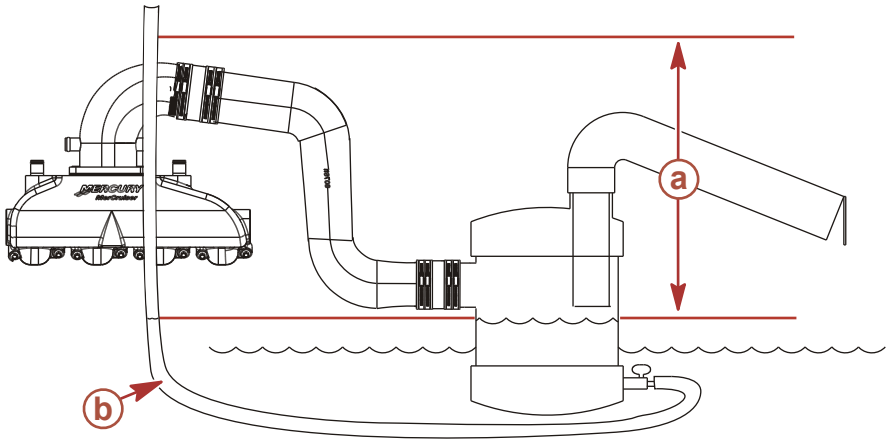
- **a -** Waterline
- **b -** Top of exhaust elbow
- **c -** Waterline to top of exhaust elbow measurement
- **d -** Clear hose
- **e -** Weight

Clear Hose Measurement Method From Seacock or Muffler Drain

IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.
IMPORTANT: The engine must have been operated previously to fill the muffler with water.
IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.
7. Slowly take the finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep the hose close to the exhaust elbow and as vertical as possible.

8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height. The maximum riser height is 20.3 cm (8 in.) on 8.2 models.



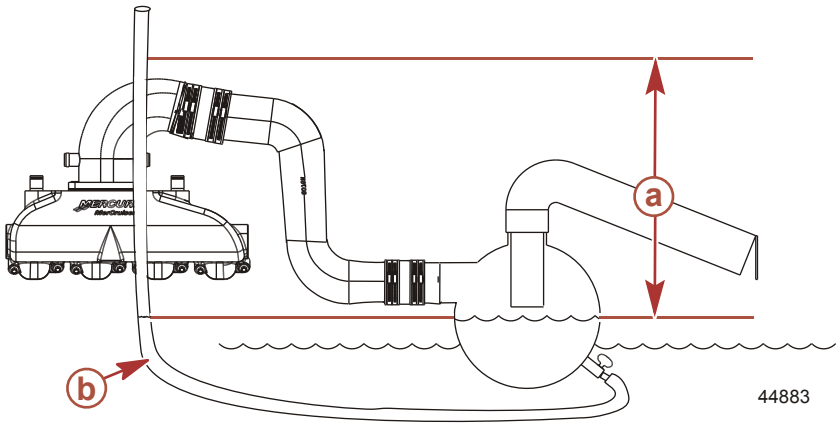
44882

Typical vertical water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

IMPORTANT: Horizontal waterlift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



44883

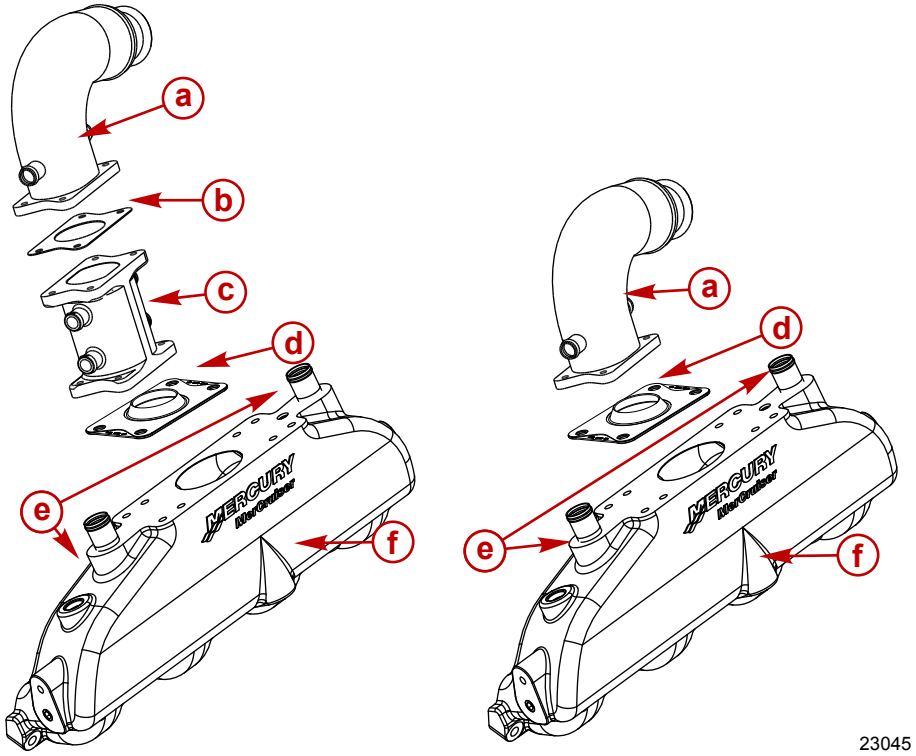
Typical horizontal water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

Manifold and Elbow

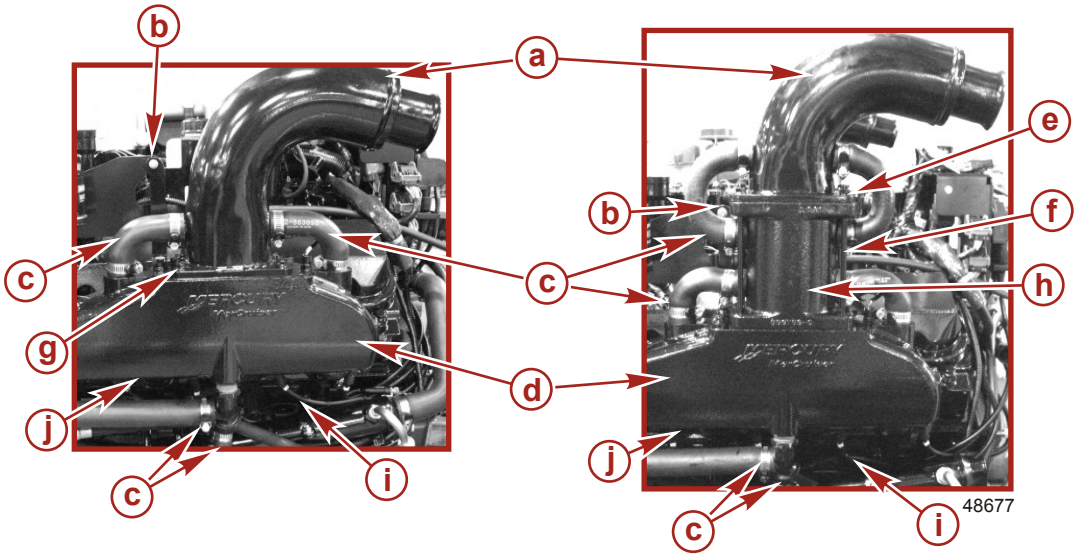
Exploded View



- **a -** Exhaust elbow
- **b -** Elbow gasket
- **c -** Riser
- **d -** Turbulator plate and gasket elbow flange
- **e -** Fittings
- **f -** Exhaust manifold

Replacing the Manifold

Removal



- **a -** Exhaust elbow
- **b -** L-bracket bolt
- **c -** Hose and clamps
- **d -** Exhaust manifold
- **e -** Nut and washer (4)
- **f -** Stud (4)
- **g -** Cap screw (4)
- **h -** Exhaust riser
- **i -** Spark plug wire (4)
- **j -** Bolt (8)

1. Drain the seawater system.
2. Disconnect the spark plug leads. Tag the leads as required to ensure that they are reconnected at the proper cylinders.
3. Remove the top screw from the L-bracket, leaving the bracket attached to the manifold.
4. Remove the water hoses from the water fitting at the bottom of the exhaust manifold. Retain the hose clamps.
5. Remove the exhaust elbow hoses. Retain hose and hose clamps for reuse.
6. Remove the cap screws securing the exhaust elbow and remove the elbow from the exhaust manifold. The elbow and screws can be reused if not damaged.
7. On models with a six-inch riser, remove the nuts and washers from the studs. Then remove the exhaust elbow and riser from the exhaust manifold. Retain the elbow, riser, and fasteners for reuse.
8. Remove two bolts, at opposite ends, securing the exhaust manifold to the cylinder head and install the alignment pins to support the weight.
9. Remove the remaining bolts and carefully remove the exhaust manifold. Do not allow the manifold to contact the spark plugs.

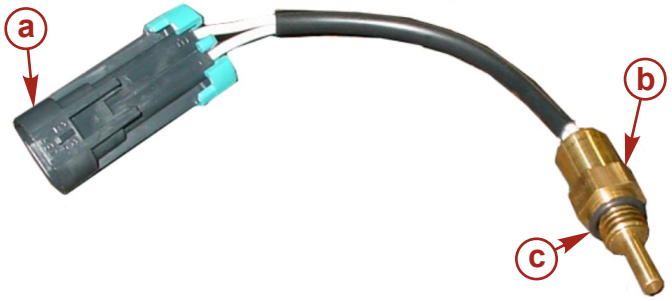
Inspection and Cleaning

1. Clean the gasket surface on the cylinder head and on the bottom of the exhaust elbow.
2. Clean all remaining gasket surfaces.
3. Inspect and replace any damaged stud, washer, or nut that was removed.
4. Replace any spark plug that is damaged during the removal or installation of the manifold.

Installation

1. If replacing the manifold, remove the exhaust manifold coolant temperature (EMCT) sensor, L-bracket, and the water drain fitting from the manifold. Note the orientation of the water drain fitting and the L-bracket, and install them in the new manifold.

a. Verify that the O-ring is on the EMCT sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

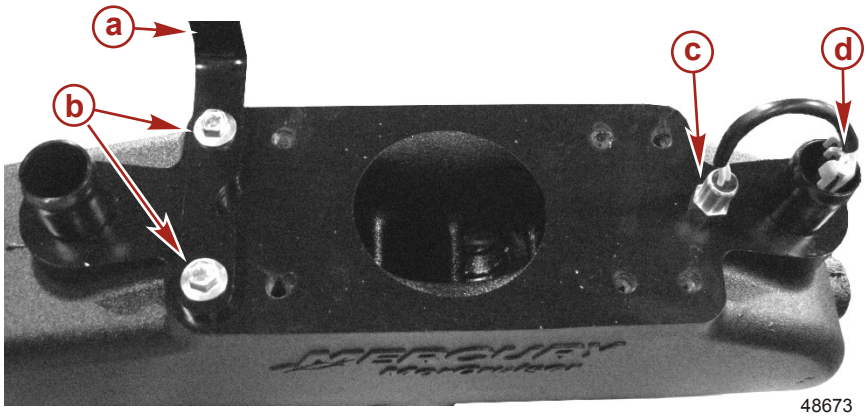
b. Hand-start the EMCT sensor in the manifold.

c. Tighten the sensor to specification and position the connector temporarily out of the way.

Description	Nm	lb-in.	lb-ft
EMCT sensor	8	–	6

d. Install the L-bracket on the manifold with two mounting screws.

e. Tighten the screws to specification.

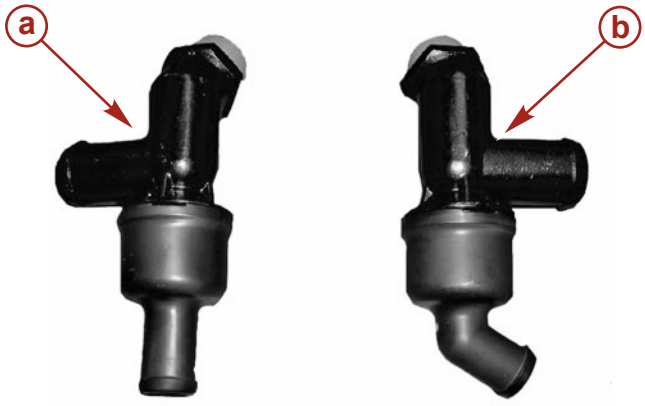


48673

a - L-bracket
b - L-bracket screw
c - EMCT sensor
d - EMCT sensor connector (temporarily out of the way)

Description	Nm	lb-in.	lb-ft
L-bracket screw to manifold	27	–	20

f. Install the water drain fitting at the bottom of the manifold. Orient the fitting similar to the original fitting to match up with the water hoses.

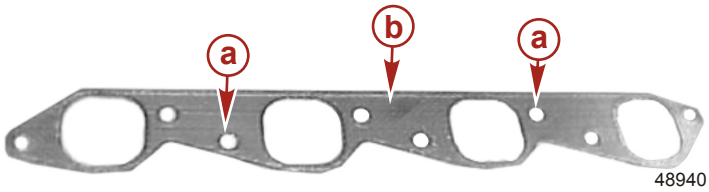


34342

a - Port manifold drain fitting
b - Starboard manifold drain fitting

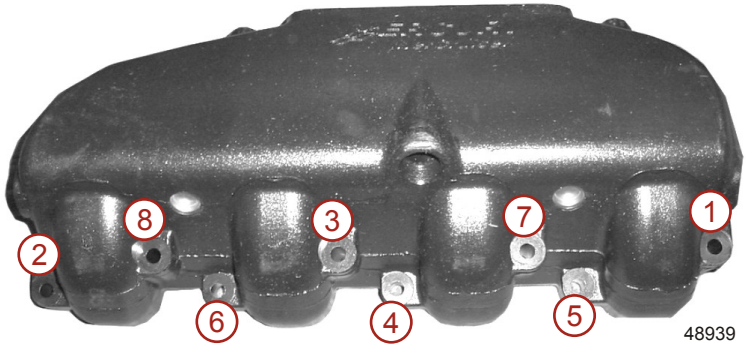
g. If discarding the manifold on models with a six-inch riser, remove and retain the studs from the old exhaust manifold.

2. Hand-tighten two alignment pins (if available) into the manifold location holes matching the gasket shown.



a - Alignment pin position
b - Gasket

3. Place the new exhaust manifold gasket on the cylinder head. Allow the alignment pins to hold the gasket in place.
4. Attach the new exhaust manifold to the head using hex head cap screws.
   NOTE: *Install the short screws in the recessed location holes and the long screws in the raised location holes.*
5. Remove the alignment pins once you have secured the manifold with at least two screws.
6. Tighten the screws to specification in the sequence shown below.

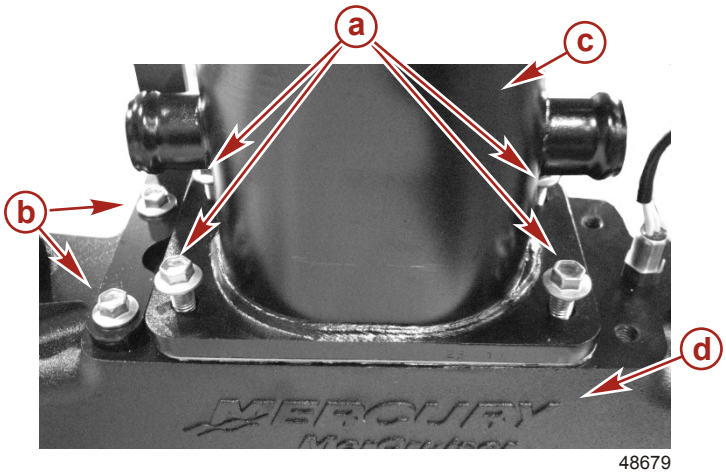


Description		Nm	lb-in.	lb-ft
Manifold to head cap screws	**First**	20	–	15
	Second	47	–	35
	Final	47	–	35

7. Install the L-bracket top screw on the plenum. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
L-bracket to plenum screw	27	–	20

8. Install a new turbulator plate.
9. Install the exhaust elbow on the manifold. Tighten the cap screws to specification.

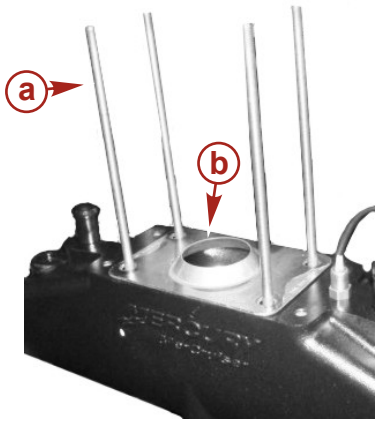


a - Exhaust elbow bolts
b - L-bracket bolts
c - Exhaust elbow
d - Exhaust manifold

Description	Nm	lb-in.	lb-ft
Cap screws	27	–	20

10. On models with six inch risers:

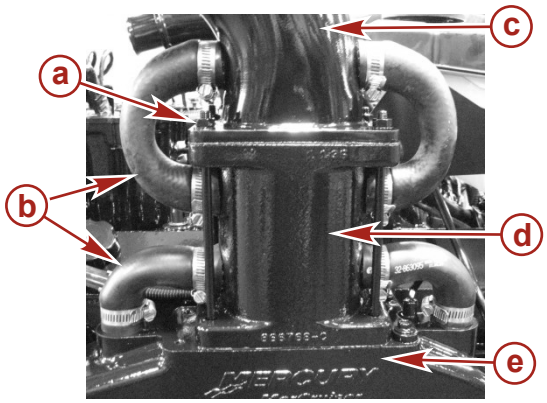
a. Install the studs in the corresponding holes in the exhaust manifold. Tighten the studs until the threads are bottomed out in the manifold.



48942

a - Studs
b - Turbulator gasket

b. Install the riser on the turbulator gasket on the manifold.
c. Install the gasket on the riser.
d. Place the exhaust elbow on the gasket on the riser.
e. Install a washer and nut on each stud.
f. Tighten the nuts to specification.



48697

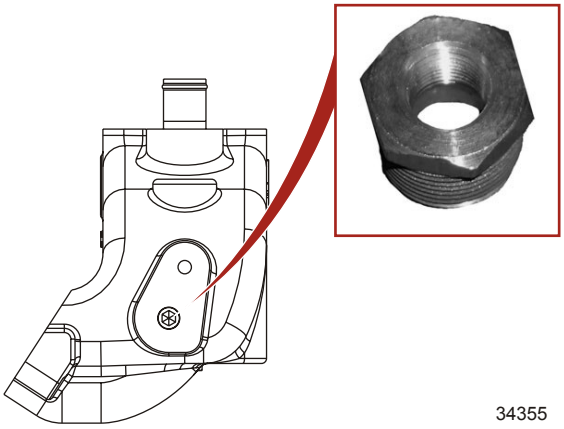
a - Nuts and washers (4 each)
b - Hose and clamps
c - Exhaust elbow
d - Exhaust riser
e - Exhaust manifold

Description	Nm	lb-in.	lb-ft
Exhaust elbow nuts	27	–	20

11. Connect the EMCT sensor to the engine harness.
12. Install the spark plug wires.

Inboard Applications

An adapter fitting is supplied for inboard applications that use a shaft log cooler hose. Remove the appropriate plug from the end of the manifold. Install the adapter and install the shaft log fitting from the original manifold system.



Location of adapter fitting

Exhaust System

Section 7C - Exhaust Collectors

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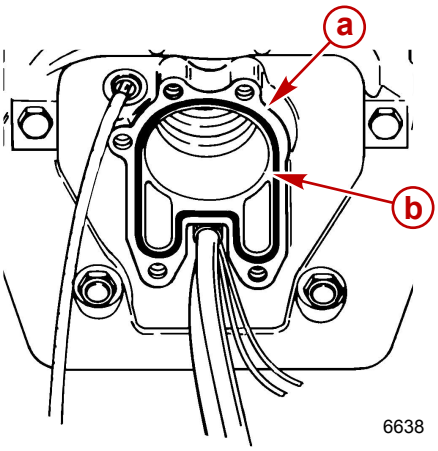
7C

Component Replacement

To replace any components in the exhaust system, adhere to the following:

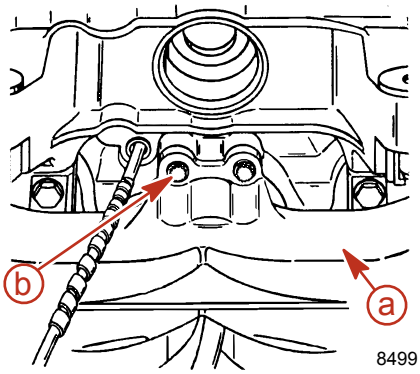
- All mating surfaces must be clean.
- The O-ring must remain in the groove to properly seal the joints to prevent leakage.
- Tighten all clamps securely.



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)

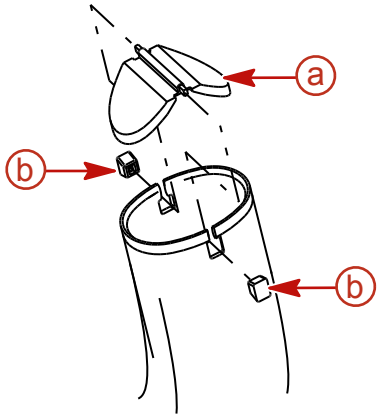
Description	Nm	lb. in.	lb. ft.
Exhaust pipe screw	34		25

Water Shutter Replacement—Sterndrive Models

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.

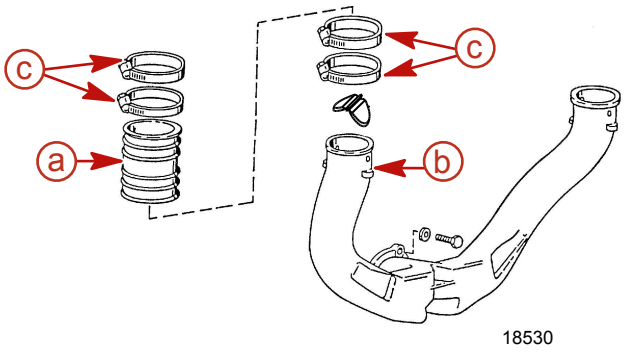
3. Install the water shutter into the Y pipe. Ensure that the water shutter is seated into the rubber grommets.



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.

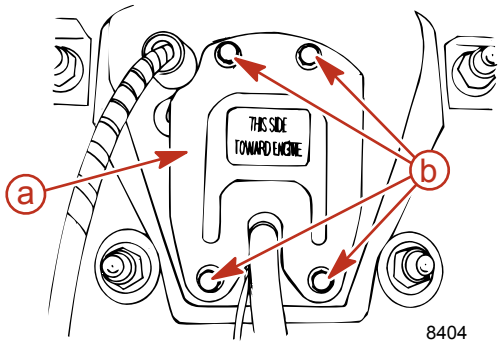


18530

Description	Nm	lb. in.	lb. ft.
Hose clamp (exhaust tube)	4	35	

Through-Transom Exhaust

IMPORTANT: A block off plate must be installed when using through the transom exhaust or below swim platform kits.



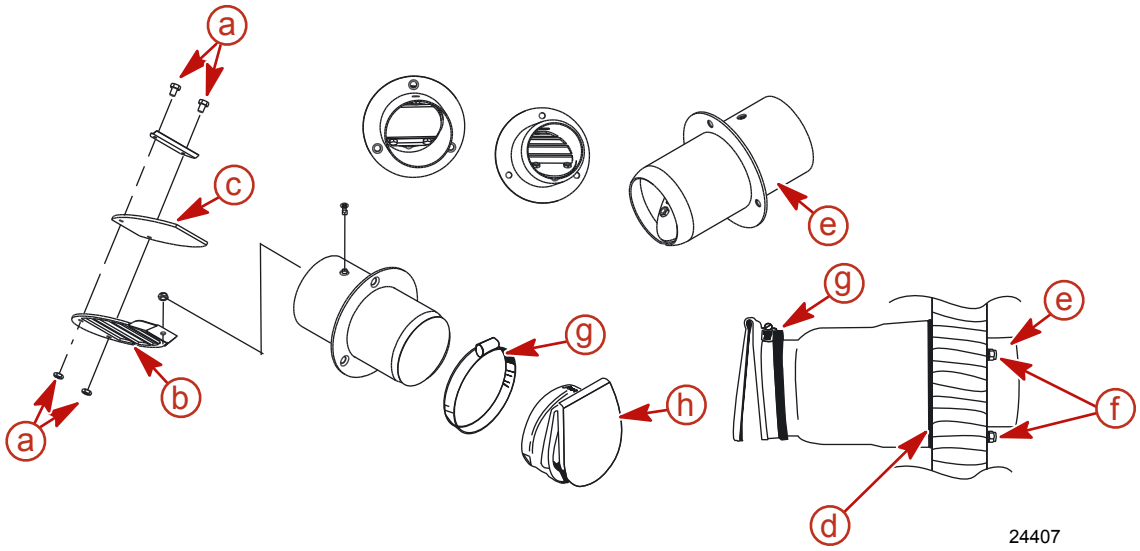
8404

a - Block off plate
b - Bolts (4)

Water Shutter Replacement—Through Transom Models

1. Remove the clamp securing the external cover (flapper) to the exhaust flange.
2. Remove the external cover (flapper).

3. Remove the internal water shutter.
4. Install the new shutter. Tighten the screws and nuts securely.
5. Reinstall the water shutter in the exhaust flange to the transom exhaust.
6. Reinstall the external flapper. Tighten the clamp securely.



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)

Preferred Exhaust System

Most Mercury MerCruiser sterndrive engines were developed and tested for the Y-pipe or through the propeller exhaust systems. The only exceptions to this are the 8.2 models. However, by using the Y-pipe system, you limit the potential for water intrusion due to the exhaust system design.

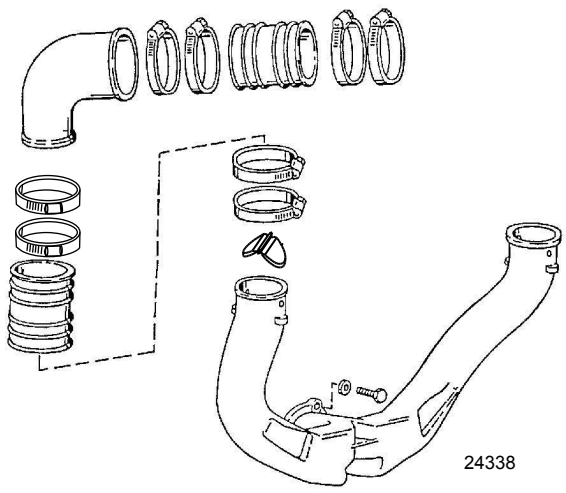
Magnum Bravo Model Exhaust Recommendation

Use through-the-transom exhaust for maximum performance from the Magnum Bravo Models. Install a block-off plate and remove the exhaust bellows on the transom assembly. 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.

Exhaust Pipe Kit

If noise regulations do not allow the use of through-the-transom exhaust, an Exhaust Pipe Kit (807130A21) and the specified intermediate exhaust elbow riser kit must be installed for through-the-prop exhaust. This kit also contains an exhaust tube that is used in place of the exhaust bellows.

IMPORTANT: To comply with the EU (European Union) Noise Emission Standard under Mercury's EU Noise Certification, the 8.2 sterndrive engines must have installed and use the exhaust pipe kit (807130A21) with a specified intermediate exhaust elbow riser kit. Installation and use of any other exhaust components will require individual certification of the installation by the governing authority.



Exhaust pipe kit and intermediate exhaust elbow riser kit

Description	Part Number
Intermediate exhaust elbow riser kit 50 mm (2 in.)	879288A13
Intermediate exhaust elbow riser kit 101 mm (4 in.)	879288A14
Intermediate exhaust elbow riser kit 152 mm (6 in.)	879288A15
Intermediate exhaust elbow riser kit 203 mm (8 in.)	879288A16

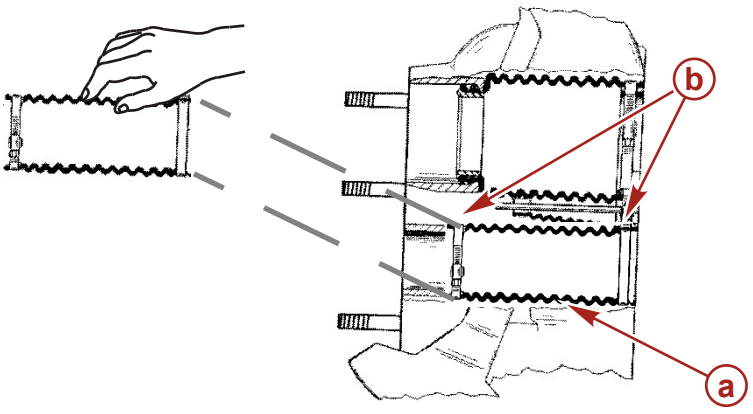
Exhaust Tube Installation

NOTE: *Installing the exhaust tube will increase exhaust noise.*

IMPORTANT: Remove the exhaust bellows and install an exhaust tube on the transom assembly when:

- **The 8.2 engine package is equipped with a Bravo sterndrive and through-the-propeller exhaust.**
- **The exhaust system can be switched to either through-the-propeller or through-the-transom exhaust.**

1. Remove and discard the clamps and exhaust bellows from the gimbal housing.



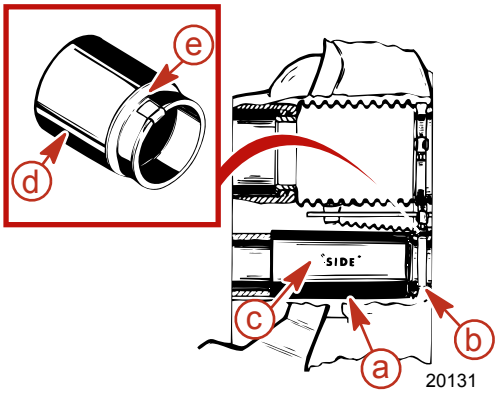
a - Exhaust bellows
b - Clamps

IMPORTANT: Failure to install the grounding clip may lead to corrosion of the exhaust tube, damaging it. Always install the grounding clip.

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 the right and left sides.
4. Install the clamp.
5. Tighten the clamp securely.

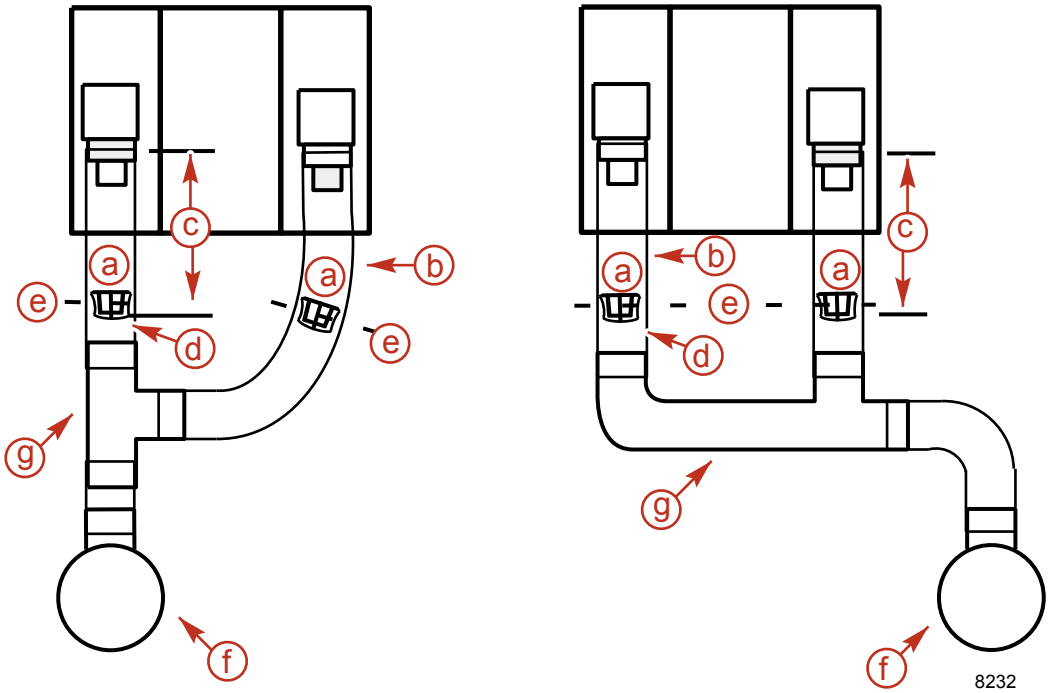


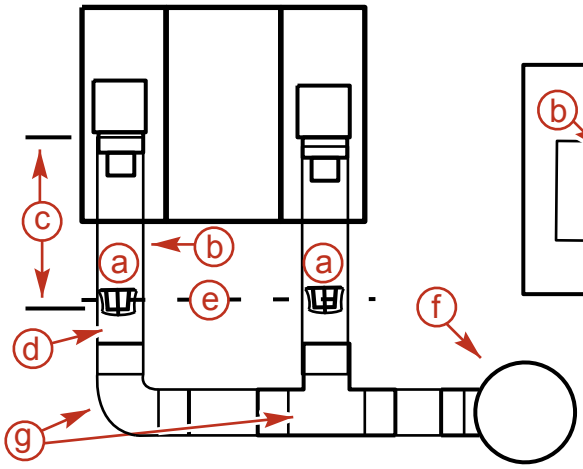
a - Exhaust tube
b - Clamp
c - "SIDE" marking
d - Exhaust tube
e - Grounding clip

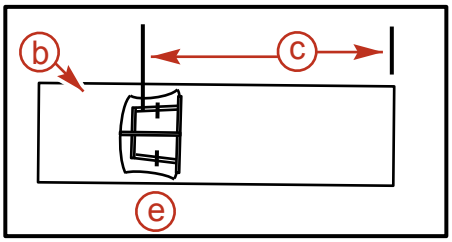
Exhaust Resonator—Inboard Models

IMPORTANT: Exhaust resonators can be used on all models with through the transom exhaust. The exhaust resonators kit 86022A1 is purchased separately for each engine.

- The exhaust resonator is positioned with the inside flat surface at the preferred distance of 432 mm (17 in.) from the front edge of the exhaust hose but no closer than 51 mm (2 in.) to the exhaust outlet. The 432 mm (17 in.) dimension can be reduced, if necessary, to a MINIMUM of 330 mm (13 in.). This dimension must be the same on both exhaust outlets.







a - Exhaust resonator
b - Exhaust hose
c - Dimension to inside flat surface of resonator approximately 432 mm (17 in.)
d - No less than 51 mm (2 in.) between collector and resonator
e - Clamp - positioned around center of resonator
f - Exhaust muffler
g - Collector

Exhaust system tuning can be affected by various factors that are beyond the control of Mercury MerCruiser. Following are several factors that can affect exhaust system tuning:

- Type and configuration of exhaust outlet.
- Length of exhaust hose.
- Amount of back-pressure in exhaust system. Refer to the appropriate **Mercury MerCruiser Product Applications Manual**.

Notes:

Transmission

Section 8A - ZF Marine Transmissions—HSW 63A, 63IV, 80A

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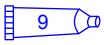
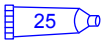
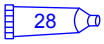
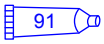
8A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads and the service port plug	92-809822
	Liquid Neoprene	Neutral start switch wire connections Exposed electrical terminals and connections.	92- 25711 3
	Dexron III Automatic	Transmission	Obtain Locally
	Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A 1

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)[1.]	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[1.]	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.)	

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

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.

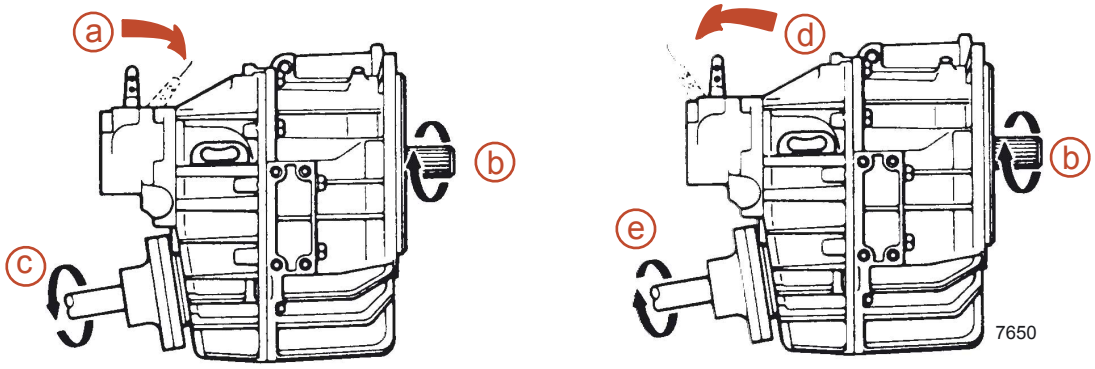
Precautions

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.

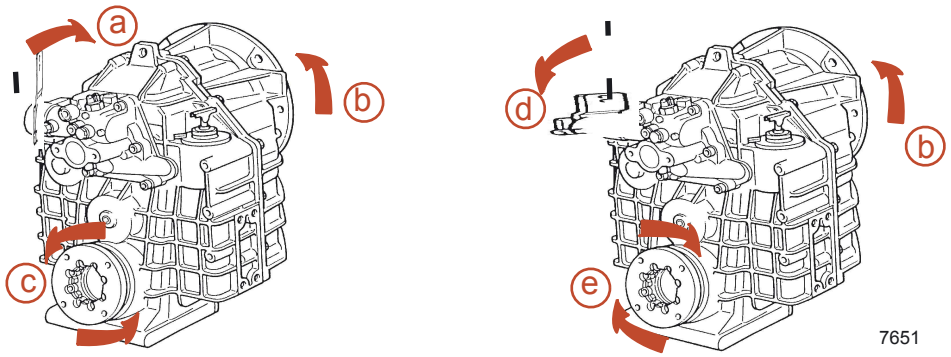
Transmission And Propeller Rotation

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)
b - Transmission input shaft rotation direction (LH)
c - Transmission output shaft rotation direction (RH)
d - Direction of shift lever engagement (away from flywheel)
e - Transmission output and propeller shaft rotation direction (LH)



ZF Marine 63IV—V-drive transmissions

- **a -** Direction of shift lever engagement (toward flywheel)
- **b -** Transmission input shaft rotation direction (LH)
- **c -** Transmission output shaft rotation direction (LH)
- **d -** Direction of shift lever engagement (away from flywheel)
- **e -** Transmission output and propeller shaft rotation direction (RH)

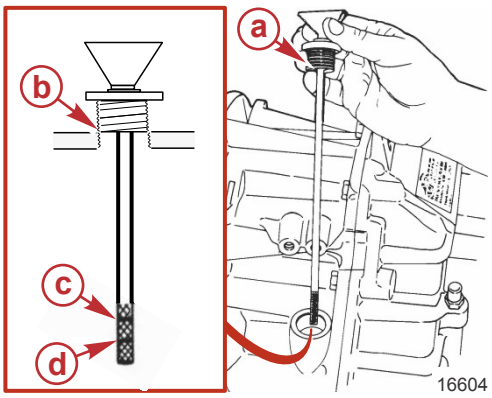
Transmission Fluid

Checking

1. Confirm that there is fluid in the transmission:
   a. When checking the fluid level, insert the dipstick into the threaded hole but do not screw it in. Remove the dipstick and check the fluid level indicated.

      NOTE: *The fluid level may be slightly over the maximum mark, as some of the fluid from the transmission fluid cooler and hoses may have drained back into the transmission.*

   b. Add transmission fluid to bring the level up to the maximum mark on the dipstick, if necessary.



- **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

2. Start the engine and operate at 1500 RPM for two minutes to fill all the hydraulic circuits.
   IMPORTANT: Failure to operate the engine immediately prior to checking the level will result in inaccurate readings.
3. Stop the engine and **immediately** check the fluid level with the dipstick resting in but not threaded into the threaded hole.
4. If the fluid is low, add transmission fluid as described in **Filling**.

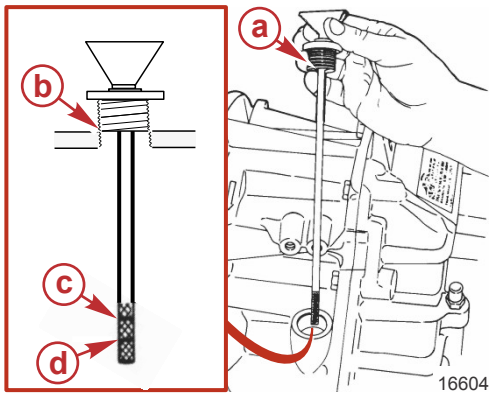
Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	Transmission	Obtain Locally

5. Insert the dipstick into the threaded hole and hand-tighten.

Filling

1. 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.



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

Manufacturer	Model	Capacity (see note)	Fluid Type
ZF Marine (Hurth)	45A	3.0 L (3-1/4 US qt)	Dexron III Automatic Transmission Fluid
	63A	4.5 L (4-3/4 US qt)	
	63IV	4.9 L (5-1/4 US qt)	
NOTE: *Always use the dipstick to determine the exact quantity of oil or fluid required.*			

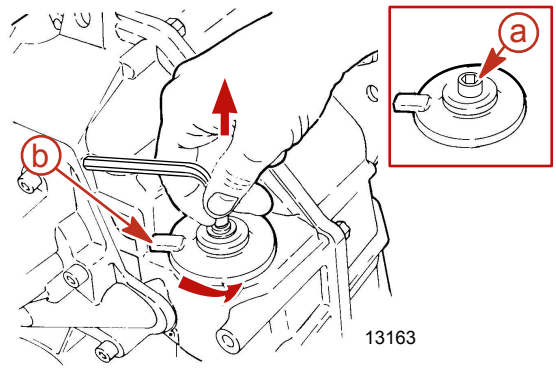
2. Install the dipstick.
3. Check the fluid level as described in **Checking**.

Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

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

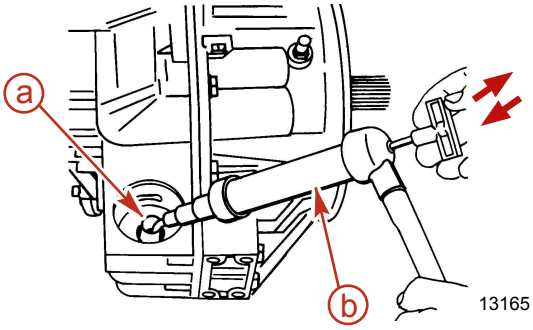
1. Clean the exterior of the transmission around the fluid filter assembly.
2. Use a 6 mm Allen wrench and remove the fluid filter assembly by turning the assembly nut counterclockwise and pulling at the same time.



a - Fluid filter assembly
b - Assembly nut

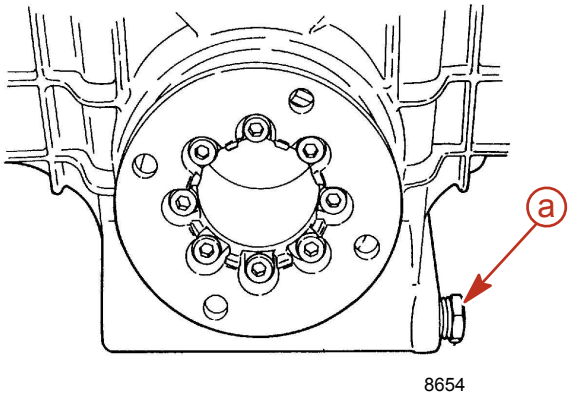
3. **On 63A and 45A transmissions:**
   a. Push the hose of a suction pump through the suction pipe and down to the bottom of the housing.

b. Pump the fluid from the housing into a suitable container. Dispose of the fluid properly.



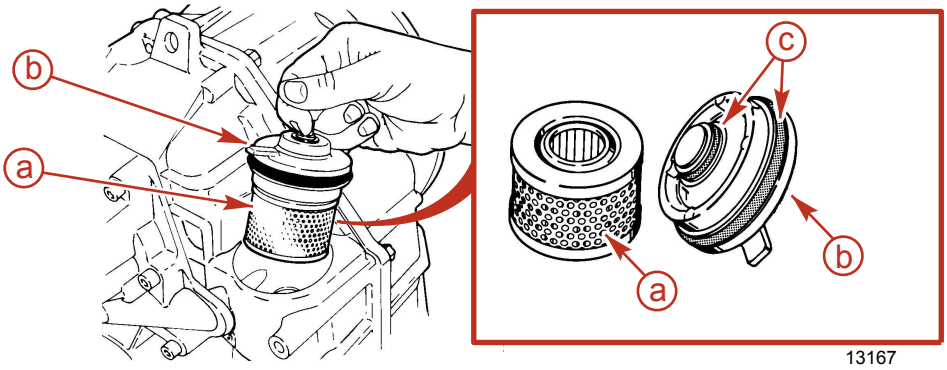
a - Suction pipe
b - Suction pump

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.



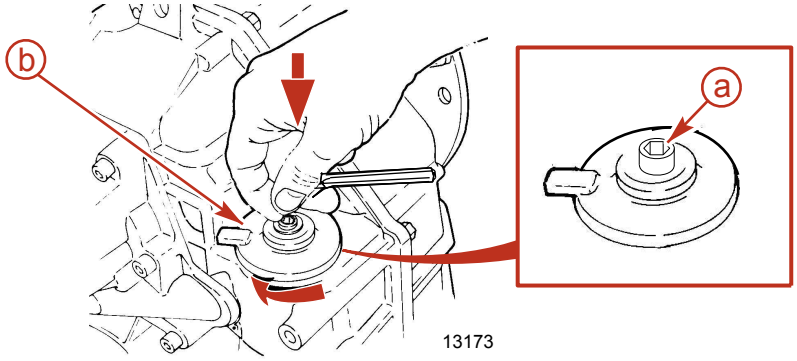
a - Filter element
b - Cover
c - O-rings

NOTICE

Improper installation of the transmission fluid filter assembly may cause the fluid to foam or leak out, resulting in decreased efficiency and damage to the transmission. Properly seat the transmission fluid filter during installation.

9. Install the fluid filter assembly in the transmission cavity by turning it clockwise and pushing at the same time.

10. Using a 6 mm Allen wrench, turn the filter assembly nut clockwise to tighten.



a - Fluid filter assembly
b - Assembly nut

11. Tighten the filter assembly nut to specification.

Description	Nm	lb. in.	lb. ft.
Filter assembly nut	6.5	60	–

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

Removal

⚠ WARNING

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

NOTICE

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

NOTE: *The following procedure describes 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.

NOTICE

The weight of an unsupported transmission can bend the transmission input shaft or damage the engine coupler. Do not permit the splines of the input shaft or coupler to support the weight of the transmission. Completely support the transmission during removal, and until the attaching hardware is secured during installation.

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	92-802869A 1

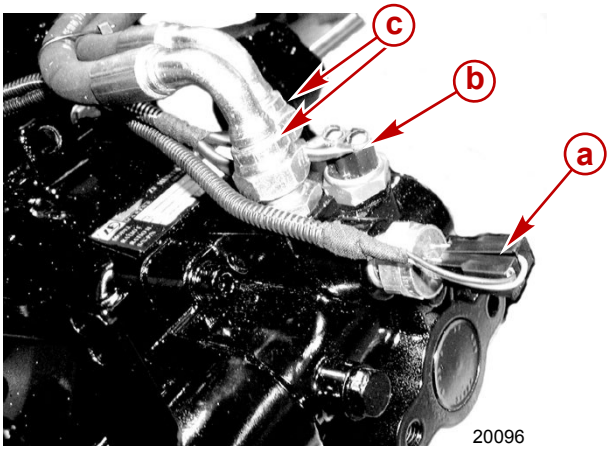
3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Push the transmission into place and secure with attaching hardware.

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.



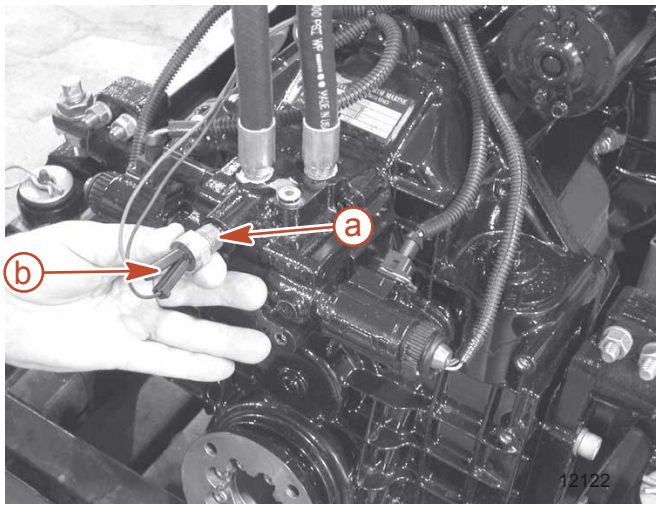
Typical
- **a -** Fluid temperature switch
- **b -** Neutral start switch
- **c -** Transmission fluid cooler hose fitting

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

IMPORTANT: Improper shift cable 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.

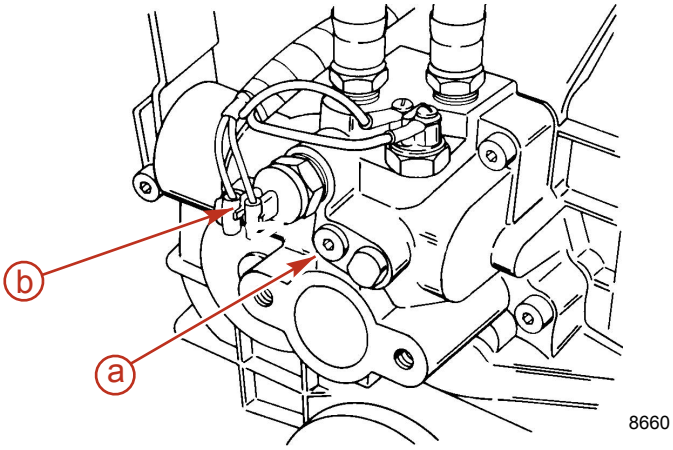
Description	Nm	lb. in.	lb. ft.
Propeller shaft coupler to transmission output flange bolt	68		50

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.

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.

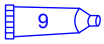


Typical ZF Marine transmission
a - Service port plug—Port **A**
b - Fluid temperature switch—Port **B**

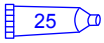
5. Operate the boat with a normal load on board.
6. Ensure that the fluid temperature and shifting pressure are as specified.

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.
	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.
	Liquid Neoprene	Exposed electrical terminals and connections.	92- 25711 3

12. Upon first operation, check for leaks.

Power-Assisted Steering System

Section 9A - Power-Assisted Steering Pump and Related Components

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Inspection..... 9A-3
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Power-Assisted Steering System—Fluid Level..... 9A-4
Power-Assisted Steering—Hydraulic Hoses 9A-5
Steering System Test.....9A-11
Power-Assisted Steering System Pressure Test..... 9A-11
Power-Assisted Steering Pump Pressure Test.....9A-13

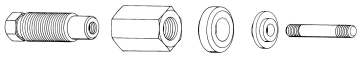
9
A

Lubricants, Sealants, Adhesives

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

Special Tools

Power Steering Pump Pulley Remover	Kent Moore J-21239
25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.

Pulley Pusher Installer	91- 93656A 1
 10047	Installs the pulley onto the power steering pump.

Power Steering Test Gauge Kit	91-38053A05
10804	Tests the power-assisted steering system pressure.

Power-Assisted Steering Pump

Removal

IMPORTANT: In the event of an internal pump failure the entire power-assisted steering system must be replaced.
IMPORTANT: The pumps are non-repairable units and are replaced with new units when they are found to be defective.

⚠ WARNING

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

⚠ CAUTION

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

1. Disconnect the 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

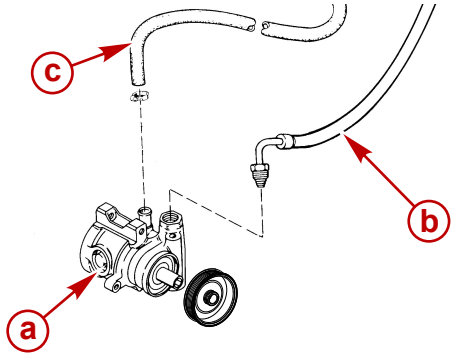
Contamination can damage the hydraulic system or cause the system to malfunction. Failure of power trim or steering components can result in injury or product damage. Ensure that the work area, shop tools and all components are clean and lint free during reassembly.

5. Drain the fluid from the power-assisted steering pump and reservoir into a suitable container.
6. Do not reuse the fluid. Dispose of the fluid properly.

NOTICE

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

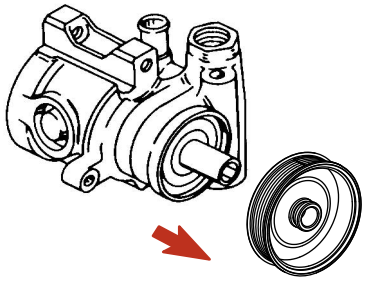
7. Remove the reservoir hose and pressure hose from the power-assisted steering pump. Cap or plug all open hydraulic connections.



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

Power Steering Pump Pulley Remover	Kent Moore J-21239

Inspection

IMPORTANT: Always replace the O-ring on the pressure hose fitting.

1. Inspect the power-assisted steering pump pulley for warping and excessive wear.
2. Inspect the pressure hose fitting.
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.

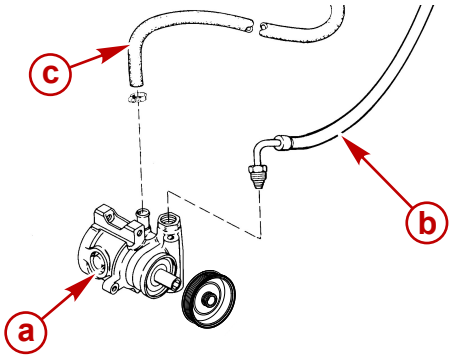
Installation

1. Install a new O-ring on the pressure hose fitting.
2. Remove the caps or plugs from the hydraulic connections.
3. Install the reservoir hose and pressure hose onto the power-assisted steering pump. Ensure that the new O-ring is in position on the pressure hose fitting.

4. Tighten the fitting to specification.

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31	–	23

5. Tighten the reservoir hose clamp securely.



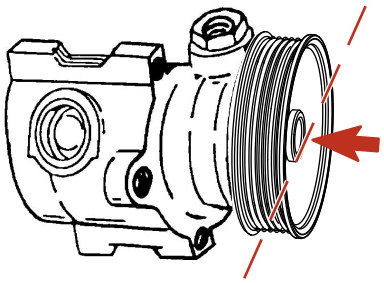
21775

a - Power-assisted steering pump
b - Pressure hose
c - Reservoir hose

6. Install the reservoir onto the reservoir bracket.
7. Install the power-assisted steering pump onto the pump bracket using the three screws retained in removal.
8. Tighten the screws to specification.

Description	Nm	lb. in.	lb. ft.
Power-assisted steering pump to pump bracket screw	26	–	19

9. Using the tool listed or 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

Pulley Pusher Installer	91- 93656A 1

10. Drain any remaining fluid out of the power-assisted steering reservoir into an approved container.
11. Do not reuse the fluid. Dispose of the old fluid properly.
12. Fill the power-assisted steering reservoir with the specified fluid.

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

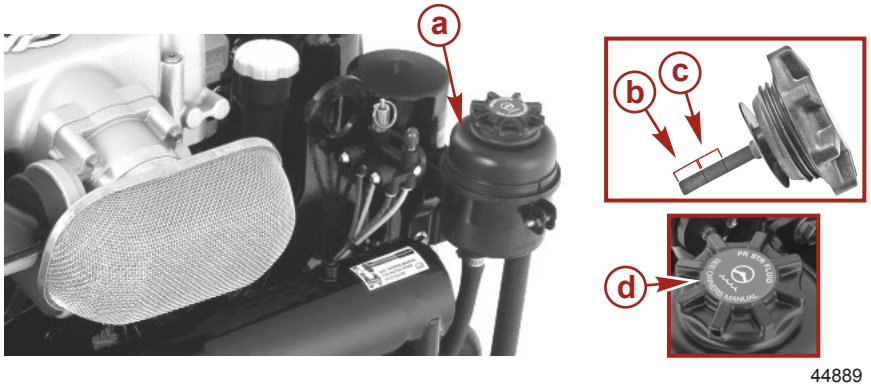
13. Connect the battery cables.
14. Install the serpentine drive belt.

Power-Assisted Steering System—Fluid Level

Checking

1. Stop the engine and center the sterndrive.

2. Remove the fill cap from the power steering fluid reservoir and observe the level. The oil level should be at the lower mark when the engine is cold and at the upper mark when the engine is warm.



44889

a - Reservoir
b - Add range
c - Operating range
d - Fill cap

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

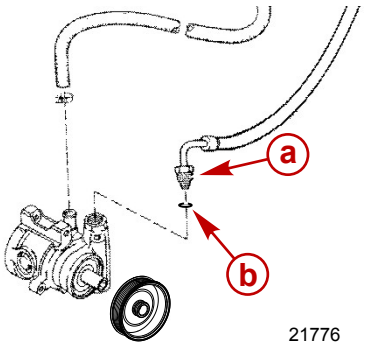
IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid from leaking.
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

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.

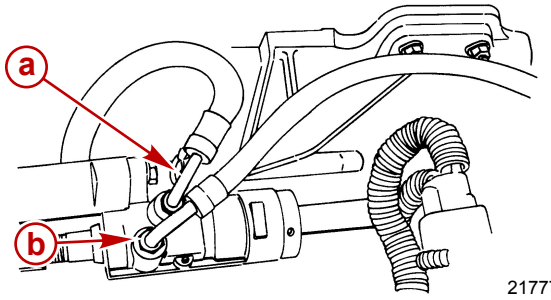


21776

a - Pressure hose fitting
b - O-ring

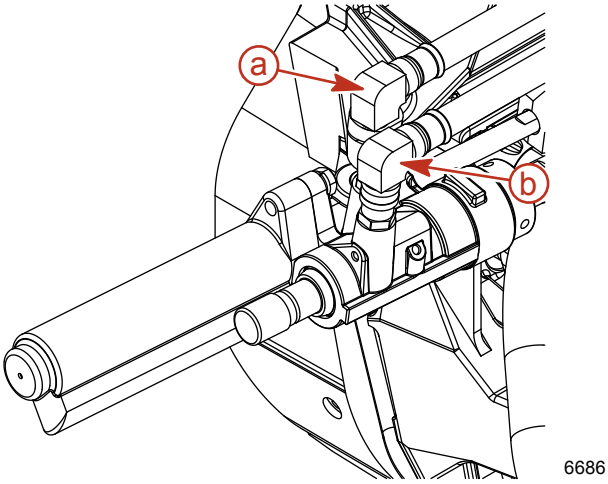
2. Remove and discard the O-ring.
3. **On models with standard fittings:**
   a. Disconnect the pressure hose from the control valve at the transom.

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.

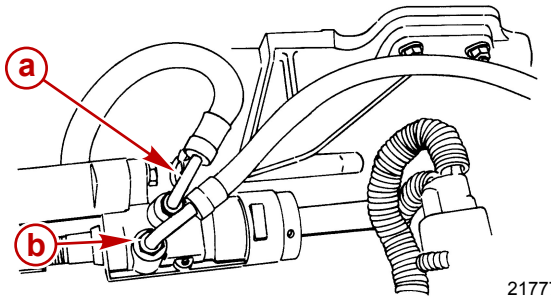


a - Pressure hose
b - Return hose

Installation

IMPORTANT: Route hoses as shown below to prevent kinks, which can damage hoses or fittings.
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

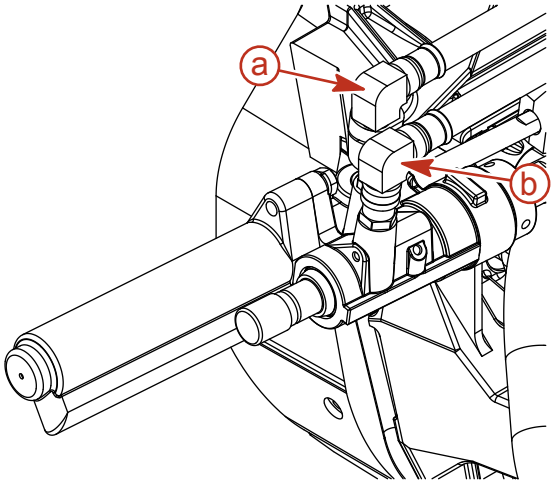
1. Route the pressure hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
   a. Ensure that the O-ring is in position on the pressure hose fitting.
   b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.



a - Pressure hose fitting
b - Return hose fitting

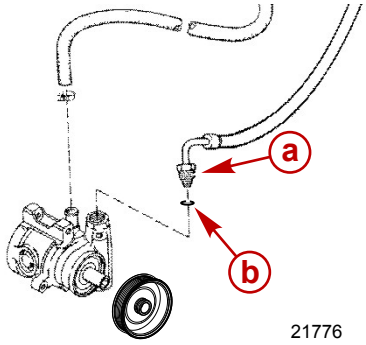
Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

3. **On models with quick-connect fittings,** install the pressure 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. Ensure that the O-ring is in position on the pressure hose fitting at the power-assisted steering pump.
5. Install the threaded hose fitting into the power-assisted steering pump. Torque the fitting.



a - Pressure hose fitting
b - O-ring

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

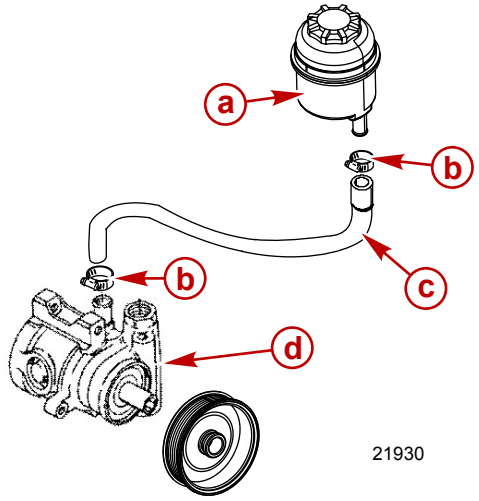
6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

Reservoir Hose (Reservoir to Pump)

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 clamps on the reservoir hose at the reservoir and the power-assisted steering pump. Remove the hose.

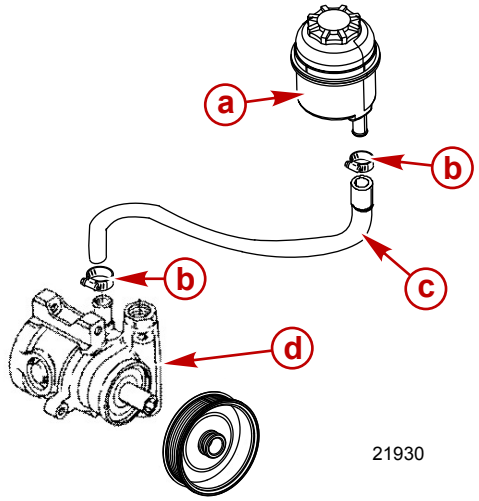


a - Reservoir
b - Hose clamp
c - Reservoir hose
d - Power-assisted steering pump

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

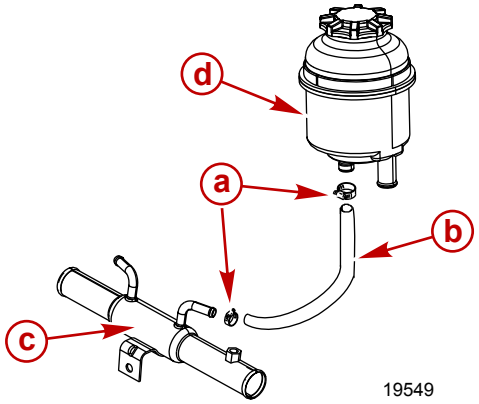
Return Hose (Cooler-To-Reservoir)

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.

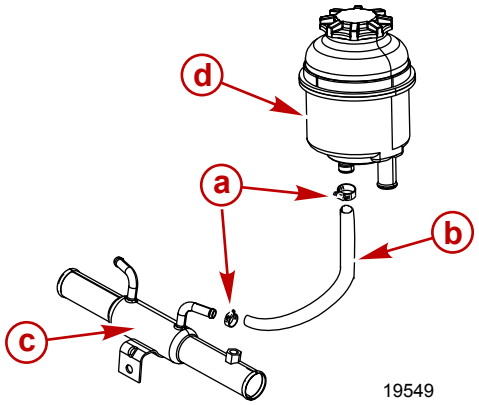


a - Hose clamp
b - Return hose
c - Fluid cooler
d - Reservoir

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.



a - Hose clamp
b - Return hose
c - Fluid cooler
d - Reservoir

3. Fill the power-assisted steering system with the specified fluid. See **Section 1B.**

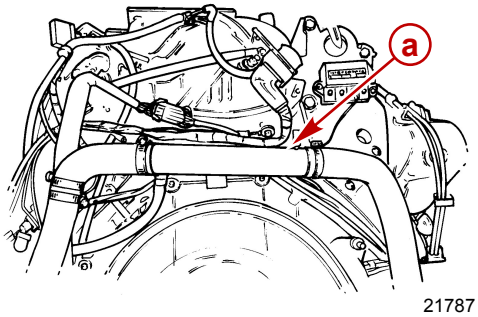
Return Hose (Control Valve-to-Cooler)

Removal

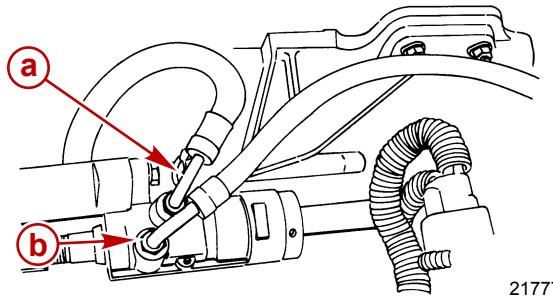
NOTE: *Catch any fluid that drains from the power-assisted steering pump, hoses, fluid reservoir, or fluid cooler in a suitable container.*

1. Loosen the hose clamp and remove the hose from the fluid cooler.

a - Return hose

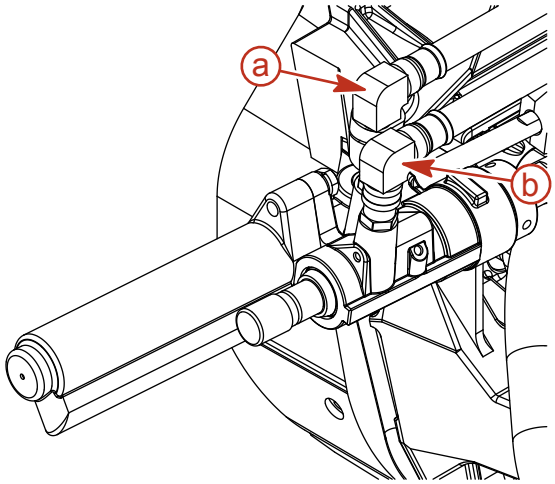


2. **On models with standard fittings,**disconnect the return hose from the control valve at the transom.



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.



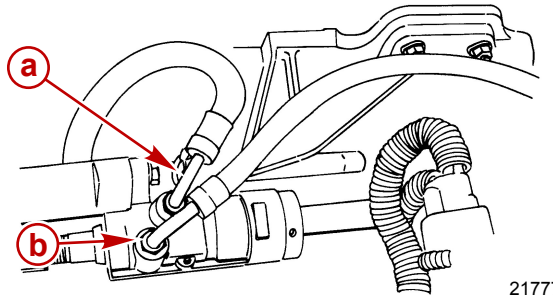
a - Pressure hose
b - Return hose

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.

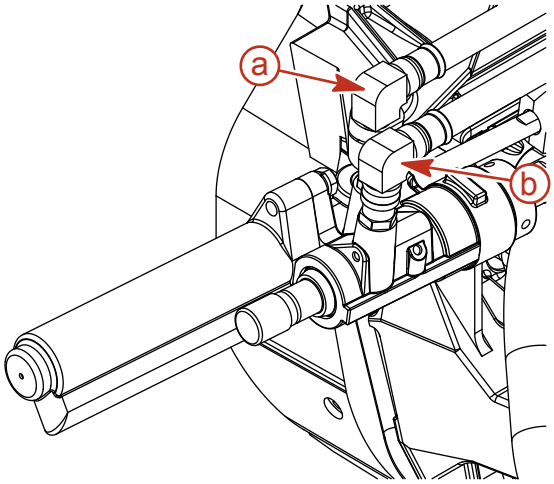
1. Route the return hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
   a. Ensure that the O-ring is in position on the return hose fitting.
   b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.



a - Pressure hose
b - Return hose

Description	Nm	lb. in.	lb. ft.
Return hose fitting	31		23

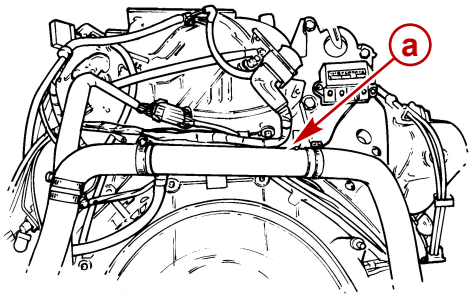
3. **On models with quick-connect fittings,** install the return hose onto the quick-connect fitting on the control valve at the transom. Ensure that the quick-connect fitting snaps into place.



6686

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

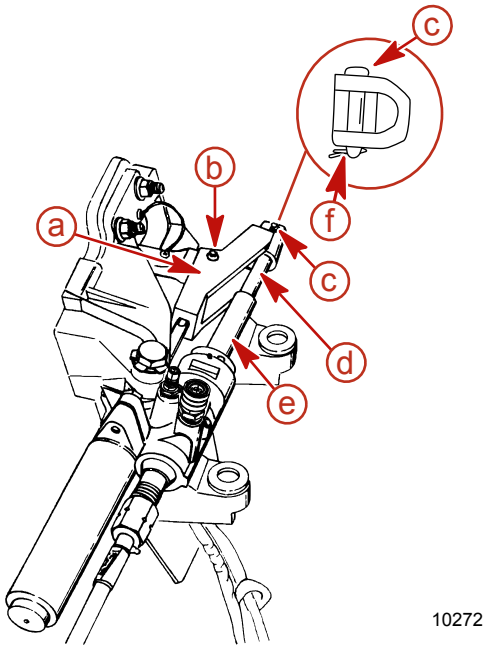
6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

Steering System Test

Power-Assisted Steering System Pressure Test

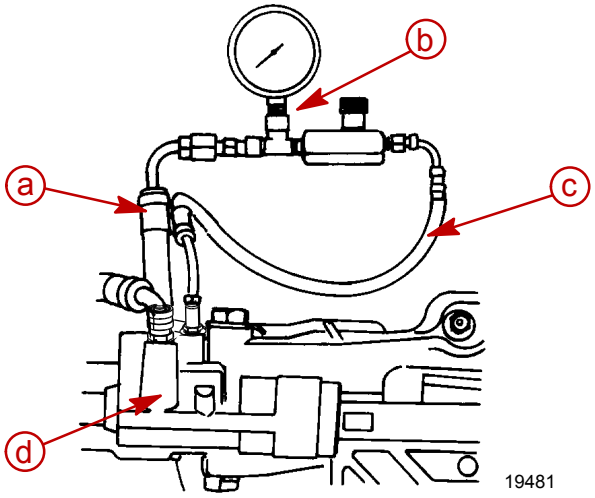
The following procedure is arranged so that a defective part can be detected through the process of elimination. Follow the order of the instructions so that the power-assisted steering system can be tested effectively.

1. Remove the front and rear clevis pins.



- **a -** Clevis
- **b -** Rear clevis pin (steering lever)
- **c -** Front clevis pin
- **d -** Steering cable end
- **e -** Cable guide tube
- **f -** Cotter pins

2. Retract the cable into the cable guide tube.
3. Assemble and install the test gauge between the high-pressure hose from the pump and the valve.



- **a -** Pump pressure hose
- **b -** Test gauge assembly
- **c -** Gauge-to-control-valve hose
- **d -** Control valve

Power Steering Test Gauge Kit	91-38053A05

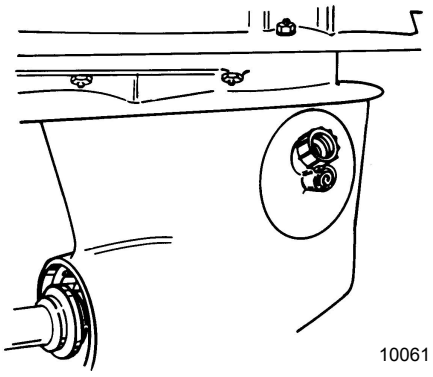
4. Open the valve on the gauge completely.

NOTICE

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

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups****.*

5. Connect a flush test device to the sterndrive. Partially open the water tap (approximately half of maximum) and allow the cooling system to fill completely. The cooling system is full when water is discharged through the propeller. Do not use full water tap pressure.



Standard Bravo shown

6. Start the engine and operate at 1000–1500 RPM until the engine reaches normal operating temperature.
7. With the engine at idle speed, the test gauge reading should be between 483 and 862 kPa (70 and 125 psi). If not, proceed as follows:

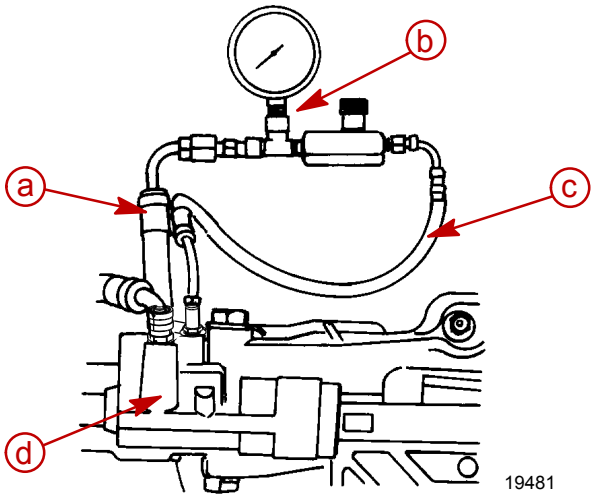
NOTICE

Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than 5 seconds.

8. Push in and then pull the steering cable momentarily. Movement in each direction should cause the gauge to show an instant increase in pressure.
9. Push the steering cable in until the booster cylinder piston rod is fully retracted. With the piston rod in this position, momentarily push the steering cable in until its maximum pressure reading is reached.
   - If the pressure is above 6897 kPa (1000 psi), system pressure is good.
   - If the pressure is below 6897 kPa (1000 psi), conduct the **Power-Assisted Steering Pump Pressure Test**.

Power-Assisted Steering Pump Pressure Test

1. Install a test gauge between the high-pressure hose from the pump and the valve.



- **a -** Pump pressure hose
- **b -** Test gauge assembly
- **c -** Gauge-to-control-valve hose
- **d -** Control valve

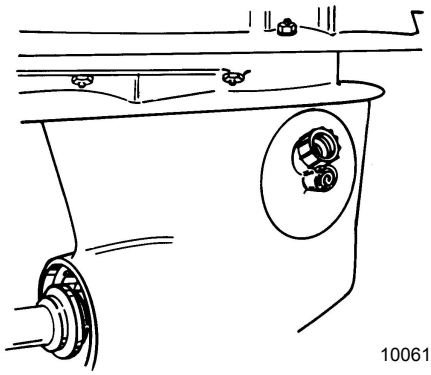
Power Steering Test Gauge Kit	91-38053A05

NOTICE

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

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups****.*

2. Connect a flush test device to the sterndrive. Partially open water tap (approximately half of maximum) and allow water to enter the cooling system. Do not use full water tap pressure.



Standard Bravo shown

3. Start the engine and operate at 1000–1500 RPM until the engine reaches normal operating temperature.
IMPORTANT: The test gauge valve blocks the flow of pressurized fluid when closed. To avoid damage to the pump, do not close the test gauge valve longer than five seconds during testing.
4. Close the test gauge valve just long enough to obtain maximum pressure reading.
5. Close and open the valve three times. Record the highest pressure reading attained each time:
   a. **If pressure readings are between 9308 and 9997 kPa (1350 and 1450 psi) and are within a range of 345 kPa (50 psi)**, the pump is within specifications. If the pump tests OK, but system pressure was low (as tested under **Power-Assisted Steering System Pressure Test**) replace the control valve assembly.
   b. **If pressure readings are between 9308 and 9997 kPa (1350 and 1450 psi) but are not within a 345 kPa (50 psi) range**, the power-assisted steering pump flow control valve is sticking or the pump hydraulic system is dirty.
   c. **If pressure readings are constant, but below 8963 kPa 1300 psi**, replace the power-assisted steering pump.

Manual Outline

1 - Important Information
- A - General Information
- B - Maintenance Sterndrive Models
- C - Maintenance Inboard Models
- D - Troubleshooting

2 - Removal and Installation
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- B - Inboard Models

3 - Engine
- A - Engine Mechanical

4 - Electrical System
- A - Starting System
- B - Ignition System
- C - Charging System
- D - Audio and Visual Warning System
- E - Components

5 - Fuel System
- A - Fuel Delivery System

6 - Cooling System
- A - Closed Cooling System

7 - Exhaust System
- A - Models With Emissions Control
- B - Models Without Emissions Control
- C - Exhaust Collectors

8 - Transmission
- A - ZF Marine Transmissions—HSW 63A, 63IV, 80A

9 - Power-Assisted Steering System
- A - Power-Assisted Steering Pump and Related Components

Models Covered

Sterndrive

Models Covered	Serial Number
8.2 MAG	1A350340 and above
8.2 MAG H.O.	
8.2 MAG with Emissions Control	
8.2 MAG H.O. with Emissions Control	
SeaCore 8.2 MAG with Emissions Control	
SeaCore 8.2 MAG H.O. with Emissions Control	

Inboard

Models Covered	Serial Number
Horizon 8.2 with Emissions Control	1A350802 and above
8.2 H.O with Emissions Control	

Notice to Users of This Manual

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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

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

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

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Mercury, Mercury Marine, MerCruiser, Mercury MerCruiser, Mercury Racing, Mercury Precision Parts, Mercury Propellers, Mariner, Quicksilver, #1 On The Water, Alpha, Bravo, Bravo Two, Pro Max, OptiMax, Sport-Jet, K-Planes, MerCathode, RideGuide, SmartCraft, Zero Effort, M with Waves logo, Mercury with Waves logo, VesselView, and SmartCraft logo are all registered trademarks of Brunswick Corporation. Mercury Product Protection logo is a registered service mark of Brunswick Corporation.

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 into the cylinders which could cause extensive internal damage when the engine is started.

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

Replacement Parts

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

⚠ WARNING

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

Cleanliness and Care of Product

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

Whenever components are removed 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.

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Important Information

Section 1A - General Information

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Introduction

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

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

Quicksilver Products

Accessories

Quicksilver gauges, remote controls, steering systems, propellers, and other accessories are available for this product. Mercury MerCruiser recommends the use of Quicksilver parts on all applications. Refer to **Mercury Precision Parts Accessories Guide** for a complete listing.

This Guide is available from:
Attn: Parts Department
Mercury Marine
W6250 W. Pioneer Road
P.O. Box 1939
Fond du Lac, WI 54935-1939

Outside of U.S.A., order through Distribution Center or Distributor.

How to Use This Manual

This manual is divided into volumes and sections that represent the major components and systems.

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

Refer to the **Service Manual Outline** following **Models Covered** in this manual for section titles.

MerCruiser Color Wiring Diagrams

Large scale, oversized color wiring diagrams are available in the MerCruiser Diagram Binder. The initial distribution of the MerCruiser Diagram Binder was delivered to MerCruiser authorized repair facilities in June and July of 2007. As new diagrams are developed they will be distributed along with a revised, comprehensive index for addition to an existing binder.

The MerCruiser Diagram Binder features:

- An index that identifies the diagrams by harness number, by engine group and drive, and by engine size and type
- The diagrams are printed on an extremely durable, coated synthetic paper and can be wiped clean of grease and oil after use.
- The larger diagrams are easier to read. The diagrams will come in two sizes, depending on the complexity of the related harness.
- Removable pages are easier to reference and allow the technician to take only the required diagram to a repair site instead of a complete service manual.
- Dry erase markers can be used directly on the diagrams for tracing circuits or for training. They wipe clean after use.
- Harness number headings make the drawings easy to find. The accompanying MerCruiser Diagram Binder Index speeds lookup when the harness number is not known.

For information about ordering additional copies of the MerCruiser Diagram Binder or binder updates contact:

- MerCruiser Authorized Dealers, Repair Centers, or OEMs can order service literature on MercNET.
- Consumers can order service literature through the Mercury Dock Store (www.mercurydockstore.com), contacting Mercury MerCruiser publications at 920-929-5110 or by contacting their local MerCruiser Authorized Dealer or Repair Center.

Abbreviations

IMPORTANT: Throughout this manual abbreviations of terms will be used, following is a listing of the abbreviations and related definitions.

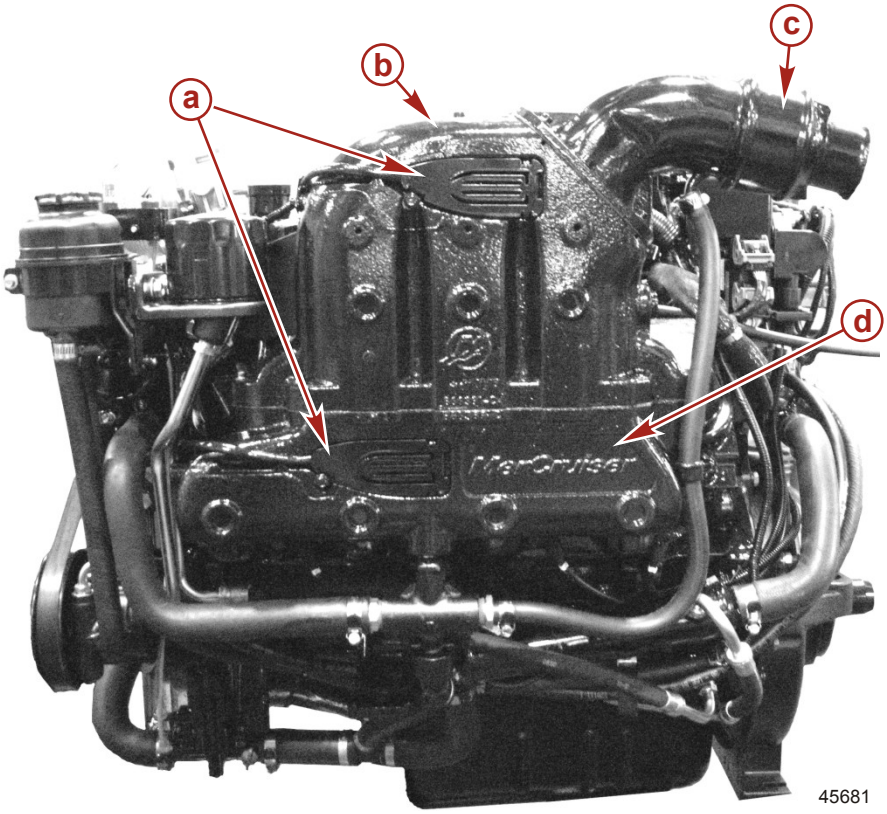
BARO	Barometric Pressure	INJ	Injection
BAT	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor
CKT	Circuit	KV	Kilovolts

CONN	Connector	MAP	Manifold Absolute Pressure
CYL	Cylinder	MDTC	Marine Diagnostic Trouble Code
DEG	Degrees	MIL	Malfunction Indicator Lamp
DIAG	Diagnostic	mSec	Millisecond
DIST	Distributor	N/C	Normally Closed
DLC	Data Link Connector	N/O	Normally Open
DTC	Diagnostic Trouble Code	OBD	On Board Diagnostic
DVOM	Digital Volt Ohm Meter	PROM	Programmable Read Only Memory
PCM	Propulsion Control Module	RAM	Random Access Memory
ECT	Engine Coolant Temperature	REF. HI	Reference High
EPROM	Electronic Erasable Programmable Read Only Memory	REF. LO	Reference Low
EMI	Electromagnetic Interference	ROM	Read Only Memory
ENG	Engine	SLV	Slave
EST	Electronic Spark Timing	SW	Switch
GND	Ground	TACH	Tachometer
GPH	Gallons Per Hour	TERM	Terminal
HEI	High Energy Ignition	TPS	Throttle Position
IAC	Idle Air Control	V	Volts
IAT	Intake Air Temperature	VAC	Vacuum
IC	Ignition Control	WOT	Wide Open Throttle
IGN	Ignition	in. Hg	Inches of Mercury
		MCM	MerCruiser Marine
		MIE	Mercury Inboard Engine
		MPI	Multi-Port Injection

Sterndrive Models Identification

Engine Exhaust With and Without Emissions Control

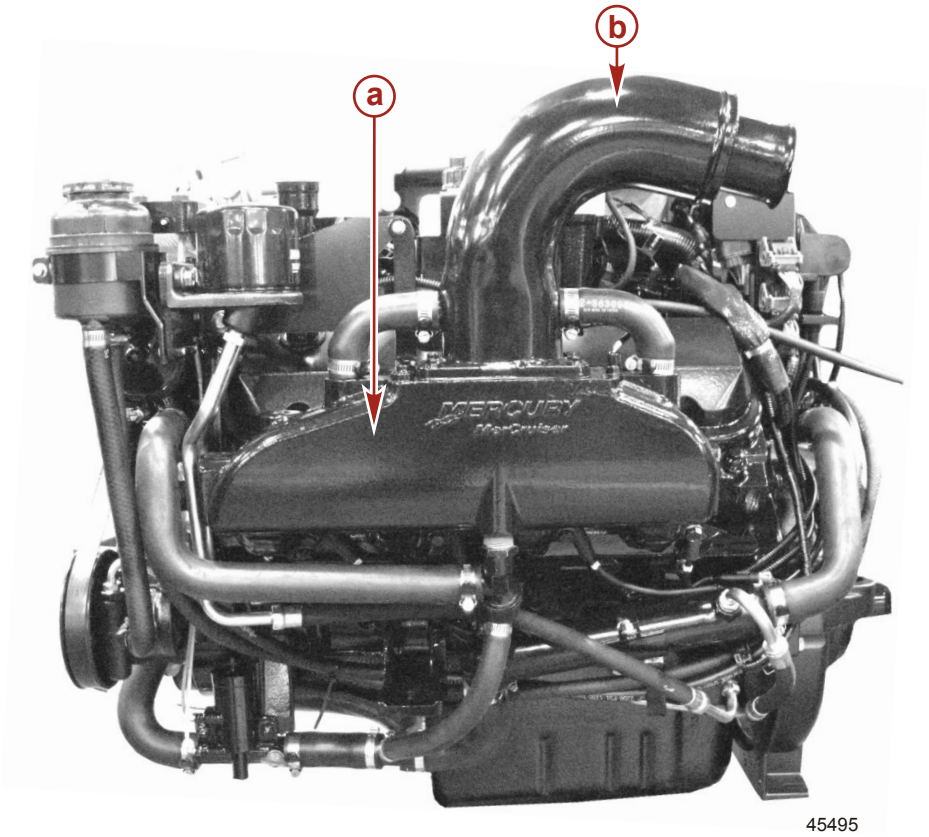
Engine With Emissions Control



Typical 8.2 MAG sterndrive with emissions control

- **a -** Catalyst sensors
- **b -** Exhaust collector
- **c -** Exhaust elbow riser
- **d -** Exhaust manifold

Engine Without Emissions Control

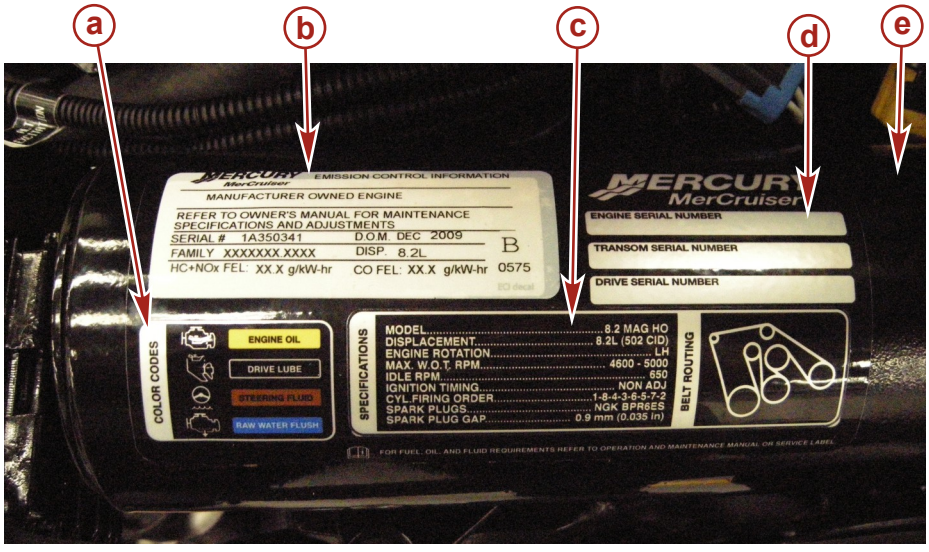


Typical 8.2 MAG sterndrive without emissions control

a - Exhaust manifold
b - Exhaust elbow

Information Decal

The information decal is located on the top starboard side of the heat exchanger.



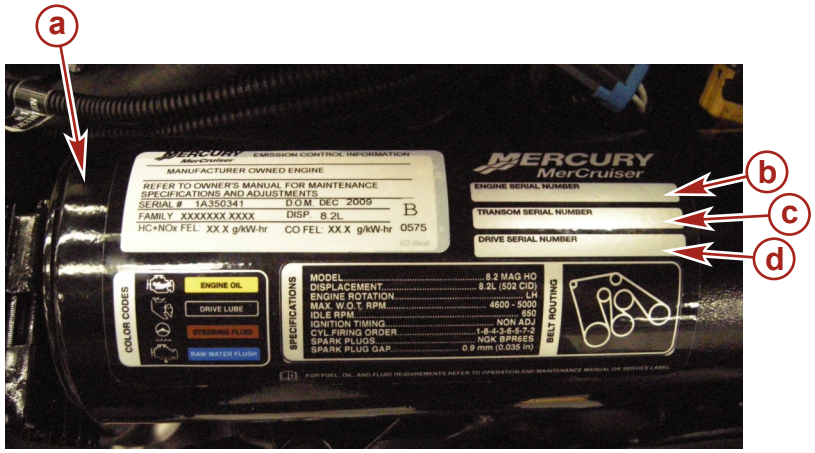
a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Heat exchanger

Serial Number Decal Strips

There are 3 sets of engine, transom assembly, and sterndrive serial number decal strips provided with each power package. Affix one of each to the following:

- Serial numbers decal
- Warranty registration Card

- Operation, Maintenance and Warranty Manual identification page



43188

a - Heat exchanger
b - Engine serial number
c - Transom serial number
d - Sterndrive serial number

Engine Serial Number

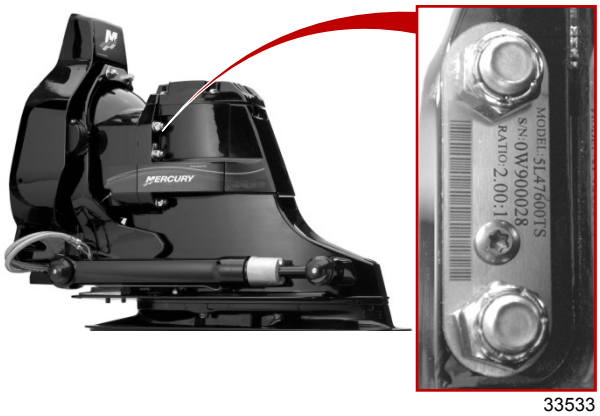
The engine serial number stamp is located on the starboard-side of the engine block next to the flywheel housing cover.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Bravo Sterndrive Serial Number and Identification

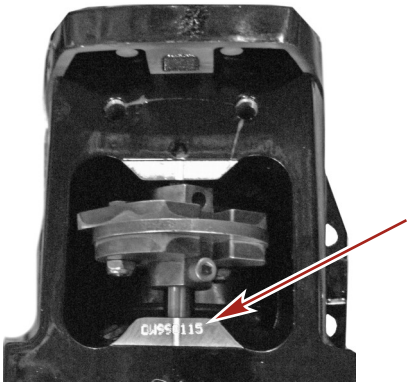
The Bravo sterndrive serial number, gear ratio, model number, and bar code are embedded in the ground plate on the port side of the sterndrive.



33533

Bravo sterndrive information on ground plate

The serial number is also stamped on the drive shaft housing behind the back cover. This is used as a permanent reference for authorized MerCruiser Dealers.

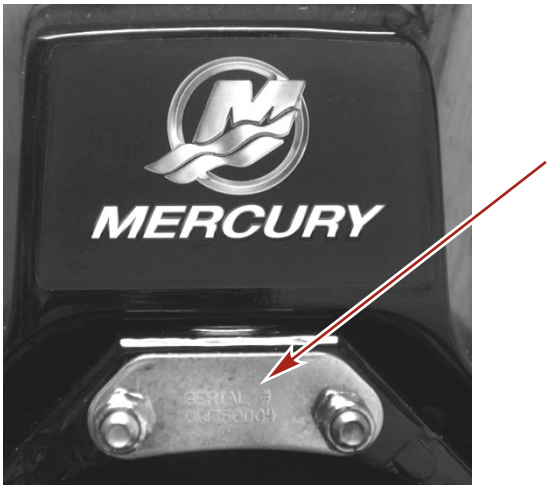


44426

Bravo sterndrive serial number stamping

Bravo Transom Serial Number

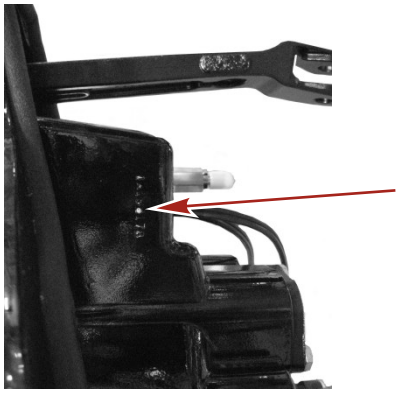
The Bravo transom serial number is stamped in the U-bolt plate of the Bravo transom assembly.



44433

Serial number location on U-bolt plate

The serial number is also stamped on the gimbal housing. This is used as a permanent reference for authorized MerCruiser Dealers.



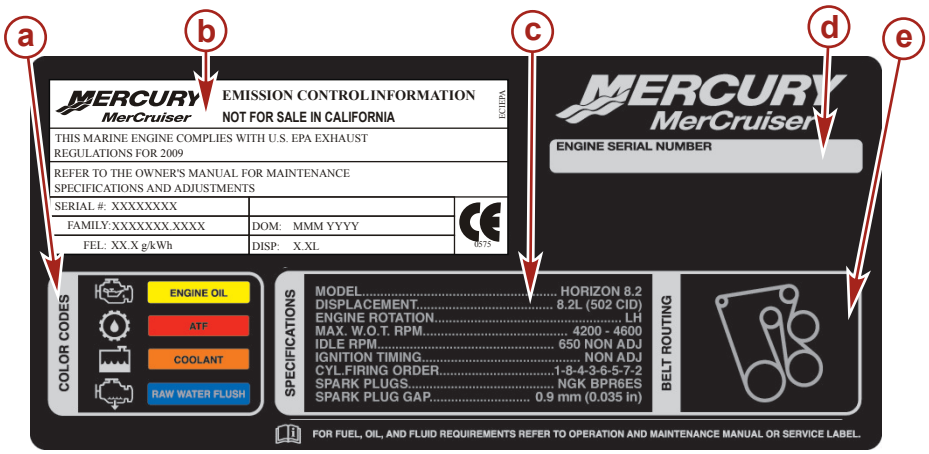
44425

Serial number location on gimbal housing

Inboard Models Identification

Information Decal

The information decal is located on the top starboard-side of the heat exchanger.



43688

a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Belt routing

Serial Number Decal Strips

There are 3 sets of engine serial number decal strips provided with each power package. Affix one to the following:

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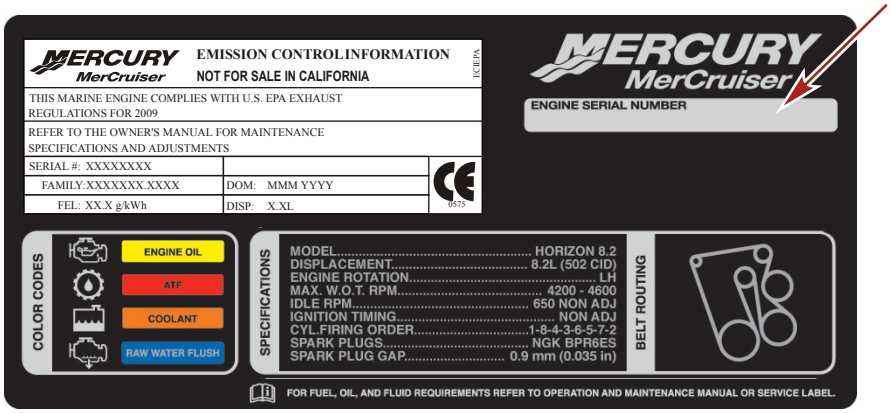


43689

Engine serial number decal on heat exchanger

Engine Serial Number

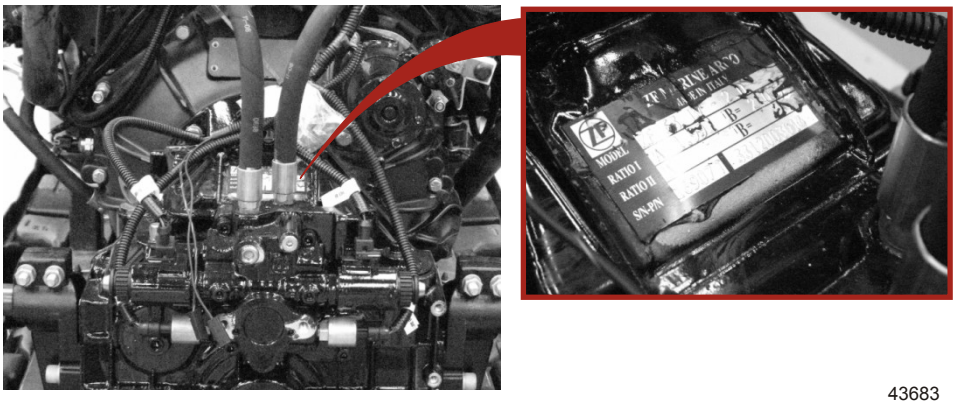
The engine serial number stamp is located on the starboard-side of the engine block next to the flywheel housing cover.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Transmission Identification Plate

On the ZF Marine 8 Degree Down-Angle and V-Drive Transmissions, the transmission identification plate indicates gear ratio, serial number, and model.



43683

Typical ZF Marine down-angle transmission shown (V-drive similar)

SeaCore Models

SeaCore Components and Castings

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

Stainless Steel Fasteners

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

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

Apply a lubricant, such as Special Lubricant 101 or an equivalent, on the threads of stainless steel fasteners during installation to avoid galling. Lubricate at least the first 8 mm (1/4 in.) of the threads before installation.

SeaCore System

The SeaCore System is a complete engine sterndrive package. The SeaCore engine and sterndrive enhancements are:

- Hardcoat anodized external castings
- Additional stainless steel fasteners and hardware

- Closed cooling on the engine
- Freshwater flush system—flushes the entire system

The SeaCore System provides corrosion protection for the engine with these standard features:

- Closed-cooling system with 5-year, long-life coolant
- Stainless steel steering shaft
- Stainless steel engine motor mounts and fasteners
- Dry joint exhaust
- MerCathode Corrosion Protection System
- SmartCraft Engine Guardian
- Compatible with 87 octane fuel

The following stainless steel fasteners and hardware are used on this engine and sterndrive package for increased corrosion resistance:

- Gimbal housing studs
- Power steering hose—high pressure end
- Flywheel housing bolts
- Pulley attaching bolts and all engine component fasteners
- Engine mount stud and fastener

NOTE: *Hardcoat anodizing is more abrasion resistant than case-hardened steel, and if the drive is scratched, the anodizing slows the destructive growth of corrosion through the drive surface.*

The SeaCore System provides corrosion protection for the sterndrive with the following standard features:

- Industrial hardcoat anodized XK360 aluminum drive housings and transom components
- Protected interior passages
- Through-the-propeller exhaust
- Non-conductive surface to reduce galvanic corrosion
- Stainless steel sterndrive and transom fasteners
- Power Trim XD
- New SeaCore transom identification plate
- Bravo III stainless steel bearing carrier
- The transom is equipped with stainless steel upper swivel shaft (and new shaft seal)

Corrosion Information

Corrosion Protection

Mercury MerCruiser power packages are equipped with anodes to help protect them from galvanic corrosion under moderate conditions. However, for severe conditions or if using a stainless steel propeller, it is recommended that a Quicksilver Anti-Corrosion Anode Kit and/or a MerCathode System with 2 additional transom mounted anode assemblies be installed (some models have a MerCathode System as standard equipment). A MerCathode Monitor also is available to allow the operator to check the operation of the MerCathode System with the push of a button. (Refer to **Mercury Precision Parts Accessories Guide** for part numbers.)

Boats that are connected to AC shore power require additional protection to prevent destructive low voltage galvanic currents from passing through the shore power ground wire. A Quicksilver Galvanic Isolator can be installed to block the passage of these currents while still providing a path to ground for dangerous fault (shock) currents. (Refer to **Mercury Precision Parts Accessories Guide** for part number.)

IMPORTANT: If AC shore power is not isolated from boat ground, the MerCathode System and anodes may be unable to handle the increased galvanic corrosion potential.

Anti-Fouling Paint

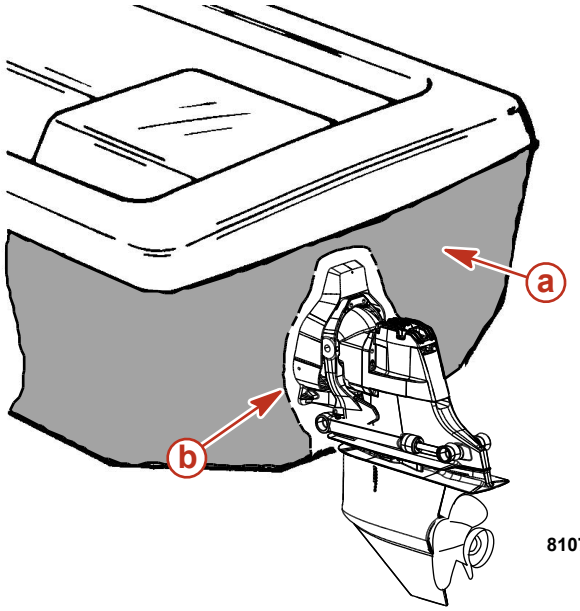
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

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

IMPORTANT: Do not paint anodes or pressure wash anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

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

- **Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on transom of the boat around these items.**

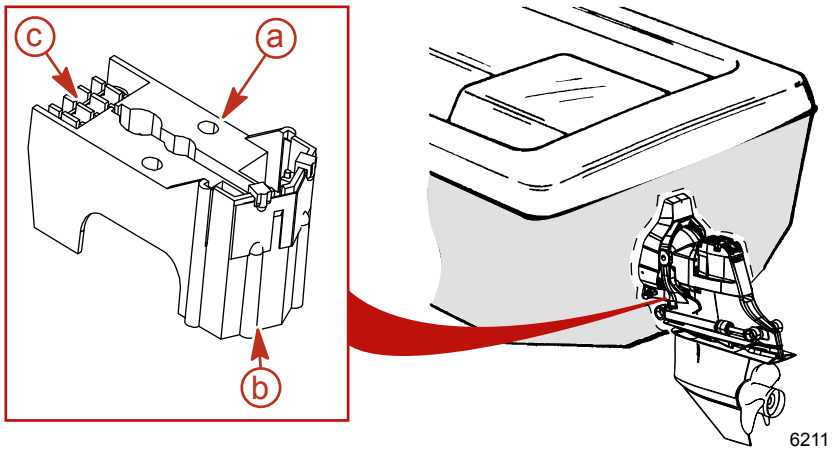


a - Painted boat transom
b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly

NOTE: Sterndrive unit and transom assembly can be painted with a good quality marine paint or an anti-fouling paint that DOES NOT contain copper or any other material that could conduct electrical current. Do not paint drain holes, anodes, MerCathode system or items specified by boat manufacturer.

NOTICE
Washing the MerCathode assembly can damage components and lead to rapid corrosion. Do not use any cleaning equipment such as brushes or high-pressure washers to clean the MerCathode assembly.

Do not wash the sterndrive unit with a power washer as this can damage the coating on the reference wire of the MerCathode assembly, if equipped, and increase corrosion.

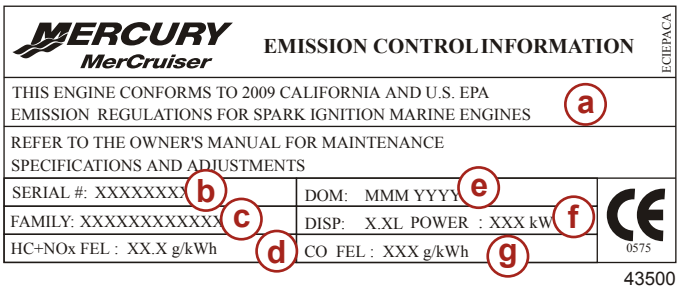


a - MerCathode reference electrode
b - Do not paint
c - Do not pressure wash

Emissions Information For Engines With Emission Control

Emission Control Information Label

A tamper-resistant emission control information (ECI) label is affixed to the engine in a visible location at the time of manufacture by Mercury MerCruiser. Please note that the low emissions certification will not affect the fit, function, or performance of the engine. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding. In addition to the required emissions statement, the label lists the engine serial number, family, applicable emission standard, date of manufacture (month, year), and engine displacement.



- **a -** Applicable standard
- **b -** Engine serial number
- **c -** Engine family name
- **d -** Hydrocarbons plus oxides of nitrogen family emission limit
- **e -** Date of manufacture
- **f -** Engine displacement, engine power
- **g -** Carbon monoxide family emission limit

IMPORTANT: A CE mark in the lower right corner of the Emission Control Information label indicates that an EU Declaration of Conformance applies. Refer to the front page of this manual for further information.
IMPORTANT: Engines designated as exempt from either Federal EPA or California emission control regulations are not covered by a separate emission control component warranty. The product's Mercury MerCruiser manufacturer's warranty is not affected by the engine's designation under Federal EPA or California emission control regulations.

ECI Label	Standard of Compliance
MERCURY MerCruiser EMISSION CONTROL INFORMATION NOT FOR SALE IN CALIFORNIA ECIEPA THIS MARINE ENGINE COMPLIES WITH U.S. EPA EXHAUST REGULATIONS FOR 2009 REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43518	Indicates a marine engine compliant with United States EPA exhaust emission regulations for 2009. This marine engine is not for sale in California.
MERCURY MerCruiser EMISSION CONTROL INFORMATION ECICARB THIS ENGINE CONFORMS TO 2009 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY:XXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43519	Indicates a marine engine compliant with California CARB exhaust emission regulations for 2009
MERCURY MerCruiser EMISSION CONTROL INFORMATION ECIEPACA THIS ENGINE CONFORMS TO 2009 CALIFORNIA AND U.S. EPA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43520	Indicates a marine engine compliant with California CARB and U.S. EPA regulations for 2009

ECI Label	Standard of Compliance
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** **NOT FOR SALE IN CALIFORNIA** ECIEXEMP THIS ENGINE IS EXEMPT UNDER 40 CFR 1068.255 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS REFER TO THE OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43521	Indicates a marine engine exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations for 2010. This marine engine is not for sale in California.
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** ECICARBX THIS ENGINE CONFORMS TO 2010 CALIFORNIA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES. THIS ENGINE IS EXEMPT UNDER 40 CFR 1068.255 FROM EMISSION STANDARDS AND RELATED REQUIREMENTS. REFER TO THE OWNERS MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS. SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43522	Indicates a marine engine compliant with 2010 California emission regulations and exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations
MERCURY MerCruiser **EMISSION CONTROL INFORMATION** ECISERV THIS ENGINE DOES NOT COMPLY WITH U.S. EPA NONROAD EMISSION REQUIREMENTS. SELLING OR INSTALLING THIS ENGINE FOR ANY PURPOSE OTHER THAN TO REPLACE A NONROAD ENGINE BUILT BEFORE JANUARY 1, 2010 MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY. SERIAL #: XXXXXXXX — DOM: MMM YYYY FAMILY: XXXXXXXXXXXX — DISP: X.XL POWER : XXX kW HC+NOx FEL : XX.X g/kWh — CO FEL : XXX g/kWh CE 0575 43499	Indicates a service marine engine that can replace a marine engine built prior to January 1, 2010.

Owner Responsibility

The operator must have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The operator may not modify the engine in any manner that alters the horsepower or allows emissions levels to exceed factory specifications.

Emission Certification Star Label

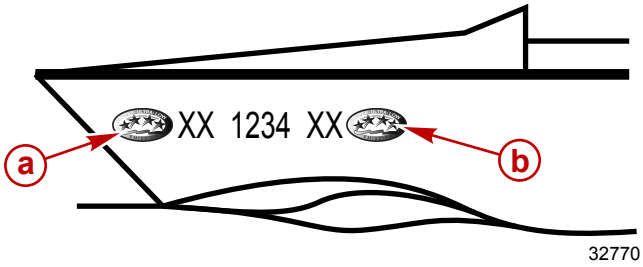
Your boat is labeled on the hull with one of the following star labels. The Symbol for Cleaner Marine Engines Means:

1. Cleaner Air and Water - for a healthier lifestyle and environment.
2. Better Fuel Economy - burns up to 30-40 percent less gas and oil than conventional carbureted two-stroke engines, saving money and resources.
3. Longer Emission Warranty - Protects consumer for worry free operation.

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

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

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



a - Recommended location
b - Secondary location

One Star - Low emission	
mc79569-1	The one-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2001 exhaust emission standards. Engines meeting these standards have 75% lower emissions than conventional carbureted two-stroke engines. These engines are equivalent to the U.S. EPA's 2006 standards for marine engines.
Two Stars - Very Low emission	
42145	The two-star label identifies personal watercraft, outboard, sterndrive and inboard engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2004 exhaust emission standards. Engines meeting these standards have 20% lower emissions than One Star - Low-Emission engines.
Three Stars - Ultra Low emission	
42146	The three-star label identifies engines that meet the Air Resources Board's Personal Watercraft and Outboard marine engine 2008 exhaust emission standards or the Sterndrive and Inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.
Four Stars - Super Ultra Low emission	
42155	The Four Star label identifies engines that meet the Air Resources Board's Sterndrive and Inboard marine engine 2009 exhaust emission standards. Personal Watercraft and Outboard marine engines may also comply with these standards. Engines meeting these standards have 90% lower emissions than One Star - Low Emission engines.

Hang Tag

The dealer must mark the appropriate box on one hang tag to match the Star label affixed to the boat. The dealer is responsible for displaying the hang tag in a visible location on the boat on display in California. Failure to properly display the hang tag could result in a citation and possible fine to the dealer from the California Air Resources Board.

If in California, the dealer must place the hang tag in a visible location in the boat prior to displaying the boat.

Hang tag front side

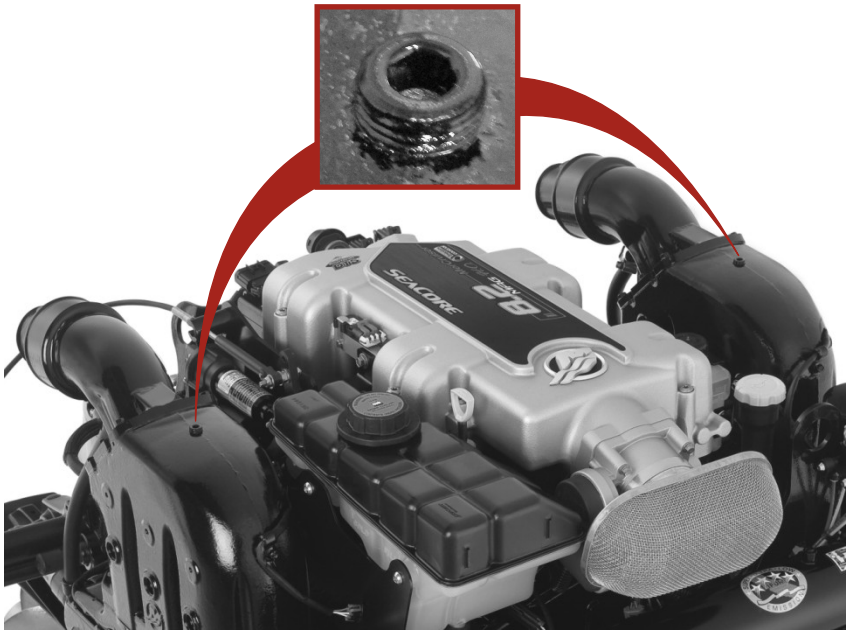
43291

Hang tag back side

Exhaust Gas Sampling

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

IMPORTANT: To comply with exhaust gas emission regulations, design considerations determined by the boat builder and specific engine installations must allow for field access to the exhaust gas sampling ports.
The 8.2 engine models exhaust gas sampling access area is located on the exhaust elbow and is secured with a pipe plug.



43674

Pipe plug access for exhaust gas sampling

Emissions Control System Overview

Combustion

Combustion is a rapid chemical reaction, called oxidation, in which fuel chemically combines with oxygen to produce heat energy. Among other elements, air contains oxygen and nitrogen, and gasoline contains hydrogen and carbon. These four primary elements combine chemically during combustion to form new chemical compounds.

If combustion were complete, the oxidation of air and gasoline would result in water, carbon dioxide, and nitrogen, which are not harmful to the environment. For combustion to be complete, it needs to occur at a specific air-to-fuel ratio called the stoichiometric ratio (14.7:1 for gasoline). Although this ratio is ideal for reducing hydrocarbons (HC) and carbon monoxide (CO), it is a lean mixture that can be difficult or slow to ignite, reducing engine power and efficiency.

Emissions

Since combustion is usually incomplete, not all of the exhaust gases burn, causing emissions. All engines sold in the state of California must comply with the standards legislated by the California Air Resources Board (CARB). In accordance with these standards, and in preparation of future standards, Mercury Marine is working to reduce the following: carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx).

Carbon Monoxide (CO)

Carbon monoxide (CO) is a poisonous gas created by incomplete combustion of gasoline. If combustion occurs in an oxygen-deficient environment, the limited amount of oxygen allows only one oxygen (O) atom to bond with a cabon (C) atom, creating CO from partially burned fuel. Richer air-to-fuel ratios create more CO than lean ratios.

Hydrocarbons (HC)

Hydrocarbon (HC) emissions are caused by incomplete combustion of gasoline and other hydrocarbon-based fuels. When gasoline burns, oxidation occurs; however, some hydrocarbons do not oxidize. Lower engine temperatures make it harder for the hydrocarbons to oxidize. Therefore, some hydrogen and carbon atoms remain bonded and pass through the exhaust system as HC gases from unburned fuel.

Oxides of Nitrogen (NOx)

Oxides of nitrogen (NOx) is a generic term for a group of chemical compounds that contain nitrogen (N) and oxygen (O) in varying amounts (x). NOx is created by overheated hydrogen and oxygen. At extremely high tempertures, N atoms can combine with O atoms to create NOx. Unlike CO and HC, which form when combustion temperatures are too low, NOx forms when combustion temperatures are too high. NOx itself is not harmful. However, when exposed to sunlight, NOx combines with unburned hydrocarbons to create the visible air pollutant called smog.

Controlling Emissions With Catalysts

Catalyst Components

A catalyst, or catalytic converter, is a device installed into the engine's exhaust system that reduces the toxicity of emissions. Mercury MerCruiser engines use three-way catalysts with the following components:

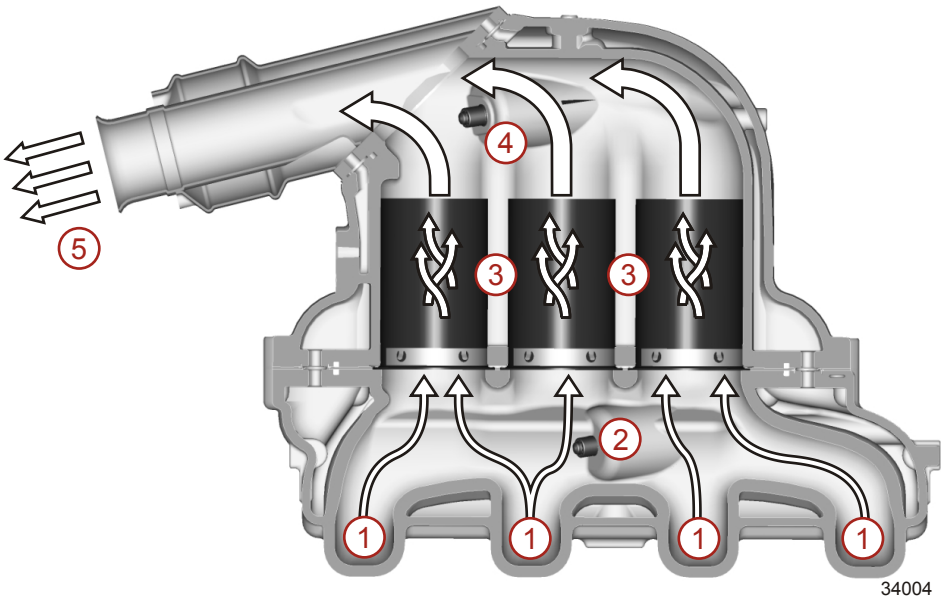
- Substrate—The substrate is a metallic foil core that provides a large surface area for the washcoat.
- Washcoat—The washcoat is applied to the substrate to act as a carrier for the catalyst. This washcoat creates an irregular, porous surface, providing more surface area for the precious metal of the catalyst.
- Catalyst—The catalyst is a combination of precious metals applied to the porous structure of the washcoat. The heated exhaust gases react with the precious metals in the catalyst to reduce harmful emissions. This catalyst assembly is housed in the mantle.
- Mantle—The mantle is the tube that contains the catalyst. The mantle is installed in the exhaust manifold housing.
- Oxygen sensors—Multiple oxygen sensors transmit emissions data to the propulsion control module (PCM) to control emissions.
- Propulsion control module—Models with emissions control use a PCM09 controller to manage fuel delivery to the engine and maintain CARB (California Air Resources Board) emissions standards.

Catalyst Operation

Mercury MerCruiser's engines with emissions control meet the CARB requirements for exhaust emissions levels that went into effect January 2008 in the state of California. These engines feature three-way catalysts, which use a combination of platinum, palladium, and rhodium (and other precious metals) to convert harmful emissions to safe levels. A three-way catalyst reduces emissions in the following ways:

- It reduces nitrogen oxides to nitrogen and oxygen ($2NOx \rightarrow xO_2 + N_2$).
- It oxidizes carbon monoxide into carbon dioxide ($2CO + O_2 \rightarrow CO_2$).

- It oxidizes unburnt hydrocarbons to carbon dioxide and water ($C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$).

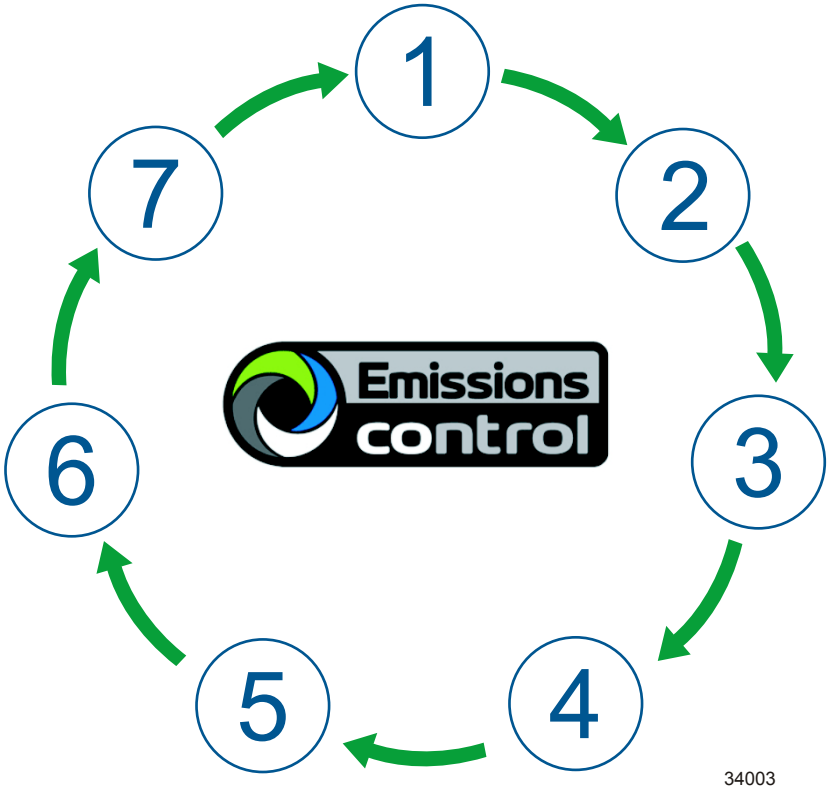


Typical exhaust manifold shown

1 - Exhaust gases from the combustion chamber
2 - Pre-catalyst oxygen sensor
3 - Catalysts
4 - Post-catalyst oxygen sensor
5 - Reduced emissions

Closed-Loop Control

The oxygen sensors send oxygen information to the PCM before and after the catalysts in the exhaust system. This dual-sensor system provides a closed-loop monitoring system, ensuring required air-to-fuel ratios and emissions. This engine is equipped with a catalytic converter on each exhaust manifold. Each catalytic converter houses three catalysts, a pre-oxygen sensor, and a post-oxygen sensor.



Closed-loop control

Reference	Action
1	PCM calculates air-fuel ratio.

Reference	Action
2	Fuel system delivers the required air-to-fuel ratio to the combustion chamber.
3	Combustion occurs (power stroke).
4	Exhaust gases enter the exhaust manifold (exhaust stroke).
5	The first oxygen sensor sends a signal to the PCM, delivering pre-catalyst oxygen information.
6	The exhaust gases pass through the catalyst. Reactions in the catalyst oxidize hydrocarbons (HC) and carbon monoxide (CO) and reduce oxides of nitrogen (NOx).
7	The second oxygen sensor sends a signal to the PCM, delivering post-catalyst oxygen information.

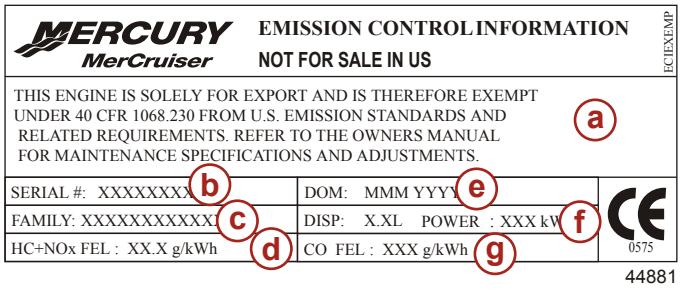
NOTE: *Each oxygen sensor is protected by a 5 amp fuse.*

NOTE: *Mercury MerCruiser engines do not depend on closed-loop control to calculate air-to-fuel ratios at all times. During some operating situations, the PCM operates in open-loop control, relying on its default programming to make fuel-delivery calculations.*

Emissions Information For Engines Without Emission Control

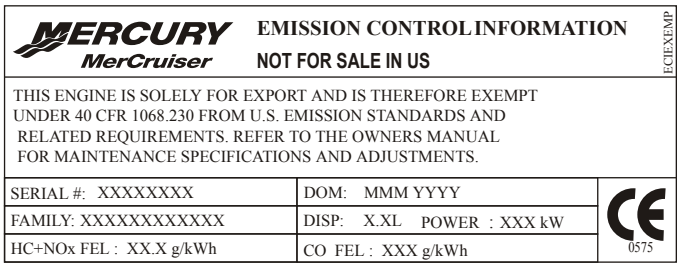
Emission Control Information Label

A tamper-resistant emission control information (ECI) label is affixed to the engine in a visible location at the time of manufacture by Mercury MerCruiser. Please note that the low emissions certification will not affect the fit, function, or performance of the engine. Boatbuilders and dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding. In addition to the required emissions statement, the label lists the engine serial number, family, applicable emission standard, date of manufacture (month, year), and engine displacement.



- **a -** Applicable standard
- **b -** Engine serial number
- **c -** Engine family name
- **d -** Hydrocarbons plus oxides of nitrogen family emission limit
- **e -** Date of manufacture
- **f -** Engine displacement, engine power
- **g -** Carbon monoxide family emission limit

IMPORTANT: A CE mark in the lower right corner of the Emission Control Information label indicates that an EU Declaration of Conformance applies. Refer to the front page of this manual for further information.
IMPORTANT: Engines designated as exempt from either Federal EPA or California emission control regulations are not covered by a separate emission control component warranty. The product's Mercury MerCruiser manufacturer's warranty is not affected by the engine's designation under Federal EPA or California emission control regulations.

ECI Label	Standard of Compliance
	Indicates a marine engine for export and is exempt under 40 CFR 1068.255 from United States EPA exhaust emission regulations for 2010. This marine engine is not for sale in U.S.

Owner Responsibility

The operator must have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The operator may not modify the engine in any manner that alters the horsepower or allows emissions levels to exceed factory specifications.

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Important Information

Section 1B - Maintenance Sterndrive Models

1 B

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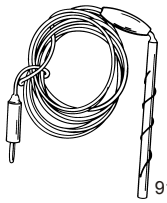
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All electrical connections	92- 25711 3
28	Dexron III Automatic Transmission Fluid	Power-assisted steering system	Obtain Locally
34	Special Lubricant 101	Steering cable grease fitting	92-802865Q02
		Steering cable	
		Propeller shaft splines	
42	U-joint and Gimbal Bearing Grease	Transom end grease fitting, engine end grease fitting, driveshaft grease fittings	92-802870A1
87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01
		Sterndrive unit	
91	Engine Coupler Spline Grease	Driveshaft splines and U-joint O-rings	92-802869A 1
		Coupler	
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
114	Power Trim and Steering Fluid	Power-assisted steering pump	92-858074K01
		Power trim pump	
115	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
120	Corrosion Guard	Painted surfaces	92-802878 55
122	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1
124	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

Special Tools

Propeller Nut Tool	91-805457T 1
10677	Aids in the removal and installation of the front propeller nut.

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

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

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

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

Gasoline and Engine Oil

Fuel Requirements

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

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

Fuel Ratings

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

USA and Canada - A posted pump Octane Rating of 87 (R+M)/2, minimum. Premium gasoline 92 (R+M)/2 Octane is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - A posted pump Octane Rating of 91 RON, minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and are acceptable for use in your Mercury MerCruiser engine. The two types of oxygenates used in these fuels are alcohol (ethanol) and ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasoline Containing Alcohol**.

Gasoline Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), be aware of possible adverse effects. These adverse effects are more severe with methanol and worsen according to the percentage of alcohol in the fuel.

Alcohol in gasoline can absorb moisture from the air, causing the water and the alcohol to separate from the gasoline in the fuel tank.

IMPORTANT: The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

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

IMPORTANT: If you use gasoline that contains or might contain alcohol, you must increase the frequency of inspection for leaks and abnormalities.
IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, do not store the gasoline in the fuel tank for long periods. Cars normally consume alcohol-blend fuels before they can absorb enough moisture to cause trouble, boats often sit idle long enough for phase separation to take place. Internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Engine Oil

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

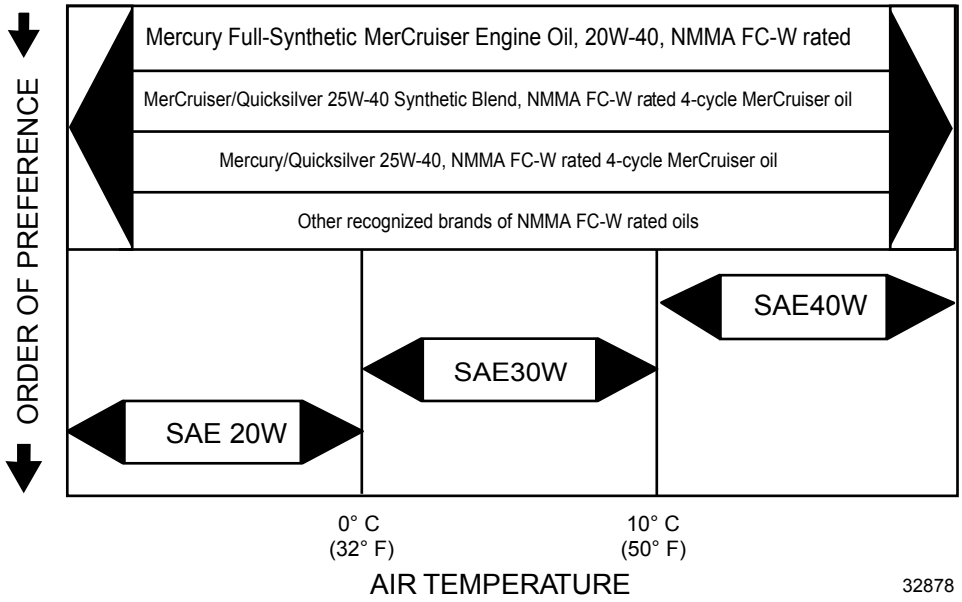
Application	Recommended Oil
All MerCruiser engines	Mercury MerCruiser Full-Synthetic Engine Oil, 20W-40, NMMA FC-W rated

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

If Mercury MerCruiser Full-Synthetic, 20W-40 oil is unavailable, use the following lubricants, listed in order of recommendation. If you are servicing a catalyst engine, use these for short periods of time only.

1. Mercury/Quicksilver 25W-40 Synthetic Blend, NMMA FC-W–rated 4-cycle MerCruiser oil
2. Mercury/Quicksilver 25W-40, NMMA FC-W–rated 4-cycle MerCruiser oil
3. Other recognized brands of NMMA FC-W–rated 4-cycle oils
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: *We do not recommend 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.*



Engine Specifications Sterndrive Models

8.2 MAG EC, 8.2 MAG H.O. EC and SeaCore 8.2 MAG EC, 8.2 MAG H.O. EC

NOTE: *Performance specifications are obtained and corrected in accordance with SAE J1228/ISO 8665 Crankshaft Power.*
All measurements are taken with the engine at normal operating temperature.
RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.
Oil pressure must be checked with the engine at normal operating temperature.

NOTE: *Oil pressure specifications are for reference and may vary.*

		8.2 MAG	8.2 MAG H.O.
Propshaft power		283 kW (380 hp)	320 kW (430 hp)
Displacement		8.2 L (502 cid)	
Alternator amperage	Hot	72 A	
	Cold	65 A	
RPM	WOT	4400–4800	4600–5000
	Rev limiter	4950	5150
Idle RPM	Mechnical	650	
	DTS		
Minimum oil pressure	At 2000 RPM	207 kPa (30 psi)	
	At idle	103 kPa (15 psi)	
Thermostat		76° C (170° F)	
Timing at idle		Not Adjustable	
Firing order		1-8-4-3-6-5-7-2	
Minimum battery rating	Non-DTS models	750 CCA, 950 MCA, 180 Ah	
	DTS models	800 CCA, 1000 MCA, 190 Ah	
Spark plug type		NGK BPR6ES	
Spark plug gap		0.83 mm (0.033 in.)	
Emission control system		Electronic engine control (EC), heated oxygen sensor (HO2S), catalyst	

Fluid Specifications

Engine

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Bravo Sterndrives

NOTE: *Oil capacity includes gear lube monitor.*

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

Power-Assisted Steering and Power Trim Fluids

Approved Power-Assisted Steering Fluids

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

Approved Power Trim Fluids

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

Maintenance Schedule Sterndrive Models

Routine Maintenance

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

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. (You can extend this interval based on experience with the product.) • Check the sterndrive gear lube level. • Check the trim pump oil level. • Check the power-assisted steering pump or the compact hydraulic steering fluid level, depending on the steering system of your model.

Task Interval	Maintenance to Be Performed
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Inspect the sterndrive anodes and replace if 50% eroded.
Every two months or 50 hours	• Lubricate the propeller shaft and retorque the nut. (If operating only in freshwater, you can extend the interval to every four months.) • If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. (If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.)

Scheduled Maintenance

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

Task Interval	Maintenance to Be Performed
After the initial 20-hour break-in period	Change the engine oil and filter.
Every 100 hours or annually (whichever occurs first)	• Touch-up the paint on the power package. • Change the engine oil and filter. • Change the sterndrive gear lube. • Check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section. • Tighten the connection of the gimbal ring to the steering shaft to specifications. • Replace the water-separating fuel filter. • Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages. • Check the continuity circuit for loose or damaged connections. Test the MerCathode unit output if equipped. • Recommended Maintenance and replacement of the PCV valve. • Clean the flame arrestor, IAC muffler, and the crankcase ventilation hoses. • Inspect the condition and the tension of the belts. • Driveshaft extension models: Lubricate the driveshaft U-joints, and tailstock input and output bearings.

Task Interval	Maintenance to Be Performed
Every 300 hours or 3 years	• Check the engine mount nuts for tightness and torque if necessary. • Replace spark plugs. • Inspect the spark plug wires and replace as necessary. • 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. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Check the engine alignment. • Inspect the U-joints, the splines, the bellows, and check the clamps. • Lubricate the U-joint splines and cross bearings, if equipped with grease fittings. • Inspect the gimbal bearing for roughness. Replace if necessary. • Lubricate the engine coupler. • Replace the vent valve and duckbill valve on each exhaust elbow (port and starboard).
Every 5 years	• Replace the coolant/antifreeze. Replace every two years if not using extended-life coolant/antifreeze.

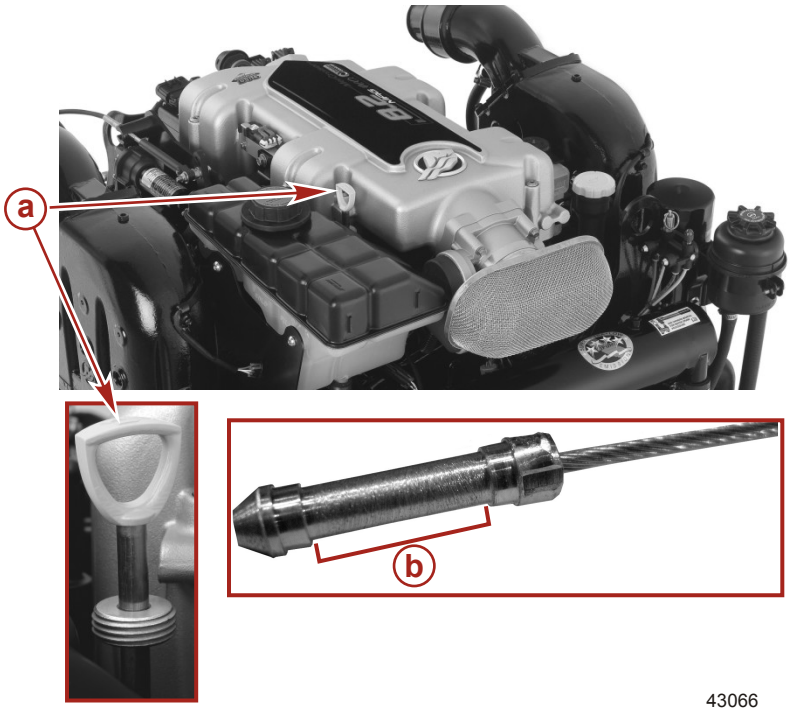
Engine Oil

NOTICE

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

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.



43066

a - Oil dipstick handle
b - Operating range

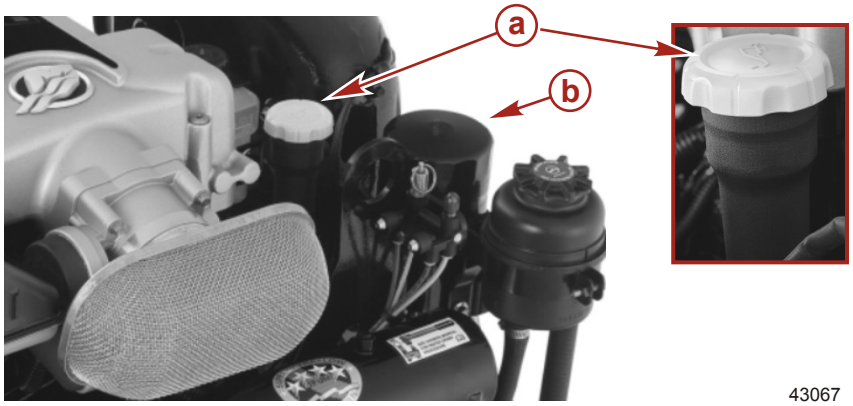
IMPORTANT: Add the specified engine oil to bring the level up to, but not over, the operating range mark on the dipstick.

3. Remove the dipstick and observe the oil level. Oil level must be in the operating range. 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 oil required.

1. Remove oil fill cap.



43067

a - Oil fill cap
b - Oil filter

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

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

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 liters (7 U.S. Quart)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

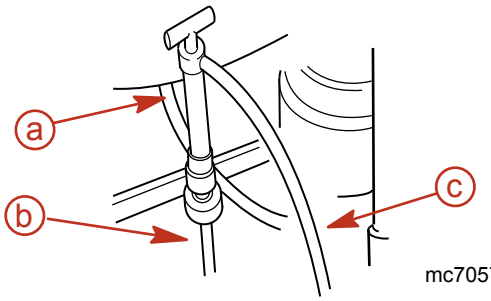
Changing Oil and Filter

See **Maintenance Schedule** for the change interval. Engine oil should be changed before placing the boat in storage.

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

Oil Removal with Drain Pump

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



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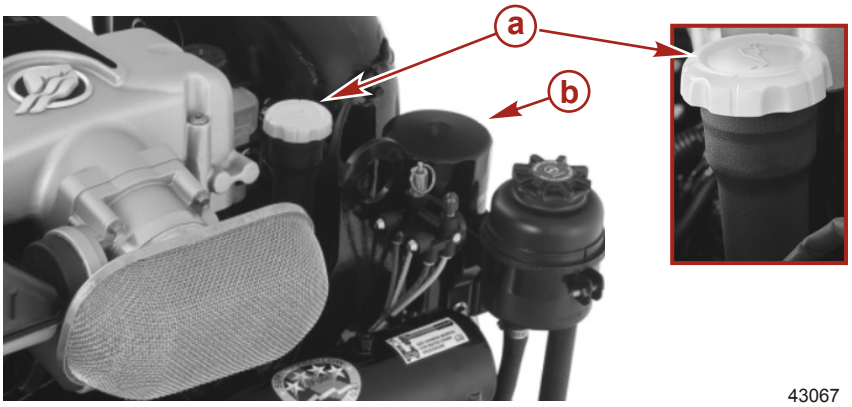
a - Oil drain pump
b - Dipstick tube
c - Oil drain hose

4. Insert the hose end of the crankcase oil pump onto an appropriate container and use the handle to pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing the Oil Filter

1. Remove and discard oil filter.



43067

Oil filter
a - Oil fill cap
b - Oil filter

2. Coat the sealing ring on the new filter with engine oil.
3. Install and tighten the oil filter securely following the filter manufacturer's instructions. Do not overtighten.
4. Remove oil fill cap.
5. Use the dipstick to determine the amount of engine oil required. Replace the dipstick.
6. Add the required amount of the recommended oil to bring the level up to the bottom of the OK range on the dipstick.
7. With the boat at rest in the water, repeat steps 5 and 6 if necessary.
   NOTE: *Adding 0.95 L (1 US qt) of engine oil raises the level from the bottom of the operating range to the top of the operating range.*

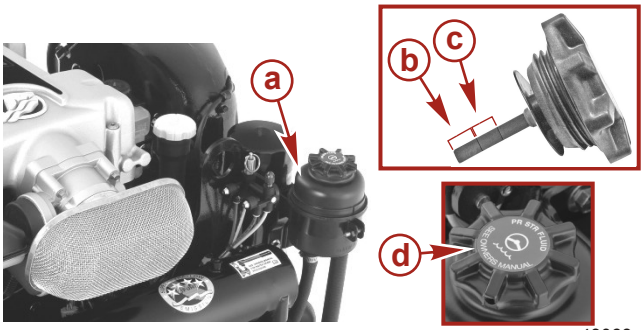
All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

8. Start the engine and operate for three minutes, checking for leaks.
9. Stop the engine and allow the oil to drain into the oil pan for approximately five minutes with the boat at rest in the water.

Power-Assisted Steering Fluid

Checking

1. Stop the engine and center the sterndrive.
2. Remove the fill cap from the power steering fluid reservoir and observe the level. The oil level should be at the lower mark when the engine is cold and at the upper mark when the engine is warm.



43068

a - Reservoir
b - Add range
c - Operating range
d - Fill cap

3. Add the specified fluid if necessary. Refer to **Filling**.

Filling

1. Remove the fill cap and dipstick and observe the fluid level.
2. Add the specified fluid to bring the fluid level up to the proper level.

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

28	Dexron III Automatic Transmission Fluid	Power-assisted steering system	Obtain Locally

3. Install the fill cap and dipstick.

Changing

Power-assisted steering fluid does not require changing unless it becomes contaminated with water or debris.

Closed Cooling System

Coolant Requirement

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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

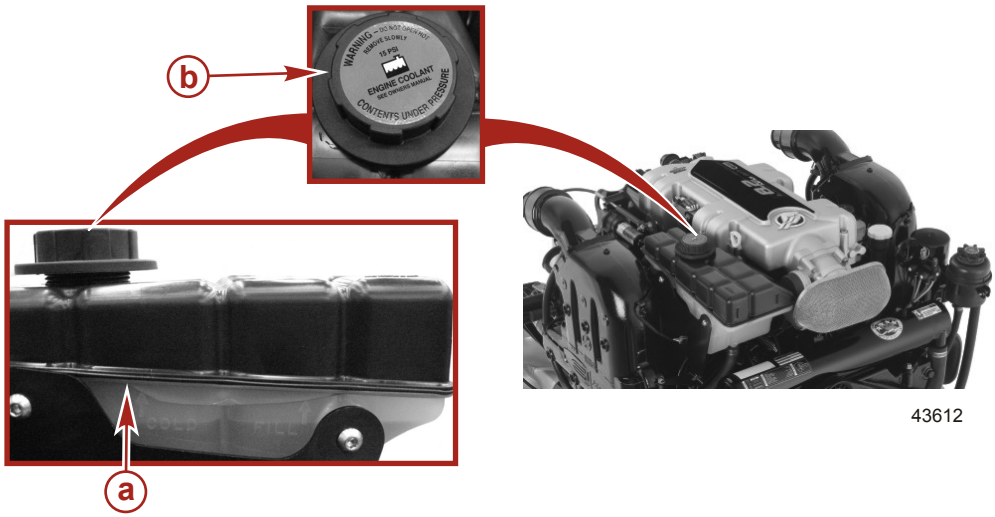
Checking Coolant Level

⚠ CAUTION

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

IMPORTANT: 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.



43612

Coolant reservoir

a - Full mark (engine cold)

b - Coolant reservoir cap

Filling the Closed Cooling System

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

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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.
	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1

NOTE: *Coolant section capacity is approximately 14.3 L (15 U.S. qt.).*

Model	8.2 (502 cid)
Closed cooling system	14.3 L (15 U.S. qt)

⚠ CAUTION

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

IMPORTANT: 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. Replace the pressure cap.

NOTICE

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

4. Supply cooling water to the engine.
5. 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.

⚠ CAUTION

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

6. After the engine has cooled completely, recheck the coolant level and add coolant, if necessary.
7. 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.
8. Maintain the coolant level in the reservoir at or near the "FULL" mark with the engine cold.

Sterndrive Gear Lube

Checking

NOTICE

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

NOTE: *The oil level fluctuates during operation, so check with the engine cold before starting.*

1. Check the gear lube oil level. Keep the oil level within the recommended operating range.
2. Inspect the gear lube oil in the monitor for any condition that may indicate a problem in the sterndrive:
   a. If any water is visible at the bottom of the gear lube monitor
   b. If the gear lube appears milky
   c. If the gear lube smells burned and looks dark

d. If metal particles are present

43200

Gear lube monitor

Filling

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

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

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

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

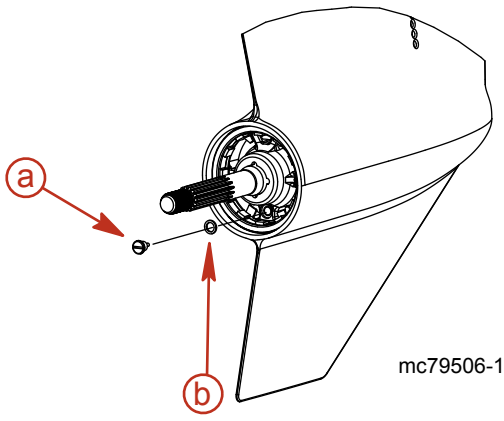
Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear lube monitor	92-858064K01

3. Replace the cap.

Changing

IMPORTANT: If any water drains from the sterndrive, or if the fluid appears milky, the sterndrive is leaking.

1. Remove the gear lube monitor from the bracket.
2. Empty the contents into a suitable container.
3. Install the gear lube monitor in the bracket.
4. Bravo One Models:
   a. Remove the propeller.
   b. Position the sterndrive to the full down position.
   c. Remove the oil fill and drain screw and sealing washer. (If water runs out, the sterndrive is leaking.)
   d. Drain the fluid into a suitable container.



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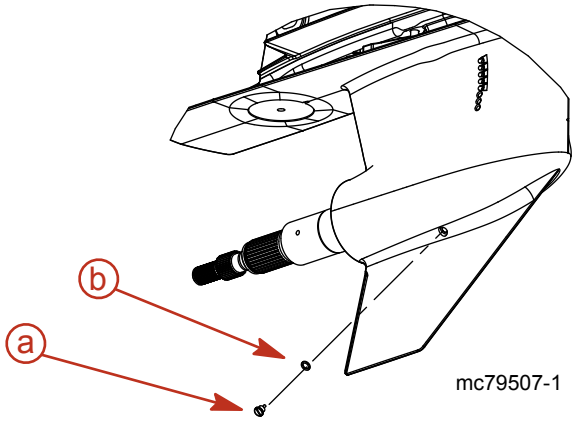
a - Oil fill and drain screw
b - Sealing washer

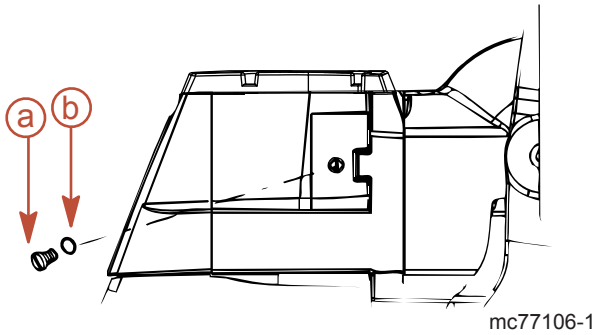
5. All Other Models:

a. Place the sterndrive in full trim out position.
b. Remove the oil fill and drain screw and sealing washer. (If water runs out, the sterndrive is leaking.)
c. Drain the fluid into a suitable container.



a - Oil fill and drain screw
b - Sealing washer

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



a - Oil vent screw
b - Sealing washer

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

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

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

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

13. Remove the pump from the oil fill and drain hole. Quickly install the sealing washer and screw. Tighten securely.
14. Reinstall the propeller.
15. Check the oil level after the first use.

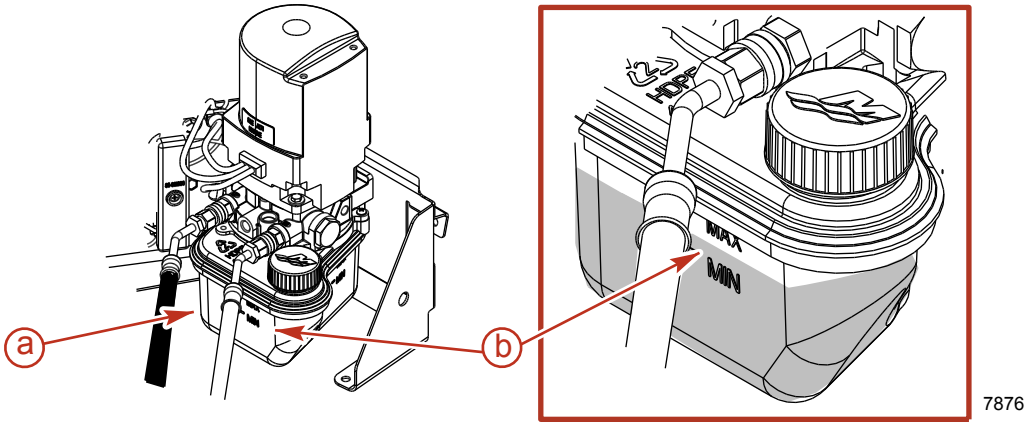
IMPORTANT: Oil level in the gear lube monitor rises and falls during operation. Always check the oil level when the sterndrive is cool and the engine is off.

Power Trim Fluid

Checking

IMPORTANT: Check the oil level with the sterndrive in the full down/in position only.

1. Place the sterndrive in full down/in position.
2. Observe the oil level. Level must be between the "MIN" and "MAX" lines on the reservoir.



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

3. Fill as necessary with the specified fluid.

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

Filling

1. Remove the fill cap from the reservoir.
   NOTE: *Fill cap is vented.*
2. Add lubricant to bring 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

3. Install the cap.

Changing

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

Battery

Refer to specific instructions and warnings accompanying your battery. If this information is not available, observe the following precautions when handling a battery.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

Multiple EFI Engine Battery Precautions

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for 2 different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself, and the engine will operate normally. The ECM shuts off and resets itself so quickly that the engine may only seem to have an ignition miss.

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's ECM has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is operating off of its own battery. Do not operate engines with switches in both or all position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

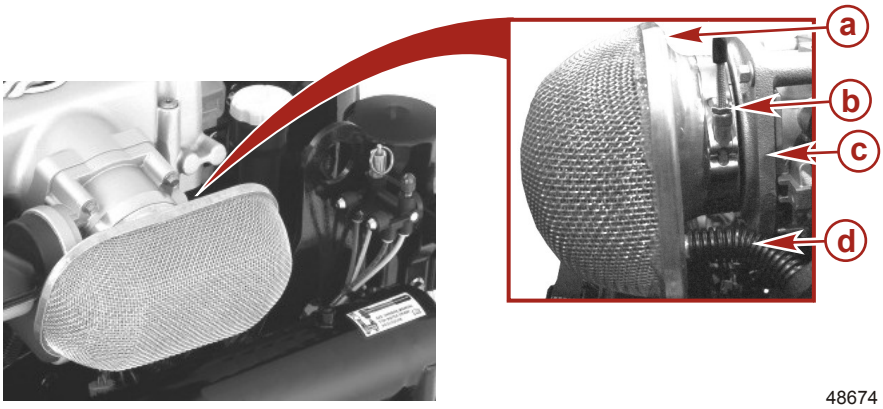
Generators: The generators battery should be considered another engine's battery.

Cleaning the Flame Arrestor

⚠ WARNING

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

1. Remove the vent hose from the flame arrestor.
2. Loosen the flame arrestor clamp nut.
3. Pull the flame arrestor from the throttle body.

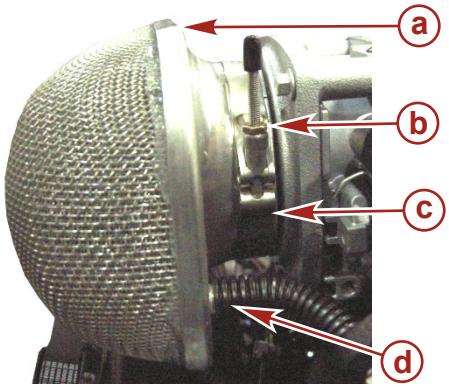


a - Flame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

48674

4. Clean the flame arrestor with solvent and dry with compressed air or set aside and allow to air dry completely.
5. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
6. Push the flame arrestor onto the throtte body.
7. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.

8. Tighten the clamp to specification. Do not overtighten the clamp.



48442

a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

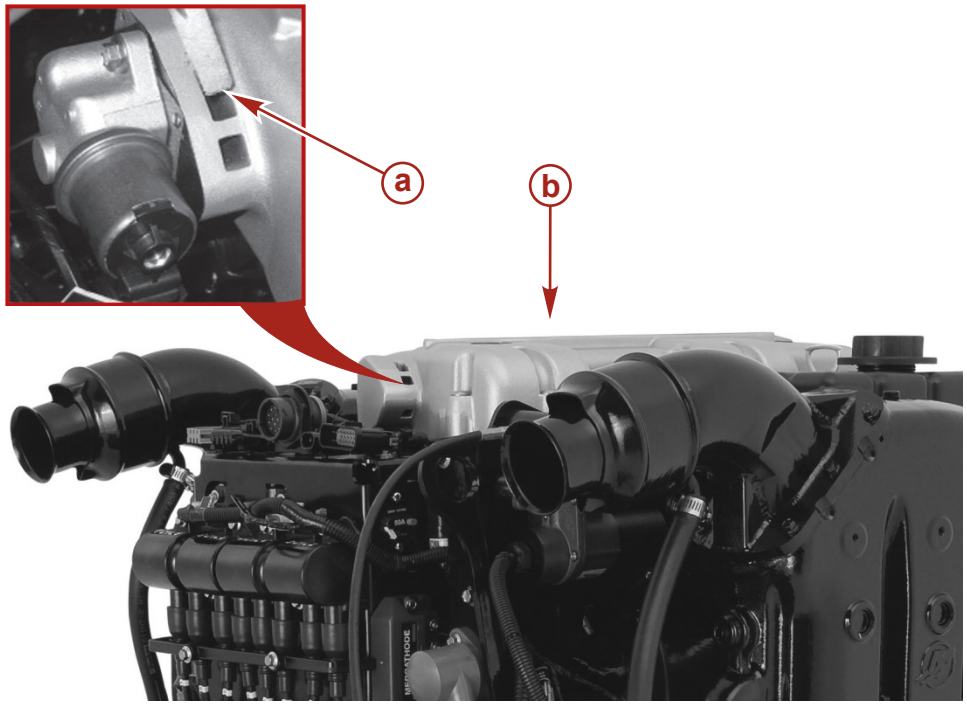
9. Install the vent hose to the bib fitting.

Cleaning the IAC Muffler (Non-DTS Models Only)

⚠ WARNING

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

1. Locate the idle air control valve (IAC) on the rear of the engine.
2. Remove the IAC muffler from the slot in the plenum.



43638

a - IAC muffler
b - Plenum

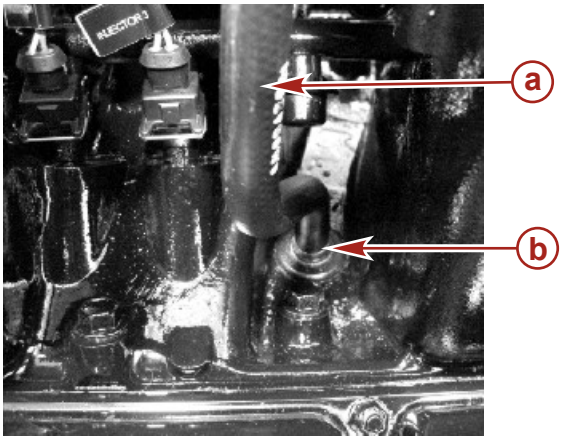
3. Inspect the muffler for holes, cracks, or deterioration. Replace if damaged.
   IMPORTANT: Do not use a cleaner that contains methyl ethyl ketone and do not use cleaner on electrical connections.
4. Clean the muffler with warm water and mild detergent. Replace if necessary.
5. Allow the IAC muffler to dry completely before use.

6. Install the IAC muffler.

Changing the Positive Crankcase Ventilation (PCV) Valve

This engine is equipped with a positive crankcase ventilation (PCV) valve . We recommend changing it every 100 hours of operation or at least once a year, whichever occurs first.

1. Pull the PCV valve out of the intake manifold and remove the PCV valve from the hose.



a - Hose from plenum to PCV valve
b - PCV valve

43215

2. Inspect the PCV valve and replace if necessary.
3. Install the PCV valve into the intake manifold.
4. Ensure that the PCV valve is tightly seated into the intake manifold.

We recommend the use of Mercury MerCruiser replacement parts.

Water-Separating Fuel Filter

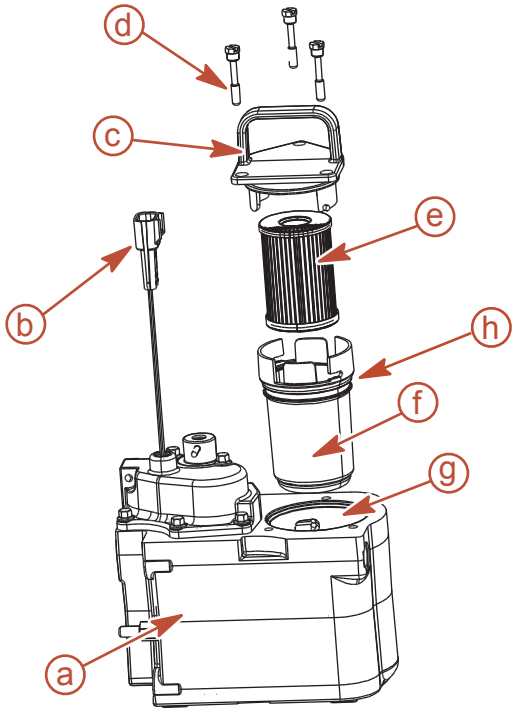
⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

GEN III Models



8837

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

Removal

1. Allow the engine to cool down.
   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*
2. Close fuel supply valve, if equipped.
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 5 seconds.
5. Turn key switch to off position.
6. Loosen each filter assembly retaining screw until the screw is 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 remove the filter assembly from the Cool Fuel Module at this time.
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 in a clockwise direction 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 that may be in the filter cup.

Installation

1. Install a new water-separating fuel filter element into the filter cup. Push the element into the cup until completely seated.
2. Install new O-ring on the filter cup.
3. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction while holding the filter cup stationary, until the filter cap locks securely into place.
4. 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.
5. 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	–

6. Open fuel supply valve, if equipped.

7. Reconnect the Cool Fuel Module harness to the engine wiring harness.
8. Properly ventilate the engine compartment.

NOTICE

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

9. Supply cooling water to the engine.
10. Start the engine. Check for gasoline leaks around the fuel filter assembly. If leaks exist, stop the engine immediately. Recheck the filter installation, clean spilled fuel and properly ventilate the engine compartment. If leaks continue, stop the engine immediately, locate the cause, and repair as required.

Lubrication

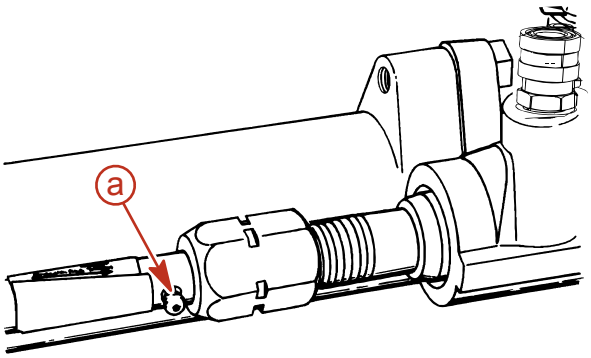
Steering System

⚠ WARNING

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

NOTE: *If steering cable does not have grease fitting, inner wire of cable cannot be greased.*

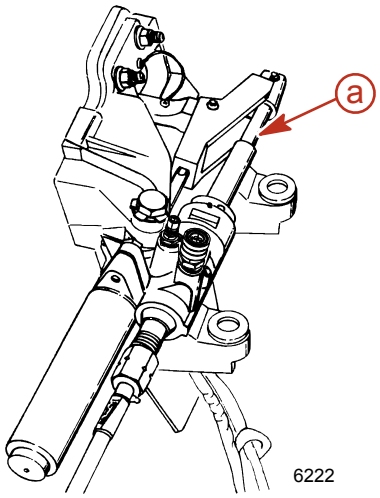
1. **If Steering Cable Has Grease Fittings:** Turn steering wheel until steering cable is fully retracted into cable housing. Apply approximately 3 pumps of grease from a typical hand-operated grease gun.



a - Steering cable grease fitting

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Steering cable grease fitting	92-802865Q02

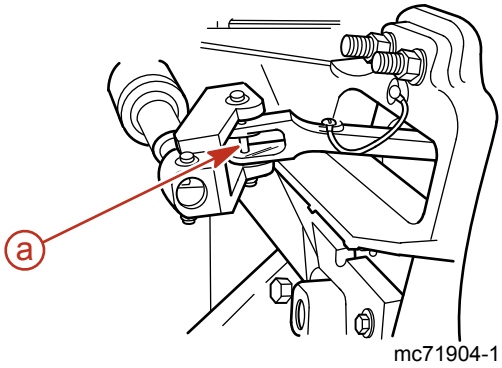
2. Turn steering wheel until steering cable fully extended. Lightly lubricate the exposed part of cable.



a - Extended steering cable

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Steering cable	92-802865Q02

3. Lubricate the steering pin.



a - Steering pin

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Steering pin	92-883725K01

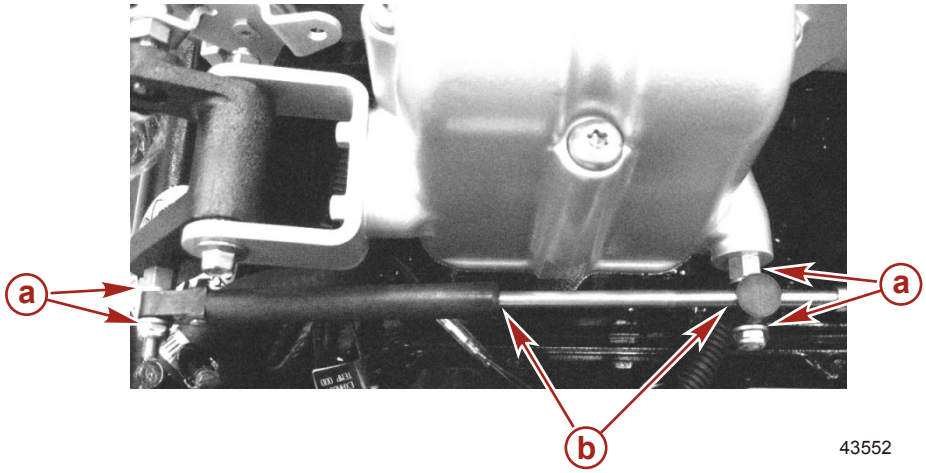
4. On dual engine boats: Lubricate the tie bar pivot points.

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Tie bar pivot points	92-883725K01

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.

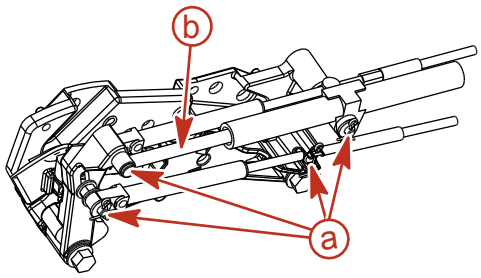


a - Pivot points
b - Guide contact surfaces

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Throttle cable pivot points & guide contact surfaces	92-883725K01

Shift Cable - Typical

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

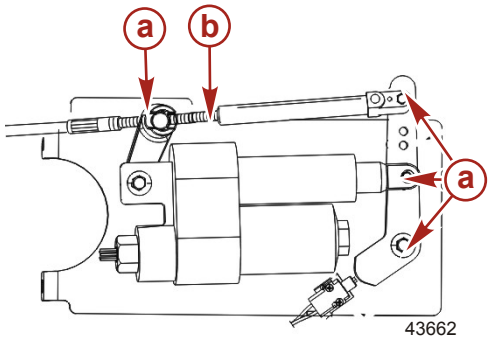


mc79736

a - Pivot points
b - Guide contact surfaces

Shift Cable - DTS

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



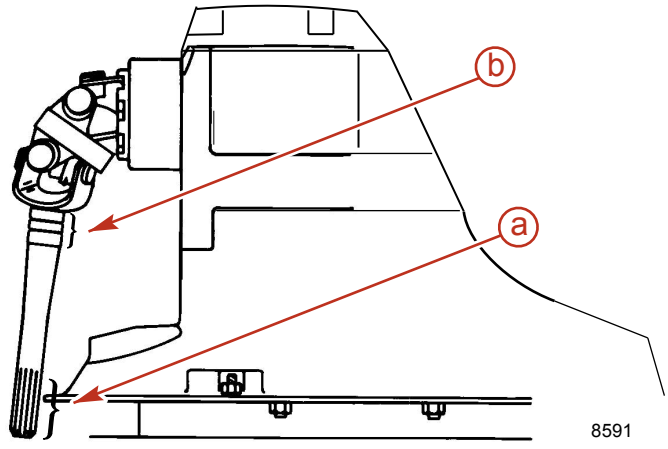
43662

a - Pivot points
b - Guide contact surfaces

Tube Ref. No.	Description	Where Used	Part No.
	Synthetic Blend MerCruiser Engine Oil SAE25W-40	Shift cable pivot points & guide contact surfaces	92-883725K01

Sterndrive U-joint Shaft Splines And O-rings (Sterndrive Unit Removed)

1. Coat sterndrive U-joint O-rings and driveshaft splines with grease.



8591

a - Driveshaft splines
b - U-joint O-rings (3)

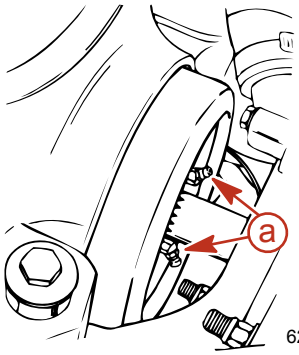
Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Driveshaft splines and U-joint O-rings	92-802869A 1

2. For propeller shaft lubrication, refer to Propellers.

Engine Coupler

1. Lubricate engine coupler splines through grease fittings on 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.*



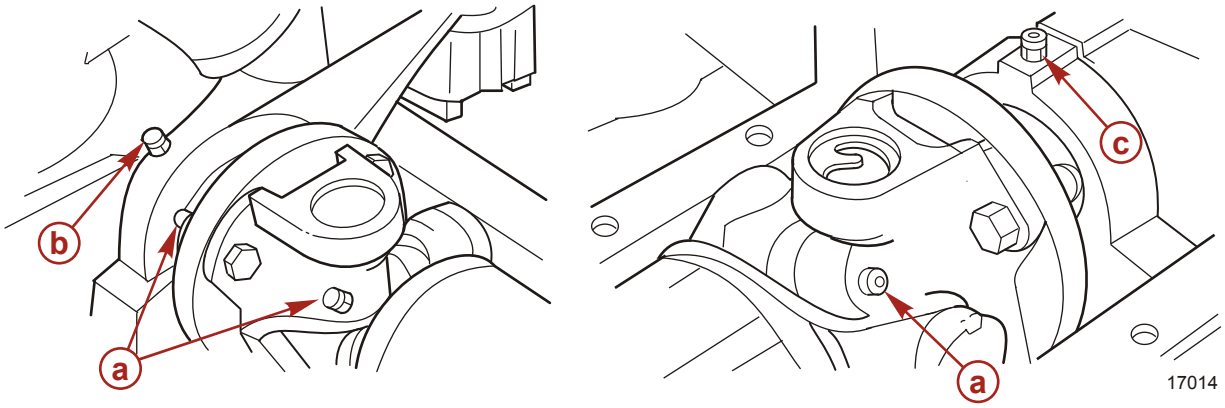
Bravo drive coupler
a - Grease fitting

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Coupler	92-802869A 1

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

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.



a - Driveshaft grease fittings
b - Transom end grease fitting
c - Engine end grease fitting

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

Propellers

Propeller Repair

Some damaged propellers can be repaired.

Bravo Sterndrive Propeller Removal

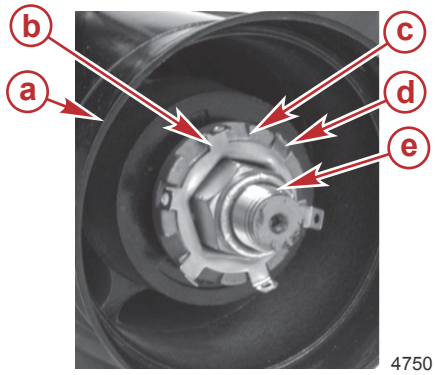
⚠ WARNING

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

Bravo One Models

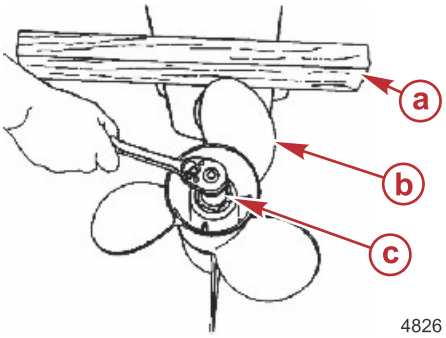
NOTE: *Bravo One XR models do not use the tab washer.*

1. If Equipped, straighten the bent tabs of the tab washer on the propeller shaft.



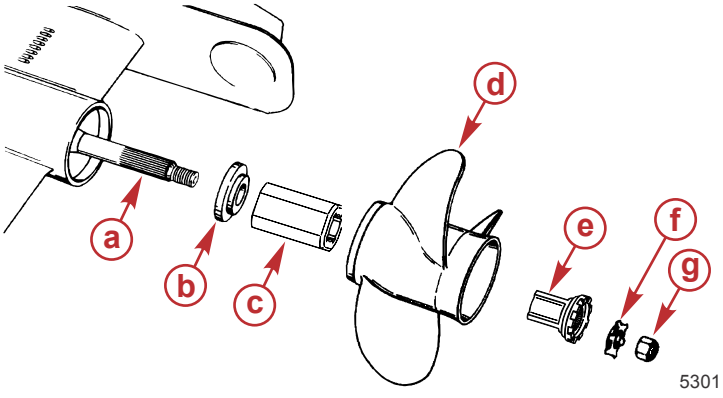
- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.



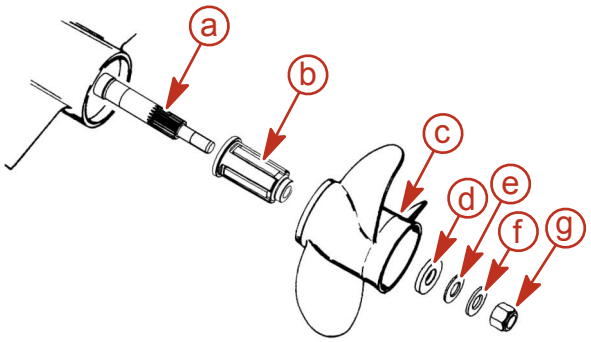
- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

3. Turn the propeller shaft nut counterclockwise and remove the nut.
4. Slide the propeller and the attaching hardware from the propeller shaft.



Bravo One models

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Flo-Torque II drive hub
- **d -** Propeller
- **e -** Drive sleeve adapter
- **f -** Tab washer
- **g -** Propeller nut

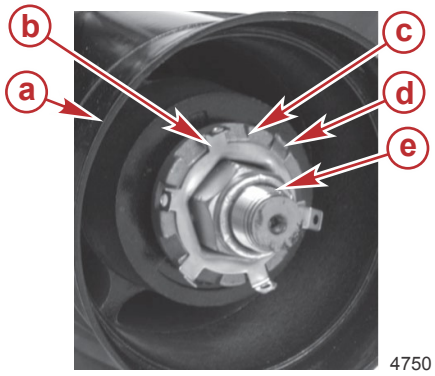


Bravo One XR models

- **a -** Propeller shaft
- **b -** Propeller hub insert with snubbers
- **c -** Propeller
- **d -** Thrust washer
- **e -** Washer
- **f -** Washer
- **g -** Propeller nut

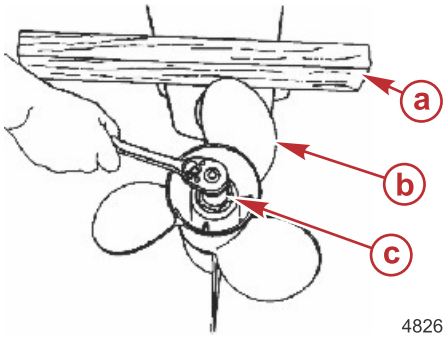
Bravo Two Models

1. Straighten the bent tabs of the tab washer on the propeller shaft.



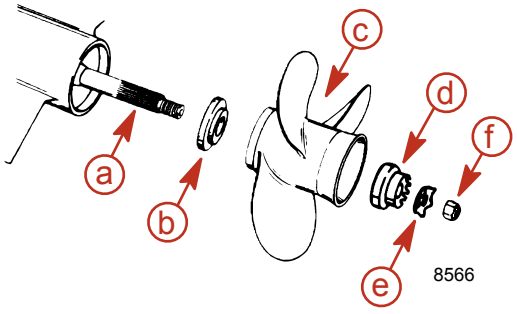
- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.



- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

3. Turn propeller shaft nut counterclockwise to remove nut.
4. Slide the propeller and attaching hardware from the propeller shaft.



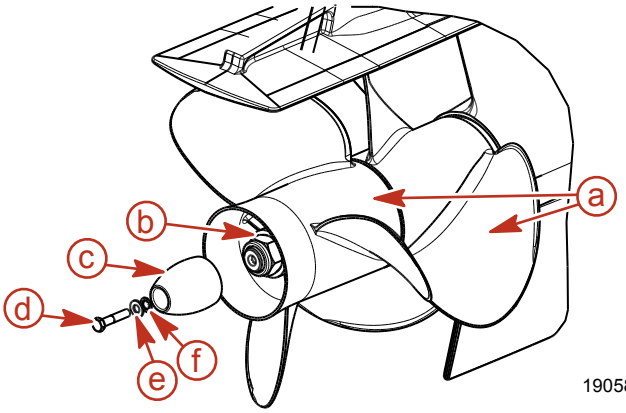
Bravo Two

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Propeller
- **d -** Spline washer
- **e -** Tab washer
- **f -** Propeller nut

Bravo Three Models

1. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate.
2. Remove the bolt and washers securing the propeller shaft anode.

3. Remove the propeller shaft anode.

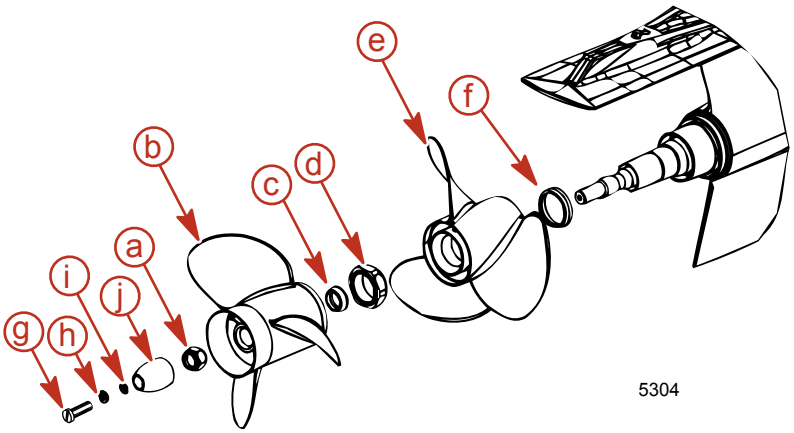


- **a -** Propeller
- **b -** Propeller shaft nut
- **c -** Propeller shaft anode
- **d -** Propeller shaft anode screw
- **e -** Flat washer
- **f -** Star washer

4. Turn aft propeller shaft nut counterclockwise to remove nut.
5. Slide propeller and thrust hub off propeller shaft.
6. Use the Propeller Nut Tool, turn the front propeller shaft nut counterclockwise and remove the nut.

Propeller Nut Tool	91-805457T 1

7. Slide the propeller and the thrust hub off the propeller shaft.



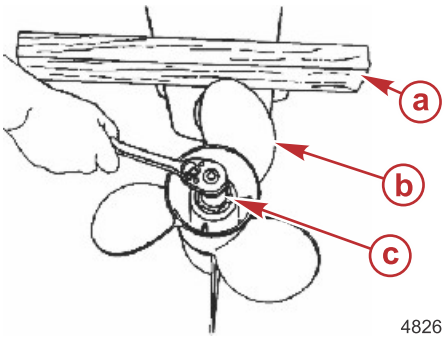
Bravo Three

- **a -** Aft propeller nut
- **b -** Aft propeller
- **c -** Aft propeller thrust hub
- **d -** Front propeller nut
- **e -** Front propeller
- **f -** Front propeller thrust hub
- **g -** Propeller shaft anode screw
- **h -** Flat washer
- **i -** Star washer
- **j -** Propeller shaft anode

Bravo Sterndrive Propeller Installation

⚠ WARNING

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



- **a -** Wood block
- **b -** Propeller
- **c -** Propeller nut under socket

Bravo One Models

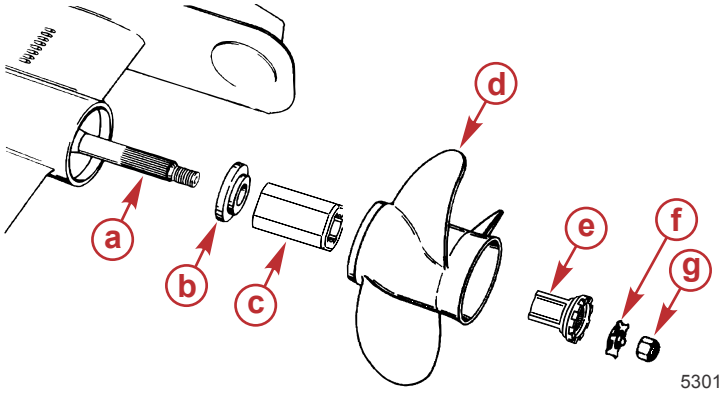
IMPORTANT: Use the correct rotation propeller. The propeller rotation must match the direction of rotation of the propeller shaft.

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1

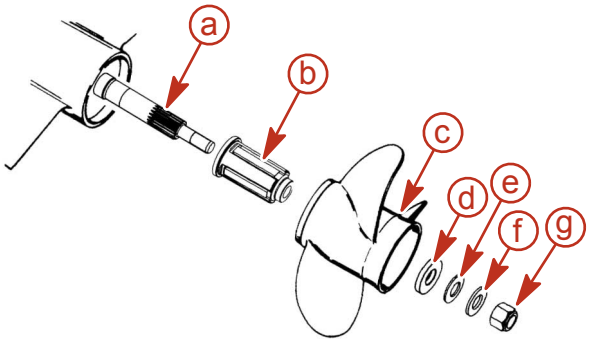
NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Install the propeller with the attaching hardware as shown.
3. Torque the propeller nut.



Typical Bravo One models

- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Flo-Torque II drive hub
- **d -** Propeller
- **e -** Drive sleeve adapter
- **f -** Tab washer
- **g -** Propeller nut



Bravo One XR models

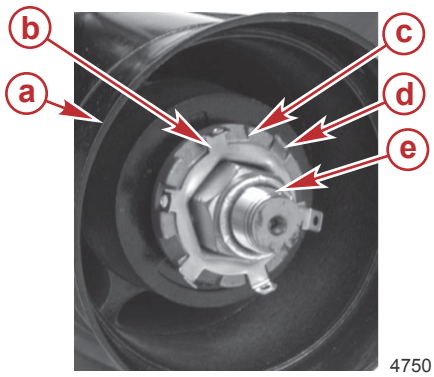
- **a -** Propeller shaft
- **b -** Propeller hub insert with snubbers
- **c -** Propeller
- **d -** Thick washer
- **e -** Washer
- **f -** Washer
- **g -** Propeller nut

NOTE: *The propeller torque stated is a minimum torque value.*

Description	Nm	lb. in.	lb. ft.
Bravo One propeller nut	75	–	55

NOTE: *Bravo One XR models do not use the tab washer.*

4. Models equipped with the tab washer: Continue to tighten the propeller nut until the three tabs on the tab washer align with the grooves on the spline washer.
5. Bend the three tabs down into the grooves.



- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

Bravo Two Models

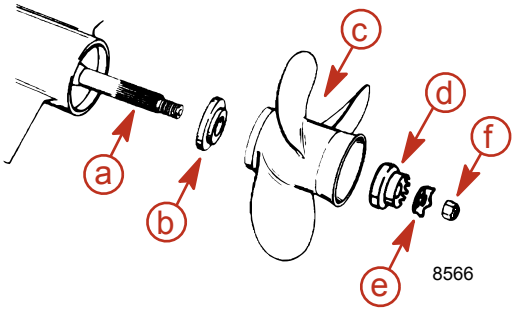
IMPORTANT: Use the correct rotation propeller. The propeller rotation must match the direction of rotation of the propeller shaft.

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867Q 1

NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Install the propeller with the attaching hardware as shown.
3. Torque the propeller nut.

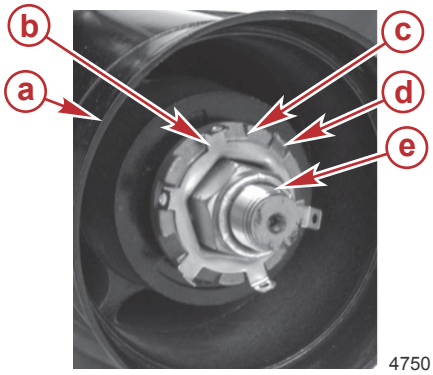


Bravo Two
- **a -** Propeller shaft splines
- **b -** Forward thrust hub
- **c -** Propeller
- **d -** Spline washer
- **e -** Tab washer
- **f -** Propeller nut

NOTE: *The propeller torque stated is a minimum torque value.*

Description	Nm	lb. in.	lb. ft.
Bravo Two propeller nut	81	–	60

4. Continue to tighten the propeller nut until the three tabs on the tab washer align with the grooves on the spline washer.
5. Bend the three tabs down into the grooves.



- **a -** Prop
- **b -** Tab washer
- **c -** Drive sleeve adapter
- **d -** Tab bent down
- **e -** Propeller nut

Bravo Three

1. Coat the propeller shaft spline with one of the following Quicksilver lubricants.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Propeller shaft splines	92-802865Q02
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1
95	2-4-C Marine Lubricant with PTFE	Propeller shaft splines	92-802859A 1

NOTE: *Anti-corrosion grease is for salt water applications only.*

2. Slide forward thrust hub onto propeller shaft, with tapered side toward propeller hub.
3. Align splines and place front propeller on propeller shaft.
4. Install front propeller locknut and torque using the Propeller Nut tool.

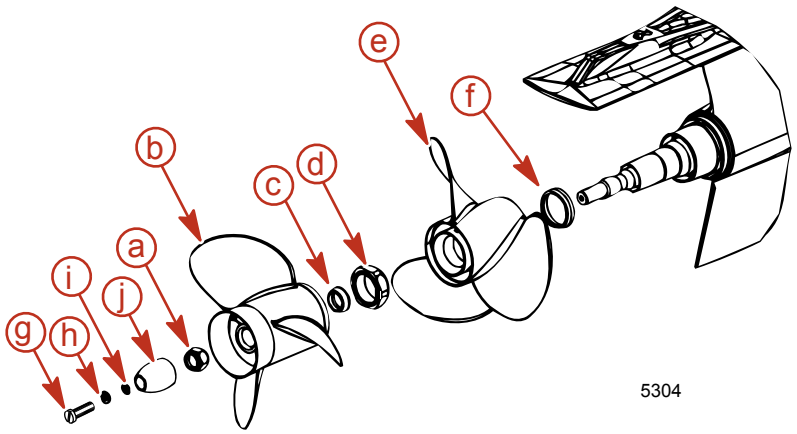
Propeller Nut Tool	91-805457T 1

Description	Nm	lb. in.	lb. ft.
Bravo Three front propeller nut	136	–	100

5. Slide aft thrust hub onto propeller shaft with tapered side toward propeller hub
6. Align splines and install aft propeller.
7. Install propeller nut and torque.

Description	Nm	lb. in.	lb. ft.
Bravo Three rear propeller nut	81	–	60

8. Install propeller shaft anode and screw and torque.



Bravo Three

- **a -** Rear propeller nut
- **b -** Rear propeller
- **c -** Rear propeller thrust hub
- **d -** Front propeller nut
- **e -** Front propeller
- **f -** Front propeller thrust hub
- **g -** Propeller shaft anode screw
- **h -** Flat washer
- **i -** Star washer
- **j -** Propeller shaft anode

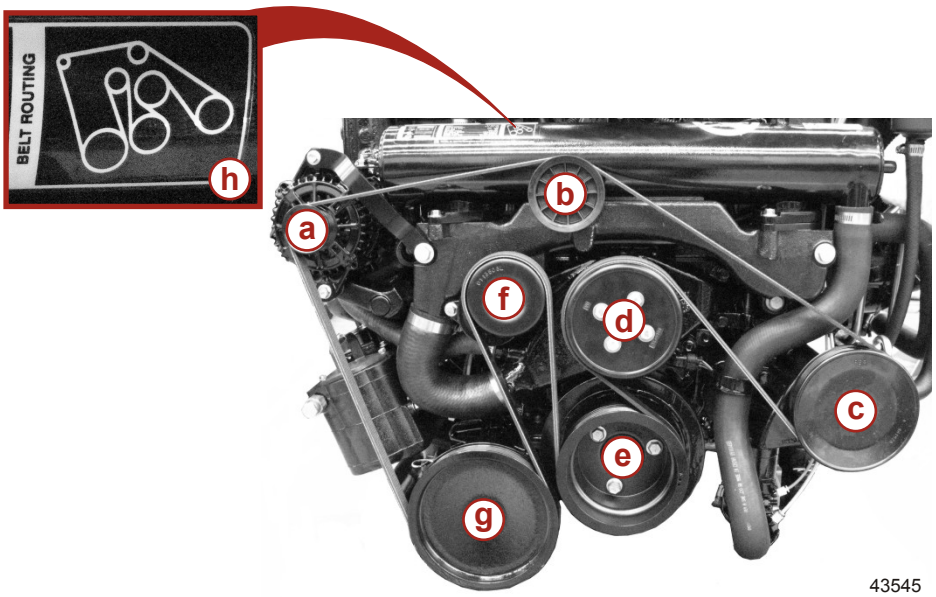
Description	Nm	lb. in.	lb. ft.
Propeller shaft anode screw	19	168	–

Serpentine Drive Belt

Inspection

⚠ WARNING

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



43545

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram

Checking

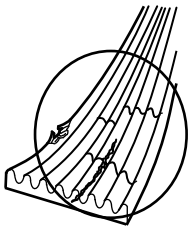
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

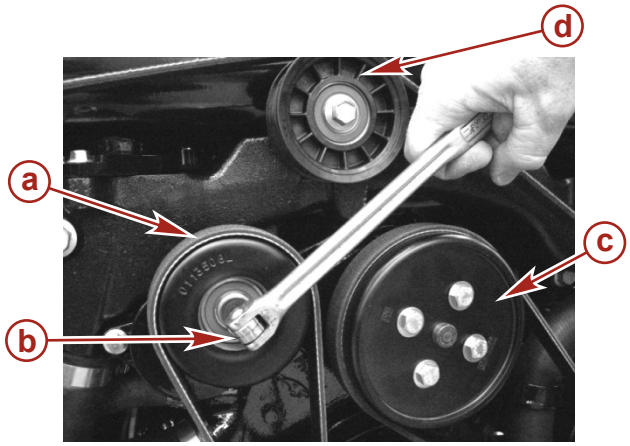
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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



43546

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

Description	
Deflection[1]	13 mm (½ in.)

Corrosion Protection

Corrosion Information

Whenever two or more dissimilar metals 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. For more information refer to the **Mercury Precision Parts / Marine Corrosion Protection Guide** (90-881813003).

Maintaining Ground Circuit Continuity

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

MerCathode System Battery Requirements

The Mercury MerCruiser MerCathode system requires a minimum battery charge of 12.6 volts at all times to maintain functionality.

Boats equipped with a MerCathode system that use shore power, and are not run for a long period of time, must use a battery charger to maintain a minimum battery charge of 12.6 volts or above.

Boats equipped with a MerCathode system that do not have access to shore power must be operated often enough to maintain a minimum battery charge of 12.6 volts or above at all times.

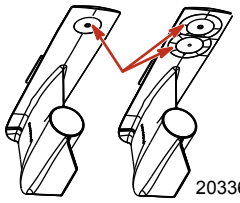
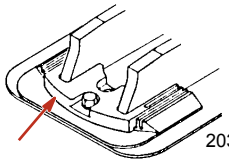
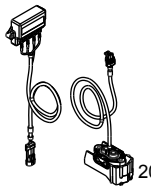
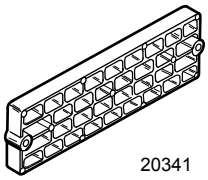
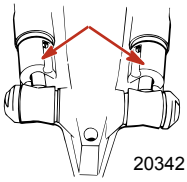
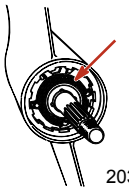
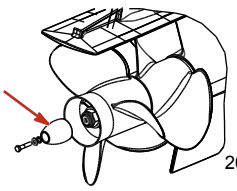
Anodes and MerCathode System Locations

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

1. Use moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

The following sacrificial anodes are installed at different locations on your power package. These anodes help protect against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the metal components on the power package.

MerCathode System— Electrode assembly replaces the Anode block. System should be tested to ensure adequate output. The test should be performed where boat is moored, using Quicksilver Reference Electrode and Test Meter.

Description	Location	Figure
Gearcase anode plate	Mounted on the underside of the lower gearcase.	 20336
Ventilation plate anode	Mounted on the front of the gearcase.	 20338
MerCathode System	The MerCathode electrode is mounted to the underside of the gimbal housing. The MerCathode controler is mounted on the engine or on the boat transom. The controler harness connects to the electrode harness.	 20340
Anode kit (if equipped)	Mounted to the boat transom.	 20341
Trim cylinder anodes	Mounted on each of the trim cylinders.	 20342
Bearing carrier anode (Bravo One)	Located in front of the propeller, between the front side of the propeller and the gear housing.	 20343
Propshaft anode (Bravo Three)	Located behind the aft propeller.	 20344

Checking the Quicksilver MerCathode System

The MerCathode system should be tested to ensure adequate output. Perform the test where the boat is moored, using the reference electrode and test meter.

Reference Electrode	91-76675T 1

Power Package Exterior Surfaces

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

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

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

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

Boat Bottom Care

To achieve maximum performance and fuel economy, the boat bottom must be kept clean. Accumulation of marine growth or other foreign matter can greatly reduce boat speed and increase fuel consumption. To ensure best performance and efficiency, periodically clean the boat bottom in accordance with manufacturer's recommendations.

In some areas, it may be advisable to paint the bottom to help prevent marine growth. Refer to the following information for special notes about the use of anti-fouling paints.

Anti-fouling Paint

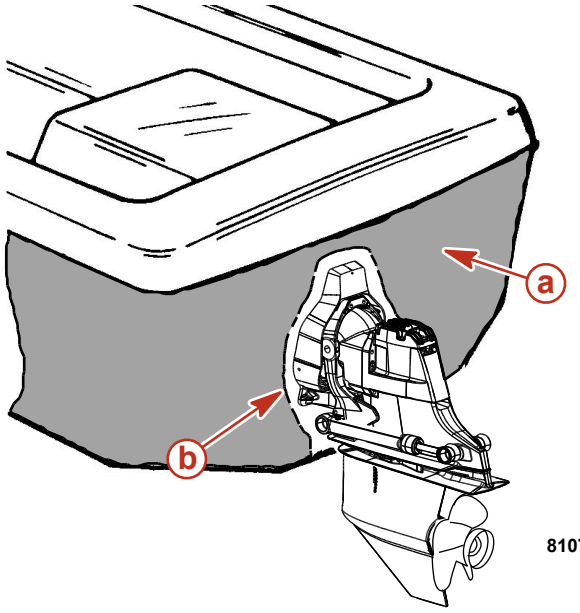
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

You may apply anti-fouling paint to the boat hull and boat transom but you must observe the following precautions:

IMPORTANT: Do not paint or pressure-wash the anodes or the MerCathode System reference electrode and anode. Doing so will render them ineffective as inhibitors of galvanic corrosion.

IMPORTANT: If anti-fouling protection is required for the boat hull or boat transom, you can use copper-based paint if it is not prohibited by law. If you are using copper based anti-fouling paint, observe the following precaution:

- **Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on transom of the boat around these items.**



a - Painted boat transom

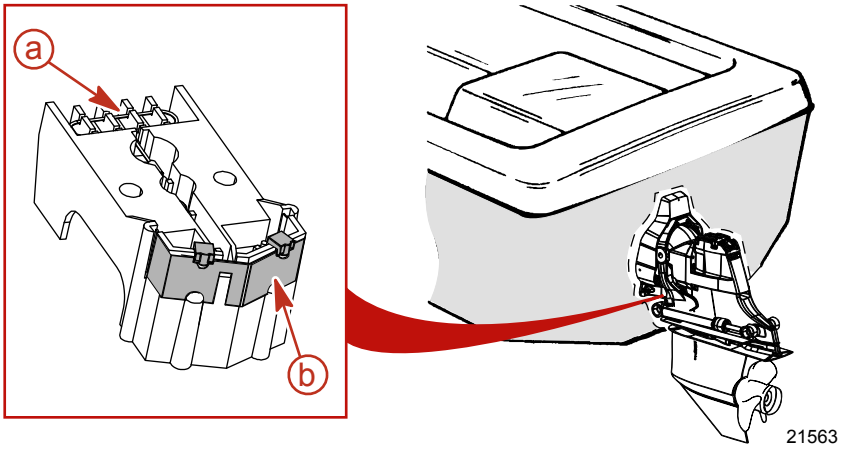
b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly

NOTE: Sterndrive and transom assembly can be painted with a good marine paint or an anti-fouling paint that DOES NOT contain copper 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.

NOTICE

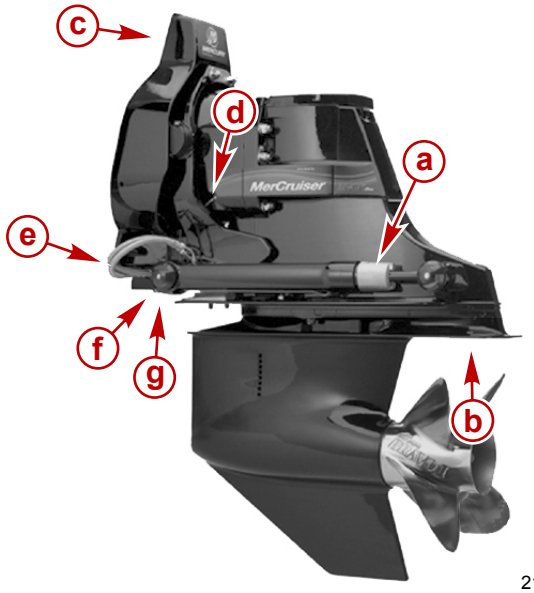
Washing the MerCathode assembly can damage components and lead to rapid corrosion. Do not use any cleaning equipment such as brushes or high-pressure washers to clean the MerCathode assembly.

Do not power-wash a sterndrive that has a MerCathode assembly. Doing so can damage the coating on the reference wire of the MerCathode assembly and increase corrosion.



a - Reference electrode
b - Anode plate

Sterndrive Surface Care



Standard Bravo sterndrive

a - Sacrificial trim cylinder anode
b - Sacrificial anodic plate
c - Steering lever ground wire
d - Ground wire between the gimbal ring and bell housing
e - Stainless steel hoses
f - Ground wire between the gimbal housing and trim cylinder
g - Ground wire between the gimbal ring and gimbal housing

We recommend the following maintenance items to help keep your sterndrive corrosion-free:

- Maintain a complete paint covering on the sterndrive.
- Check the finish regularly. Prime and paint nicks and scratches using Mercury enamel paint and touch up paint. Use only tin–based anti–fouling paint or its equivalent on or near aluminum surfaces below the waterline.
- If bare metal is showing, apply 2 coats paint.

Description	Where used	Part number
Mercury Phantom Black	Bare metal	92- 802878-1

- Spray all electrical connections with sealant.

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

- Inspect the sacrificial trim tab or anode plate if equipped, at regular intervals and replace it before it is half gone. If a stainless steel propeller is installed, additional anodes or a MerCathode System will be required.

- Inspect the propeller shaft for fishing line, which can cause corrosion on a stainless steel shaft.
- Remove the propeller at least every 60 days and lubricate the propeller shaft.
- Do not use lubricants containing graphite on or near the aluminum in saltwater.
- Do not paint trim tabs or the mounting surface.

Flushing the Seawater System—Sterndrive Models

General Information—Bravo Sterndrive

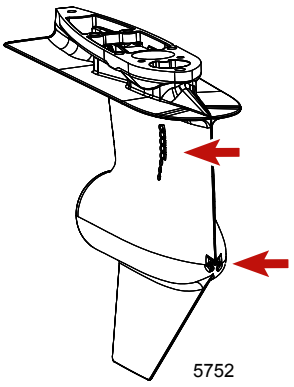
Your boat could be equipped with a combination of any of three different types of water pickups: through-hull, through-transom, and through-sterndrive. The flushing procedures for these systems are separated into two categories: sterndrive water pickups and alternative water pickups.

Flushing Attachments

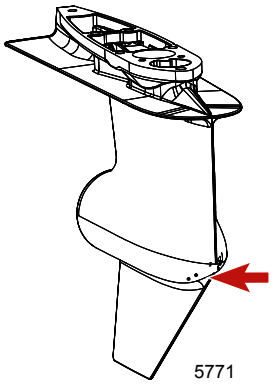
Flushing Device	91-44357Q 2
Dual Water Pick-up Flush Gearcase Seal Kit	91-881150K 1
Flushing Kit	91-849996T 1

Sterndrive Water Pickups

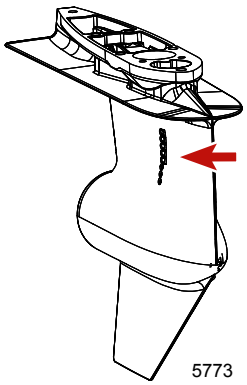
There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side pickups. Dual water pickups require the flushing attachment (44357Q 2) and the flush seal kit (881150K 1), low water pickups require the flushing attachment (849996T 1), and side pickups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



Dual Water Pickup



Low Water Pickup



Side Pickup

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

8. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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.
13. Stop the engine.
14. Immediately shut off the supply water. Do not remove the flushing attachment from the sterndrive at this time.

NOTICE

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

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

15. Close the seacock, if equipped, then disconnect 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.

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

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

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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

9. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in neutral for 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.
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.**

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.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

2. Close the seacock, if equipped, then disconnect 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

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

SeaCore Power Package Flushing Procedure

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

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

Models Using The Sterndrive Water Pickup

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

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

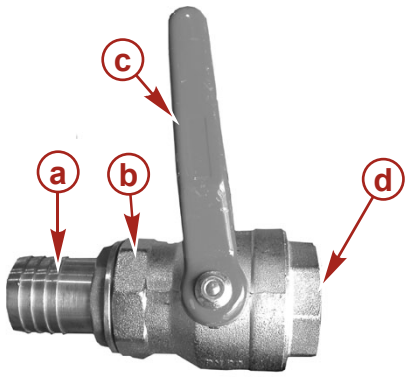
⚠ WARNING

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

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

1. Remove the boat from the water.

2. Close the seacock, if equipped.

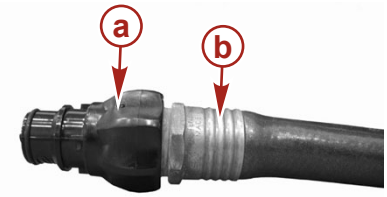


18510

For visual clarity, the secock shown is not installed

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

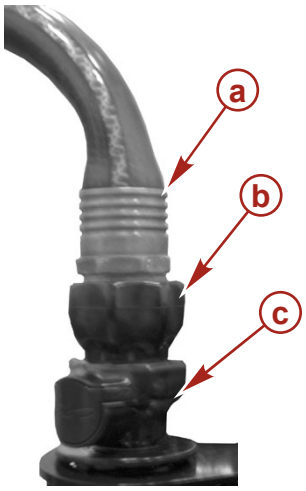
3. If equipped with an alternative water pickup and not equipped with a seacock, disconnect the water hose from the alternative water pickup and plug both ends, excluding the Bravo sterndrive.
4. Ensure that the inlet water hose from the sterndrive to the engine is connected.
5. Remove the quick-connect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



18487

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

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



18489

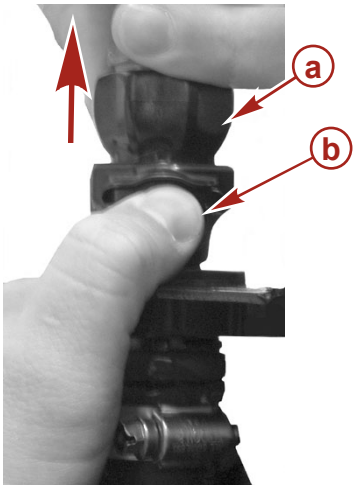
- **a -** Water hose
- **b -** Quick-connect fitting (water hose end)
- **c -** Flush socket

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

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

11. Operate the engine at idle speed in neutral gear. Do not exceed 1200 RPM.
12. Monitor the engine temperature while operating the engine.

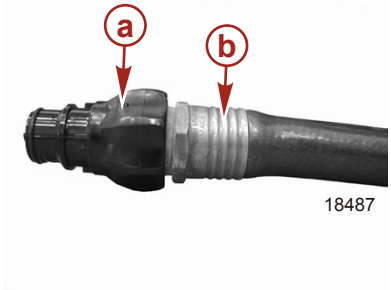
13. Flush the engine for 5 to 10 minutes or until discharge water is clear.
14. Shut off the engine.
15. Turn off the water source.
16. Disconnect the quick-connect fitting and water hose from the flush socket on the engine by pressing the release button on the flush socket.



18488

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

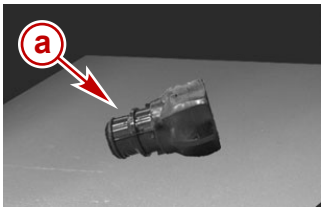
17. Remove the quick-connect fitting from the water hose.



18487

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

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



25900

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

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

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

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

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

Cold Weather or Extended Storage

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

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

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

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

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. Check the antifreeze concentration. Refer to the **Specifications** section.
3. 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 Mercury/Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to **Fuel Requirements** for additional information.
4. Flush the cooling system. Refer to the **Maintenance** section.
5. Supply cooling water to engine. Refer to the **Maintenance** section
6. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Mercury/Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off the engine.
7. Change the oil and oil filter.
8. Prepare the engine and fuel system for storage. See **Engine and Fuel System Preparation**.
9. Drain the engine seawater cooling system. See **Draining the Seawater System**.

NOTICE

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

10. For additional assurance against freezing and rust, after draining, fill the seawater 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.
11. Store the battery according to the manufacturer's instructions.

Engine and Fuel System Preparation

⚠ WARNING

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

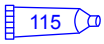
⚠ WARNING

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

NOTICE

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

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

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

2. Allow the engine to cool.
   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 five minutes.
6. After the specified operating time is complete, slowly return the throttle to idle and shut the 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. Refer to **Section 5**.

Maintenance

⚠ WARNING

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

⚠ WARNING

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

IMPORTANT: Refer to the maintenance schedule for the complete listing of all scheduled maintenance to be performed.

NOTE: *Maintenance points are color-coded for ease of identification.*

Maintenance Point Color Codes	
Yellow	Engine oil
Black	Drive lube
Brown	Power steering fluid
Blue	Drain or flush

Draining the Seawater System

⚠ CAUTION

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

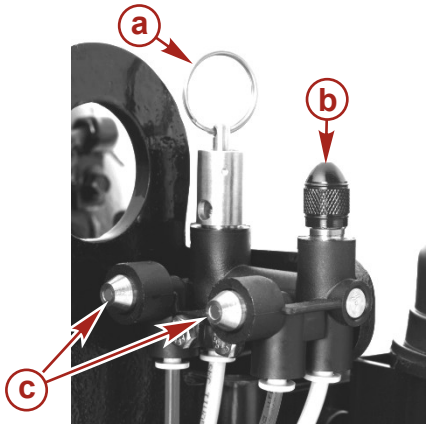
IMPORTANT: Only drain the seawater section of the closed cooling system.
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

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.

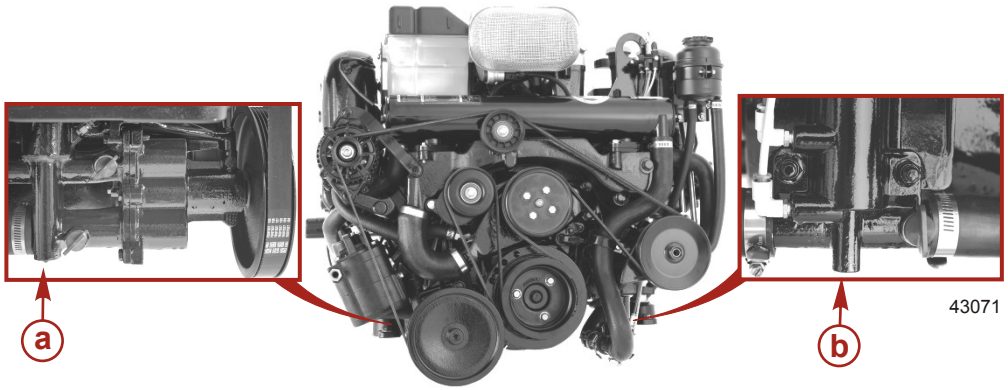
Drain System Identification

Air Actuated Single Point Drain System



43070

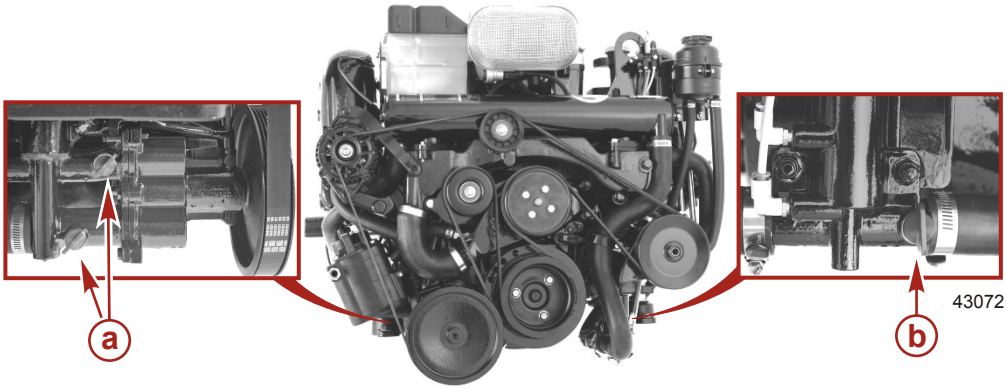
a - Manual pressure release valve
b - Threaded cap for air connection
c - Green indicators



43071

a - Starboard side air actuated drain location
b - Port side air actuated drain location

Manual Drain System



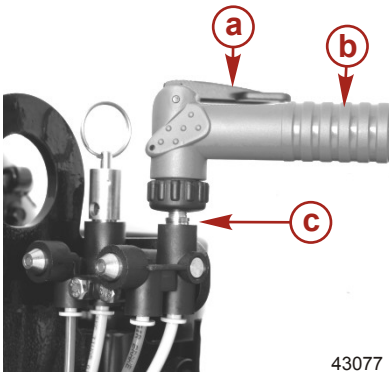
a - Starboard side blue drain plugs
b - Port side blue drain plug

Air Actuated Single Point Drain System

Boat in the Water

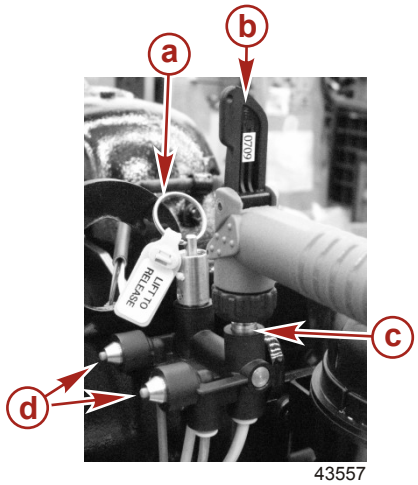
NOTE: *This procedure is written for the air pump that was shipped with the engine from the factory. However, any air source can be used.*

1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Obtain the air pump.
3. Remove the threaded cap from the air connection.
4. Ensure that the lever on top of the air pump is against the handle (horizontal).
5. Install the air pump on the air connection.



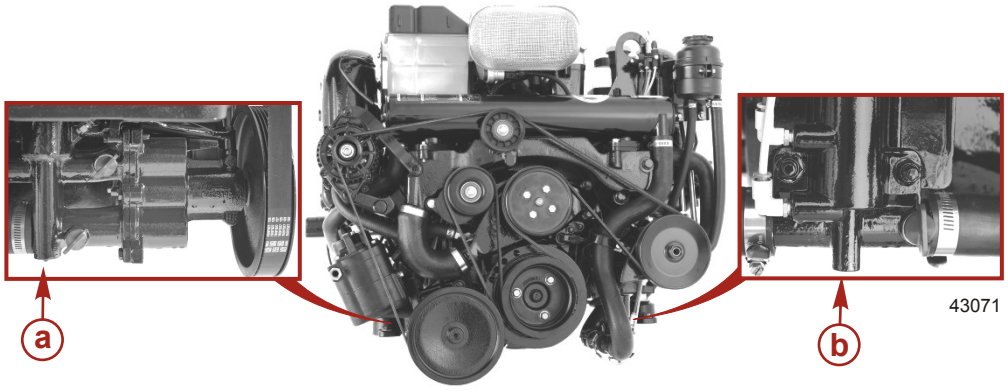
a - Lever
b - Air pump
c - Air connection

6. Pull the lever on the air pump (vertical) to seal the pump to the connection.
7. 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.



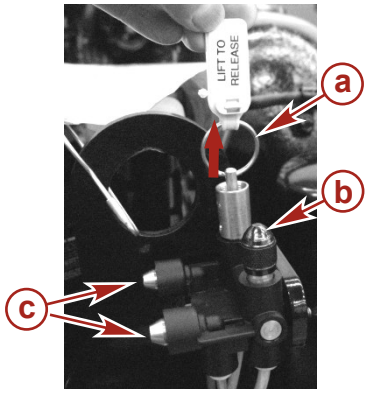
a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

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



a - Starboard side air actuated drain location
b - Port side air actuated drain location

9. Allow the system to drain for a minimum of five minutes. Pump air as necessary to keep the green indicators extended.
10. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
11. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
12. Remove the air pump from the air connection and return it to the mounting bracket.
13. 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.
14. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



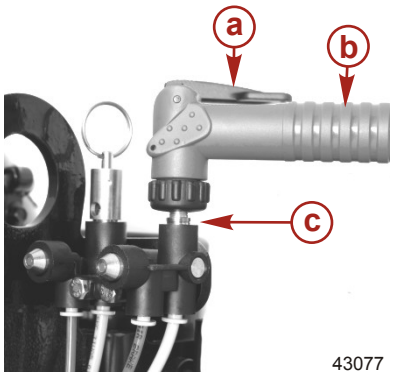
a - Manual release valve pull ring
b - Threaded cap on air connection
c - Green indicators

15. 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.*

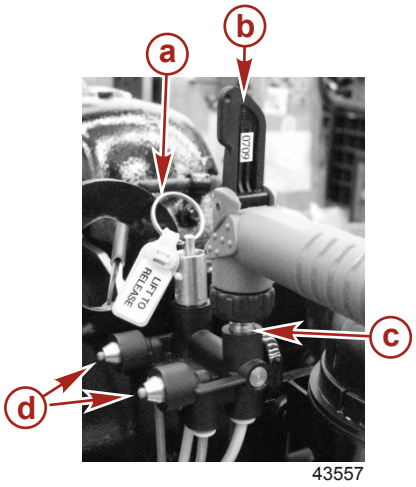
1. Place the boat on a level surface and ensure the boat is level.
2. Obtain the air pump.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the air connection.



a - Lever
b - Air pump
c - Air connection

5. Pull the lever on the air pump (vertical) to seal the pump to the air connection.

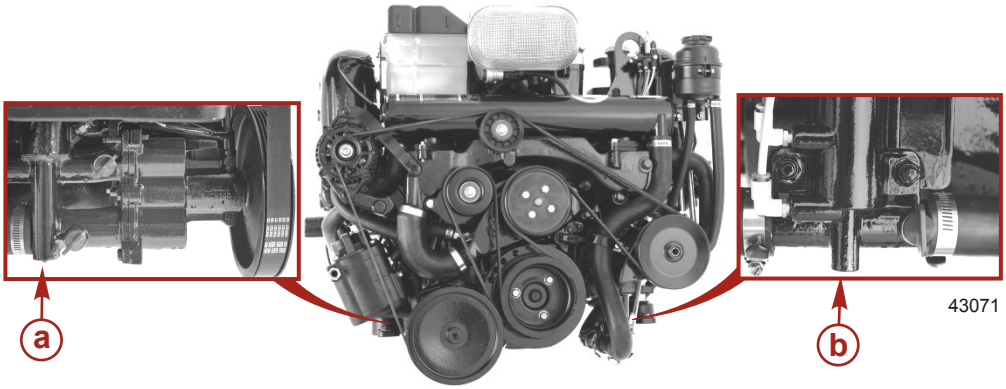
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

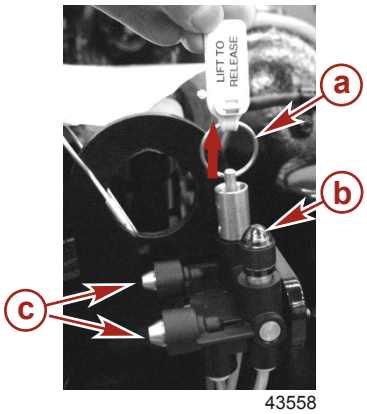
7. Verify that water is drining from each opening. If not, use the **Manual Drain System** instructions.



43071

a - Starboard side air actuated drain location
b - Port side air actuated 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.



43558

a - Manual release valve pull ring
b - Threaded cap
c - Green indicators

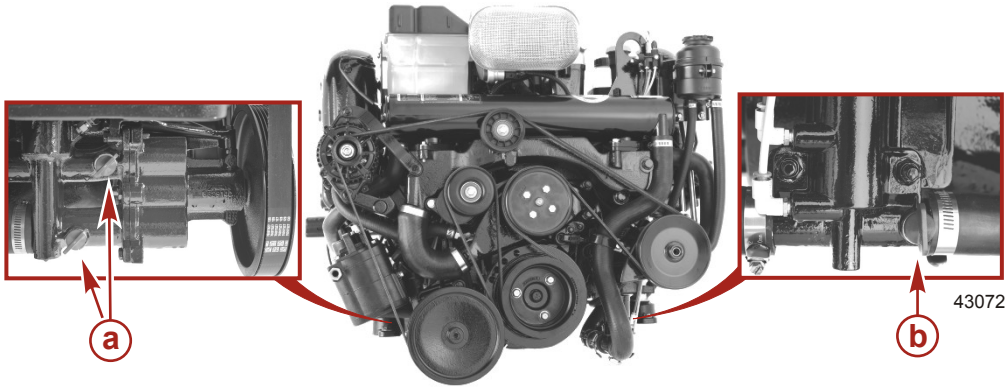
Manual Drain System

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 hoses are disconnected.*

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



a - Starboard side blue drain plugs
b - Port side blue drain plug

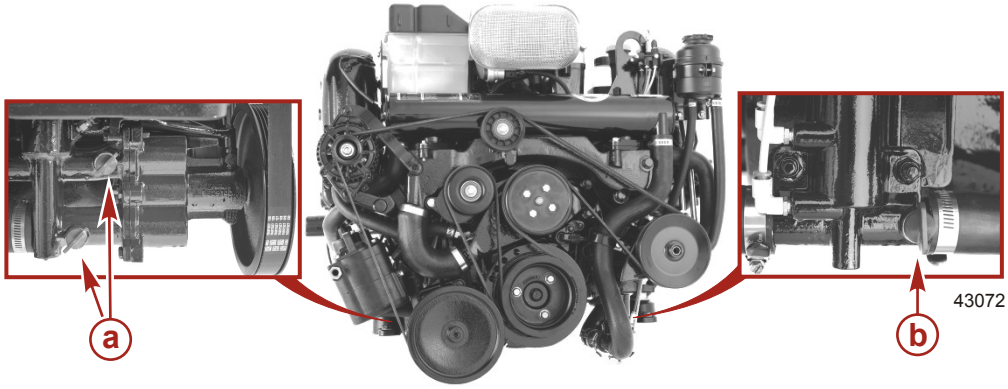
3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. 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 lever surface to ensure complete draining of the system.
2. Remove the port side blue drain plug.
3. Remove two blue drain plugs from the seawater pickup pump (front, starboard side).



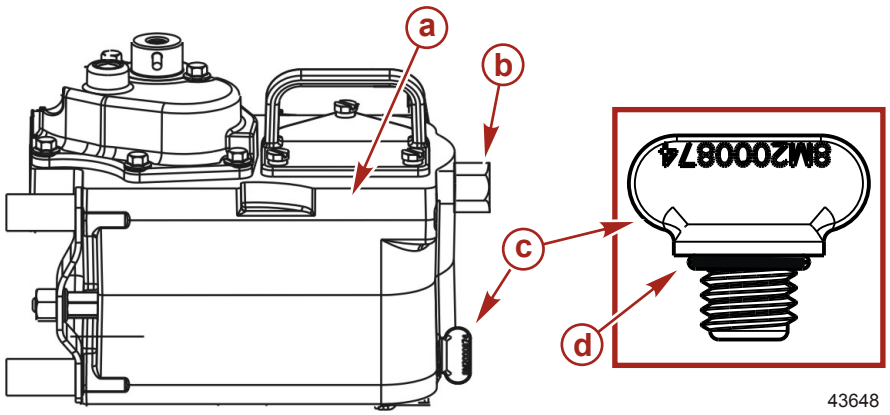
a - Starboard side blue drain plugs
b - Port side blue drain plug

4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of five 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. For DTS engines, 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 two blue drain plugs.

Draining Water From the Gen III Cool Fuel Module

Mercury MerCruiser recommends draining the Gen III Cool Fuel module if it is equipped with a drain plug.

1. Remove the drain plug from the Gen III Cool Fuel module and allow the water to completely drain from the module.
2. Inspect the drain plug and the O-ring for damage. Replace if needed.
3. Place the O-ring on the drain plug and install the drain plug in the module drain hole. Tighten the drain plug to finger tight.

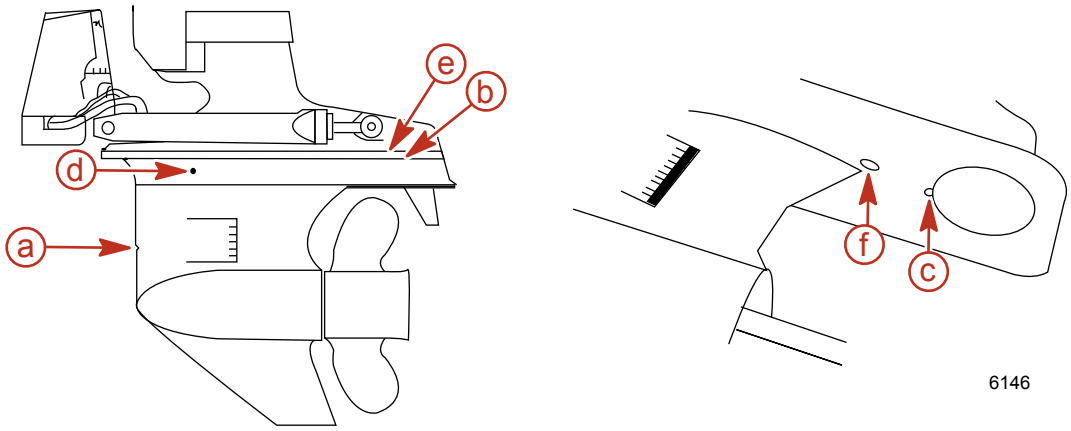


a - Gen III Cool Fuel module
b - Fuel inline fitting
c - Drain plug
d - O-ring

Draining the Sterndrive

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

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



Sterndrive Water Drain Holes

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

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

2. Lower the sterndrive unit to the full down/in position.
3. For additional assurance against freezing and rust, after draining, fill the cooling system with propylene glycol mixed to the manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during freezing temperatures or extended storage

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

Battery Storage

Whenever the battery will be stored for an extended period of time, be sure the cells are full of water and the battery is fully charged and in good operating condition. It should be clean and free of leaks. Follow the battery manufacturer's instructions for storage.

Recommissioning the Power Package

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

⚠ CAUTION

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

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect cables. 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 **Operation Chart**.

NOTICE

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

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

Notes:

Important Information

Section 1C - Maintenance Inboard Models

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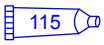
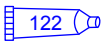
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Extended Life Antifreeze/ Coolant	Closed cooling system	92-877770K1
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

Gasoline and Engine Oil

Fuel Requirements

NOTICE

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

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

Fuel Ratings

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

USA and Canada - A posted pump Octane Rating of 87 (R+M)/2, minimum. Premium gasoline 92 (R+M)/2 Octane is also acceptable. Do not use leaded gasoline.

Outside USA and Canada - A posted pump Octane Rating of 91 RON, minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasoline (USA Only)

Reformulated gasoline is required in certain areas of the USA and are acceptable for use in your Mercury MerCruiser engine. The two types of oxygenates used in these fuels are alcohol (ethanol) and ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasoline Containing Alcohol**.

Gasoline Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), be aware of possible adverse effects. These adverse effects are more severe with methanol and worsen according to the percentage of alcohol in the fuel.

Alcohol in gasoline can absorb moisture from the air, causing the water and the alcohol to separate from the gasoline in the fuel tank.

IMPORTANT: The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on your boat's fuel system components (fuel tanks, fuel lines, and fittings).

Be aware that gasoline containing alcohol may cause increased:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through the rubber fuel lines
- Starting and operating difficulties

⚠ WARNING

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

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

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

Engine Oil

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

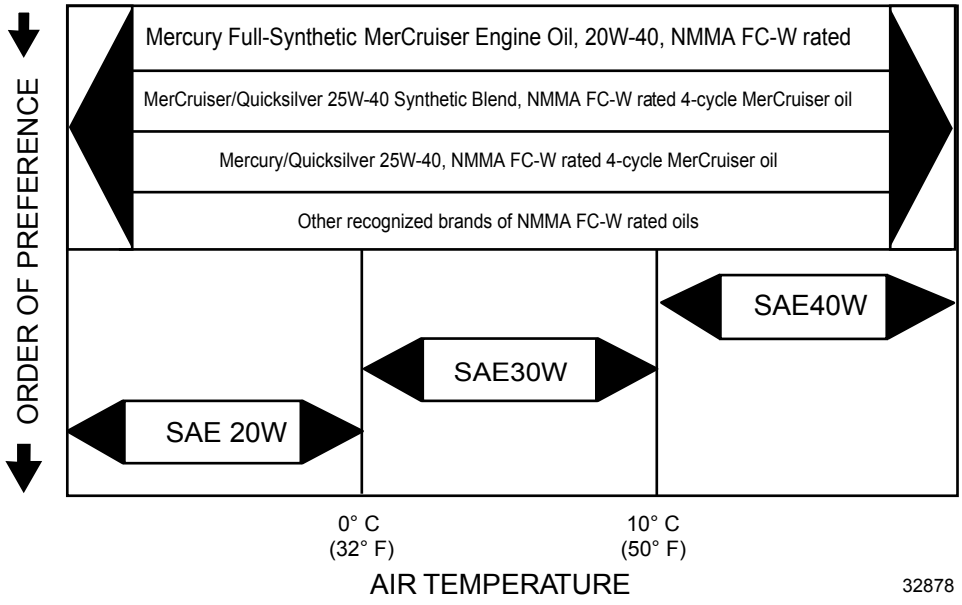
Application	Recommended Oil
All MerCruiser engines	Mercury MerCruiser Full-Synthetic Engine Oil, 20W-40, NMMA FC-W rated

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

If Mercury MerCruiser Full-Synthetic, 20W-40 oil is unavailable, use the following lubricants, listed in order of recommendation. If you are servicing a catalyst engine, use these for short periods of time only.

1. Mercury/Quicksilver 25W-40 Synthetic Blend, NMMA FC-W–rated 4-cycle MerCruiser oil
2. Mercury/Quicksilver 25W-40, NMMA FC-W–rated 4-cycle MerCruiser oil
3. Other recognized brands of NMMA FC-W–rated 4-cycle oils
4. A good-grade, straight-weight detergent automotive oil according to the last row of the operating chart below.

NOTE: *We do not recommend 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.*



Cruising RPM

Material and design advancements allow modern inboard engines to operate at higher engine speeds than their predecessors. Increased RPM significantly increases the horsepower of these new engines and is a critical part performance and efficiency. The materials and design of the new engines allow these higher speeds without durability penalty. Over-propping the boat to reduce its cruising RPM to previous levels increases the engine's susceptibility to engine damage from detonation and pre-ignition. The recommended cruising RPM ranges are:

Cruising RPM for peak efficiency	
Model	**RPM range**
Horizon 8.2	3200–3600
8.2 H.O.	3400–3800

Engine Specification Inboard Models

Horizon 8.2 EC and 8.2 H.O. EC

NOTE: *Performance specifications are:*

- *Obtained and corrected in accordance with SAE J1228/ISO 8665 Crankshaft Power.*
- *All measurements are taken with the engine at normal operating temperature.*
- *RPM range is measured using an accurate service tachometer with the engine at normal operating temperatures.*
- *Oil pressure must be checked with the engine at normal operating temperature.*

NOTE: *Oil pressure specifications are for reference and may vary.*

		Horizon 8.2	8.2 H.O.
Propshaft power		280 kW (375 hp)	317 kW (425 hp)
Displacement		8.2 L (502 cid)	
Alternator amperage	Hot	72 A	
	Cold	65 A	
RPM	WOT	4200–4600	4400–4800
	Rev limiter	4750	4950
Idle RPM	Mechanical	675	
	DTS		
Minimum oil pressure	At 2000 RPM	431 kPa (60 psi)	
	At idle	207 kPa (30 psi)	
Thermostat	MPI models with Closed Cooling	76° C (170° F)	
Timing at idle		Not Adjustable	
Firing order		1-8-4-3-6-5-7-2	
Minimum battery rating	Non-DTS models	750 CCA, 950 MCA, 180 Ah	
	DTS models	800 CCA, 1000 MCA, 190 Ah	
Spark plug type		NGK BPR6ES	
Spark plug gap		0.83 mm (0.033 in.)	
Emission Control System		Electronic control (EC), heated oxygen sensor (HO2S), catalyst	

Maintenance Schedule Inboard Models

Routine Maintenance

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

Task Interval	Maintenance to Be Performed
Each day start	• Check the engine oil level. You can extend this interval based on experience with the product. • Check the transmission fluid level.
Each day end	• If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use.
Weekly	• Check the water inlets for debris or marine growth. • Check and clean the seawater strainer, if equipped. • Check the coolant level. • Check the transmission fluid.

Task Interval	Maintenance to Be Performed
Every two months or 50 hours	• If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. • Check the battery connections and the fluid level. • Ensure that the gauges and the wiring connections are secure. Clean the gauges. If operating in saltwater, reduce this interval to every 25 hours or 30 days, whichever occurs first.

Scheduled Maintenance

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

Task Interval	Maintenance to Be Performed
After the initial 20-hour break-in period	Change the engine oil and filter. • Change the engine oil and filter. • Change the transmission fluid and filter. ZF Marine requires changing the transmission fluid and filter to maintain warranty.
Every 100 hours or annually (whichever occurs first)	• Touch up the paint on the power package. • Change the engine oil and filter. • Change the transmission fluid (Transmission Models). • If the condition of the spark plugs, spark plug wires, and the distributor cap and rotor was satisfactory at the initial inspection (as listed in **Every 300 hours or 3 years**), inspect the condition of these components. Replace as necessary. • Replace the water-separating fuel filter element. • Clean the flame arrestor and the crankcase ventilation hoses. • Replace the positive crankcase ventilation (PCV) valve. • Inspect the condition and the tension of the belts. • On models with closed cooling, check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the **Specifications** section.
Every 300 hours or 3 years (whichever occurs first)	• Check the engine mounts for tightness and tighten to specifications if necessary. • Inspect the condition of the spark plugs, spark plug wires, and the distributor cap and rotor, if equipped. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. • Check the electrical system for loose, damaged, or corroded fasteners. • Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. • Disassemble and inspect the seawater pump and replace worn components. • On models with closed cooling, clean the seawater section of the closed cooling system. • Clean, inspect, and test the pressure cap of the closed cooling system. • Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. • Replace the vent valve and duckbill valve on each exhaust elbow (port and starboard).
Every 5 years	• On models with closed cooling, replace the coolant/anitifreeze. Replace every two years if not using extended-life coolant/antifreeze.

Fluid Specifications

Engine

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Transmission

Model	Capacity	Fluid Type
63A	4.3 L (4.5 US qt)	Dexron III Automatic Transmission Fluid
63V	4.3 L (4.5 US qt)	
80A	5.7 L (6 US qt)	

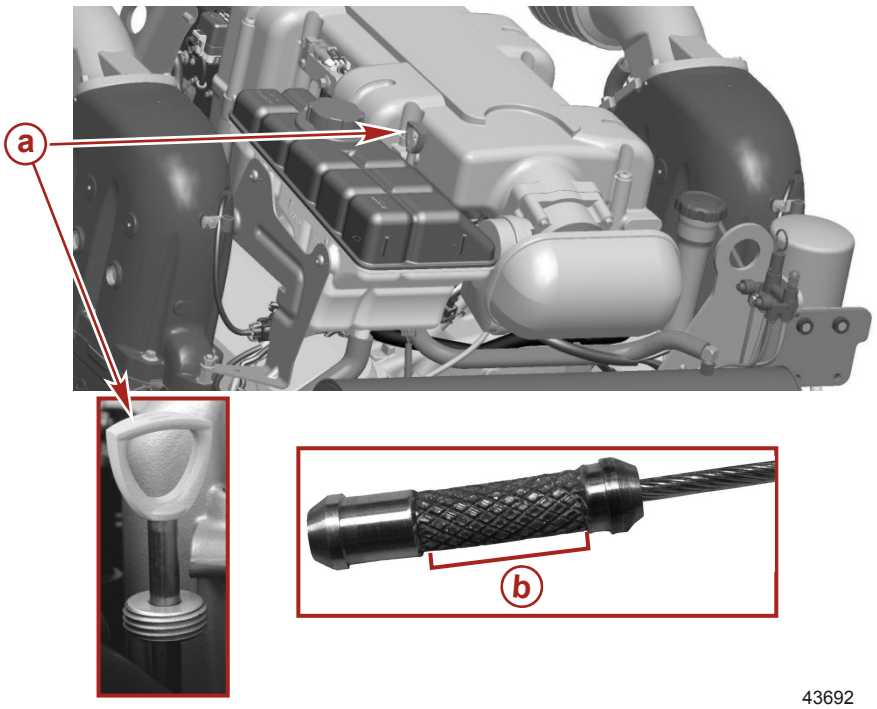
Engine Oil

Checking

NOTICE

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

1. Stop the engine. Allow the oil to drain into the oil pan for approximately five minutes with the boat 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.



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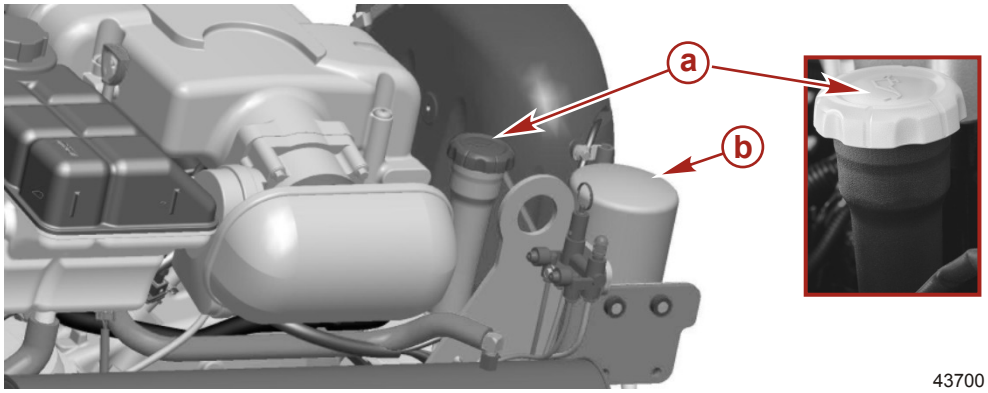
a - Oil dipstick handle
b - Operating range

3. Inspect the dipstick reading, which should indicate a level at the operating range (cross markings) on the dipstick. Reinstall the dipstick into the dipstick tube. If the oil level is low, refer to **Filling**.

Filling

IMPORTANT: Always use the dipstick to determine the exact quantity of oil or fluid required. Do not overfill the engine with oil.

1. Remove oil fill cap.



a - Oil fill cap
b - Oil filter

2. Add the specified engine oil to bring the level up to, but not over, the operating range (cross markings) on the dipstick.

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

3. Check the oil level and replace the fill cap.

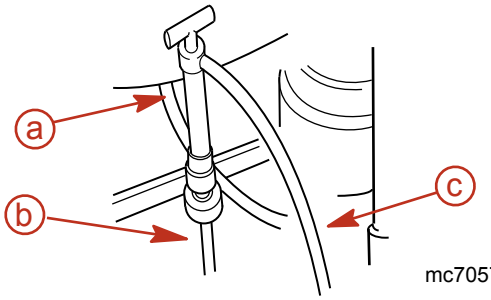
Changing Oil and Filter

See **Maintenance Schedule** for the change interval. Engine oil should be changed before placing the boat in storage.

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

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.

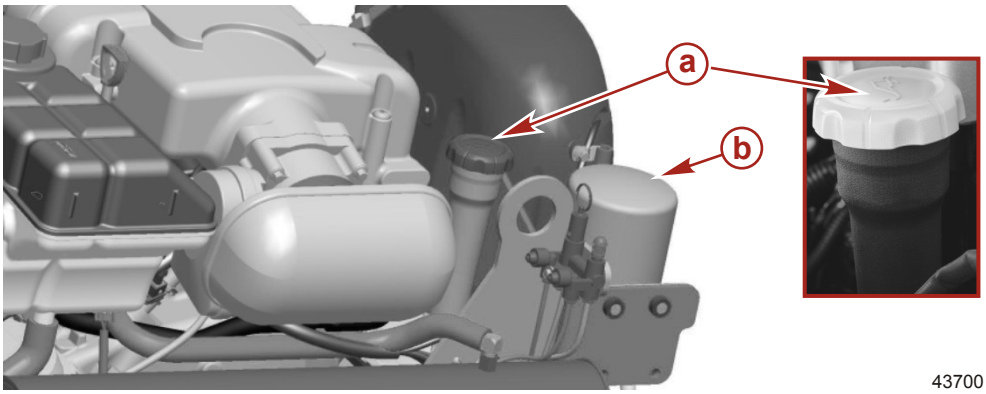


a - Oil pump
b - Dipstick tube
c - Oil drain hose

4. Insert the hose end of the crankcase oil pump onto an appropriate container and usie the handle to pump until the crankcase is empty.
5. Remove the pump.
6. Install the dipstick.

Changing the Oil Filter

1. Remove and discard oil filter.



a - Oil fill cap
b - Oil filter

2. Coat the sealing ring on the new filter with engine oil.
3. Install and tighten the oil filter securely following the filter manufacturer's instructions. Do not overtighten.
4. Remove oil fill cap.
5. Use the dipstick to determine the amount of engine oil required. Replace the dipstick.
6. Add the required amount of the recommended oil to bring the level up to the bottom of the OK range on the dipstick.
7. With the boat at rest in the water, repeat steps 5 and 6 if necessary.

   NOTE: *Adding 0.95 L (1 US qt) of engine oil raises the level from the add mark to the top of the operating range.*

All Models	Capacity	Fluid Type
Engine oil (with filter)	6.5 L (7 US qt)	Mercury Full-Synthetic MerCruiser Engine Oil 20W-40

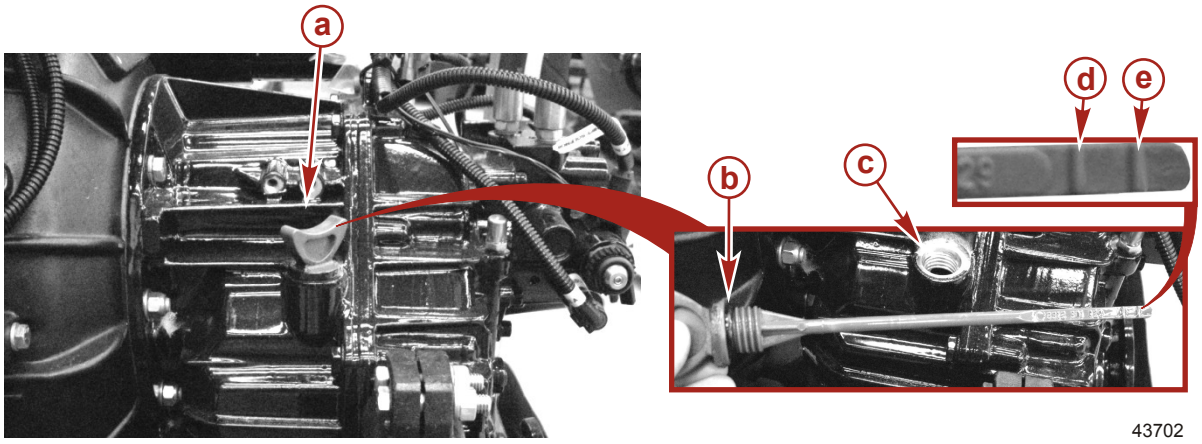
8. Start the engine and operate for three minutes, checking for leaks.
9. Stop the engine and allow the oil to drain into the oil pan for approximately five minutes with the boat at rest in the water.

Transmission Fluid

Checking While Engine is Warm

1. Stop the engine.
2. Remove the dipstick from the transmission.
3. If the fluid level is below the add mark on the dipstick, add the specified fluid through the dipstick hole. Do not overfill.

4. Install the dipstick, hand tighten the T-handle to seat the O-ring. Do not overtighten.



Typical ZF Marine Transmission

- **a -** Dipstick
- **b -** O-ring
- **c -** Dipstick hole
- **d -** Full mark
- **e -** Add mark

Checking While Engine is Cold

NOTE: *Cold Fluid Level Check: To ease checking the fluid level, the dipstick can be marked or scribed with a cold level mark.*

1. Follow the procedure for the warm fluid level check, then allow the boat to sit overnight.
2. Remove the dipstick, wipe clean and reinsert.
3. Remove the dipstick, observe the fluid level and mark the cold fluid level.
4. Install the dipstick, hand tighten the T-handle to seat the O-ring. Do not overtighten.

Transmission Fluid

Model	Capacity	Fluid Type
63A	4.3 L (4.5 US qt)	Dexron III Automatic Transmission Fluid
63V	4.3 L (4.5 US qt)	
80A	5.7 L (6 US qt)	

Changing

Refer to **Transmission**.

Closed Cooling System

Coolant Requirement

NOTICE
Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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

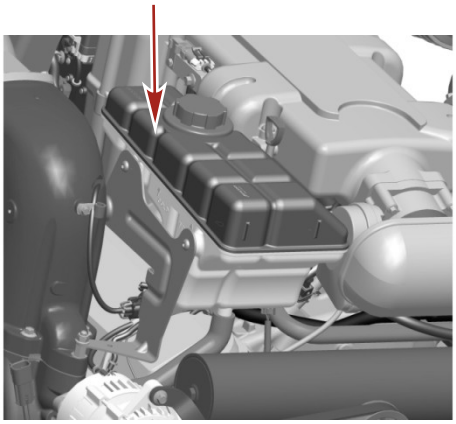
Checking Coolant Level

⚠ CAUTION

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

IMPORTANT: Tighten the pressure cap securely.

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



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Coolant recovery bottle

Filling the Closed Cooling System

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

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

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 approximate.*

Model	8.2
Closed cooling system	14.3 liters (15 qt.)

⚠ CAUTION

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

IMPORTANT: 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.

NOTICE

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

5. Supply cooling water to the engine.
6. 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.

⚠ CAUTION

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

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

Refer to specific instructions and warnings accompanying your battery. If this information is not available, observe the following precautions when handling a battery.

⚠ WARNING

Recharging a weak battery in the boat, or using jumper cables and a booster battery to start the engine, can cause serious injury or product damage from fire or explosion. Remove the battery from the boat and recharge in a ventilated area away from sparks or flames.

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

Multiple EFI Engine Battery Precautions

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for 2 different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself, and the engine will operate normally. The ECM shuts off and resets itself so quickly that the engine may only seem to have an ignition miss.

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's ECM has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is operating off of its own battery. Do not operate engines with switches in both or all position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

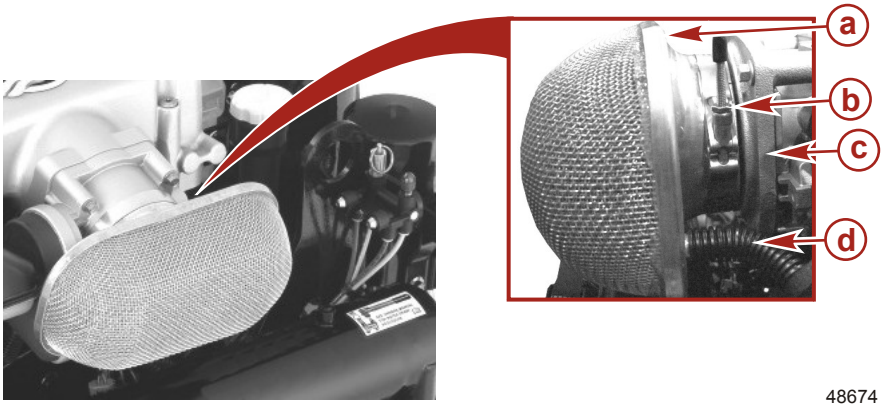
Generators: The generators battery should be considered another engine's battery.

Cleaning the Flame Arrestor

⚠ WARNING

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

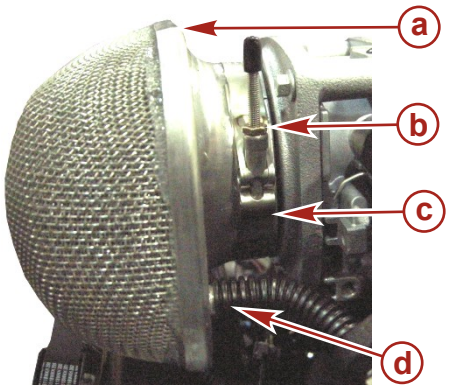
1. Remove the vent hose from the flame arrestor.
2. Loosen the flame arrestor clamp nut.
3. Pull the flame arrestor from the throttle body.



48674

a - Flame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

4. Clean the flame arrestor with solvent and dry with compressed air or set aside and allow to air dry completely.
5. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
6. Push the flame arrestor onto the throtte body.
7. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.
8. Tighten the clamp to specification. Do not overtighten the clamp.



48442

a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

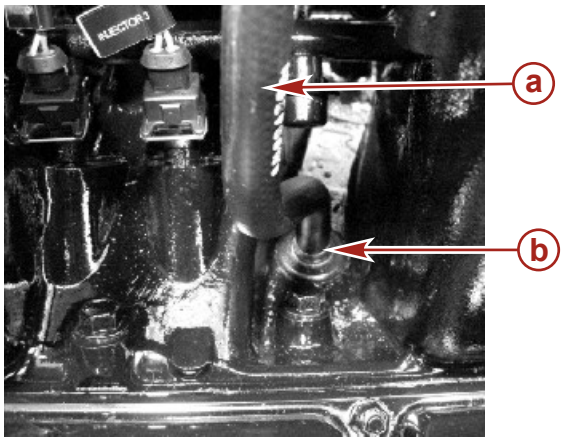
Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

9. Install the vent hose to the bib fitting.

Changing the Positive Crankcase Ventilation (PCV) Valve

This engine is equipped with a positive crankcase ventilation (PCV) valve . We recommend changing it every 100 hours of operation or at least once a year, whichever occurs first.

1. Pull the PCV valve out of the intake manifold and remove the PCV valve from the hose.



a - Hose from plenum to PCV valve
b - PCV valve

43215

2. Inspect the PCV valve and replace if necessary.
3. Install the PCV valve into the intake manifold.
4. Ensure that the PCV valve is tightly seated into the intake manifold.

We recommend the use of Mercury MerCruiser replacement parts.

Water-Separating Fuel Filter

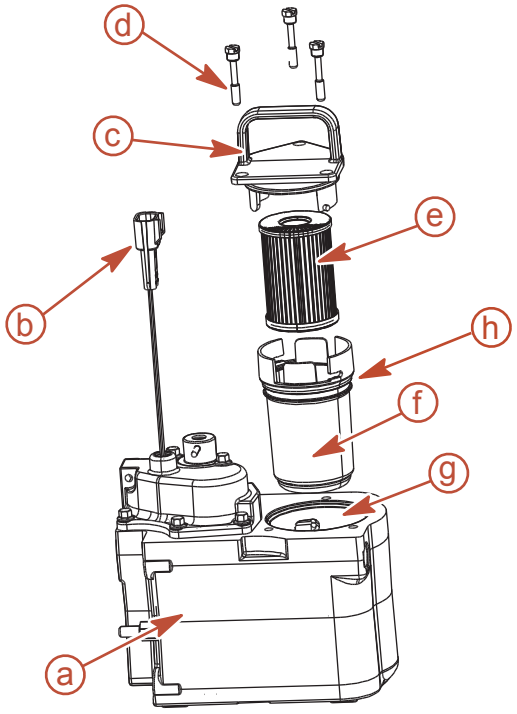
⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

GEN III Models



8837

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

Removal

1. Allow the engine to cool down.
   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*
2. Close fuel supply valve, if equipped.
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 5 seconds.
5. Turn key switch to off position.
6. Loosen each filter assembly retaining screw until the screw is 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 remove the filter assembly from the Cool Fuel Module at this time.
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 in a clockwise direction 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 that may be in the filter cup.

Installation

1. Install a new water-separating fuel filter element into the filter cup. Push the element into the cup until completely seated.
2. Install new O-ring on the filter cup.
3. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction while holding the filter cup stationary, until the filter cap locks securely into place.
4. 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.
5. 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	–

6. Open fuel supply valve, if equipped.

7. Reconnect the Cool Fuel Module harness to the engine wiring harness.
8. Properly ventilate the engine compartment.

NOTICE

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

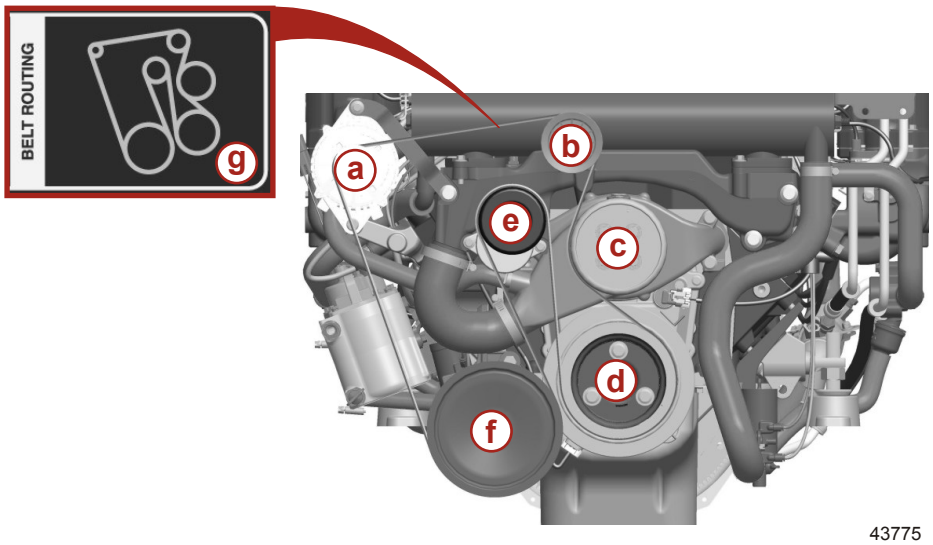
9. Supply cooling water to the engine.
10. Start the engine. Check for gasoline leaks around the fuel filter assembly. If leaks exist, stop the engine immediately. Recheck the filter installation, clean spilled fuel and properly ventilate the engine compartment. If leaks continue, stop the engine immediately, locate the cause, and repair as required.

Serpentine Drive Belt

Inspection

⚠ WARNING

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



- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

Checking

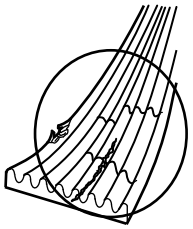
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.



21062

Replacing

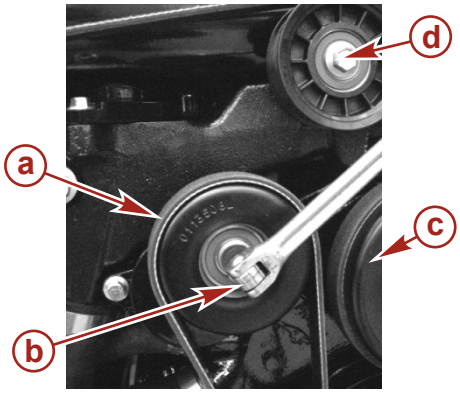
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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

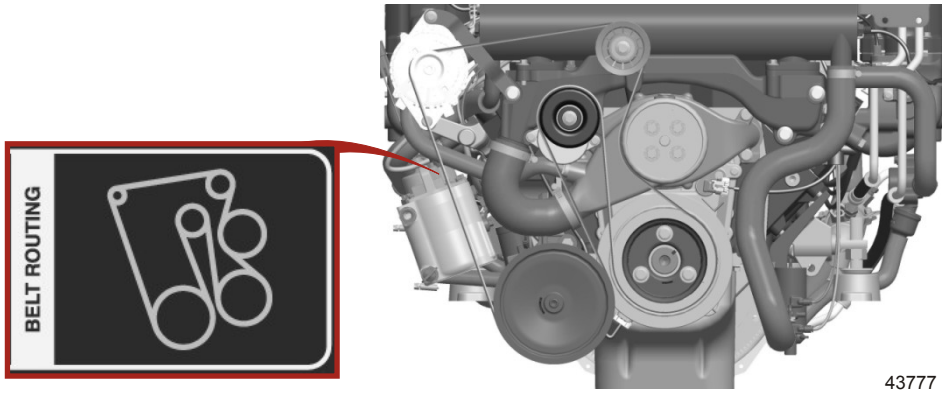


43776

a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

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



43777

Description	
Deflection	13 mm (½ in.)

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: We recommend flushing after each outing in salty, brackish, mineral-laden, or polluted water and before cold weather and extended storage.

⚠ WARNING

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

1. 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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 power packages operated in salty, brackish, mineral-laden, or polluted water:* Continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to idle speed position.
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: We recommend flushing the engine after each outing in salty, brackish, mineral-laden, or polluted water and before cold weather and extended storage.

NOTICE

Disconnecting the seawater inlet hose will cause water to enter the bilge resulting in engine damage. Close the seacock before disconnecting the seawater inlet hose. Plug the seawater inlet hose immediately after disconnecting it.

1. Close the seacock, if equipped, then disconnect 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.

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. 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.

NOTICE

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

7. Depress the throttle-only button and slowly advance the throttle until the engine reaches 1300 RPM (± 100 RPM).
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 power packages operated in salty, brackish, mineral-laden, or polluted water:* Continue to operate the engine until the discharge water is clear.
11. Slowly return the throttle to idle speed position.
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.

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 temperatures IS NOT covered by the Mercury MerCruiser Limited Warranty.

NOTICE

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

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

IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the 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.

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. Check the antifreeze concentration. Refer to the **Specifications** section.
3. 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 Mercury/Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to **Fuel Requirements** for additional information.
4. Flush the cooling system. Refer to the **Maintenance** section.
5. Supply cooling water to engine. Refer to the **Maintenance** section
6. Operate the engine sufficiently to bring it up to normal operating temperature and allow fuel with Mercury/Quicksilver Gasoline Stabilizer to circulate through the fuel system. Shut off the engine.
7. Change the oil and oil filter.
8. Prepare the engine and fuel system for storage. See **Engine and Fuel System Preparation**.
9. Drain the engine seawater cooling system. See **Draining the Seawater System**.

NOTICE

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

10. For additional assurance against freezing and rust, after draining, fill the seawater 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.
11. Store the battery according to the manufacturer's instructions.

Engine and Fuel System Preparation

⚠ WARNING

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

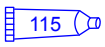
⚠ WARNING

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

NOTICE

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

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

Tube Ref No.	Description	Where Used	Part No.
	Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-858026K01
	Fuel System Treatment & Stabilizer	Fuel system	92-8M0047932

2. Allow the engine to cool.
   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 five minutes.
6. After the specified operating time is complete, slowly return the throttle to idle and shut the 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. Refer to **Section 5**.

Draining the Seawater System

⚠ CAUTION

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

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

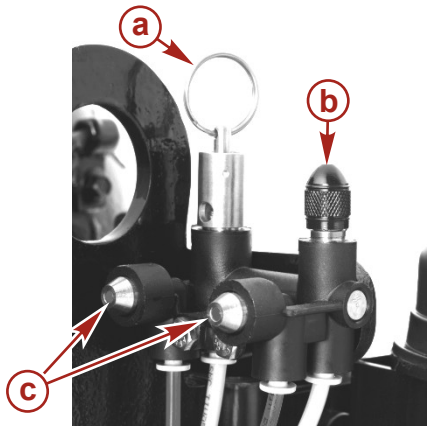
IMPORTANT: The boat must be as level as possible to ensure complete draining of the cooling system.

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.
IMPORTANT: Mercury MerCruiser requires that propylene glycol antifreeze, mixed to the manufacturer's instructions, be used in the seawater section of the cooling system for freezing temperatures or extended storage. 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.

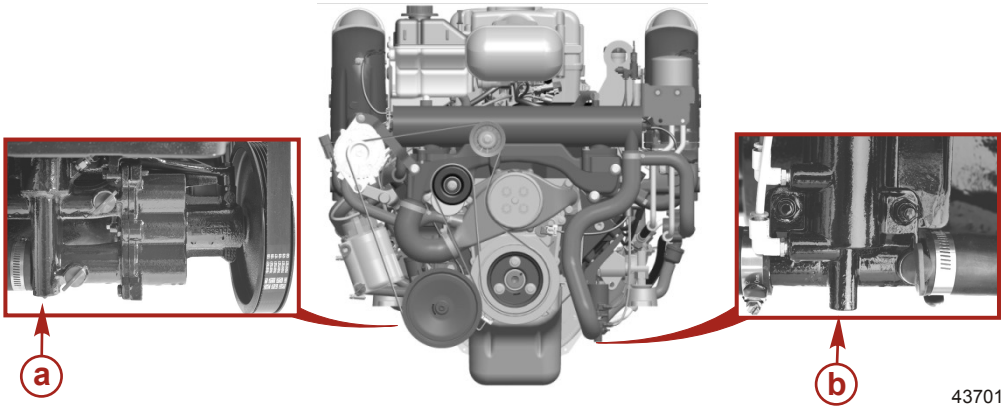
Drain System Identification

Air Actuated Single Point Drain System



43070

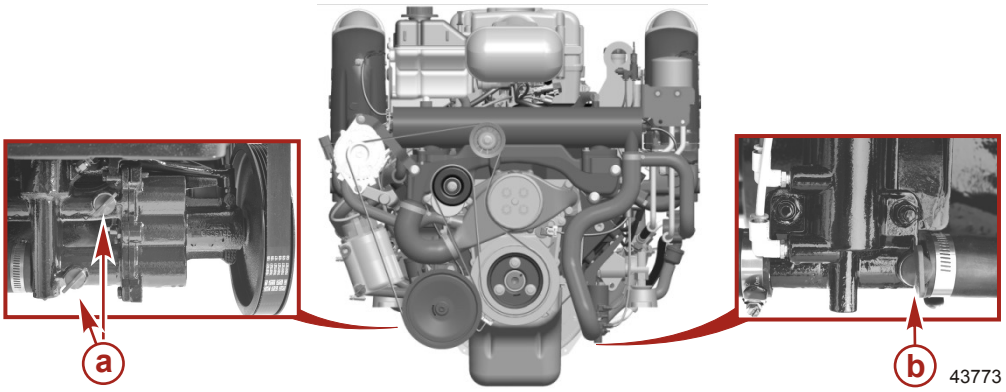
- **a -** Manual pressure release valve
- **b -** Threaded cap for air connection
- **c -** Green indicators



43701

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

Manual Drain System



43773

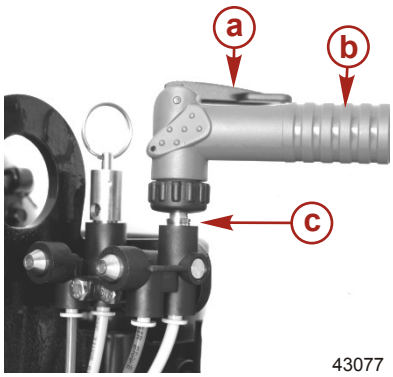
- **a -** Starboard side blue drain plugs
- **b -** Port side blue drain plug

Air Actuated Single Point Drain System

Boat in the Water

NOTE: *This procedure is written for the air pump that was shipped with the engine from the factory. However, any air source can be used.*

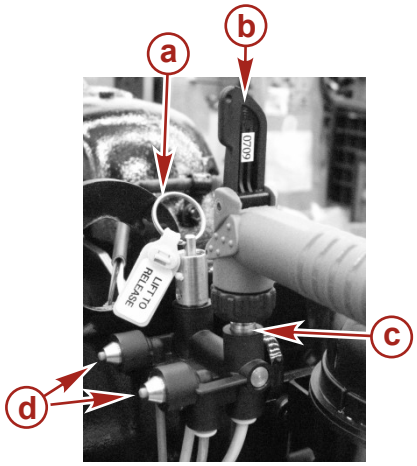
1. Close the seacock (if equipped) or remove and plug the water inlet hose.
2. Obtain the air pump.
3. Remove the threaded cap from the air connection.
4. Ensure that the lever on top of the air pump is against the handle (horizontal).
5. Install the air pump on the air connection.



43077

a - Lever
b - Air pump
c - Air connection

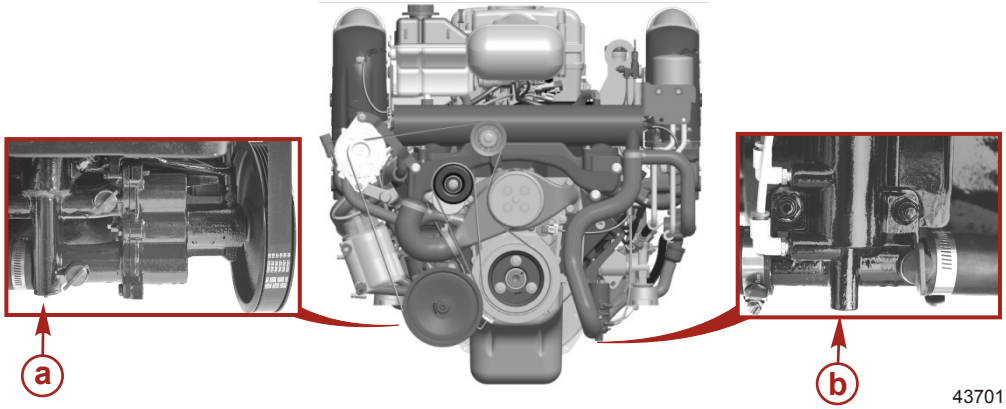
6. Pull the lever on the air pump (vertical) to seal the pump to the connection.
7. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

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

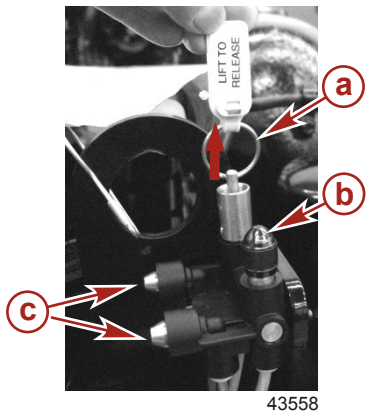


43701

a - Starboard side air actuated drain location
b - Port side air actuated drain location

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

10. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
11. Crank the engine over slightly with the starter motor to purge any water trapped in the seawater pump. Do not allow engine to start.
12. Remove the air pump from the air connection and return it to the mounting bracket.
13. 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.
14. Before launching the boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.



43558

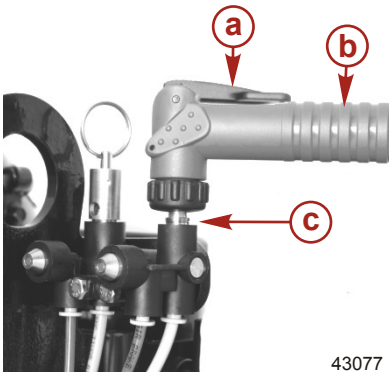
a - Manual release valve pull ring
b - Threaded cap on air connection
c - Green indicators

15. 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 and ensure the boat is level.
2. Obtain the air pump.
3. Ensure that the lever on top of the pump is flush with the handle (horizontal).
4. Install the air pump on the air connection.

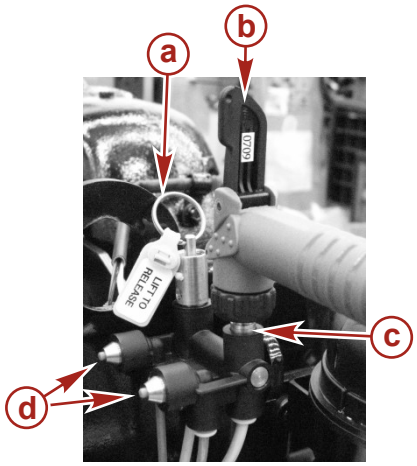


43077

a - Lever
b - Air pump
c - Air connection

5. Pull the lever on the air pump (vertical) to seal the pump to the air connection.

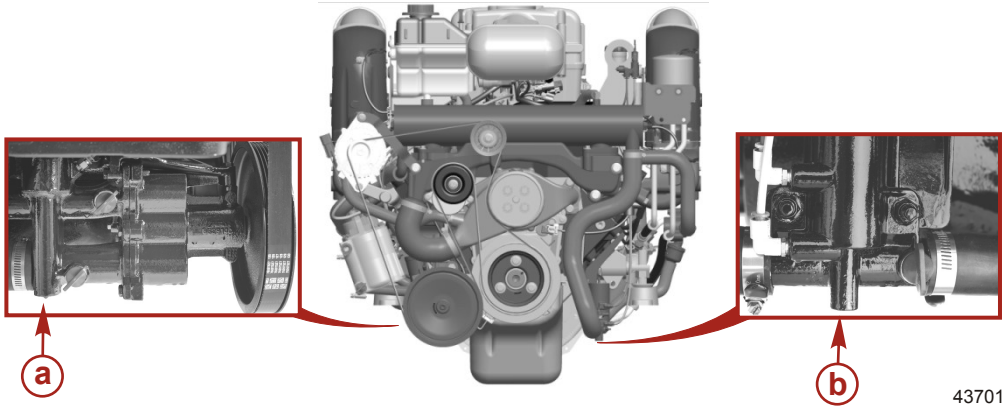
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



43557

a - Manual release valve
b - Air pump lever (locked)
c - Air connection
d - Green indicators extended

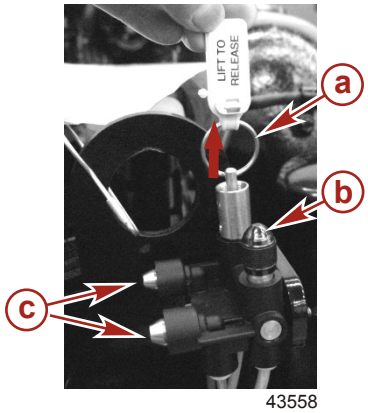
7. Verify that water is draining from each opening. If not, use the **Manual Drain System** instructions.



43701

a - Starboard side air actuated drain location
b - Port side air actuated 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.



43558

a - Manual release valve pull ring
b - Threaded cap
c - Green indicators

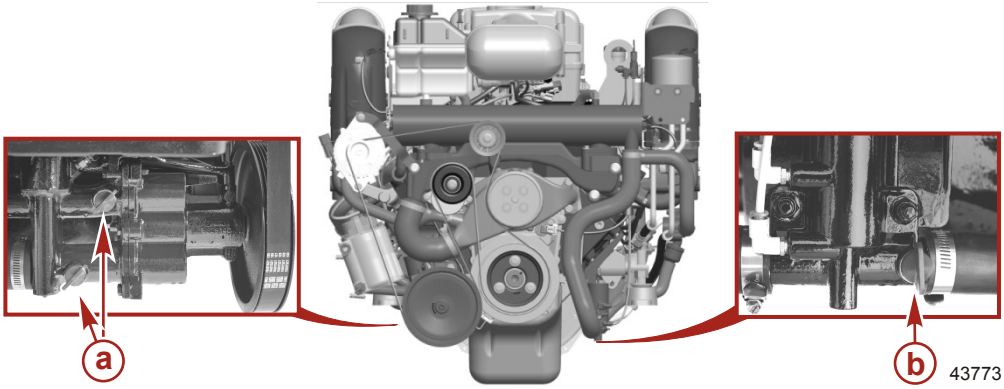
Manual Drain System

Boat in the Water

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

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

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



a - Starboard side blue drain plugs
b - Port side blue drain plug

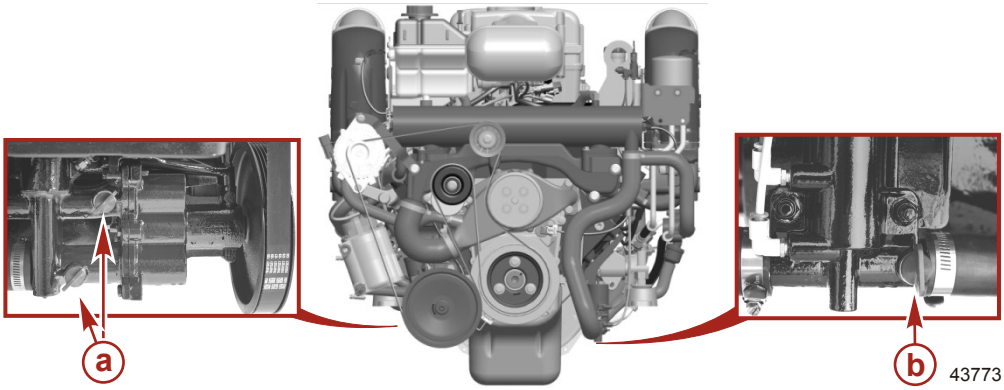
3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance to ensure that all water is drained.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. 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 lever surface to ensure complete draining of the system.
2. Remove two blue drain plugs from the seawater pickup pump (front, starboard side).



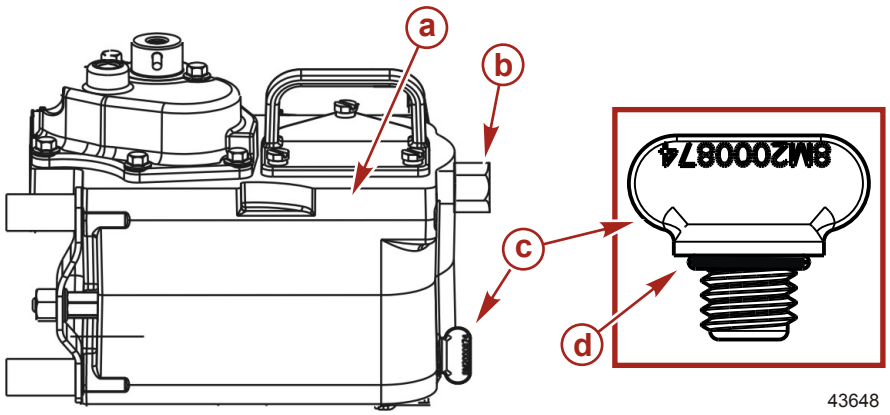
a - Starboard side blue drain plugs
b - Port side blue drain plug

3. Verify that water is draining from each opening.
4. Allow the system to drain for a minimum of five 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.
5. For DTS engines, pull the lanyard stop switch (if equipped), or disable the ignition circuit by pulling the fuse marked "CD".
6. 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.
7. Prior to launching the boat or starting the engine, close the drain system by installing the two blue drain plugs.

Draining Water From the Gen III Cool Fuel Module

Mercury MerCruiser recommends draining the Gen III Cool Fuel module if it is equipped with a drain plug.

1. Remove the drain plug from the Gen III Cool Fuel module and allow the water to completely drain from the module.
2. Inspect the drain plug and the O-ring for damage. Replace if needed.
3. Place the O-ring on the drain plug and install the drain plug in the module drain hole. Tighten the drain plug to finger tight.



a - Gen III Cool Fuel module
b - Fuel inline fitting
c - Drain plug
d - O-ring

Battery Storage

Whenever the battery will be stored for an extended period of time, be sure the cells are full of water and the battery is fully charged and in good operating condition. It should be clean and free of leaks. Follow the battery manufacturer's instructions for storage.

Recommissioning the Power Package

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

⚠ CAUTION

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

2. Install a fully charged battery. Clean the battery cable clamps and terminals and reconnect cables. 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 **Operation Chart**.

NOTICE

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

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

Notes:

Important Information

Section 1D - Troubleshooting

1 D

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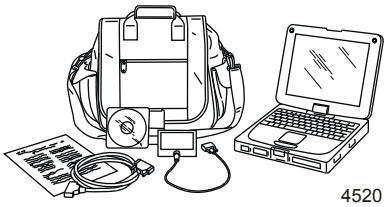
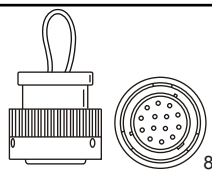
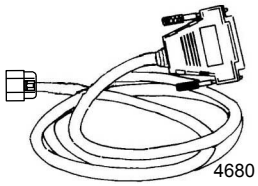
Special Tools

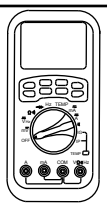
Computer Diagnostic System (CDS)	Order through SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA -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

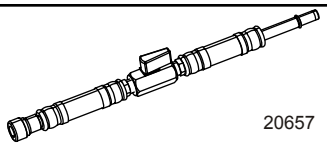
CDS G3 Diagnostic Interface Tool With Harness	8M0046124
41993	Provides diagnostic support for the Computer Diagnostic System.

Terminal Test Probe Kit	SPX P/N MM-46523
7915	Test probes adapt test meter leads to harness connections without damaging harness terminals. May be used with Computer Diagnostic System (CDS).

12 Volt Shunt Connector	889675A01
 8036	Connects to data harness allowing operation of the DTS system with the Digital Diagnostic Terminal.

Can 1 Diagnostic Cable	84-892663
 4680	Connects into a junction box or male to male adapter cable for Command Module configuration. Not for use with DDT.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Fuel Shut Off Tool	91-805918A 1
 20657	Used to perform fuel system pressure tests.

Finding Other Diagrams

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

Audio and Visual Warning System

Warning Horn

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem. Refer to **Section 4D: Audio and Visual Warning System**.

There are three warning horn states:

- Caution
- Severe
- Onboard Diagnostic Marine (OBDM) fault (not available for non-emissions controlled engines)

Visual Warning

An emissions controlled Mercury MerCruiser power package is required to have a visual warning system installed to be compliant with the EPA and CARB regulations. This Onboard Diagnostic Marine (OBDM) visual warning activates for faults related to emissions or fuel systems. Refer to **Section 4D: Audio and Visual Warning System**.

DTS Diagnostics

DTS Statement

Refer to the **Mercury MerCruiser PCM 09 Diagnostic Service Manual** for troubleshooting DTS engines.

General Information

NOTE: *All of the following are determined by the calibration of the PCM. Upgrading the calibration can result in changes to these settings.*

Default Sensor Values

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

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

Most pressure sensors default to a preprogrammed number also. MAP sensors usually default to 100 kPa (29.5 in. Hg). This can be verified by unplugging the sensor in question and watching the data stream value. Other pressure sensors will have their own default values which may be determined as described previously.

Fault Conditions

Most faults can be detected with the engine running, or key-on, engine off. However, some faults require the presence of engine RPM, and cannot be detected key-on, engine off. Examples of this type of fault are EST (cylinders 1 through 8) shorted circuit and all injector faults (fuel and direct).

Some faults are only detected in the key-on, engine off mode. Examples of the type of fault would be EST (cylinders 1 through 8) open circuit.

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

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

Sticky/Non-Sticky Faults

All faults are classified as either sticky or non-sticky.

Sticky means that the fault, once set, will continue to show up as active, even if the circuit or problem has corrected itself. A key switch cycle is required to reset a sticky fault. The CDS G3 will continue to display a sticky fault as active, even though the cause of the fault has been corrected. Cycle the key to reset all faults if there is difficulty correcting a fault. Some faults may require up to 3 running (90 seconds minimum) cycles of key on then key off, waiting 60 seconds between key cycles.

A non-sticky fault is a fault that will change it's status from active to inactive without requiring a key switch cycle.

Engine Guardian

Engine Guardian reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Below are some examples of what Engine Guardian monitors:

- Oil pressure
- Engine overspeed
- Exhaust manifold temperature
- Seawater pressure
- Coolant temperature
- Transmission pressure

IMPORTANT: Guardian can reduce power anywhere from 100% to idle, depending on the severity of the problem. If forced to idle, boat speed might not respond to throttle operation.

Computer Diagnostic System (CDS) G3

Models Covered	Serial Number Range
Models with Emissions Control	All

Mercury Marine is pleased to announce that it has developed a PC-based diagnostic tool kit to enhance and supplement the Mercury Computer Diagnostic System (CDS). The new program, CDS G3, runs efficiently on any of the CDS computers sold through SPX. CDS G3 and the current version of CDS are compatible with one another and can be installed on the same computer.

CDS G3 will complement the current version of CDS by providing diagnostic support for engines and Joystick Boat Control systems not covered by CDS. In its first release, CDS G3 will provide limited diagnostic coverage for the MerCruiser engines with Emissions Control (EC). Internet updates are planned to complete the diagnostic functionality for the EC product. Future updates on the Internet will provide support for additional engines and control systems.

CDS G3 presents an easy-to-use graphical interface with a fresh new design and appearance. The first release will provide the following electronic data:

- **Configuration:** Provides a means for configuration of the Axius electronic steering system, Axius and standard DTS helm stations, Axius electronic compasses and all CAN-based (controller-area network) TrackPads.
- **Module Data:** Provides detailed information on each module on the SmartCraft CAN-bus. Data will include, but is not limited to: software and calibration IDs, city IDs (electronic addresses), module status and module quantity.
  - **Fault Status:** Displays the active and historic faults (trouble codes) available from each module, as well as freeze frame buffers where applicable.
  - **Data Stream:** Displays sensor values, ECU (engine control unit) calculations, actuator information and other important information.
- **Active Tests:** Allows the technician to set and adjust ECU parameters and control ECU outputs. These types of functions help the technician to quickly configure product for delivery, as well as providing powerful functions that will enhance the diagnostic experience.

The current version of CDS continues to be offered through SPX in several configurations: software-only, on a Dell laptop, or on a Panasonic ToughBook. Basic and deluxe versions of the kits are available for both laptop brands. Electronic service manuals will continue to be hosted by the current version of CDS. For more information, visit http://mercurymarinecds.spx.com/ (Europe: http://www.spxeurope.com/index.php?id=260).

At this time, English is the only language available for the CDS G3 program. Additional languages are planned for future updates. CDS G3 will require a new interface cable, which will be available for purchase from Mercury Marine Parts and Accessories. The CDS G3 program is included with the cable. The interface cable will provide communication with two separate SmartCraft CAN-bus networks and connects to a standard SmartCraft 10-pin junction box-style connector.

Connection points are made at the engine or the helm. Regardless of connection point, proper CAN bus termination must be maintained. When removing a termination resistor to allow connection of the interface cable, use adapter harness part number 8M0045065, which is provided in the kit and has a termination resistor. This adapter harness must be used when connecting to the CAN P connection on the engine wire harness where the termination resistor has been removed.

The interface cable may be extended by using a suitable yellow 10-pin SmartCraft data cable. On EC product only, you may use either yellow or blue 10-pin SmartCraft data cables. Proper termination must be maintained when using any extension.

Minimum Computer Specifications for CDS and CDS G3

Requirement	Note
1.2 GHz Pentium processor	Or equivalent
2 GB RAM	4 GB or higher recommended
120 GB hard drive	A 40 GB minimum hard drive is recommended if installing all of the electronic service manuals and the Electronic Parts Catalog.
Integrated 9-pin RS-232 serial port	
Graphics 1024 × 768 display	The graphics resolution requirement for the current version of CDS was originally 800 × 600. The specification for CDS G3 (and recommended for current CDS) is 1024 × 768.
USB 2.0 port	
DVD-ROM optical drive	
PCMCIA card slot	
Windows XP Professional, Service Pack 3 (Recommended OS is Windows 7 Professional)	Earlier version of Windows XP can be upgraded through Windows or Microsoft Update.

Operating System Requirements

The CDS G3 program will work on all CDS computer systems sold through SPX Corporation. If you purchased a CDS kit with a Dell or Panasonic computer before September 2004, your computer was shipped with the Windows 2000 operating system. Because G3 requires Windows XP, Service Pack 3, it is necessary to update the operating system on these computers. As originally planned, computers purchased with CDS kits from SPX are licensed for Windows 2000 and Windows XP. Through an agreement with Dell, Panasonic, and Microsoft, these computers have a Windows XP certificate of authority and were "downgraded" from Windows XP to Windows 2000 at SPX. SPX shipped these early Dell and Panasonic computers with special Windows 2000 recovery CDs that would return the computer to its original setup (as it left SPX). SPX also included the Windows XP recovery discs that were supplied by Dell or Panasonic. These discs will return the computer to its original Dell or Panasonic factory setup with Windows XP. These discs will be needed to upgrade the operating system to Windows XP.

NOTE: *The Windows 2000 downgrade process remained in effect from the original release of CDS through CDS Version 3.23. Starting with CDS Version 4.18, CDS became compatible with Windows XP. At that time (September of 2004), SPX stopped the downgrade process and began shipping computers (Dell, HP, or Panasonic) with their original Windows XP operating system intact. If you are currently using an SPX computer with the Windows 2000 operating system, watch for future communications detailing the Windows XP upgrade process. Now is a good time to locate the Windows XP recovery CDs that were shipped with your CDS kit.*

IMPORTANT: Restoring the computer to the original factory setup will result in the loss of all data and programs stored on the hard drive. Before restoring the computer to its original factory setup, follow the kit instructions concerning backup of all data and having program discs available.

Special Tools - DTS Troubleshooting

NOTE: *The CDS G3 service tool is software that is designed for use on products using PCM-09 and above, and all engines equipped with emissions control. G3 is also required for Axius. All communications to the computer are through a smartcomms cable. You must install special CDS G3 software to the CDS laptop and have access to the internet to use G3 software. Contact your Product Integration Engineer (PIE) or Technical Account Manager (TAM) for assistance.*

Computer Diagnostic System (CDS)	Order through SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124
Terminal Test Probe Kit	SPX P/N MM-46523
12 Volt Shunt Connector	889675A01
Can 1 Diagnostic Cable	84-892663

DMT 2004 Digital Multimeter	91-892647A01
CAN P Diagnostic Cable	84-892663
Fuel Shut Off Tool	91-805918A 1

Precautions

⚠ WARNING

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

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

NOTICE

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

⚠ WARNING

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

NOTICE

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

NOTICE

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

NOTICE

Flushing the engine when it is not operating will result in water collecting in the exhaust system, damaging the engine. Do not supply flush water for more than 15 seconds without the engine operating.

⚠ WARNING

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

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 G3 (Computer Diagnostic System), or a diagnostic tool. If faults are present, correct the fault before proceeding.

   NOTE: *The tool Computer Diagnostic System (CDS G3) procedural information is available in the* ***Mercury MerCruiser PCM 09 Diagnostic Service Manual****.*

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
Computer Diagnostic System (CDS)	Order through SPX

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. Disable the ignition system to prevent ignition of gasoline vapors.
6. 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 Clean power harness not connected.	**1.3** Connect the clean power harness.
	1.4 Water in the fuel.	**1.4** 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.
	1.5 Low grade or stale fuel.	**1.5** Drain the fuel tank and refill with fuel that is known to be fresh.
	1.6 Faulty fuel pump relay.	**1.6** Check the fuel pump relay.
	1.7 Slow cranking battery.	**1.7** Check the battery and battery connections.
	1.8 Vapor lock.	**1.8** 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

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

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 ETC.
	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.

Symptom	Cause	Action
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 G3) 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
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 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

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.
	2.6 Worn cylinder.	**2.6** Inspect the cylinder. Bore as necessary. Replace the cylinders if necessary.
3. Engine noise in camshaft area, front of the engine, timed to 1/2 engine speed.	**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.

Symptom	Action	Cause
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.

Symptom	Action	Cause
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

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 **Section 3 - On the Water**, in the **Operation Maintenance and Warranty Manual**.
	1.1 Water ingestion through the exhaust system.	**1.1** Verify the exhaust elbow height. Repair the exhaust system.
	1.2 Improper engine or exhaust hose installation.	**1.2** Check the engine installation specifications.
	1.3 Cracked exhaust manifold.	**1.3** Replace the exhaust manifold.
	1.4 Corroded exhaust elbow.	**1.4** Replace the exhaust elbow.
	1.5 Loose cylinder head bolts.	**1.5** Tighten the cylinder head bolts.
	1.6 Blown cylinder head gasket.	**1.6** Determine the cause of blown gasket and replace the gasket.
	1.7 Cracked valve seat.	**1.7** 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

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—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 shrader 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	91-805918A 1

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.

Removal and Installation

Section 2A - Sterndrive Models

2
A

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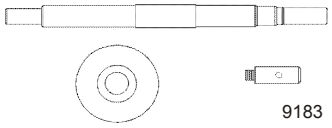
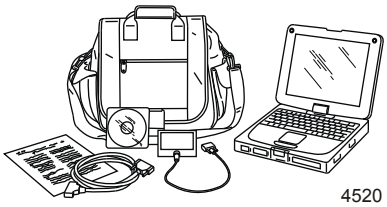
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Engine mounting hardware threads and nuts	92-34227Q02
25	Liquid Neoprene	All electrical connections	92- 25711 3
34	Special Lubricant 101	Rear engine mounting bolts	92-802865Q02
		Shift cable stud	
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally
91	Engine Coupler Spline Grease	Coupler splines	92-802869A 1

Special Tools

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

Computer Diagnostic System (CDS G3)	Order from SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System G3 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

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
41993	Provides diagnostic support for the Computer Diagnostic System.

CDS G3 Termination Harness	84-8M0045065
43351	Contains termination resistors to allow communication when G3 is connected to the engine's diagnostic connector.

Engine Removal

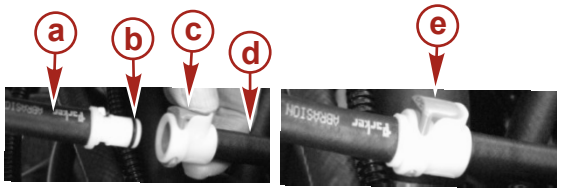
Removal

⚠ WARNING

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

IMPORTANT: The propellers and sterndrive must be removed prior to engine removal. Refer to the Mercury MerCruiser Bravo Sterndrive Service Manual.

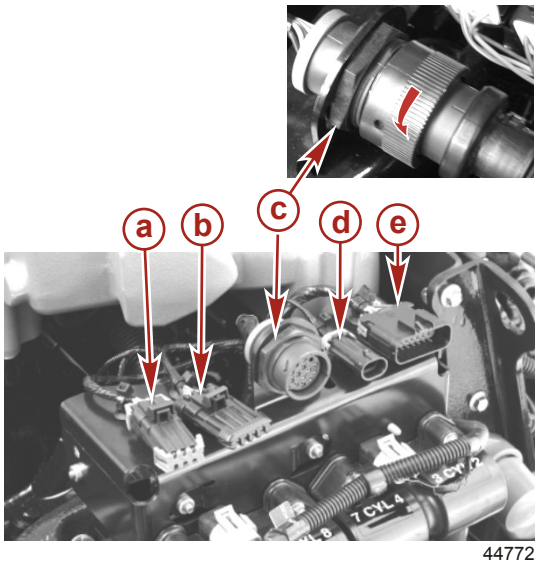
1. Remove the boat from the water.
2. Disconnect the negative (–) battery cable from the battery.
3. Disconnect the positive (+) battery cable and MerCathode controller positive wire from the battery.
4. Disconnect the battery isolator wires, if equipped.
5. Disconnect the gear lube monitor hose.



43559

a - Gear lube monitor hose assembly from transom
b - O-ring
c - Quick connect release
d - Gear lube monitor hose assembly from gear lube monitor
e - Connection secured

6. Remove the sterndrive. Refer to the **Mercury MerCruiser Bravo Sterndrive Service Manual**.
7. Disconnect the exhaust system hoses.
8. Disconnect the seawater inlet hose.
9. Disconnect the water heater lines, if equipped.
10. Disconnect the trim sender wire connections from the engine harness.
11. Disconnect the following connectors if applicable.
    a. Disconnect the boat harness from the engine harness. Turn the locking ring counterclockwise to release the thread engagement then pull the connection straight out.
    b. Disconnect the paddle wheel and tank level connector.
    c. Disconnect the power harness connector.
    d. Disconnect the transom harness connector.



44772

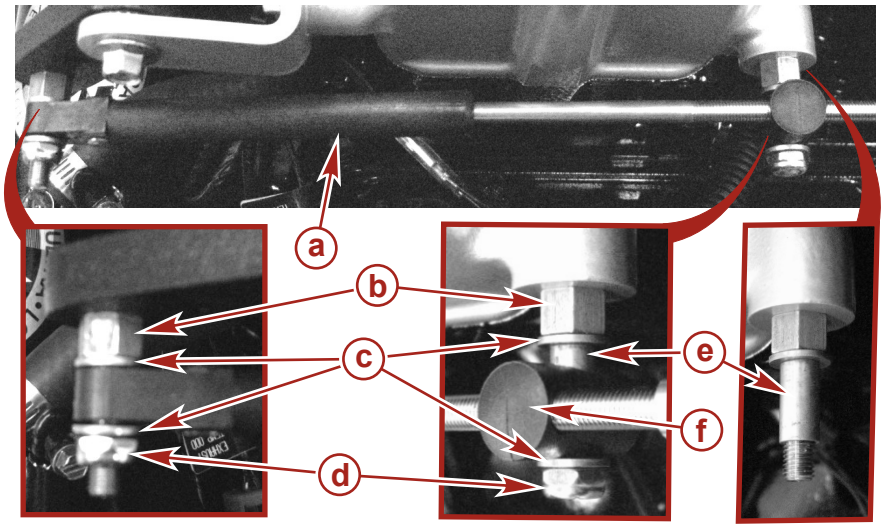
a - Paddle wheel and tank level connector
b - Diagnostic connector
c - Engine harness connector
d - Power harness connector
e - Transom harness connector

12. Close the fuel shut-off valve, if equipped.

⚠ WARNING

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

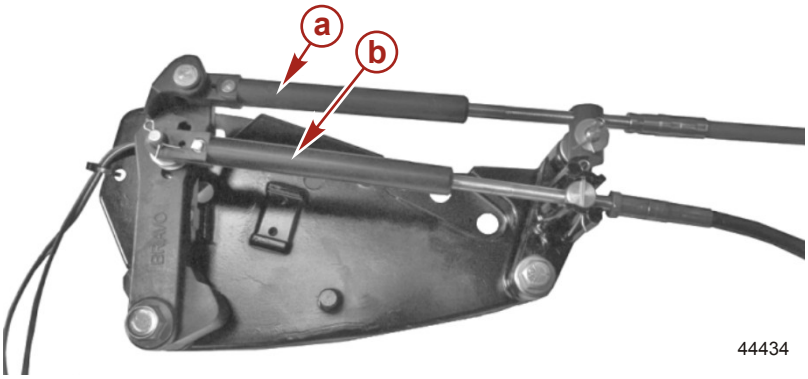
13. Disconnect and plug the fuel lines to prevent fuel from leaking into the bilge.
14. On non-DTS models, disconnect the throttle cable from the throttle body and retain the fasteners.



43159

a - Cable end guide
b - Hex spacer
c - Flat washer
d - Locknut
e - Sleeve
f - Barrel

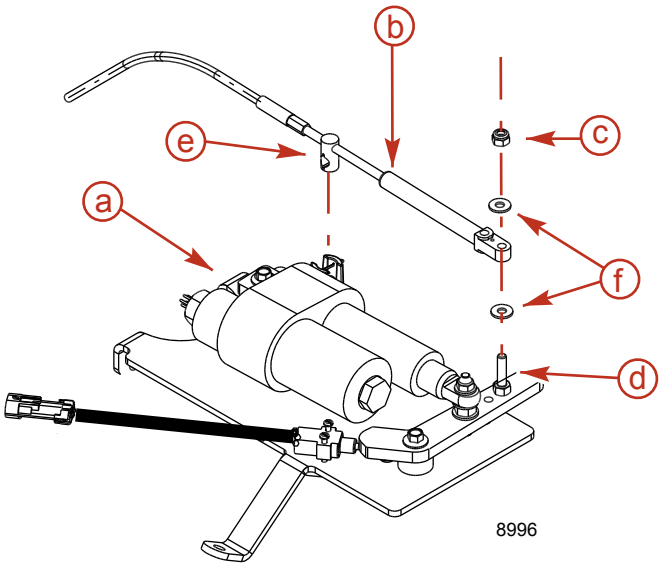
15. On non-DTS models, remove both of the shift cables from the shift plate. Retain the locknuts and hardware.



44434

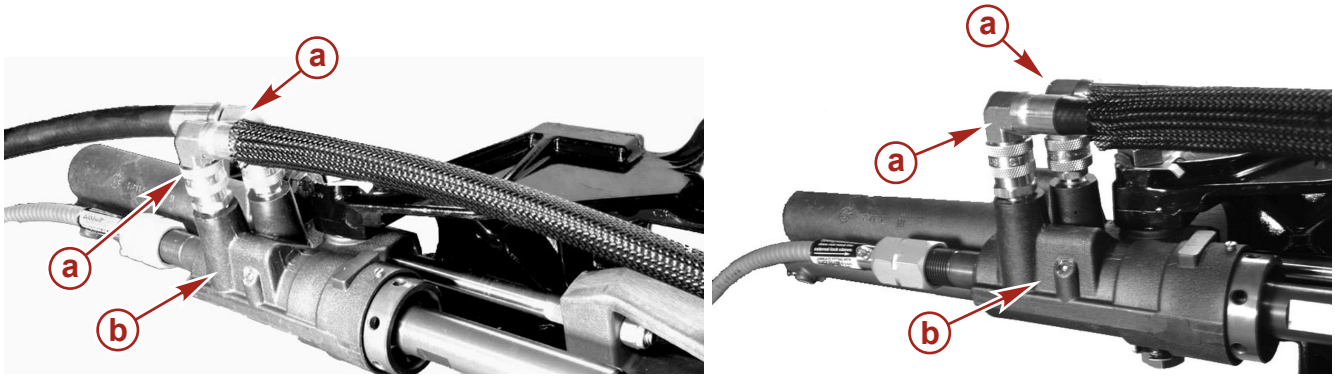
a - Remote control shift cable
b - Sterndrive intermediate shift cable

16. On DTS models, remove the sterndrive intermediate shift cable from the shift actuator on the engine. Retain the locknuts and hardware.



a - Shift actuator
b - Shift cable
c - Locknut
d - Shift cable stud
e - Shift cable barrel
f - Washers

17. Disconnect the power-assisted steering hydraulic hoses from the steering control valve and connect the hoses together to prevent leaking.



a - Hydraulic lines
b - Power-assisted steering control valve

18. If applicable, disconnect continuity wires and accessories that are connected to the engine.

⚠ CAUTION

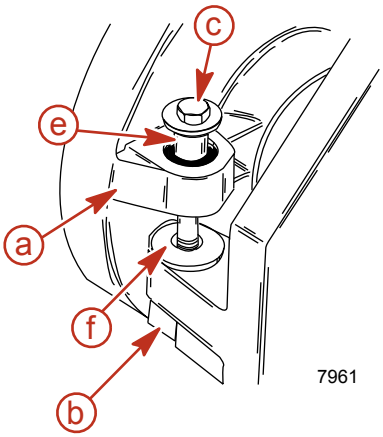
Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components.

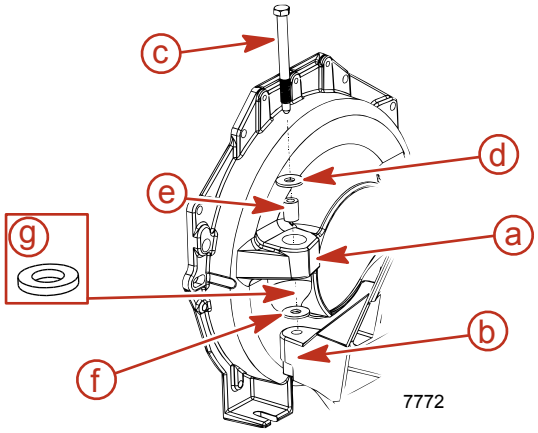
IMPORTANT: Do not allow the engine to rest on the oil pan.

19. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

a - Rear lifting eye
b - Front lifting eye

20. Remove and retain the rear engine mounting fasteners.

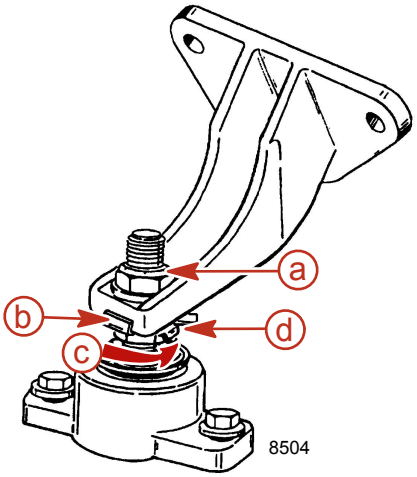




a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer
g - Stainless steel washer (optional spacer kit)

21. Remove and retain the starboard and port front engine mounting fasteners.

NOTE: *If the engine will be reinstalled you may want to leave the base on the stringer and only remove the top nut and locking washer.*



a - Nut and lockwasher
b - Tab washer
c - Direction (counterclockwise) to raise front of engine
d - Adjustment nut

22. Using an overhead hoist, carefully remove the engine. Do not damage the power-assisted steering control valve.

Emission-Related Instructions

Important Information

NOTICE
Failure to follow these instructions when installing a certified engine in a vessel violates U.S. federal law (40 CFR 1068.105[b]) and may result in fines or other penalties as described in the U.S. Clean Air Act.

Controlling Evaporative Emissions

Specific installation steps are required to control evaporative emissions. The installer and/or the vessel manufacturer must meet the requirements of EPA regulation 1045.112 and federal regulation 40 CFR part 1060.

Meeting Design Specifications

Other instructions to ensure that the engine will operate according to the manufacturer's design specifications are referenced in the Mercury MerCruiser installation manual provided with the product. Refer to:

1. **Section 3—Exhaust System.**
   - Important Information
   - Exhaust Recommendation
   - Exhaust Emissions
   - Measuring Exhaust Elbow Height
2. **Section 6—Drive System and Engine Mounting.**
   - Exhaust System Hose and Tube Connection

Emission Control Information Label

If you install the engine in a way that makes the engine's emission control information label difficult to read during normal engine maintenance, you must place a duplicate label on the vessel, as described in 40 CFR 1068.105.

Refer to **Section 1—Emission Control Information Label**.

Engine Installation

DTS System Installation Requirement

Due to updates on software and diagnostic tools we are not including this information in the service manual.

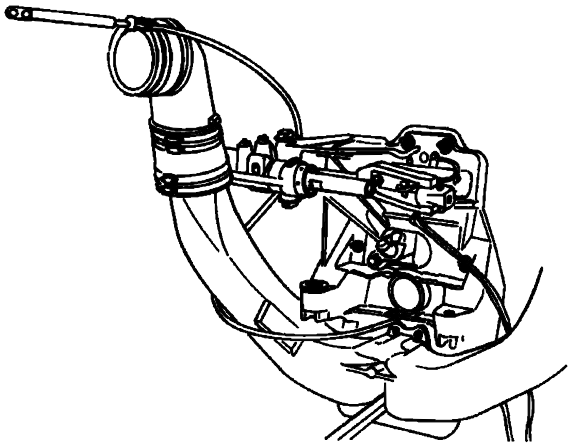
Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Shift Cable Routing

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.*

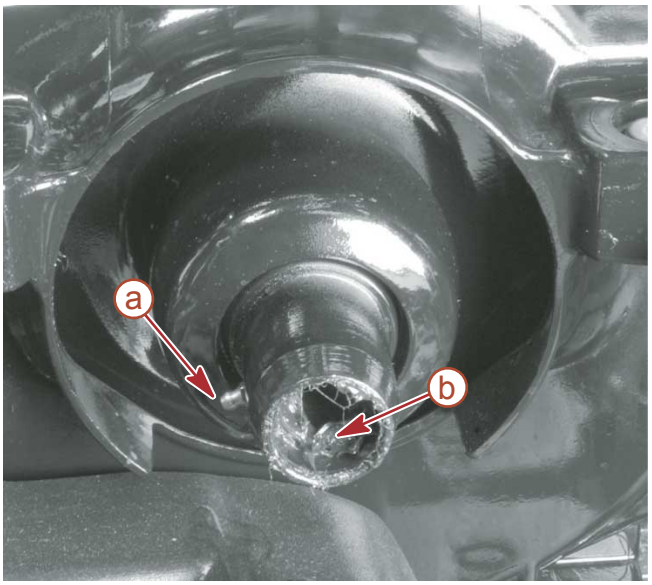


8995

Refer to **Section 8 - Remote Control**.

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.



12163

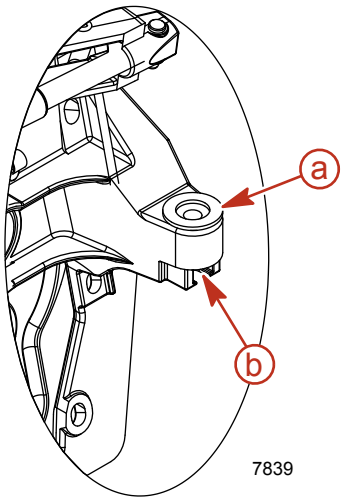
a - Grease fitting
b - Coupler splines

Tube Ref No.	Description	Where Used	Part No.
91	Engine Coupler Spline Grease	Coupler splines	92-802869A 1

NOTICE

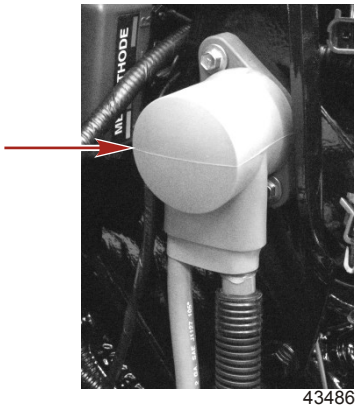
Mismatched flywheel housing mounts and inner transom plate mounting hardware will result in improper engine alignment and possible engine damage. Ensure that the flywheel housing mounts and the inner transom plate mounting hardware, port and starboard, are the correct parts and match before installing the engine.

3. Position rear engine mount attaching hardware on the inner transom plate mounts as shown.



a - Fiber washer (2)
b - Locknut (2)

4. Lay the battery cable over the top of the engine to prevent interference during installation.



IMPORTANT: Do not allow the engine to rest on the oil pan.

5. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

a - Rear lifting eye
b - Front lifting eye

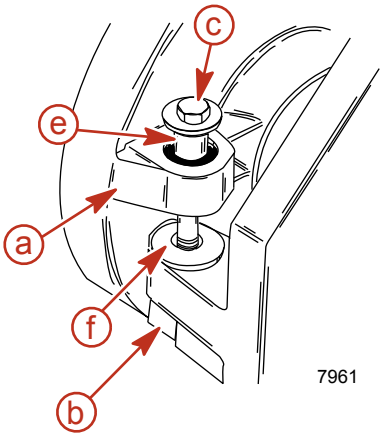
6. Lift the engine into position in the boat using an overhead hoist.
IMPORTANT: When lowering the engine into position. do not set the engine on the shift cable.
7. Ensure that the fiber washers and locknuts are on the inner transom plate mounts.
8. Align the rear engine mounts with the inner transom plate mounts, while simultaneously aligning the exhaust tube with the exhaust pipe bellows.
NOTE: *Do not use silicone on the exhaust tubes.*
9. To help with installation, apply lubricant into the exhaust tubes.

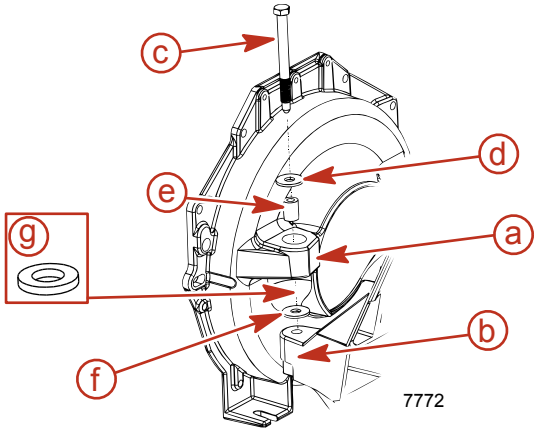
To help with installation, apply lubricant into the exhaust tubes.	Exhaust tubes	Part Number
Liquid Soap	Exhaust tubes	Obtain locally

10. Apply lubricant to the first 8 mm (1/4 in.) of the threads of the rear engine mounting bolts.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Rear engine mounting bolts	92-802865Q02

11. Install both rear engine mounting bolts and hardware. Relieve the hoist tension from the engine lifting eyes. Tighten the mounting bolts to specification.





a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer
g - Stainless steel washer (optional spacer kit)

Description	Nm	lb-in.	lb-ft
Rear engine mounting bolts	47	–	35

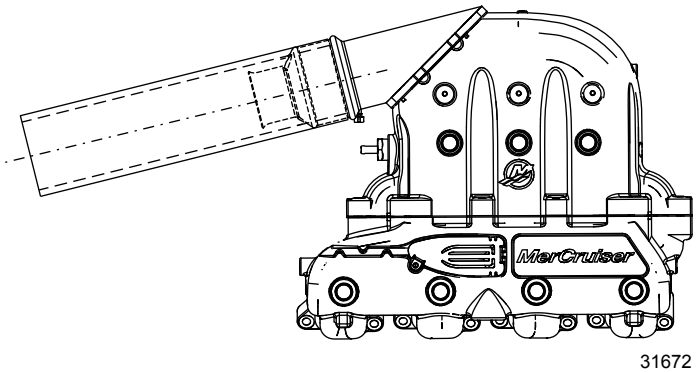
12. Set the engine on the front engine mounts and boat stringers.
13. Relieve the hoist tension.
14. Fasten both engine mounts to the boat stringers using the appropriate hardware.

NOTICE

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

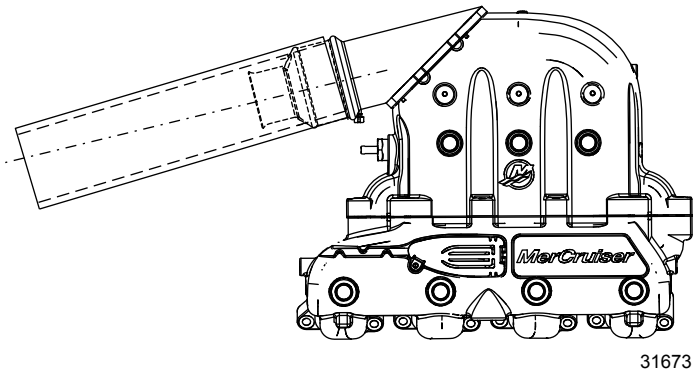
IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

15. Install the hoses on exhaust elbow outlets so the discharge water from the exhaust elbow flows around the entire inside diameter of the hose.



31672

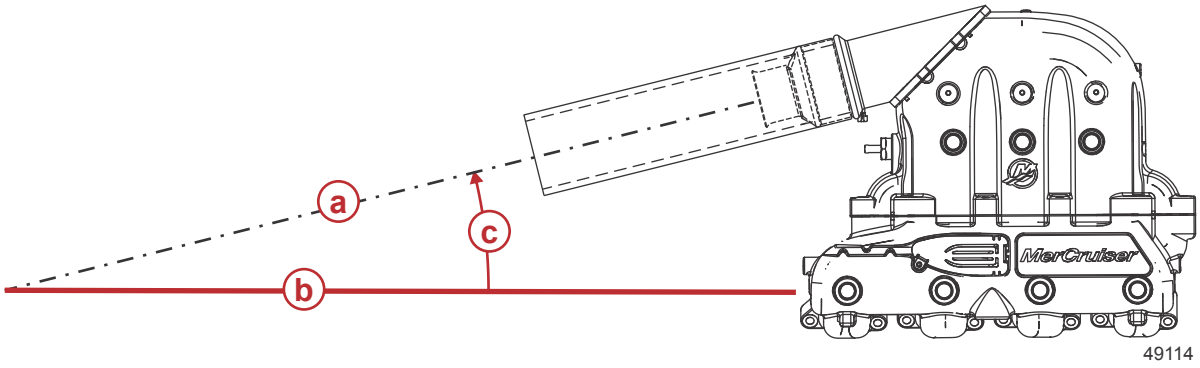
Correct alignment



31673

Incorrect connection

16. Install the exhaust hoses at the angle shown below. Doing so will avoid hot spots that can burn exhaust hoses.

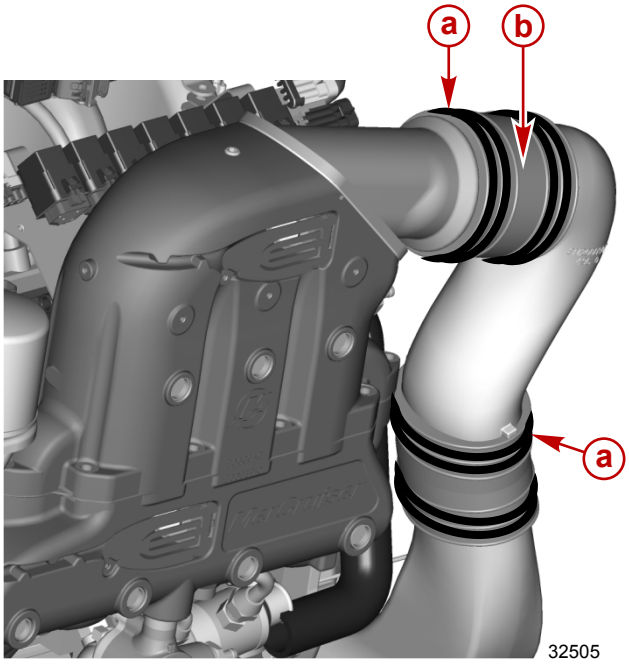


49114

a - Exhaust outlet centerline
b - Parallel with crankshaft centerline
c - Exhaust angle 14° ± 5°

17. Secure all exhaust hoses or tubes with at least two hose clamps. Tighten to specification.

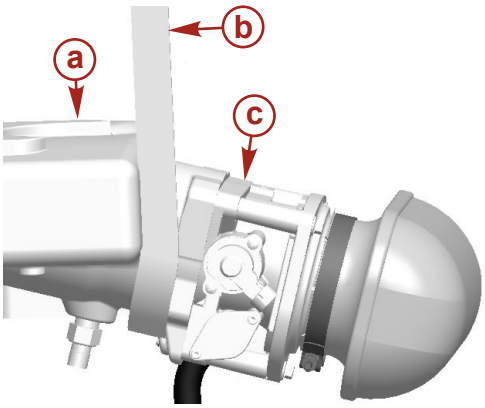
NOTE: The following example may not depict your model or installation.



a - Clamps
b - Exhaust tubes

Description	Nm	lb-in.	lb-ft
Exhaust hose clamps	3	28	–

18. Place a suitable polymer strap under the plenum behind the throttle body for assistance during engine alignment.



a - Plenum
b - Suitable polymer strap
c - Throttle body

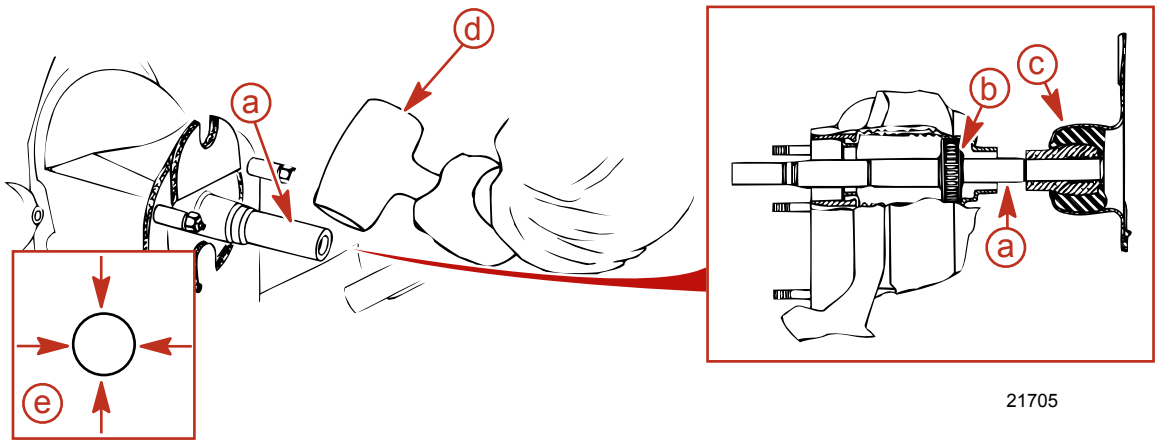
IMPORTANT: Alignment tools from other manufacturers may cause improper alignment and damage to the gimbal bearing or engine coupler. Use only the Quicksilver Alignment Tool.

NOTICE

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

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

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

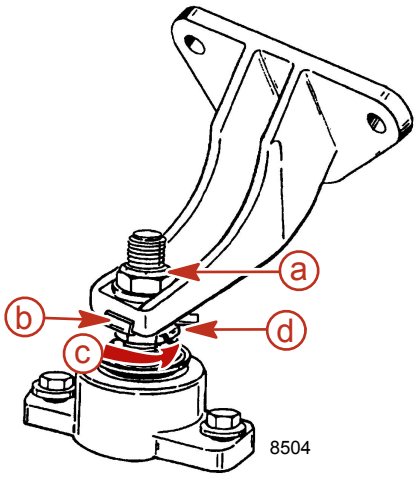


21705

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

Alignment Tool Assembly	91-805475A 1

21. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
22. 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.

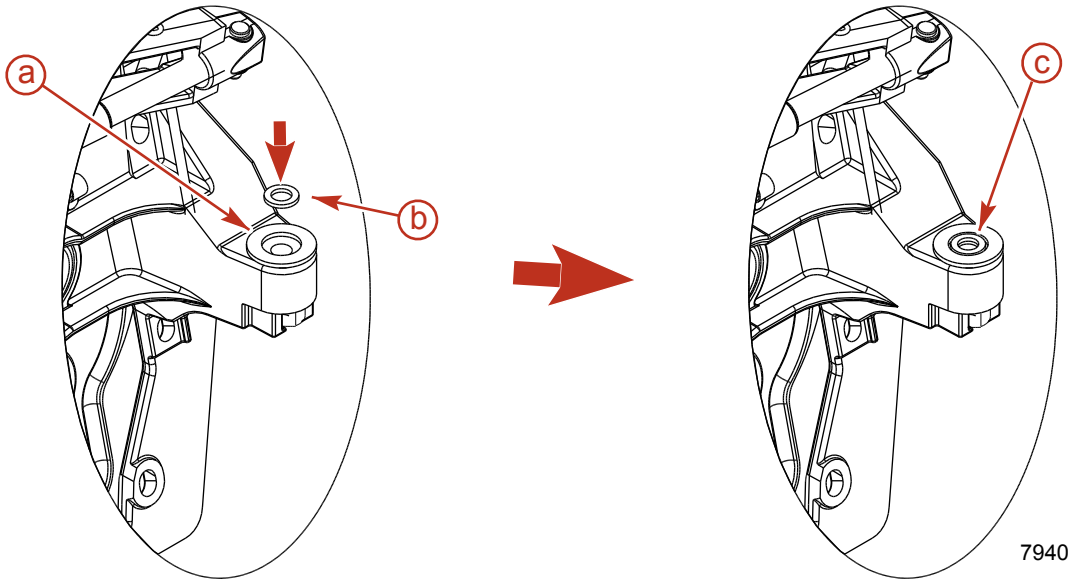


8504

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

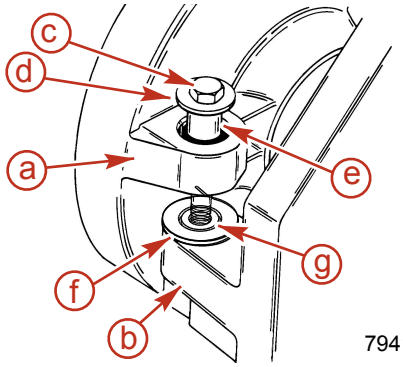
23. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
NOTE: *Spacer Kit (12-892619A01) is available to raise the rear of the engine. The kit is required only if alignment cannot be obtained with the normal adjustment. If the front or 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.*
24. On models where the front engine mounts cannot be lowered enough to allow for proper engine alignment:
    a. Attach a suitable sling and lifting arm to the engine lifting eyes and adjust so that the engine is level when suspended.
    b. Remove the rear engine mounting bolts and hardware.
    c. Using an overhead hoist, lift the engine enough to install a stainless steel washer inside the inner diameter of both fiber washers.

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



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

d. Install both rear engine mounting bolts with appropriate hardware as shown and tighten to specification.



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

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

e. Set the engine on the boat stringers.
f. Relieve the hoist tension.
g. Disconnect the sling from the engine lifting eyes.

25. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.
26. 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.
27. Fasten the front mount assemblies to the boat stringers using the appropriate hardware (lag bolts or thru-bolts, and so on).
28. Tighten both front mount locking (jam) nuts to specifications.

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

29. 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.
30. Remove the alignment tool.
31. 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	92-34227Q02

Electrical Connections

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

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

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

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

Boat Harness and Instrumentation Connections

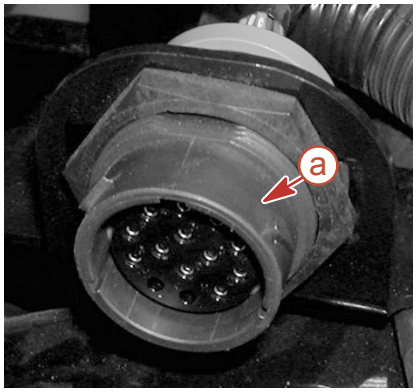
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses.

The four basic gauges that must be used with the engine are:

- Tachometer
- Oil pressure
- Water temperature
- Voltmeter

IMPORTANT: Maximum accessory load on the engine harness is 15 amps. If additional accessory load is needed, an accessory kit is available.

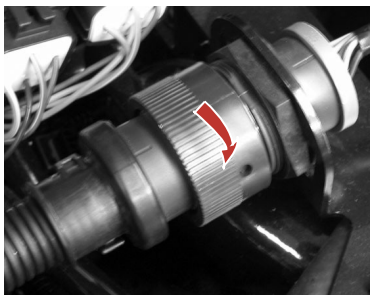
1. If an extension harness is required, connect the boat harness to the extension harness and connect the extension harness to the engine harness. Ensure that the harness does not rub or get pinched.
2. Fasten harnesses to boat at least every 46 cm (18 in.) using appropriate fasteners.



23135

Typical
a - Engine harness plug

3. Connect 14-pin harness to engine. Turn locking ring until firm snap is felt.



23136

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are engine rpm, coolant temperature, water pressure, battery voltage, fuel consumption, and engine operating hours. The Smartcraft instrument package will also aid in engine diagnostics.

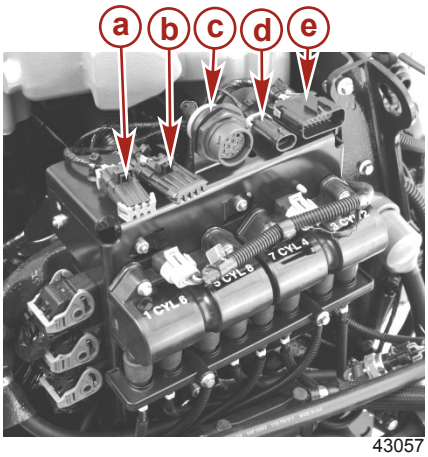
The SmartCraft instrument package will display critical engine alarm data and potential problems.

Refer to the Mercury SmartCraft Operator's Supplement (90-10229023) for the warning functions monitored and basic operation of the SmartCraft Instrument package. Refer to the instructions included with the instruments for installation instructions.

Engine Harness Connections

IMPORTANT: The 14 pin wiring harness can supply a maximum 15 amps of accessory power. An accessory relay and harness kit is available for higher accessory needs.

1. Route the instrumentation harness to engine. Do not allow the harness to rub or get pinched. If an extension harness is required, secure the connection properly.
2. Fasten the harnesses to the boat at least every 45.7cm (18 in.), using appropriate fasteners.
3. Connect the following:



43057

a - Paddle wheel and tank level connector
b - Diagnostic connector
c - 14-pin harness connector
d - Power harness connector
e - Transom harness connector

Continuity Wire Connection

IMPORTANT: Models equipped with 14-pin engine harness have the transom continuity circut incorporated into the transom harness.

Audio Warning System Connections

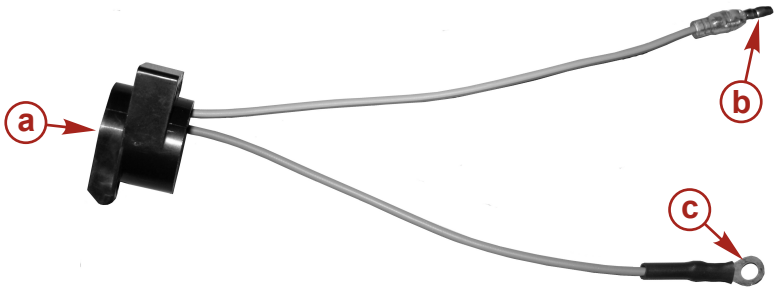
⚠ WARNING

Installing non-potted electrical components in explosive environments can result in serious injury or death from fire or explosion. Install all non-potted electrical components such as warning alarms away from environments where fuel or fuel vapor is present such as engine or fuel tank compartments.

1. Select a location for the audio warning alarm that meets all of the following:
   - Alarm can be easily heard, yet is out of sight
   - Alarm can be easily accessed for installation and maintenance
   - Alarm will remain dry
   - Alarm is within length limits of the 46 cm (18 in.) purple alarm wire that connects to the "I" terminal or 12 volt source on switched side of ignition switch.

   NOTE: *The terminal to which wire is attached must have no voltage when ignition switch is in the OFF position.*
2. Place the alarm in desired location and secure it to wire bundle with the tie strap provided.
3. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.

4. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or ignition switch. Tighten the connection securely.



45019

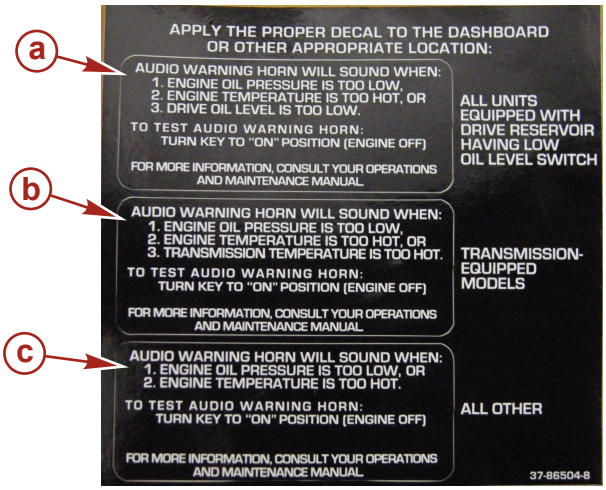
a - Alarm
b - TAN/ BLUE wire
c - PURPLE wire

5. Place the small transparent alarm decals on the bottom of the water temperature and the oil pressure gauges.

45021

Small transparent alarm decals

6. Choose the proper large decal for the engine package installed and place it on the instrument panel or other appropriate location easily viewed by the operator.



45020

a - Models equipped with a drive reservoir having low oil level switch
b - Models equipped with a transmission
c - All other models

7. Test the audio warning system as detailed.
   a. Turn the ignition switch to the "ON" position without cranking the engine.
   b. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

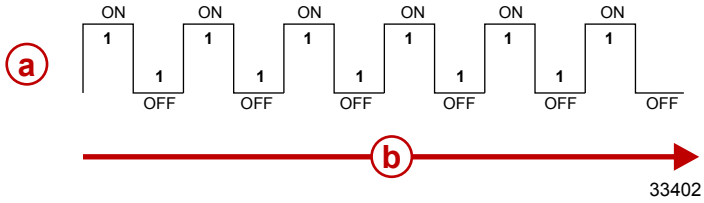
The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

There are two warning horn states:

- Caution
- Severe

Caution

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

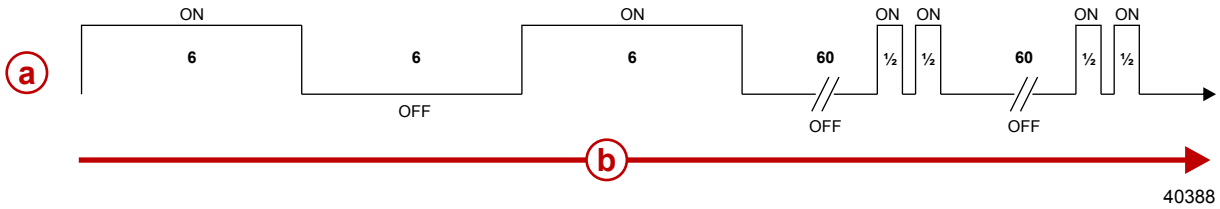
Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

Severe

IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Service Engine Light and OBD-M MIL Kit

Boats powered by Emissions Control Technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

47594

SC 1000 gauge and service engine light

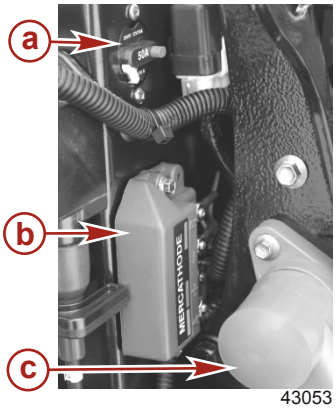
Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL light will remain illuminated for 4 seconds if the visual indication system is functioning correctly.

MerCathode Connections

The engine harness supports the MerCathode system. The engine harness has a MerCathode connector which connects to a MerCathode connector on the transom harness.

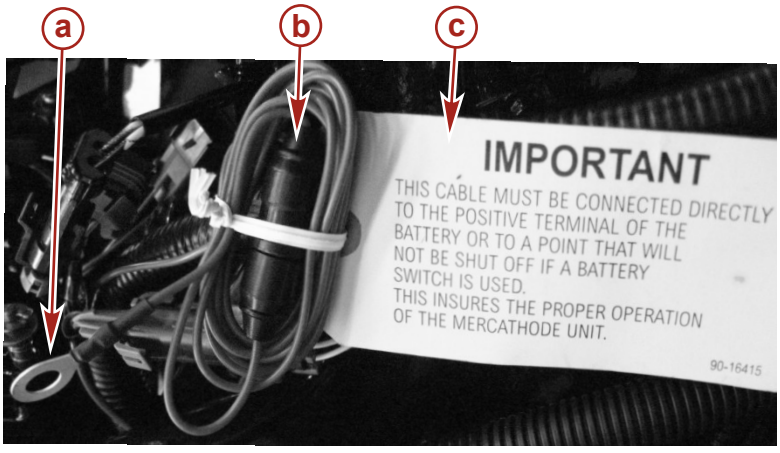
1. Locate the MerCathode controller assembly on the engine rear starboard.



43053

a - Circuit breaker
b - MerCathode controller
c - Remote battery connection

2. Connect the MerCathode positive (+) battery wire to the battery positive (+) terminal.

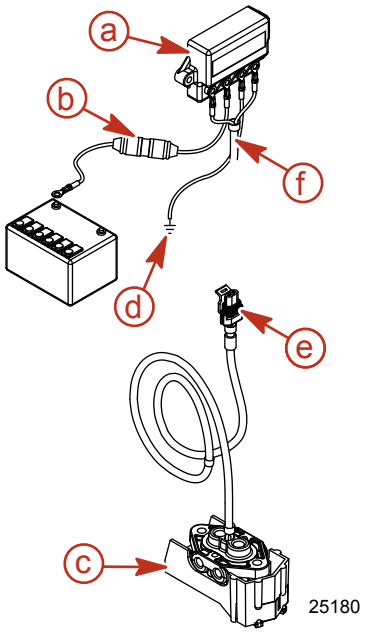


43556

MerCathode positive (+) battery wire

a - Connector
b - Fuse
c - Tag

IMPORTANT: Opposite end of RED/PURPLE wire must be connected directly to battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. MerCathode system must function continuously for proper corrosion protection.



- **a -** MerCathode controller
- **b -** RED/PURPLE wire - to positive (+) battery terminal
- **c -** Electrode on transom assembly
- **d -** Ground wire (in the engine harness, no hookup needed)
- **e -** Connector on the transom harness
- **f -** Engine harness to the MerCathode controller

Power Trim Electrical Connection

ABYC (American Boat and Yacht Council) installation recommends installing a battery switch in the positive conductor of any battery or battery bank with CCA rating greater than 800 amperes. (See ABYC for additional information)

ABYC further recommends, if a boat is equipped with a battery switch, the power trim pump may not be connected to the continuously energized circuit (battery). It must be connected to the switched side of the battery switch. Wire length requirements and location of circuit protection are also specified.

MerCruiser has developed three methods to facilitate compliance with ABYC recommendations. These come in the form of one standard production and two accessory kits.

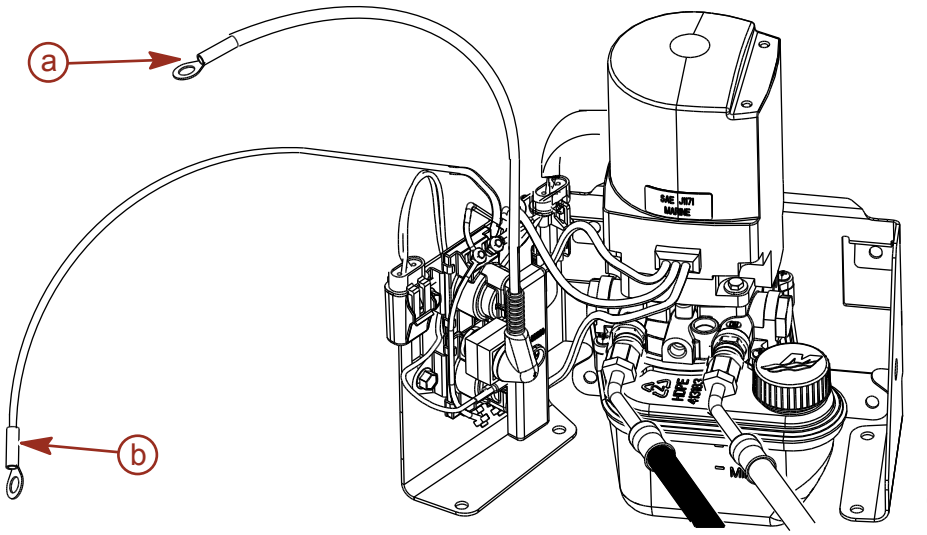
- Installations with the batteries (or battery banks) rated at less than or equal to 800 Cold Cranking Amps (CCA) and without battery switches: The trim pump may be installed using the wires supplied with the power trim pump and should be connected directly to the battery.
- Installations with batteries (or battery banks) rated at more than 800 CCAs (requiring a battery switch) or any boat with a battery switch:
  a. The red current conductor (for the trim pump) must be connected to the switched side of the battery switch and either:
     - provided with circuit protection within 7 inches of the power source or
     - Provided with circuit protection within 40 inches of the point of connection with the power source and sheathed the entire length of wire from the point of connection to the source and the circuit protection device. This will require the use of an Accessory cable kit.

Accessory Part Numbers

Part Number	Description	Color	Length	Type
8M2000587	Cable Assembly – Trim Pump	Red	72 inches	Fused
8M2000588	Cable Assembly – Trim Pump	Red	40 inches	Sheathed

Power Trim Pump Connections

1. Connect power trim pump BLACK (–) battery cable to negative (–) battery terminal and pump's RED (+) battery cable to positive (+) battery terminal or to the switched side of the battery switch.



a - Positive battery lead
b - Negative battery lead

Battery Cables Connection

IMPORTANT: Engine electrical system is negative (-) ground.

1. Connect engine positive (+) battery cable (usually RED) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually BLACK) to negative (–) battery terminal.
3. Install the power harness. Refer to **Section 7— Power Harness**.
4. Secure the battery cables and the power harness leads to the battery with hex nuts. Tighten the hex nuts to the specified torque.

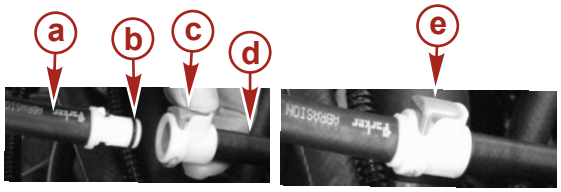
Description	Nm	lb-in.	lb-ft
Hex nut	13.5	120	–

5. Spray battery terminals with a battery connection sealant to help prevent corrosion.

Fluid Connections

Gear Lube Monitor Connection

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: Hose must not come in contact with steering system components, engine coupler, U-joint shaft, or drive shaft.
3. Fasten the quick connect.



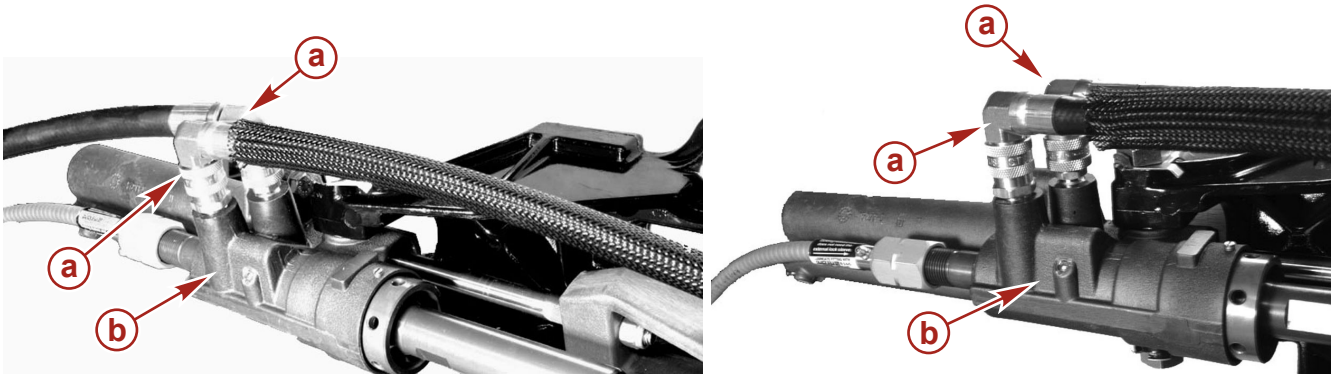
a - Gear lube monitor hose assembly from transom
b - O-ring
c - Quick connect release
d - Gear lube monitor hose assembly from gear lube monitor
e - Connection secured

Power-Assisted Steering Hoses

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

1. Disconnect the quick connect fittings on the power-assisted steering hoses.
2. Connect the power-assisted 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 hose to transom.



16225

a - Hydraulic lines
b - Power-assisted steering control valve

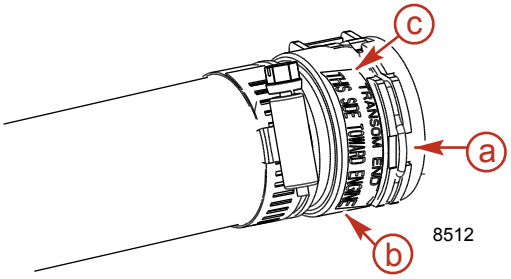
NOTE: *Steering Fluid can be added at this time if desired.*

Bravo Seawater Cooled Models Using Sterndrive Water Pickups

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

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

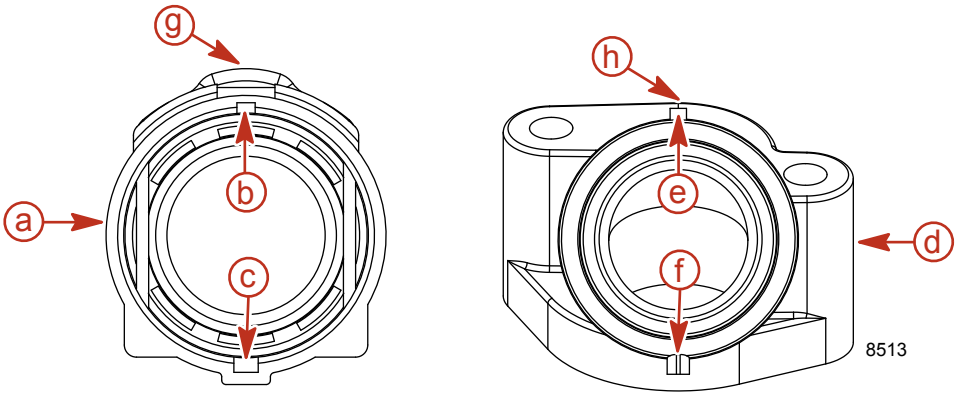
1. Install the seawater inlet hose assembly to the water inlet fitting.
   a. Position the retainer clip in the closed position.



8512

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.

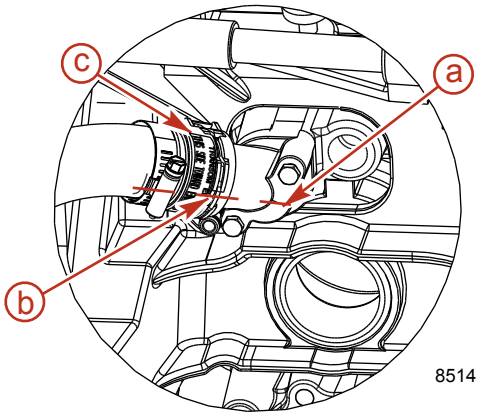


8513

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.

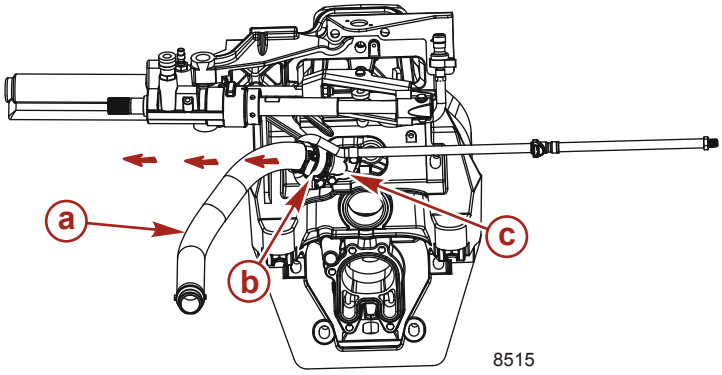
NOTE: *The retainer clip snaps into place and resumes the closed position when properly connected.*



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

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

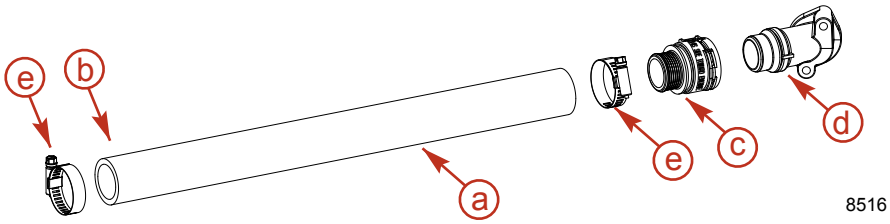
3. Perform a pull test on the water hose quick connection.
   a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 N (25 lbf). If the seawater inlet hose does not become separated from the seawater inlet fitting when force is applied, the seawater inlet hose is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



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.*

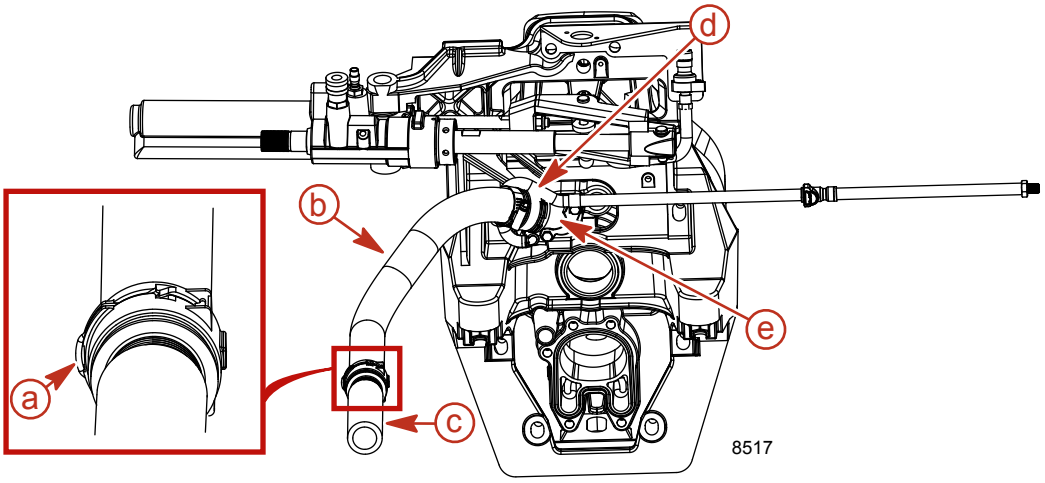


Seawater inlet hose assembly
a - Seawater inlet hose
b - To engine
c - Quick connect fitting
d - Seawater inlet fitting
e - Hose clamps

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.

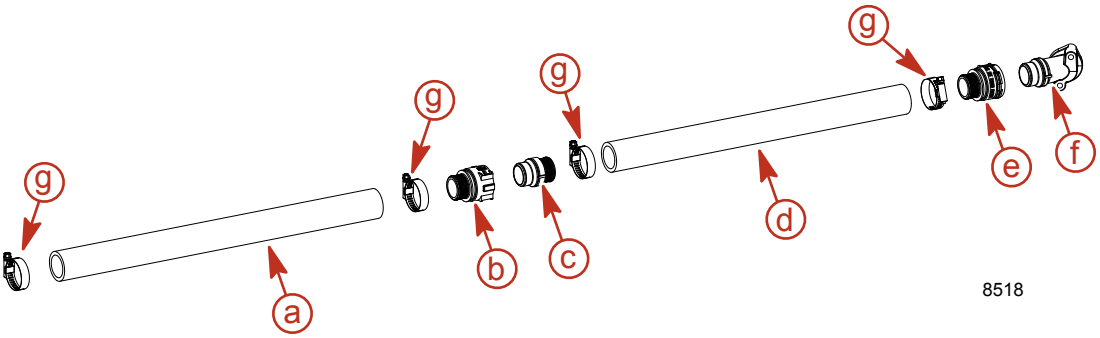


a - Retainer clip position (away from engine)
b - Seawater extension hose
c - Seawater inlet hose (to engine seawater pump)
d - Quick connect fitting (to seawater inlet fitting)
e - Seawater inlet fitting (to transom)

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

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

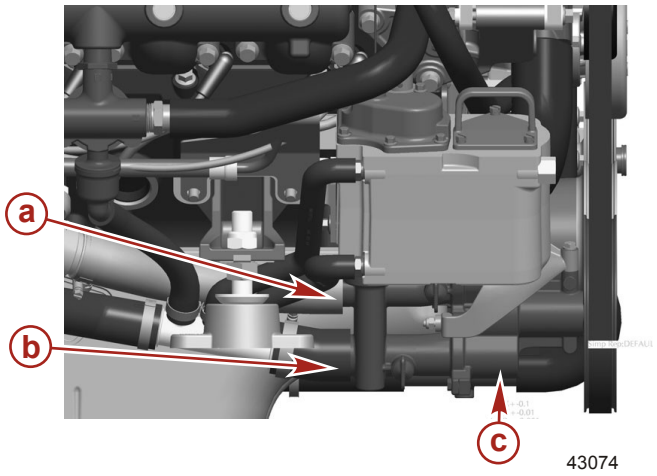
NOTE: *The seawater extension hose assembly connects to the transom and the seawater inlet hose.*



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

Seawater Pump Pickup Connection

1. Ensure the seawater inlet hose is connected to the upper hose fitting of the seawater pump.



43074

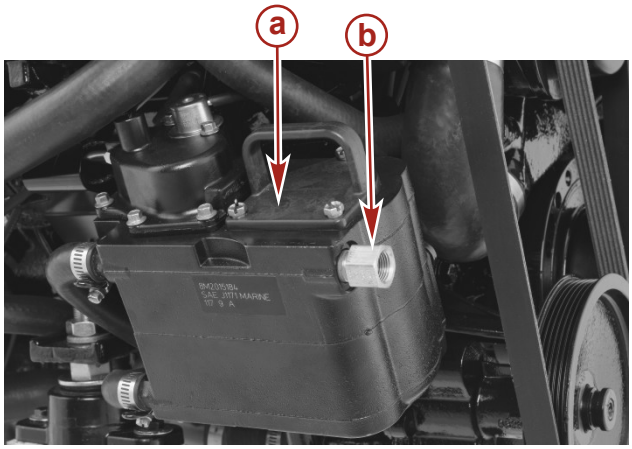
a - Seawater inlet hose
b - Seawater (out) hose to cooler
c - Seawater pump

Fuel Line Connection to Gen III Cool Fuel Module

Fuel Line Connection

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

1. Remove the shipping plug from the fuel fitting.
2. Connect the flexible fuel line to the fuel fitting.
   IMPORTANT: Hold fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.



43055

a - Gen III Cool Fuel Module
b - Fuel fitting

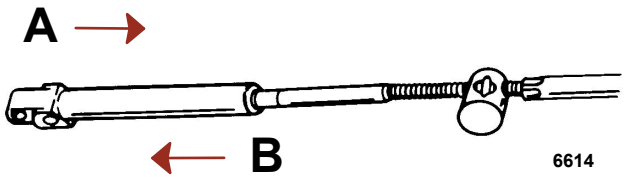
Bravo Model Shift Cable Installation

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.*

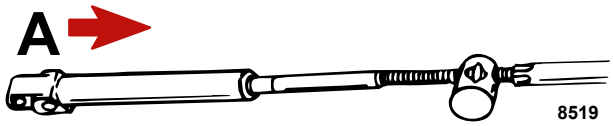
IMPORTANT: Sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.

- 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

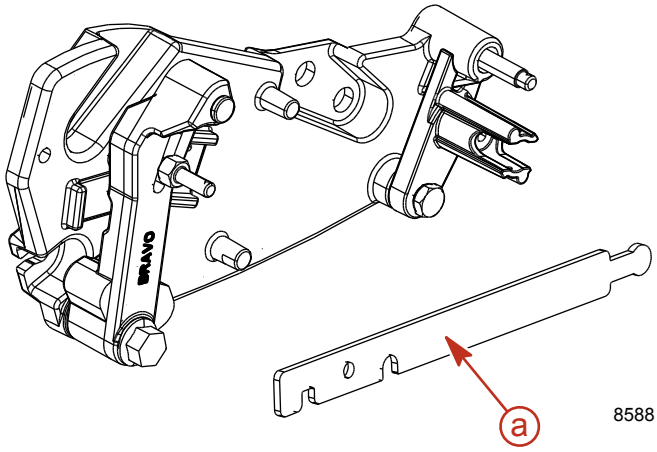
- Bravo Three - Front propeller on sterndrive unit is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction A, when control lever is placed in FORWARD gear position.



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

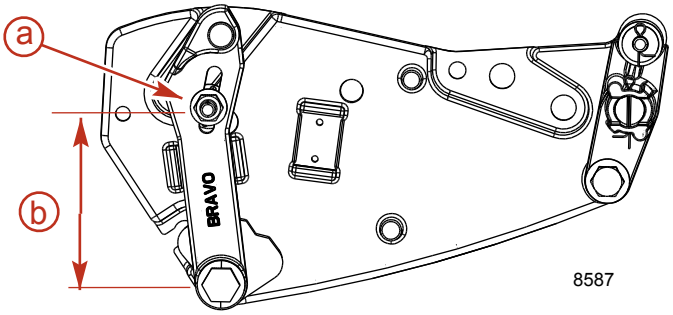
Bravo Models Shift Cable Adjustment

1. Remove the adjustment tool.



Typical Bravo shift bracket shown without switch
a - Adjustment tool

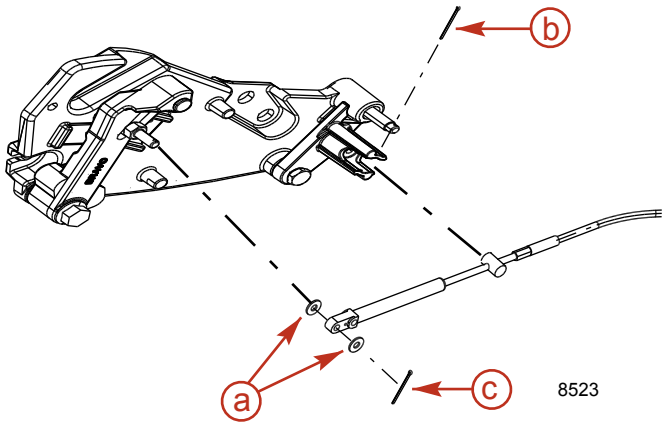
2. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud.



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 unit shift cable.
4. Install cotter pin.

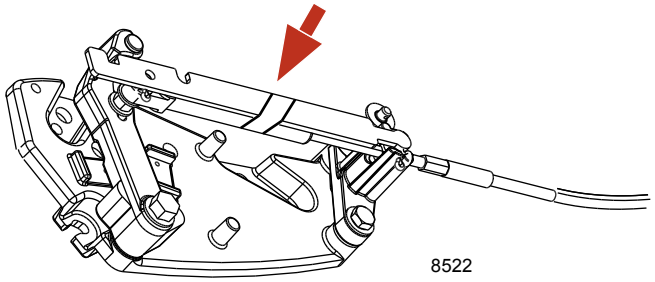
5. Insert cotter pin from top and spread ends fully.



Typical Bravo shift bracket shown without switch

a - Washers (2)
b - Long cotter pin
c - Short cotter pin

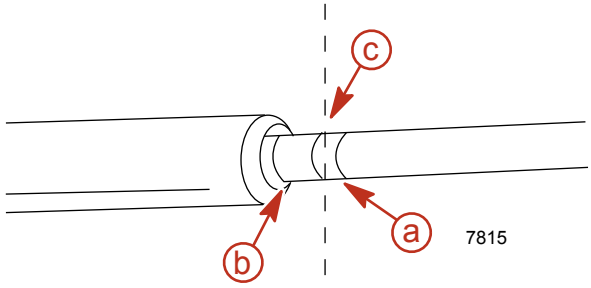
6. Place adjustment tool over sterndrive unit shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer.



Typical Bravo shift bracket shown without switch

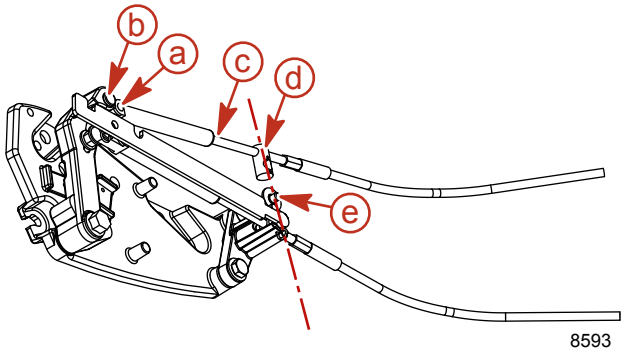
a - Adjustment tool
b - Sterndrive unit shift cable

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.
   a. Shift remote control to NEUTRAL.
   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."



8. Temporarily install control cable end guide into shift lever and insert anchor pin.
9. 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.

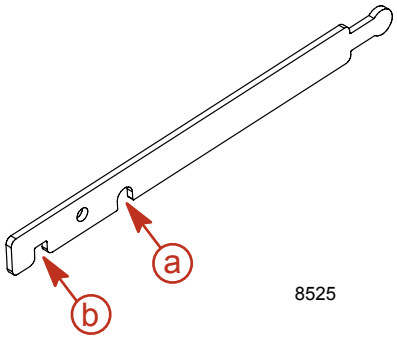
10. Remove control cable end guide from shift lever by removing clevis pin.



Typical Bravo shift bracket shown without switch

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

11. Install the control cable.
12. Install the washer and cotter pin to secure the barrel.
13. Install the clevis pin.
14. Install the cotter pin into the clevis pin from the top and spread the ends.
15. 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.

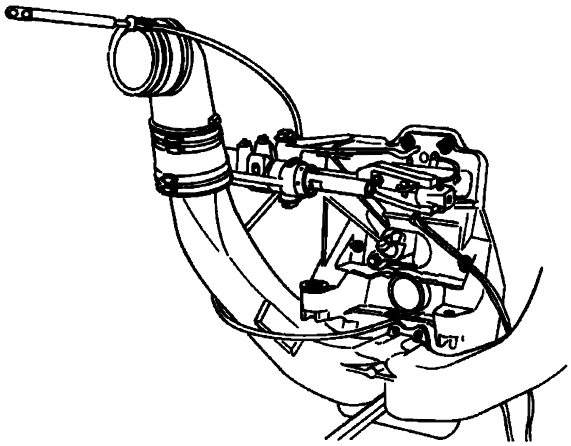
Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Shift cable pivot points	Obtain Locally

Shift Cable Installation for the 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.*

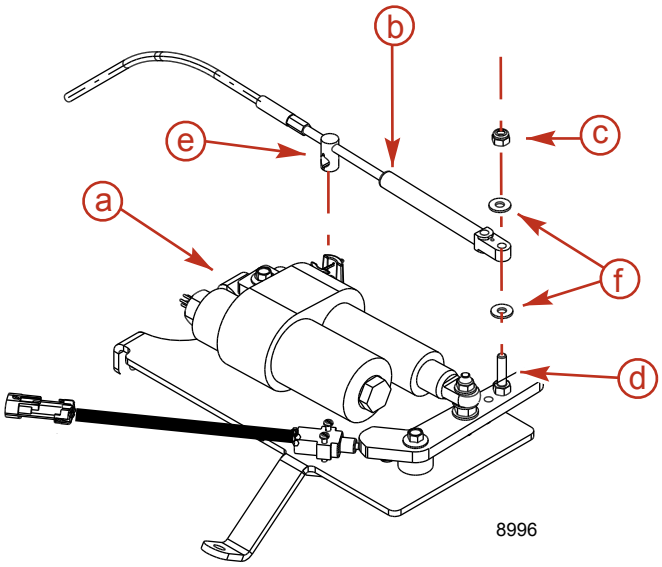


NOTE: *A final check of the adjustments should be made with the boat in the water and engine running. If this cannot be done or is not done at your manufacturing facility, arrangement should be made with the dealer to do this as part of the pre-delivery inspection.*

2. Apply lubricant to the threads of the shift cable stud.

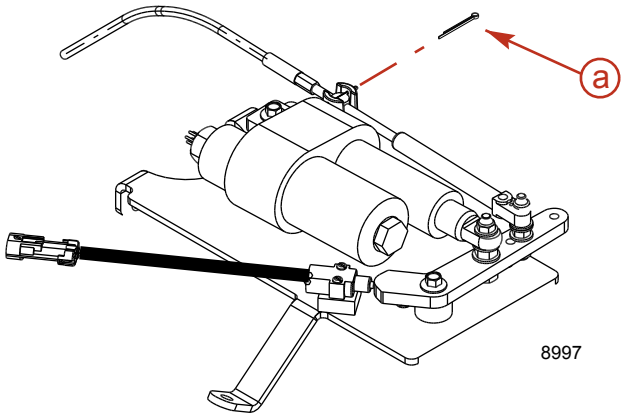
Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Shift cable stud	92-802865Q02

3. Install the intermediate shift cable to the shift actuator on the engine.
4. 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

5. Insert cotter pin from top and spread ends.



a - Cotter pin

DTS System Installation Requirement

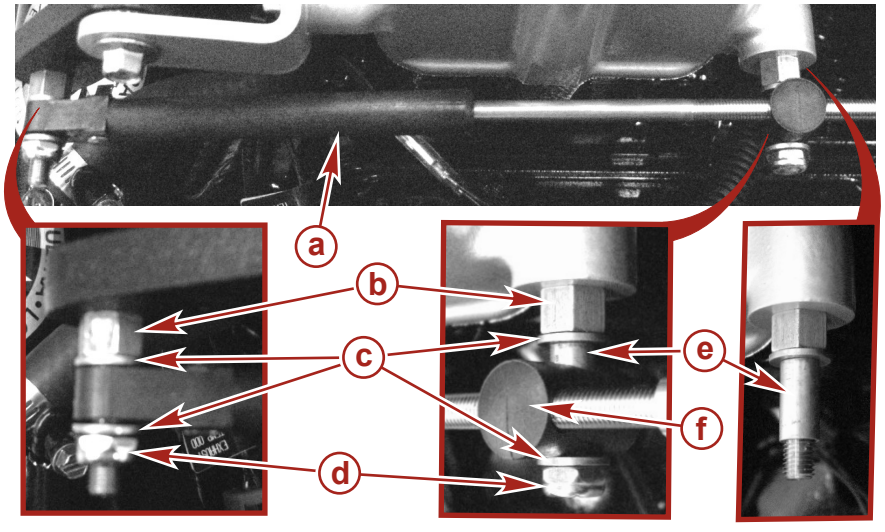
Due to updates on software and diagnostic tools we are not including this information in the service manual.

Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Throttle Cable Installation And Adjustment

1. Place the remote control handles in the neutral idle position.
   IMPORTANT: Ensure that the cable is routed to avoid sharp bends and/or 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. 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 anchor plate. Ensure that the hole in barrel positions the cable as shown.



a - Cable end guide
b - Hex spacer
c - Flat washer
d - Locknut
e - Sleeve
f - Barrel

3. Secure the throttle cable with the hardware as shown and tighten securely. Loosen locknut "a" 1/2 turn.
4. Place the remote control throttle level in the wide open throttle (WOT) position and ensure the throttle plates are completely open.
5. Return the remote control throttle lever to the idle position and ensure the throttle lever is completely closed.

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.

Engine Installation G3 Service Tool

Computer Diagnostic System (CDS) G3

Use the CDS G3 service tool for the following if applicable:

1. Configuration—Helm Configuration, CAN Pad Configuration, Drive Configuration, Compass Configuration, Import

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2. Active Test—Set Trailer Limit, Set Trim Limit, Set Engine Location, Set Tach Link

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Connecting the Computer Diagnostic System (CDS G3) Service Tool

NOTE: *The Computer Diagnostic System (CDS G3) procedural information is available in the help menu. If you have the CDS hardware, order the software and cable 8M0046124 from Mercury. The complete system is available from SPX.*

Computer Diagnostic System (CDS G3)	Order from SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124

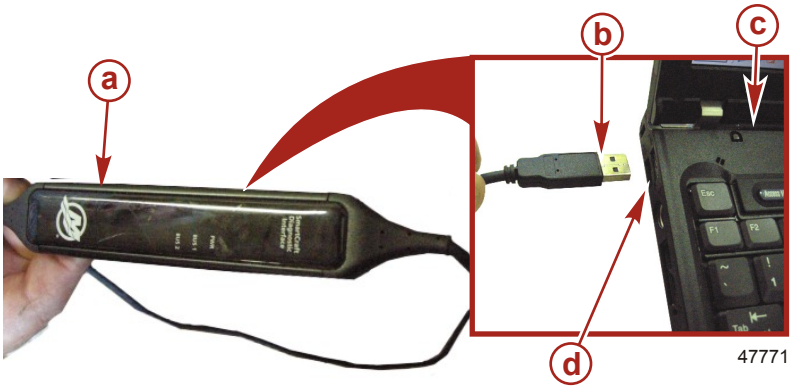
Models Equipped With a SmartCraft Diagnostic Port

1. Ensure all engine key switches and engines are off.
2. Locate the SmartCraft diagnostic port at the boat helm.

   NOTE: *The diagnostic port may not be mounted on the dashboard if space is limited, but may be mounted under the dashboard, or in the cabin at an inconspicuous, but accessible location.*
3. Remove the cover and insert the CDS G3 interface harness connection.

SmartCraft diagnostic port

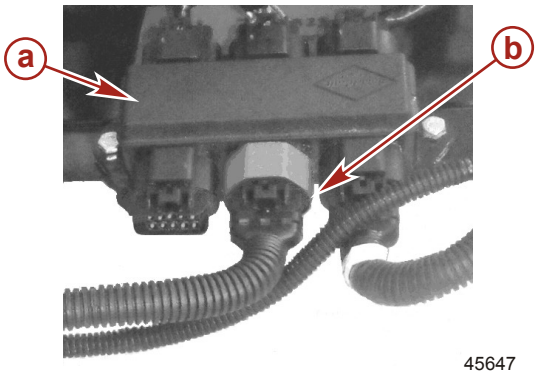
4. Connect the CDS G3 interface USB port connector to the USB port on the G3 service tool.



a - CDS G3 interfacetool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

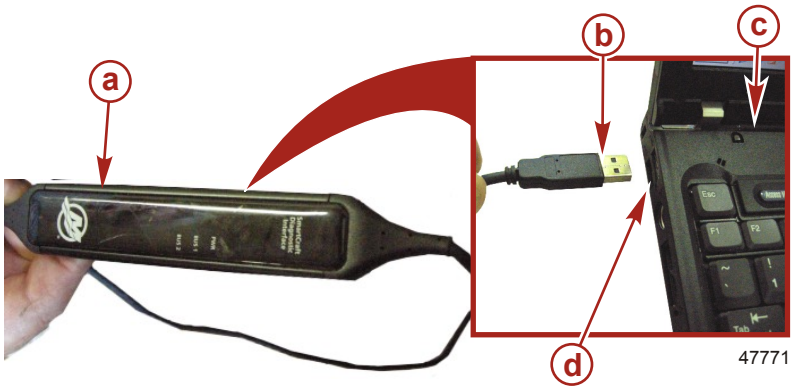
Models Equipped With a SmartCraft Diagnostic Junction Box

1. Ensure all engine key switches and engines are off.
2. Locate the standard junction box under the boat helm and connect the CDS G3 interface harness.



a - Junction box
b - CDS G3 interface harness connector

3. Connect the CDS G3 interface USB port connector to the USB port on the CDS G3 service tool.



a - CDS G3 interface tool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

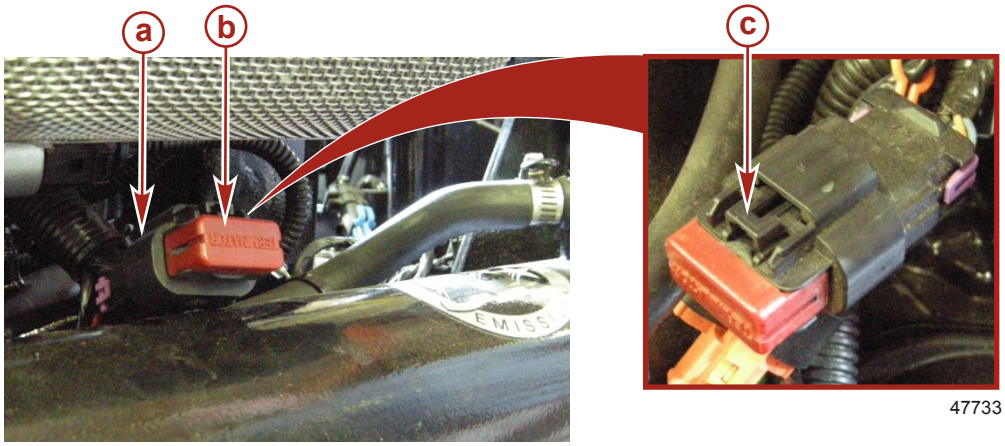
Models Not Equipped With SmartCraft Diagnostic Port or Junction Box

IMPORTANT: The CDS G3 termination harness is a terminal resistor. Only use it when connecting to the engine harness terminator connection. Do not connect the termination harness to the junction box or diagnostic port at the helm.

CDS G3 termination harness

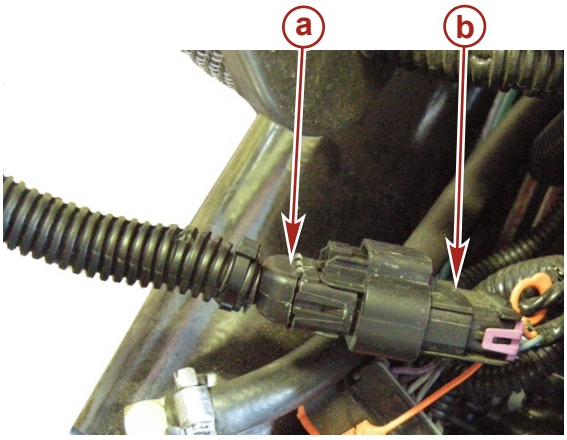
CDS G3 Termination Harness	84-8M0045065

1. Ensure all engine key switches and engines are off.
2. Locate the yellow or red terminator resistor on the engine harness and remove it by pushing the tab in while pulling the connections apart. Retain the yellow or red terminator resistor to reinstall after using the service tool.



Terminator resistor red or yellow
a - Terminator connection
b - Yellow or red terminator resistor
c - Tab

3. Connect the CDS G3 termination harness to the terminator connection on the engine.



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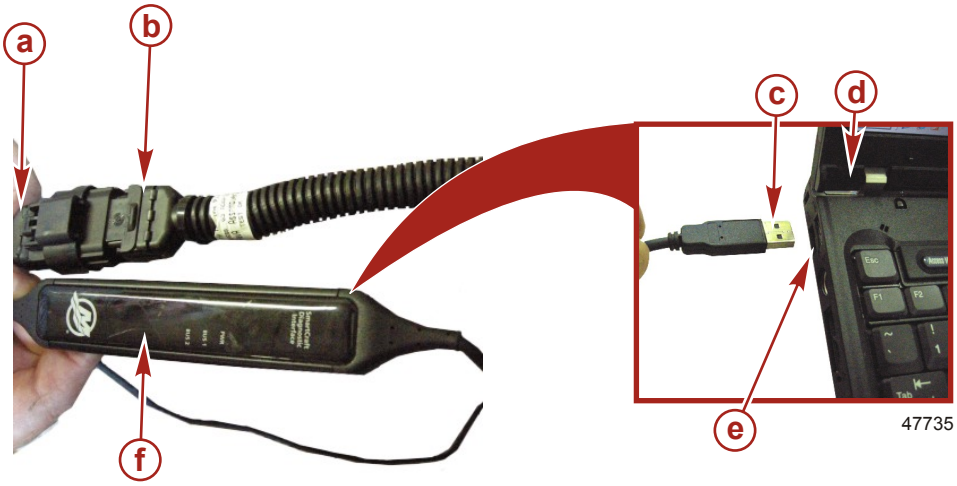
a - CDS G3 termination harness
b - Terminator connection

4. Connect the CDS G3 termination harness connector to the CDS G3 interface harness connector.
5. Connect the CDS G3 interface USB connector to the USB port on the CDS G3 service tool.



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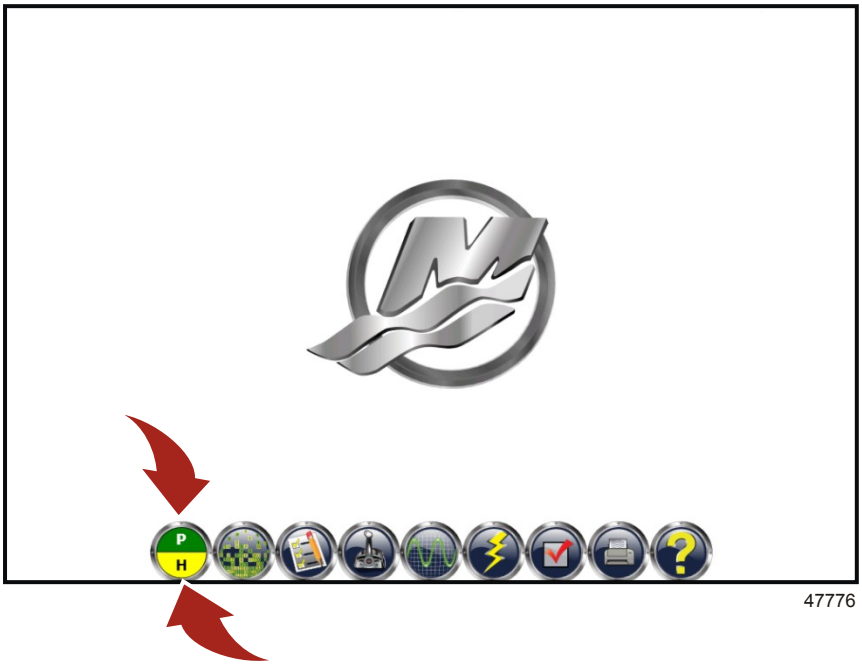
a - CDS G3 interface harness connector
b - CDS G3 termination harness connector
c - CDS G3 interface USB connector
d - CDS G3 service tool
e - USB port on the CDS G3 service tool
f - CDS G3 interface tool

Mechanical Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the connection problem.

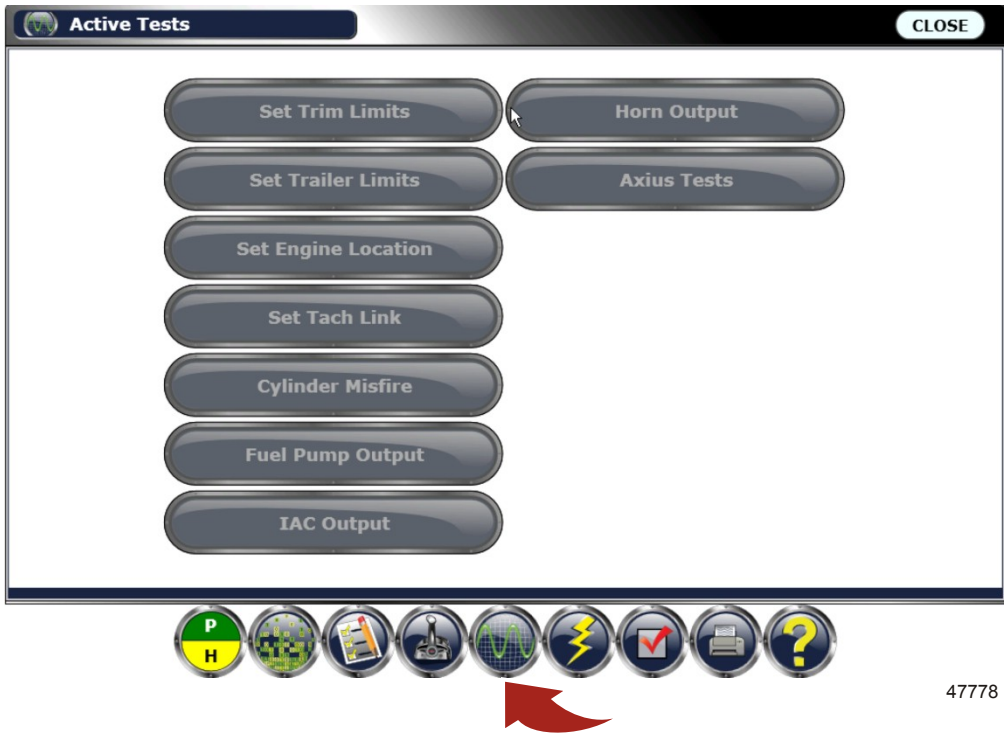


47776

2. Wait for the "Module Data" screen to appear.

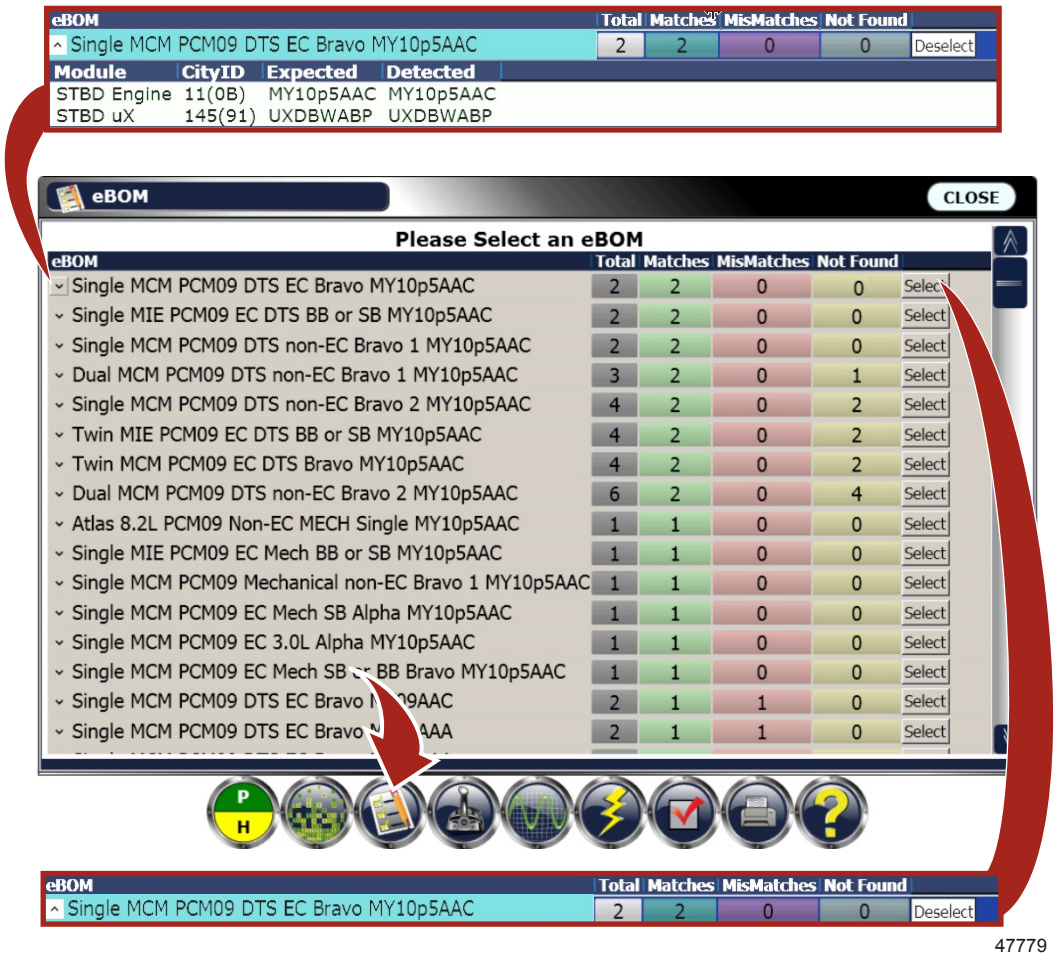
47777

3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

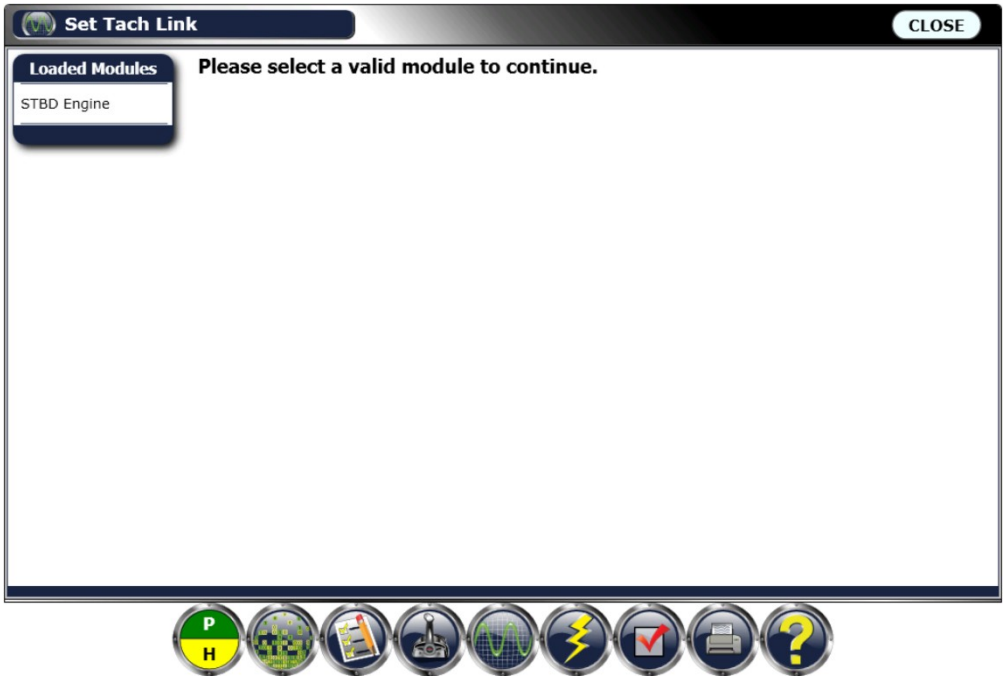
c. When you are finished, click on the Configuration icon to continue with the setup.

47782

6. Select "Active Tests."
7. Initiate the "Set Tach Link" procedure.

47788

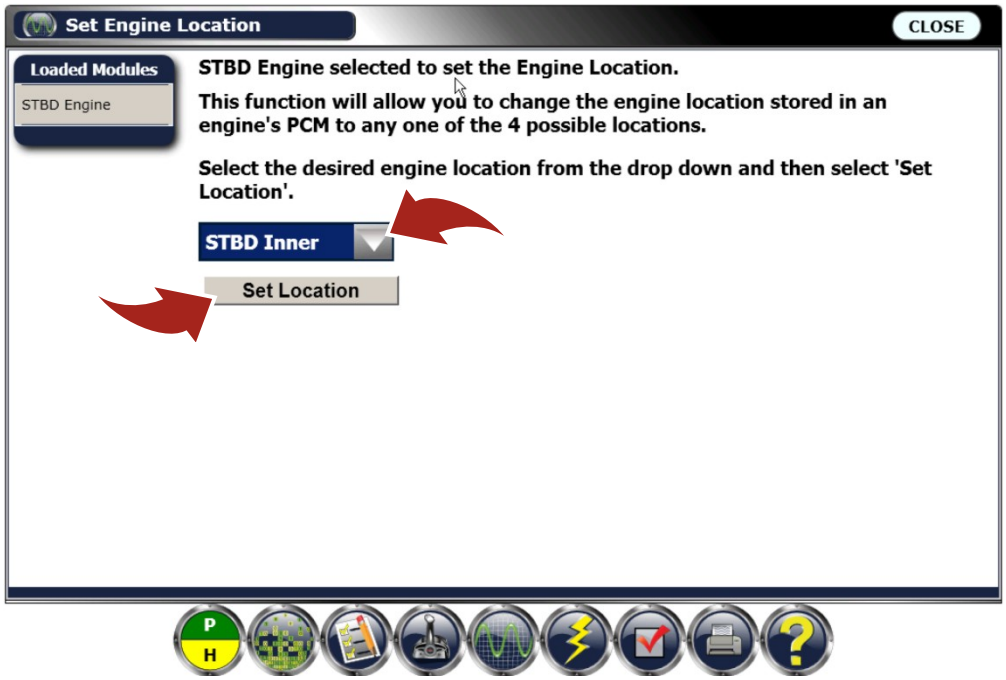
8. Select the appropriate engine.



9. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.

47790

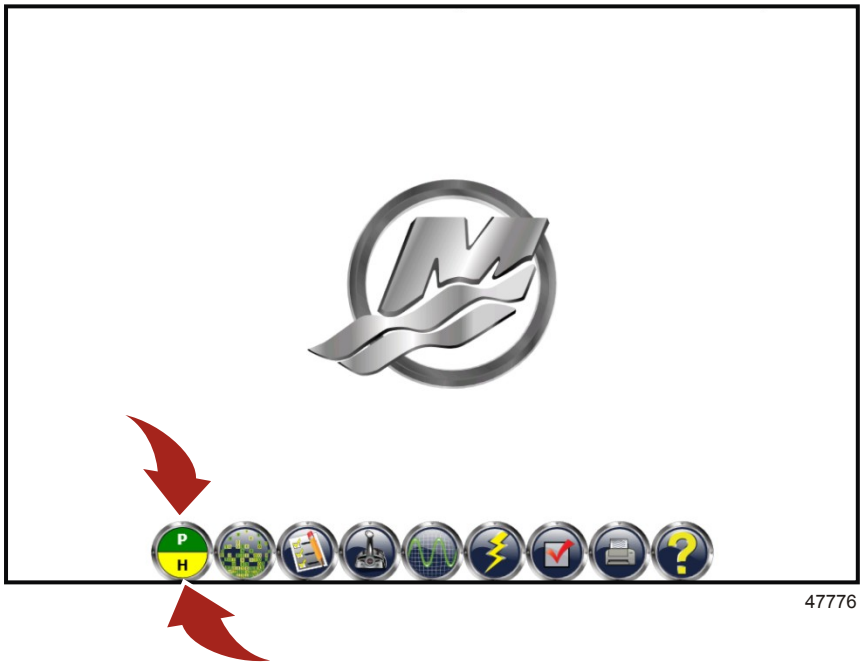
10. Use the drop-down box and "Set Location" button to change the engine location, if required.



47791

DTS Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the connection problem.

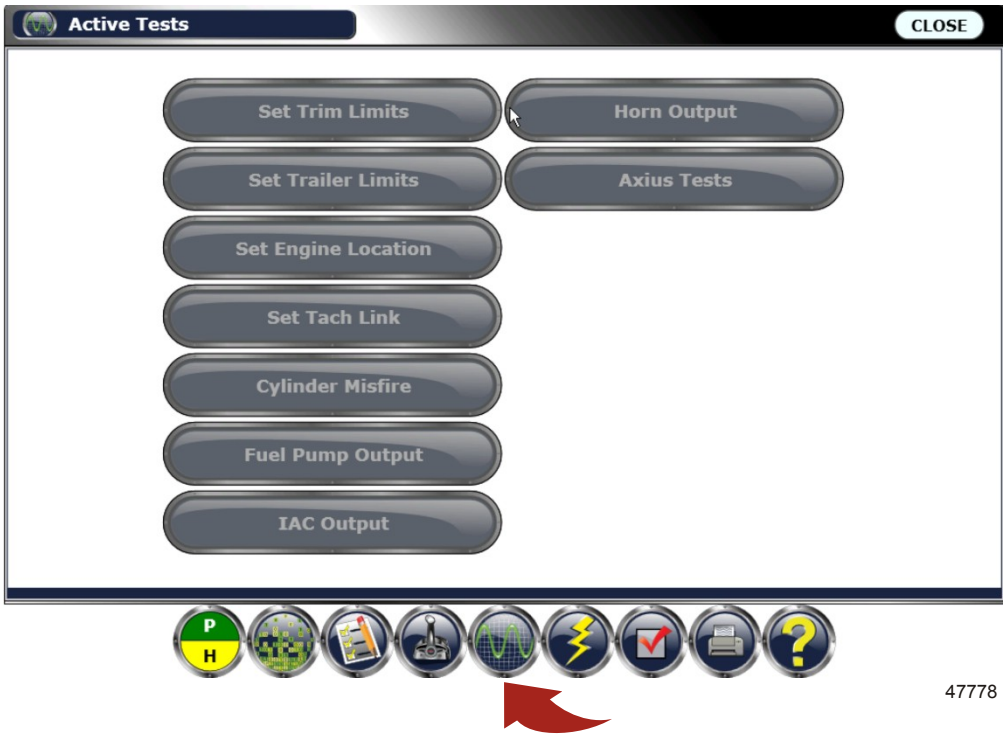


47776

2. Wait for the "Module Data" screen to appear.

47777

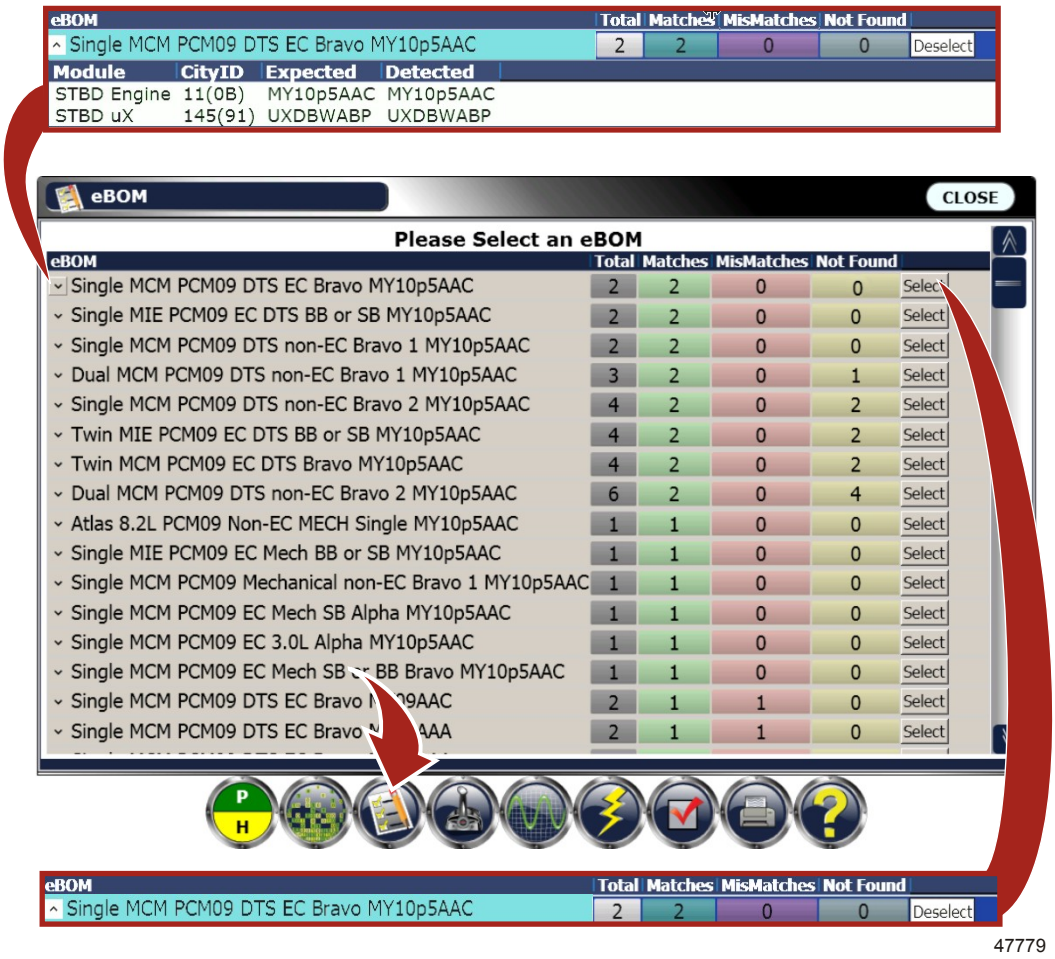
3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



47778

4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

c. When you are finished, click on the Configuration icon to continue with the setup.

47782

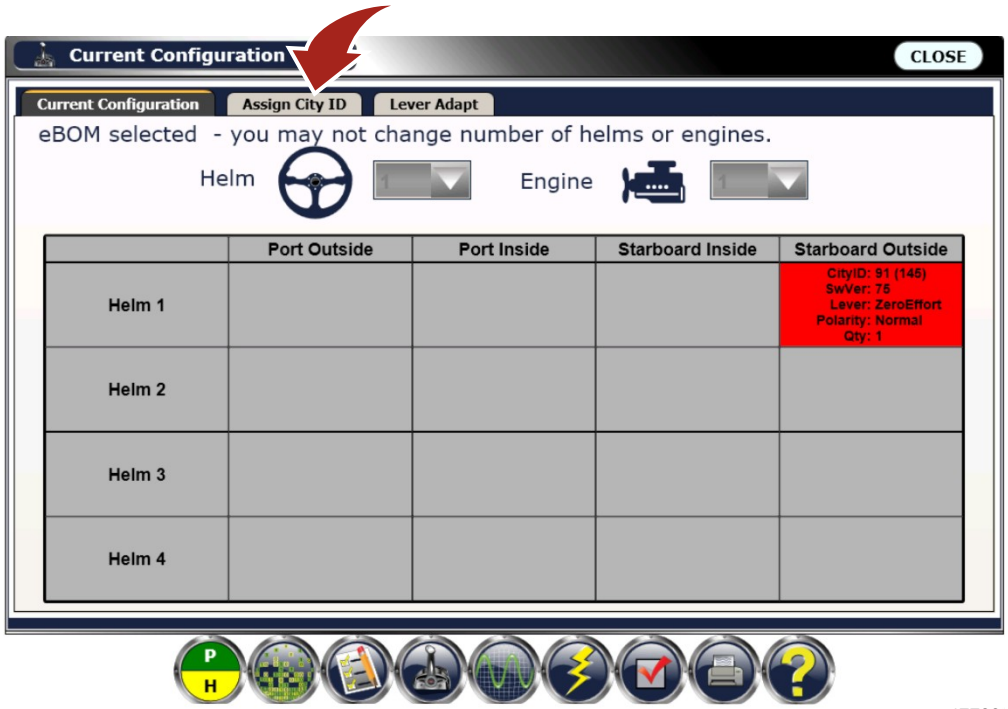
6. Select "Helm Configuration."

45499

7. Initiate "Helm Setup."

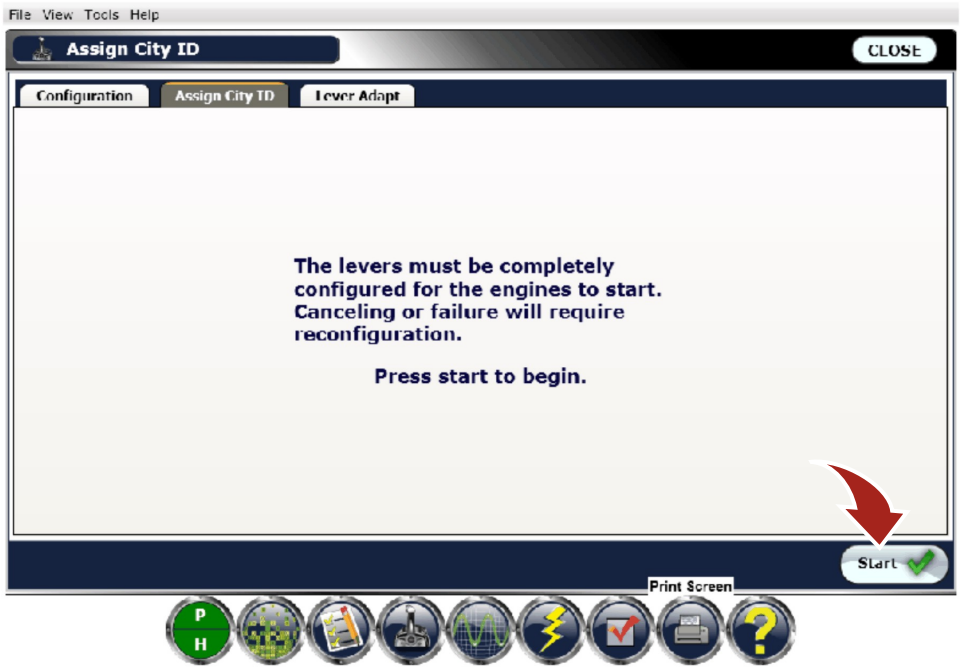
45500

8. Follow the on-screen directions presented by the G3 tool.
   a. Select the number of helms and engines to configure. You may need to wait a moment while the helm configuration is validated.
   b. Notice that the cell for the helm module will have a red background.
   c. Select "Assign City ID" to continue.



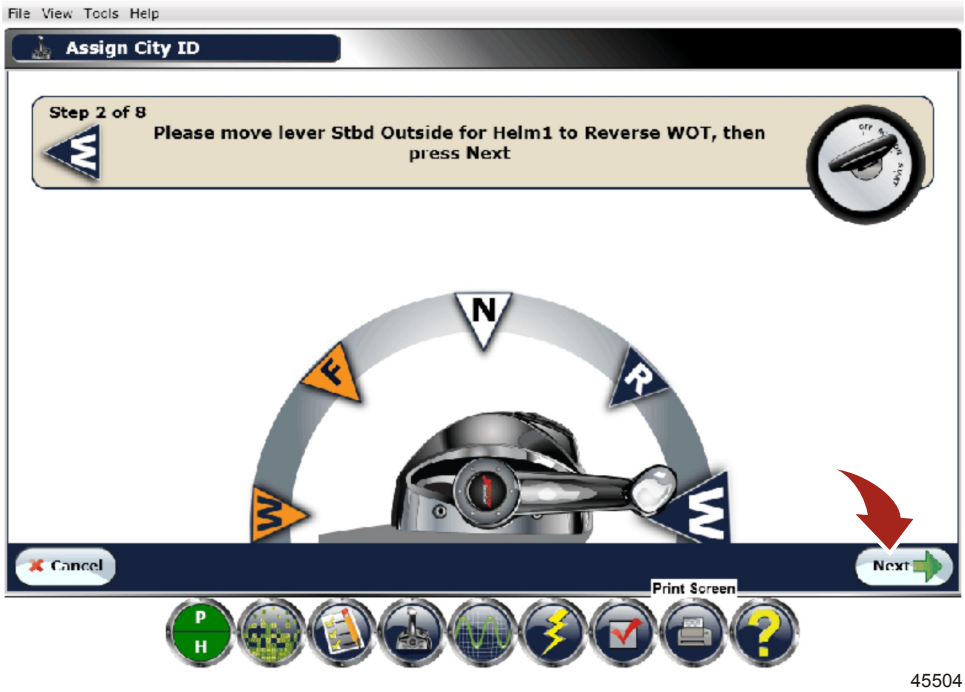
47780

9. Select "Start" to begin setup of the City ID.



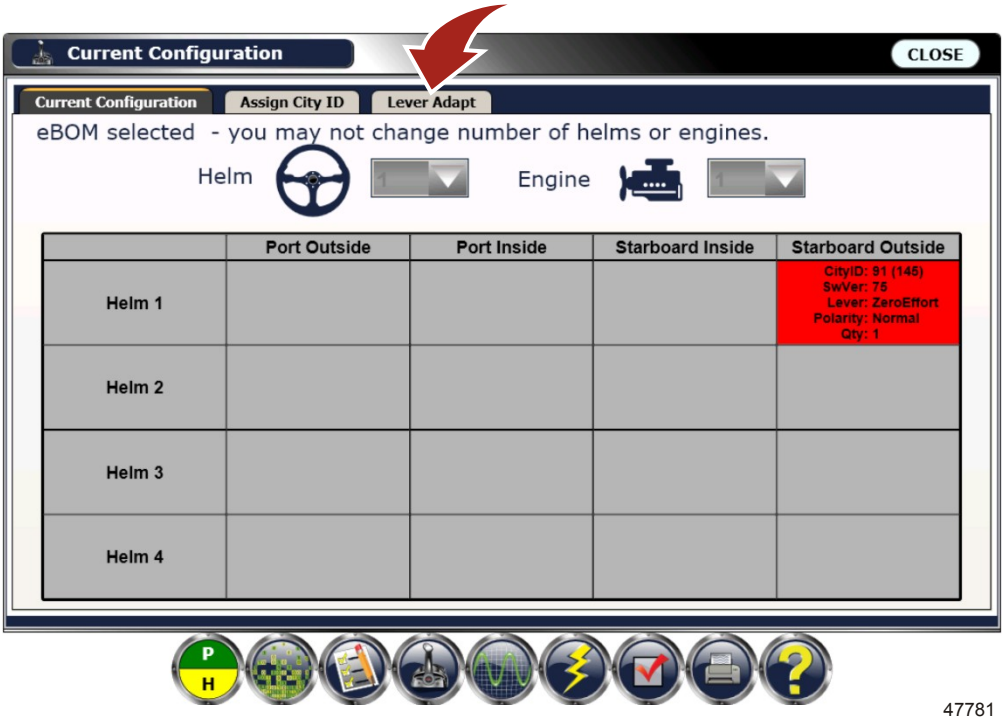
45503

10. Follow the on-screen directions, selecting "Next" to advance through the screens. When you reach the end of the on-screen directions, you may encounter a brief wait while the G3 tool updates the helm modules.



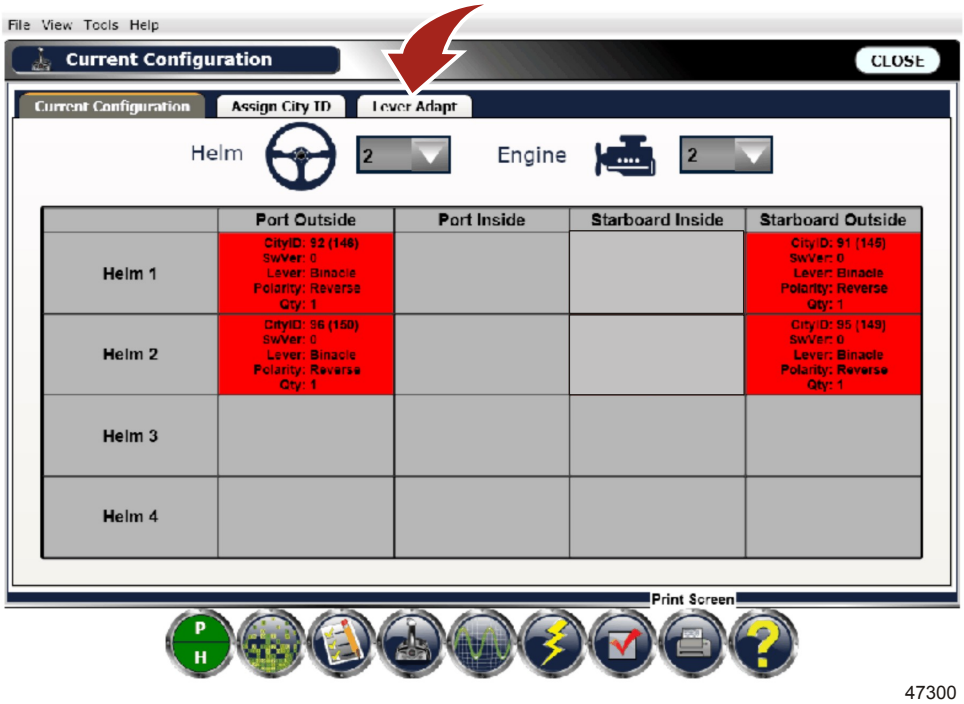
45504

11. The "Current Configuration" screen will display the City IDs assigned to all helm modules, although the cells will still have red backgrounds. You must select "Lever Adapt" to complete the helm configuration.



47781

Single engine example



47300

Multiple engine example

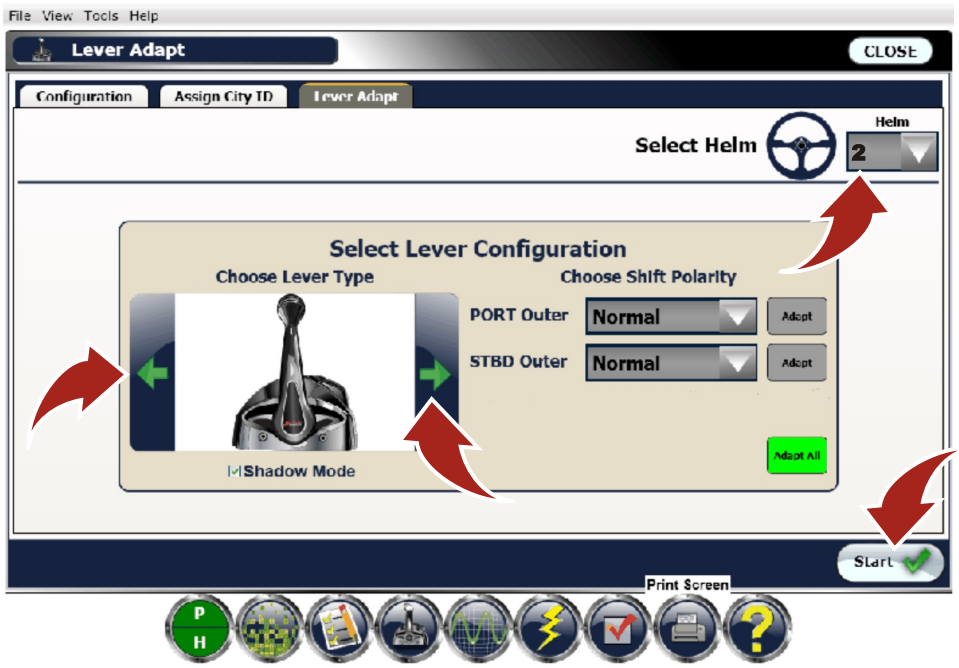
12. Select the helm to adapt, then choose the type of lever used at that helm. Click "Start" to begin the lever adaptation.

47301

13. Follow the on-screen directions, moving the control levers as instructed.

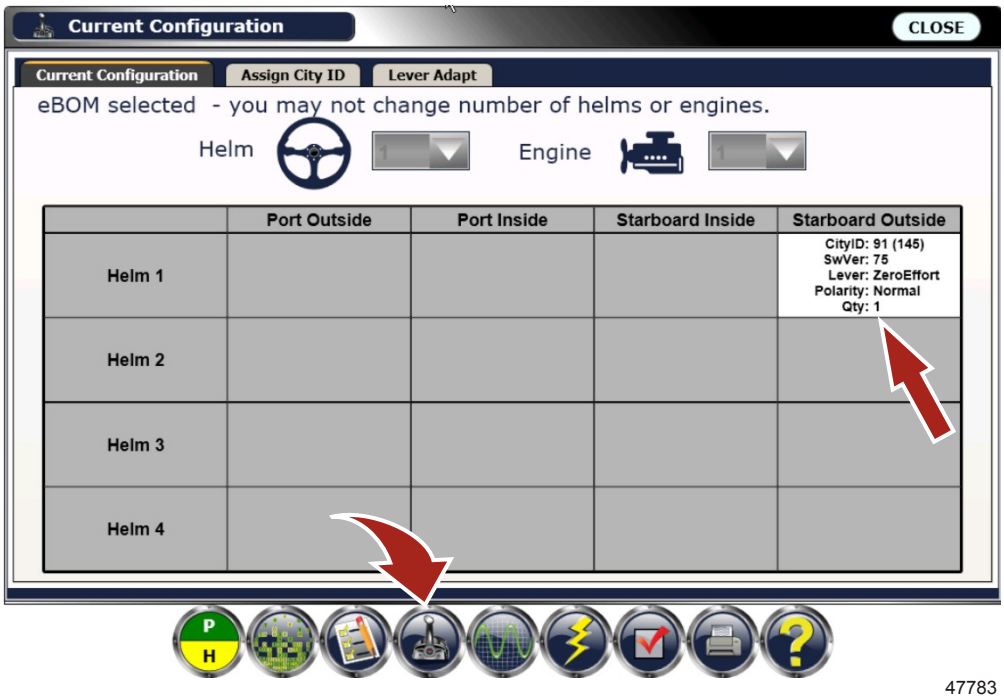
45507

14. Repeat the process for any additional helms. Be certain to select the helm number, choose the appropriate lever type for that helm, and follow the on-screen directions as before. Note that a slight wait may occur while the G3 tool updates the helm module.



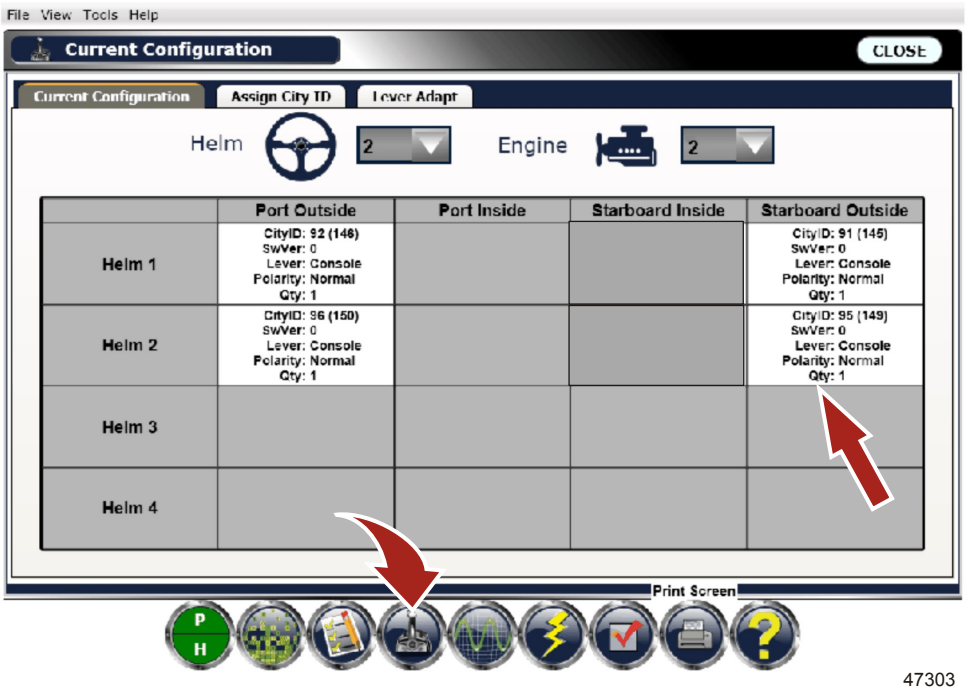
47302

15. After all levers have been adapted, the helm module cell backgrounds on the "Current Configuration" screen will be white. Select the Configuration icon to continue setup.



47783

Single engine example



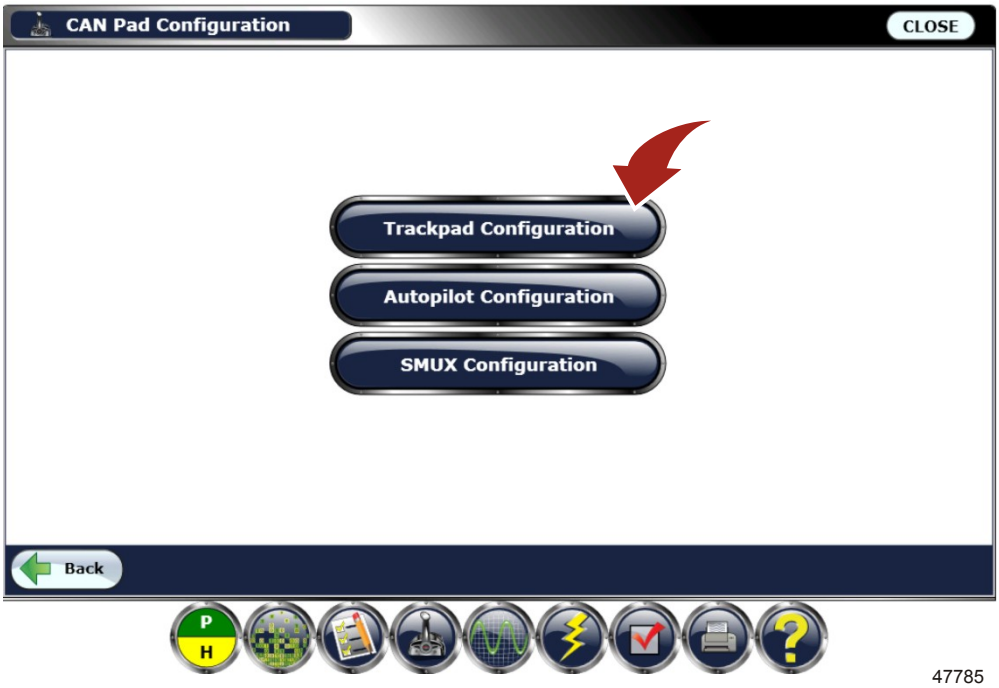
47303

Multiple engine example

16. Select "CAN Pad Configuration."

45550

17. Select "Trackpad Configuration," and follow the on-screen directions. The CAN pad must be installed for dual and multiple-engine applications.

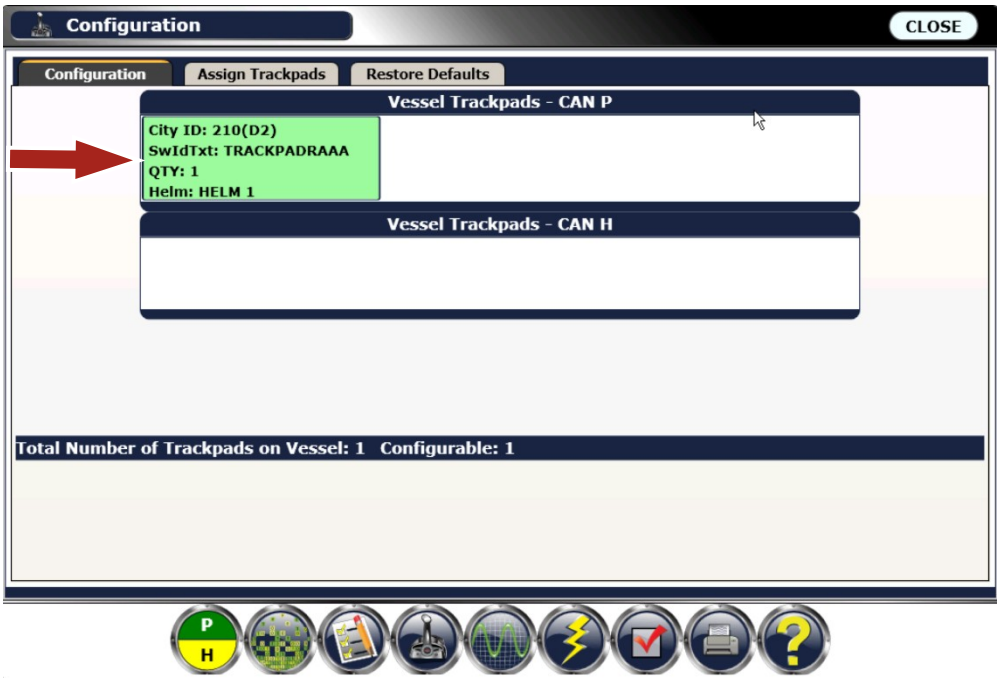


47785

18. Follow the directions in the G3 tool for assigning the City ID for the trackpads.
19. On the "Assign Trackpads" screen, select a helm and the number of trackpads at that helm; then click "Start" to begin. Complete the process for all applicable helms. Then click "Save" to save the configuration information.

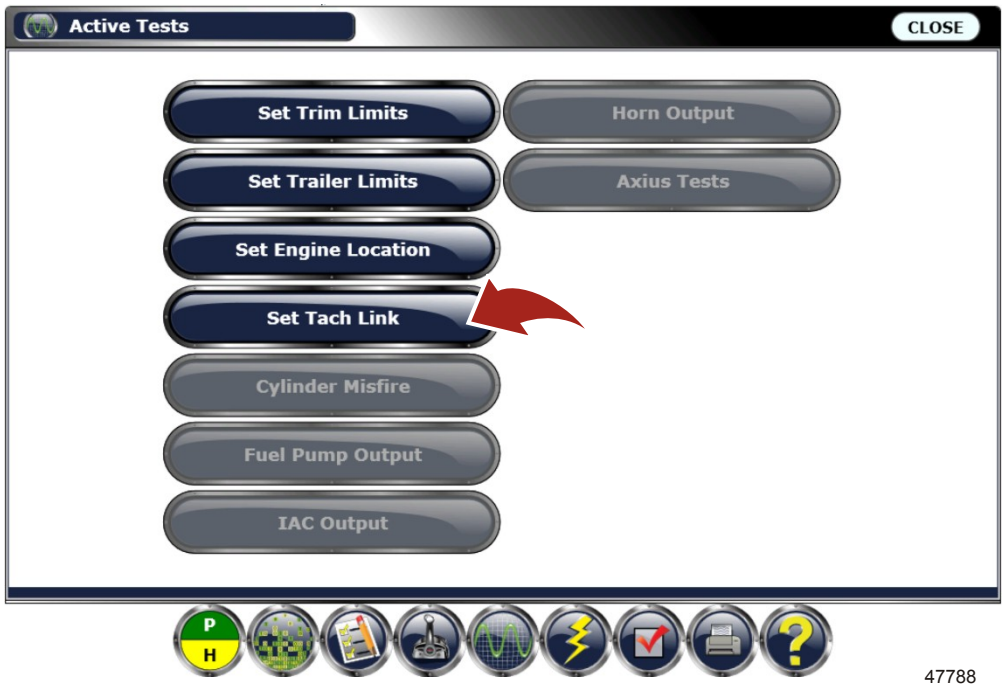
47787

20. When the trackpad assignment is complete, the trackpad City ID will turn green.



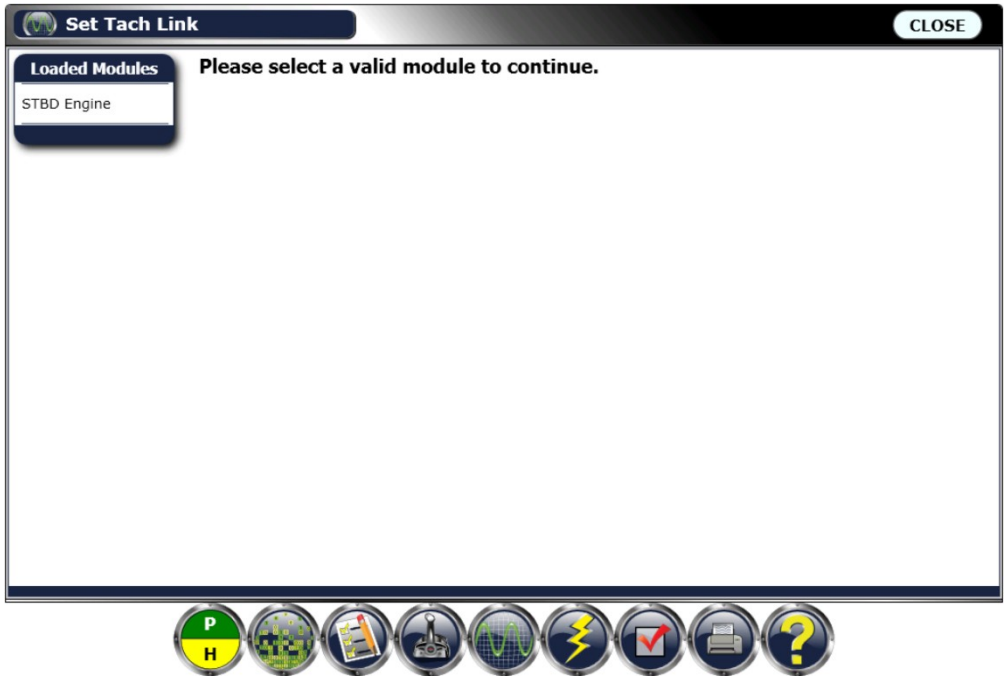
47786

21. If applicable, follow the same process for the DTS trackpads (CAN P).
22. Select "Active Tests."
23. Initiate the "Set Tach Link" procedure.

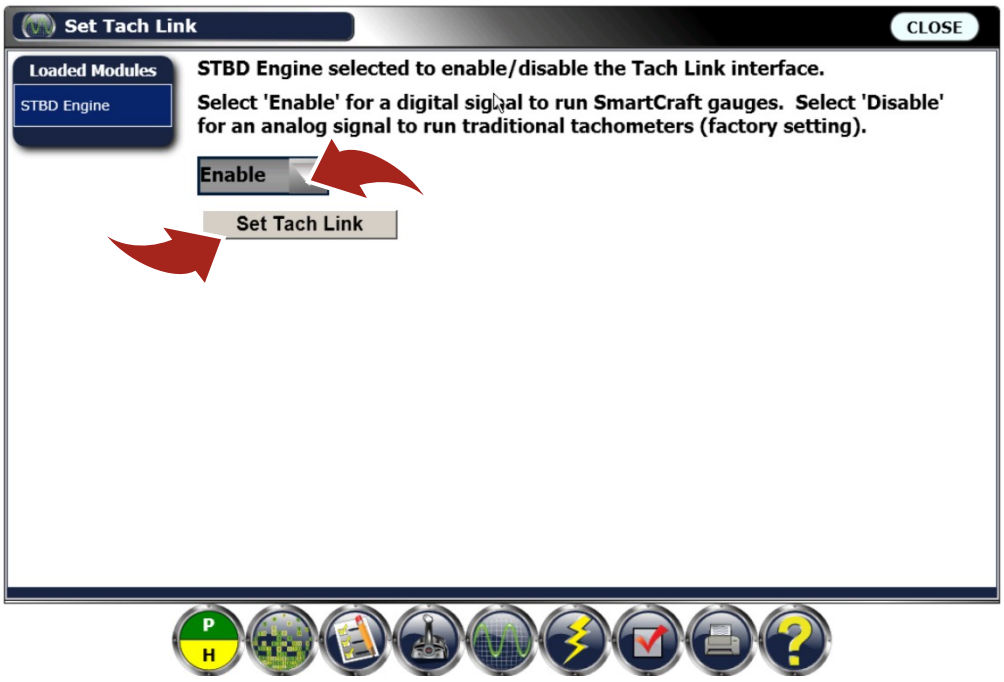


47788

24. Select the appropriate engine.

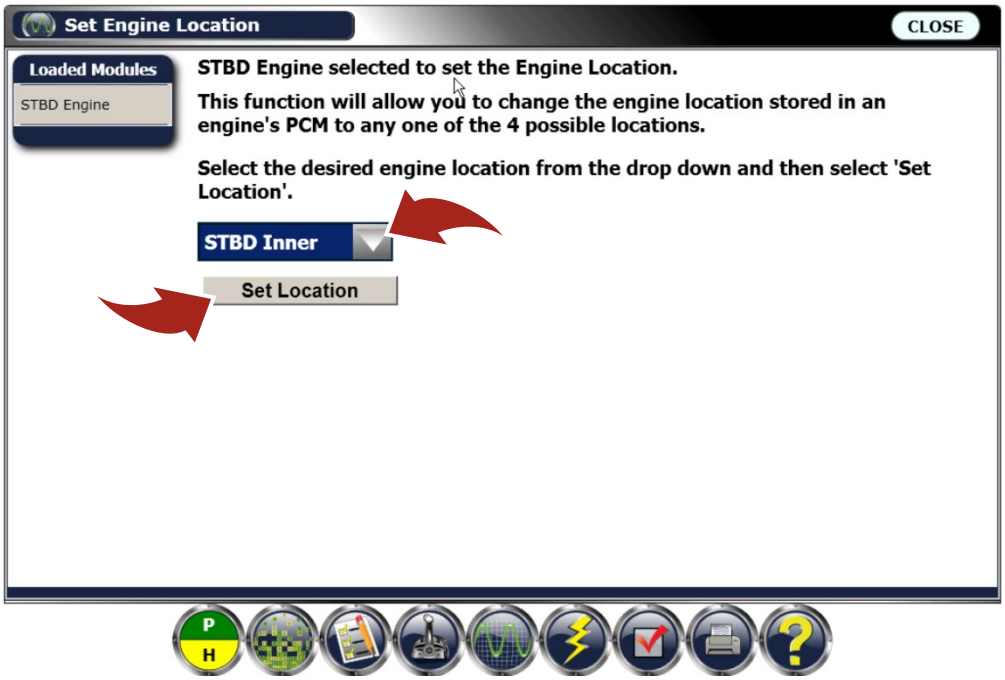


25. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.



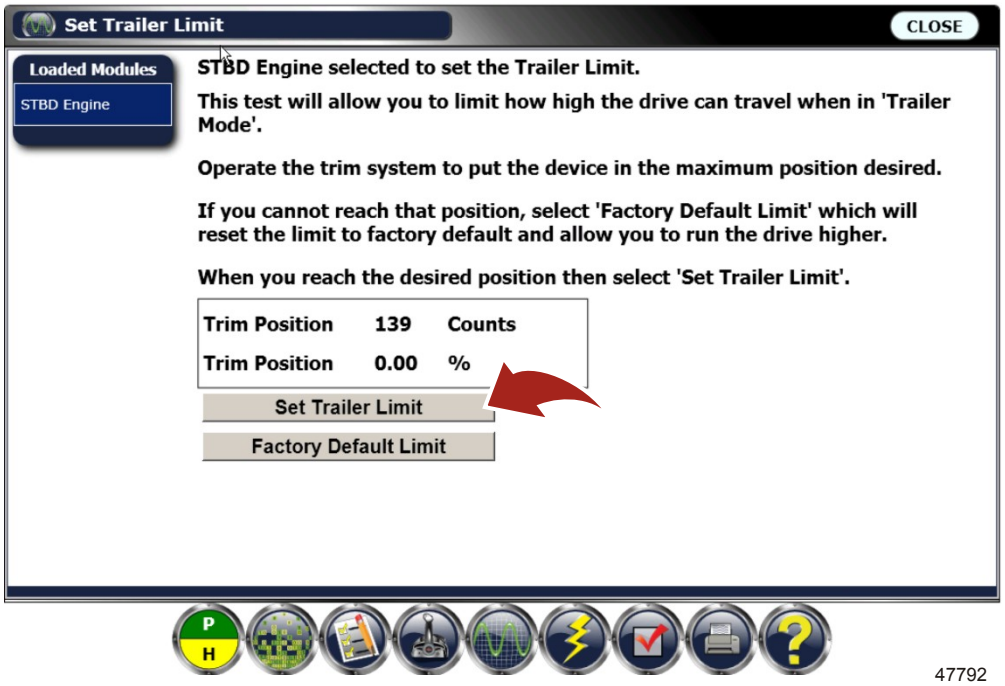
47790

26. Use the drop-down box and "Set Location" button to change the engine location, if required.



47791

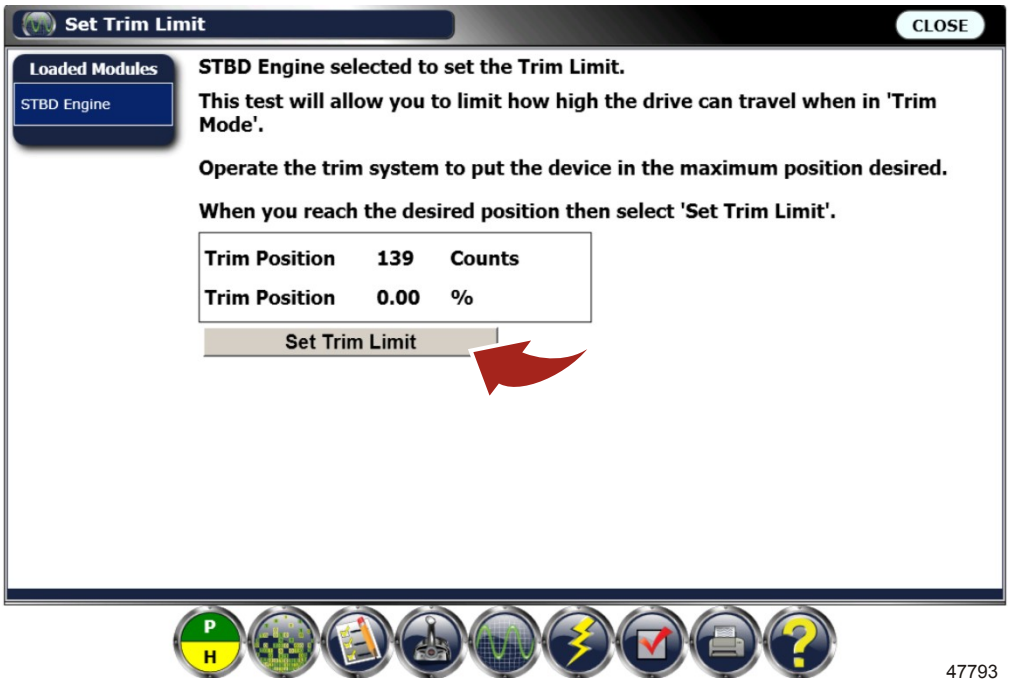
27. From the "Active Tests" screen, select "Set Trailer Limits," and follow the on-screen directions. The trailer limit must be set for boats equipped with a swim platform. The "Factory Default Limit" may be used if the drive can be trimmed without causing damage to the boat or equipment.



47792

28. From the "Active Tests" screen, select "Set Trim Limits" and follow the on-screen directions.

NOTE: It is necessary to measure the trim distance to ensure it does not exceed the 55.2 cm (21.75 in.) trim limit. This measurement is dependent on the position of the trim-in insert.



Removal and Installation

Section 2B - Inboard Models

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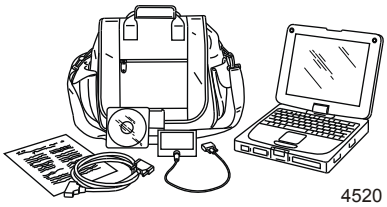
Lubricant, Sealant, Adhesives

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

Special Tools

Computer Diagnostic System (CDS G3)	Order from SPX
 4520	Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System G3 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

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

CDS G3 Termination Harness	84-8M0045065
 43351	Contains termination resistors to allow communication when G3 is connected to the engine's diagnostic connector.

Engine Removal

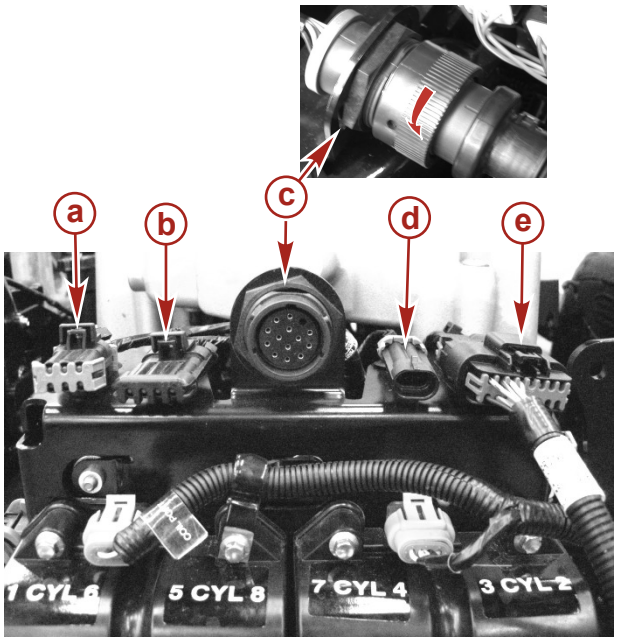
Removal

⚠ WARNING

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

1. Remove the boat from the water.
2. Disconnect the negative (–) battery cable from the battery.
3. Disconnect the positive (+) battery cable from the battery.
4. Disconnect the following connectors if applicable.
   a. Disconnect the boat harness from the engine harness. Turn the locking ring counterclockwise to release the thread engagement then pull the connection straight out.
   b. Disconnect the paddle wheel and tank level connector.
   c. Disconnect the power harness connector.

d. Disconnect the transom harness connector.



44777

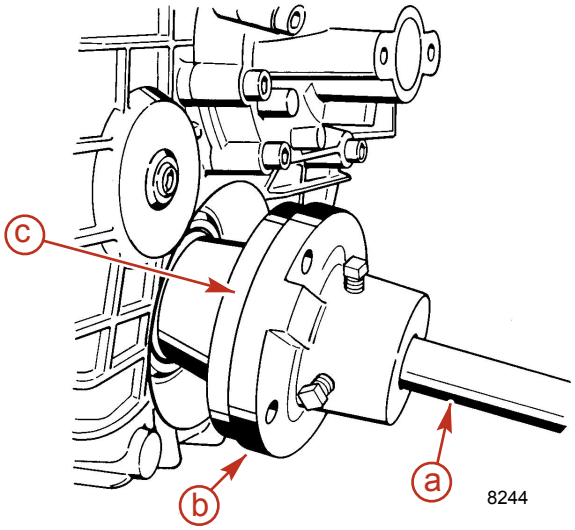
- **a -** Paddle wheel and tank level connector
- **b -** Diagnostic connector
- **c -** Engine harness connector
- **d -** Power harness connector
- **e -** Transmission harness connector

5. Close the fuel shut-off valve, if equipped.

⚠ WARNING

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

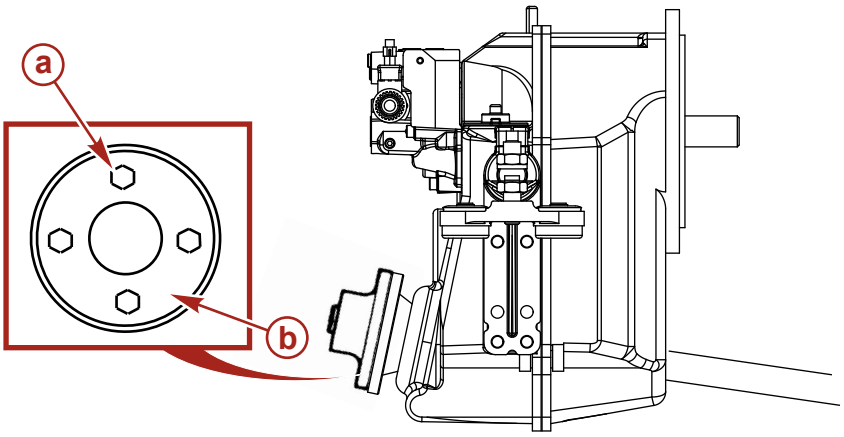
6. Disconnect and plug the fuel lines to prevent fuel from leaking into the bilge.
7. Disconnect the trim sender wire connections from the engine harness.
8. Disconnect the battery isolator wires, if equipped.
9. Disconnect the seawater inlet hose.
10. Disconnect the water heater lines, if equipped.
11. Disconnect the exhaust system hoses.
12. Disconnect the shaft-log-seal hose from the hose fitting on the exhaust manifold.
13. Remove the propeller shaft as follows:
    a. Remove and retain the bolts, lock-washers, and nuts from the propeller shaft coupler, and disengage the couplings.



8244

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

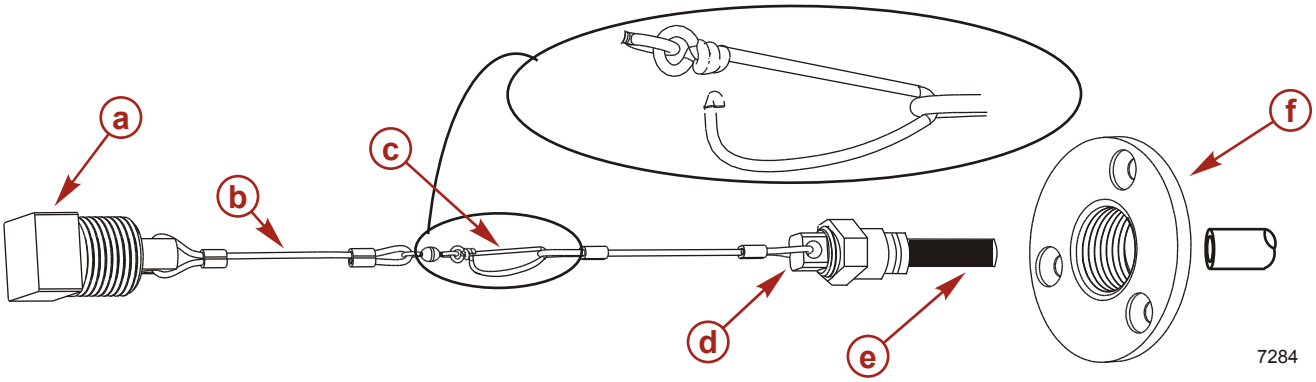
b. On V-drive models, remove the safety wire, set screws, and the propeller shaft flange from the propeller shaft.



a - Bolts
b - Transmission coupler

c. Slide the propeller shaft away from the transmission to create suitable clearance.

14. Remove and retain the boat drain plug.
15. Disconnect the oil drain hose lanyard from the boat drain plug.



a - Bilge drain plug
b - Tether
c - Clip
d - Oil drain hose plug
e - Oil drain hose
f - Bilge drain flange

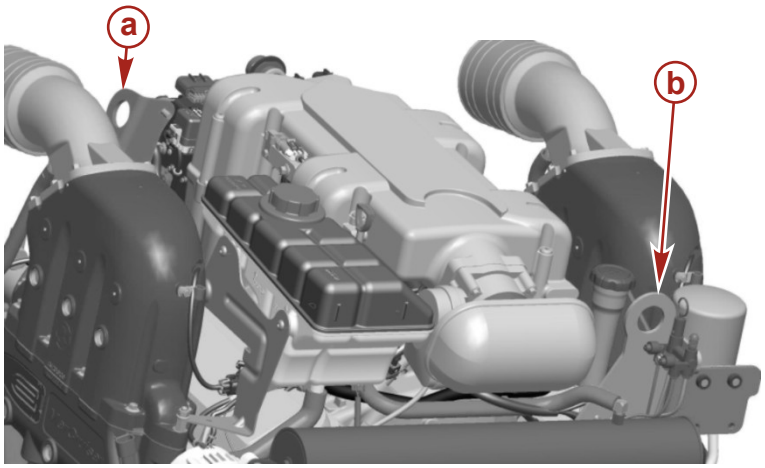
16. If applicable, disconnect continuity wires and accessories that are connected to the engine.

⚠ CAUTION

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

IMPORTANT: Do not allow the engine to rest on the oil pan.

17. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended.

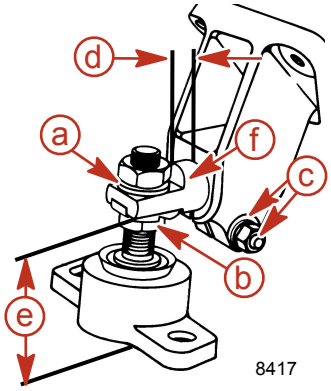


43746

a - Rear lifting eye
b - Front lifting eye

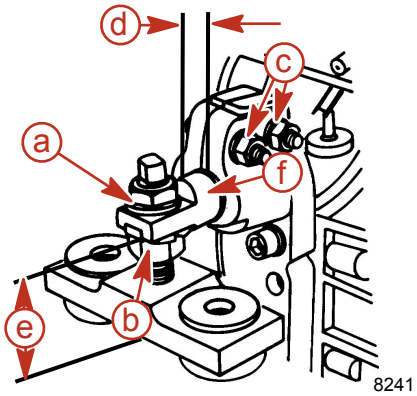
18. Remove and retain the port and starboard rear engine mounting fasteners.
19. Remove and retain the starboard and port front engine mounting fasteners.

NOTE: *If the engine will be reinstalled you may want to leave the base on the stringer and only remove the locking nut and locking washer.*



8417

Typical front mount



8241

Typical rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolts and nuts, with lock-washers
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

20. Using an overhead hoist, carefully remove the engine and the transmission. Do not damage the control valve assembly on the transmission.

DTS System Installation Requirement

Due to updates on software and diagnostic tools we are not including this information in the service manual.

Refer to the appropriate Mercury MerCruiser Installation Manual for the boat instrumentation and engine package software settings. Do not operate the boat without setting the trim limit and helm configuration.

Refer to the PCM 09 Diagnostic Service Manual for software installation or fault code diagnostic issues.

Emission-Related Instructions

Important Information

NOTICE

Failure to follow these instructions when installing a certified engine in a vessel violates U.S. federal law (40 CFR 1068.105[b]) and may result in fines or other penalties as described in the U.S. Clean Air Act.

Controlling Evaporative Emissions

Specific installation steps are required to control evaporative emissions. The installer and/or the vessel manufacturer must meet the requirements of EPA regulation 1045.112 and federal regulation 40 CFR part 1060.

Meeting Design Specifications

Other instructions to ensure that the engine will operate according to the manufacturer's design specifications are referenced in the Mercury MerCruiser installation manual provided with the product. Refer to:

1. **Section 3—Exhaust System.**
   - Important Information
   - Exhaust Recommendation
   - Exhaust Emissions
   - Measuring Exhaust Elbow Height
2. **Section 6—Drive System and Engine Mounting.**
   - Exhaust System Hose and Tube Connection

Emission Control Information Label

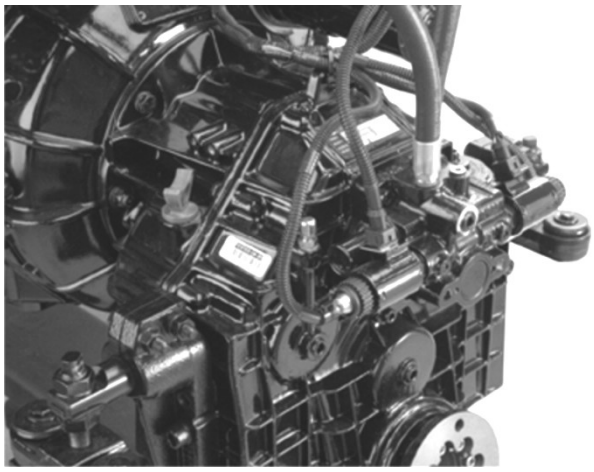
If you install the engine in a way that makes the engine's emission control information label difficult to read during normal engine maintenance, you must place a duplicate label on the vessel, as described in 40 CFR 1068.105.

Refer to **Section 1—Emission Control Information Label**.

Engine Preparation

ZF Marine Transmissions—DTS

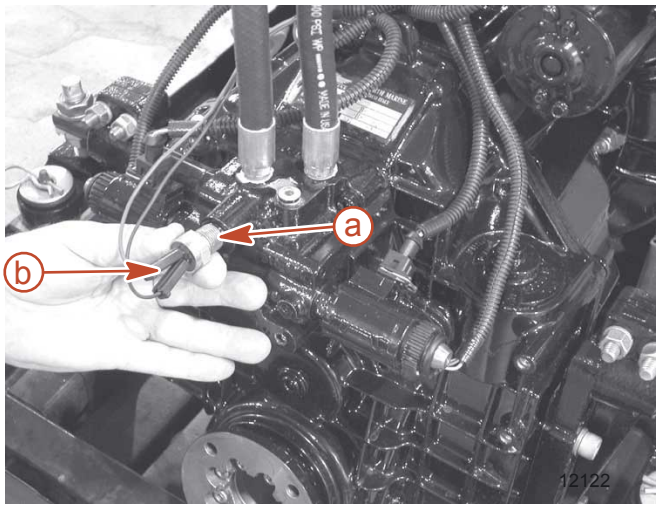
The oil temperature sensor for the ZF Marine transmissions with electronic shift is not installed at the factory. An allen plug is installed in the port for shipping. The oil temperature sensor is provided in a parts bag.



20418

ZF Marine transmission—DTS (oil temperature sensor not installed)

Remove the allen plug and install the oil temperature sensor. Connect the wire connections, of the harness, to the oil temperature sensor.



ZF Marine transmission—DTS (oil temperature sensor installed)

a - Oil temperature sensor
b - Oil temperature sensor wire connections

Positive (+) Connections on Engine

IMPORTANT: There is a fuse located at the starter solenoid. Do not remove this fuse.

1. Install the battery positive (+) cable directly to the positive (+) stud on the starter.
2. Tighten the nut to specification.

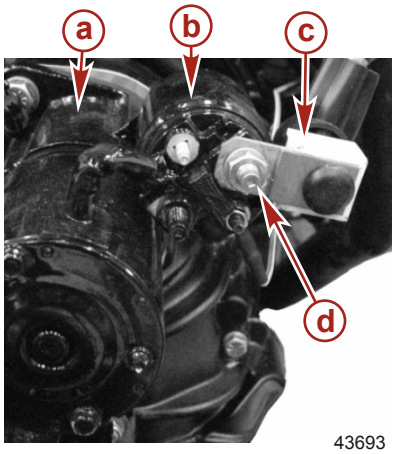


Image shown without battery cable attached

a - Starter
b - Starter solenoid
c - 90 amp fuse - do not remove
d - Positive (+) starter stud

Description	Nm	lb-in.	lb-ft
Positive battery cable on the starter stud	9.5	84	–

3. Apply a thin coat of sealant over the stud and the connection.

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

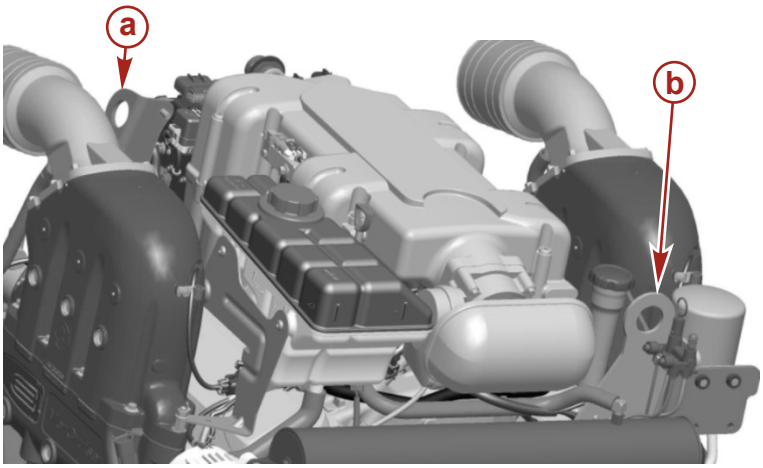
4. Drape the battery cable over the top of the engine to prevent interference during installation.

Engine Installation

Engine Mount Pre-Adjustment

1. Remove the hardware that secures the engine to the shipping pallet.

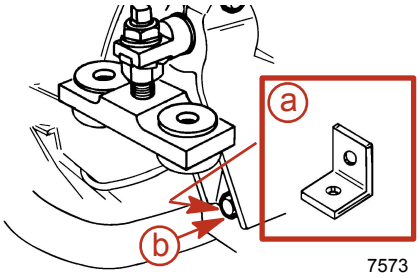
2. Attach a suitable sling and spreader bar (to prevent plenum and throttle plate damage) to the lifting eyes on the engine and adjust so that the engine is level when suspended. Lift the engine with an overhead hoist.



43746

a - Rear lifting eye
b - Front lifting eye

3. Remove the L-shaped shipping brackets from both rear (transmission) mounts. Retighten the mount bracket attaching bolts.



7573

Typical
a - L-shaped bracket
b - Transmission mount bracket attaching bolt

Description	Nm	lb–in.	lb-ft
Mount bracket bolt	64	–	47

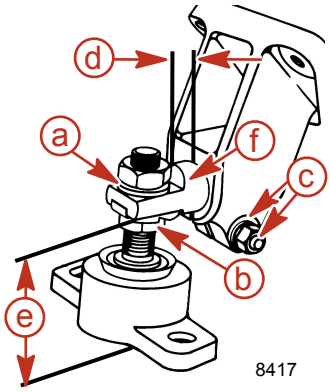
IMPORTANT: Engine mounts must be adjusted, as explained in steps 4 and 5, to center mount adjustment and establish a uniform height on all mounts.

4. 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 specified. If it is not, loosen the mount locking nut and turn the adjusting nut in the direction required to obtain the proper dimension; then retighten the locking nut.

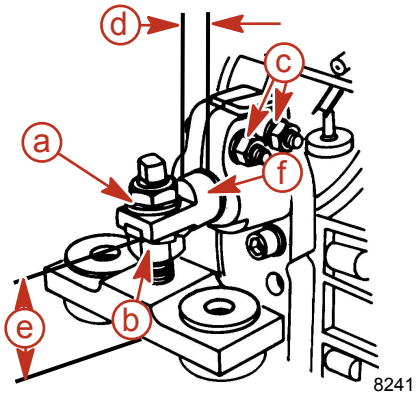
Description	Specification
Distance from the bottom of the mount to the bottom of the trunnion	67 mm + 2 mm (2-5/8 in. + 1/16 in.)

5. Loosen the clamping bolts and nuts on all four engine mount brackets.
   - Keep the bolts tight enough to prevent the trunnions from moving in or out during engine installation, yet loose enough to allow the engine position to be laterally adjusted.
   - Keep each mount trunnion equally extended.

- When the base of the engine mount is on the boat stringers, the mount trunnion must extend a minimum of 10 mm + 2 mm (3/8 in. + 1/16 in.) from the trunnion clamp.



Typical front mount



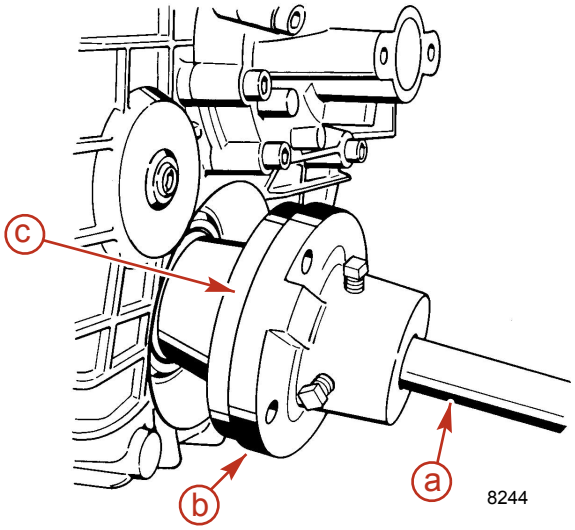
Typical rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolts and nuts, with lock-washers
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

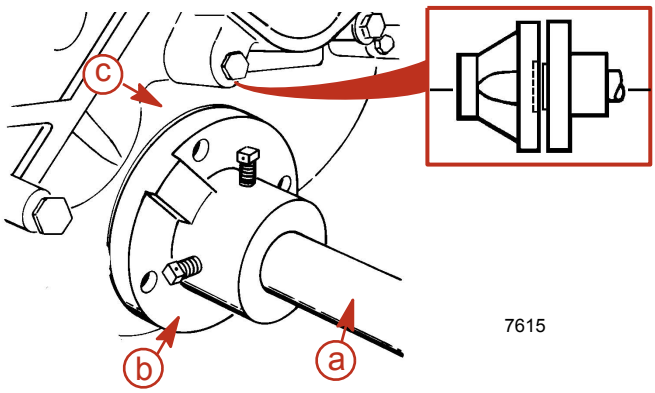
Models With 8 Degree Down Angle Transmissions

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



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 4 mounts after performing the initial alignment. This is necessary to allow for the final engine alignment.



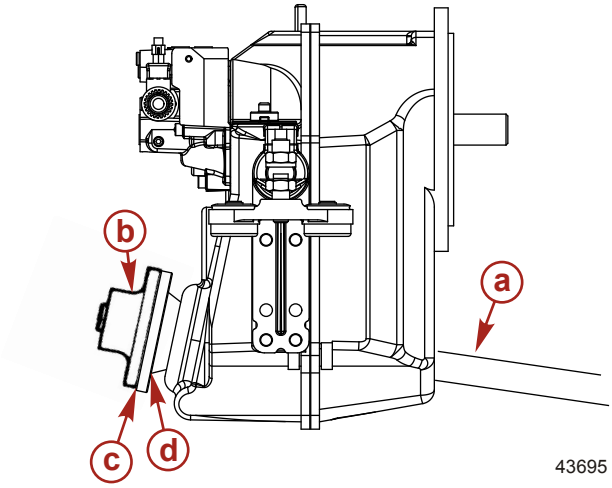
7615

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

2. Ensure that all 4 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 the lag bolts securely.
3. Disconnect the overhead hoist and remove the sling.

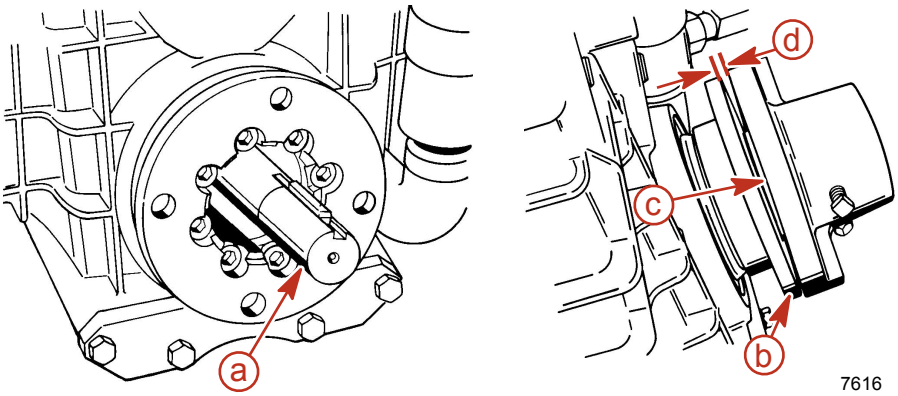
Models with V-Drive Transmissions

1. Lift the engine into the boat and position it so that enough propeller shaft protrudes through the transmission and the output flange for the propeller shaft coupler to be attached. Then install the coupler and position the engine (no visible gap between the coupling faces when butted together). Adjust the engine bed height if necessary to obtain the proper alignment. Do not use the mount adjustments to adjust the engine position at this time.
IMPORTANT: The engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all 4 mounts after performing the final alignment. This is necessary to allow for the final engine alignment.



43695

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



7616

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

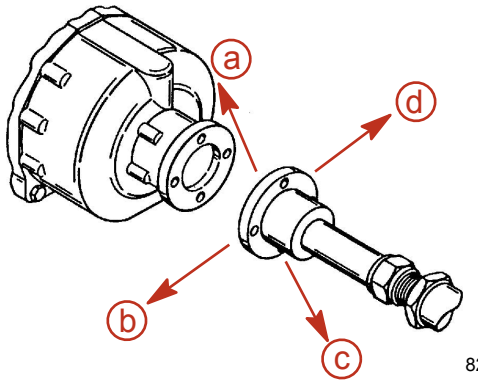
2. Ensure that all 4 mounts are positioned properly, then fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts (of sufficient length) and flat washers. Tighten the lag bolts securely.
3. Disconnect the overhead hoist and remove the sling.

Final Engine Alignment

IMPORTANT: The engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

The engine must be aligned so the transmission and the 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.

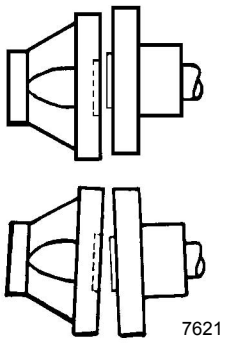
1. Check the mating faces on the transmission output flange and the propeller shaft coupler to ensure that they are clean and flat.
2. Center the propeller shaft in the shaft log as follows:
   a. Push down and then lift the shaft as far as it will move. Then place the shaft in the middle of the movement.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



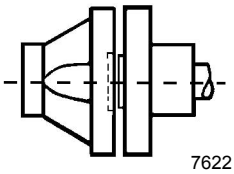
Typical down angle (V-drive similar)

- **a -** Up
- **b -** Port
- **c -** Down
- **d -** Starboard

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

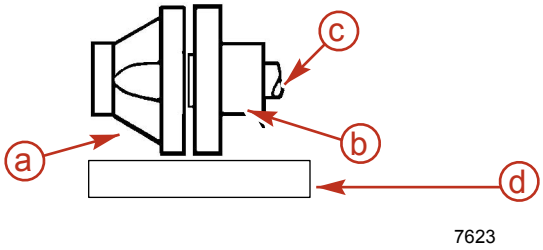


Incorrect



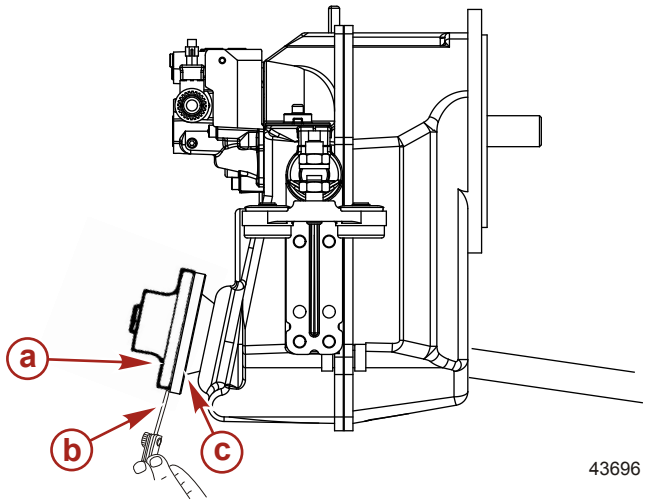
Correct

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

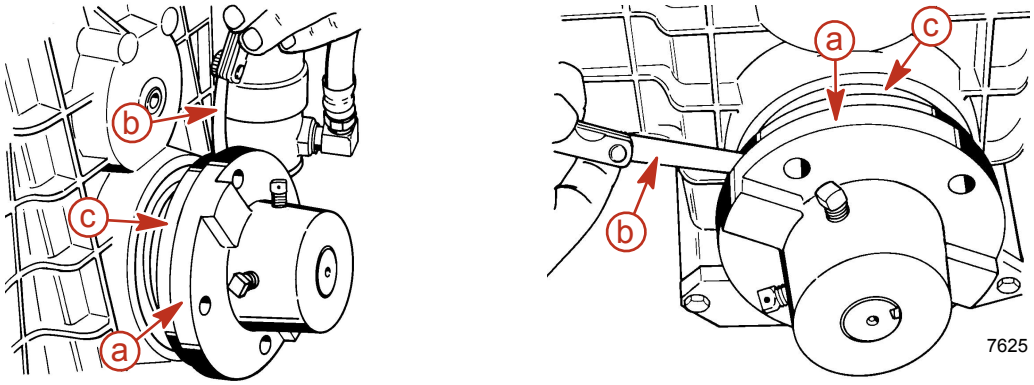


- **a -** Transmission output flange
- **b -** Propeller shaft coupler
- **c -** Propeller shaft
- **d -** Straight edge

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.



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



ZF Marine

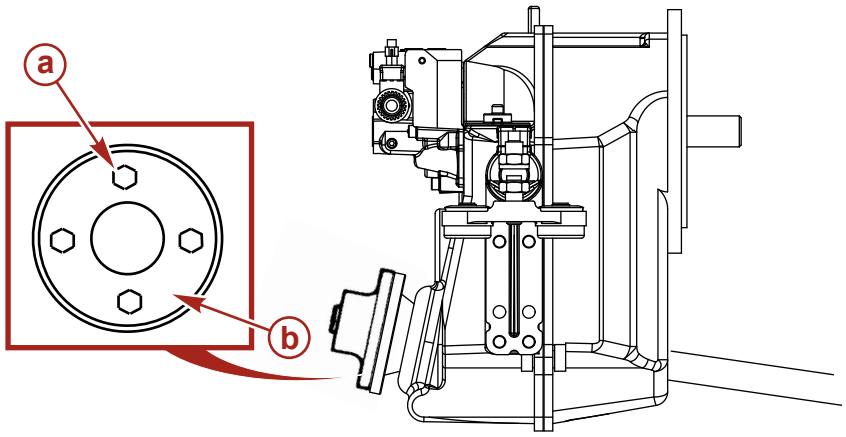
a - Propeller shaft coupler
b - Feeler gauge
c - Transmission output flange

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 mounts (or rear mounts) adjusting nuts must be turned equally to keep the engine level from side to side.
   NOTE: *Some rear mounts have 1 clamping screw and nut on each side.*
   b. To move the engine to the left or the right: Loosen the clamping bolts and nuts on all 4 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 the front end of some mounts. Loosen the lag bolts (which fasten mounts to 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. Tighten the clamping bolts and nuts on all 4 mount brackets to specification.

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

8. Tighten the locknut on all 4 mounts.
9. Bend one of the tabs on the tab washer down onto the flat of the adjusting nut.
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 coupling together with the bolts, lockwashers and nuts. Tighten the fasteners to specification.

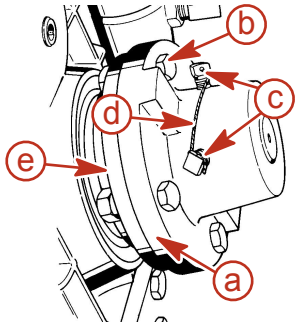


43697

a - Bolts
b - Transmission coupler

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

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



7627

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

Description	Nm	lb–in.	lb–ft
Coupling bolts and nuts	68	–	50

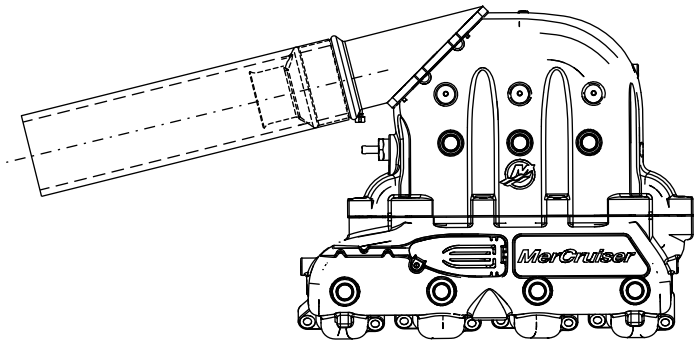
Exhaust System Hose and Tube Connection

NOTICE

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

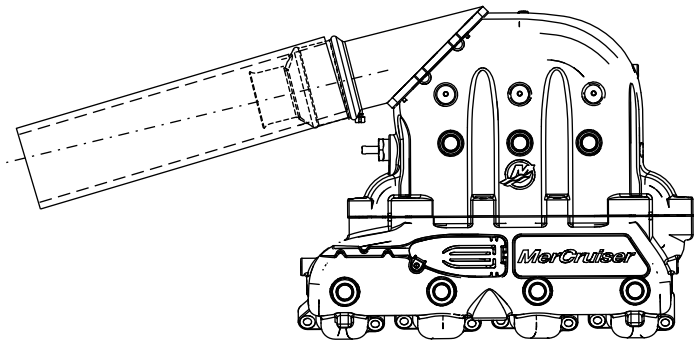
IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Install hoses on exhaust elbow outlets so discharge water from the exhaust elbow flows around the entire inside diameter of the hose.



31672

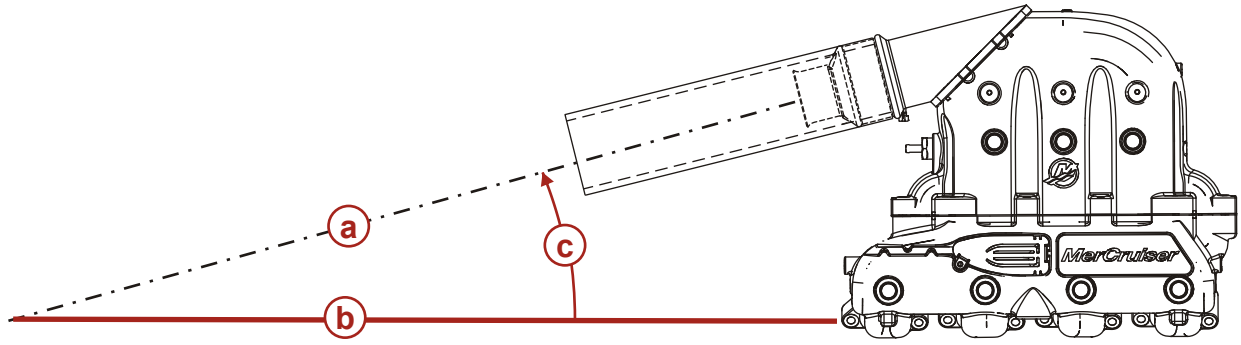
Correct alignment



31673

Incorrect connection

To avoid hot spots that can burn exhaust hoses, install the exhaust hoses at the angle shown below.

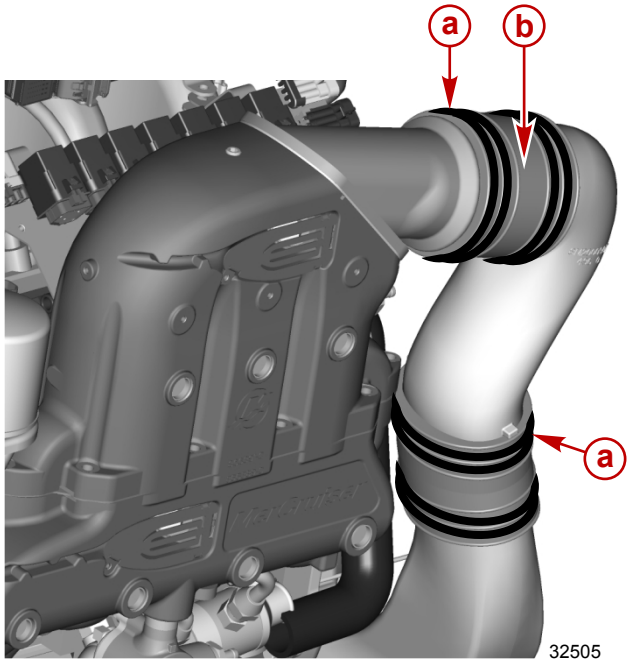


43665

a - Exhaust outlet centerline
b - Parallel with crankshaft centerline
c - Exhaust angle 14° ± 5°

Secure all exhaust hoses or tubes with at least two hose clamps. Tighten to specification.

NOTE: *The following example may not depict your model or installation.*

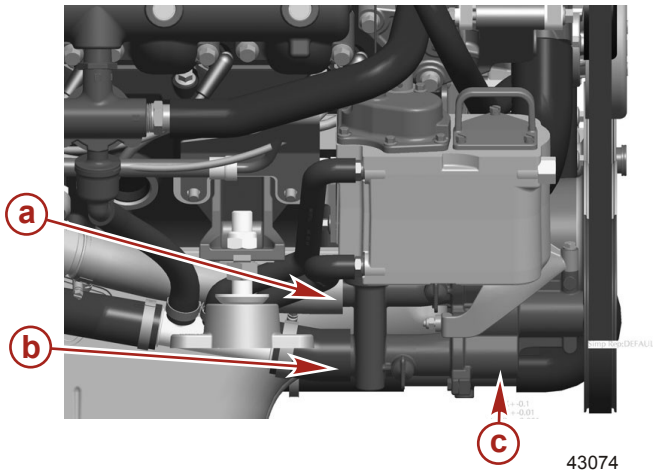


a - Clamps
b - Exhaust tubes

Fluid Connections Inboard Models

Seawater Pump Pickup Connection

1. Ensure the seawater inlet hose is connected to the upper hose fitting of the seawater pump. Connect the opposite end of the hose to the seawater inlet source.



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

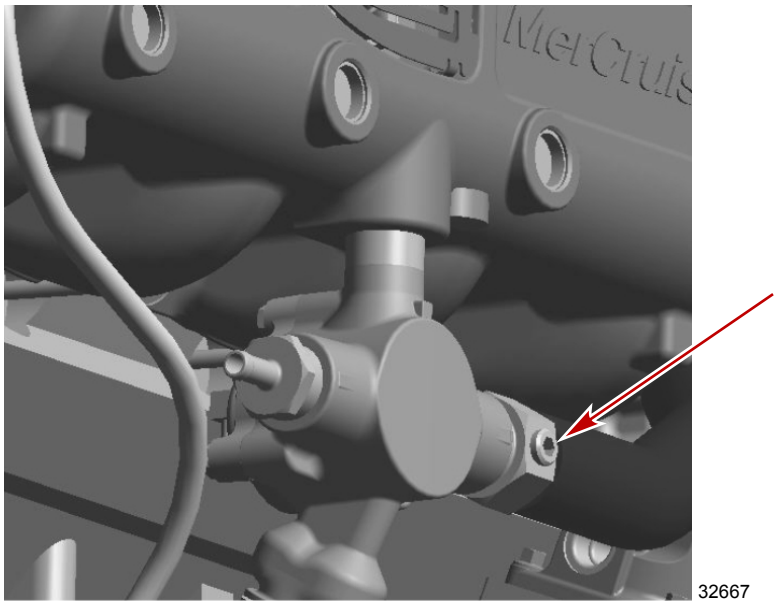
Shaft Log Seal Connection

NOTICE
Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.

1. Attach the shaft log seal cooling water hose fitting to the access port in the reducer fitting, located on the aft side of the poppet valve underneath the exhaust manifold.
   IMPORTANT: Do not remove the reducer fitting, even if you are not using the shaft log seal. The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system.

NOTICE

Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.



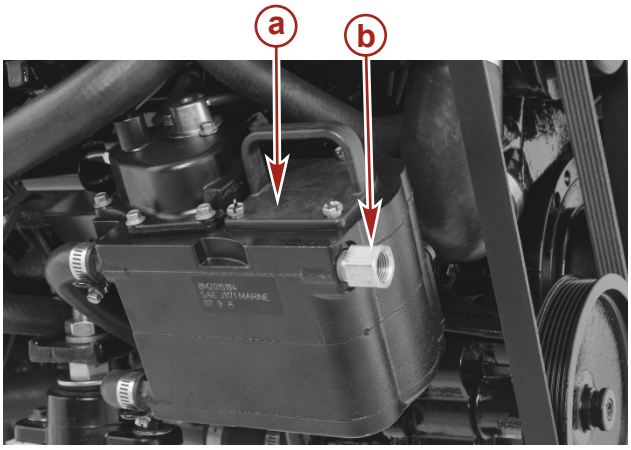
Shaft log seal access port

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

Fuel Line Connection

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

1. Remove the shipping plug from the fuel fitting.
2. Connect the flexible fuel line to the fuel fitting.
   IMPORTANT: Hold the fuel inlet fitting stationary with a suitable wrench while tightening the fuel line.



a - Gen III Cool Fuel Module
b - Fuel fitting

Engine Electrical Connections

Electrical Connections

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

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

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

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

Boat Harness and Instrumentation Connections

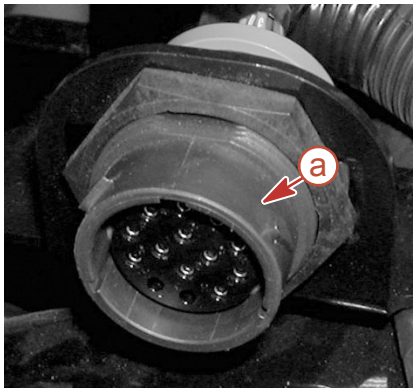
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses.

The four basic gauges that must be used with the engine are:

- Tachometer
- Oil pressure
- Water temperature
- Voltmeter

IMPORTANT: Maximum accessory load on the engine harness is 15 amps. If additional accessory load is needed, an accessory kit is available.

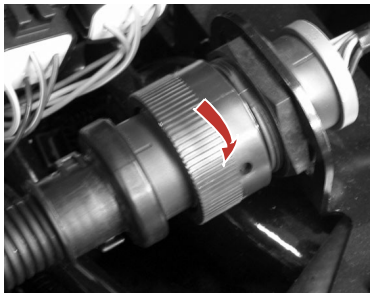
1. If an extension harness is required, connect the boat harness to the extension harness and connect the extension harness to the engine harness. Ensure that the harness does not rub or get pinched.
2. Fasten harnesses to boat at least every 46 cm (18 in.) using appropriate fasteners.



23135

Typical
a - Engine harness plug

3. Connect 14-pin harness to engine. Turn locking ring until firm snap is felt.



23136

SmartCraft Product

A Mercury SmartCraft System instrument package can be purchased for this product. A few of the functions the instrument package will display are engine rpm, coolant temperature, water pressure, battery voltage, fuel consumption, and engine operating hours. The Smartcraft instrument package will also aid in engine diagnostics.

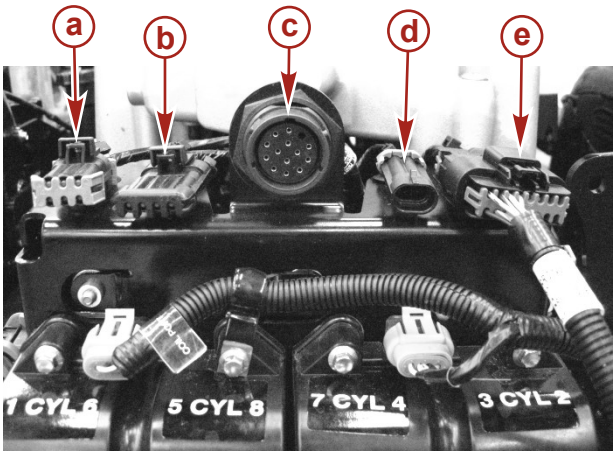
The SmartCraft instrument package will display critical engine alarm data and potential problems.

Refer to the Mercury SmartCraft Operator's Supplement (90-10229023) for the warning functions monitored and basic operation of the SmartCraft Instrument package. Refer to the instructions included with the instruments for installation instructions.

Engine Harness Connections

IMPORTANT: The 14-pin wiring harness can supply a maximum 15 amps of accessory power. An accessory relay and harness kit is available for higher accessory power needs.

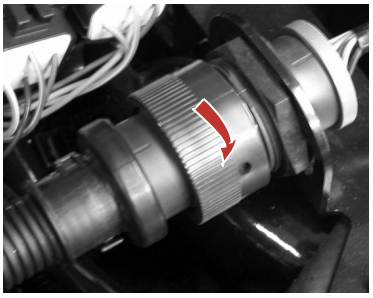
1. Route the instrumentation harness to the engine. Do not allow the harness to rub or get pinched. If an extension harness is required, secure the connection properly.
2. Fasten the harness to the boat at least every 45.7cm (18 in.), using appropriate fasteners.
3. Connect the following:



43698

a - Paddle wheel and tank level connector
b - Diagnostic connector
c - 14-pin harness connector
d - Power harness connector
e - Transmission connector

NOTE: *When connecting the 14-pin harness to the connector on the engine, turn the locking ring until a firm snap is felt.*



23136

NOTE: *Refer to Instrumentation Wiring Diagrams for specific wiring diagrams.*

Audio Warning System Connections

⚠ WARNING

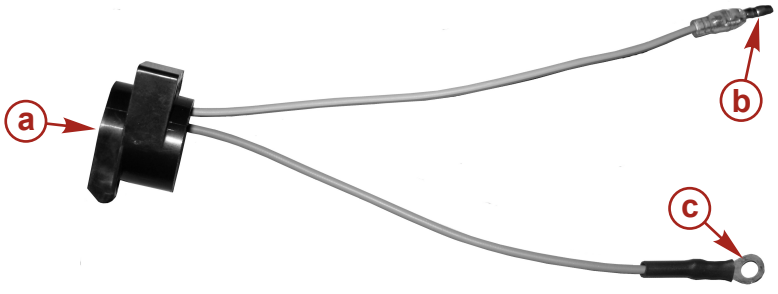
Installing non-potted electrical components in explosive environments can result in serious injury or death from fire or explosion. Install all non-potted electrical components such as warning alarms away from environments where fuel or fuel vapor is present such as engine or fuel tank compartments.

1. Select a location for the audio warning alarm that meets all of the following:
   - Alarm can be easily heard, yet is out of sight
   - Alarm can be easily accessed for installation and maintenance
   - Alarm will remain dry

- Alarm is within length limits of the 46 cm (18 in.) purple alarm wire that connects to the "I" terminal or 12 volt source on switched side of ignition switch.

NOTE: *The terminal to which wire is attached must have no voltage when ignition switch is in the OFF position.*

2. Place the alarm in desired location and secure it to wire bundle with the tie strap provided.
3. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.
4. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or ignition switch. Tighten the connection securely.



a - Alarm
b - TAN/ BLUE wire
c - PURPLE wire

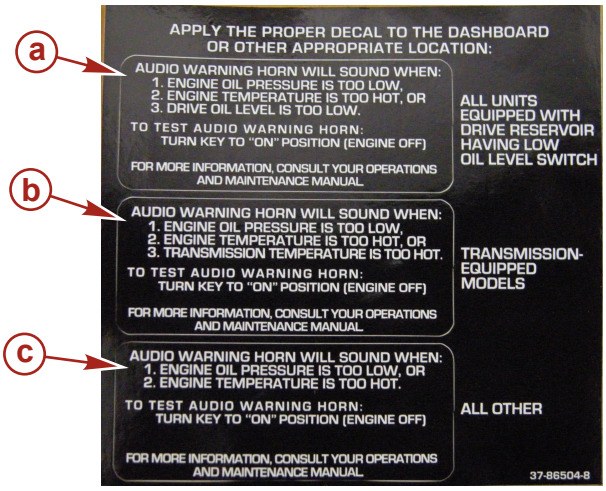
45019

5. Place the small transparent alarm decals on the bottom of the water temperature and the oil pressure gauges.

45021

Small transparent alarm decals

6. Choose the proper large decal for the engine package installed and place it on the instrument panel or other appropriate location easily viewed by the operator.



45020

a - Models equipped with a drive reservoir having low oil level switch
b - Models equipped with a transmission
c - All other models

7. Test the audio warning system as detailed.
   a. Turn the ignition switch to the "ON" position without cranking the engine.
   b. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

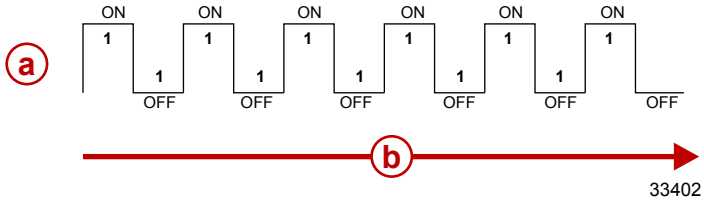
There are two warning horn states:

- Caution

- Severe

Caution

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

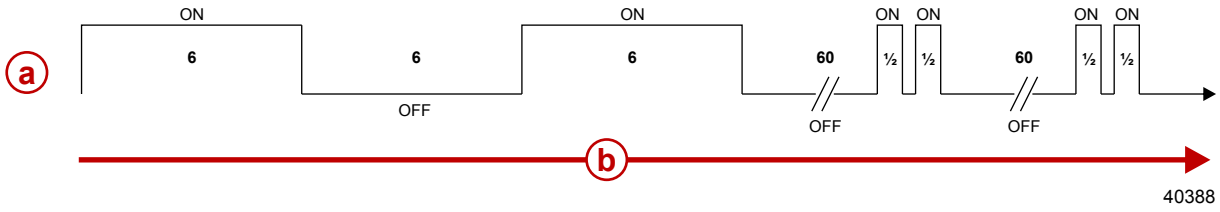
Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

Severe

IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Service Engine Light and OBD-M MIL Kit

Boats powered by Emissions Control Technology (ECT) catalyzed engines must be equipped with a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light. Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

The service engine icon or MIL will provide a visual indication of a malfunction with the engine's emission control system and will remain illuminated while the OBD-M fault is active.

SC 1000 gauge and service engine light

Testing the OBD-M Malfunction Indicator Lamp (MIL)

1. Turn the ignition switch to the on position without cranking the engine.
2. The service engine icon and MIL light will remain illuminated for 4 seconds if the visual indication system is functioning correctly.

Battery Cables Connection

IMPORTANT: The engine's electrical system uses a negative (–) ground.

1. Connect the engine's positive (+) battery cable (usually RED) to the positive (+) battery terminal.
2. Connect the engine's negative (–) battery cable (usually BLACK) to the negative (–) battery terminal.
3. Install the power harness.
4. Secure the battery cables and the power harness leads to the battery with hex nuts. Tighten the hex nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Hex nut	13.5	120	–

5. Spray the battery terminals with a battery connection sealant to help prevent corrosion.

Engine Installation G3 Service Tool

Computer Diagnostic System (CDS) G3

Use the CDS G3 service tool for the following if applicable:

1. Configuration—Helm Configuration, CAN Pad Configuration, Drive Configuration, Compass Configuration, Import

47774

2. Active Test—Set Trailer Limit, Set Trim Limit, Set Engine Location, Set Tach Link

47775

Connecting the Computer Diagnostic System (CDS G3) Service Tool

NOTE: *The Computer Diagnostic System (CDS G3) procedural information is available in the help menu. If you have the CDS hardware, order the software and cable 8M0046124 from Mercury. The complete system is available from SPX.*

Computer Diagnostic System (CDS G3)	Order from SPX
CDS G3 Diagnostic Interface Tool With Harness	8M0046124

Models Equipped With a SmartCraft Diagnostic Port

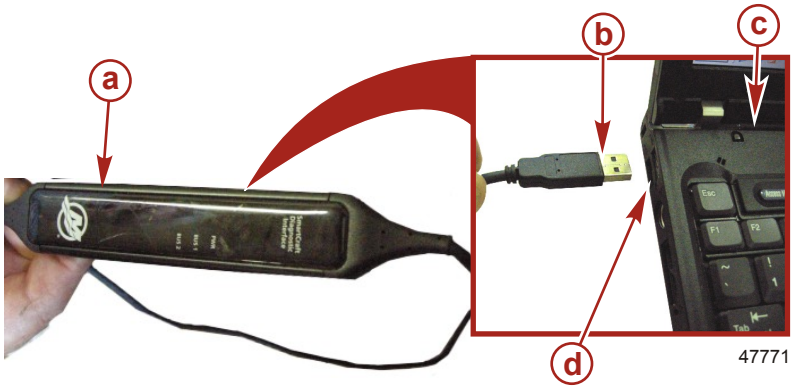
1. Ensure all engine key switches and engines are off.
2. Locate the SmartCraft diagnostic port at the boat helm.

   NOTE: *The diagnostic port may not be mounted on the dashboard if space is limited, but may be mounted under the dashboard, or in the cabin at an inconspicuous, but accessible location.*
3. Remove the cover and insert the CDS G3 interface harness connection.

47772

SmartCraft diagnostic port

4. Connect the CDS G3 interface USB port connector to the USB port on the G3 service tool.

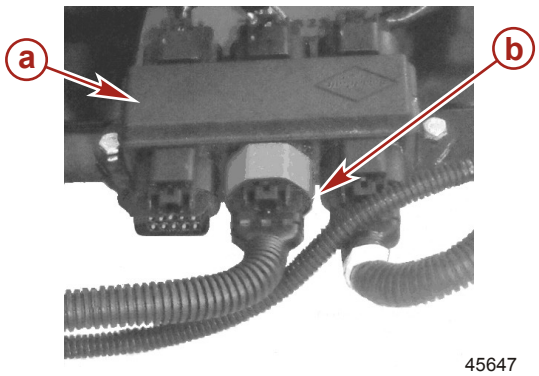


47771

a - CDS G3 interfacetool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

Models Equipped With a SmartCraft Diagnostic Junction Box

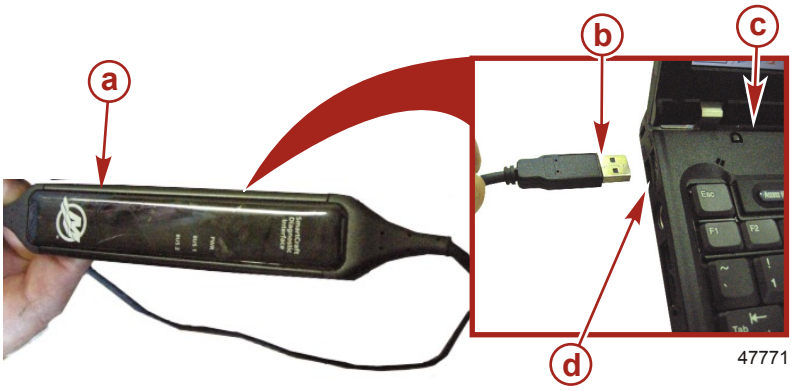
1. Ensure all engine key switches and engines are off.
2. Locate the standard junction box under the boat helm and connect the CDS G3 interface harness.



45647

a - Junction box
b - CDS G3 interface harness connector

3. Connect the CDS G3 interface USB port connector to the USB port on the CDS G3 service tool.



a - CDS G3 interface tool
b - CDS G3 interface USB port connector
c - CDS G3 service tool
d - USB port on the CDS G3 service tool

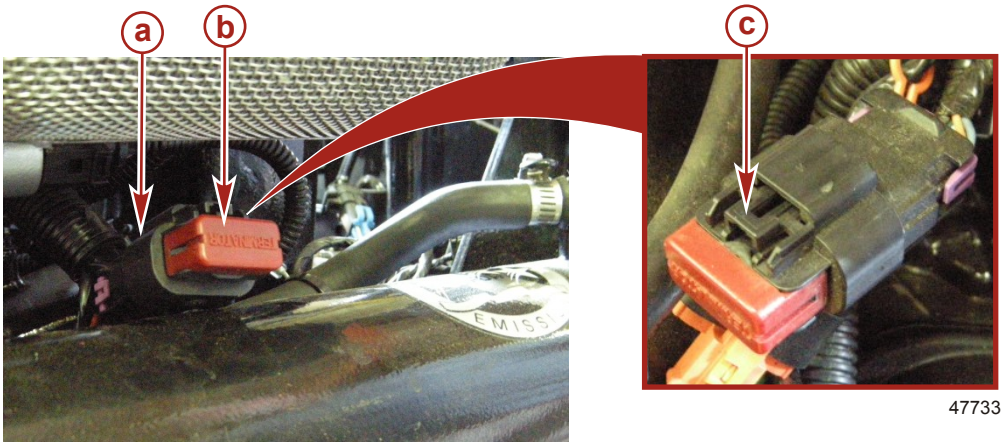
Models Not Equipped With SmartCraft Diagnostic Port or Junction Box

IMPORTANT: The CDS G3 termination harness is a terminal resistor. Only use it when connecting to the engine harness terminator connection. Do not connect the termination harness to the junction box or diagnostic port at the helm.

CDS G3 termination harness

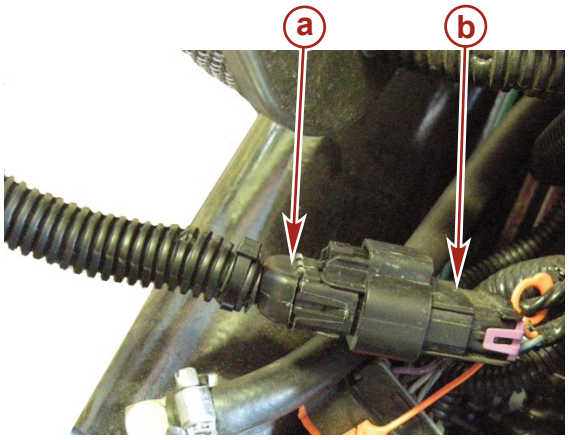
CDS G3 Termination Harness	84-8M0045065

1. Ensure all engine key switches and engines are off.
2. Locate the yellow or red terminator resistor on the engine harness and remove it by pushing the tab in while pulling the connections apart. Retain the yellow or red terminator resistor to reinstall after using the service tool.



Terminator resistor red or yellow
a - Terminator connection
b - Yellow or red terminator resistor
c - Tab

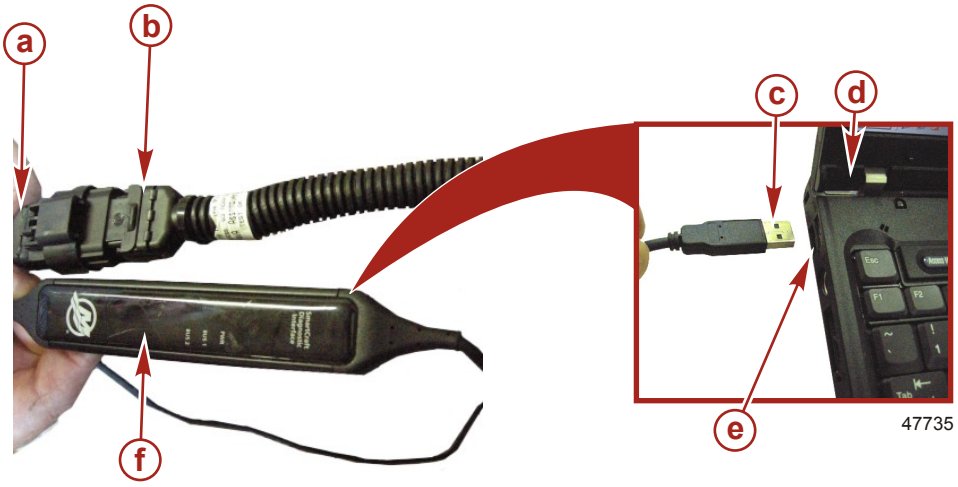
3. Connect the CDS G3 termination harness to the terminator connection on the engine.



47734

a - CDS G3 termination harness
b - Terminator connection

4. Connect the CDS G3 termination harness connector to the CDS G3 interface harness connector.
5. Connect the CDS G3 interface USB connector to the USB port on the CDS G3 service tool.

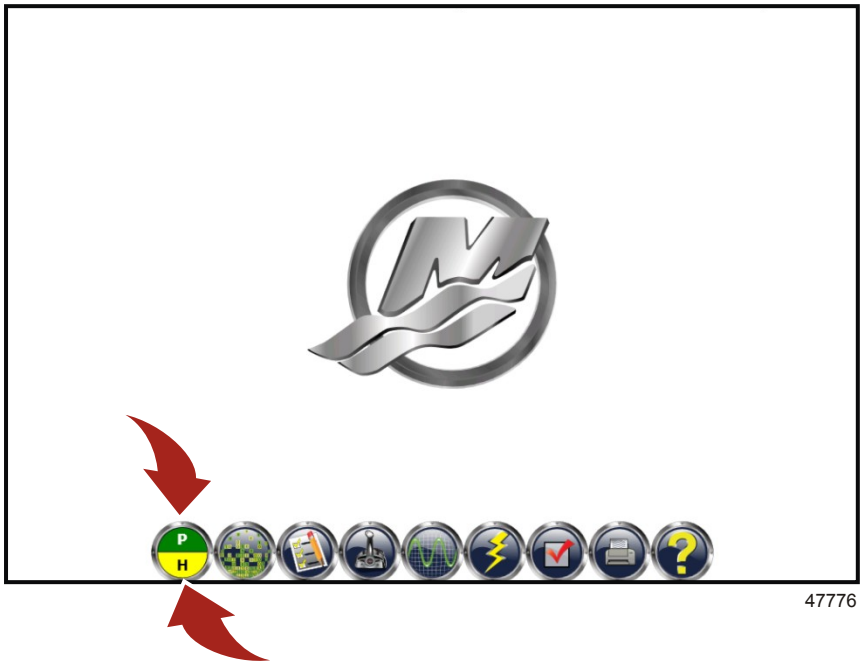


47735

a - CDS G3 interface harness connector
b - CDS G3 termination harness connector
c - CDS G3 interface USB connector
d - CDS G3 service tool
e - USB port on the CDS G3 service tool
f - CDS G3 interface tool

Inboard DTS Gas Engine Package Installation Using the CDS G3 Service Tool

1. With the G3 Service tool connected, turn on all engine key switches. If the CAN P and CAN H icons are both yellow, the PCM controller is not communicating. Find and correct the the connection problem.

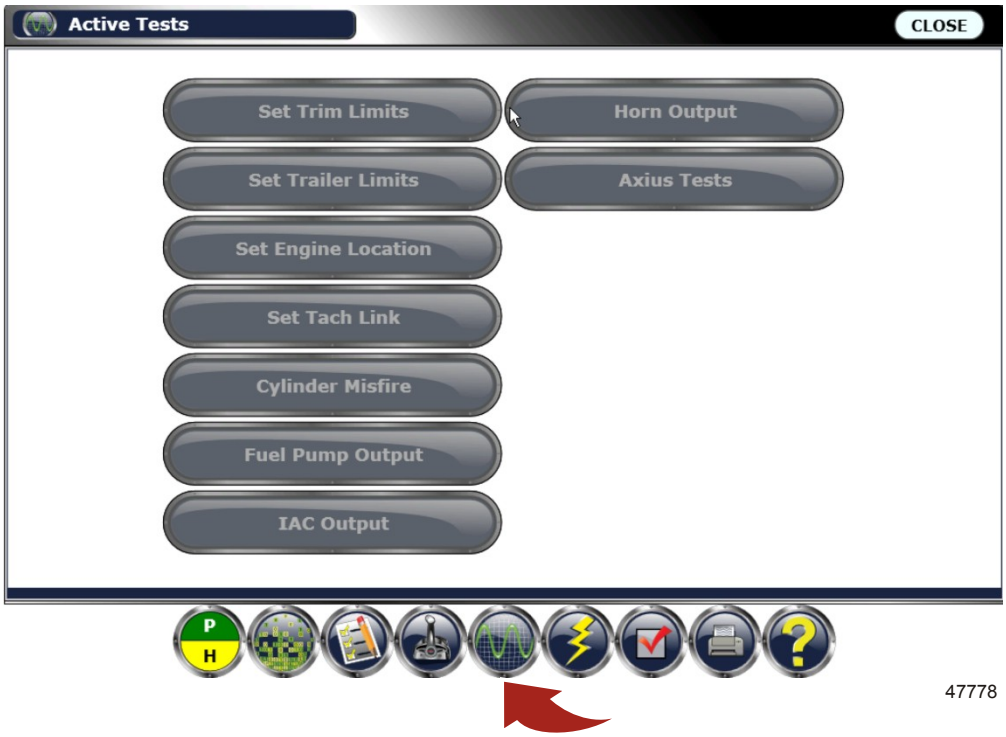


47776

2. Wait for the "Module Data" screen to appear.

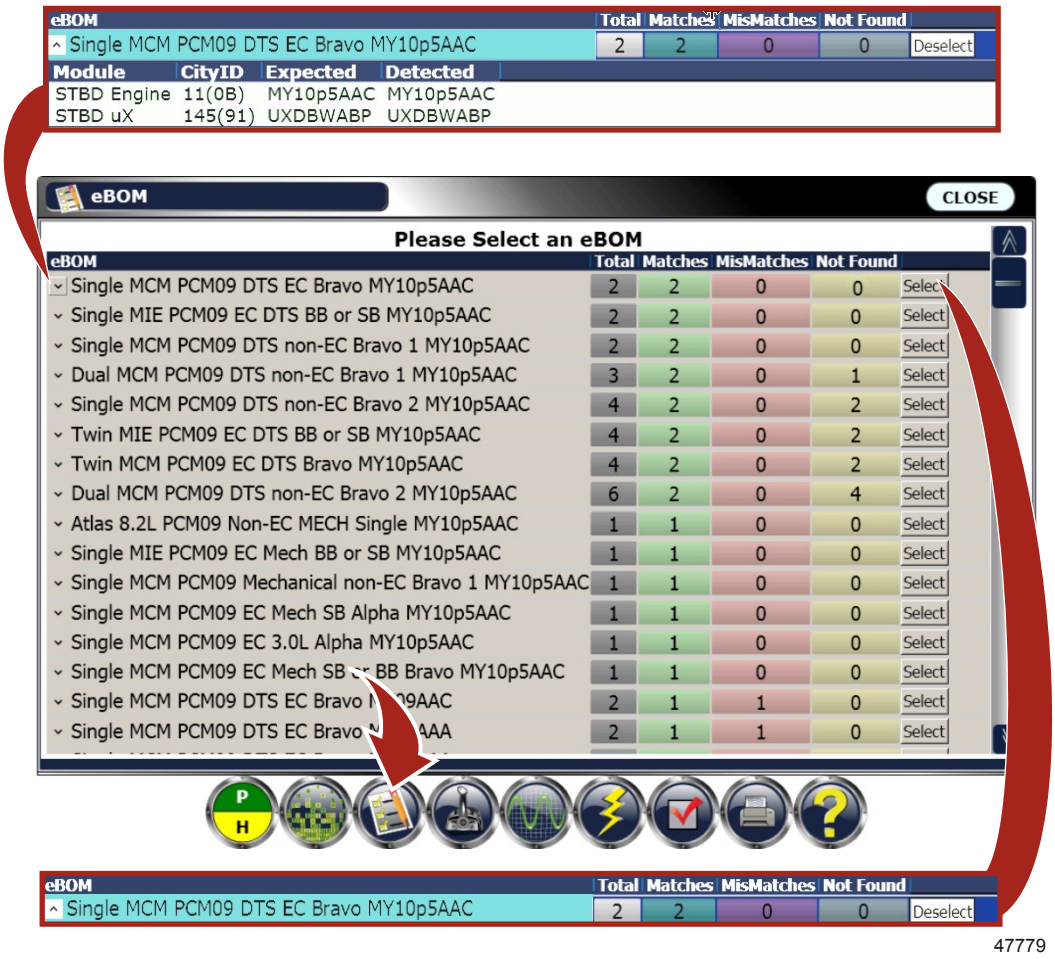
47777

3. The shaded buttons on the "Active Tests" screen indicate that the tests cannot be used because an eBOM has not been selected.



4. Select the "eBOM" icon.
   a. While the best choice for your power package will normally be near the top of the screen, it may appear anywhere in the list.
   b. Use the drop-down box to view the city ID.

c. Once you have located the eBOM that matches your power package, be sure to click the "Select" button.



47779

5. Return to the "Module Data" screen.
   a. Notice that the "Data Stream" is now available.
   b. This is a good time to "View Faults" to make sure that no faults are set in the controllers.

c. When you are finished, click on the Configuration icon to continue with the setup.

47782

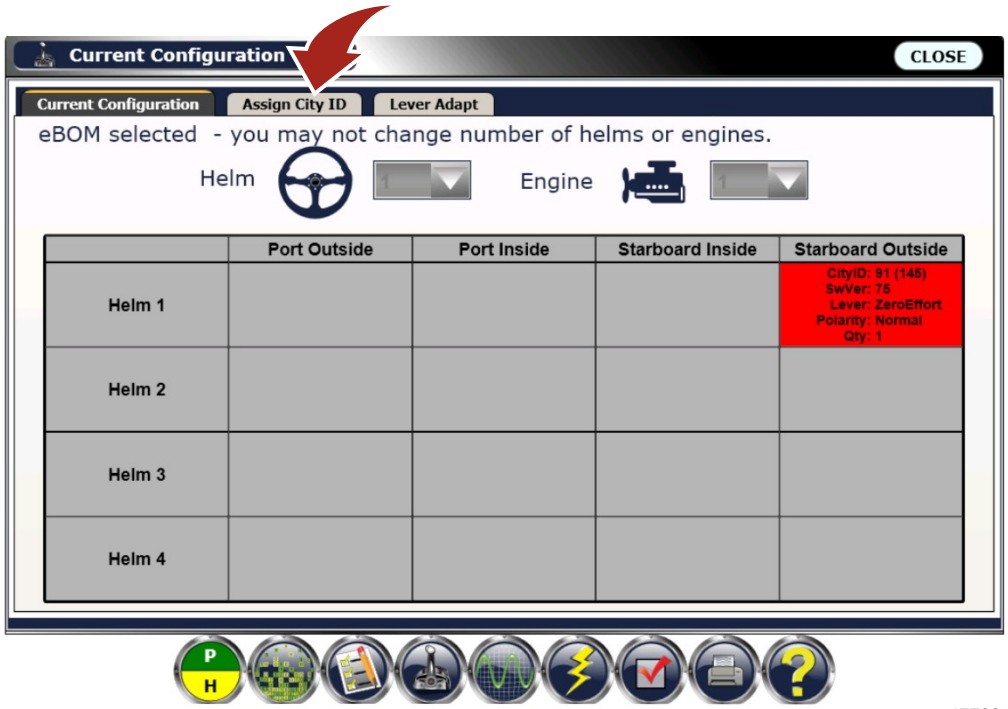
6. Select "Helm Configuration."

45499

7. Initiate "Helm Setup."

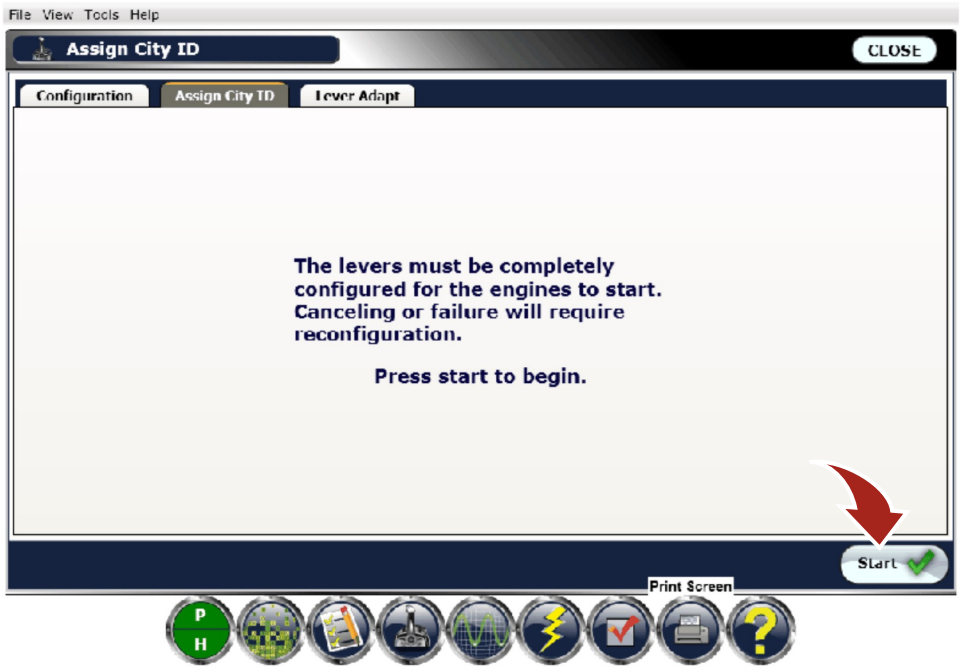
45500

8. Follow the on-screen directions presented by the G3 tool.
   a. Select the number of helms and engines to configure. You may need to wait a moment while the helm configuration is validated.
   b. Notice that the cell for the helm module will have a red background.
   c. Select "Assign City ID" to continue.



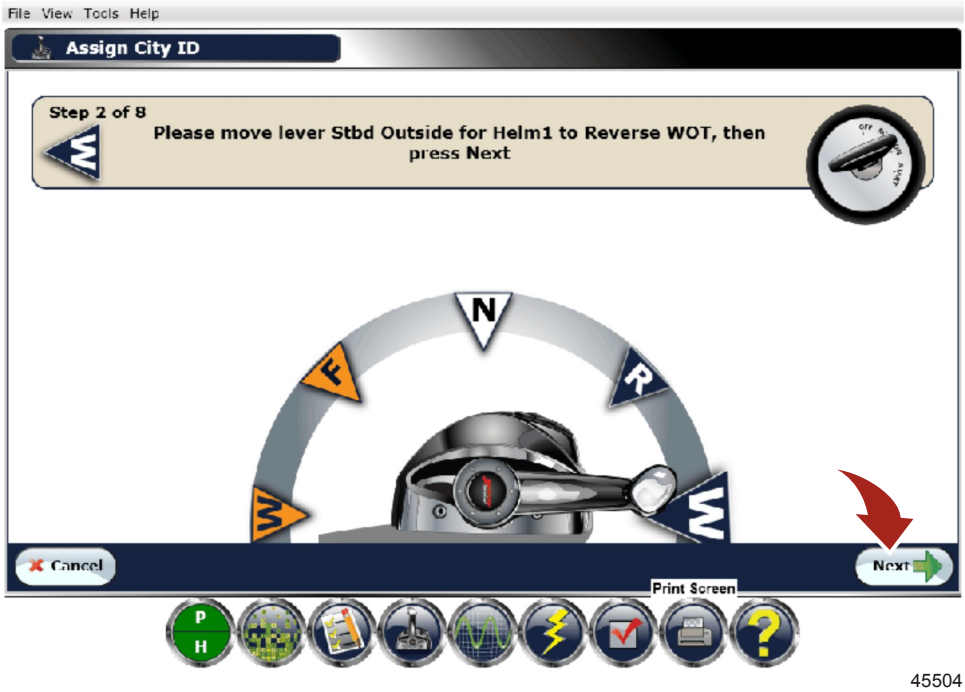
47780

9. Select "Start" to begin setup of the City ID.



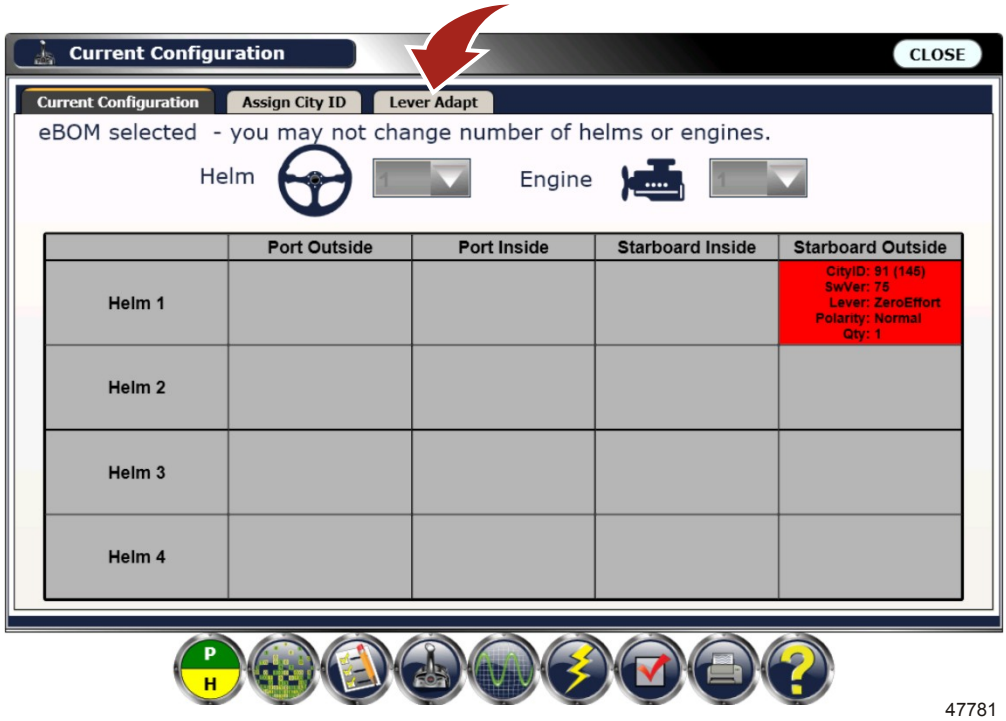
45503

10. Follow the on-screen directions, selecting "Next" to advance through the screens. When you reach the end of the on-screen directions, you may encounter a brief wait while the G3 tool updates the helm modules.



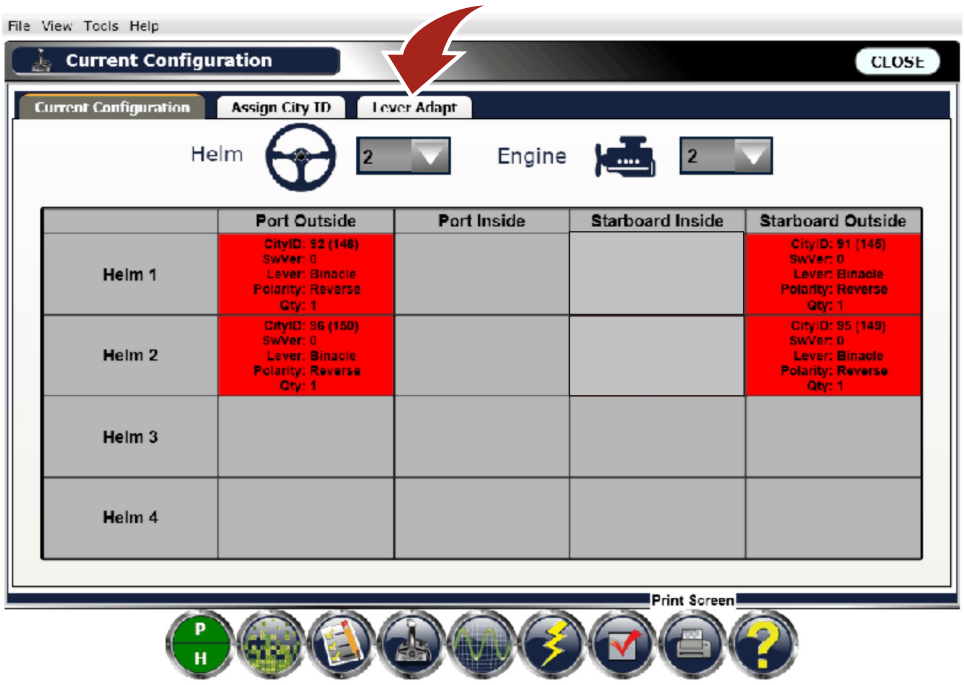
45504

11. The "Current Configuration" screen will display the City IDs assigned to all helm modules, although the cells will still have red backgrounds. You must select "Lever Adapt" to complete the helm configuration.



47781

Single engine example



47300

Multiple engine example

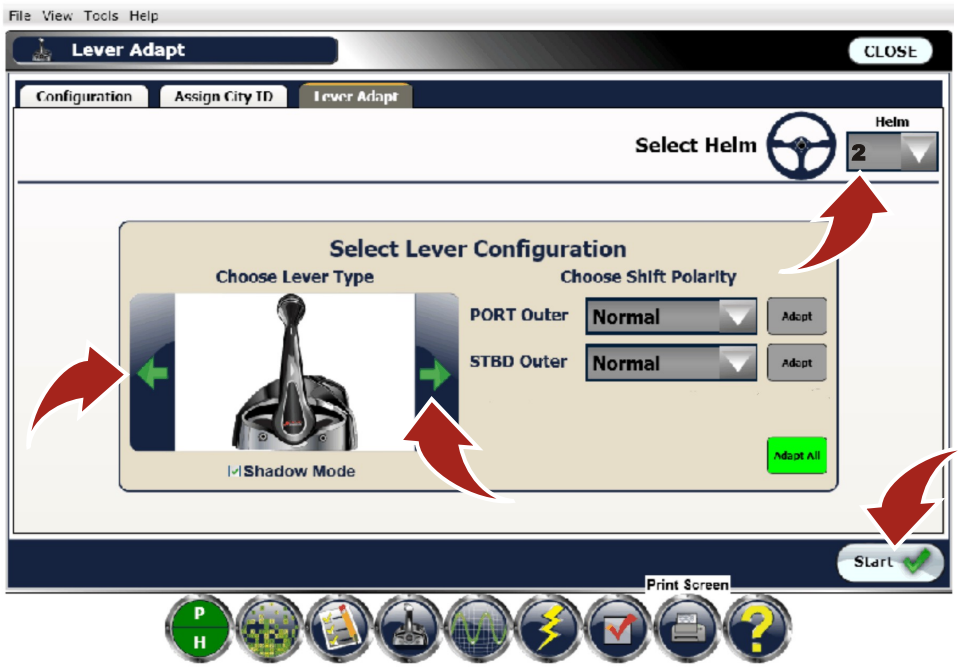
12. Select the helm to adapt, then choose the type of lever used at that helm. Click "Start" to begin the lever adaptation.

47301

13. Follow the on-screen directions, moving the control levers as instructed.

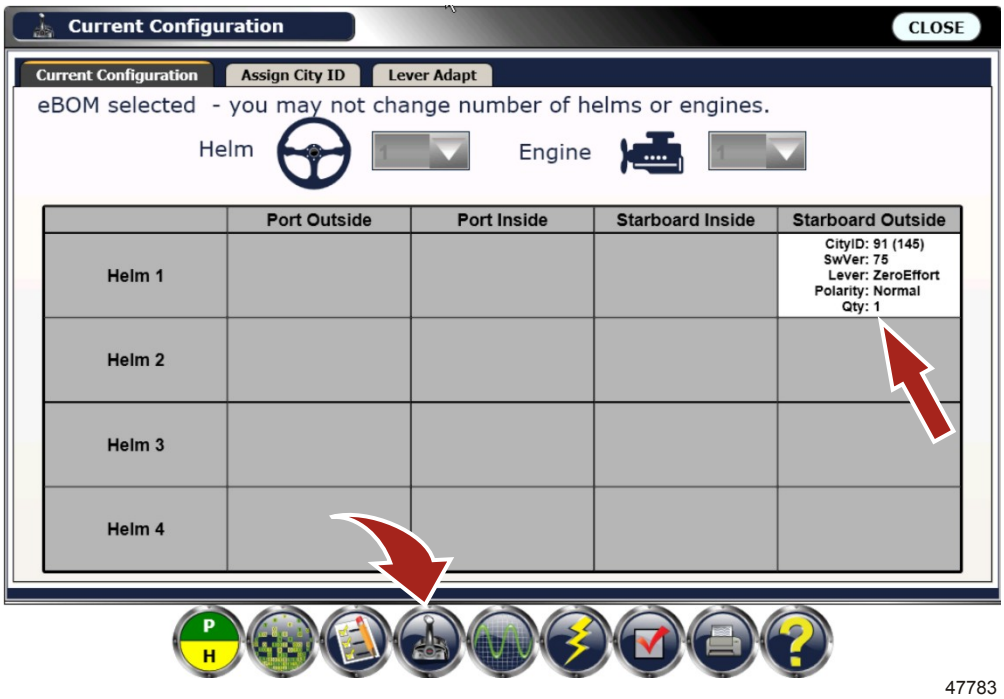
45507

14. Repeat the process for any additional helms. Be certain to select the helm number, choose the appropriate lever type for that helm, and follow the on-screen directions as before. Note that a slight wait may occur while the G3 tool updates the helm module.



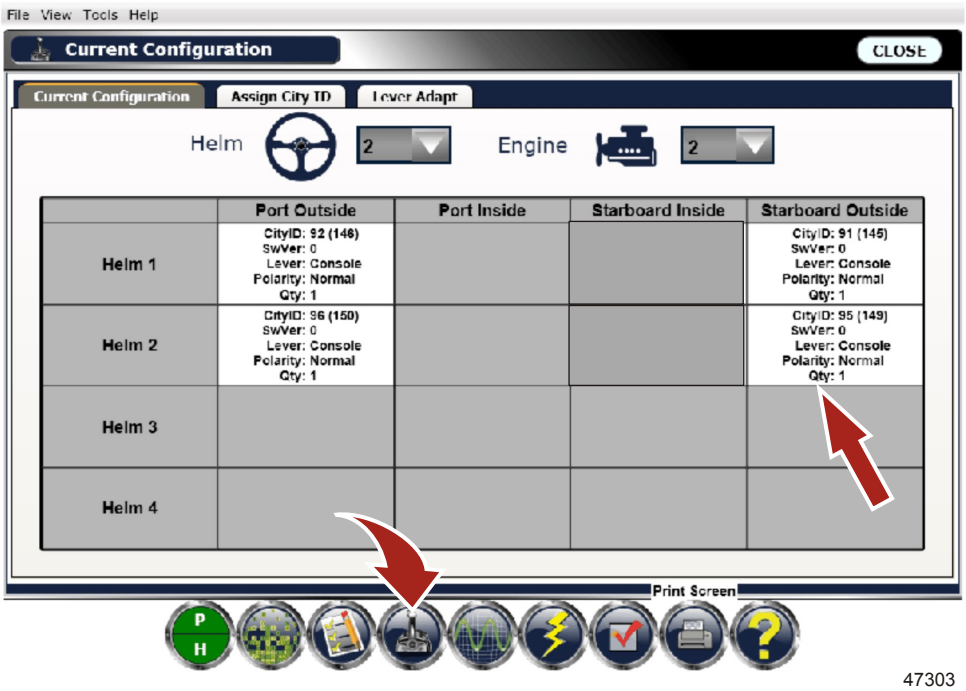
47302

15. After all levers have been adapted, the helm module cell backgrounds on the "Current Configuration" screen will be white. Select the Configuration icon to continue setup.



47783

Single engine example



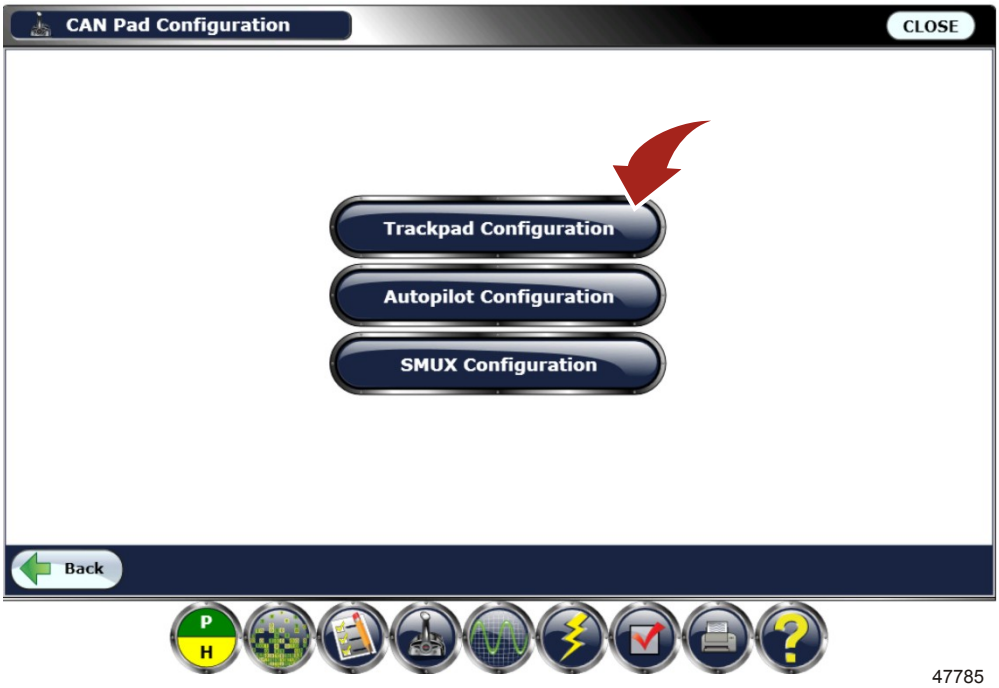
47303

Multiple engine example

16. Select "CAN Pad Configuration."

45550

17. Select "Trackpad Configuration," and follow the on-screen directions. The CAN pad must be installed for dual and multiple-engine applications.

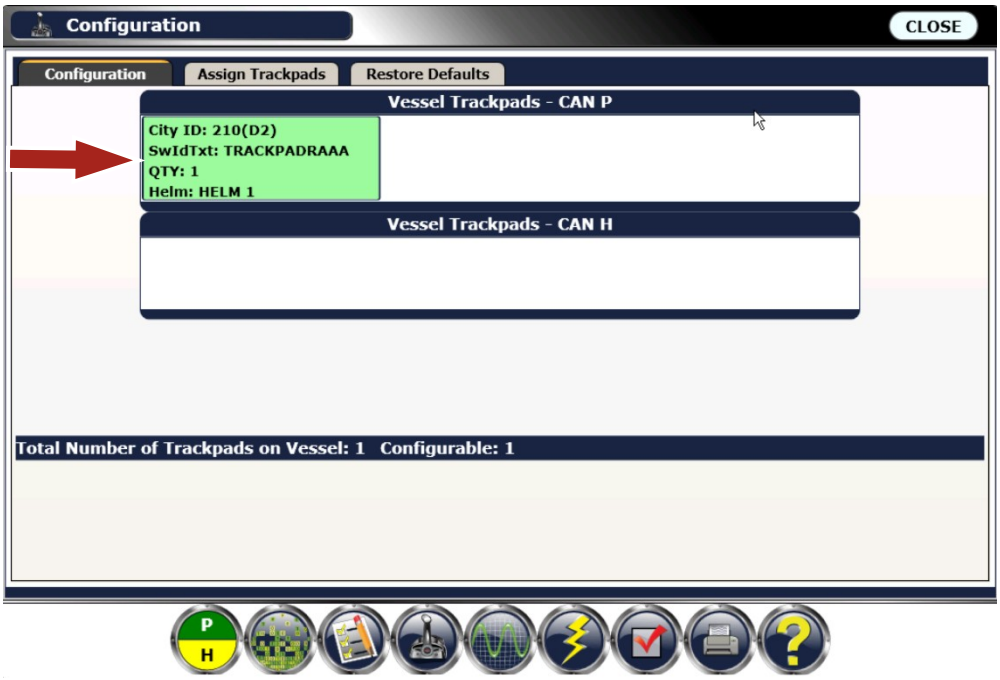


47785

18. Follow the directions in the G3 tool for assigning the City ID for the trackpads.
19. On the "Assign Trackpads" screen, select a helm and the number of trackpads at that helm; then click "Start" to begin. Complete the process for all applicable helms. Then click "Save" to save the configuration information.

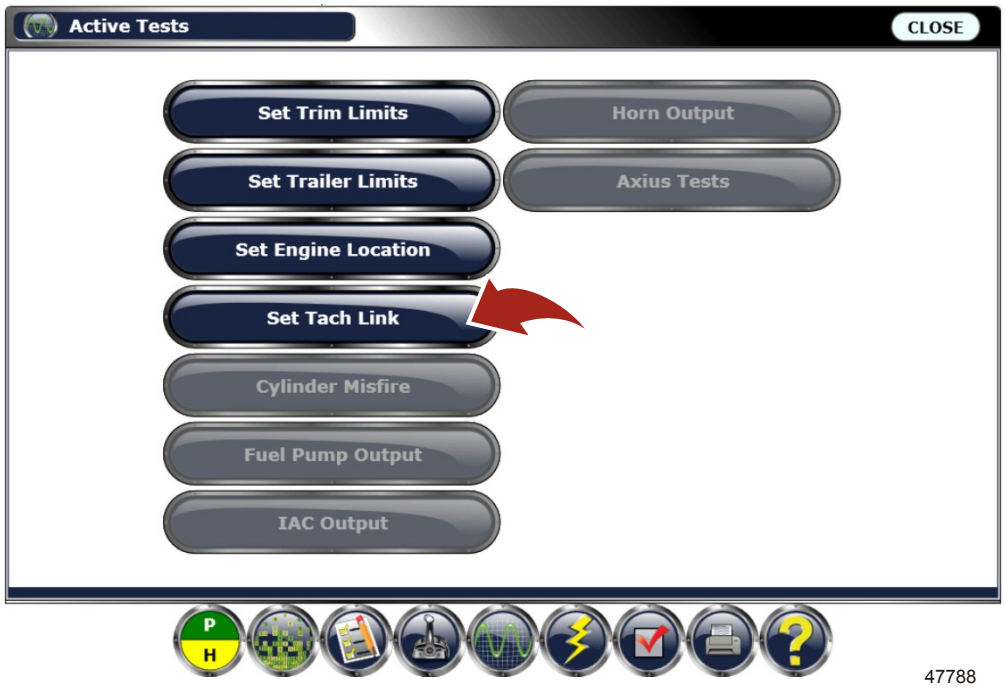
47787

20. When the trackpad assignment is complete, the trackpad City ID will turn green.



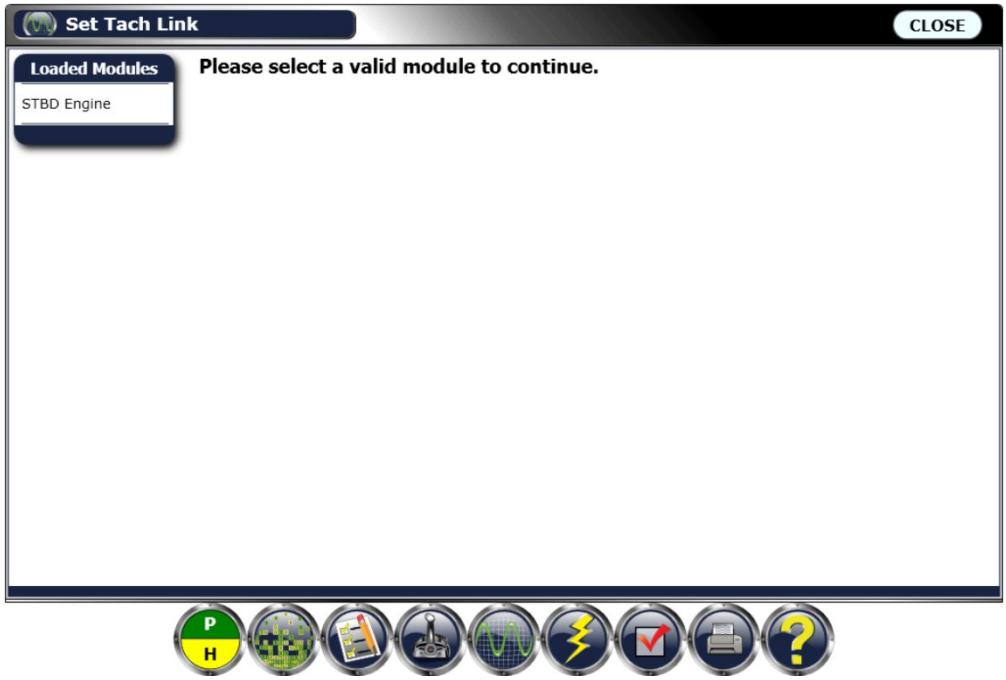
47786

21. If applicable, follow the same process for the DTS trackpads (CAN P).
22. Select "Active Tests."
23. Initiate the "Set Tach Link" procedure.

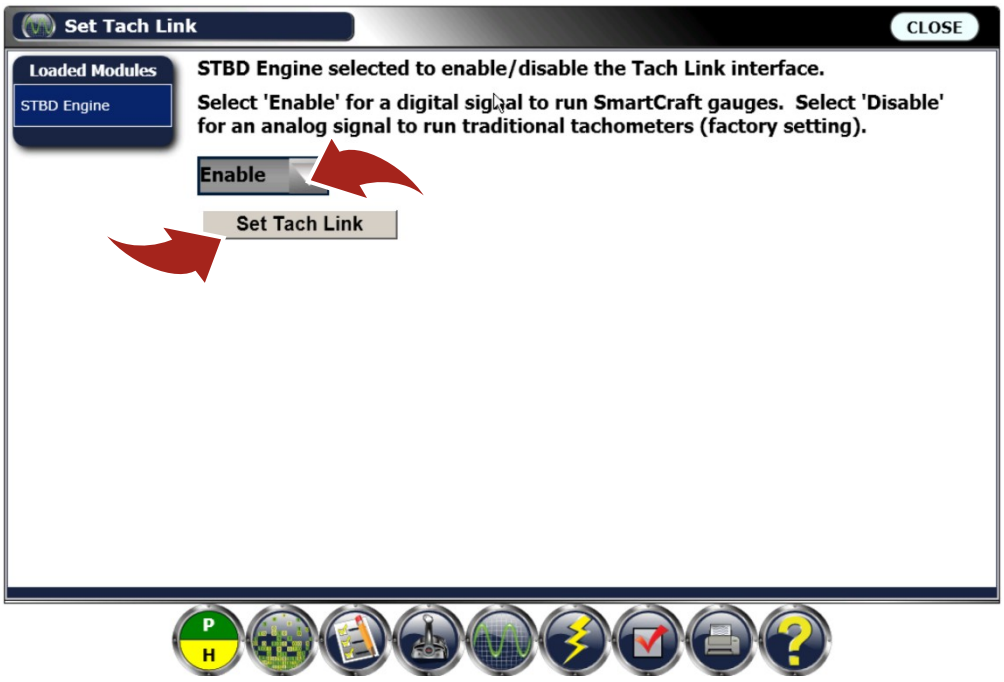


47788

24. Select the appropriate engine.

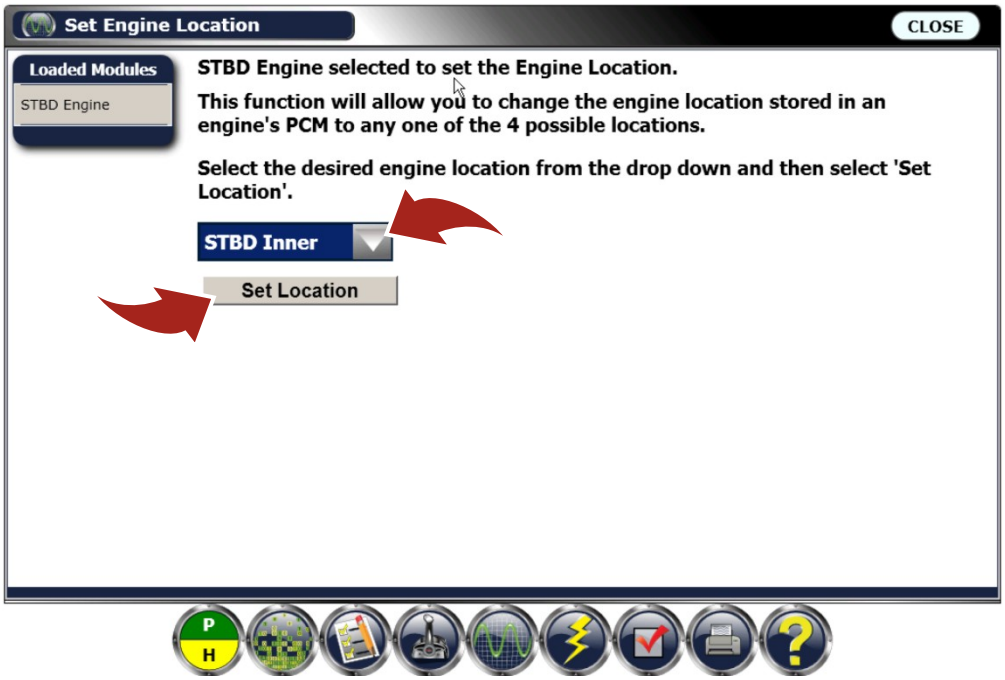


25. Click on the drop-down box, and select "Enable." Save the setting by clicking on the "Set Tach Link" button.



47790

26. Use the drop-down box and "Set Location" button to change the engine location, if required.



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Engine

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Cylinder head and valve cover surfaces Head gasket surfaces	Obtain Locally
9	Loctite 567 PST Pipe Sealant	Intake manifold bolts	92-809822
19	Perfect Seal	Cylinder head coolant passages Manifold gasket coolant passages Oil hose fitting	92-34227Q02
33	Loctite 680 Retaining Compound	Seal retainer mating surface Engine block/seal mating surface	92-809833
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Engine block end seal boss Rear main bearing cap sealing surface	92-809826
136	Lubriplate SPO 255	Valve lifters and camshaft lobes	Obtain Locally
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Cylinder head bolt thread, head, and washer Bearing surfaces and crankshaft journals Piston pin bore, piston pin, rod pin bore Connecting rod bearings Pistons, rings, cylinder walls Rod cap bearing surface Timing chain	92-858087K01

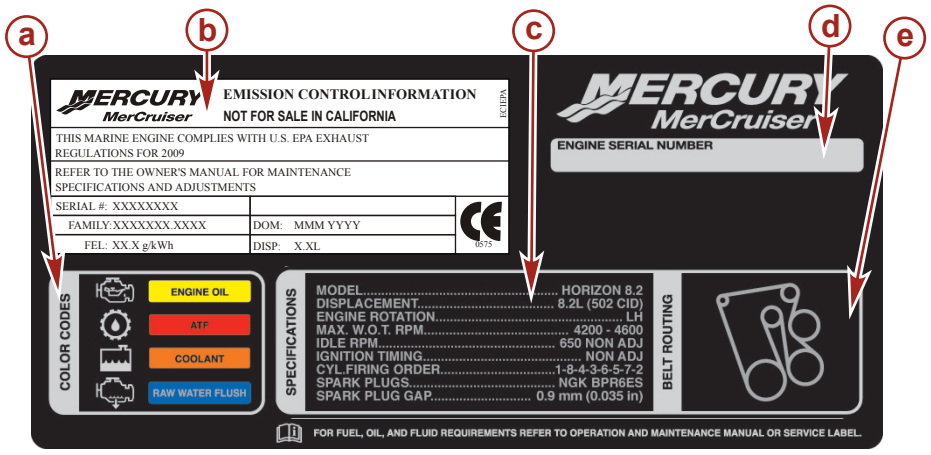
Replacement Parts Warning

⚠ WARNING

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

Information Decal

The information decal is located on the top starboard-side of the heat exchanger.

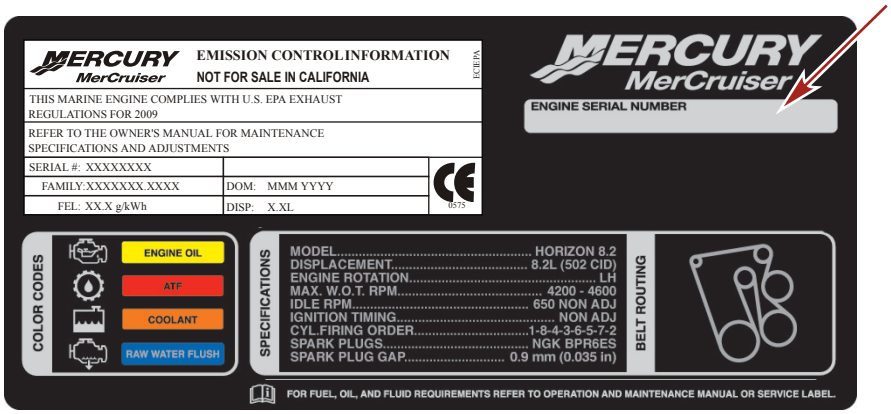


43688

a - Service point decal
b - Emissions control information decal
c - Specification decal
d - Serial numbers decal
e - Belt routing

Engine Serial Number Decal

The serial number decal is placed on the information decal.



43689

Engine serial number decal on heat exchanger

The engine serial number is also stamped in the engine block.

43554

a - Flywheel housing cover
b - Engine serial number stamp
c - Engine block

Engine Specifications

Description	8.2 MAG		8.2 MAG H.O.
Crankshaft horsepower	283 KW 380 HP at 4600 RPM		320 KW 430 HP at 5000 RPM
Peak crankshaft torque	667 Nm 492 lb. ft. at 3600 RPM		663 Nm 489 lb. ft. at 3600 RPM
Displacement L / cid	8.2 L 502 cid		
Bore	No. 1–6 cylinders	113.436 mm (4.4658 in.)	
	No. 7–8 cylinders	113.453 mm (4.6664 in.)	
Stroke	101.6 mm (4.0 in.)		
Compression ratio	8.75:1		
Maximum RPM at WOT	4400–4800 RPM		4600–5000 RPM
RPM rev limit	4950 RPM		5150 RPM
Idle speed in gear	650 RPM		
Idle speed in neutral	650 RPM		
Ignition system	Wasted spark control, PCM controlled (distributorless ignition with knock control)		
IAC duty cycle at idle RPM	Approximately 20%		
Fuel delivery system	EFI, sequential port fuel injection (cool fuel)		
Induction system	Normally aspirated		
Cooling system	Closed cooling with circulating pump; single-stage sea pump for raw water, coolant to raw water heat exchanger, Dex-Cool 50/50 mixture		
Thermostat	76 °C (169 ºF)		
Minimum allowable seawater pressure at WOT	115 kPa (17 psi)		
Maximum allowable seawater pressure at WOT	296 kPa (43 psi)		
Fuel pump pressure	281–305 kPa (40.8–44.2 psi)		
Compression pressure (engine at normal operating trempérature) —all cylinders should be within 20% of each other	965 kPa (140 psi)		
Firing order	1-8-4-3-6-5-7-2		
Electrical system	12 volt negative (–) ground		
Alternator rating	65 amps (847 Watts at 13.03 volts)		
Recommended battery rating	Minimum 750 CCA, 850 MCA or 180 amp / hrs.		

Oil Temperature and Pressure

NOTE: *The 8.2 engine does not have an oil temperature sensor. However, the oil temperature specifications are helpful for service and troubleshooting. To measure the oil temperature, temporarily install a thermocouple or sensor.º*

Peak Oil Temperature	Specification
Upstream of oil cooler at 4800-5000 RPM WOT (ie, sump oil temperature)	120–140º C (257–284º F)
Downstream of oil cooler at 4800-5000 RPM WOT (ie, main gallery oil temperature)	90–115º C (194–239º F)

Typical Oil Pressure	Specification
Engine at WOT (hot) (After running a minimum of 3 minutes at 4400-5000 RPM WOT)	280–460 kPa (41–67 psi)
Engine at idle (hot) (Within 30 sec following throttle chop from 4800-5000 RPM WOT to idle)	80–220 kPa (12–32 psi)
Engine at idle (warm)	220–320 kPa (32–46 psi)
Engine at idle (cold)	320–450 kPa (46–65 psi)

Cylinder Bore

Cylinder Bore		Specification
Diameter		No. 1–6 cylinders 113.424 - 113.442 mm (4.4655 - 4.4662 in.)
		No. 7–8 cylinders 113.444 - 113.462 mm (4.4663 - 4.4670 in.)
Out-of-round (production and service)		0.0254 mm (0.001 in.) max
Taper	Thrust side	0.0127 mm (0.0005 in.) max
	Relief side	0.0127 mm (0.0005 in.) max
	Service	0.0381 mm (0.0015 in.) over production

Piston

Piston		Specification
Clearance	No. 1–6 cylinders	0.044 - 0.076 mm (0.0017 - 0.0030 in.)
	No. 7–8 cylinders	0.064 - 0.096 mm (0.0025 - 0.0038 in.)

Piston Ring

Compression Ring		Specification
Groove side clearance	Top	0.02 - 0.085 mm (0.0008 - 0.0033 in.)
	2nd	0.01 - 0.058 mm (0.0004 - 0.0022 in.)
Gap	Top	0.28 - 0.43 mm (0.0110 - 0.0169 in.)
	2nd	0.40 - 0.65 mm (0.0157 - 0.0255 in.)

Oil Ring	Specification
Groove side clearance	0.008 mm (0.0003 in.) interference to 0.176 mm (0.0070 in.) clearance
Gap (rails / oil scrapers)	0.15 - 0.66 mm (0.0060 - 0.0260 in.)

Piston Pin

Pin	Specification
Diameter	22.997 - 23.000 mm (0.9054 - 0.9055 in.)
Clearance in piston	0.0040 - 0.0130 mm (0.00016 - 0.00051 in.)
Clearance in rod	0.0150 - 0.0280 mm (0.00059 - 0.00110 in.)

Crankshaft

Crankshaft			Specification
Main journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out-of-round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Main bearing clearance	Production and service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)
Crankshaft end play			0.152 - 0.254 mm (0.006 - 0.010 in.)
Connecting rod journal	Diameter		55.8546 - 55.8673 mm (2.1990 - 2.1995 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out-of-round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Rod bearing clearance		Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
		Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max
Rod side clearance			0.305 - 0.61 mm (0.012 - 0.024 in.)
Crankshaft runout at No.3 main bearing			0.088 mm (0.0035 in.) max

Cylinder Head

Cylinder Head	Specification
Gasket surface flatness	0.1016 mm (0.004 in.) overall; 0.0508 mm (0.002 in.) per 15.2 x 15.2 cm (6.00 x 6.00 in.) span/area
Valve guide diameter (intake and exhaust)	9.479 - 9.497 mm (0.3732 - 0.3739 in.)

Valve System

Valve System		Specification
Lifter		Hydraulic / Roller
Rocker arm ratio		1.7:1
Face angle (intake & exhaust)		45°
Seat angle (intake & exhaust)		45°
Seat runout (intake & exhaust)		0.0508 mm (0.002 in.)
Seat width	Intake	2.032 +/- 0.1524 mm (0.080 +/- 0.006 in.)
	Exhaust	3.175 +/- 0.1524 mm (0.125 +/- 0.006 in.)
Stem clearance	Intake	0.0178 - 0.061 mm (0.0007 - 0.0024 in.)
	Exhaust	0.0482 - 0.0914 mm (0.0019 - 0.0036 in.)
Stem diameter	Intake	9.436 - 9.461 mm (0.3715 - 0.3725 in.)
	Exhaust	9.406 - 9.431 mm (0.3703 - 0.3713 in.)
Valve margin	Intake	1.27 mm (0.050 in.)
	Exhaust	1.651 mm (0.065 in.)
Valve diameter ± 0.127 mm (0.005 in.)	Intake	57.15 mm (2.25 in.)
	Exhaust	47.78 mm (1.881 in.)

Valve Spring

Valve Spring			Specification
Inner valve spring (no stripe)	Free length		48.76 mm (1.92 in.)
	Force	Closed at 46.99 mm (1.85 in.)	147 - 165 N (33 - 37 lbf)
		Open at 31.1 mm (1.225 in.)	576 - 625 N (129.5 - 140.5 lbf)
	Installed height		43.18 mm (1.70 in.)
Outer valve spring (blue stripe)	Free length		52.78 mm (2.078 in.)
	Force	Closed at 45.72 mm (1.800 in.)	338 - 374 N (76 - 84 lbf)
		Open at 29.85 mm (1.175 in.)	1112 - 1201 N (250 - 270 lbf)
	Installed height		45.75 mm (1.80 in.)

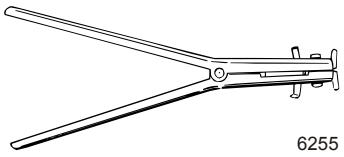
Roller Camshaft

Roller Camshaft		Specification
Lobe lift	Exhaust	8.327 mm (0.327 in.)
	Intake	7.569 mm (0.298 in.)
Duration (crank angle) 1.27 mm (0.050 in.) valve lift	Exhaust	254°
	Intake	236°
Journal diameter		49.479 - 49.522 mm (1.948 - 1.9497 in.)
Journal out-of-round		0.0508 mm (0.002 in.) max
Camshaft runout		0.0508 mm (0.002 in.) max
Timing chain deflection		12.7 mm (0.50 in.) from taut position

Flywheel

Flywheel	Specification
Runout	0.203 mm (0.008 in.) max

Special Tools

Piston Ring Expander	**91-24697**
Description: Removes and installs the piston rings.	 6255

Torque Specifications

Description	Nm	lb. in.	lb. ft.
Alternator bracket to engine	41	–	30
Alternator to mounting bracket (pivot)	27	–	20
Alternator to mounting bracket (anchor)	27	–	20
Coil to bracket	11	–	8
Electrical center bracket to cylinder head	54	–	40
Camshaft sprocket	27	–	20
Camshaft thrust plate	11	–	8
Connecting rod caps (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn		
Coupler/Flywheel (MCM)	48	–	35
Crankshaft pulley	48	–	35
Damper attaching bolt	244	–	180
Crossover to block	66	–	49
Cylinder head (follow 3 step procedure)	95	–	70
Exhaust manifold	47	–	35
Flame arrestor to throttle body	6	55	-
Flywheel	95	–	70
Flywheel housing to block	41	–	30
Flywheel housing cover	13	114	–
Heat exchanger to crossover	19	–	14
Lifter hold down	20	–	15
Intake manifold (follow 2 step procedure)	48	–	35
Plenum to intake	24	–	18
Main bearing caps (follow 2 step procedure)	149	–	110
Oil baffle nuts	35	–	26
Oil filter adapter	47	–	35
Oil pan bolts	20	–	15
Oil pan drain plug	27	–	20
Oil pump	95	–	70
Oil pump driver mechanism	20	–	15

Description	Nm	lb. in.	lb. ft.
Oil pump cover	11	–	8
Power steering pump brace to block	66	–	49 (large)
Power steering pump bracket	47	–	35 (small)
Engine mount	38	–	28
Remote oil connector (1/2 in. x 13)	34	–	25
Rocker adjusting lock set screw	34	–	25
Rocker arm studs	75	–	55
Remote oil filter adapter nut/fitting	27	–	20
Seawater pump brace to engine mount	41	–	30
Seawater pump bracket	66	–	49 (large)
	41	–	30 (small)
Spark plug	20	–	15
Starter motor	44	–	33
Throttle body to plenum	11	96 (DTS)	–
	14	120 (mech)	–
Timing cover	11	96	–
Valve cover nuts	14	120	–
Valve cover stud	13	112	–
Water circulating pump	47	–	35

Fuel Supply Connections

⚠ WARNING

Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

- Apply #592 Loctite Pipe Sealant with PTFE to threads of brass fitting or plug.
- Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.
- Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns. Do not overtighten.
- Install fuel line. To prevent over-tightening, hold brass fitting with a wrench and tighten fuel line connectors securely.

Service Precautions

IMPORTANT: The following information must be adhered to when working with the fuel system:

- Always keep a dry chemical fire extinguisher at the work area.
- Do not replace fuel pipe with fuel hose.
- Observe all Warnings and Cautions.

⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

NOTICE

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

Recommendations

IMPORTANT: Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing a fuel delivery system.

Valve Covers

Removal

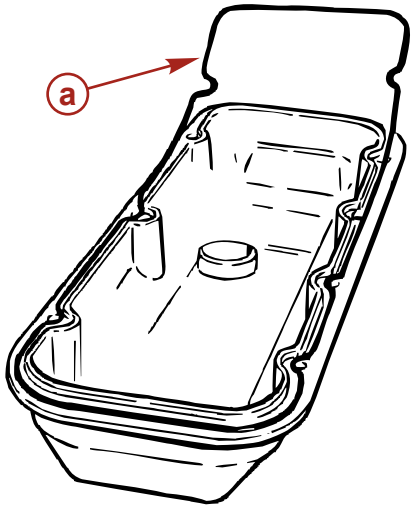
1. Disconnect the crankcase ventilation hoses.
2. Remove the coolant reservoir and bracket.
3. Remove the shift bracket or DTS shifter and bracket assembly.
4. If equipped, remove the gear lube bottle from the bracket.
5. If equipped, remove the oxygen sensors and EMCT sensors.
6. Remove the engine exhaust system or move it out of the way.
7. Remove the valve cover attaching nuts.
8. If applicable, remove the special stud.
9. Remove the valve cover.

Installation

1. Clean the sealing surfaces on the cylinder head and valve cover with a cleaner degreaser.

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Cylinder head and valve cover surfaces	Obtain Locally

2. Place the valve cover gasket in the groove of the valve cover.

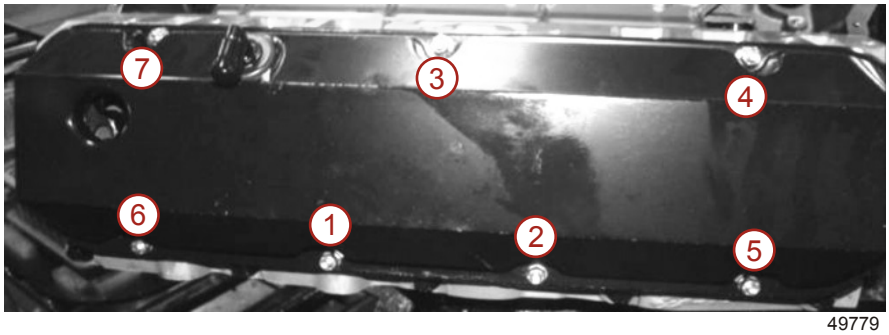


6257

a - Valve cover gasket

3. Align the valve cover with the studs and place the valve cover on the head.
4. If removed, install the special stud.
5. Place a washer and hand start a nut on each stud.

6. Tighten the valve cover nuts and special stud (if equipped) to specification.



49779

Valve cover torque pattern

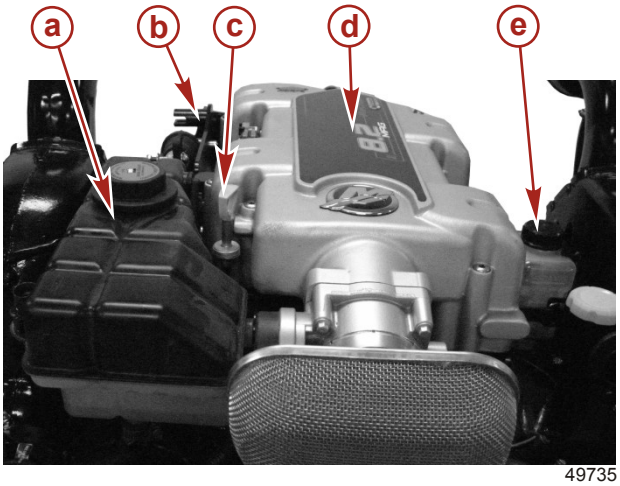
Description	Nm	lb. in.	lb. ft.
Valve cover nuts and special stud	14	120	–

7. Install the engine exhaust system.
8. Install items that were removed to allow access to the valve covers.
9. Connect the crankcase ventilation hoses to the valve covers.
10. Start the engine and check for oil leaks.

Intake Plenum and Manifold

Removal

1. Remove the engine block drain plugs and drain the closed cooling system.
2. Remove the coolant reservoir and bracket.
3. Remove the shift bracket or DTS shifter and bracket assembly.
4. If equipped, remove the gear lube bottle from the bracket and harness.



49735

a - Coolant reservoir
b - DTS shifter and bracket assembly
c - Oil dipstick
d - Intake plenum
e - Gear lube bottle

5. If equipped, disconnect sensors:
   - TPS
   - IAT
   - MAP
   - IAC
   - MAT
   - EMCT
   - Oxygen Sensor
   - Crankshaft position sensor
   - Camshaft position sensor

6. Disconnect the hoses from the PCV valve, crankcase ventilation hose, fuel pressure regulator, and fuel pump vent to the upper plenum.
7. Remove and retain the intake plenum bolts.
8. Remove the intake plenum. Refer to **Intake Plenum**.
9. It is optional to loosen the two nuts securing the electrical mounting bracket and allow the bracket with the components to tilt back out of the way.
10. Disconnect the fuel injector and fuel pressure switch electrical connectors.
11. Remove the stay straps securing the engine wiring harness and move the harness away from the intake manifold.

⚠ WARNING

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

13. Bleed the fuel pressure from the fuel rail at the shrader valve. Refer to **Relieving Fuel System Pressure**.
14. Remove the fuel inlet line from the fuel rail fitting. Refer to **Fuel Rail**.
15. Remove the PCV valve and vent line from the valve covers.
16. Remove the intake manifold bolts, and remove the intake manifold assembly.

Cleaning and Inspection

1. Remove the gasket material from all of the mating surfaces.
   IMPORTANT: When cleaning the cylinder head mating surface, do not allow the gasket material to enter the engine crankcase or intake ports.
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 build-up or other material. Clean as necessary.
4. Remove the formed seals from the intake manifold and clean the grooves.
5. Place new formed seals in the grooves of the intake manifold.

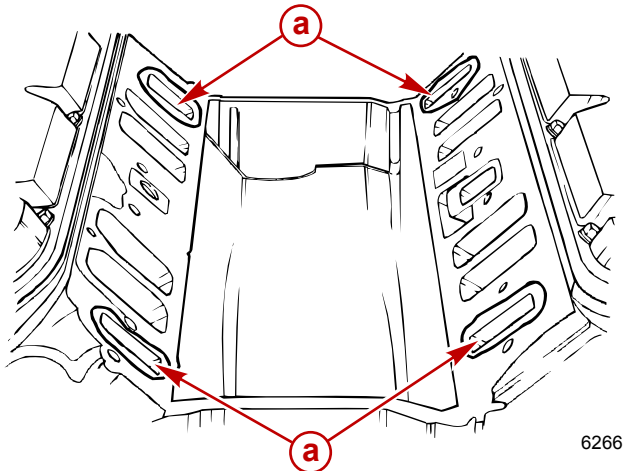
Installation

1. Apply a bead of sealant on the cylinder head around the coolant passages and to the edge of the casting.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Cylinder head coolant passages	92-34227Q02

IMPORTANT: Make sure the gasket is on the correct bank, see words "LEFT" and "TOP". Ensure the word "FRONT" is at the front of the engine.

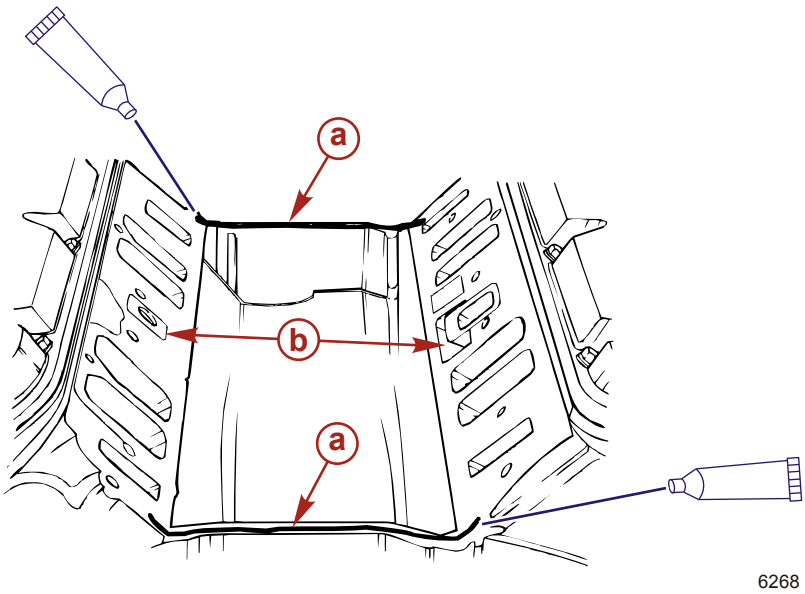
2. Place the gasket on cylinder head with the wording "front" toward the front of the engine. Slip the edge of the gasket under the clips.
3. Apply a bead of sealant on the gasket around the coolant passages and to the edge of the gasket.



a - Coolant passages

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Manifold gasket coolant passages	92-34227Q02

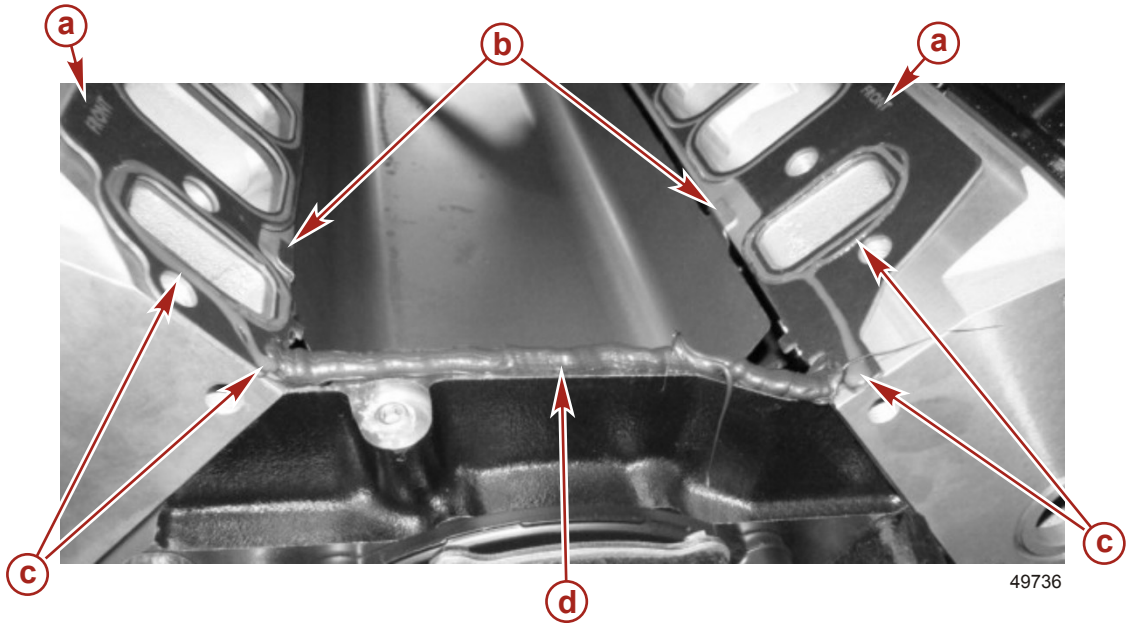
4. Apply a ¼ in. bead of sealant on the end seal boss of the engine block between the cylinder heads. The sealer should extend 12.7 mm (0.50 in.) onto the cylinder head.



a - End seal boss
b - Intake manifold gasket

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Engine block end seal boss	92-809826

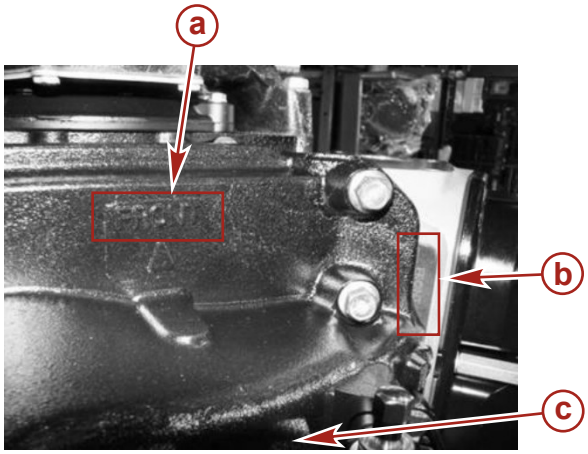
5. Ensure the wording "front" on the gasket is toward the front of the engine, the gasket is under the clips, and the sealant is applied correctly.



a - Gasket wording "front"
b - Clips
c - Coolant passages sealant
d - Sealant on end seal boss

IMPORTANT: The word "FRONT" on the intake manifold and the port and starboard gaskets face the front of the engine block.

6. Carefully install the manifold assembly with the word "FRONT" on the intake and the word "FRONT" on the gaskets at the front of the engine.



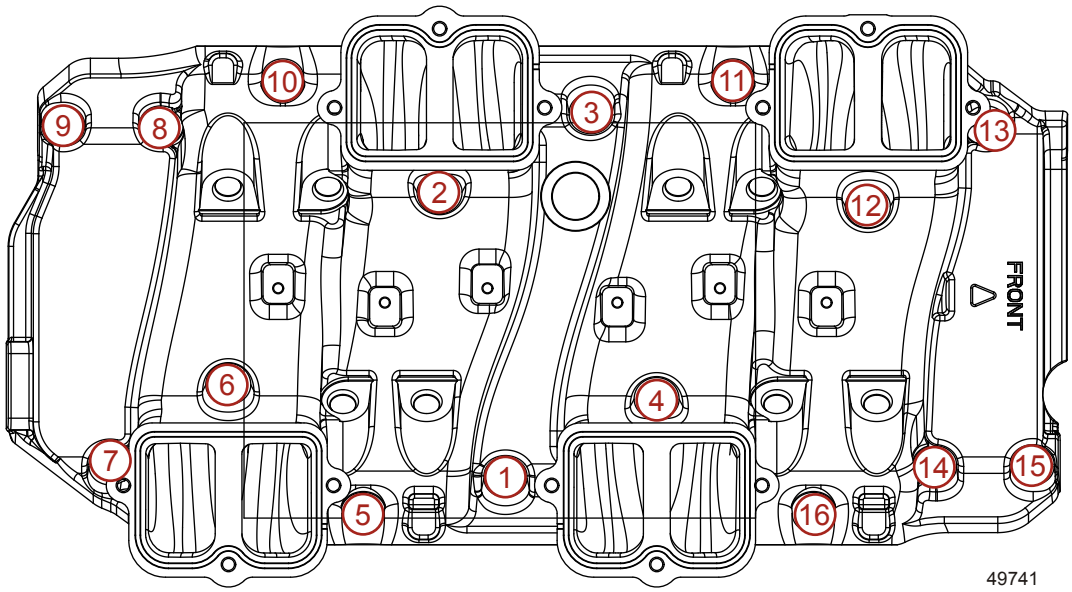
49780

a - "FRONT" on the intake
b - "FRONT" on the gasket
c - Front side of engine

7. Apply sealant to the threads of the intake manifold bolts.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Intake manifold bolts	92-809822

8. Hand start four short bolts at the corners of the intake manifold. Then hand start the remaining eight short bolts and four long bolts.
9. In two steps, tighten the bolts to specification in the sequence shown.



49741

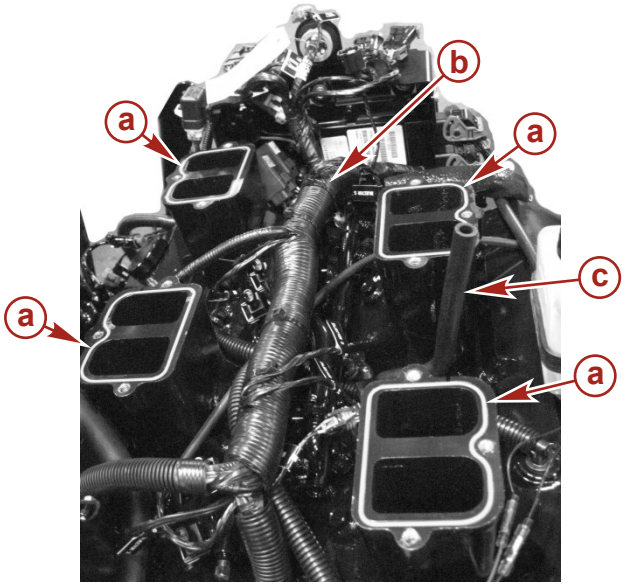
Intake manifold torque sequence

Description		Nm	lb. in.	lb. ft.
Intake manifold to cylinder head bolts	Step #1	27	–	20
	Step #2	48	–	35

IMPORTANT: Use dielectric compound on all of the electrical connector contact points.

10. Position the engine harness and install new stay straps to secure it's position.
11. Connect the fuel injector electrical leads. They are tagged to correspond to the engine cylinder number.

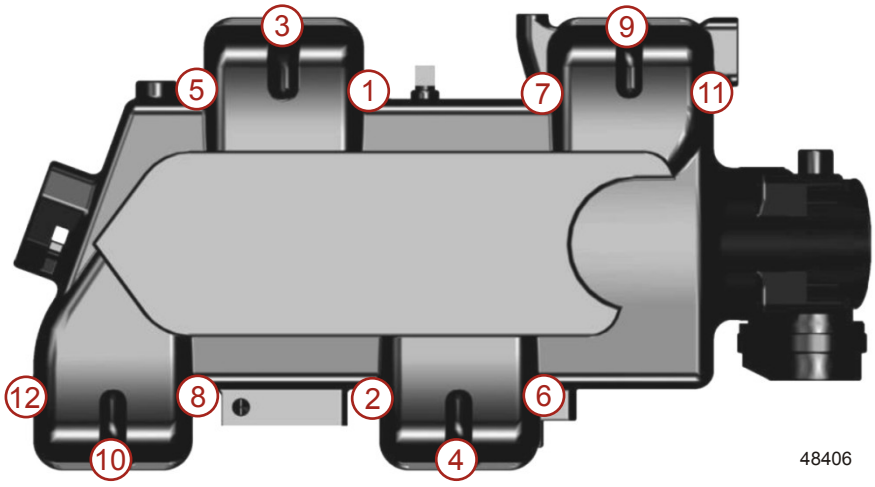
12. Install the fuel inlet line to the fuel rail fitting. Refer to **Fuel Rail**.
13. Connect the crankcase ventilation hoses to the rocker arm covers.
14. Ensure that the engine harness and components are positioned out of the way and the connections are easily accessible.



48821

a - Seal
b - Engine harness
c - Crankcase vent hose

15. Install the plenum. Refer to **Intake Plenum**.
16. In two steps, tighten the screws to specification in the sequence shown.



48406

Intake plenum torque sequence

Description		Nm	lb-in.	lb-ft
Intake plenum screw	Step #1	7	–	5
	Step #2	24	–	18

17. Install the shift bracket or DTS shifter and bracket assembly and connect to engine harness.

Description	Nm	lb-in.	lb-ft
Shift bracket to plenum screw	27	–	20
Shift bracket to lift bracket screw			

18. Install the gear lube bottle in the bracket and connect to engine harness.
19. If loosened, tighten the two nuts securing the electrical bracket.

Description	Nm	lb-in.	lb-ft
Electrical bracket to head nut	54	–	40

20. Connect the hoses to the flame arrestor, fuel pressure regulator, and fuel pump vent to plenum.
21. If equipped, ensure that the sensors are connected:
    - TPS
    - IAT
    - MAP
    - IAC
    - MAT
    - EMCT
    - Oxygen Sensor
    - Crankshaft position sensor
    - Camshaft position sensor
22. Install the coolant reservoir and bracket assembly.
23. Connect the throttle cable, if equipped.
24. Install the engine block drain plugs and refill the closed cooling system.
25. Start the engine and check the hose connections, gaskets and seals for leaks.
26. Inspect the fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

1. Remove the rocker arm covers.
2. Remove the rocker arm assemblies and push rods.
   IMPORTANT: Place rocker arm assemblies and push rods in a rack for re-assembly in their original locations.

Cleaning and Inspection

1. Clean all of the parts with solvent and dry them with compressed air.
2. Inspect all of the contact surfaces for wear. Replace any damaged parts.

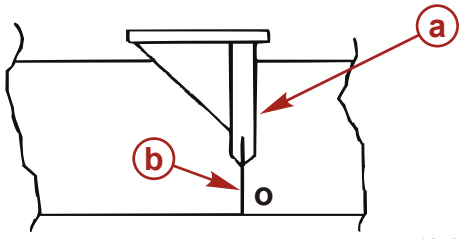
Installation

IMPORTANT: When installing the rocker arm components, coat the bearing surfaces with engine oil.

1. Install the push rods in their original locations. Ensure the push rods are seated in the lifter sockets.
2. Install the rocker arms in their original locations and adjust the valves.

Valve Adjustment

1. Remove the spark plugs. Using a wrench on the center bolt of the crankshaft pulley, turn the engine over in its normal direction of rotation while placing a finger over the "No. 1" cylinder spark plug opening. Compression will be felt at the spark plug opening as 0° TDC is approached. If not, the engine is in the "No. 6" firing position and should be rotated through one more revolution (360°) to reach the "No. 1" position 0° TDC.

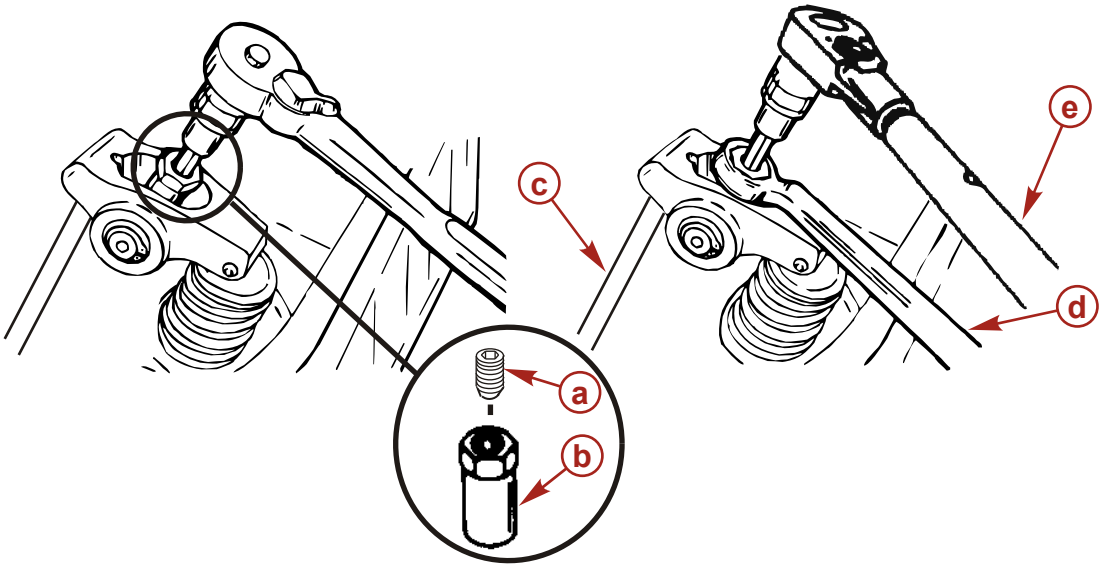


6276

a - Timing tab
b - 0° TDC torsional damper timing mark

2. When the engine is at the number one TDC position, adjust the following valves: Exhaust: 1-3-4-8, Intake: 1-2-5-7.
3. Loosen the allen head set screw.
4. Loosen adjusting nut until lash is felt at push rod, and then hand tighten adjusting nut until all lash is removed. Lash can be checked by rotating push rod while hand tightening adjusting nut until all play is removed.

IMPORTANT: If the lifter has not been pumped up with oil, the push rod could be rotated while the plunger in the lifter is being collapsed. Any resistance felt while rotating the push rod should be considered no lash. This can be checked by making sure there is no up and down movement of the push rod or zero clearance between the rocker arm and valve stem.



6281

- **a -** Allen head set screw
- **b -** Adjusting nut
- **c -** Push rod
- **d -** Box end wrench
- **e -** Torque wrench

5. Rotate the adjustment nut an additional, 3/4 turn (270°).
6. While holding the adjusting nut in position, torque the allen head set screw.

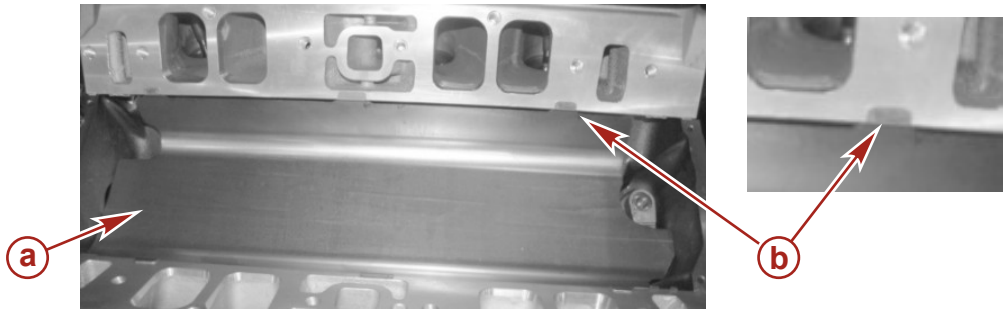
Description	Nm	lb. in.	lb. ft.
Allen head set screw	34		25

7. Using a wrench on the center bolt of the crankshaft pulley, turn the engine over in its normal direction of rotation while placing a finger over the "No. 6" cylinder spark plug opening. Compression will be felt at the spark plug opening as 0° TDC is approached. If not, the engine is in the "No. 1" firing position and should be rotated through one more revolution (360°) to reach "No. 6" position, 0° TDC.
8. When the engine is at the number six TDC position, adjust the following valves: Exhaust: 2-5-6-7, Intake: 3-4-6-8.

Hydraulic Valve Roller Lifters

Removal

1. Remove the rocker arm covers.
2. Remove the intake manifold.
3. Unclip and remove the oil splash shield.

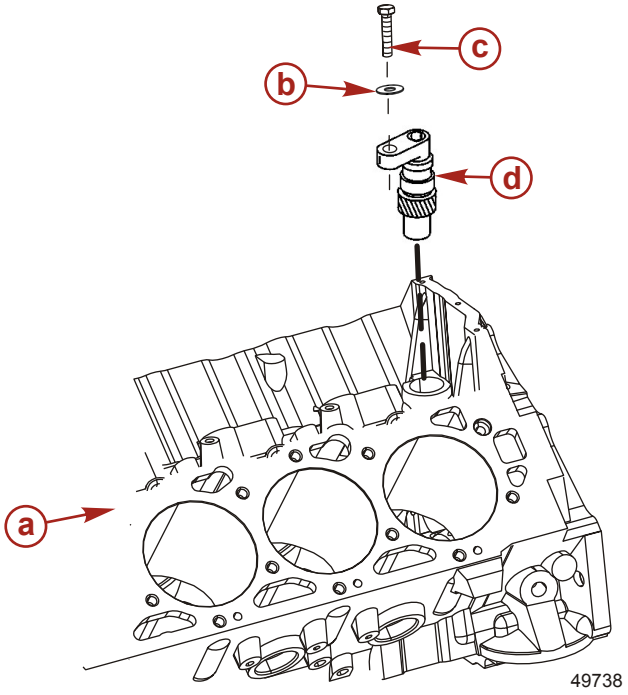


49798

- **a -** Splash shield
- **b -** Clip (4 places)

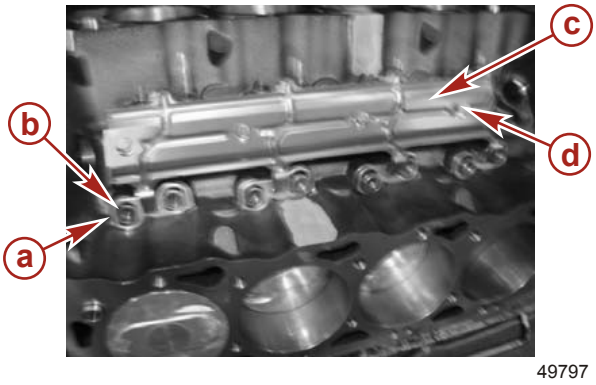
4. Remove the rocker arm assemblies and push rods.

5. Remove the oil drive mechanism.

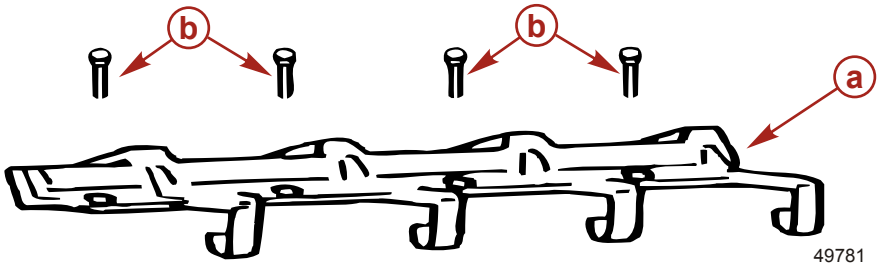


a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

6. Remove the lifter guide retainer.



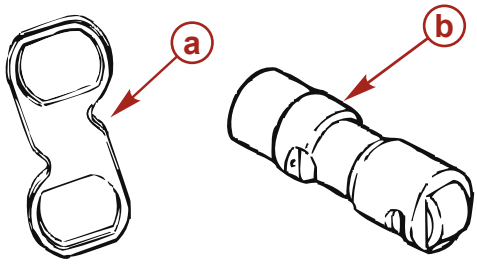
a - Guide
b - Lifter
c - Retainer
d - Screw (4)



a - Lifter guide retainer
b - Screw (4)

IMPORTANT: IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.

7. Remove the lifter guides and the valve lifters. Store the lifters in the upright position in order of removal.



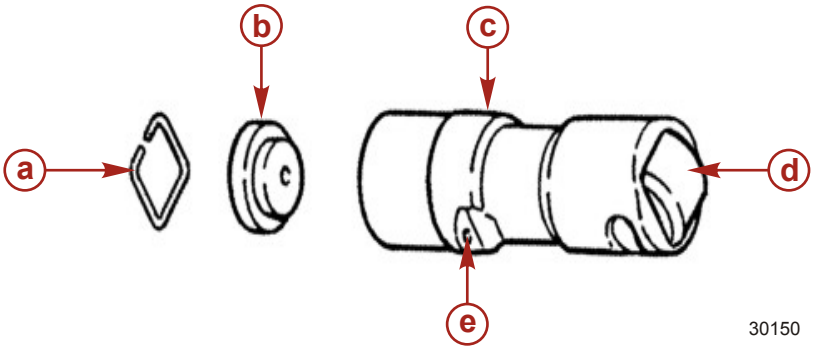
a - Lifter guide
b - Valve lifter

Cleaning

1. Except for the valve lifters, clean the parts with cleaning solvent.
2. Dry the parts with compressed air.
3. Keep the valve lifter upright, wipe with a clean, oil saturated, lint free cloth. Store valve lifters in the upright position.

Inspection

1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect the pushrod seat. If the seat is scuffed or worn, inspect the pushrod for warping or damage.
3. Inspect outer lifter body. If the lifter is scuffed or worn, inspect the engine block lifter bore.
4. Inspect the roller of valve lifter. If roller is scuffed or worn, inspect the camshaft lobe.
5. Ensure the oil hole is unobstructed.
6. Inspect all parts carefully. Replace any valve lifter assembly that is damaged or excessively worn.



Lifter inspection points

- **a -** Seat retainer clip
- **b -** Pushrod seat
- **c -** Valve lifter body
- **d -** Roller
- **e -** Oil hole

Installation

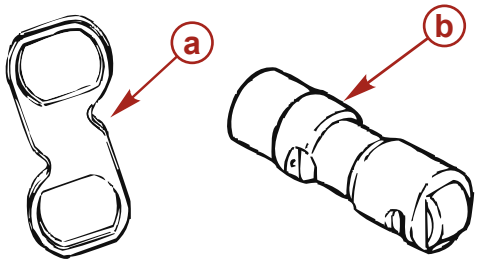
IMPORTANT: The engine oil must be changed and a new oil filter installed after servicing the valve lifters or the camshaft. Before installing the lifters, coat the bottom of the lifter with engine oil. If installing new lifters or a new camshaft, an additive containing EP lube (General Motors Cam and Lifter Pre-lube or equivalent) should be applied to the camshaft lobes before installing the lifters.
Coat the entire valve lifter with engine oil before installation.
New valve lifters must be installed with a new camshaft.

1. Before installing valve lifters, coat the camshaft lobes and valve lifters with engine assembly lube.

Tube Ref No.	Description	Where Used	Part No.
136	Lubriplate SPO 255	Valve lifters and camshaft lobes	Obtain Locally

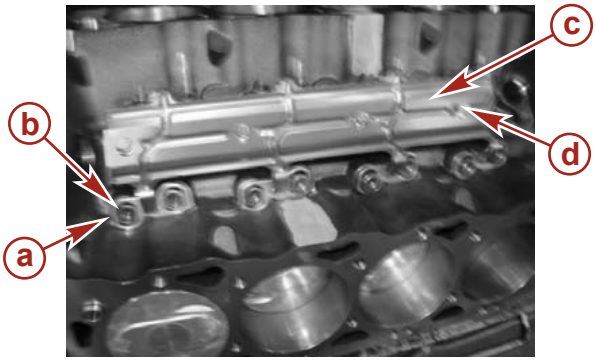
2. Install the valve lifters. Install the lifters in their original locations if being reused.
3. Install the lifter guides.

NOTE: *The flat side of the lifters matches the flats of the lifter guide.*



- **a -** Lifter guide
- **b -** Valve roller lifter

4. Install the lifter guide retainer. Tighten the four screws to specification.

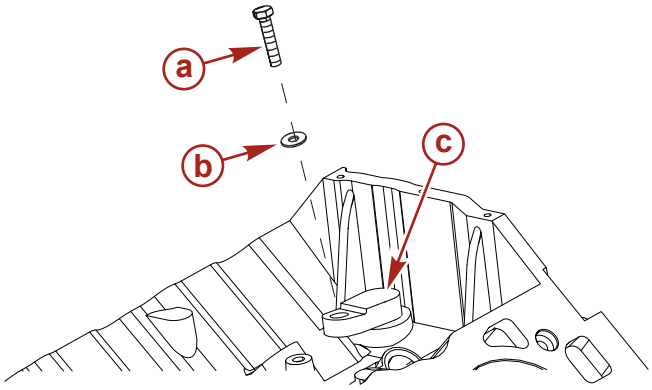


49797

a - Guide
b - Lifter
c - Retainer
d - Screw (4)

Description	Nm	lb-in.	lb-ft
Valve lifter guide retainer screw	16	144	–

5. Install the oil drive mechanism. Rotate the crankshaft to engage the oil drive mechanism with the oil pump.
IMPORTANT: The oil drive mechanism is not properly installed if it is not resting on the engine casting and engaged with the oil pump.
6. Ensure that the mechanism is resting on the engine casting as shown.
7. Install the washer and screw. Tighten the screw to specifications.

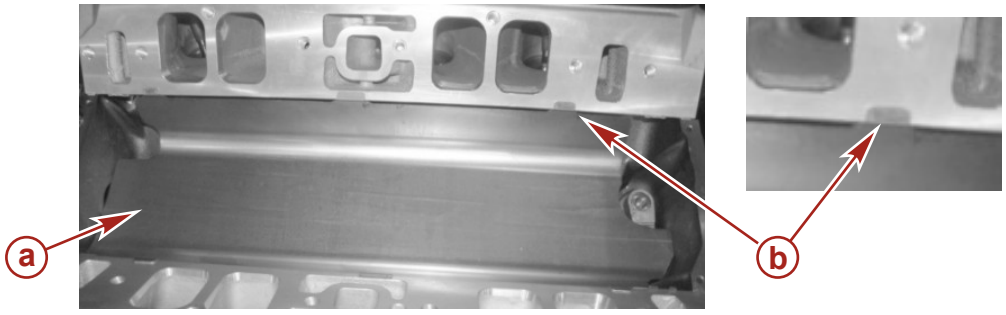


49740

a - Mounting bolt
b - Washer
c - Oil drive mechanism

Description	Nm	lb-in.	lb-ft
Oil drive mechanism screw	20	180	–

8. Clip the oil splash shield in position as shown.



49798

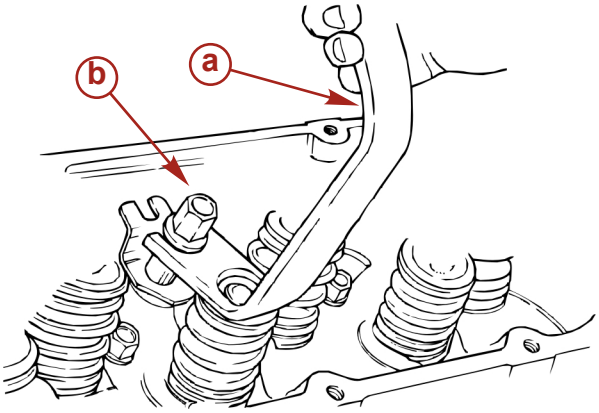
a - Splash shield
b - Clip (4 places)

9. Install the intake manifold.
10. Install and adjust the push rods and rocker arms.
11. Install the rocker arm covers.
12. Start the engine and check for leaks.

Valve Stem Seal and Valve Spring

Removal With Head Installed

1. Remove:
   a. Valve cover.
   b. Spark plug of affected cylinder.
   c. Rocker arm assembly.
2. Install an air line adapter tool in the spark plug opening and apply compressed air to hold the valves in place.
3. Use a valve spring compressor to compress valve spring and remove valve locks.
   IMPORTANT: Maintain air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

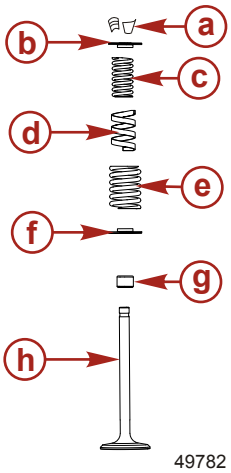


6290

a - Valve spring compressor
b - Nut

4. Slowly release the valve spring compressor. Remove the cap and valve spring.
5. Remove the push rod guides if required.

Valve Assembly—Exploded View



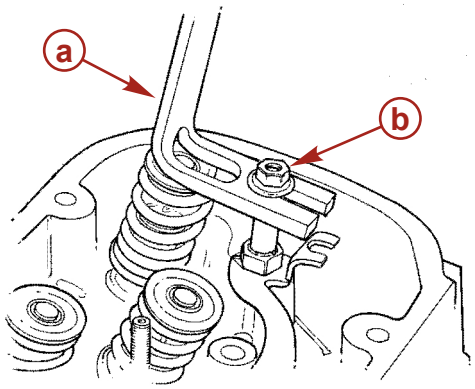
49782

a - Valve keeper
b - Upper spring seat
c - Inner spring
d - Damper
e - Outer spring
f - Lower spring seat
g - Seal
h - Valve

Valve Seal Installation—Head Installed

1. Install the push rod guides if removed.
2. Place a spring seat into the spring pocket.
   NOTE: *A spring seat must always be used underneath the valve spring.*
3. Install the new oil seals onto the valve guides of the cylinder head.
4. If taken apart, re-assemble the damper and valve spring.
5. Place the valve spring assembly in position against the spring seat.
6. Coat the valve stem and the new seal with engine oil.
7. Set the cap on the valve stem, and align the valve stem with the center of the cap.

8. Compress the valve spring using a valve spring compressor and install the valve locks (grease may be used to hold the valve locks in place). Slowly release the tool to prevent damaging the seal. Make sure the valve locks seat properly in the valve stem grooves.



6297

a - Valve spring compressor
b - Rocker arm nut

9. Turn off the compressed air and remove the air line adapter tool from the spark plug opening.
10. Install and adjust the push rods and the rocker arm assemblies.
11. Install the valve cover, than install the spark plug.

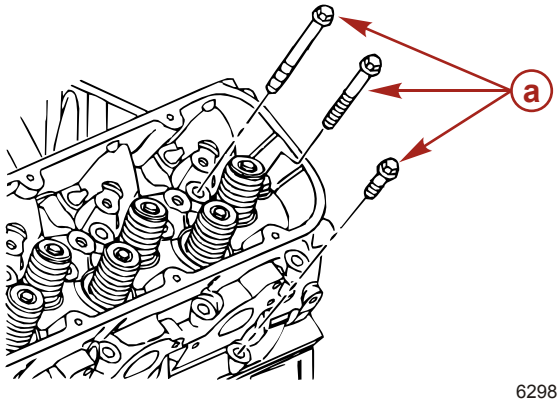
Description	Nm	lb. in.	lb. ft.
Valve cover nuts	14	120	–
Spark plugs	27	–	20

Cylinder Head and Valves

Cylinder Head and Valve Conditioning

Removal

1. Drain the closed cooling system.
2. Remove these components as outlined:
   a. Exhaust manifolds.
   b. Intake manifold assembly.
   c. Valve covers.
   d. Rocker arm assemblies.
   e. Any components attached to front or rear of cylinder head.
   f. Spark plugs.
   g. Head bolts.



6298

a - Head bolts

3. Remove the cylinder head.
4. Place the cylinder head on a bench on wooden blocks to prevent damaging the gasket surfaces.

Cleaning

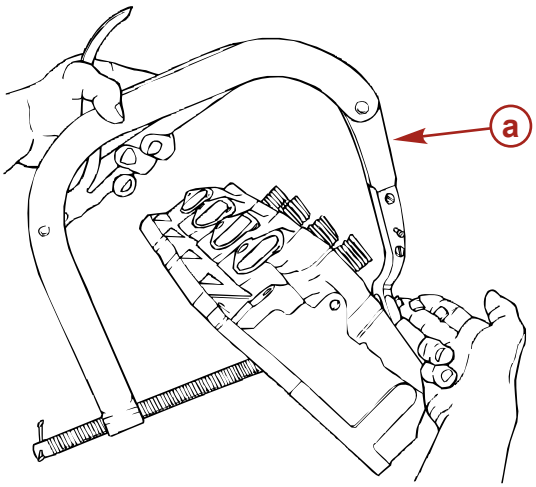
Clean the gasket material and sealer from the cylinder heads.

Inspection

1. Inspect the sealing surfaces for deep nicks and scratches.
2. Inspect for corrosion damage around the cooling passages, and inspect for evidence of cylinder head leakage.

Disassembly

1. Using a valve spring compressor, compress the valve spring and remove the valve keepers, then slowly release the tool.



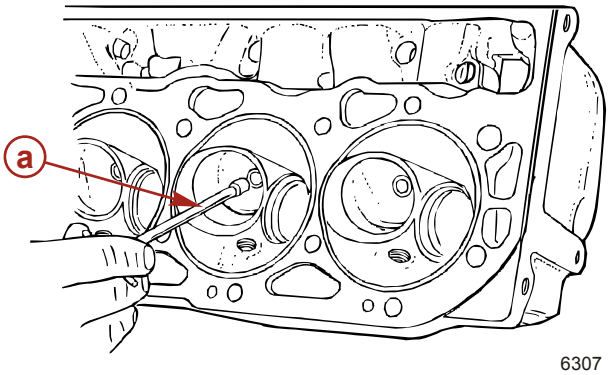
6301

a - Valve spring compressor

2. Remove the retainers and the valve springs.
   IMPORTANT: If the valve stem ends are not square anymore, then use a file to square the edges before removing the valves. This will prevent damaging the valve guides when removing the valves.
3. Carefully remove the valves from the cylinder head and mark them for re-assembly in their original locations.

Cleaning

1. Clean the push rods and rocker arm assemblies with a suitable solvent.
2. Clean the carbon from the valves using a wire wheel.
3. Remove the carbon from the combustion chambers and valve ports using plastic bead media under low pressure, 276 kPa (40 psi).
4. Clean the valve guides thoroughly with valve guide cleaner.



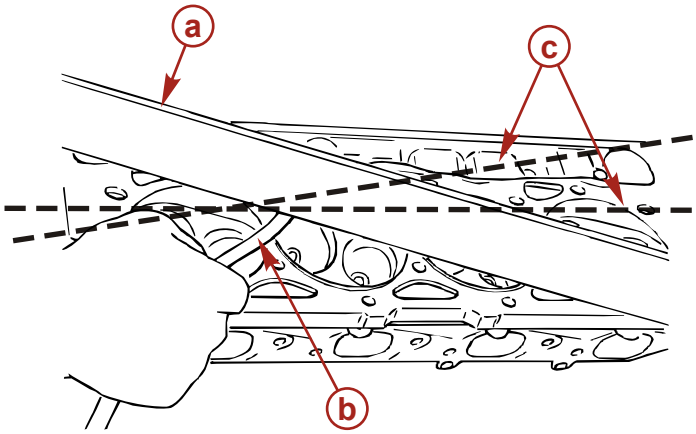
6307

a - Valve guide cleaner

Inspection

1. Inspect the cylinder heads for cracks in the exhaust ports, water jackets and combustion chambers (especially around the spark plug openings and valve seats). Replace the heads if any cracks are found.

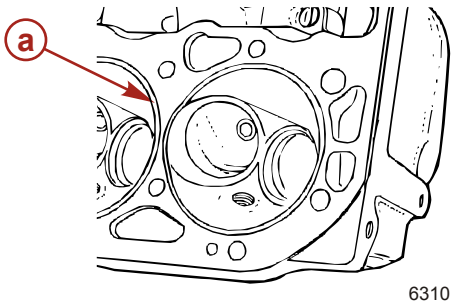
2. Inspect the cylinder head gasket surface for burrs, nicks or corrosion or other damage. Also, check the flatness of the cylinder head gasket surface using a machinist's straight edge and feeler gauges as shown. Take both measurements diagonally across the head (both ways) and straight down the center of the head, a 0.1016 mm (0.004 in.)difference (maximum) overall.



6309

a - Straight edge
b - Feeler gauge
c - Diagonal and straight measurements

3. Inspect the area between the combustion chambers for damage. If there is evidence of damage, check the area with a straight edge and a feeler gauge for flatness. No more than 0.0508 mm (0.002 in.) of a gap is allowed between the surface and the straight edge over a 15.24 cm (6 in.) span.

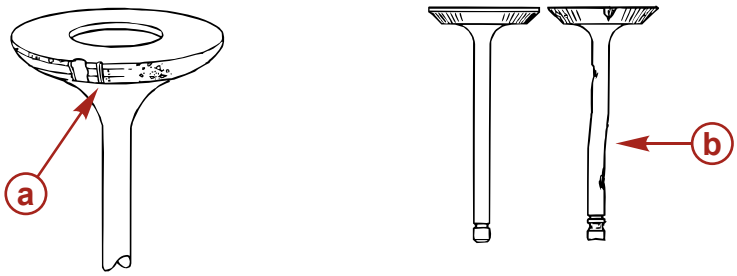


6310

a - Inspect

IMPORTANT: The cylinder head gasket surface should be re-surfaced if it is out of tolerance. When head re-surfacing is required, the intake manifold gasket surface on the cylinder head must be milled to provide for proper alignment between the intake manifold and the cylinder head.

4. Inspect the valves for heat damage, cracked faces or damaged stems.



6311

a - Cracked and pitted face
b - Damaged stems

5. Inspect the rocker arm assemblies and push rod guides for wear and damage.
IMPORTANT: Incorrect clearance between the valve stem and bore may cause excessive oil consumption, valve noise, and possible valve damage. Ensure that valve clearance is within specifications.
6. Measure the valve stem and compare the measurement with the table. If the valve stem is worn, replace the valve.

Valve System		Specification
Stem diameter	Intake	9.436 - 9.461 mm (0.3715 - 0.3725 in.)
	Exhaust	9.406 - 9.431 mm (0.3703 - 0.3713 in.)

7. Measure the valve guide with a dial bore gauge and subtract the valve stem measurement from the guide diameter. That measurement will be the stem clearance.
   a. If the clearance exceeds the specification, replace the valve guide.

Cylinder Head	Specification
Valve guide diameter (intake and exhaust)	9.479 - 9.497 mm (0.3732 - 0.3739 in.)

Valve System		Specification
Stem clearance	Intake	0.0178 - 0.061 mm (0.0007 - 0.0024 in.)
	Exhaust	0.0482 - 0.0914 mm (0.0019 - 0.0036 in.)

Valve Guide Replacement

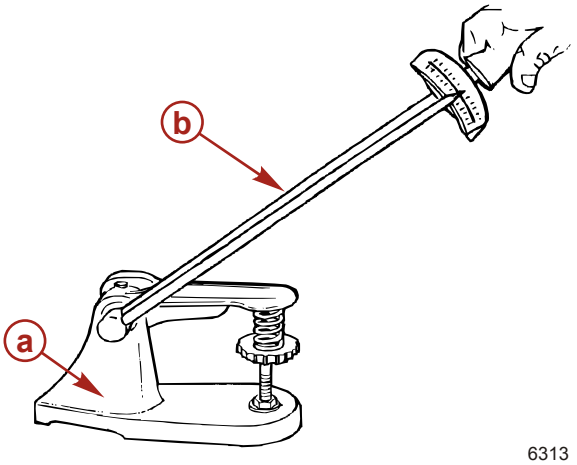
Any cylinder head requiring repair, other than valve and valve seat reconditioning, should be taken to a reputable cylinder head repair facility for repair.

Valve Guide Specifications		
Valve Guide Tool	**mm**	**in.**
Guide removal ream size[1]	11.11	0.4375
Drift to remove guide	11.11	0.4375
Guide installation tool[2]	9	0.355
Initial ream size	9.469-9.474	0.3728-0.3730
Hone	9.489	0.3736

Valve Spring Testing

IMPORTANT: The valve spring pressure must be checked with the inner and outer springs and the upper retainer in place.

Measure the valve spring length and pressure and compare with the table below. Replace any spring, keeper and retainer that does not meet the specifications.



6313

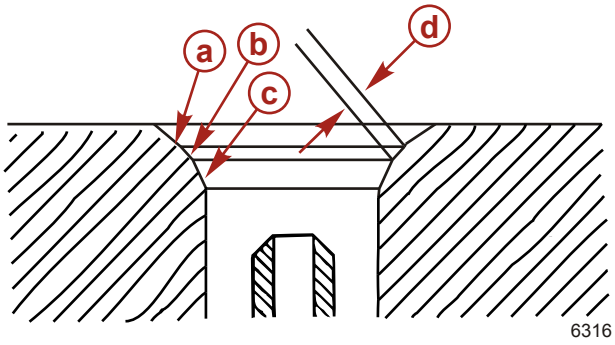
a - Valve spring tester
b - Torque wrench

Valve Spring			Specification
Inner valve spring (no stripe)	Free length		48.76 mm (1.92 in.)
	Force	Closed at 46.99 mm (1.85 in.)	147 - 165 N (33 - 37 lbf)
		Open at 31.1 mm (1.225 in.)	576 - 625 N (129.5 - 140.5 lbf)
	Installed height		43.18 mm (1.70 in.)
Outer valve spring (blue stripe)	Free length		52.78 mm (2.078 in.)
	Force	Closed at 45.72 mm (1.800 in.)	338 - 374 N (76 - 84 lbf)
		Open at 29.85 mm (1.175 in.)	1112 - 1201 N (250 - 270 lbf)
	Installed height		45.75 mm (1.80 in.)

1. Leave a step in the guide for the guide drift to work against when removing the guide.
2. Use Sunnen B-200 lubricant on outer surface of guide.

Valve Seat Repair

The tool manufacturer's recommendations should be followed carefully to attain proper results.

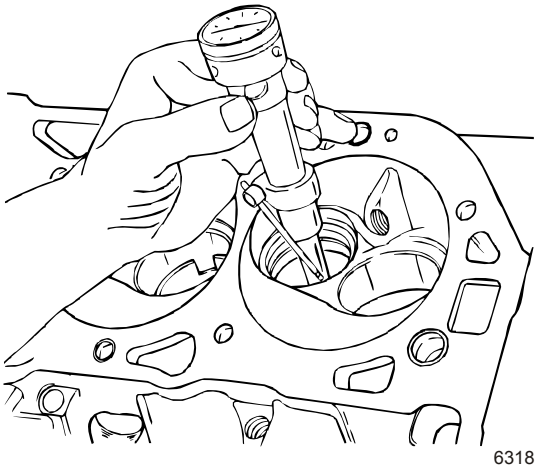


Typical "Three Angle" Valve Seat

- **a -** Top angle (30°)
- **b -** Seat angle (45°)
- **c -** Bottom angle (60°)
- **d -** Seat width

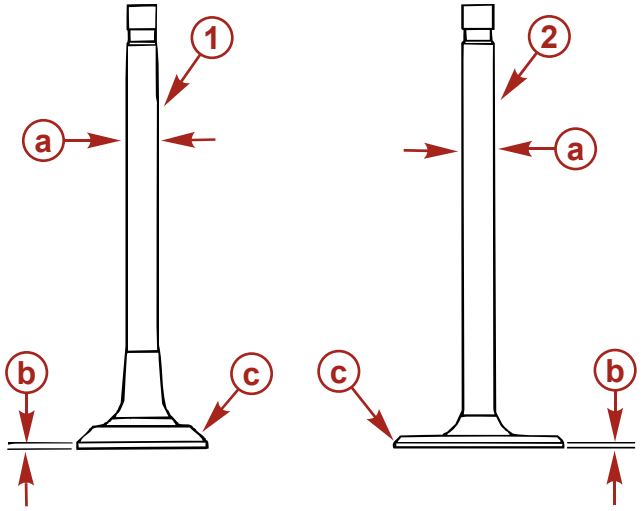
Valve System		Specification
Seat width	Intake	2.032 +/- 0.1524 mm (0.080 +/- 0.006 in.)
	Exhaust	3.175 +/- 0.1524 mm (0.125 +/- 0.006 in.)

IMPORTANT: It is essential that valve guide bores be free from carbon or dirt to achieve proper centering of the pilot in the valve guide to ensure concentricity.



Valve Grinding

Valves that are pitted must be re-faced to the proper angle. Valve stems that show excessive wear or valves that are warped must be replaced. When a warped valve is re-faced, 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 re-face it. 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 in.) after grinding, replace the valve.



1. **Exhaust**
   - **a.** 9.406 - 9.431 mm (0.3703 - 0.3713 in.)
   - **b.** 1.651 mm (0.065 in.)
   - **c.** 45°
2. **Intake**
   - **a.** 9.436 - 9.461 mm (0.3715 - 0.3725 in.)
   - **b.** 1.27 mm (0.050 in.)
   - **c.** 45°

Re-assembly

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. Verify the installed height.

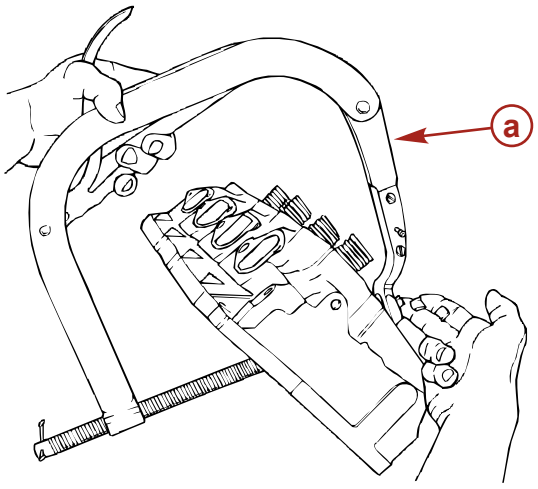
NOTICE

Serious engine damage can result if the valve springs bind. Do not shim valve springs to give an installed height less than the minimum specified.

Valve Spring		Specification
Inner valve spring (no stripe)	Installed height	43.18 mm (1.70 in.)
Outer valve spring (blue stripe)		45.75 mm (1.80 in.)

NOTE: *A spring seat must always be used underneath the valve spring assembly.*

3. Use a valve spring compressor to install the retainer and valve keepers. Use grease to hold keepers in place during assembly.



6301

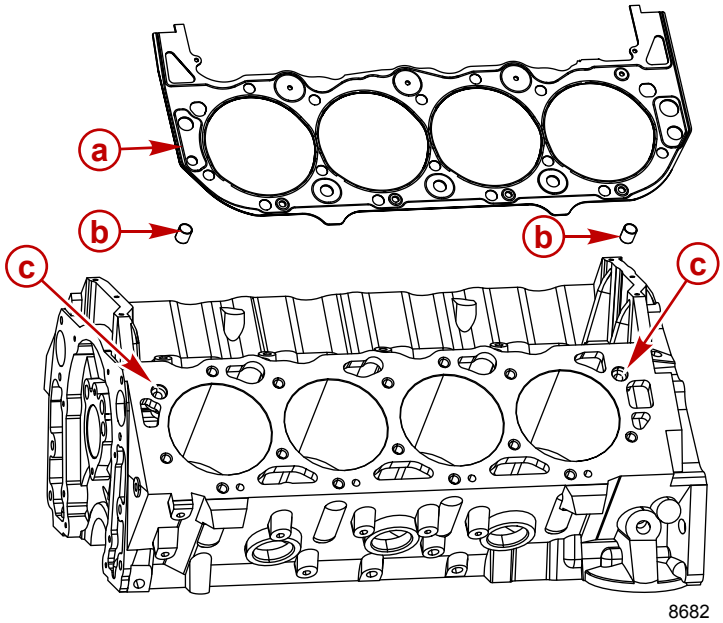
a - Valve spring compressor

Cylinder Head Gasket Installation

1. Clean the cylinder block and cylinder head gasket surfaces with a cleaner degreaser.

Tube Ref No.	Description	Where Used	Part No.
	Loctite Natural Blue Biodegradable Cleaner Degreaser	Head gasket surfaces	Obtain Locally

2. Remove the split dowel pins from the cylinder block and install the dowel pins supplied with the kit.
3. Install the head gasket onto the cylinder block and install the cylinder head.



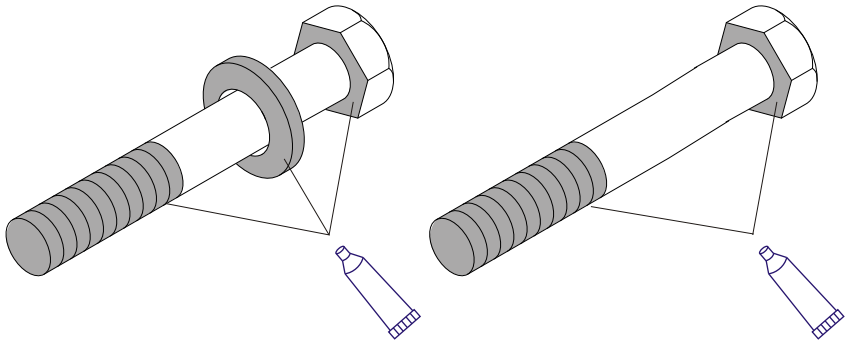
8682

Port shown, starboard similar

a - Head gasket
b - Dowel pin
c - Dowel pin location

IMPORTANT: Do not use washers with the head bolts on cast iron cylinder heads.

4. Generously lubricate the threads of the cylinder head bolt, under the head of the bolt, and on the washer (aluminum heads only).

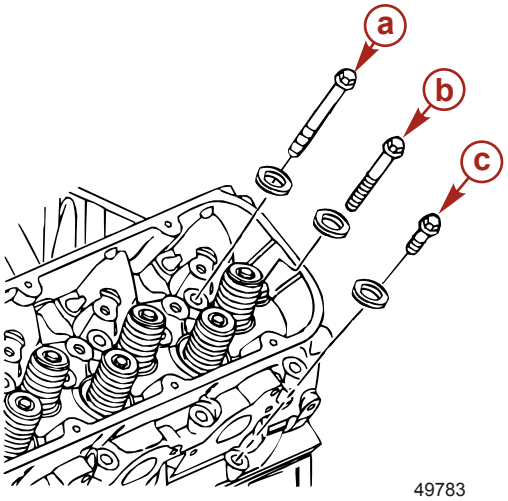


9262

Aluminum cylinder head bolt with washer lubrication area **Cast Iron cylinder bolt lubrication area**

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Cylinder head bolt thread, head, and washer	92-858087K01

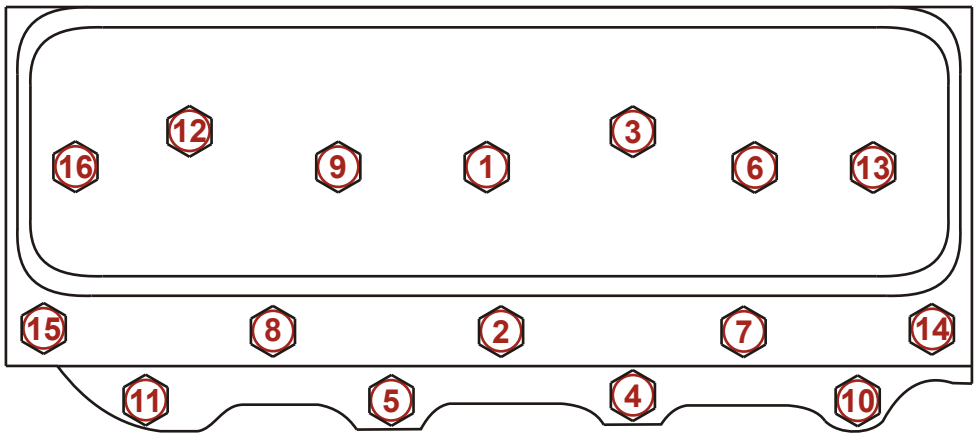
5. Install the head bolts with washers finger-tight.



49783

a - Long bolt with washer
b - Medium bolt with washer
c - Short bolt with washer

6. Tighten the head bolts in three steps, following the torque sequence for each step, and finish with a slow pull to the final torque. Repeat the final torque sequence.



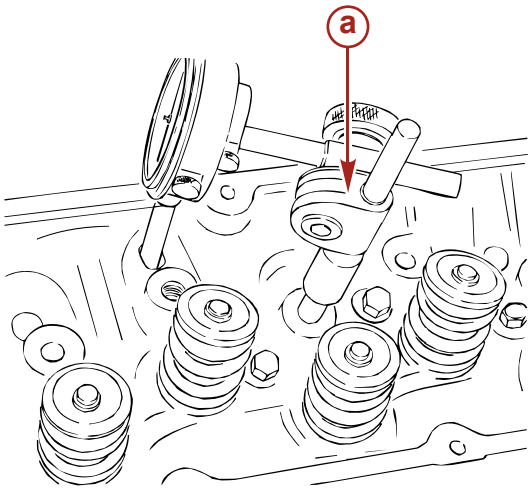
6339

Component		Nm	lb. in.	lb. ft.	Lubricants, Sealants, Adhesives
Aluminum Cylinder Head	Step #1	41	–	30	**Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated**Under the head and on the threads of the cylinder head bolt and on both sides of the washer
	Step #2	68	–	50	
	Step #3	95	–	70	

Camshaft

Measuring the Camshaft Lobe Height

1. Remove one of the rocker arm assemblies as previously outlined.
2. Install a dial indicator and tool as shown. Position the indicator with the ball socket adapter tool on the push rod. Ensure that the push rod is seated in the lifter cup.



6343

a - Dial indicator and tool

3. Rotate the torsional damper slowly in the direction of rotation until the lifter is on the base circle or "heel" of the cam lobe. At this point, the push rod will be in its lowest position.
4. Set the dial indicator to zero, then rotate the damper slowly until the push rod is in the fully raised position.
5. Compare the total lift to the specifications.

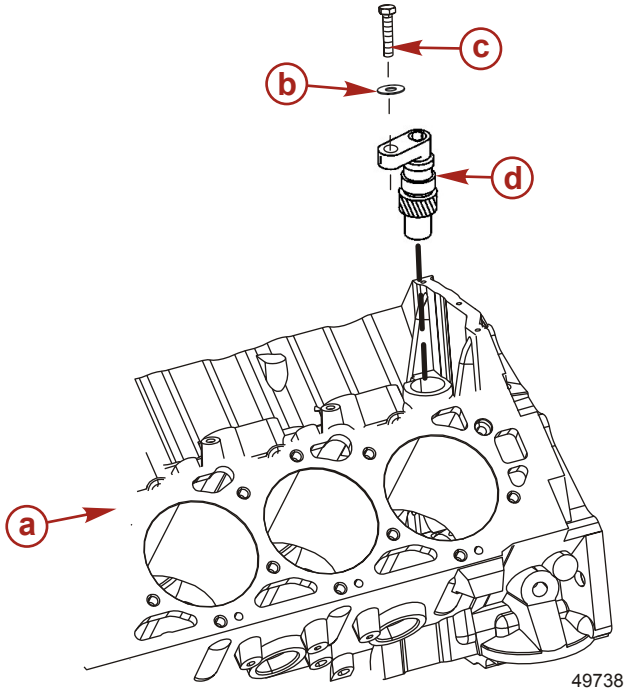
Roller Camshaft Lobe Lift	Specification
Exhaust	8.327 mm (0.327 in.)
Intake	7.569 mm (0.298 in.)

6. Continue to rotate the damper until the indicator reads zero. This will be a check on the accuracy of the original indicator reading.
7. If the camshaft lobe lift readings are not within the specifications, replace the camshaft.
8. Install and adjust the rocker arm(s).

Removal

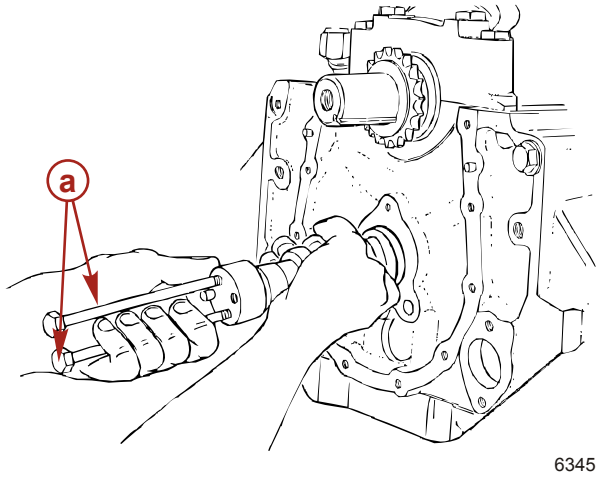
1. Remove the rocker arms, windage tray, push rods and the valve lifters.

2. Remove the oil drive mechanism.



a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

3. Remove the timing cover.
4. Remove the timing chain and sprocket.
5. Remove the cam retaining plate.
6. Install two 5/16-18 x 5 in. bolts in the camshaft bolt holes. These will be used as a handle for removing the camshaft.
7. Carefully remove the camshaft.

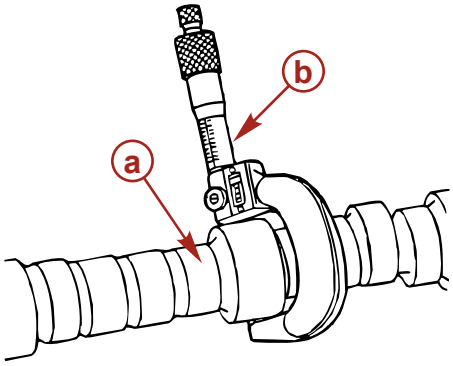


Removing the camshaft
a - 5/16 - 18 x 5 in. bolts

Inspection

1. Inspect the camshaft bearings, whenever the camshaft is removed. Refer to the **Camshaft Bearings** section of this manual.

2. Measure the camshaft bearing journals with a micrometer.

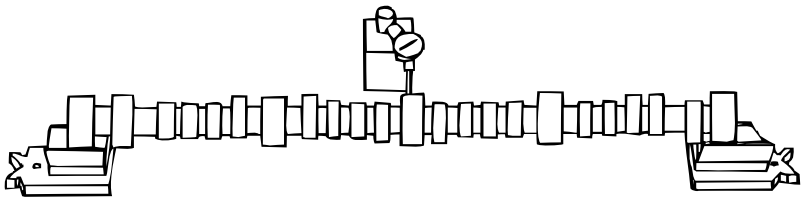


6346

a - Camshaft
b - Micrometer

Roller Camshaft	Specification
Journal diameter	49.479 - 49.522 mm (1.948 - 1.9497 in.)
Journal out of round	0.0508 mm (0.002 in.) max

3. If the journals measurement is above the out-of-round specification, the camshaft must be replaced.
4. Check the camshaft for excessive runout using V-blocks and a dial indicator.



6347

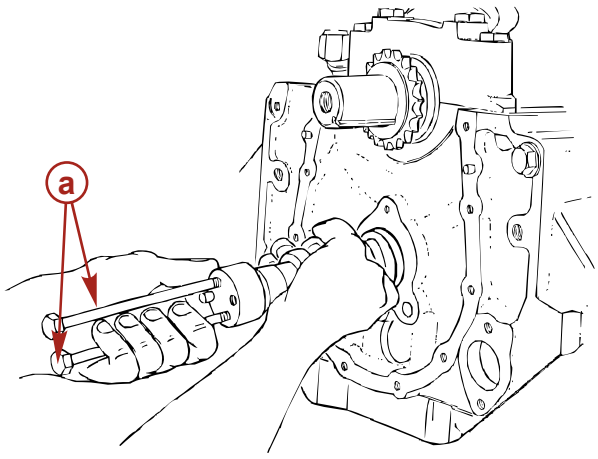
Checking camshaft alignment

Roller Camshaft	Specification
Camshaft runout	0.0508 mm (0.002 in.) max

5. If the runout is more than specification, the camshaft must be replaced.

Installation

1. Install two 5/16-18 x 5 in. bolts in the camshaft bolt holes.
2. Lubricate the camshaft journals with engine oil or assembly lube.
3. Install the camshaft into the camshaft bore. Be careful not to damage the camshaft's precision ground surfaces or the bearings by bumping the camshaft around in the boreline. Ensure that the camshaft rotates freely during and after installation.



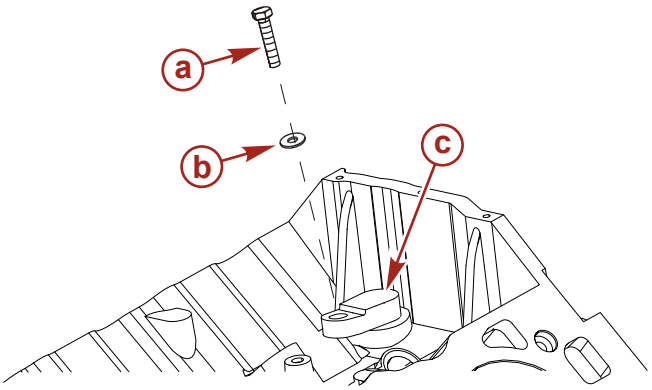
6345

Installing the camshaft
a - 5/16 - 18 x 5 in. bolts

4. Apply engine oil to both sides of the camshaft retainer plate. Secure with two screws and tighten to specification.

Description	Nm	lb-in.	lb-ft
Cam retainer to block screw	11	96	–

5. Apply Crane Camshaft Assembly Lube (supplied with the camshaft) or an equivalent (moly-based assembly lube) to the camshaft lobes in preparation for lifter installation.
6. Install the oil drive mechanism. Rotate the crankshaft to engage the oil drive mechanism with the oil pump.
IMPORTANT: The oil drive mechanism is not properly installed if it is not resting on the engine casting and engaged with the oil pump.
7. Ensure that the mechanism is resting on the engine casting as shown.
8. Install the washer and screw. Tighten the screw to specifications.



49740

a - Mounting bolt
b - Washer
c - Oil drive mechanism

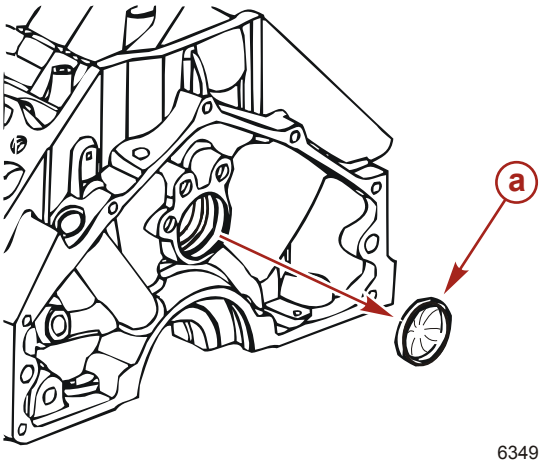
Description	Nm	lb-in.	lb-ft
Oil drive mechanism screw	20	180	–

9. Install the timing chain and timing cover.
10. Install the rocker arm assemblies, lifters, retainer, and windage tray.

Camshaft Bearings

Removal

1. With the camshaft and crankshaft removed, drive the camshaft rear plug from the cylinder block.

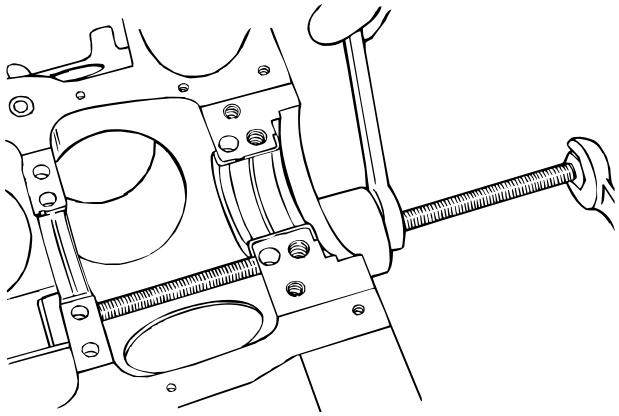


6349

a - Camshaft rear plug

NOTE: *Several tools are available to remove and install camshaft bearings, follow the instructions supplied with the tool to remove the bearings.*

2. Using a camshaft bearing remover and installer set, remove the camshaft bearings.



6350

Inspection

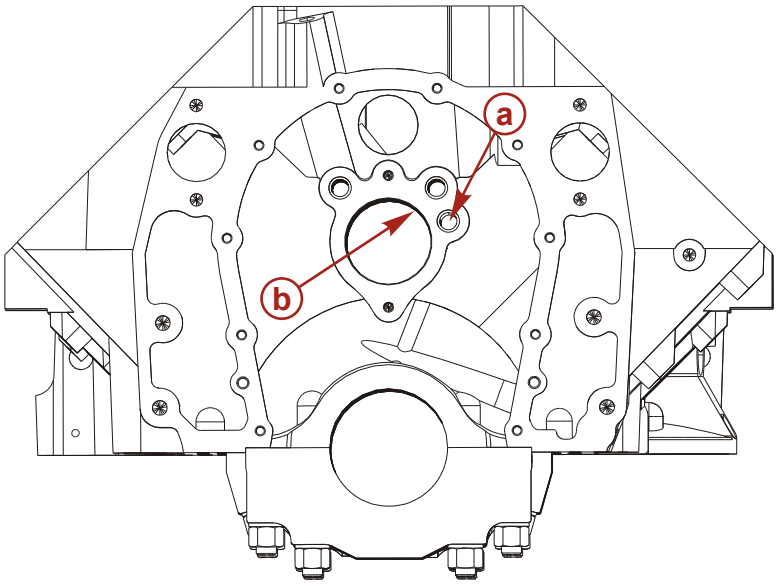
Clean the camshaft bearing bores with solvent and blow them out with compressed air. Ensure that the grooves and the drilled oil passages are clean.

Installation

IMPORTANT: If the new cam bearings are not supplied with instructions:The #1 cam bearing is narrower than the others. #3 and #4 cam bearings have the same outside diameter and #2 and #5 cam bearings have the same outside diameter.

NOTE: *Several tools are available to remove and install camshaft bearings, follow the instructions supplied with the tool to install the bearings.*

1. Lubricate the outer surface of the camshaft bearings with high pressure grease to aid in the bearing installation.
2. Install the camshaft bearings, as written in the following paragraphs, making sure that the camshaft rotates freely in the bearing as each bearing is installed and before installing the cam gear and cover.
3. Position the camshaft bearings as follows (directional references are clock positions from the front of the engine looking rearward):
   - The front bearing must be positioned so that the oil hole is at the "2:30" clock position, aligned with the oil gallery and the hole in the bore.
   - The rear, intermediate, and center bearings must be positioned so that the oil hole is at the two o'clock position and aligned with the hole in the block.



a - Front bearing alignment
b - Remaining bearing alignment

6351

IMPORTANT: The plug must be installed flush to 0.8 mm (1/32 in.) deep and it must be parallel with the rear surface of the cylinder block.

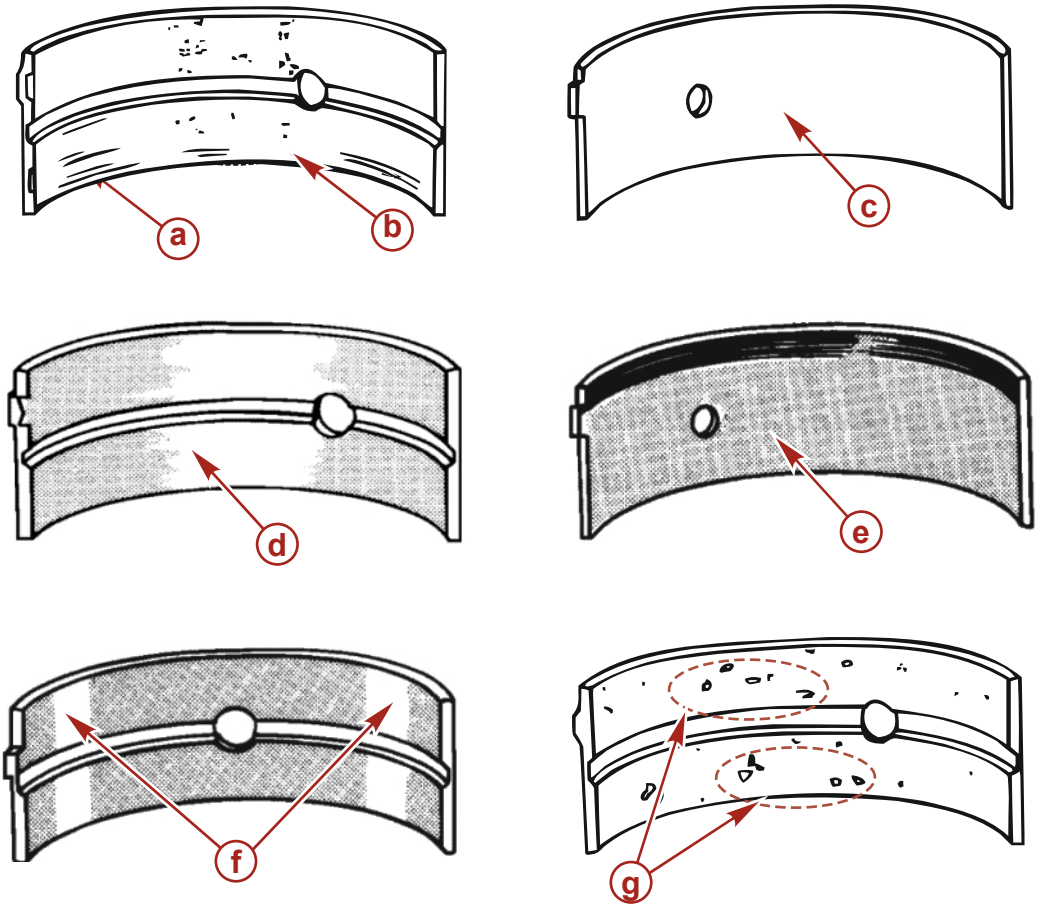
4. Install a new camshaft rear plug.
5. Install the crankshaft and camshaft.

Crankshaft and Main Bearings

Inspection of Main Bearings

In general, the lower half of the bearing (except bearing number one) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that 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.

The main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and 0.001 in., 0.002 in., 0.010 in. and 0.020 in. undersize.

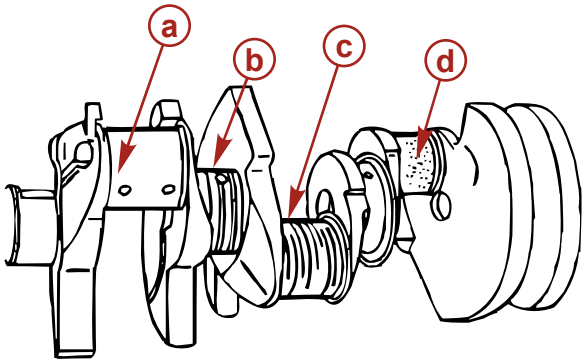


a - Scratched by dirt - scratches
b - Dirt embedded in bearing material
c - Tapered journal - overlay gone from entire surface
d - Lack of oil - overlay worn off
e - Radius ride - worn area
f - Improper seating - bright or polished sections
g - Fatigue failure - craters or pockets

Inspection of Crankshaft

1. Wash the crankshaft in solvent and dry it with compressed air.

2. Inspect the crankshaft.

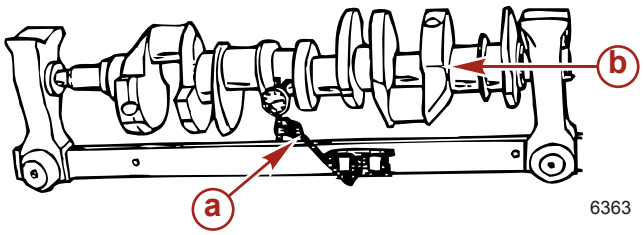


6362

a - Smooth surface
b - Grooves
c - Scratches or uneven surface
d - Pitted surface

NOTE: *The journal dimensions should be checked at two spots, 90° apart, don't take measurements near the oil galleries.*

3. Measure the main bearing journal dimensions with a micrometer and record the dimensions. Check for out-of-round, taper or undersize, see specifications.
4. Support the front and rear main bearing journals with V-blocks and check the crankshaft for runout, see specifications.



6363

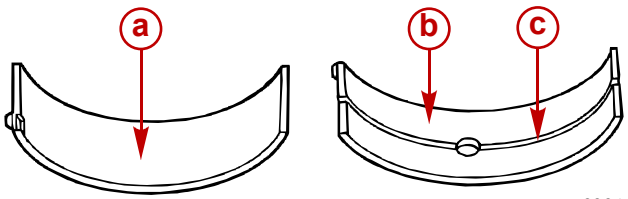
a - Dial indicator
b - Crankshaft

5. Replace or recondition the crankshaft if it is not within the specifications.

Crankshaft			Specification
Main journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
	Out of Round	Production	0.0127 mm (0.0005 in.) max
		Service	0.0254 mm (0.001 in.) max
Crankshaft runout @ No.3 main bearing			0.088 mm (0.0035 in.) max

Measuring Main Bearings (Factory Method [Preferred])

1. Install main bearings in engine block as follows.

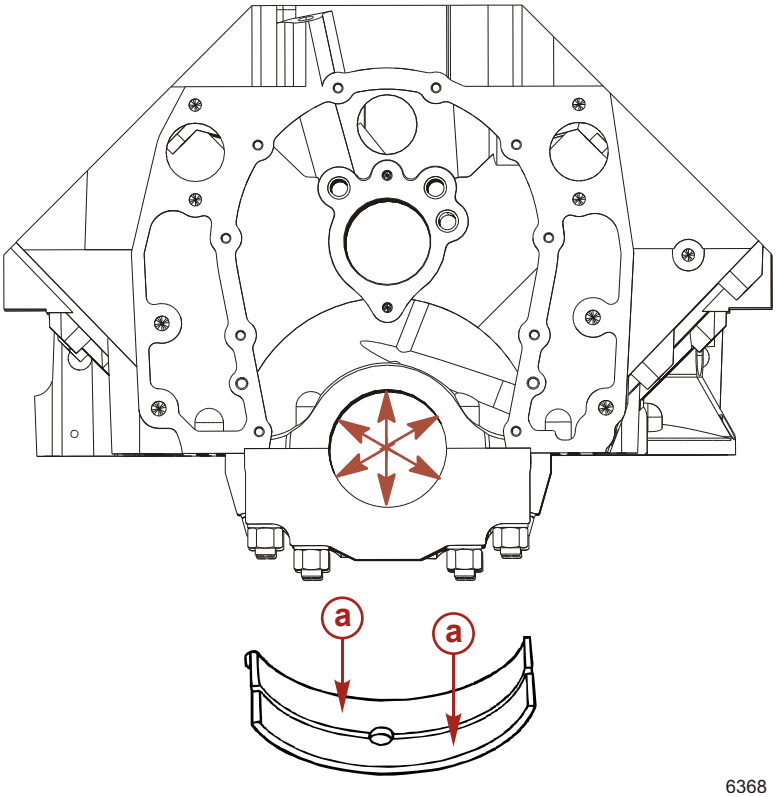


6364

Main Bearing Inserts
a - Lower bearing insert (install in cap)
b - Upper bearing insert (install in block)
c - Oil groove

2. Install the main bearing caps with the bearings installed and tighten them to specifications.

3. Using a dial bore gauge, measure the front and rear dimensions of the bearing and around the entire inside diameter of the bearing, record readings. All dimensions must be within clearance specifications, if not, replace bearing. This is your main bearing bore dimension.



6368

a - Front and rear of bearing

4. Subtract the journal diameter from the main bore diameter, this is the main bearing clearance.

Crankshaft			Specification
Main Bearing Clearance	Production and Service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)

5. If the clearance is not within specification, replace the bearing if it is used. A standard, or 0.025 mm (0.001 in.), undersize bearing may produce the proper clearance. if not, re-grind the crankshaft and install an undersized bearing. Mixing half-sizes or sanding the backside of a bearing to gain the proper clearance is also acceptable.

Installation

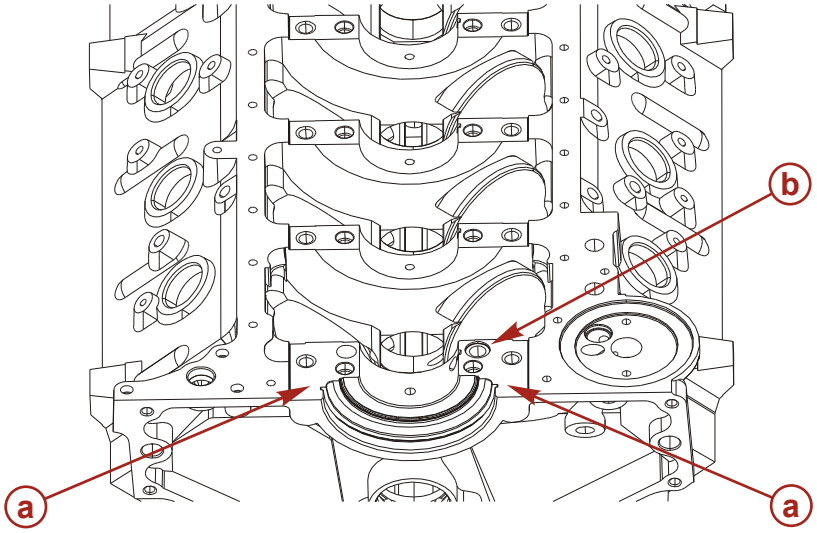
1. Apply engine oil to the bearing surfaces and crankshaft journals.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Bearing surfaces and crankshaft journals	92-858087K01

2. Apply a very thin coat of silicone to the rear sealing surface of the rear main bearing cap to prevent oil seepage between the cap and the block and be sure to install the cap before the sealant cures.

Tube Ref No.	Description	Where Used	Part No.
128	Loctite 5900 Ultra Black RTV Silicone Sealant	Rear main bearing cap sealing surface	92-809826

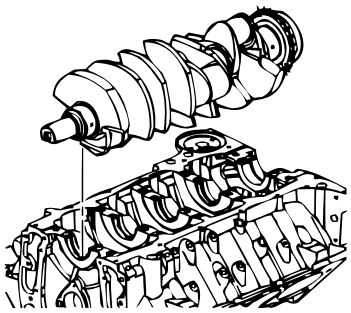
3. Install the o-ring.



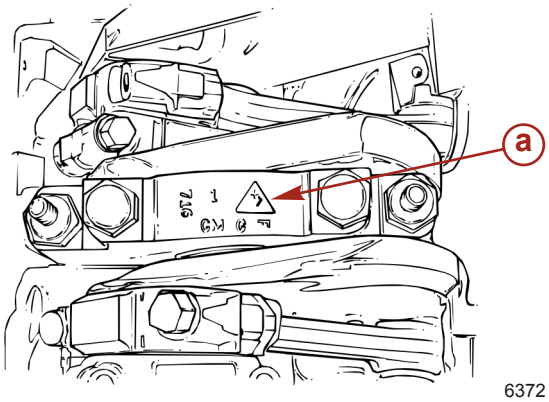
6370

a - Silicone sealant
b - O-ring

4. Carefully lower the crankshaft into position and install the main bearing caps in the proper order, "1" through "5" with arrows pointing toward front of engine.



6371



6372

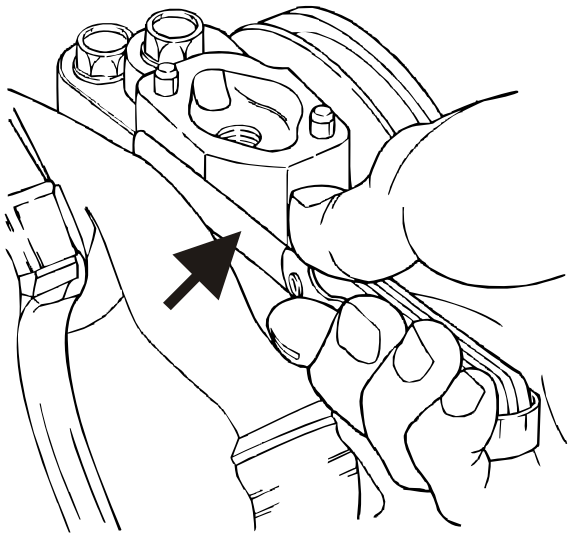
a - Bearing cap marking

NOTE: *Install the fasteners as received or as removed from the engine. Do not apply additional lubrication.*

5. Install and tighten the main bearing caps, "1,", "2," "3," and "4" to specifications.
6. Tighten the rear main bearing cap to specifications; then tap the end of the crankshaft, first rearward then forward with a lead or plastic hammer. This will line up the rear main bearing and the crankshaft thrust surfaces. Tighten the rear main bearing cap to specifications.

Description	Nm	lb. in.	lb. ft.
Main bearing cap torque "1" through "4"	149	–	110
Rear main bearing cap torque (first step)	14-16	–	10-12
Rear main bearing cap torque (second step)	149	–	110

7. Measure the crankshaft end play, see specifications, by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.



6373

Crankshaft	Specification
Crankshaft end play	0.152 - 0.254 mm (0.006 - 0.010 in.)

8. If the end play exceeds the specifications and the bearing is used, install a new bearing and re-check the main bearing clearance and end play. If the end play is still excessive, the crankshaft will either have to be re-worked or replaced.
9. If there is not enough end play, remove the rear main bearing and lightly and evenly sand the thrust surface and re-measure end play.
10. Rotate the crankshaft by hand feeling for excessive resistance, if the crankshaft cannot be rotated easily by hand, the cause must be found and fixed.
11. Check the piston rod big end clearances and re-install pistons and valve train.
12. Install as outlined:
    a. Timing chain and sprocket on camshaft align marks with crankshaft.
    b. Timing chain cover.
    c. Oil pump and baffle.
    d. Dipstick tube and oil pan.
    e. Spark plugs.
    f. Torsional damper and crankshaft pulley.
    g. Water pump.
    h. Belt(s).
    i. Flywheel / drive coupler/plate and flywheel housing.
    j. Starter.
13. Install a new oil filter and fill the crankcase with oil, refer to **Section 1B - Maintenance.**

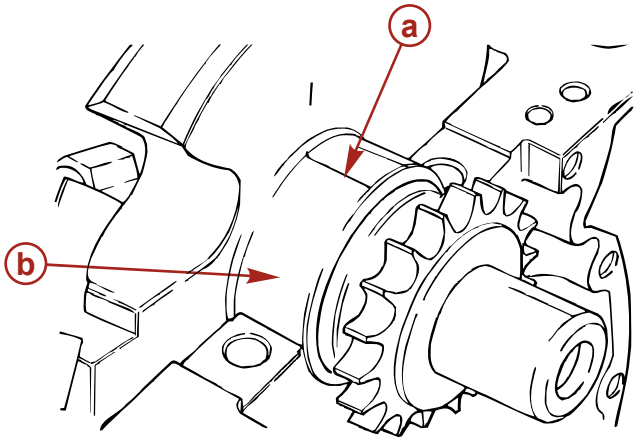
Crankshaft and Main Bearings (Plastic Gauging Method [Not Preferred])

To obtain accurate measurements while using Plastigage™ or its equivalent, the engine must be out of the boat and upside down so that the crankshaft will rest on the upper bearings. The total clearance can now be measured between the lower bearing and the journal.

IMPORTANT: To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, prior to checking the fit of the bearings, the surface of the crankshaft journal and bearing should be wiped clean.

1. With the oil pan and oil pump removed, wipe the oil from the journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.
3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap Must be tightened to specifications in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

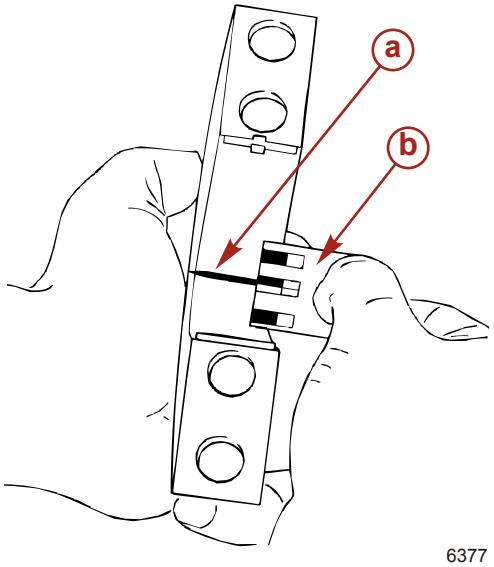
IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.



6376

a - Gauging plastic
b - Journal

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



6377

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 0.0254 mm (0.001 in.) maximum, be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter, and the journal is out of round 0.0254 mm (0 .001 in.), 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 0.0254 mm (0.001 in.) difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory.

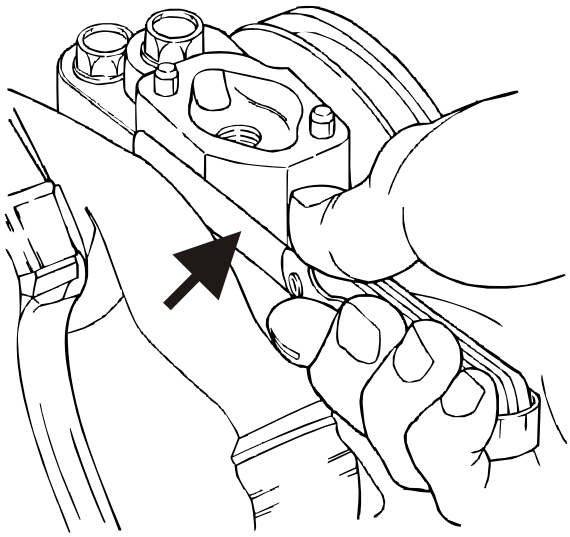
Crankshaft			**Specification**
Main Bearing Clearance	Production and Service	No.1,2,3,4	0.0508 - 0.0889 mm (0.0020 - 0.0035 in.)
		No.5	0.0711 - 0.1016 mm (0.0028 - 0.0040 in.)

7. A standard, or 0.0254 mm (0.001 in.), undersize bearing or half of a over or undersize bearing may produce the proper clearance. If not, it will be necessary to re-grind the crankshaft journal for use with the next undersize bearing.

   NOTE: *After selecting a new bearing, re-check the clearance.*

8. Proceed to the next bearing. After all of the bearings have been checked, rotate the crankshaft to check for excessive drag. When checking the number one main bearing, loosen the accessory drive belts. The drive belt pulling on the crankshaft will distort the reading.

9. Measure the crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.

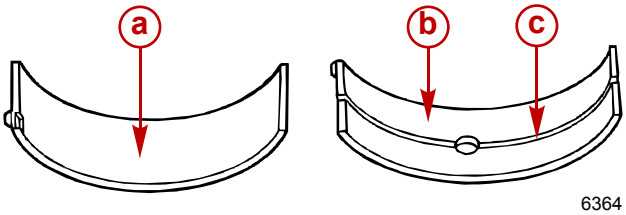


6373

Crankshaft	Specification
Crankshaft end play	0.152 - 0.254 mm (0.006 - 0.010 in.)

Replacement

NOTE: *The main bearings can be replaced with or without the crankshaft in place.*



6364

Main Bearing Inserts

a - Lower bearing insert (install in cap)
b - Upper bearing insert (install in block)
c - Oil groove

With Crankshaft Removed

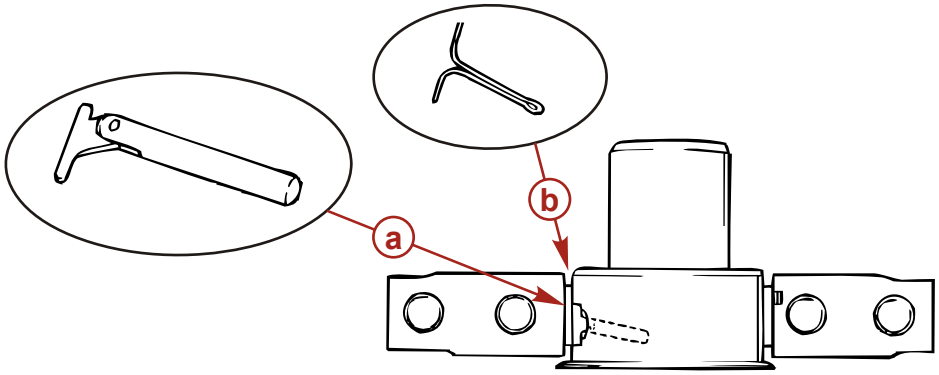
1. Remove and inspect the crankshaft as outlined.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

Without Crankshaft Removed

IMPORTANT: Inspect the bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before dis-assembly so that they can be re-installed in their original locations.

1. With oil pan, oil pump and spark plugs removed, make suitable marks on cap and remove cap on main bearing requiring replacement. Remove bearing from cap.

2. Install main bearing remover/installer in oil hole in crankshaft journal. If tool is not available, a cotter pin may be bent, as shown, to do the job.



6379

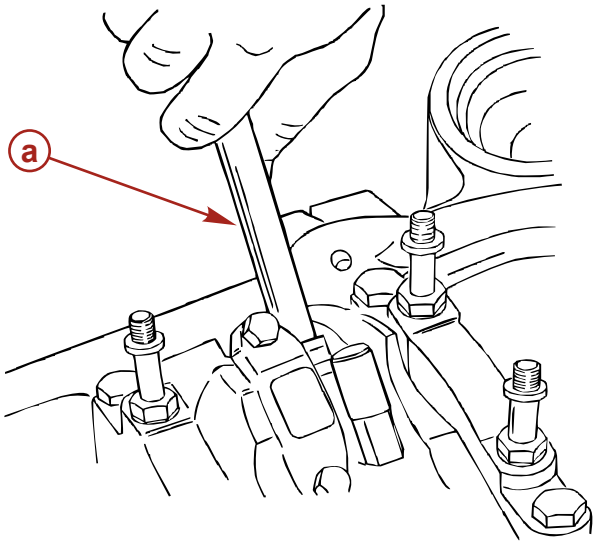
a - Main bearing remover/ installer
b - Cotter pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll the upper bearing out of the block.
4. Oil the new upper bearing and insert the plain (no notched) end between the crankshaft and the indented or notched side of the block. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
5. Oil the new lower bearing and install it in the bearing cap.
6. Install the main bearing, cap with marks made on dis-assembly or arrows if present, pointing toward the front of the engine.
7. Tighten the main bearing caps "1," "2," "3," and "4" to specifications.
8. Tighten the rear main bearing cap to specifications; then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Tighten the rear main bearing cap to specifications.

Description	Nm	lb. in.	lb. ft.
Main bearing cap torque "1" through "4"	149	–	110
Rear main bearing cap torque (first step)	14-16	–	10-12
Rear main bearing cap torque (second step)	149	–	110

9. Install the connecting rod bolt guide. Push the connecting rod and piston assembly out through the top of the cylinder block.

NOTE: *It will be necessary to turn the crankshaft slightly to disconnect and remove some of the connecting rod and piston assemblies.*

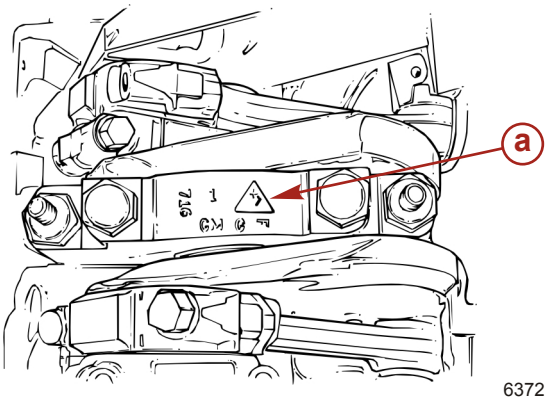


6381

a - Connecting rod bolt guide

NOTE: *The main bearing caps have arrows cast in them (facing forward) with the numbers "1" through "5" stamped on them.*

10. Remove each main bearing cap being careful to keep the bearing half with its respective cap.



a - Bearing cap marking

11. Carefully remove the crankshaft.

Pistons and Connecting Rods

IMPORTANT: Do not use an impact wrench.
Be sure to use soft jaws in the vise when clamping the rod and new piston.
Take precautions to avoid nicking the rod, cap, or bolts; they are highly stressed and susceptible to fatigue cracks that start with surface defects.

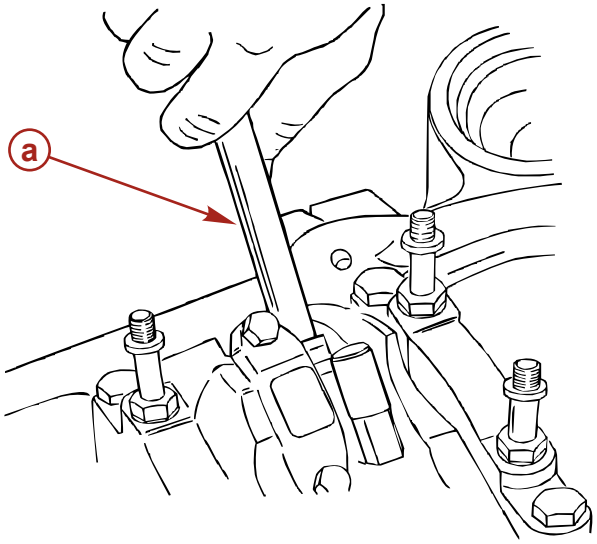
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. Never file rods or rod caps. If the clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersize for use with new and used standard size crankshafts, and in 0.010 in. and 0.020 in. undersize for use with reconditioned crankshafts.

Removal

1. Remove the engine.
2. Remove the coupling and flywheel and mount the engine on a suitable stand.
3. Remove the cool fuel system, engine mount and oil cooler.
4. Remove the starter and cylinder heads.
5. Remove the oil pan and torsional damper.
6. Remove the oil pump and baffle.
7. Remove the timing chain cover and timing chain.
8. Remove the camshaft.
9. Use a ridge reamer to remove any ridge or deposits from the top of the cylinder bore.
   IMPORTANT: Before the ridge and deposits are removed, rotate the crankshaft to position the piston at the bottom of the stroke and place a cloth on top of the piston to collect the cuttings. After the ridge and deposits are removed, rotate the crankshaft to position the piston at the top of the stroke, then remove the cloth and cuttings.

   NOTE: *The connecting rod caps and the connecting rods are matched by a process called cracked rod.*
10. Remove each connecting rod cap being careful to keep the bearing half with its respective cap.
11. Install the connecting rod bolt guide on the rods. Push the connecting rod and piston assembly out of the top of the cylinder block.

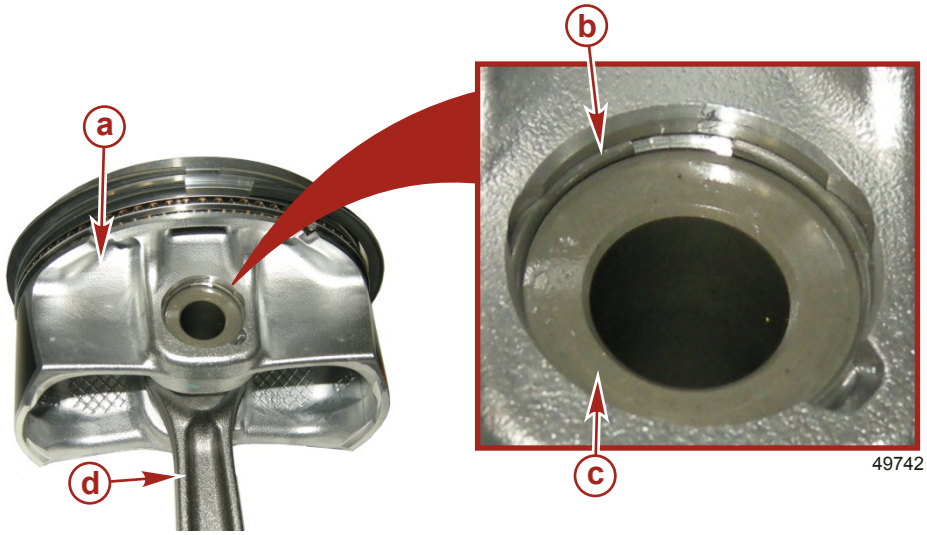
NOTE: It will be necessary to turn the crankshaft slightly to disconnect and remove some of the connecting rod and piston assemblies.



a - Connecting rod bolt guide

Disassembly and Inspection

1. Remove the retaining clip and remove the piston pin to disassemble the piston from the connecting rod.



a - Piston
b - Retaining clip
c - Piston pin
d - Connecting rod

2. Inspect the bearing surface for wear and damage.
3. Remove the oil film from the crank pin, and the upper and lower bearing shells.
4. Measure the crankpin for out-of-round or taper with a micrometer. If it is not within the specifications, replace or recondition the crankshaft. If it is within the specifications and a new bearing is to be installed, measure and record the maximum diameter of the crankpin to determine the new bearing size required.

Crankshaft			**Specification**
Main Journal	Diameter	No.1,2,3,4	69.8042 - 69.8220 mm (2.7482 - 2.7489 in.)
		No. 5	69.7789 - 69.7967 mm (2.7472 - 2.7479 in.)
	Taper	Production	0.0127 mm (0.0005 in.) Max
		Service	0.0254 mm (0.001 in.) Max
	Out of Round	Production	0.0127 mm (0.0005 in.) Max
		Service	0.0254 mm (0.001 in.) Max

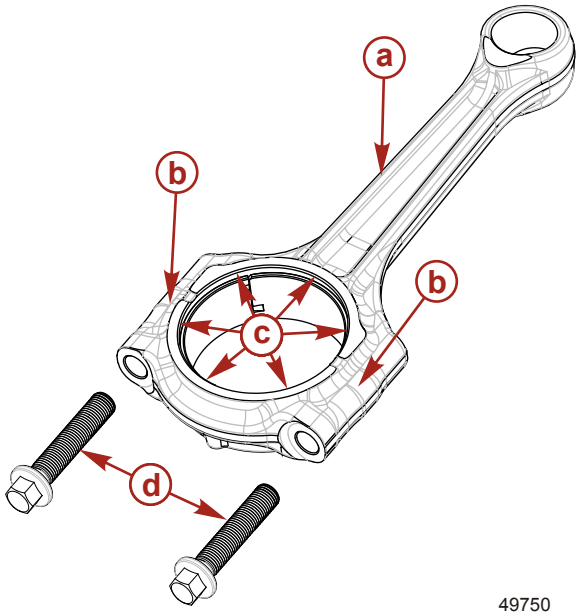
NOTICE

Attaching bearing cap bolts to a connecting rod that is secured in a vise can lead to product damage. When clamping rods in a vise, always use a soft-jawed vise and clamp at the crankshaft end of the rod, as close to the parting line of the bearing cap as possible.

5. Clamp the connecting rod into a vice with soft jaws.
6. Install the bearing caps with the bearings and tighten them to specifications.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

7. Using a dial bore gauge, measure and record the inside diameter of the bearing. Subtract the crank pin diameter from the rod bearing inside diameter to obtain clearance.



49750

a - Connecting rod
b - Parting area (cracked cap)
c - Inside diameter
d - Bolt

Crankshaft		Specification
Rod Bearing Clearance	Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
	Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max

8. If the clearance exceeds the specifications, select a new, correct size bearing and measure the clearance.

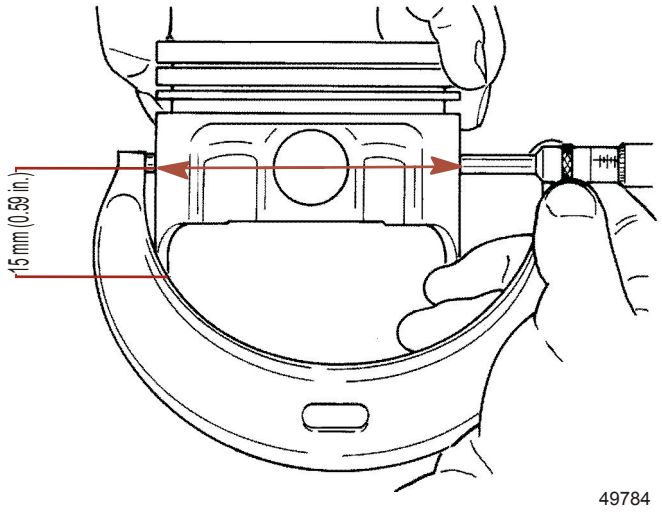
   NOTE: *Be sure to check the size of the bearing being removed in order to determine proper replacement size bearing. If the clearance cannot be brought to within the specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace the crankshaft.*

Cleaning

1. Remove the varnish from the piston skirts with a cleaning solvent. Do not use a wire brush to clean the piston. Clean the ring grooves with a groove cleaner and make sure the oil ring openings are clean.
2. Inspect the piston for cracked ring lands, skirts and pin bosses, wavy worn ring lands, scuffed or damaged skirts, and eroded areas at the top of piston. Replace the pistons that are damaged or show signs of excessive wear.
3. Inspect the ring grooves for nicks and burrs that might cause the rings to hang up.

Measuring

1. Measure the piston diameter at the skirt across the center line of the piston pin as shown. Find the piston centerline at 15 mm (0.59 in.) as shown.



   a. Subtract the piston diameter from the cylinder bore diameter to determine the piston-to-bore clearance.
   b. Determine if the piston-to-bore clearance is acceptable.

Piston		Specification
Clearance	No. 1–6 cylinders	0.044 - 0.076 mm (0.0017 - 0.0030 in.)
	No. 7–8 cylinders	0.064 - 0.096 mm (0.0025 - 0.0038 in.)

2. If a used piston is not satisfactory, determine if a new piston can be selected to fit the cylinder bore within an 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 the correct clearance (preferable range).
4. Mark the piston to identify the cylinder for which it was fitted.

   NOTE: *The cylinder bore and taper must be within the specifications before the pistons can be considered for re-use.*

Piston Pins

1. The piston pin clearance is designed to maintain an adequate clearance under all engine operating conditions.
2. Inspect the piston pin bores and the piston pins for wear. The piston pin bores and the piston pins must be free of varnish and scuffing when measured. Measure the piston pin with a micrometer and the piston pin bore with a dial bore gauge or inside micrometer. If the clearance is in excess of the 0.0130 mm (0.00051 in.) wear limit, replace the piston and piston pin assembly.

Piston Pin	Specification
Diameter	22.997 - 23.000 mm (0.9054 - 0.9055 in.)
Clearance in piston	0.0040 - 0.0130 mm (0.00016 - 0.00051 in.)
Clearance in rod	0.0150 - 0.0280 mm (0.00059 - 0.00110 in.)

Cylinder Block Cleaning

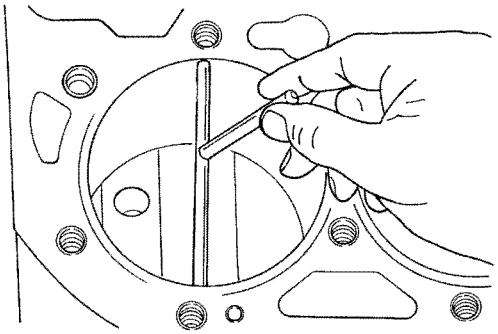
1. Wash the cylinder block thoroughly with a cleaning solvent and clean all of the gasket surfaces.
2. Remove the oil gallery plugs and clean all of the oil passages.
3. Remove the expansion plugs and clean the water passages in the cylinder block.

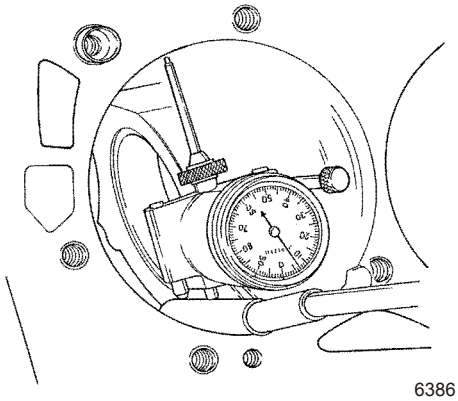
   NOTE: *These plugs may be removed with a sharp punch, or may be drilled and pried out.*

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.

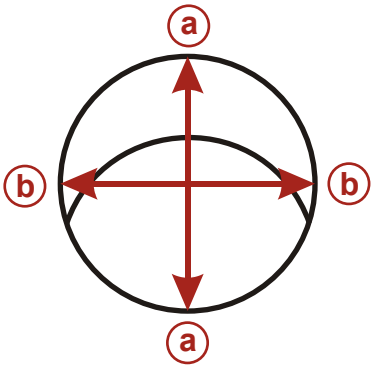
3. Measure the cylinder wall taper, runout and for an excessive ridge at the top of the ring travel. This should be done with a dial indicator or an inside micrometer. Carefully work the gauge up and down the cylinder to determine the taper and make sure to measure it at different points around the cylinder wall to determine the out-of-round condition. If the cylinders exceed the specifications, honing and boring or just honing may be necessary to bring the cylinder(s) back into specifications.





6386

NOTE: *"Out of Round" equals the difference between the measurements "a" and "b" taken at both the top and bottom of the cylinder bore.*



6387

Cylinder Measurement

a - At right angles to centerline of engine

b - Parallel to centerline of engine

Cylinder Re-conditioning

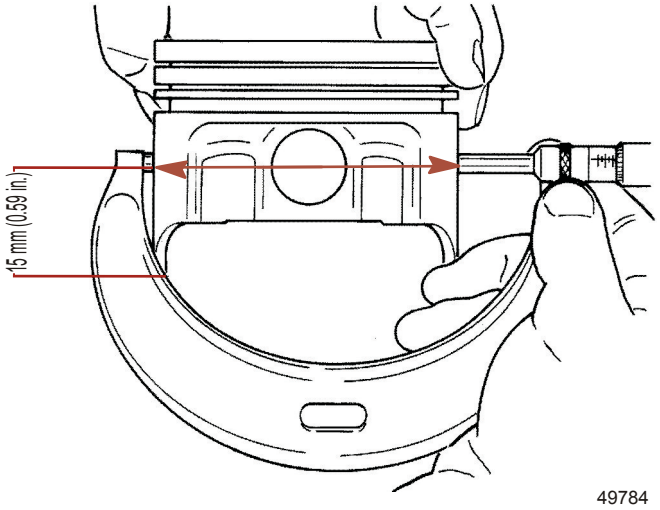
1. Whether or not the following operation is necessary depends upon the engine condition at the time of repair:
   a. If the cylinder block inspection indicates that the block is suitable for continued use (except for out-of-round or tapered cylinders), they can be re-conditioned by either honing or boring and honing.
   b. If the cylinders have less than 0.0127 mm (0.0005 in.) taper or wear, they can be conditioned with a hone and fitted with a standard size piston at the higher limit of the piston to bore clearance.

   NOTE: *A cylinder bore with more than 0.0127 mm (0.0005 in.) of wear or taper may not clean up entirely when fitted to a piston that's at the higher limit of the piston to bore clearance. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If there is more than 0.0127 mm (0.0005 in.) of taper or wear, bore and hone to the smallest oversize that will permit a complete resurfacing of all of the cylinders.*

Cylinder Boring

1. Before using any type boring bar, file off the top of the cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with the result that the bored cylinder wall is not at right angles to the crankshaft.

2. Measure the piston to be fitted with a micrometer, measuring at the center of piston skirt 15 mm (0.59 in.), and at right angles to the piston pin. Bore the cylinder to the same diameter as the piston and hone it to give the specified clearance.



Cylinder Honing

NOTE: *Follow the hone manufacturer's recommendations for using the hone and the cleaning and lubrication during the honing. Occasionally, during the honing operation, thoroughly clean the cylinder bore and check the piston for correct fit in the cylinder.*

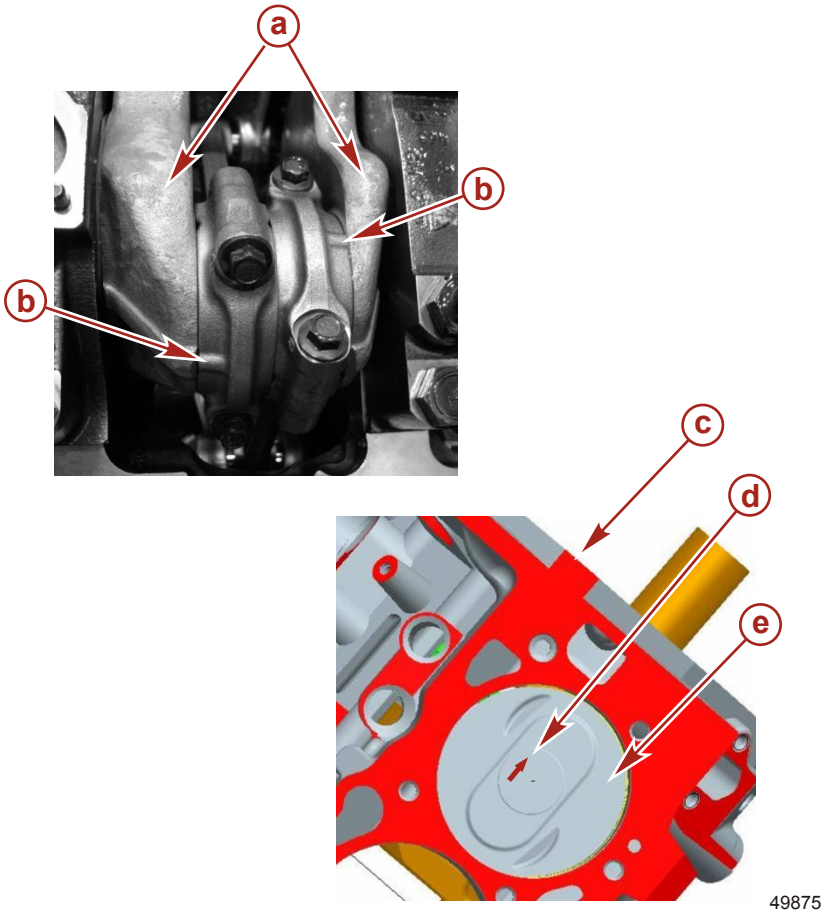
1. When finish-honing a cylinder bore to fit a piston, move the hone up and down at a sufficient speed to obtain the very fine uniform surface finish marks in a crosshatch pattern of approximately 22–32 degrees to the cylinder bore. The finish marks should be clean, but not sharp, and free from imbedded particles and torn or folded metal.
2. Permanently mark the piston (with the number of the cylinder it has been fitted to).
   IMPORTANT: Handle the pistons with care and do not attempt to force them through the cylinder until the cylinder is honed to the correct size, this type of piston can be distorted by careless handling.
3. Thoroughly clean the cylinder bores with hot water and detergent. Scrub them with a stiff bristle brush and completely rinse them with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in the cylinder bores, rings, the cylinder bores and bearings lubricated by the contaminated oil will wear rapidly. Swab the bores several times with a clean transmission fluid on a clean cloth, then wipe with a clean, dry cloth. The cylinder should not be cleaned with kerosene or gasoline. Clean the remainder of the cylinder block to remove any excess material spread during the honing operation.

Piston Reassembly

The cracked rod cap has a forged nub and the piston has an arrow to ensure correct orientation during assembly.

IMPORTANT: The forged nub on the rod caps assemble away from each other when correctly installed on each crankpin.
IMPORTANT: The laser etched arrow on each piston points toward the front of the engine when correctly installed.

1. Determine the correct position before assembly. Position the connecting rod to the piston so the arrow on top of the piston is pointing toward the front of the engine and the nub on the rod cap is against the crankshaft lobe when installed.

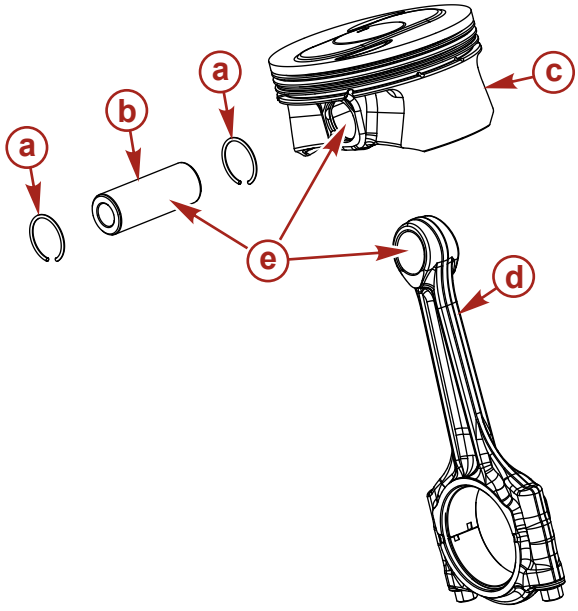


- **a -** Crankshaft lobe
- **b -** Nub on the rod cap
- **c -** Front of engine
- **d -** Arrow (etched on piston)
- **e -** Piston

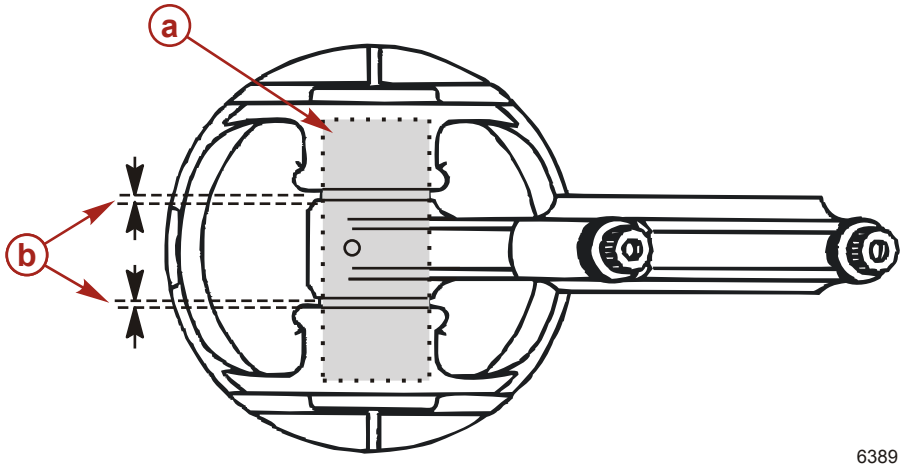
2. Apply a very light film of engine oil to the piston pin bore, the piston pin, and the rod pin bore.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Piston pin bore, piston pin, rod pin bore	92-858087K01

3. Slide the piston pin in the piston/rod assembly and install a retaining clip in each groove securing both ends of the pin.

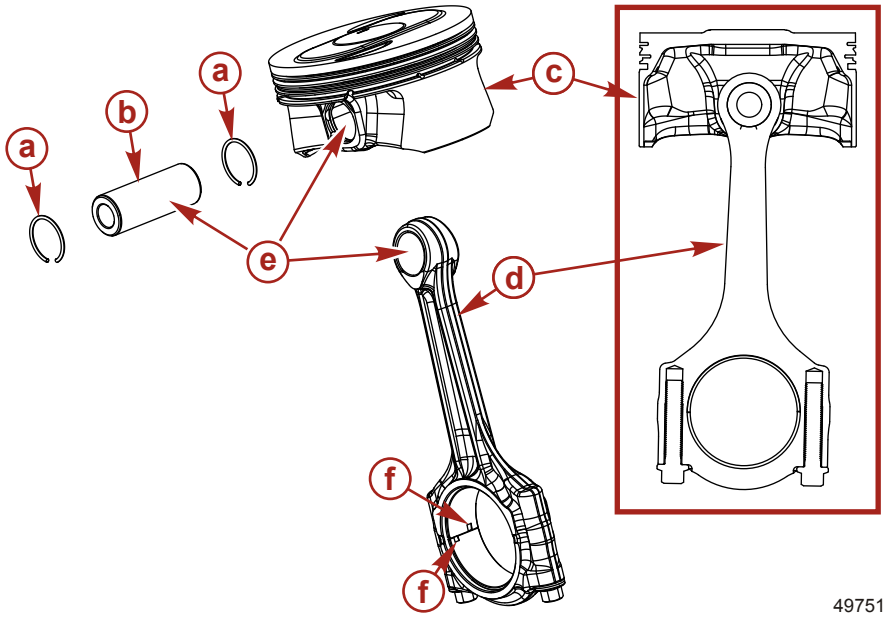


a - Retaining clip
b - Piston pin
c - Piston
d - Connecting rod
e - Lubrication area



a - Piston pin
b - Rod to piston clearance

4. Once assembled, check the piston for freedom of movement on the connecting rod (rod swing and lateral movement). The piston should move freely in all directions. If not, the piston pin bore is tight and should be disassembled to determine the cause.

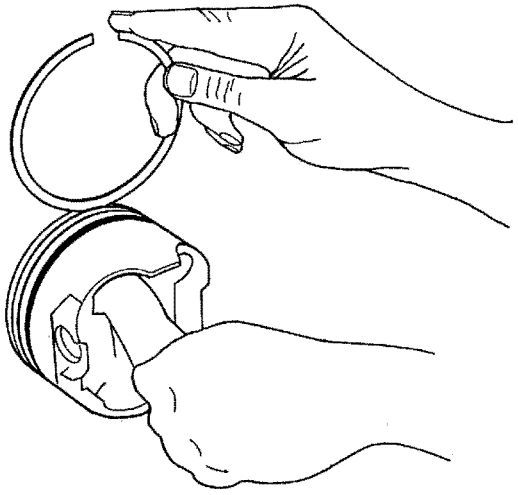


49751

a - Retaining ring
b - Piston pin
c - Piston
d - Connecting rod
e - Light film of engine oil prior to assembly
f - Bearing tang notches in the rod

Piston Rings

1. 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 make sure that the ring is free as shown. If binding occurs at any point, determine the cause. If it is caused by a ring groove, remove the obstruction by dressing it with a fine cut file. If the binding is caused by a distorted ring, recheck it with another ring.



6398

2. The proper clearance of the piston ring in its piston ring groove is very important to provide the proper ring action and reduce the wear. Therefore, when fitting new rings, clearances between the ring and the groove surfaces should be measured.

6399

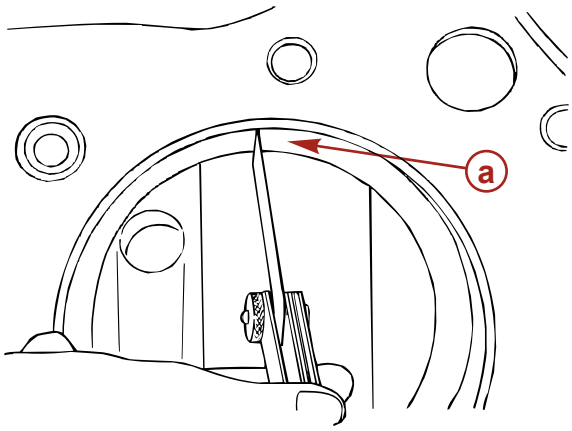
Compression Ring		Specification
Groove side clearance	Top	0.02 - 0.085 mm (0.0008 - 0.0033 in.)
	2nd	0.01 - 0.058 mm (0.0004 - 0.0022 in.)
Gap	Top	0.28 - 0.43 mm (0.0110 - 0.0169 in.)
	2nd	0.40 - 0.65 mm (0.0157 - 0.0255 in.)

Oil Ring	Specification
Groove side clearance	0.008 mm (0.0003 in.) interference to 0.176 mm (0.0070 in.) clearance
Gap (rails / oil scrapers)	0.15 - 0.66 mm (0.0060 - 0.0260 in.)

NOTE: *The top compression ring is marked with a dot on the top side. The second ring or scraper is not marked and installed with the scraper edge down.*

NOTE: *The oil control rings are a three-piece type, consisting of two rings and an expander*

3. Select the rings comparable in size to the cylinder bore and the piston size.
4. Slip the compression ring in the cylinder bore, then press the ring down into the cylinder bore about 6.4 mm (1/4 in.) (below the ring travel). Ensure that the ring is square with the cylinder wall.
5. Measure the gap between the ends of the ring with a feeler gauge as shown, record the measurements.

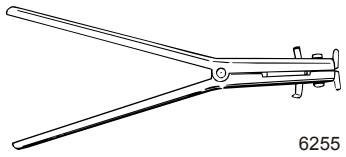


a - Piston ring

6400

6. Clean and inspect the pistons, if needed.

7. Install the piston rings as follows:
   a. Install the oil ring expander in the groove.
   b. Install the lower steel oil ring rail with the gap properly located.
   c. Install the upper steel oil ring rail with the gap properly located.
   d. Flex the oil ring assembly to make sure the ring is free. If binding occurs at any point, the cause should be determined and, if caused by the ring groove, remove the obstruction by dressing the groove with a fine cut file. If the binding is caused by a distorted ring, use a new ring.
   e. Install the lower compression ring with the scraper edge down, using a ring expander.
   f. Install the top compression ring with the dot and chamfer bevel up, using a ring expander.

Piston Ring Expander	91-24697
Description: Removes and installs the piston rings.	 6255

Installation

IMPORTANT: The cylinder bores must be clean before the piston installation. Clean them with a light honing, as necessary. Then clean them with hot water and detergent wash. After cleaning, swab bores several times with clean transmission fluid and a clean cloth, then wipe them with a clean dry cloth.

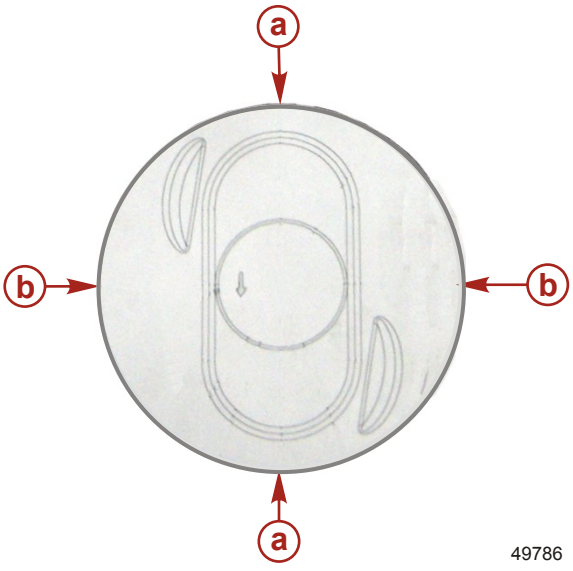
1. Install and lubricate the connecting rod bearings.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Connecting rod bearings	92-858087K01

2. Lightly coat the pistons, rings and the cylinder walls with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Pistons, rings, cylinder walls	92-858087K01

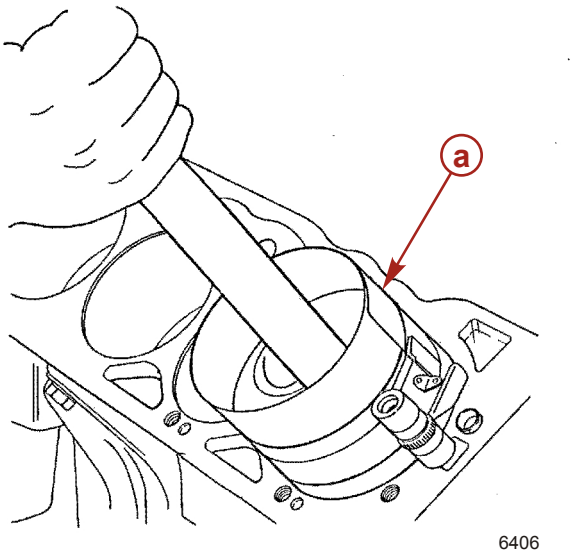
3. With the bearing caps removed, install the connecting rod guide on the connecting rod.
   IMPORTANT: Ensure that the ring gaps are properly positioned as shown.



49786

a - Oil ring expander
b - Top and bottom oil rings 180° apart: First and second compression rings 180° apart

4. Install each connecting rod and piston assembly in its respective bore. Install with the 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 guide. Use the hammer handle with light blows to install the piston into the bore. Hold the ring compressor firmly against the cylinder block until all the piston rings have entered the cylinder bore. **IMPORTANT: Be sure to install the new pistons in the same cylinders for which they were fitted, and the used pistons in the same cylinder from which they were removed. Mark each connecting rod and bearing cap 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). The numbers on the connecting rod and bearing cap must be on the same side when they are installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, the new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**



a - Piston ring compressor

5. Remove the connecting rod guide. Coat the bearing surface with oil.

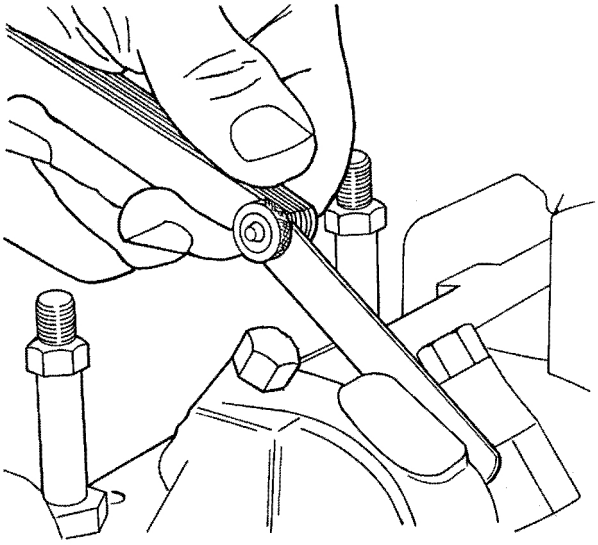
Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Rod cap bearing surface	92-858087K01

6. Install the rod bearing caps.
7. Evenly tighten the rod bolts to specification.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

8. When all of the connecting rod bearings have been installed, tap each rod lightly, parallel to the crankpin, to make sure there is clearance.

9. Measure all of the connecting rod side clearances between the connecting rod caps as shown.



6408

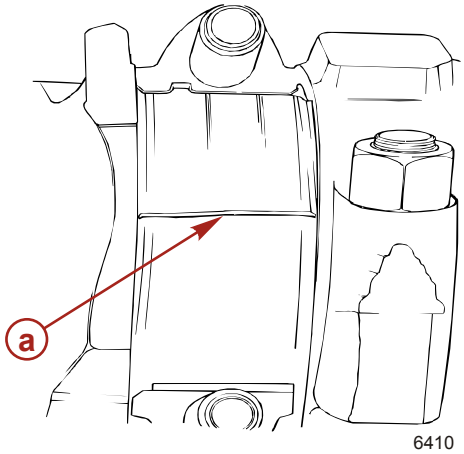
Crankshaft	Specification
Rod side clearance	0.305 - 0.61 mm (0.012 - 0.024 in.)

Using Plastic Gauging

The connecting rod bearings are of the precision insert type and do not use shims for adjustment. Do not file the rods or rod caps. If the clearances are found to be excessive, a new bearing will be required. Service bearings are available in a standard size and a 0.0254 mm (0.001 in.) and 0.051 mm (0.002 in.) undersize for use with the new and used standard size crankshafts, and in a 0.254 mm (0.010 in.) and 0.051 mm (0.020 in.) undersize for use with reconditioned crankshafts.

Inspection and Replacement

1. Inspect the bearing for wear and damage. Do not re-install a worn or damaged bearing.
2. Wipe both upper and lower bearing shells and crank pin clean of oil.
3. Measure the crankpin for an out-of-round or taper using a micrometer. If they are not within the specifications, replace or recondition the crankshaft. If they are within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine the new bearing size required.
4. If they are within specifications, measure the new or used bearing clearances with a gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit it to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round 0.0254 mm (0.001 in.), an interference between the bearing and the crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin 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 it is placed elsewhere.)



6410

a - Gauging plastic

b. Install and lubricate the connecting rod bearings.

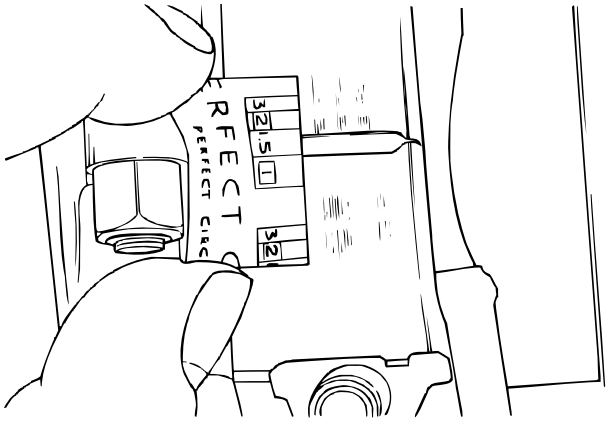
Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Connecting rod bearings	92-858087K01

5. Install the bearing caps and hand start the bolts.
6. Evenly tighten the rod bolts to specifications.

Description	Specification
Connecting rod bolts (do not lubricate bolt)	20 Nm 14.8 lb.ft. + 90 degree turn

a. When all the connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.

b. 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 rotate the crankshaft with the gauging plastic installed.



6411

7. If the clearance exceeds the specifications, select a new, correct size bearing and measure the clearance.

Crankshaft		Specification
Rod Bearing Clearance	Production	0.0558 - 0.0685 mm (0.0022 - 0.0027 in.) max
	Service	0.0558 - 0.0762 mm (0.0022 - 0.0030 in.) max

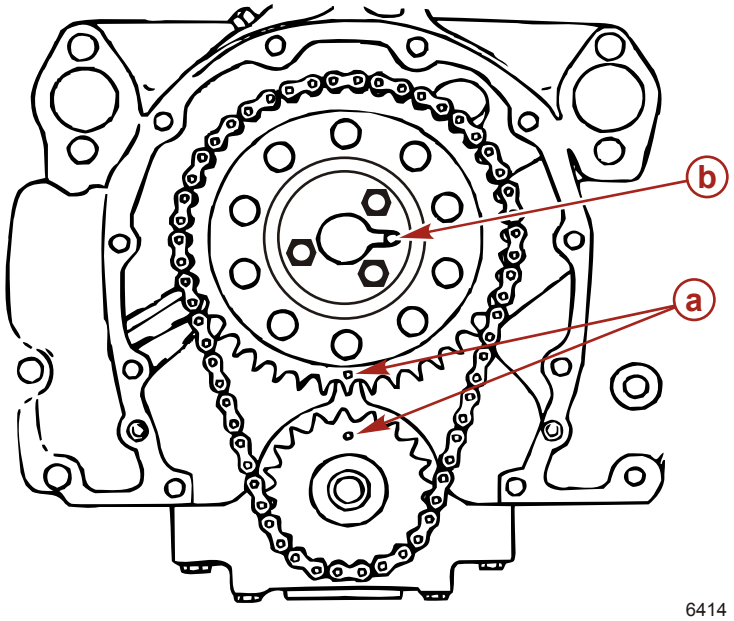
IMPORTANT: Be sure to check the size of the bearing being removed in order to determine the proper replacement size bearing. If the clearance cannot be brought to within the specifications, the crankpin will have to be ground undersize. If the crankpin is already at a maximum undersize, replace the crankshaft.

Timing Chain and Sprocket

Removal

1. Remove the torsional damper, oil pan and timing cover.

2. Turn the crankshaft until the timing marks on the crankshaft and camshaft sprockets are in alignment as shown.



a - Timing marks aligned
b - Locating pin

3. 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.
4. If the crankshaft sprocket requires replacement, remove it.

Cleaning and Inspection

1. Clean all the parts in solvent and dry them with compressed air.
2. Inspect the timing chain and sprockets for wear and damage.

Installation

1. If the crankshaft sprocket was removed, re-install as outlined in the **Crankshaft Sprocket** section of this manual.
2. 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.
3. Install the sprocket on the camshaft.
IMPORTANT: Do not attempt to force the sprocket onto the camshaft, or the welch plug at the rear of the engine could be dislodged.

Description	Nm	lb. in.	lb. ft.
Camshaft sprocket mounting bolts	27	–	20

4. Lubricate the timing chain with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Timing chain	92-858087K01

5. Install the timing cover, oil pan, and torsional damper.

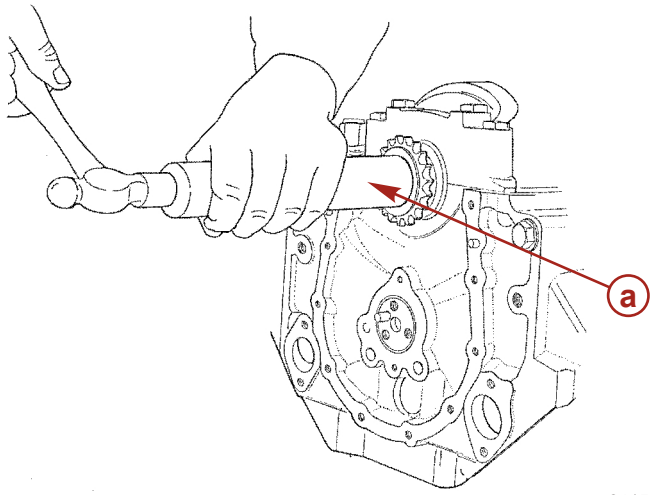
Crankshaft Sprocket

Removal

1. Remove the torsional damper and the crankcase front cover.
2. Remove the camshaft timing chain.
3. Remove the crankshaft sprocket using a crankshaft gear and sprocket puller.

Installation

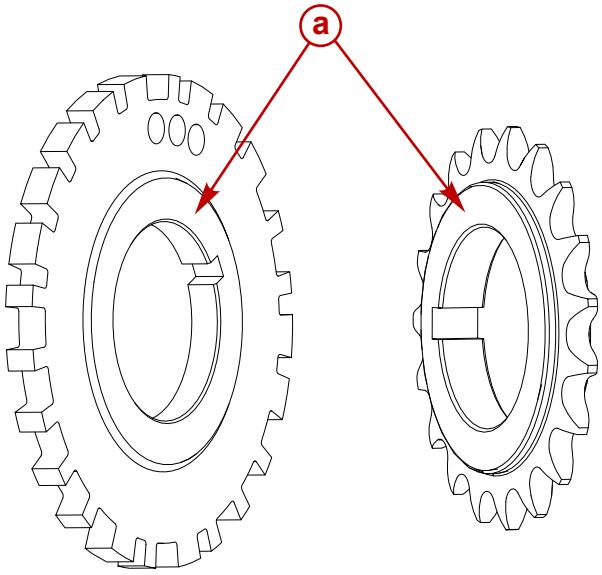
1. Using a crankshaft gear and sprocket installation tool as shown, install the sprocket on the crankshaft.



6415

a - Crankshaft gear and sprocket installation tool

2. Install the timing chain as outlined.
3. Install the crankshaft sensor target wheel with the raised portion of the target wheel facing the raised portion of the crankshaft sprocket.



20763

a - Raised portion of target wheel and sprocket.

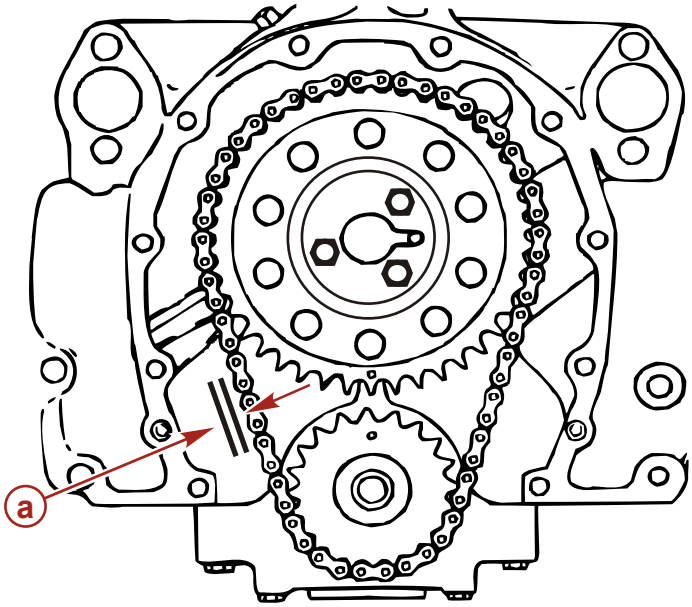
4. Install the crankcase cover and the torsional damper as outlined.

Checking Timing Chain Deflection

The timing chain and the sprockets must be replaced as a set. Check the timing chain deflection anytime the cover is removed and replace the set during every engine rebuild.

1. Rotate the camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate the camshaft in the opposite direction to remove the chain tension, then force the chain out with your fingers and again measure the distance between the reference point and the 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.



6418

a - Reference point

Roller Camshaft	Specification
Timing chain deflection	12.7 mm (0.50 in.) from taut position

5. Install the crankcase front cover and the torsional damper.

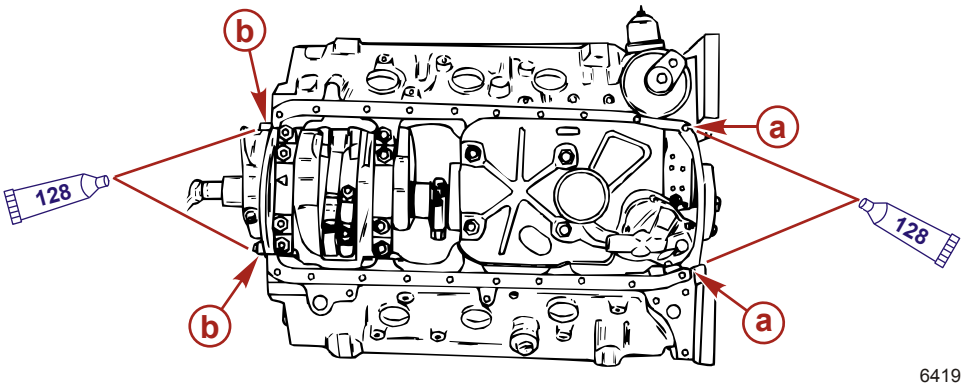
Oil Pan

Removal

1. Drain the crankcase oil.
2. Remove the dipstick.
3. Remove the oil pan.

Installation

1. Clean the sealing surfaces of the engine block and the oil pan.
   IMPORTANT: The sealer sets up in about 15 minutes. Be sure to complete the assembly process promptly.
2. Apply a small amount of sealer to the joints of the rear seal retainer and the joints of the front cover.

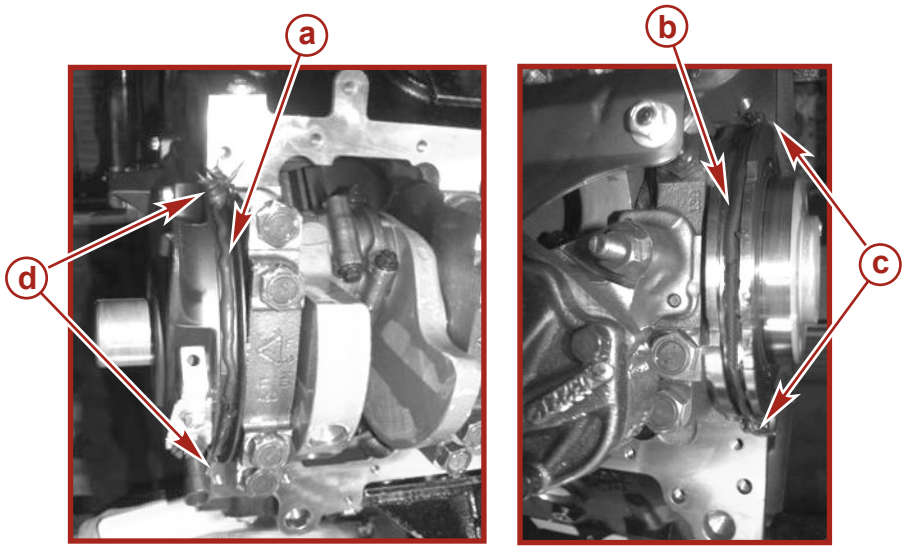


6419

a - Joints of rear seal retainer
b - Joints of front cover

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally

3. Apply a bead of sealer in the rear main bearing groove and the front cover groove where the oil pan gasket will nest.

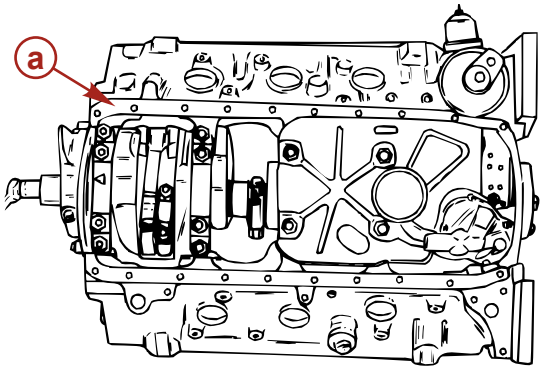


49790

a - Font cover groove
b - Rear main bearing groove
c - Joints of rear seal retainer
d - Joints of front cover

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Front cover and rear seal retainer	Obtain Locally

4. Install the oil pan gasket in the position shown.



6421

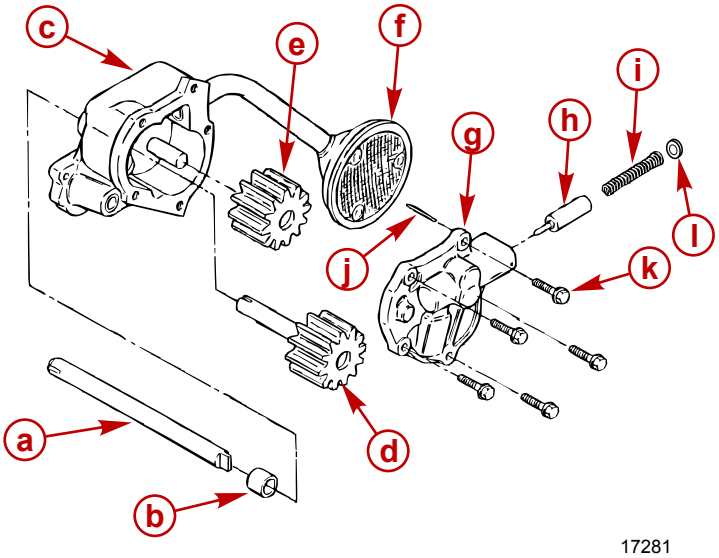
a - Oil pan gasket

5. Install the oil pan. Starting from the center and working outward in each direction, torque the mounting bolts to specifications.

Description	Nm	lb. in.	lb. ft.
Oil pan mounting bolts	20	–	15

6. Fill the crankcase with the required quantity of oil.

Oil Pump



17281

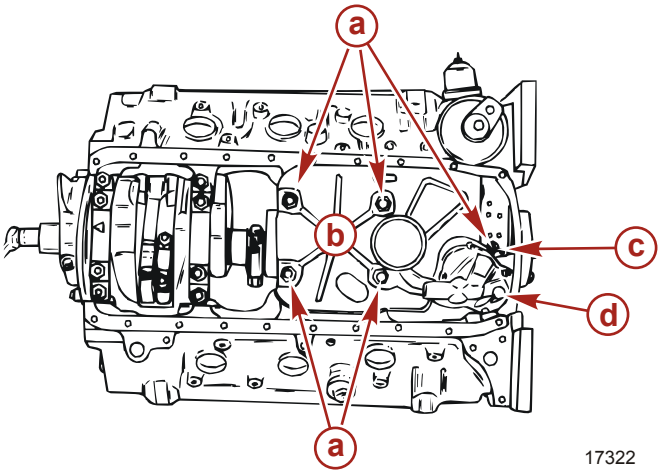
Oil pump assembly

- **a -** Extension shaft
- **b -** Shaft coupling
- **c -** Pump body
- **d -** Drive gear and shaft
- **e -** Idler gear
- **f -** Pickup screen and pipe
- **g -** Pump cover
- **h -** Pressure regulator valve
- **i -** Pressure regulator spring
- **j -** Retaining pin
- **k -** Screws
- **l -** Washer

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. The oil pump is driven by an extension shaft that is driven by a helical gear on the camshaft.

Removal

1. Remove the oil pan and its gasket.
2. Remove the baffle.

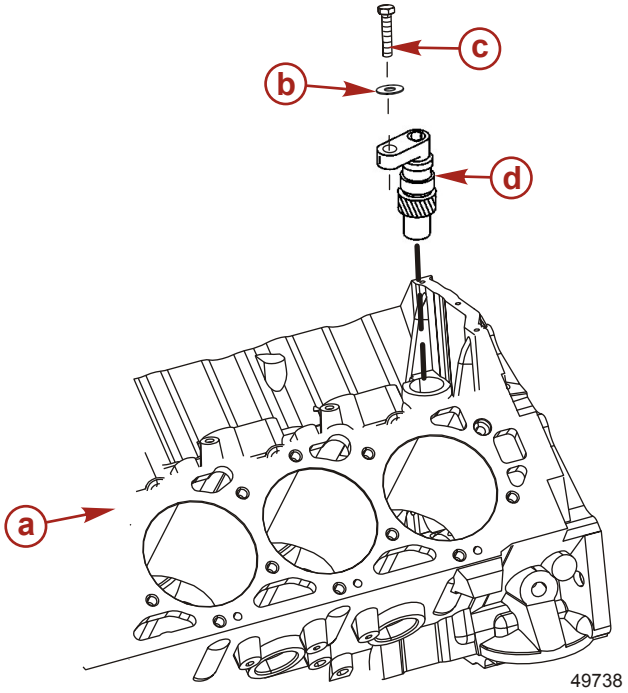


17322

- **a -** Baffle retaining nuts
- **b -** Oil deflector baffle
- **c -** Oil pump mounting bolt with baffle stud
- **d -** Oil pump

3. Remove the oil pump mounting bolt. Remove the oil pump and extension shaft.

4. If necessary, the oil drive mechanism can also be removed.



a - Cylinder block
b - Washer
c - Mounting bolt
d - Oil drive mechanism

Disassembly

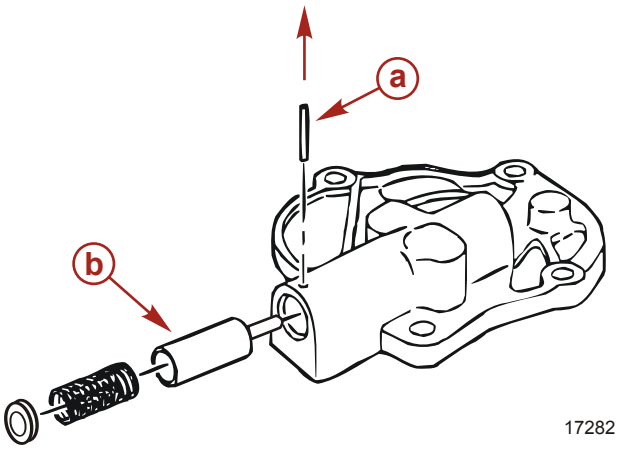
NOTE: *Refer to the exploded view shown previously.*

1. Remove the pump cover.
   IMPORTANT: Mark the gear teeth for reassembly with same teeth indexing.
2. Remove the idler gear and the drive gear from the pump body.

⚠ CAUTION

The pressure regulator valve is spring-loaded, retained by a snap ring. The force of the spring can cause injury during removal. Use caution when disassembling components and wear protective eye equipment.

3. Remove the retaining pin from the pump cover with a punch (remove in direction shown). The spring may release violently. Remove the pressure regulator valve from the pump cover.



a - Retaining pin
b - Pressure regulator valve

Cleaning

1. Wash all the parts in cleaning solvent and dry them with compressed air.
2. Inspect the pump body and the cover for cracks or excessive wear.
3. Inspect the pump gears for damage and excessive wear.
4. Check for a loose drive gear shaft in the pump body.

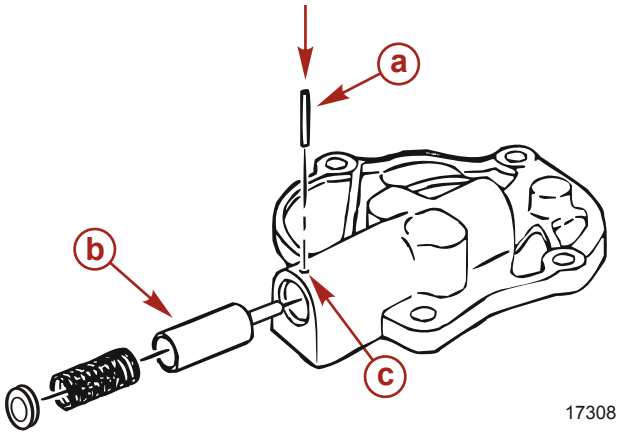
5. Inspect the inside of the pump cover for wear that would permit the oil to leak past the ends of the gears.
6. Inspect the pickup screen and the pipe assembly for damage to the screen and pipe.
7. Check the pressure regulator valve for fit.
   IMPORTANT: The oil pump is not serviceable. If any parts are worn or damaged, replacement of the entire pump assembly and pickup tube is necessary.

Reassembly

IMPORTANT: Oil the internal parts liberally with the specified engine oil before installation.

NOTE: *Refer to the oil pump exploded view shown previously.*

1. Install the pressure regulator valve and the related parts. Ensure that the retaining pin is tight, if not, install the pin and stake it with a punch and hammer to keep it tight in the housing.



17308

a - Retaining pin
b - Pressure regulator valve
c - Stake here with a punch and hammer

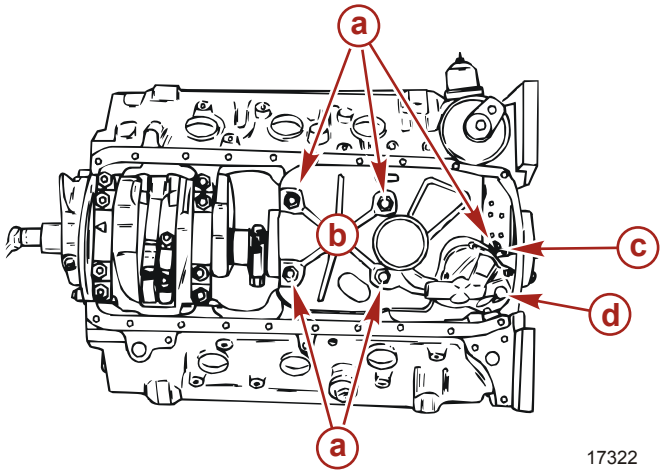
2. Install the drive gear in the pump body.
3. Install the idler gear in the pump body with the smooth side of the gear toward the pump cover opening. Align the marks made during disassembly.
4. Fill the gear cavity with the specified engine oil.
5. Install the pump cover and torque the attaching screws to specifications.

Description	Nm	lb. in.	lb. ft.
Oil pump cover attaching bolts	11	–	8

6. Turn the extension shaft by hand to check for smooth operation.

Installation

1. Install the pump, with the extension shaft, and the rear main bearing, aligning the extension shaft with the distributor drive shaft.
2. Install the baffle. Tighten the baffle nuts to specifications.
3. Tighten the oil pump mounting bolt to specifications.



17322

a - Baffle retaining nuts
b - Oil deflector baffle
c - Oil pump mounting bolt with baffle stud
d - Oil pump

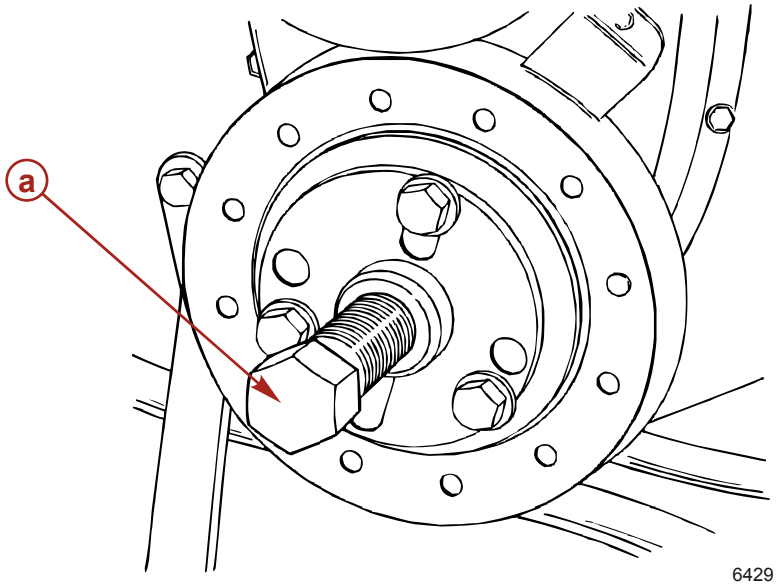
Description	Nm	lb. in.	lb. ft.
Oil baffle nuts	35	–	26
Oil pump mounting bolt	95	–	70

4. Install the oil pan as outlined in the **Oil Pan** section of this manual.

Torsional Damper

Removal

1. Remove the drive belt.
2. Remove the drive pulley and the water pump pulley.
3. Remove the torsional damper retaining bolt.
   IMPORTANT: Do not use a universal claw type puller to remove the torsional damper (in 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.
4. Remove the torsional damper.



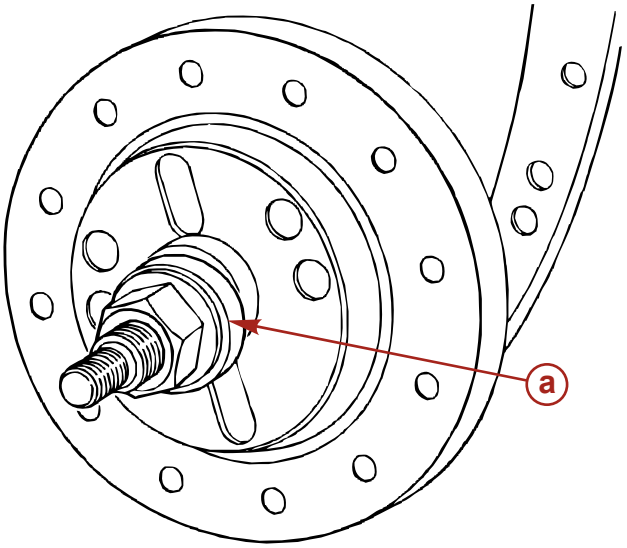
a - Torsional damper tool

Installation

IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace the key in the crankshaft if it is damaged.
2. Coat the interference surface of the torsional damper with a High Pressure Grease.

3. Install the torsional damper on the crankshaft, using a Torsional Damper tool.



6432

a - Torsional damper tool

   a. To prevent oil leakage, apply an RTV sealant to the keyway.
   b. Install the torsional damper bolt. Tighten it to specifications.
4. Install the drive pulley and the water pump pulley..
5. Install and adjust the drive belt.

Description	Nm	lb. in.	lb. ft.
Water pump pulley attaching bolts	24	–	18
Drive pulley attaching bolts	47	–	35
Torsional damper attaching bolt	244	–	180

Front Cover/Oil Seal

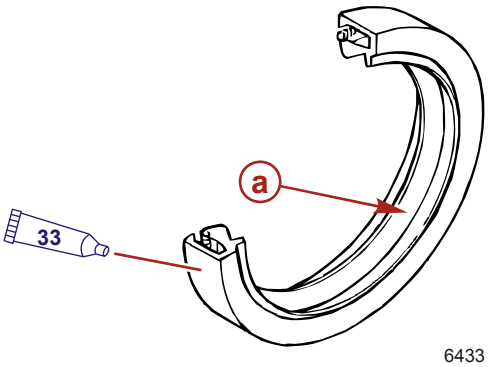
Oil Seal Replacement (Without Removing Front Cover)

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.

Installation

1. Apply Loctite 680 to the seal retainer mating surface and apply grease to the seal lips.

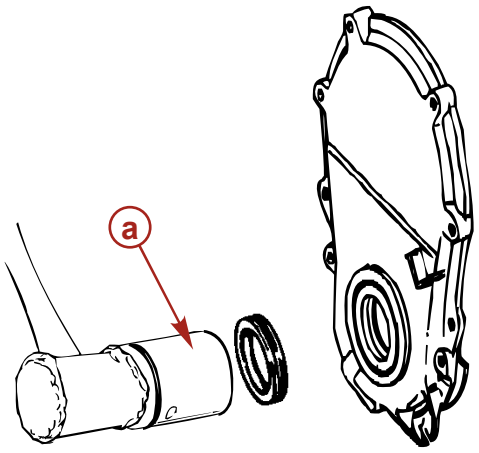


6433

a - Seal lip

Tube Ref No.	Description	Where Used	Part No.
33	Loctite 680 Retaining Compound	Seal retainer mating surface	92-809833

2. Install a new seal with the open end of the seal inward (lip of seal toward inside of engine), using a crankcase front cover seal installation tool. Drive the seal in until it seats. Do not use excessive force.



6434

a - Crankcase front cover seal installation tool

3. Re-install the torsional damper as outlined.

Front Cover

Removal

1. Remove engine from boat if necessary.
2. Remove the torsional damper, oil pan, water circulating pump and the front cover.
3. If damaged, drive the oil seal out of the front cover (from the rear) using a punch.

Cleaning

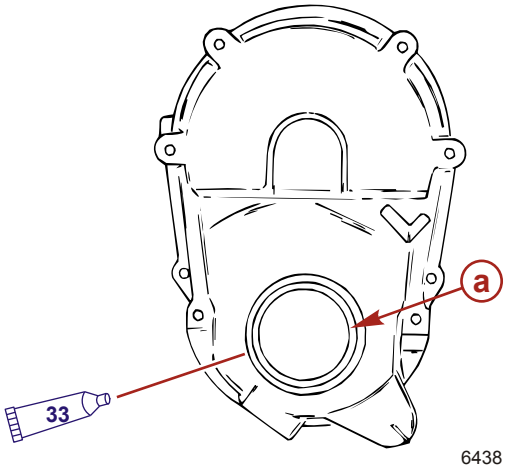
1. Clean the front cover in solvent and it dry with compressed air.
2. Remove the old sealer from the mating surfaces on the cover and the cylinder block.

Inspection

IMPORTANT: The front cover is cast aluminum and uses a molded o-ring style gasket that must be replaced if damaged. This gasket is retained in a cast groove.

Installation

1. Apply Loctite 680 to the outer edge of the seal and grease to the inner lip. Install the oil seal in the cover with the lip of the seal toward the inside of the engine using a seal driver. Support the cover around the seal area with an appropriate tool.



6438

a - Crankcase front cover seal

2. Coat both sides of the front cover gasket with Perfect Seal.
3. Install the front cover, making sure the holes in the cover align with the dowel pins in the block. Torque the front cover attaching bolts to **Specifications.**

Description	Nm	lb. in.	lb. ft.
Front cover attaching bolts	11		8

4. Install the oil pan, torsional damper, and water circulating pump.
5. Fill the crankcase with engine oil.
6. Re-install the engine in the boat (if necessary).

NOTICE

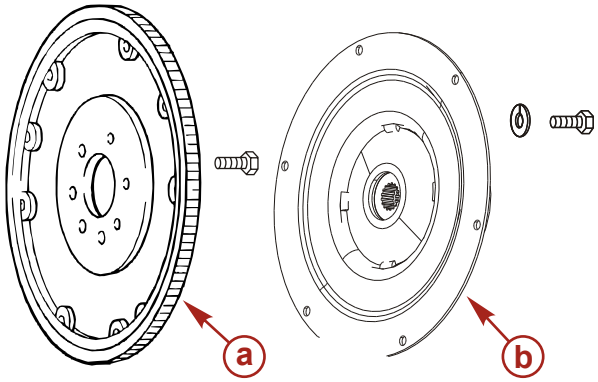
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

7. Start the engine and check for water and oil leaks.

Flywheel

Removal

1. Remove the engine from boat if necessary.
2. Remove the flywheel housing and related parts.
3. Remove the coupler.
4. Remove the flywheel.



a - Flywheel
b - Bravo coupler

Inspection

1. Inspect the splines in the drive plate or the coupler for wear.
2. Check the flywheel ring gear for worn and missing teeth.

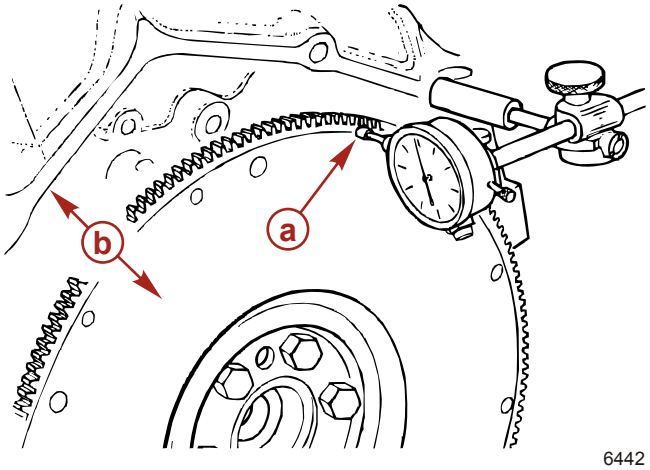
Installation

1. Clean the mating surfaces of the flywheel and the crankshaft until the metal is bare and remove any burrs.
2. Align the dowel hole in the flywheel with the dowel in the crankshaft and install the flywheel. Tighten the mounting bolts to specifications.

Description	Nm	lb. in.	lb. ft.
Flywheel mounting bolts	95	–	70

3. Check the flywheel runout as follows:
   a. Attach a dial indicator to the engine block.
   b. Take several readings around the outer edge of the flywheel. Push in on the flywheel to remove the crankshaft end play.

c. Maximum runout is 0.20 mm (0.008 in.).



6442

a - 0.20 mm (0.008 in.) maximum runout
b - Direction fore and aft

Description	Nm	lb. in.	lb. ft.
Drive coupler or drive plate mounting bolts	48	–	35
Flywheel housing mounting bolts	41	–	30
Flywheel housing cover mounting bolts	13	114	–
Transmission mounting bolts (V-Drive)	68	–	50

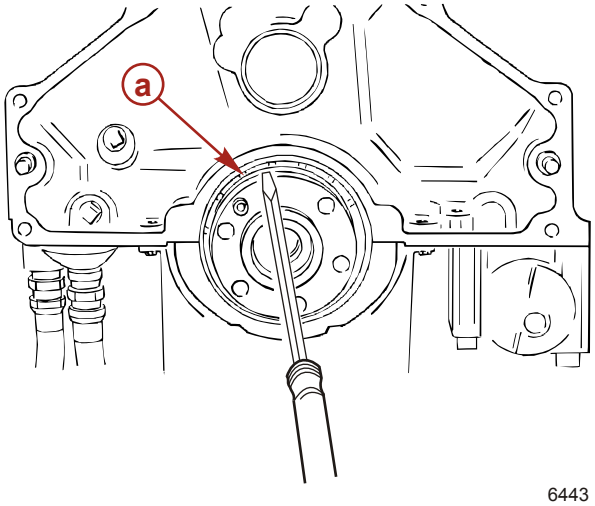
4. Install the drive coupler or drive plate. Tighten the mounting bolts to specifications.
5. Install the flywheel housing and related parts.
6. Install the flywheel housing cover.
7. Install the transmission if applicable.

Rear Main Oil Seal

The rear main crankshaft oil seal can be replaced without removing the oil pan or the rear main bearing cap from the engine.

Removal

Remove the seal by using a screwdriver to pry it out of the engine block as shown.



6443

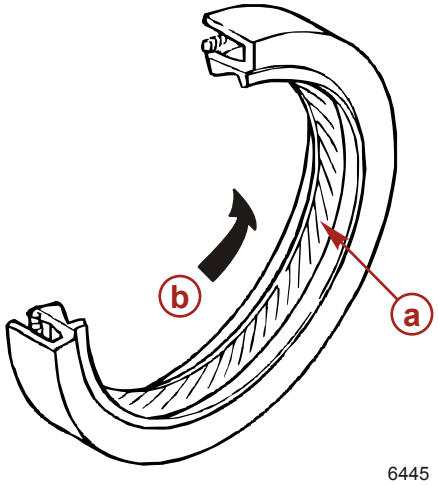
a - Rear main crankshaft oil seal

IMPORTANT: Do not nick or gouge the engine block or the rear main bearing cap sealing surface. Protect the crankshaft end of the crankshaft/seal running surface from damage.

Cleaning and Inspection

Clean the crankshaft/seal running surface and the seal retainer.

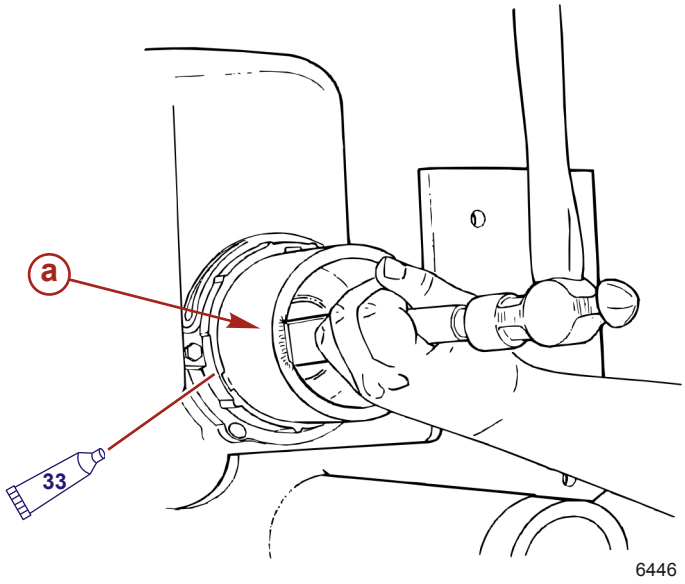
IMPORTANT: The correct rotation of the oil seal must be used to prevent oil leakage.



a - Rear seal with helical grooves - Seal lip toward inside of engine
b - Rotation of crankshaft as viewed from flywheel end looking forward

Installation

1. Apply Loctite 680 to the engine block/seal mating surface. Apply grease to the seal lips.
2. Install the seal using a rear main seal driver.



a - Suitable seal driver

Tube Ref No.	Description	Where Used	Part No.
33	Loctite 680 Retaining Compound	Engine block/seal mating surface	92-809833

Oil Filter Bypass Valves and Adapter

Inspection and Replacement

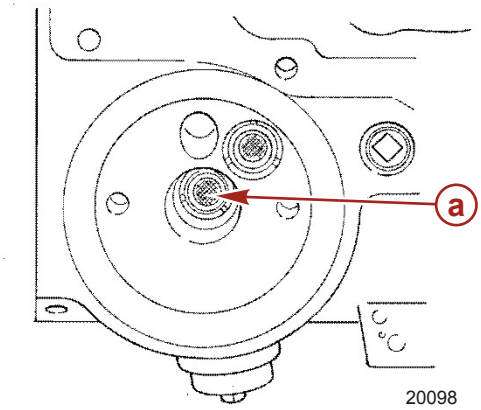
The oil bypass valve and adapter should be inspected whenever the engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

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	92-34227Q02

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

Notes:

Electrical System

Section 4A - Starting System

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Starter Specifications....4A-2
Periodic Inspection....4A-2
Starter Removal....4A-3
Installation....4A-4

4
A

Lubricants, Sealants, Adhesives

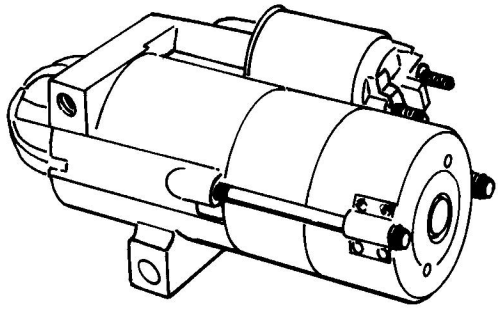
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter terminals	92- 25711 3

Finding Other Diagrams

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

Starter Motor

Identification



19724

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					

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. Tighten the starter mounting bolts to specification.

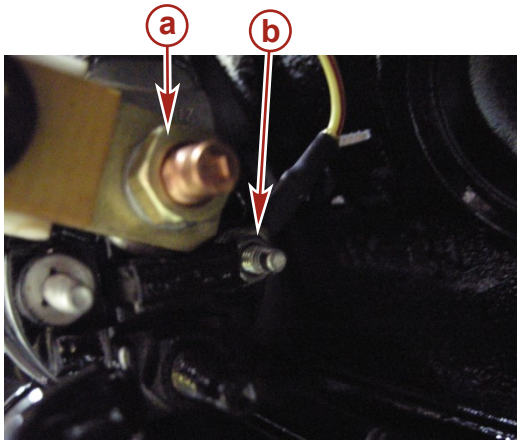
Description	Nm	lb. in.	lb. ft.
Starter mounting bolt	41	–	30

Starter Removal

⚠ WARNING

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

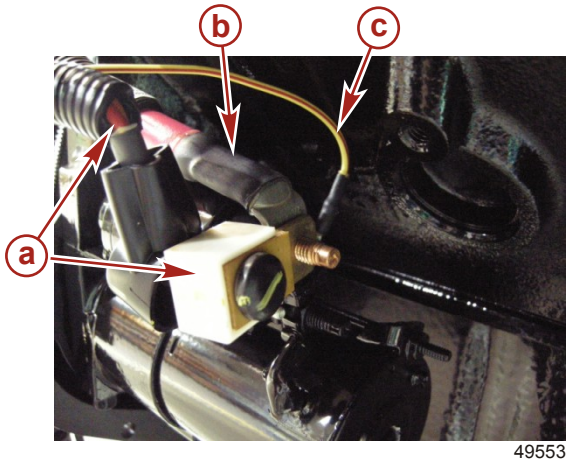
1. Disconnect the battery cables from the battery.
2. Remove and retain the nuts and washers from the solenoid terminals.



49555

a - Nut and washer on large terminal
b - Nut and washer on small terminal

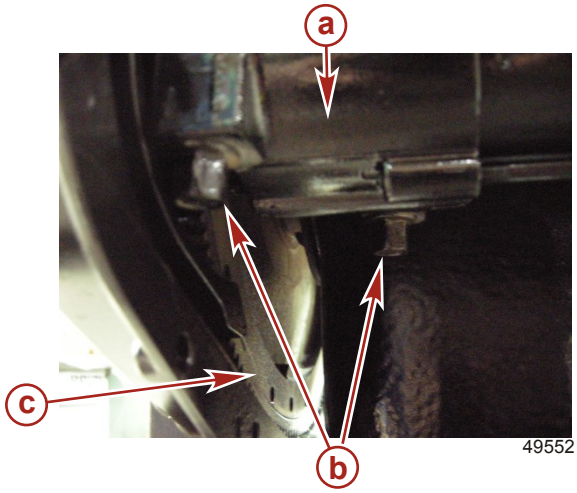
3. Remove and retain the wires from the solenoid terminals.



49553

a - ORANGE wire, RED wire, and fuse
b - Hot stud wire (RED power)
c - YELLOW/RED wire

4. Support the starter while removing the starter mounting bolts.



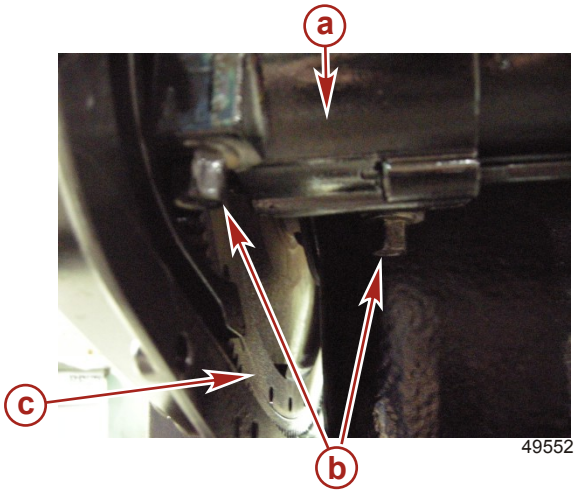
49552

a - Starter
b - Starter mounting bolt (2)
c - Flywheel

5. Pull the starter assembly away from the flywheel and remove it from the engine.

Installation

1. Place the starter motor in position and install the mounting bolts.
2. Tighten the bolts to specification.

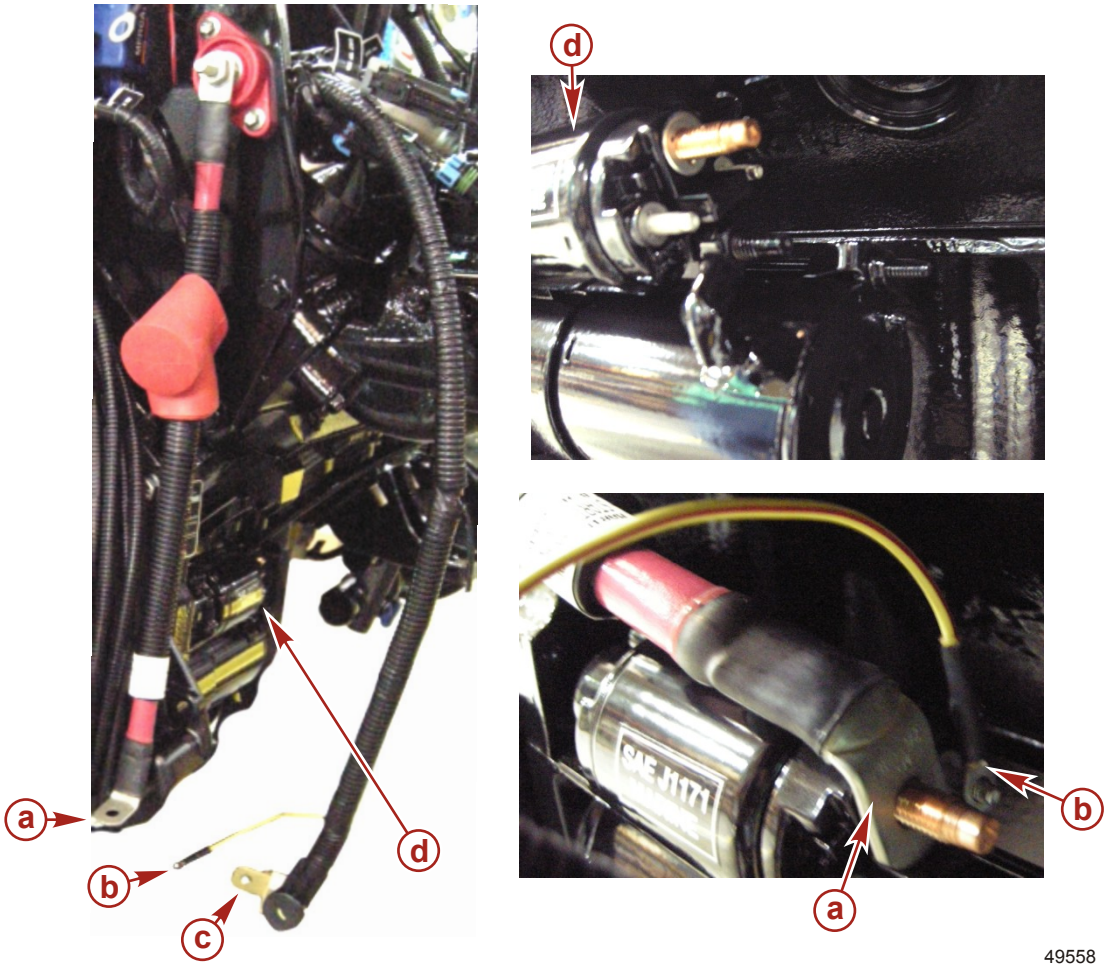


a - Starter
b - Starter mounting bolt (2)
c - Flywheel

Description	Nm	lb. in.	lb. ft.
Starter mounting bolts	41	–	30

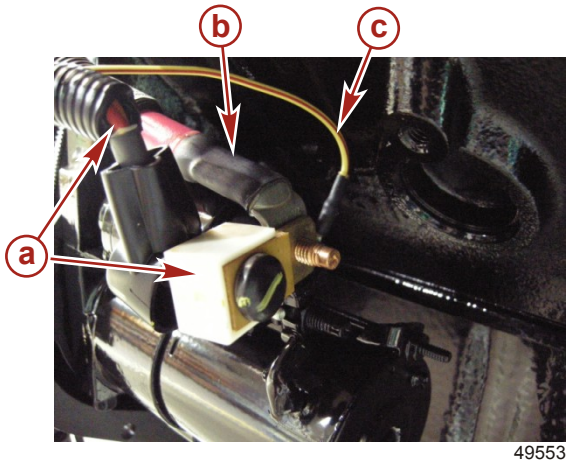
3. Connect the YELLOW/RED wire from the harness assembly to the upper solenoid terminal.

4. Connect the hot stud cable to the large terminal.



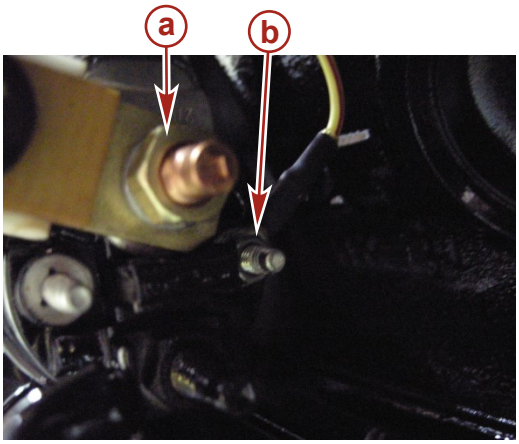
a - Hot stud cable
b - YELLOW/RED wire
c - ORANGE wire, RED wire, and fuse
d - Starter solenoid

5. Connect the ORANGE wire, RED wire, and fuse from the harness assembly to the large terminal over the hot stud wire.



a - ORANGE wire, RED wire, and fuse
b - Hot stud wire (RED power)
c - YELLOW/RED wire

6. Install washers and nuts on the large and small terminals to secure the wires. Tighten the nuts to specification.



49555

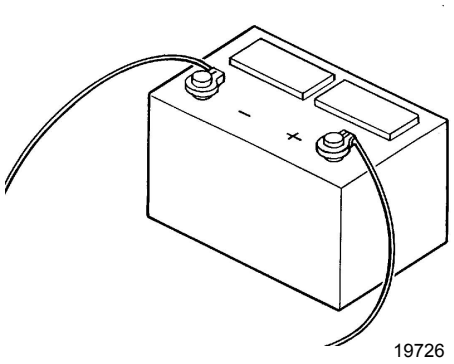
a - Nut and washer on large terminal
b - Nut and washer on small terminal

Description	Nm	lb-in.	lb-ft
Starter solenoid small terminal nut	2	20	–
Starter solenoid large terminal nut	7	50	–

7. Apply sealant to the starter terminals.

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

8. 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.



19726

Typical

Electrical System

Section 4B - Ignition System

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Ignition System Components..... 4B-2
EFI System Maintenance Precautions..... 4B-2
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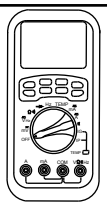
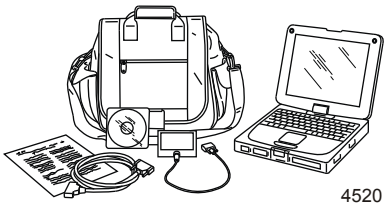
Spark Plug Wire—High-Tension Leads..... 4B-4
Ignition Coil..... 4B-6

4
B

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

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.)

Finding Other Diagrams

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

Ignition System Components

EFI System Maintenance Precautions

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

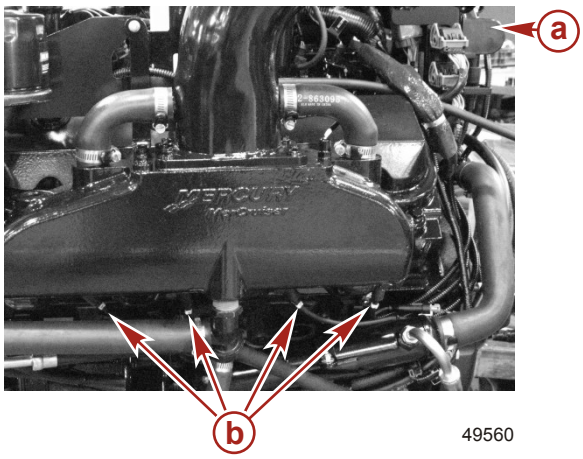
IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system.

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

Spark Plug

Checking

1. Disconnect the spark plug wires (high-tension leads) from the spark plugs.



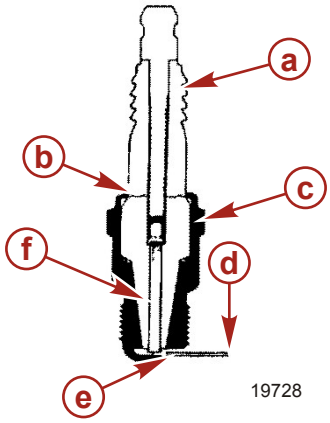
Non-ECT engine model shown, ECT models similar

- **a -** Coil pack
- **b -** Spark plug wires at spark plugs

NOTE: *Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot 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.

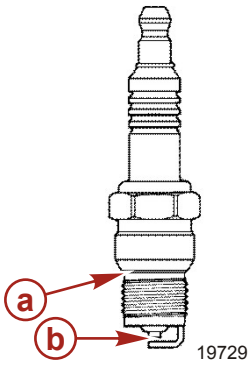
Description	Nm	lb. in.	lb. ft.
spark plugs	20	–	15

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 Wire—High-Tension Leads

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
Computer Diagnostic System (CDS)	Order through SPX

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.

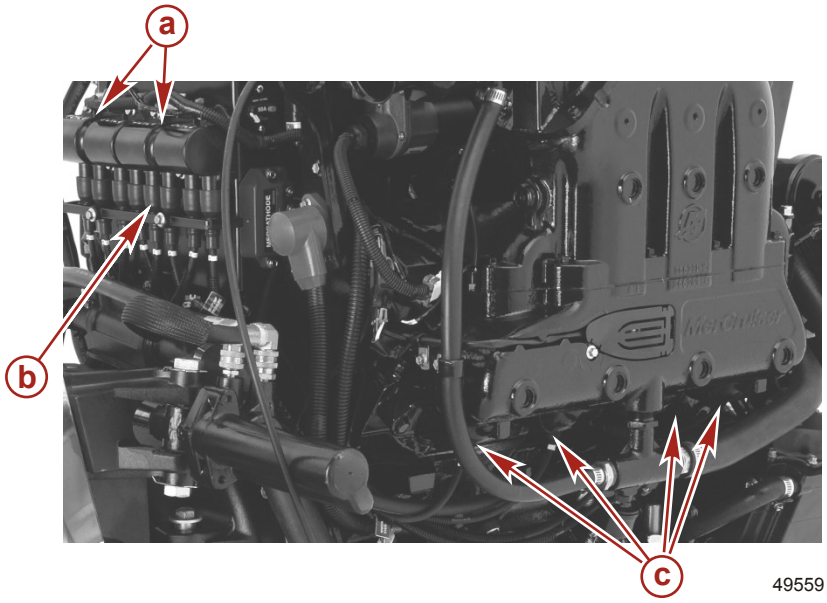
Replacing

IMPORTANT: Only use spark plug wires recommended for marine application.

NOTE: *Replace one spark plug wire at a time to reduce the risk of installation error.*

1. Disconnect individual spark plug wire from the spark plug.

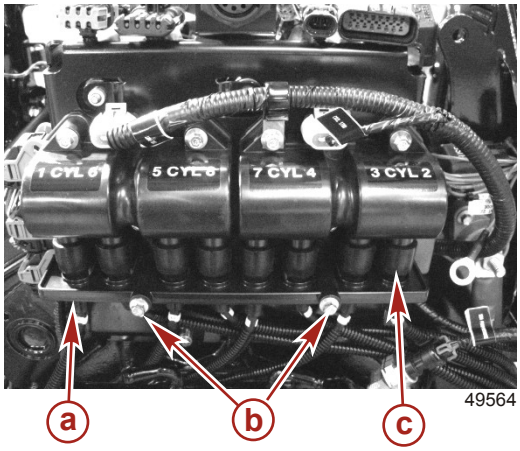
NOTE: Use care when removing the spark plug wires from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the boot to remove the spark plug wire from the spark plug.



ECT engine model shown, non-ECT models similar

- **a -** Coil packs (2)
- **b -** Spark plug wires to coil (8)
- **c -** Starboard spark plug wires to spark plugs (4)

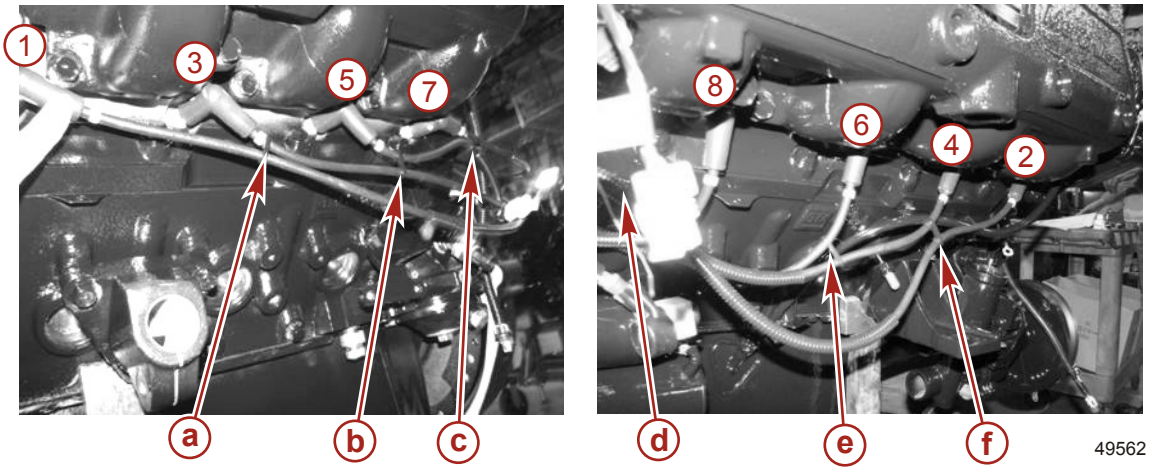
2. Remove the Spark plug wire retainer bracket.



- **a -** Spark plug retainer bracket
- **b -** Screw (2)
- **c -** Spark plug wire (8)

3. Pull the spark plugs wire from the coil.
4. 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.



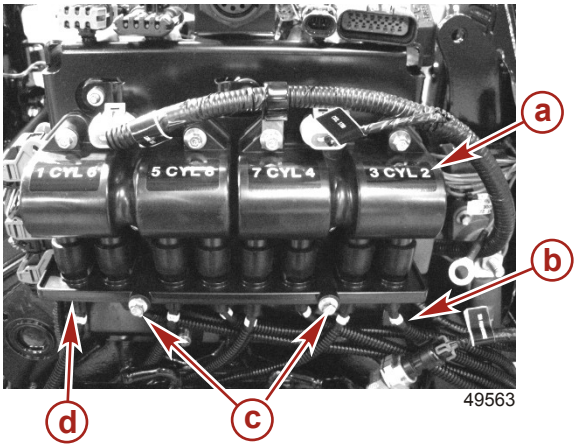
Engine parts removed for visual clarity

- **a -** Retainer clip on spark plug wires number 1 and 3
- **b -** Retainer clip on spark plug wires number 3 and 5
- **c -** Retainer clip on spark plug wires number 5 and 7
- **d -** Retainer clip on spark plug wires number 6 and 8
- **e -** Retainer clip on spark plug wires number 4 and 6
- **f -** Retainer clip on spark plug wires number 2 and 4

b. Attach the spark plug wires to the appropriate spark plug and coil pack. Each end must fit securely.

c. Install the spark plug retainer bracket and mounting screws.

d. Tighten the bracket mounting screws to specification.



- **a -** Cylinder numbers on coil (8)
- **b -** Cylinder numbers on spark plug wire (8)
- **c -** Screw
- **d -** Spark plug wire retainer bracket

Description	Nm	lb. in.	lb. ft.
Spark plug wire retainer bracket screw	11	96	–

Ignition Coil

NOTE: *For ignition coil troubleshooting* ***refer to the appropriate Mercury MerCruiser PCM Diagnostic Service Manual.***

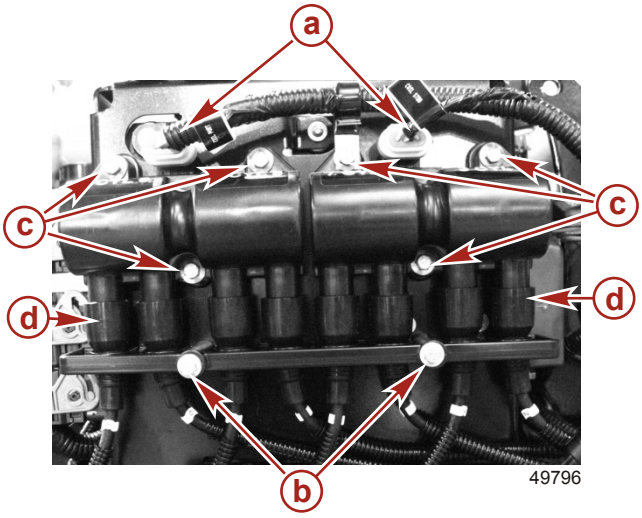
Removal

⚠ WARNING

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

1. Disconnect both battery cables from the battery.

2. Remove and retain the two screws securing the spark plug wire retainer bracket and remove the bracket.
3. Disconnect the spark plug wires at the ignition coils.
4. Disconnect the ignition coil harness connector.
5. Remove and retain the three ignition coil mounting screws.
6. Remove the ignition coil.



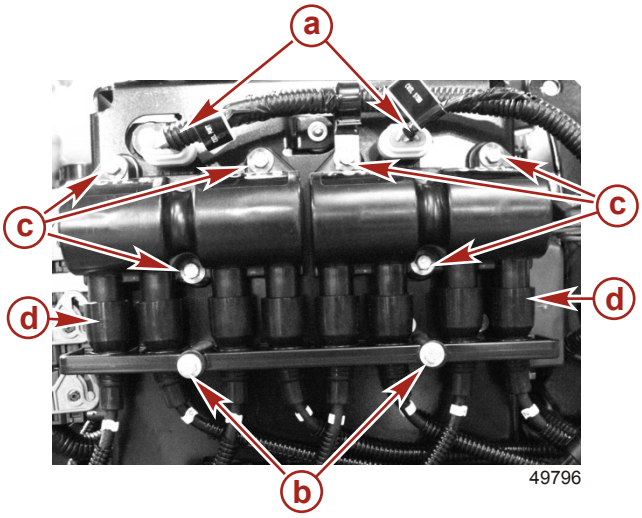
a - Ignition coil harness connector (starboard and port)
b - Retainer bracket screw (2)
c - Ignition coil mounting screw (3)
d - Spark plug wire (8)

Installation

1. Position the ignition coil packs onto the mounting bracket.
2. Install the ignition coil mounting screws and J-clip. Tighten the screws to specification.

Description	Nm	lb. in.	lb. ft.
Ignition coil screw	11	96	–

3. Connect the starboard and port ignition coil harness.
4. Connect the spark plug wires to the ignition coils.
5. Install the spark plug wire retainer bracket.
6. Install the retainer bracket mounting screws. Tighten the screws to specification.

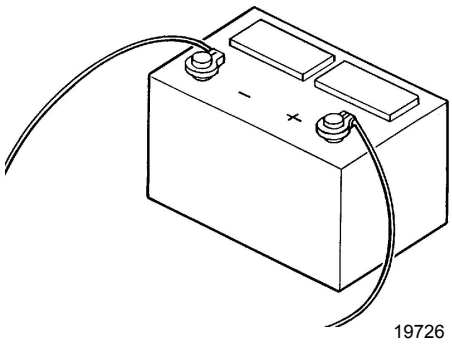


a - Ignition coil harness connector (starboard and port)
b - Retainer bracket screw (2)
c - Ignition coil mounting screw (3)
d - Spark plug wire (8)

Description	Nm	lb. in.	lb. ft.
Spark plug wire retainer bracket screw	11	96	–

7. 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.



Typical

Electrical System

Section 4C - Charging System

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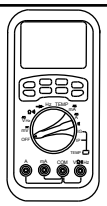
4C

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.

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

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

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

Charging System Components

The alternator system consists of the alternator, battery, the ignition switch, and the wiring that connects these components.

Periodic Maintenance

⚠ WARNING

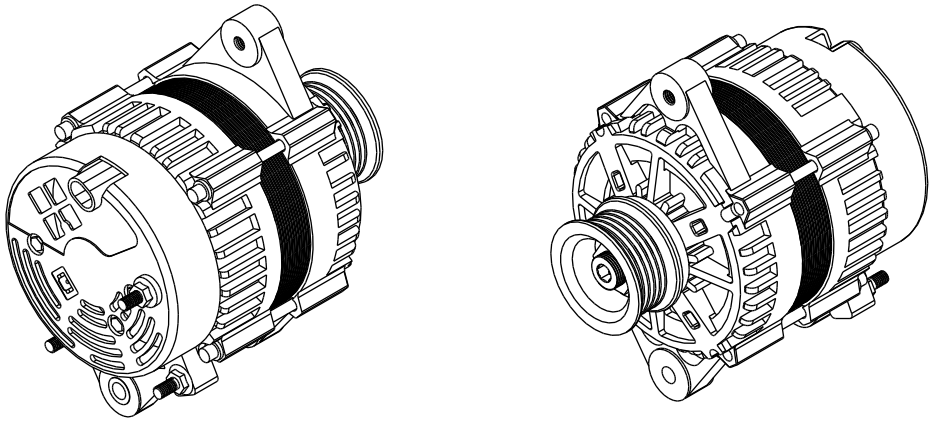
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

1. 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.

Alternator

Delco Alternator

Identification



23405

Delco 65-amp alternator

Replacement Parts Warning

⚠ WARNING

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

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****.*

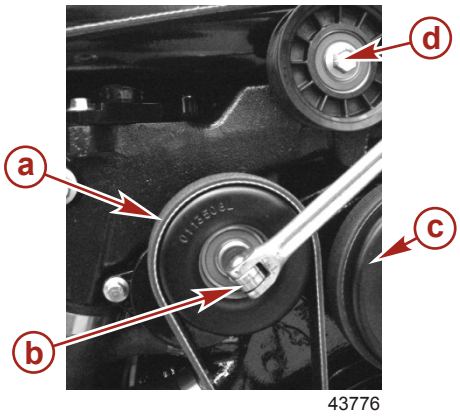
Tools

Description	Part Number
Multi-Meter / DVA Tester	91-99750A1
Ammeter (0–100 Amp)	Obtain locally

Removal

1. Use a breaker bar and appropriate socket to relieve the serpentine belt tensioner. Rotate the tensioner away from the belt until it stops.
   IMPORTANT: If a belt is to be reused, it should be reinstalled with the same direction of rotation.

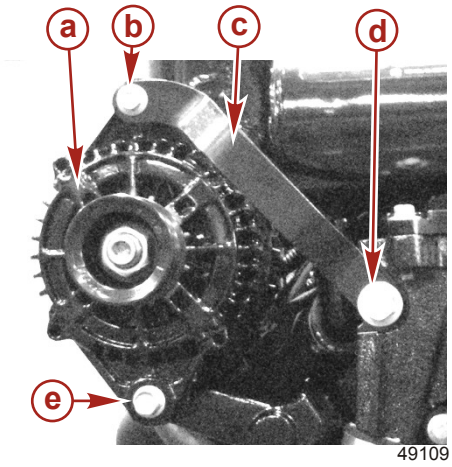
2. Remove the serpentine belt from the idler pulley; then slowly relieve the tension on the breaker bar and remove the belt.



43776

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

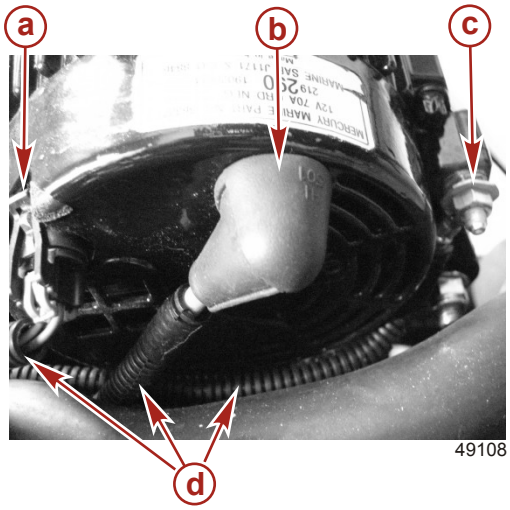
3. Loosen the alternator brace-to-crossover screw.



49109

- **a -** Alternator
- **b -** Upper alternator mounting screw
- **c -** Alternator brace
- **d -** Alternator brace-to-crossover screw
- **e -** Lower alternator mounting bolt

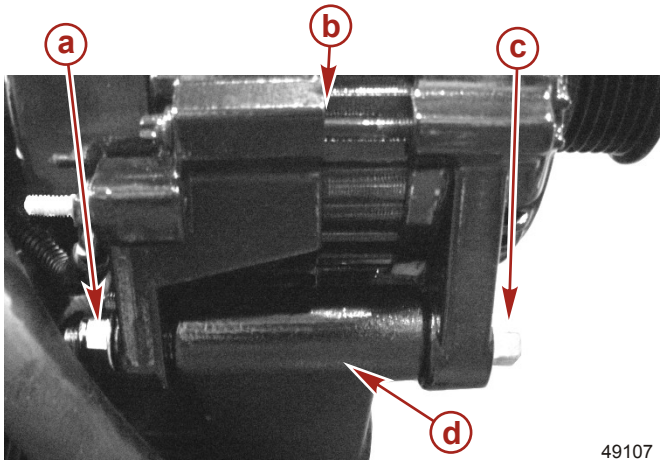
4. Remove the upper alternator mounting screw. Allow the brace to hang from the crossover screw.
5. Rotate the alternator away from the heat exchanger.
6. Remove the alternator wires.
   a. Disconnect the wiring harness from the alternator.
   b. Remove and retain the nut and the positive ORG wire from the alternator.
   c. Remove and retain the nut and the negative BLK wire from the alternator.
   d. Move the wires out of the way for alternator removal and installation. Do not pinch the wires.



49108

- **a -** Wiring harness connector
- **b -** Positive wire with boot
- **c -** Negative wire
- **d -** Wire routes

7. Remove the locknut from the lower alternator mounting bolt.

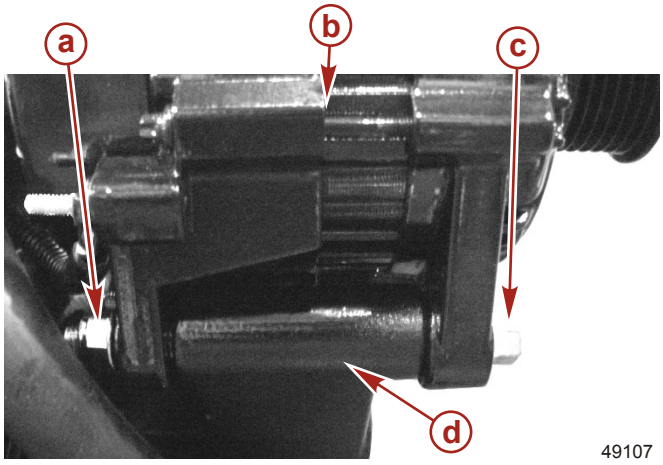


a - Locknut
b - Alternator
c - Bolt
d - Mounting bracket

8. Support the alternator and remove the bolt from the mounting bracket. Lift the alternator from the mounting bracket.

Installation

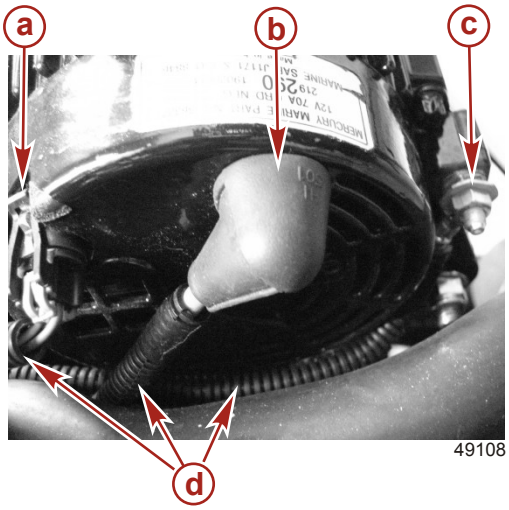
1. Position the alternator in the mounting bracket.
2. Install the lower alternator mounting bolt, and locknut.



a - Locknut
b - Alternator
c - Bolt
d - Mounting bracket

3. Route and connect the alternator wires. Do not pinch the wires.
   a. Connect the wiring harness to the alternator.
   b. Install the positive ORG wire to the alternator and hand-start the nut.
   c. Install the negative BLK wire to the alternator and hand-start the nut.

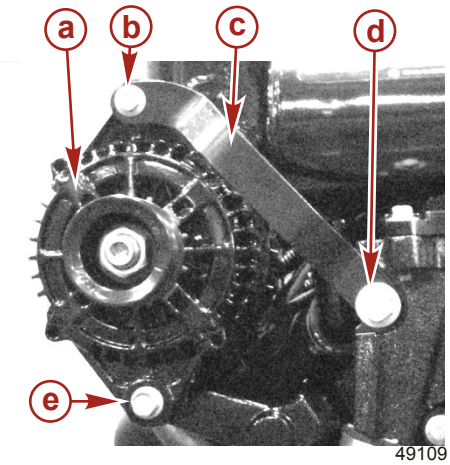
d. Tighten the nuts to specification and cover the positive connection with the boot.



a - Wiring harness connector
b - Positive wire with boot
c - Negative wire
d - Wire routes

Description	Nm	lb-in.	lb-ft
Alternator positive wire nut	2.8–4.5	25–40	–
Alternator negative wire nut	2.8–4.5	25–40	–

4. Install the alternator brace and the upper alternator mounting screw.



a - Alternator
b - Upper alternator mounting screw
c - Alternator brace
d - Alternator brace-to-crossover screw
e - Lower alternator mounting bolt

5. Tighten the lower alternator mounting bolt, and locknut to specification.

Description	Nm	lb-in.	lb-ft
Lower alternator mounting bolt, and locknut	91	–	72

6. Tighten the upper alternator mounting screw to specification.

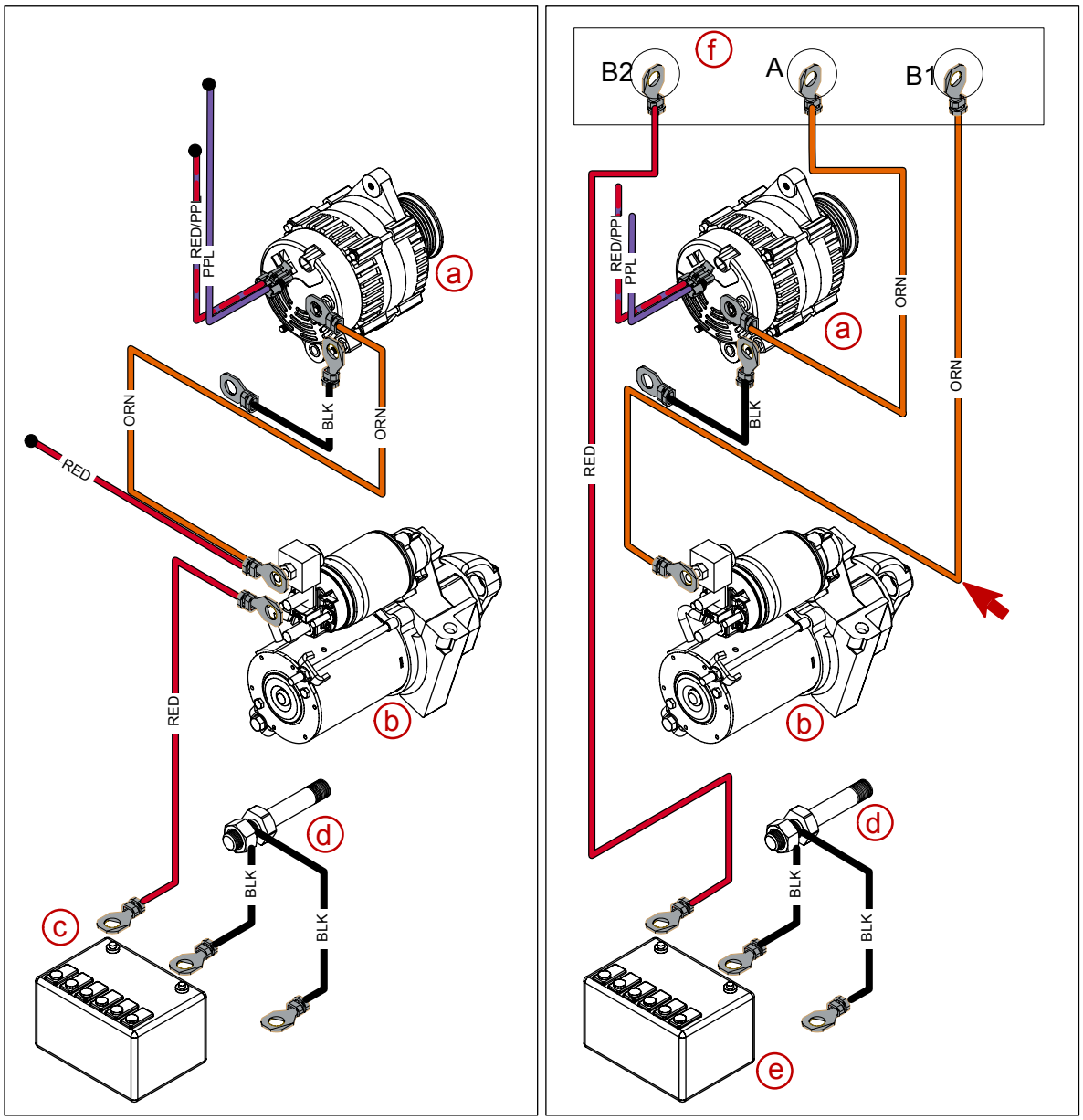
Description	Nm	lb-in.	lb-ft
Upper alternator mounting screw with brace	27	–	20

7. Tighten the alternator brace-to-crossover screw to specification.

Description	Nm	lb-in.	lb-ft
Alternator brace-to-crossover screw	27	–	20

8. Install the serpentine drive belt.
9. Connect the negative battery cable to the battery.

Battery Isolator Diagram



- **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.

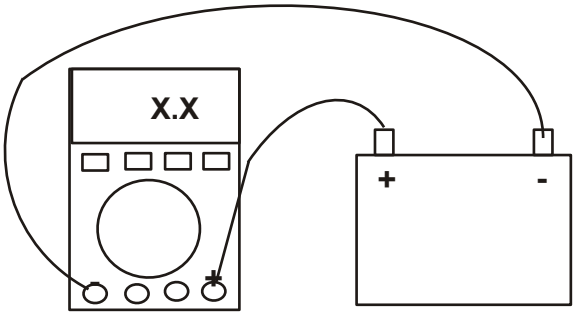
Troubleshooting Tests (Alternator on the Engine)

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

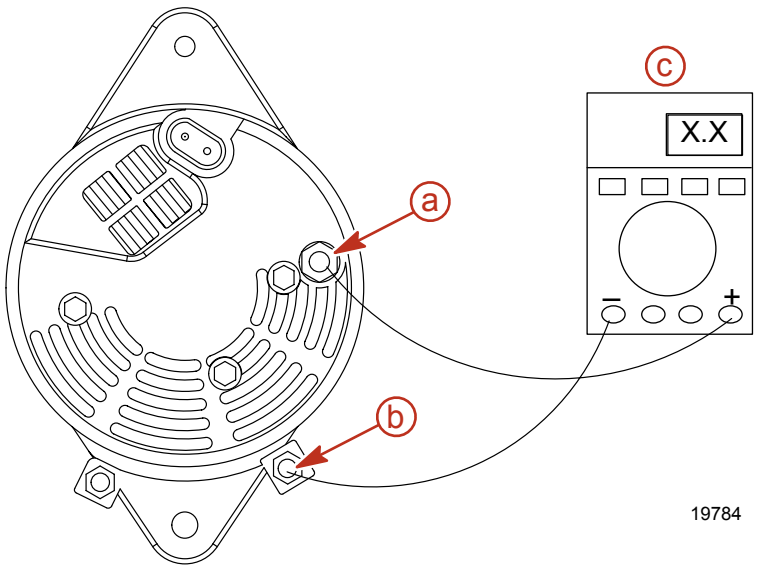
DMT 2004 Digital Multimeter	91-892647A01

NOTICE

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

2. 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.



19784

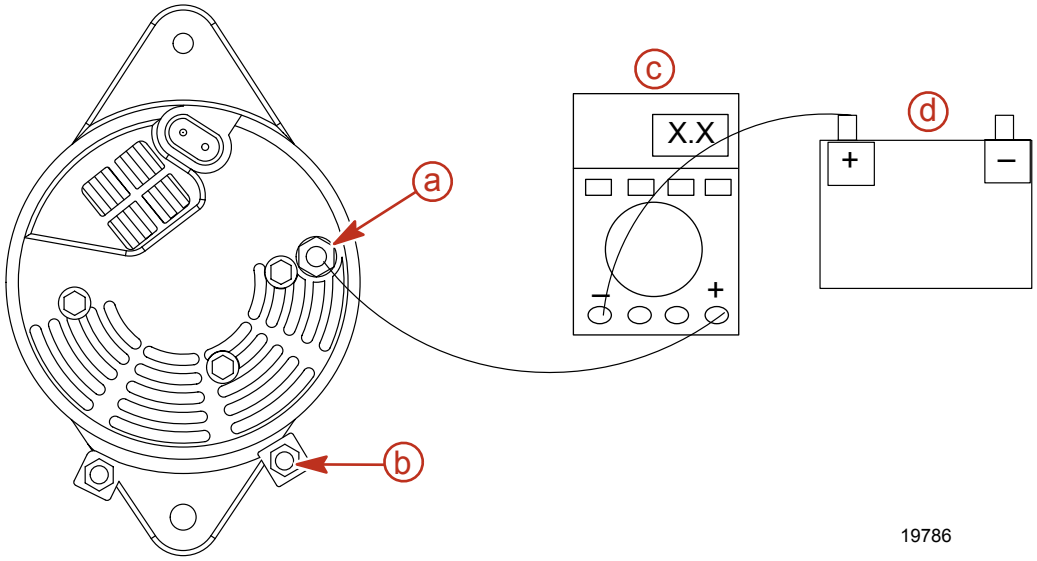
Typical
a - Output terminal
b - Ground terminal
c - Voltmeter

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.*



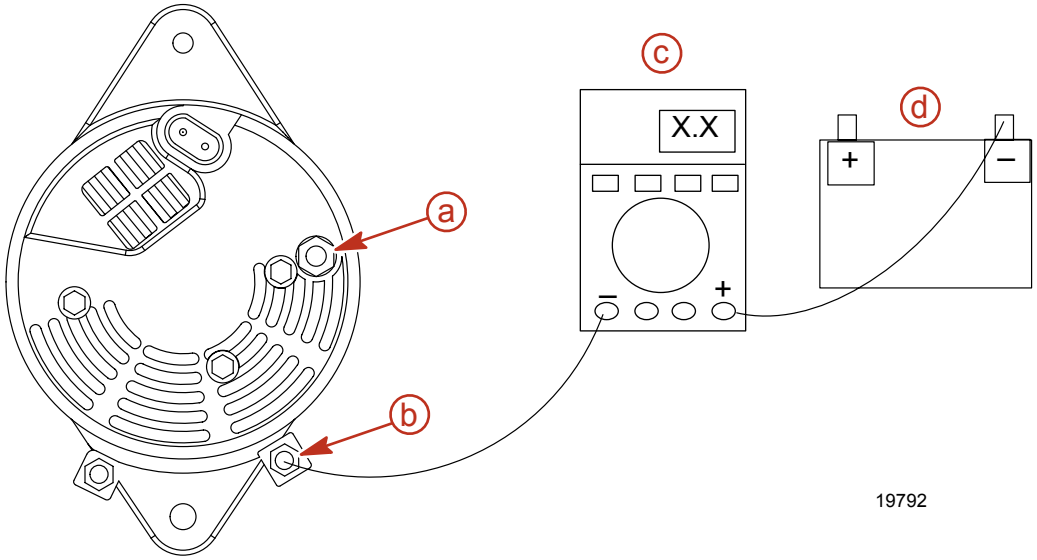
Typical

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.

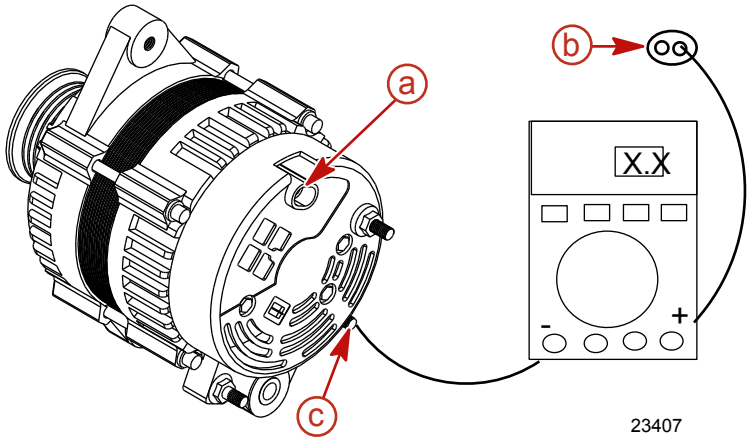
DMT 2004 Digital Multimeter	91-892647A01

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

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.

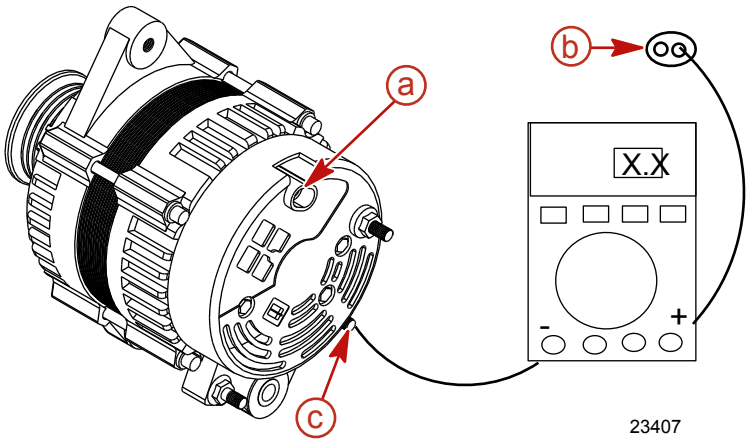


Typical

- **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.



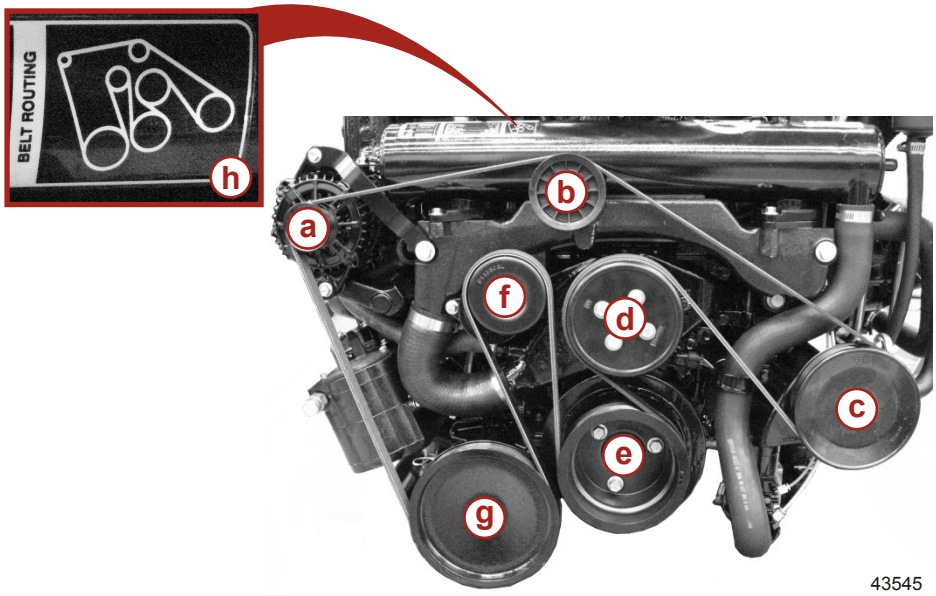
Typical
- **a -** Connector location
- **b -** PURPLE and RED / PURPLE connector
- **c -** Ground

Serpentine Drive Belt—Sterndrive Models

Inspection

⚠ WARNING

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



- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram

Checking

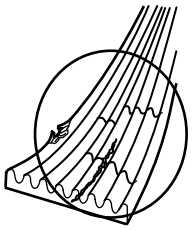
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

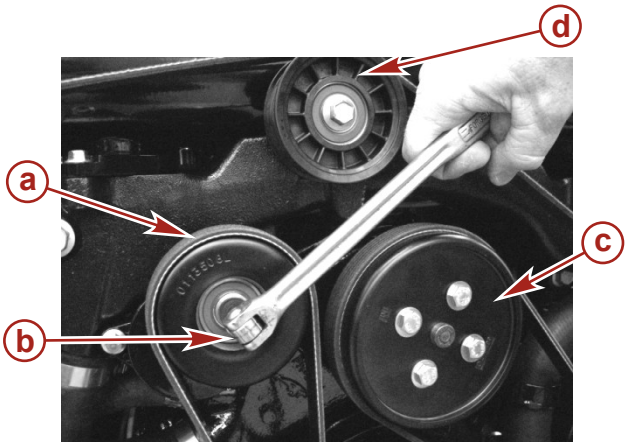
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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



43546

- **a -** Tensioner pulley
- **b -** Socket and breaker bar
- **c -** Water circulating pump pulley
- **d -** Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

Description	
Deflection[1]	13 mm (½ in.)

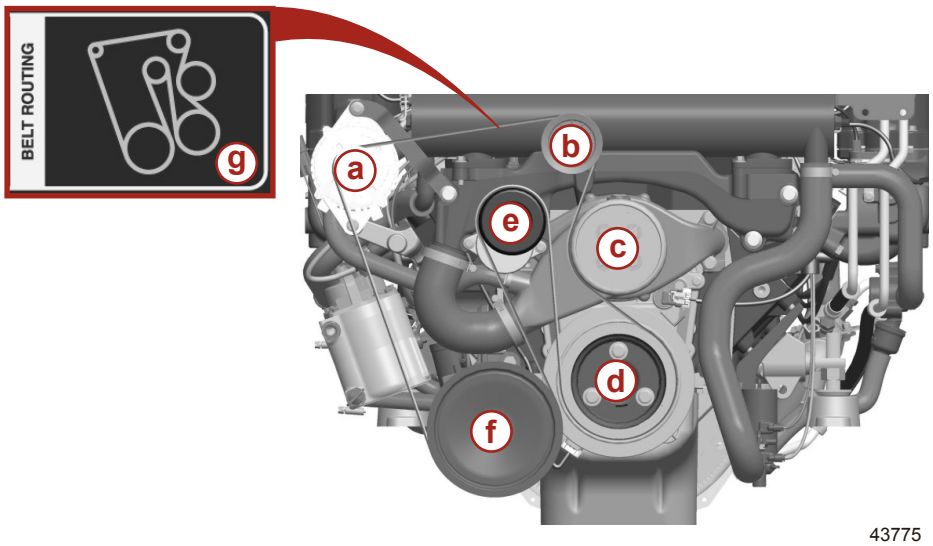
1. Use moderate thumb pressure on the belt at the location that has the longest distance between two pulleys.

Serpentine Drive Belt—Inboard Models

Inspection

⚠ WARNING

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



43775

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

Checking

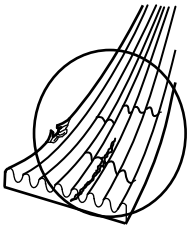
Inspect the drive belt for:

- Proper belt tension deflection
- Excessive wear
- Cracks
- Fraying
- Glazed surfaces
- Proper tension

Use moderate thumb pressure on the belt at the location with the longest distance between two pulleys.

Description	
Deflection	13 mm (1/2 in.)

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.*



21062

Replacing

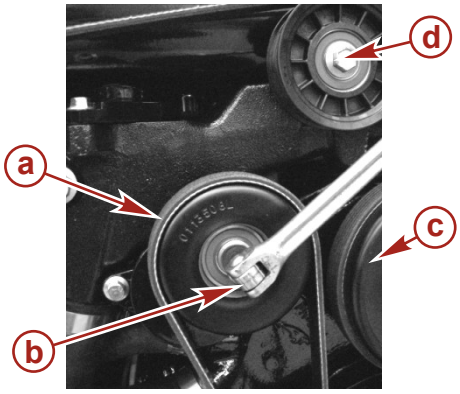
IMPORTANT: If reusing a belt, install it in the same direction of rotation as before.

The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops.

⚠ CAUTION

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

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

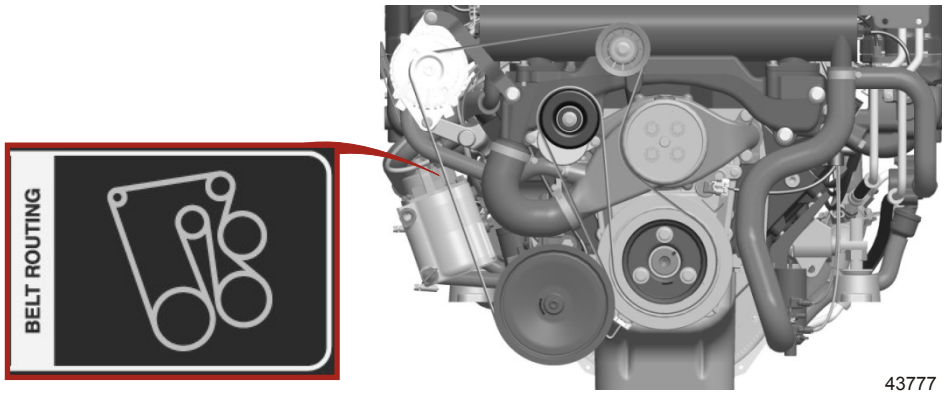


43776

a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

3. Remove the belt and route the replacement belt according to the belt routing diagram.
4. Carefully release the tensioner and ensure that the belt stays positioned properly.
5. Check the belt tension.

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



43777

Description	
Deflection	13 mm (½ in.)

Electrical System

Section 4D - Audio and Visual Warning System

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4
D

Engine Guardian Strategy

Engine Guardian reduces the potential for engine damage by restricting engine power when the PCM detects a potential problem. Engine Guardian monitors the following:

- Oil pressure
- Coolant temperature
- Seawater pressure
- Engine overspeed
- Exhaust manifold temperature

The Guardian strategy also reduces power to 90% of maximum if any sensor on the power package fails. The PCM stores the fault for diagnostics.

For example, if the water inlet becomes partially blocked, Guardian reduces the available power level of the engine to help prevent damage from decreased water flow to the engine. If the debris passes through, and full water flow is restored, Guardian restores engine power to normal.

To avoid possible recurrence of the problem, we suggest boat owners contact an authorized dealer. The PCM stores the fault and with this information the technician will be able to more rapidly diagnose problems.

Transmission Guardian Strategy

IMPORTANT: Boat speed could be reduced to idle and may not respond to the throttle.

Transmission Guardian is a MerCruiser DTS feature that protects transmissions from clutch damage. Transmission Guardian monitors the clutch pack pressure in forward and reverse gears. If the transmission fluid pressure drops below a predetermined level, Transmission Guardian lowers the engine torque and speed to prevent clutch slippage.

To avoid possible recurrence of the problem, we suggest boat owners contact an authorized dealer. The PCM stores the fault and with this information the technician will be able to more rapidly diagnose problems.

Audio Warning System

Warning Horn Signals

IMPORTANT: The audio warning system alerts the operator that a problem has occurred. It does not protect the engine from damage.

The Mercury MerCruiser power package may be equipped with an audio warning system. Most faults cause the warning horn circuit to activate. How the warning horn activates depends on the severity of the problem.

There are three warning horn states:

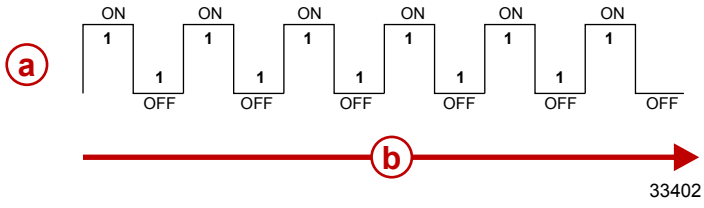
- Caution
- Severe
- Onboard Diagnostic Marine (OBDM) fault (not available for non-emissions controlled engines))

Caution

Below are some examples of a caution fault:

- Drive oil is low (sterndrive models only)
- Sensor failure

If a caution is detected, the audio warning system will sound for six one-second intervals.



a - Horn (on or off)
b - Time (in seconds)

Severe

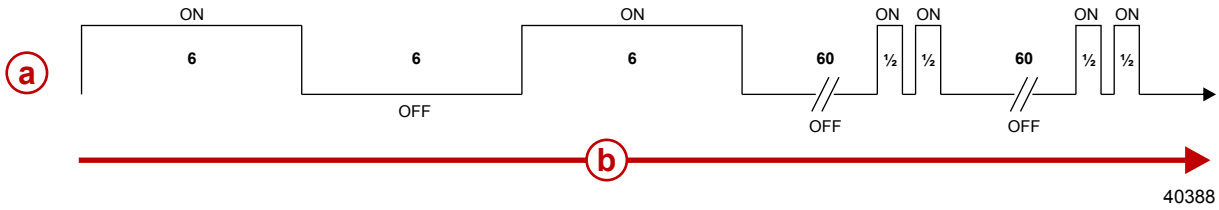
IMPORTANT: Operators are advised to contact an authorized Mercury MerCruiser dealer if a severe fault is activated.

Below are some examples of a severe fault:

- Transmission fluid temperature is too hot
- Engine oil pressure is too low
- Engine temperature is too hot
- Seawater pressure is too low

- Transmission pressure is low

If a severe fault is detected, the audio warning system sounds for six seconds, turns off for six seconds, and sounds for six more seconds. Then the audio warning system sounds for two half-second intervals every sixty seconds.



a - Horn (on or off)
b - Time (in seconds)

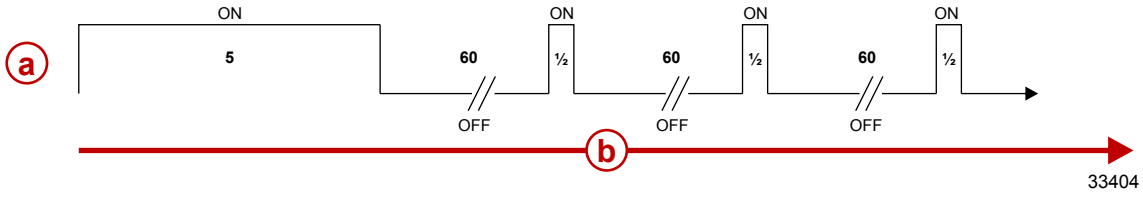
OBDM—Emissions Controled Engines

NOTE: *The OBDM fault is not available for non-emissions controlled engines.*

Below are some examples of a OBDM fault:

- Emissions too hot
- Fuel too hot

If an OBDM fault is detected, the audio warning system sound with one five-second horn, then one short, ½-second horn every 60 seconds for certain faults related to the emissions or fuel system. Owners are advised to contact an authorized Mercury MerCruiser dealer for assistance.



a - Horn (on or off)
b - Time (in seconds)

Testing the Audio Warning System

1. Turn the ignition switch to the "ON" position without cranking the engine.
2. Listen for the audio alarm. The alarm will sound if the system is functioning correctly.

Visual Warning System—Emissions Control Engines

Notice to Installer—Malfunction Indicator Lamp (MIL)

A malfunction indicator lamp (MIL) must be installed with this engine to be compliant with EPA and CARB regulations.

47769

OBDM Malfunction Indicators For Engine Serial Numbers

Models Covered	Serial Number Or Year
8.2 Emissions Controlled	1A352945 and below—ending build 05/19/2011

Engines are equipped with an OBDM warning horn for faults related to emissions or fuel systems. The horn will sound an audio warning while the fault is active.

If an OBDM malfunction indicator light kit is installed, the malfunction indicator light (MIL) will remain illuminated while the fault is active. In addition, the OBDM horn is deactivated and the fault will not sound an audio warning horn.

Models Covered	Serial Number Or Year
8.2 Emissions Controlled	1A352946 and above—starting build 05/20/2011

IMPORTANT: A malfunction indicator lamp (MIL) must be installed with this engine to be compliant with EPA and CARB regulations.
IMPORTANT: If the MIL light is not connected, the boat operator will not receive any warnings pertaining to the emissions control or fuel system.

Engines are equipped with an OBDM malfunction indicator light (MIL). The light will remain illuminated while the fault is active.

There is no OBDM horn for this calibration.

OBDM Malfunction Indicator Light (MIL) Options

The OBDM light provides a visual indication of a malfunction with the engine emissions control system and will remain illuminated while the OBDM fault is active.

Use a service engine icon or MIL such as a SmartCraft-enabled gauge capable of displaying the service engine icon, or a dash mounted service engine light.

Malfunction indicator lamp (MIL) kits containing a dash mounted service engine light and a special harness that connects to the engine harness may be purchased separately.

47594

SC 1000 gauge and service engine light

Installation Information

⚠ WARNING

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

⚠ CAUTION

Avoid injury or product damage. Obstructions, such as braces and wiring, may be unseen when looking at the front of the dashboard. Before drilling or cutting any holes in the dashboard, check the area behind the dashboard for obstructions. Do not drill or cut when obstructions are present.

NOTE: *Emissions Control [EC]) engines built before 5/20/2011 may require software updates for OBDM light operation. Contact a MerCruiser Customer Service for information on software updates when installing this kit on a boat that is powered by MerCruiser EC engines with serial numbers 1A352945 and below.*

NOTE: *Some engines may not be equipped with an OBDM light connector. Adaptor Harness 8M2100233 must be used on engines that do not have the OBDM light helm harness connector.*

Description	Part Number
OBDM Malfunction Indicator Light kit (Emissions Control (EC) Engines)	8M0046481

Dashboards

IMPORTANT: Some dashboards may already be equipped with a precut hole.
Panels must be 0.76–4.75 mm (0.03–0.19 in.) thick.

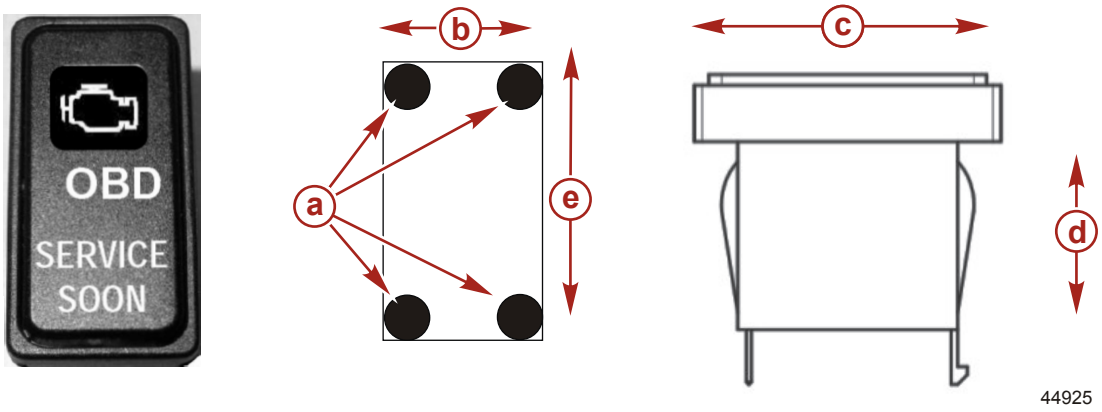
Before cutting any holes, check area behind dashboard for obstructions (braces, cables, wiring, etc.). When cutting the dashboard for the OBDM light installation, follow these cutting tips:

- Fiberglass—Apply masking tape to the area that will be cut to prevent the dashboard from cracking.
- Vinyl covered—Remove vinyl from area to be cut with a razor blade to keep the vinyl from tearing.

Installing the OBDM Light

1. Disconnect both battery cables from the battery or batteries
2. Select a location with unobstructed visibility for the OBDM light using the dimensions shown below.
3. Prepare the selected area with masking tape and remove vinyl as necessary.
4. Remove the four corners of the selected area using an appropriate size drill.
5. Cut a 21.1 mm (0.83 in.) x 36.8 mm (1.45 in.) rectangular opening for the OBDM light with a reciprocating saw.

6. Dress cutout with a flat file if necessary and install the OBDM light into the dashboard.



OBDM light cutout

- **a -** Holes (4)
- **b -** 21.1 mm (0.83 in.)
- **c -** 48.5 mm (1.91 in.)
- **d -** 29.5 mm (1.16 in.)
- **e -** 36.8 mm (1.45 in.)

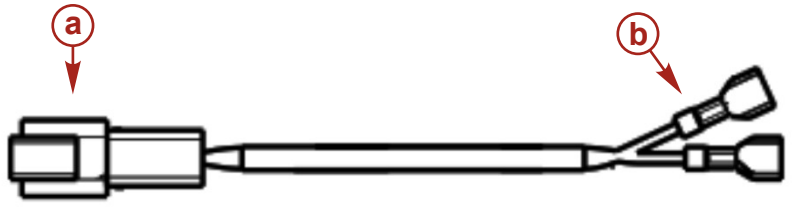
NOTE: *Drawing is not to scale. Use drawing as a dimensional reference only.*

Installing a Single Station Helm Harness for the OBDM Light

NOTE: *Harness must be ordered separately.*

Description	Part Number
3.0 m (10 ft) OBDM helm harness	8M0048049
4.6 m (15 ft) OBDM helm harness	8M0048054
6.1 m (20 ft)OBDM helm harness	8M0048055
7.6 m (25 ft) OBDM helm harness	8M0048056
9.2 m (30 ft) OBDM helm harness	8M0048057
12 m (40 ft) OBDM helm harness	8M0048058
15 m (50 ft) OBDM helm harness	8M0048059

1. Connect the two spade connectors on the helm harness to the spade terminals on the OBDM light.
2. Route the OBDM helm harness from the dashboard to the engine. Secure the OBDM helm harness with cable-ties or non-metallic clamps every 45 cm (18 in.).
3. Connect the OBDM helm harness to the connector on the engine labeled OBDM light. (The connector on the engine will be located near the engine 14-pin data harness.)



OBDM helm harness

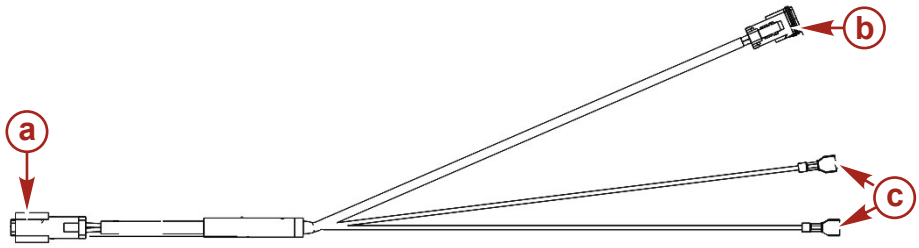
- **a -** Connector (to engine harness)
- **b -** Spade terminals (to OBDM light)

Installing a Dual-Station Helm Harness for the OBDM Light

NOTE: *Harness must be ordered separately.*

Description	Part Number
3.0 m (10 ft) dual-station OBDM helm harness	8M0048040
4.6 m (15 ft) dual-station OBDM helm harness	8M0048043
6.1 m (20 ft) dual-station OBDM helm harness	8M0048044
7.6 m (25 ft) dual-station OBDM helm harness	8M0048045
9.2 m (30 ft) dual-station OBDM helm harness	8M0048046
12 m (40 ft) dual-station OBDM helm harness	8M0048047
15 m (50 ft) dual-station OBDM helm harness	8M0048048

1. Connect the two spade connectors on the dual-station OBDM helm harness to the spade terminals on the OBDM light.
2. Route the dual-station OBDM helm harness from the dashboard to the engine and secure with cable ties or non-metallic clamps every 45 cm (18 in.).
3. Connect the dual-station OBDM helm harness to the connector on the engine labeled OBD-M light. The connector on the engine will be located near the engine 14-pin data harness.
4. Connect the dual-station helm harness to the second-station helm harness.
5. Route the second-station OBDM helm harness to the back of the second-station dash panel. Connect the OBDM helm harness spade connectors to the spade terminals on the second-station OBDM light.



45063

Dual station OBDM helm harness

- **a -** Connector (to engine harness)
- **b -** Connector to second-station OBDM helm harness
- **c -** Spade connectors (OBDM light at lower station)

Testing the OBDM Light

1. Turn the ignition switch to the on position. Do not start the engine.
2. The OBDM light will remain illuminated for four seconds if the system is functioning correctly.

Notes:

Electrical System

Section 4E - Components

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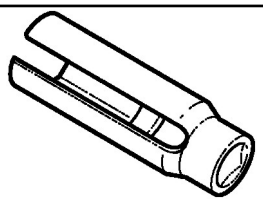
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Sensor threads	92-809822
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821
		MAP sensor retaining screw	
		Screw threads	
		IAC screw	
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Seal on MAP sensor	92-858087K01

Special Tools

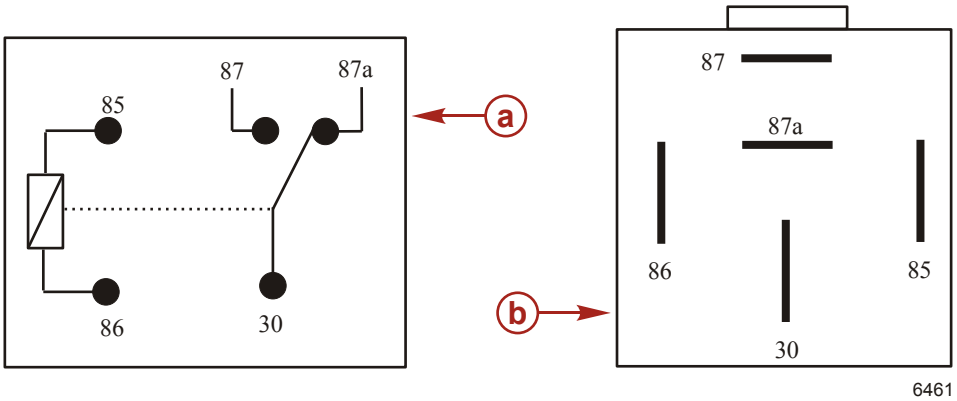
Terminal Test Probe Kit	SPX P/N MM- 46523
7915	Test probes adapt test meter leads to harness connections without damaging harness terminals. May be used with Computer Diagnostic System (CDS).

Kent-Moore Oxygen Sensor Socket	KN-46577
 32314	Kent-Moore socket (or equivalent 7/8 in. automotive oxygen sensor socket) Aids in the removal and installation of oxygen sensors on products equipped with Emissions Control.

Relays

The relays used for the Main Power C7 and C8, fuel pump C5 circuits are de-energized to connect terminals 87a and 30 and energized to connect terminals 87 and 30.

The resistance across terminals 85 and 86 is 75-95 Ohms, if not, replace the relay.



6461

a - Relay circuit schematic
b - Relay terminal identification

Each relay is listed below with it's respective terminal connections and wire colors:

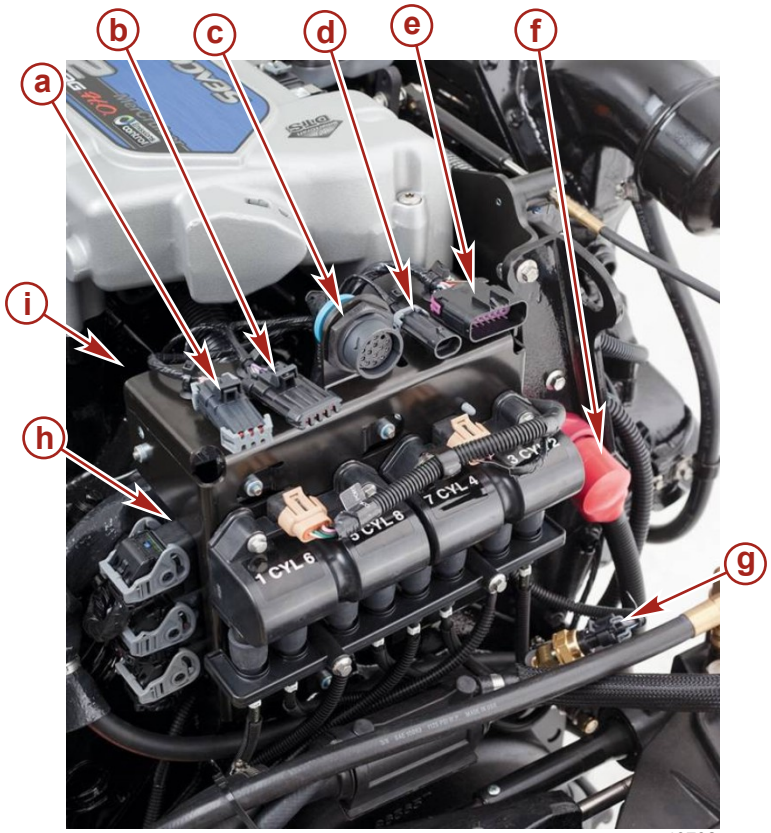
Relay	Terminal 85	Terminal 86	Terminal 30	Terminal 87	Terminal 87a
Main Pwr C7	RED/BLU	YEL/PPL	RED	RED/GRN	N/A

Relay	Terminal 85	Terminal 86	Terminal 30	Terminal 87	Terminal 87a
Main Pwr C8	RED/BLU	YEL/PPL	RED	RED/GRN	N/A
Fuel Pump C5	YEL/BLK	RED/BLU	RED	RED/GRN	N/A

Engine Electrical Connections

IMPORTANT: The opposite end of the RED/PPL power wire must be connected directly to the battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. The MerCathode system must function continuously for proper corrosion protection.

1. **Engine Mounted MerCathode** RED/PPL Lead - Connect to the positive (+) battery terminal.



49792

- **a -** Fuel tank/paddle wheel connector
- **b -** Data link connector (DLC)
- **c -** 14-Pin harness connector
- **d -** DTS clean power harness connector
- **e -** Transom harness connector (driveline packages have the extension harnesses attached to the engine)
- **f -** Hot stud, positive battery cable terminal
- **g -** Sea pump pressure sensor
- **h -** PCM
- **i -** Fuse holders (behind bracket)

Fuse Locations

Four fuses protect the main power, fuel pump, ignition, and accessory circuits. Four 10 amp fuses protect the Oxygen sensors. These are located on the top of the engine in the electrical center near the PCM and plenum.

Fuse Pack C-16 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
RED/BLK - RED/PNK	20	A, B	Fuel pump
RED/BLU - RED/GRN	20	C, D	IAC,
RED/GRN - RED/YEL	20	E, F	Coil packs, PCM
RED/WHT - RED/GRN	25	G, H	Fuel injectors

Fuse Pack C-17 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
RED/GRN - RED/ORN	5	A, B	Hour meter
RED/PPL - RED	20	C, D	Relay switched power
REDL/BLU -RED	20	E, F	Constant power

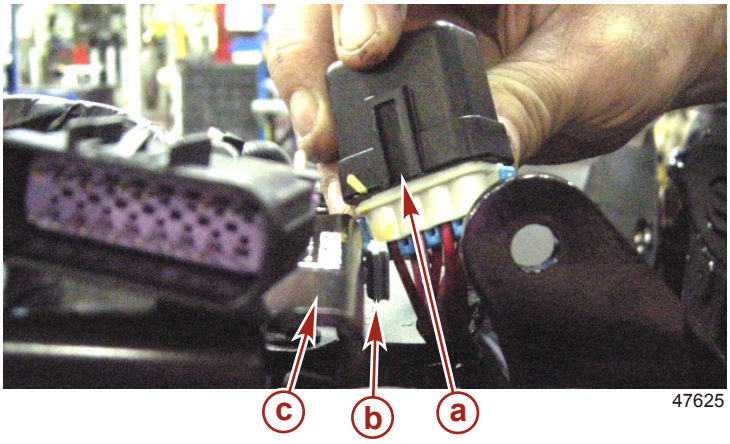
Fuse Pack C-17 (Reference the wire colors at the fuse pack)			
Wire Color	**Amperage Rating**	**Position**	**Assignment**
PPL/WHT - PPL	5	G, H	Accessories

Propulsion Control Module (PCM)

IMPORTANT: The PCM is a sensitive electrical device, subject to electrostatic damage. Do not touch the connector pins when removing or installing the module.

Removal

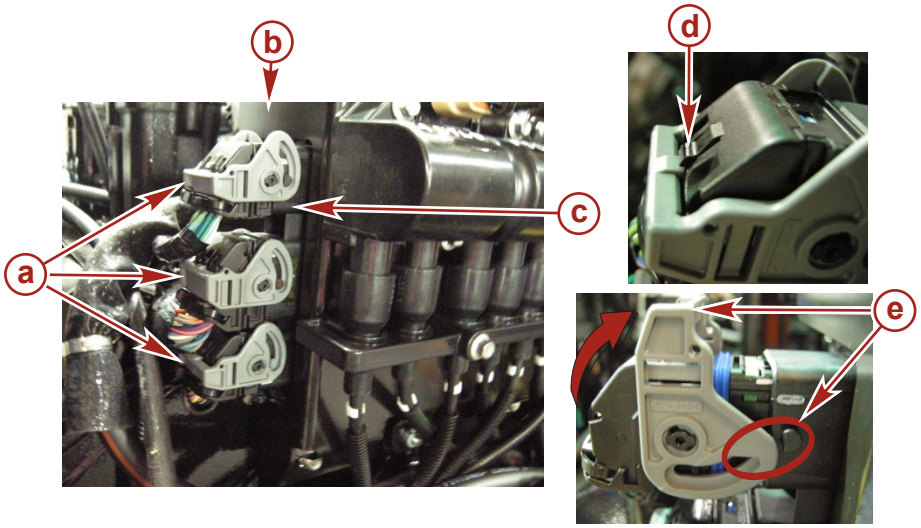
1. Slide the fuse connector up and remove it from its mount on the electrical bracket.



47625

a - Fuse connector
b - Fuse connector mount
c - Electrical bracket

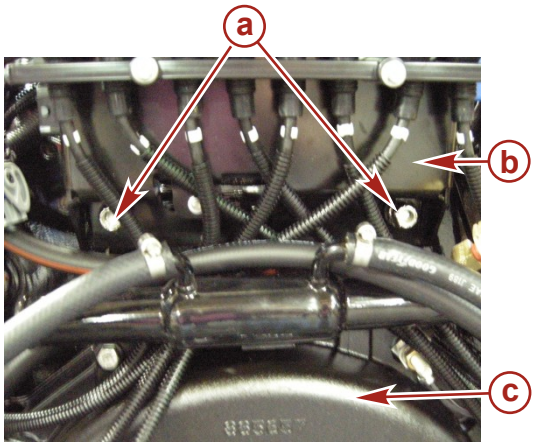
2. Remove the electrical connectors from the PCM.



47626

a - Electrical connectors
b - Electrical bracket
c - PCM
d - Locking tab
e - Latch and latch pin

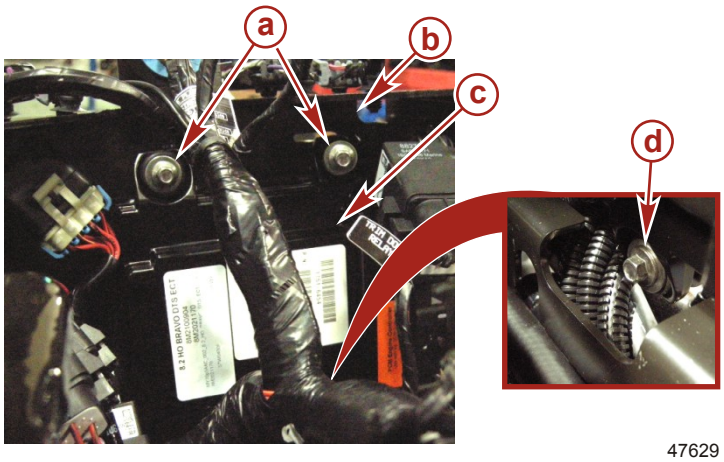
3. Remove and retain the nuts and washers from the electrical bracket on the flywheel side of the engine.



47627

a - Nut and washer
b - Electrical bracket
c - Engine flywheel housing

4. Slide the electrical bracket away from engine to gain access to the PCM fasteners.
5. Remove and retain the bottom and top screws holding the PCM to the bracket.



47629

a - Top screw
b - Electrical bracket
c - PCM
d - Bottom screw

6. Remove the PCM.

Cleaning and Inspection

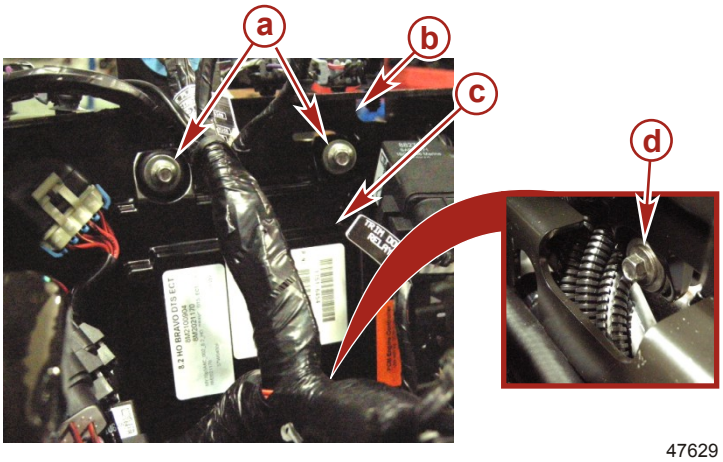
1. Clean the exterior of the PCM with a dry cloth, being careful to avoid contact with connector pins.
2. Inspect the outer surfaces for any obvious damage.
3. Visually inspect the electrical pins on the PCM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: *The PCM is a sealed electrical component. Do not use a damaged PCM.*

Installation

1. Place the PCM on the bracket and secure it to the bracket using the screws previously removed.

2. Tighten the PCM screws to specification.

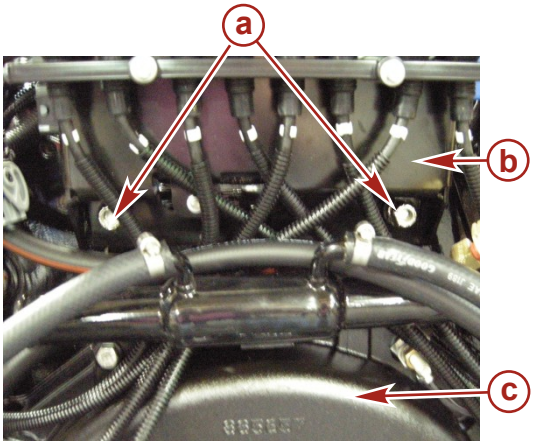


47629

a - Top screw
b - Electrical bracket
c - PCM
d - Bottom screw

Description	Nm	lb-in.	lb-ft
Screws, PCM to electrical bracket	6	40	–

3. Push the Electrical bracket all the way back on the studs and secure it with the washers and nuts previously removed.
4. Tighten the nuts to specification.

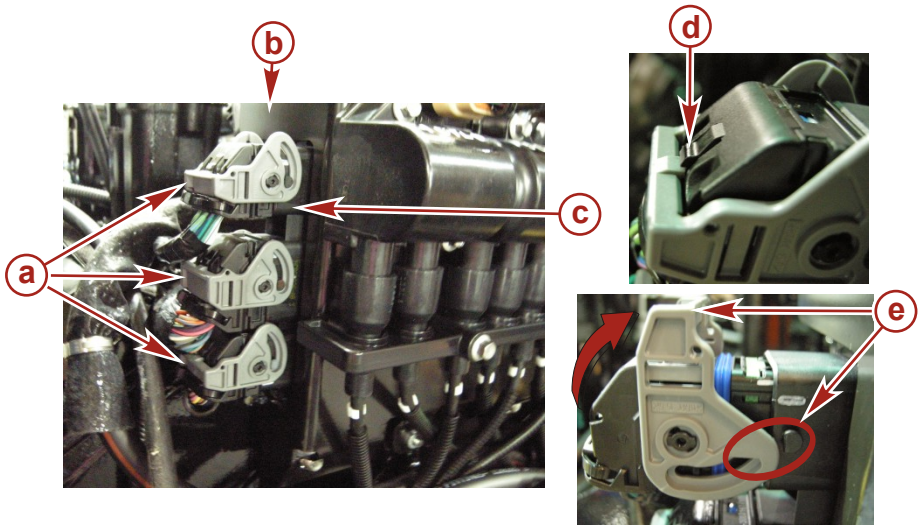


47627

a - Nut and washer
b - Electrical bracket
c - Engine flywheel housing

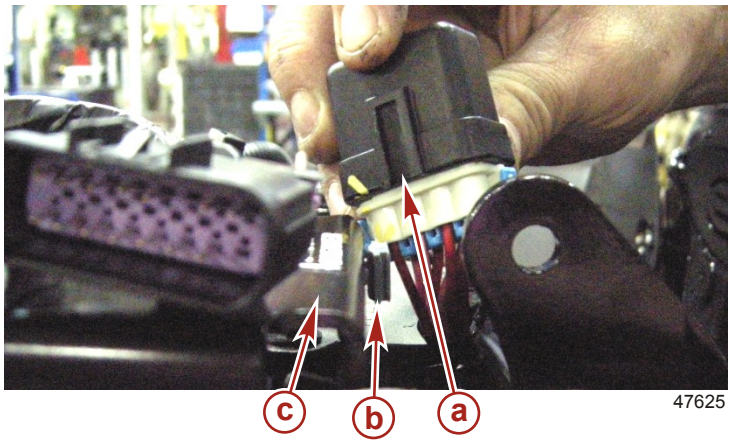
Description	Nm	lb-in.	lb-ft
Nut, electrical bracket to engine	54	–	40

5. Install the electrical connectors to the PCM.



a - Electrical connectors
b - Electrical bracket
c - PCM
d - Locking tab
e - Latch and latch pin

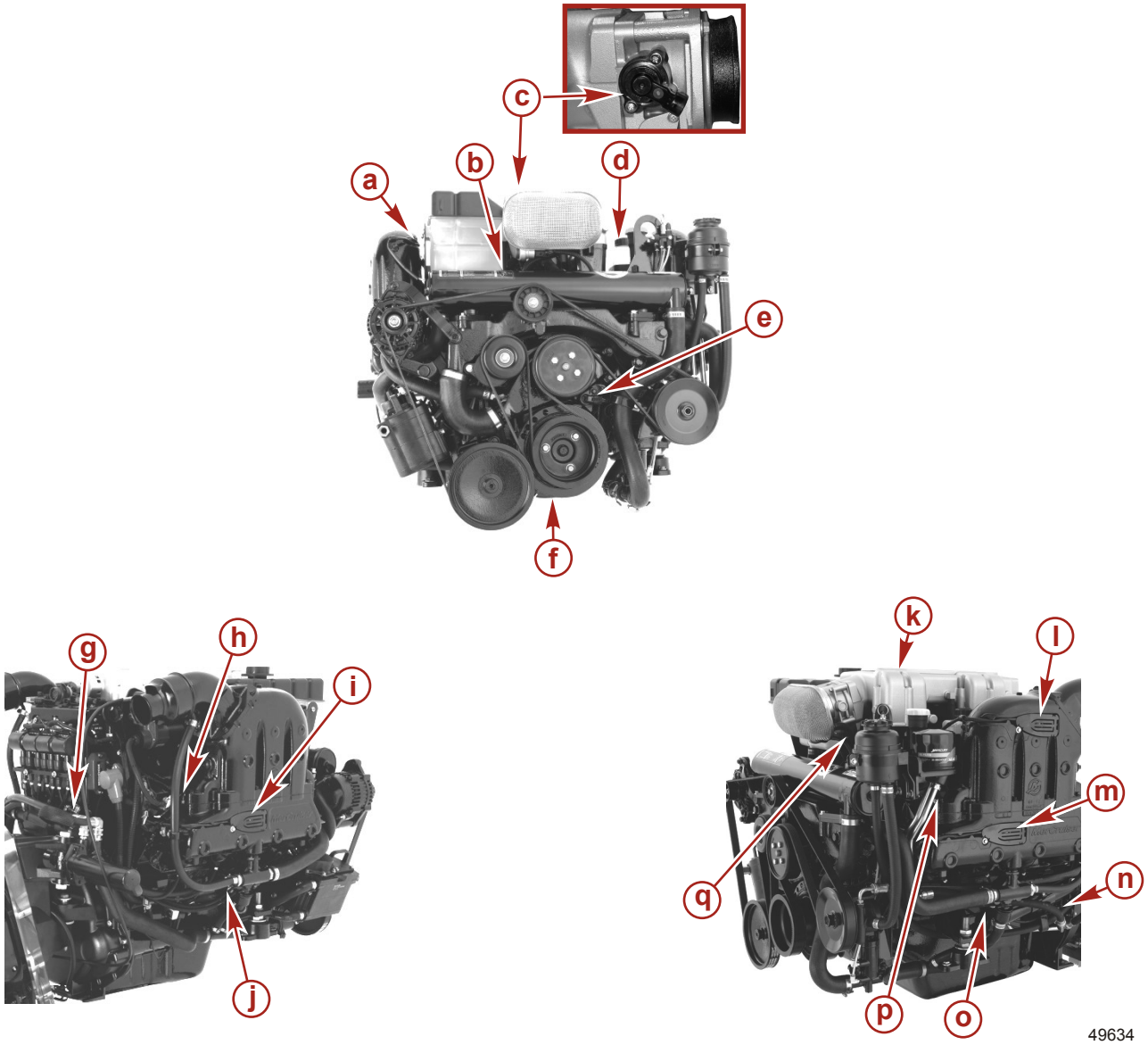
6. Slide the fuse connector in its mount on the electrical bracket.



a - Fuse connector
b - Fuse connector mount
c - Electrical bracket

Sensors

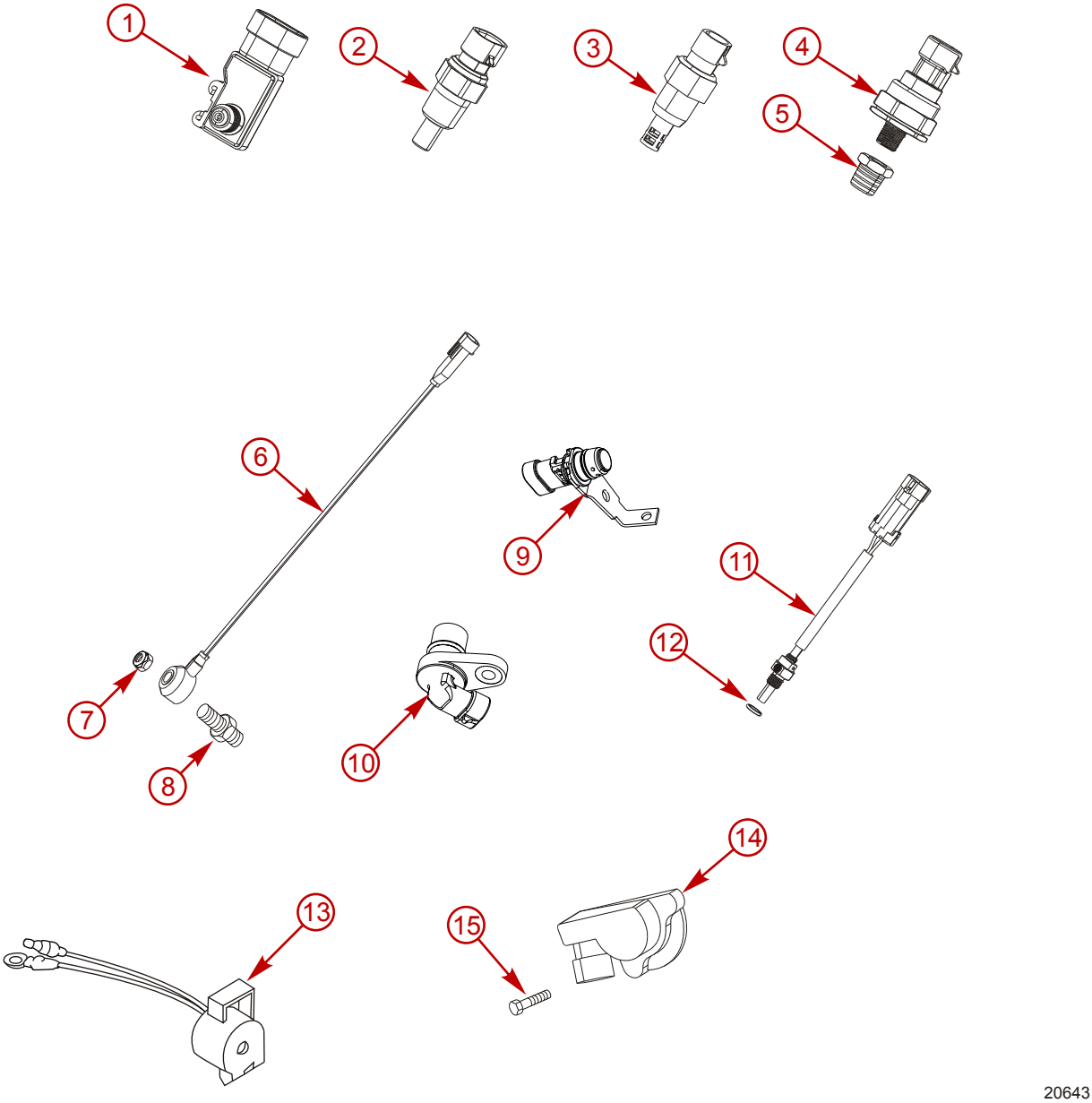
Sensor Locations



- **a -** Oxygen sensor (post starboard)
- **b -** Coolant temperature sensor
- **c -** Throttle position sensor (mechanical shift)
- **d -** Gear lube bottle sensor
- **e -** Camshaft sensor
- **f -** Crankshaft position sensor
- **g -** Sea pump pressure sensor
- **h -** Exhaust manifold coolant temperature (EMCT) sensor starboard
- **i -** Oxygen sensor (pre starboard)
- **j -** Knock sensor (starboard)
- **k -** Manifold air pressure sensor (MAP)
- **l -** Oxygen sensor (post port)
- **m -** Oxygen sensor (pre port)
- **n -** Oil pressure sensor
- **o -** Knock sensor (port)
- **p -** Exhaust manifold coolant temperature (EMCT) sensor port

q - Manifold air temperature sensor (MAT)

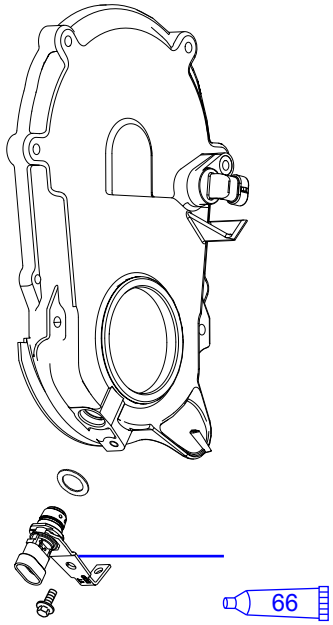
Electrical Senders and Sensors



REF.	QTY.	Description
1	1	SENSOR (MAP)
2	1	SENSOR (Coolant Temperature)
3	1	SENSOR (MAT)
4	1	SENSOR (Oil Pressure)
	1	SENSOR (Fuel Pressure)
	1	SENSOR (Water Pressure)
5	1	REDUCER **(Used With Oil Pressure Sensor)**
6	2	SENSOR ASSEMBLY (Knock)
7	2	NUT (M10)
8	2	STUD **(Knock Sensor Assembly Mounting)**
9	1	SENSOR ASSEMBLY (Crankshaft Position)
10	1	SENSOR ASSEMBLY (Camshaft)
11	1	SENSOR ASSEMBLY (coolant temperature) (EMCT)
12	1	O-RING
13	1	ALARM KIT (Audio Warning)
14	1	SENSOR (Throttle Position)
15	2	SCREW (#8-32 x 0.500)

Crankshaft Position Sensor

1. Install the sensor with spacer and tighten the mounting bolt to specification.

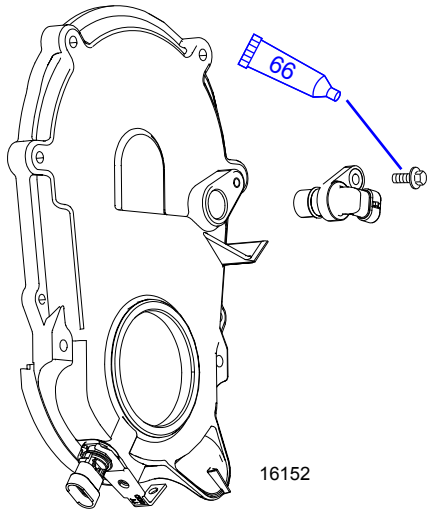


Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821

Description	Nm	lb. in.	lb. ft.
Crankshaft sensor mounting bolt	11	–	8

Camshaft Position Sensor

1. Install the camshaft sensor and tighten the mounting bolt to specification..



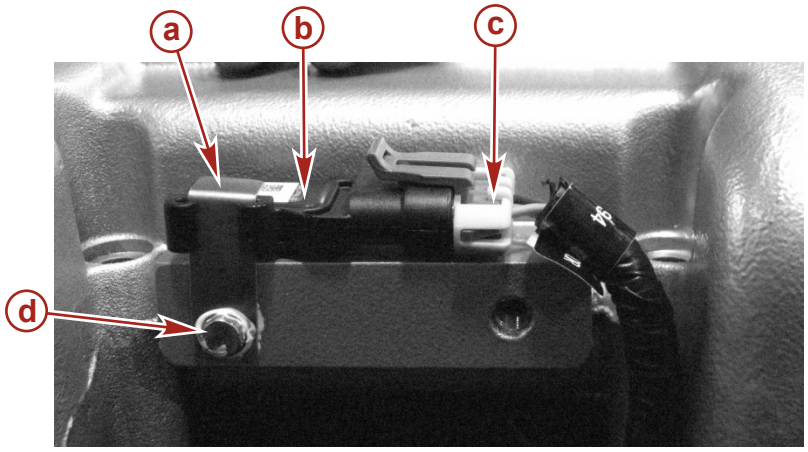
Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Threads of mounting bolt	92-809821

Description	Nm	lb. in.	lb. ft.
Mounting bolt	11	–	8

Manifold Absolute Pressure Sensor (MAP)

Removal

1. Remove the engine harness connection at the MAP connector.
2. Remove screw and bracket retaining the MAP sensor.

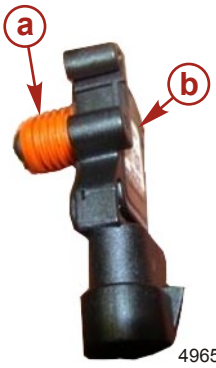


a - Bracket
b - MAP connector
c - Engine harness connection
d - Screw

3. Pull the sensor straight up from the plenum.

Installation

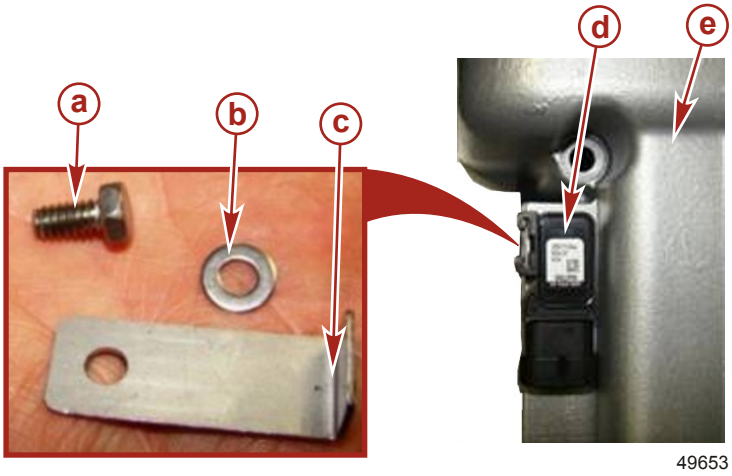
1. Lubricate the seal.



a - Seal
b - MAP sensor

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Seal on MAP sensor	92-858087K01

2. Install the MAP sensor and be careful not to damage the seal. (The sensor should lie flat on the mounting surface.)
3. Apply Loctite #242 to the threads of the retaining screw, install the retaining bracket and tighten the screw to Specification.

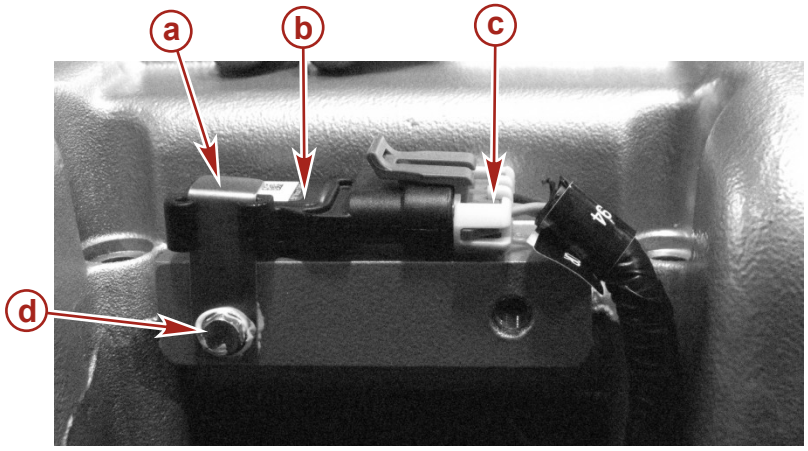


a - Screw
b - Washer
c - Bracket
d - MAP sensor
e - Plenum

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	MAP sensor retaining screw	92-809821

Description	Nm	lb. in.	lb. ft.
MAP sensor retaining screw	6	50	–

4. Connect the electrical harness to the MAP sensor.



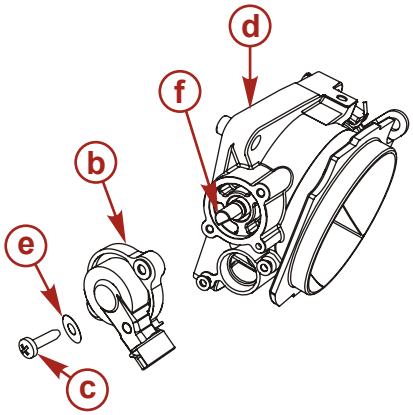
49651

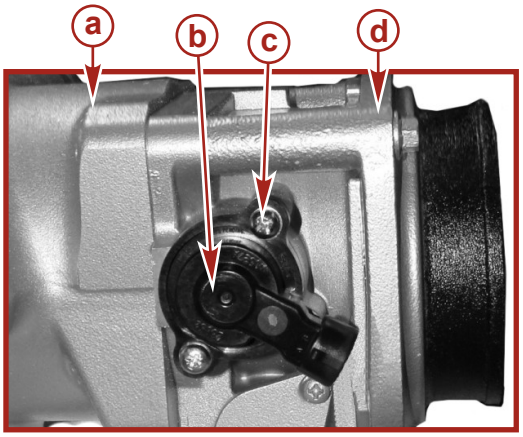
a - Bracket
b - MAP connector
c - Engine harness connection
d - Screw

Throttle Position Sensor (TPS)

Removal

1. Disconnect the electrical connector from the TPS sensor.
2. Remove the two retaining screws and the TPS sensor from the throttle body.





49791

a - Plenum
b - TPS sensor
c - Screw
d - Throttle body
e - Throttle shaft

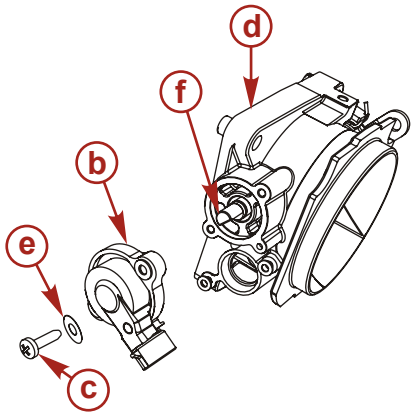
Installation

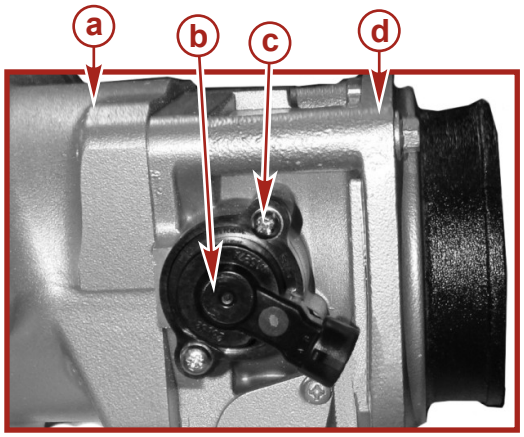
1. Apply adhesive to the screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Screw threads	92-809821

2. Install the TPS sensor on the throttle shaft and secure it to the throttle body with screws with washers.

3. Tighten the screws to specification.





49791

a - Plenum
b - TPS
c - Screw
d - Throttle body
e - Throttle shaft

Description	Nm	lb-in.	lb-ft
TPS sensor screw	2.7	24	–

Manifold Intake Air Temperature Sensor (MAT)

Removal

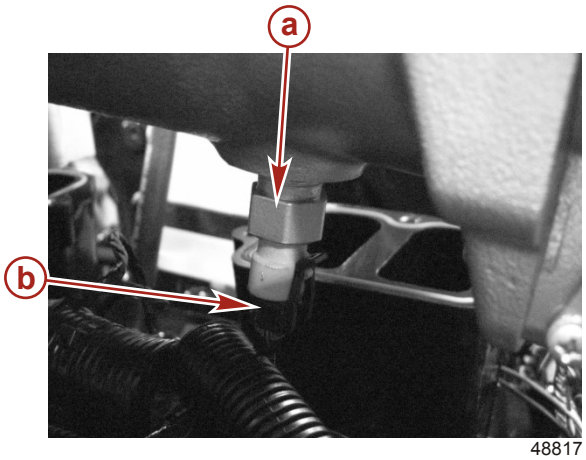
1. Remove the plenum. Refer to **Intake Plenum**.
2. Remove the sensor from the plenum.

Installation

1. If pre-applied sealant is not visible on the threads, apply pipe sealant to the threads of the sensor.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Sensor threads	92-809822

2. Install the sensor in the plenum. Tighten two and a half turns maximum.
3. Install the plenum. Refer to **Intake Plenum** and follow installation instructions.
4. Install the engine harness connection to the Air Temp sensor.

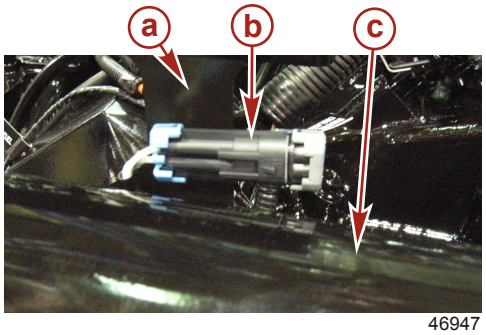


48817

a - Air Temp sensor
b - Engine harness connection

Coolant Temperature Sensor Replacement

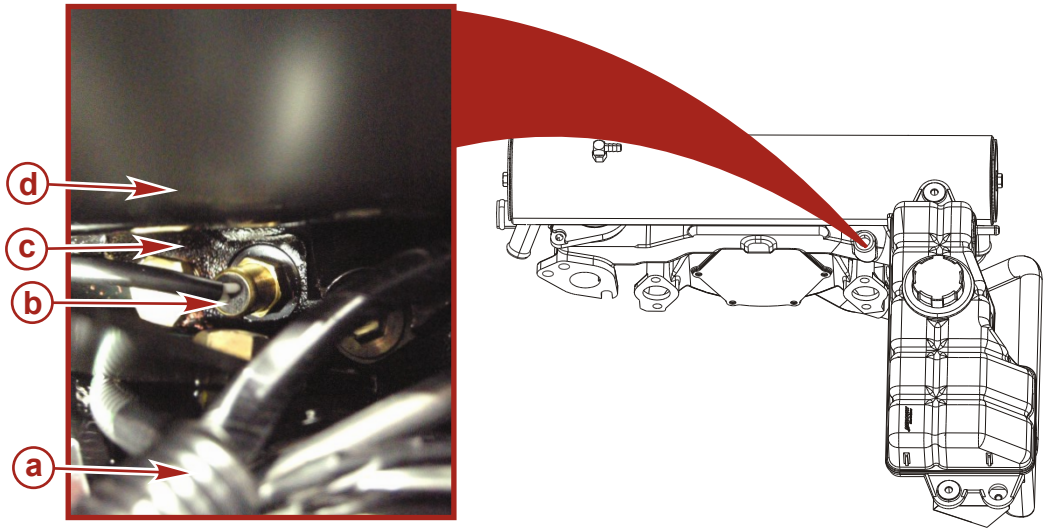
1. Disconnect the coolant temperature sensor from the engine harness.



46947

a - Reservoir bracket
b - Coolant temperature sensor
c - Heat exchanger

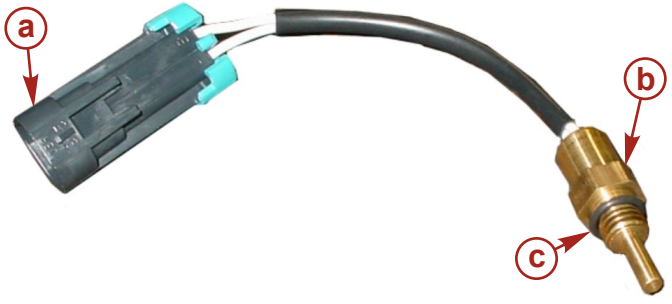
2. Remove the sensor.



49794

a - Engine harness
b - Sensor mounting location
c - Crossover
d - Heat exchanger

3. Verify that the O-ring is on the sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

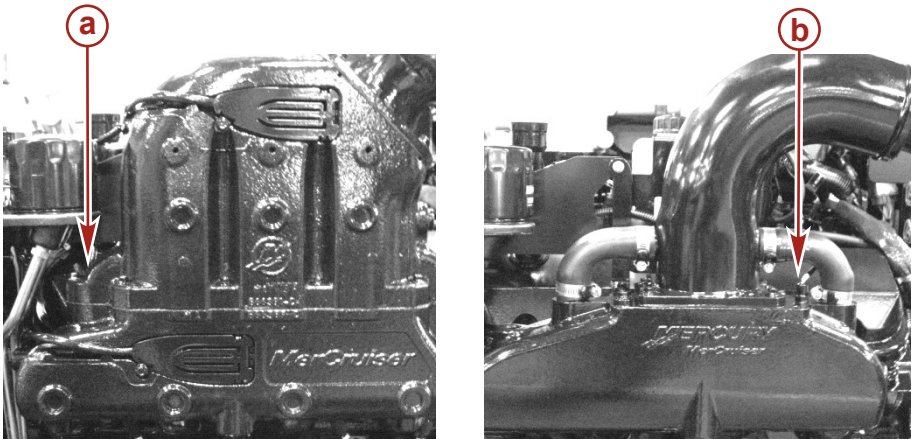
4. Install the sensor finger tight. Tighten the sensor to specification.

Description	Nm	lb-in.	lb-ft
Coolant temperature sensor	5	47	–

Exhaust Manifold Coolant Temperature (EMCT)

1. Remove the EMCT sensor connector from the engine harness.

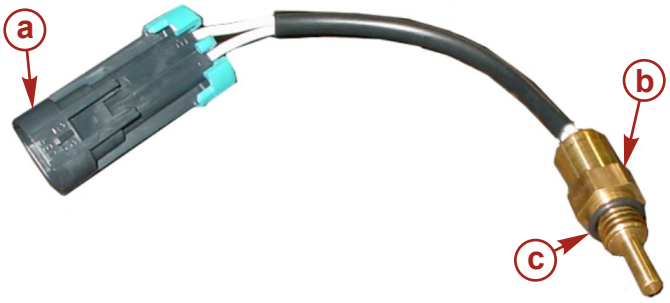
2. Remove the EMCT sensor from the manifold.



48675

a - EMCT sensor location on emission controlled engine
b - EMCT sensor location on non-emission controlled engine

3. Verify that the O-ring is on the EMCT sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

4. Hand-start the EMCT sensor in the manifold.
5. Tighten the sensor to specification.

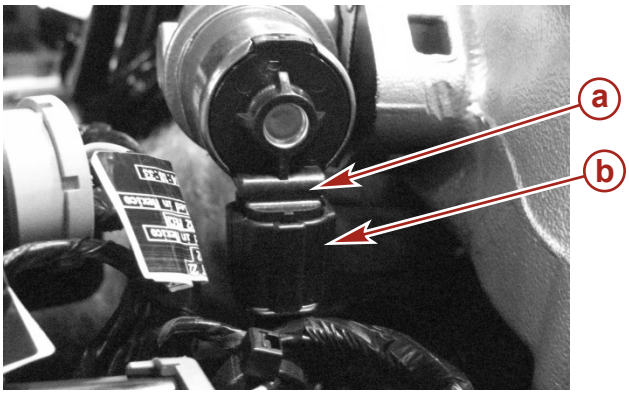
Description	Nm	lb-in.	lb-ft
EMCT sensor	8	–	6

6. Connect the EMCT sensor to the engine harness.

Idle Air Control (IAC) Valve

Removal

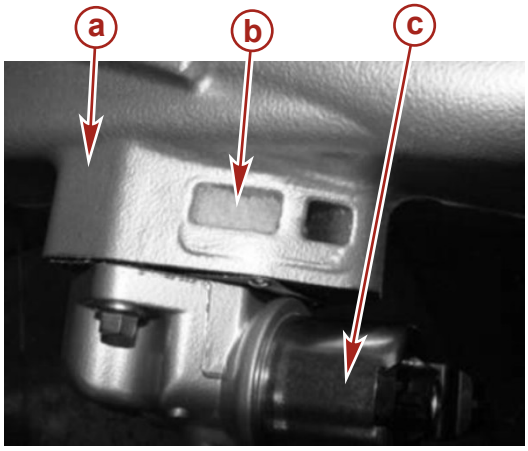
1. Disconnect the engine harness connection from the Idle air control (IAC) valve.



48815

a - IAC connector
b - Engine harness connection

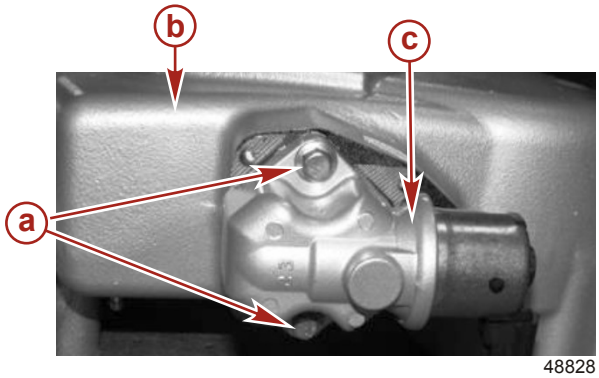
2. Remove the muffler.



48829

a - Plenum
b - Muffler
c - IAC valve

3. Remove the retaining screws and the IAC valve from the plenum.

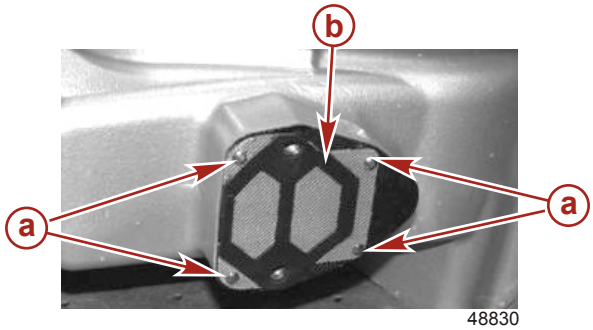


48828

a - Screw
b - Plenum
c - IAC valve

Installation

1. Clean the gasket surface.
2. Install a new gasket and four new rivets.



48830

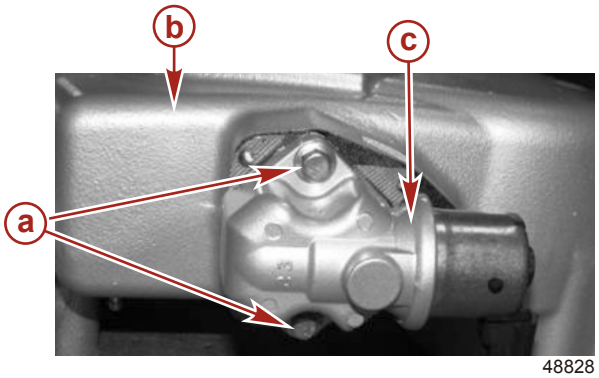
a - Rivets
b - Gasket

3. If not applicable, apply sealant to the screw threads.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	IAC screw	92-809821

6

4. Install the IAC valve onto the gasket and secure it with two screws.

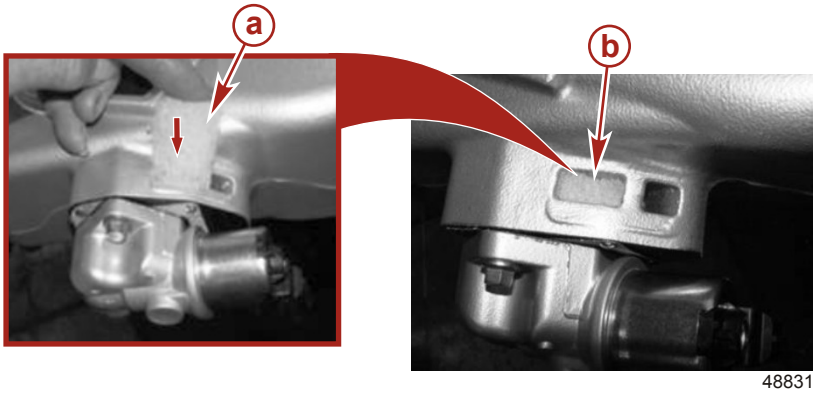


48828

a - Screw
b - Plenum
c - IAC valve

Description	Nm	lb. in.	lb. ft.
IAC mounting screw	11	100	–

5. Install a clean muffler.



48831

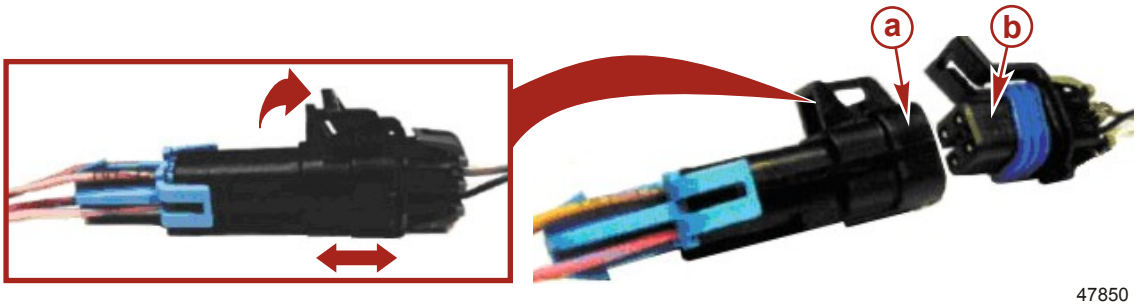
a - Muffler
b - Muffler installed

Oxygen Sensor

Inspecting the Oxygen Sensor Connectors

IMPORTANT: If light to moderate corrosion is present on any engine harness connector or sensor, and cannot be removed with the cleaning process. Replace the sensor or wiring harness as needed.

1. Disconnect two post and two pre-exhaust oxygen sensors from the engine wiring harness, being careful not to damage the locking tabs.



47850

Pre-exhaust and post-exhaust oxygen sensor

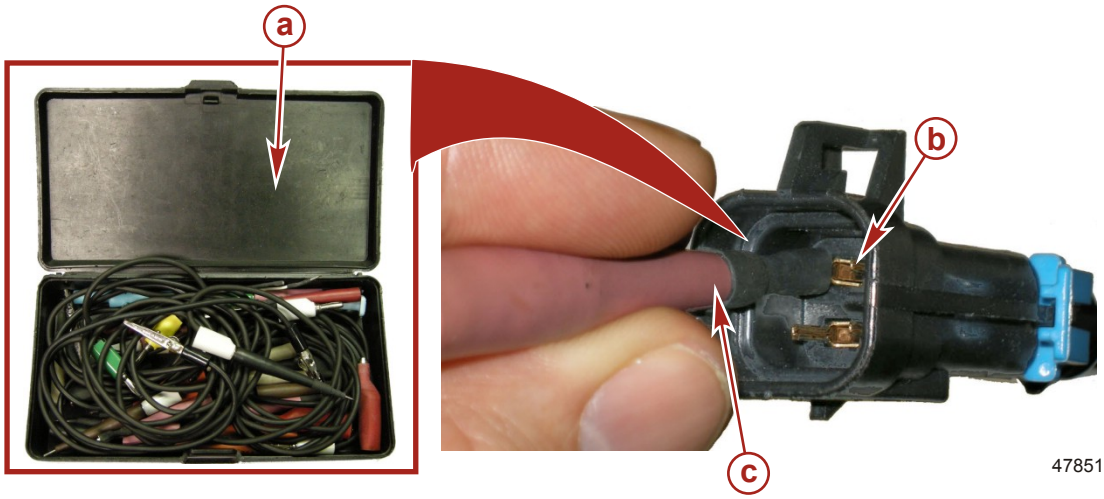
a - Engine harness connector (male)
b - Oxygen sensor connector (female)

2. Inspect each sensor and engine harness connector for evidence of condensation (moisture), corrosion, or damaged terminals and sockets. See image below.
3. If condensation is present, carefully use low-pressure compressed air to dry out both the male and female connectors.
4. Clean the pins and sockets using rubbing alcohol and a standard Q-tip (obtained locally) and then air dry.
5. Carefully inspect each pin and socket for corrosion or damage.

6. If damage is present, replace the sensor or harness as necessary.
7. If corrosion is present on any sensor pin, replace that oxygen sensor.
8. If light to moderate corrosion is present on any oxygen sensor connector, it can be removed as follows:
   a. Locate the pink female terminal adapter (J-35616-5) from the CDS Terminal Adapter kit (SPX P/N MM-46523)

Terminal Test Probe Kit	SPX P/N MM- 46523

   b. Using rubbing alcohol, slide the adapter on and off of each male pin until the corrosion has been removed. See image below.
   c. When finished cleaning all four pins, dry the connector with low pressure compressed air.



a - CDS Terminal Adapter kit
b - Pink female terminal adapter
c - Male pin (4)

9. Reconnect each oxygen sensor to the engine harness as you complete the inspection/cleaning process.
10. If the corrosion was not removed during the cleaning process, replace the sensor or wiring harness as needed.
11. Use the CDS-G3 service tool to clear any faults.

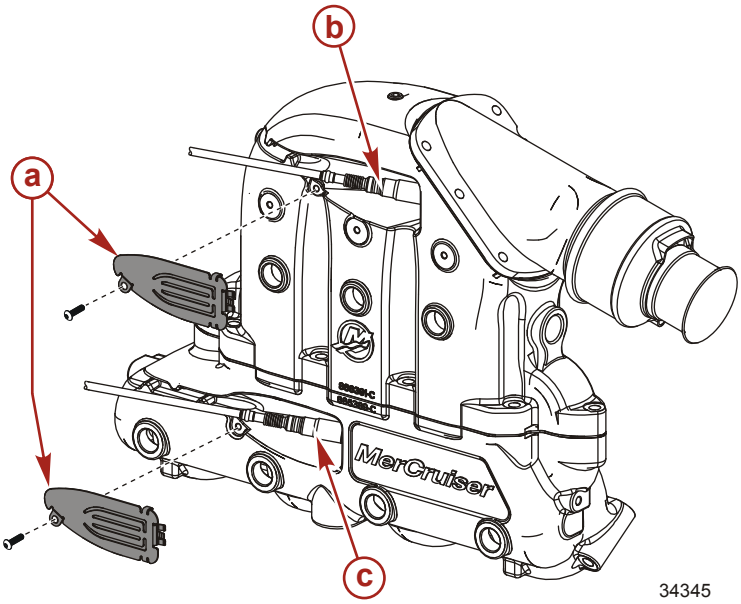
Replacing the Oxygen Sensor

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the oxygen sensor from the engine harness.

2. Loosen the screw securing the oxygen sensor cover to the collector and remove the cover.



a - Oxygen sensor cover
b - Post-catalyst oxygen sensor
c - Pre-catalyst oxygen sensor

3. Remove the oxygen sensors, as needed.

Kent-Moore Oxygen Sensor Socket	KN-46577

4. Use the oxygen sensor tool to install the oxygen sensor. Tighten the sensor to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	37

5. Install the oxygen sensor cover so it is flush against the collector. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor cover screw	3.5	31	–

6. Connect the oxygen sensor connector to the engine harness.

Fuel System

Section 5A - Fuel Delivery System

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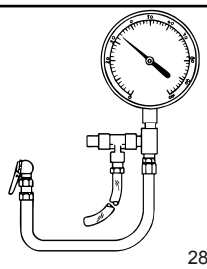
5A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting adapter Fuel line inlet fitting to adapter.	92-809822
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector o-ring Fuel injector O-rings Fuel line O-ring	92-858087K01

Special Tools

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Specifications

Description	Specifications
Fuel pump pressure	296 kPa (43 psi)

Torque Specifications

Description	Nm	lb. in.	lb. ft.
Cool fuel module top cover screw	14	124	–
Cool fuel module pressure regulator screw	14	124	–
Cool fuel module brackets to module screw	23	–	17
Cool fuel module support bracket to engine block screw	66	–	49
Hose clamp	3	26	–
Fuel line retainer screw	9	80	–
Throttle body screw to plenum	14	120	–
ECT throttle body screw to plenum	11	96	–
J-clip nut on flywheel housing	48	–	36
Fuel rail mounting bolts	12	105	–
Plenum to intake screw	24	–	18
Flame arrestor clamp	6	55	–
Shift bracket assembly to plenum	18	–	14
Rear lift brace screw to plenum	18	–	14
Sheild on engine mount nut	37	–	27
Fuel inlet fitting adapter	22	–	16

Replacement Parts Warning

⚠ WARNING

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

Service Precautions

IMPORTANT: The following information must be adhered to when working with the fuel system:

- Always keep a dry chemical fire extinguisher at the work area.
- Do not replace fuel pipe with fuel hose.
- Observe all Warnings and Cautions.

⚠ WARNING

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

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

NOTICE

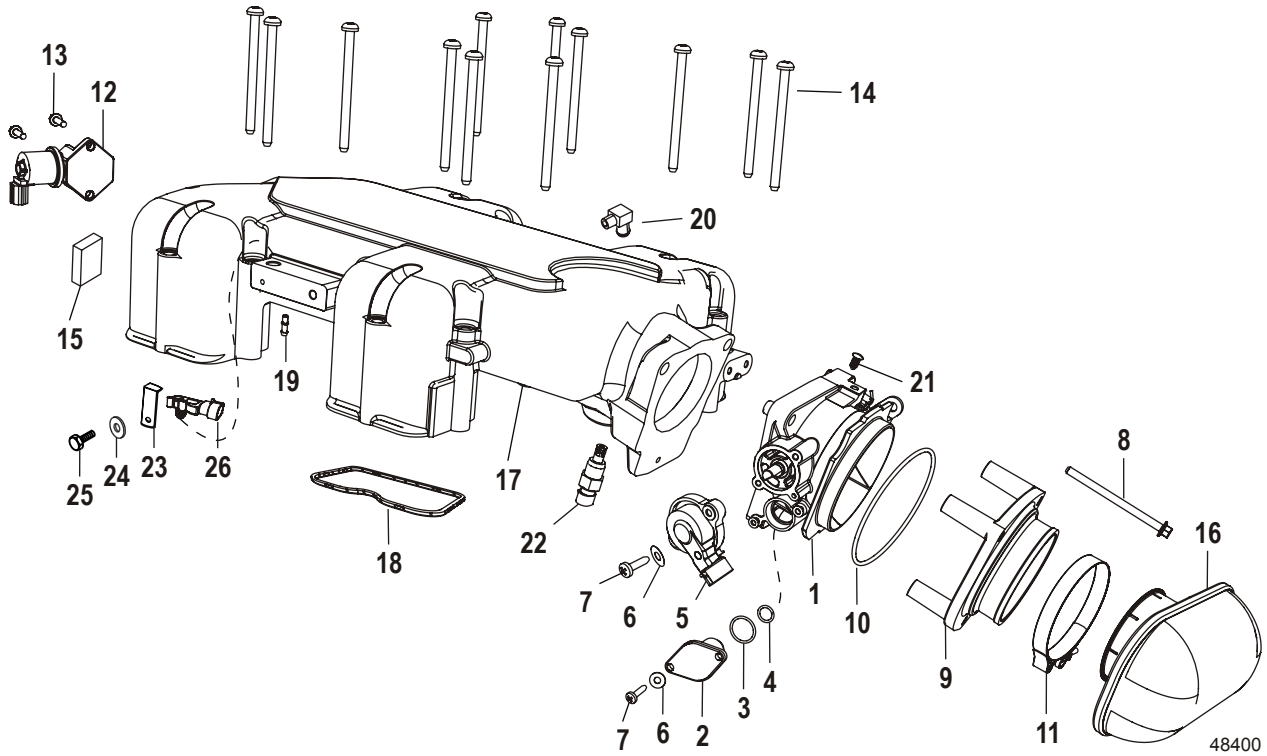
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Recommendations

IMPORTANT: Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing a fuel delivery system.

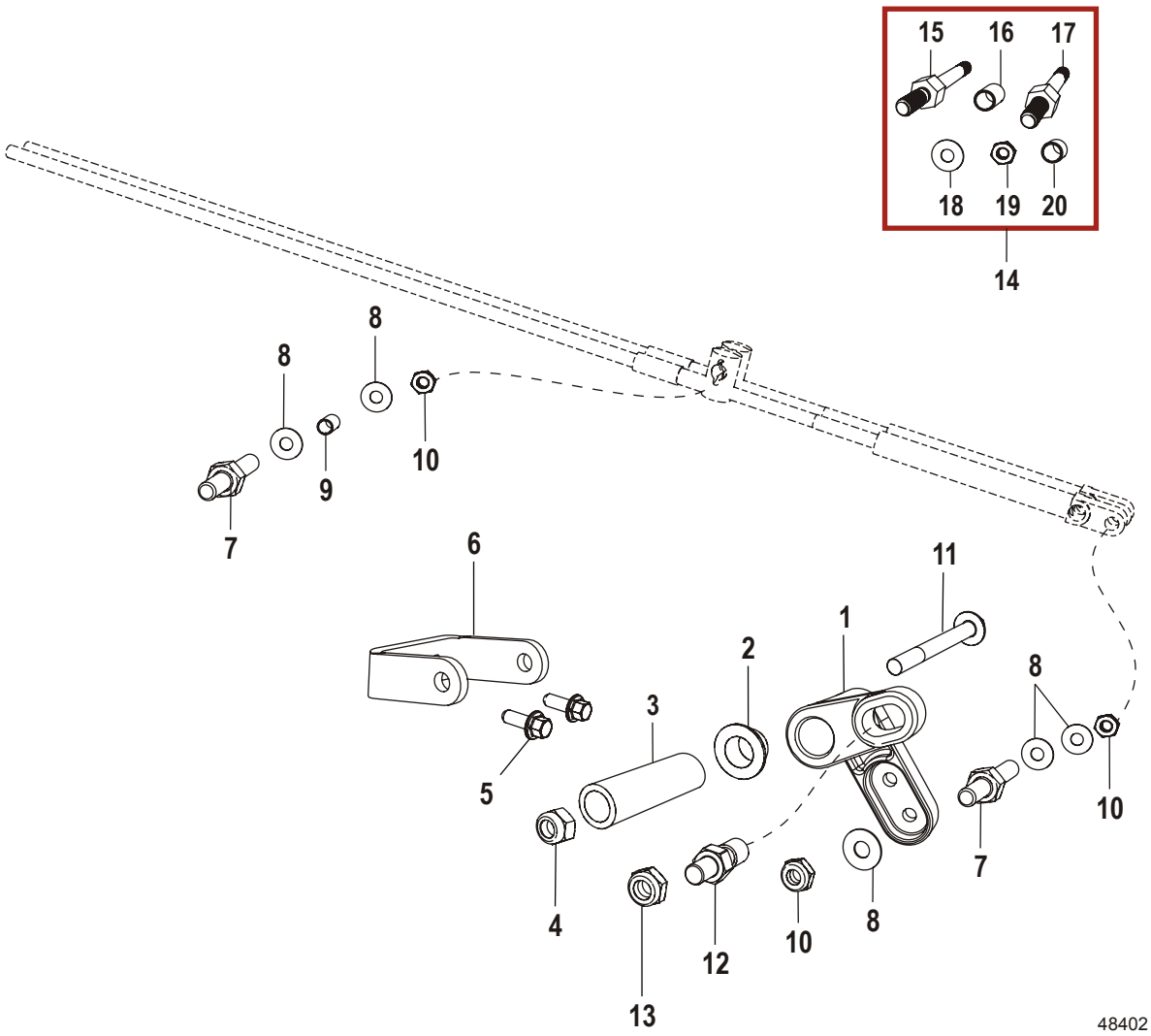
Intake Plenum and Throttle Body

Intake Plenum and Throttle Body—Mechanical Throttle and Shift



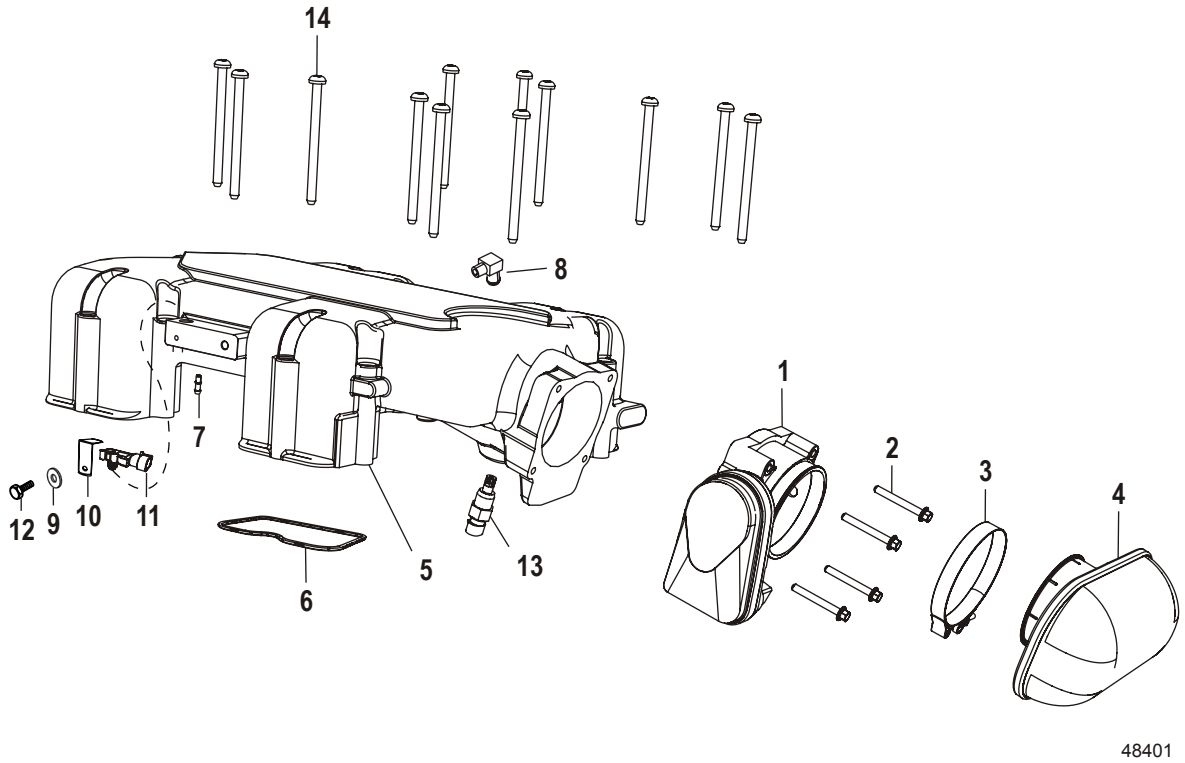
1 - Throttle body assembly with seal
2 - Plug
3 - O-ring
4 - O-ring
5 - Throttle position sensor (TPS)
6 - Washer
7 - Screw (3)
8 - Screw (stainless steel)
9 - Adaptor (HO or Base separate)
10 - O-ring
11 - Clamp
12 - Idle air control valve (IAC)
13 - Screw (stainless steel)
14 - Screw (12)
15 - Filter
16 - Flame arrestor
17 - Plenum assembly
18 - Seal (4) (intake manifold)
19 - Barb fitting
20 - 90º fitting
21 - Screw
22 - Intake air temperature sensor
23 - MAP sensor mount
24 - Washer (stainless steel)
25 - Screw
26 - Manifold air pressure sensor (MAP)

Throttle Lever Assembly—Mechanical Throttle and Shift



1 - Throttle lever assembly
2 - Bushing
3 - Bushing
4 - Nut
5 - Screw (2)
6 - Bracket
7 - Throttle cable stud
8 - Washer
9 - Spacer
10 - Nut
11 - Screw
12 - Throttle roller assembly
13 - Nut
14 - Dual station kit
15 - Stud
16 - Spacer
17 - Stud
18 - Washer
19 - Nut
20 - Spacer

Intake Plenum and Throttle Body—Digital Throttle and Shift



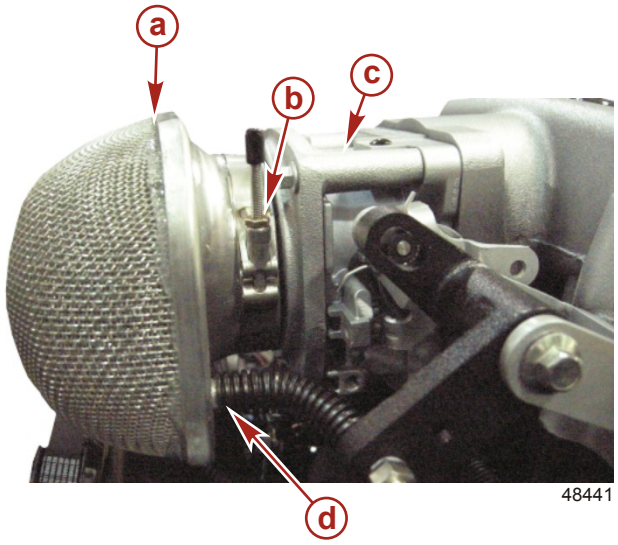
1 - Throttle body assembly with seal
2 - Screw (4)
3 - Clamp
4 - Flame arrestor
5 - Plenum assembly
6 - Seal (4) (intake manifold)
7 - Barb fitting
8 - 90º fitting
9 - Washer (stainless steel)
10 - MAP sensor mount
11 - Manifold air pressure sensor (MAP)
12 - Screw
13 - Intake air temperature sensor
14 - Screw (12) (stainless steel)

Flame Arrestor

Removal

1. Remove the vent hose.
2. Loosen the clamp nut.

3. Pull the flame arrestor from the throttle body.



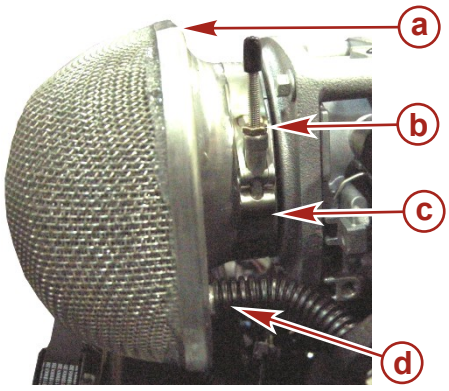
a - Fame arrestor
b - Clamp nut
c - Throttle body
d - Vent hose

Inspection

1. Inspect the flame arrestor for cuts or dents.
2. Clean the flame arrestor with soapy water and air dry with compressed air.
3. Inspect the clamp for damage that could affect the clamp load.

Installation

1. Position the clamp on the base of the flame arrestor so the nut is facing upward on the bib fitting side of the flame arrestor.
2. Push the flame arrestor onto the throtte body.
3. Hold the flame arrestor in position on the throttle body with the clamp completely around the flame arrestor and throttle body. Position the clamp nut as shown.
   IMPORTANT: The clamp position is important to obtain a uniform clamp load around the throttle body. If the clamp load is overtightened the throttle plate will not move easily.
4. Tighten the clamp to specification. Do not overtighten the clamp.



a - Fame arrestor
b - Clamp nut
c - Clamp
d - Vent hose

Description	Nm	lb-in.	lb-ft
Flame arrestor clamp	6	55	–

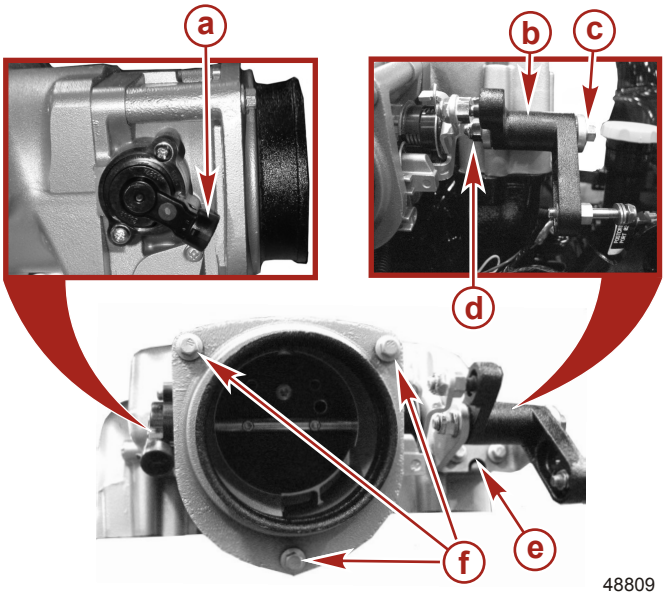
5. Install the vent hose to the bib fitting.

Throttle Body

Removal

1. Remove the flame arrestor, refer to **Flame Arrestor**.
2. On mechanical throttle and shift models:
   a. Remove the engine harness connection from the TPS connector.

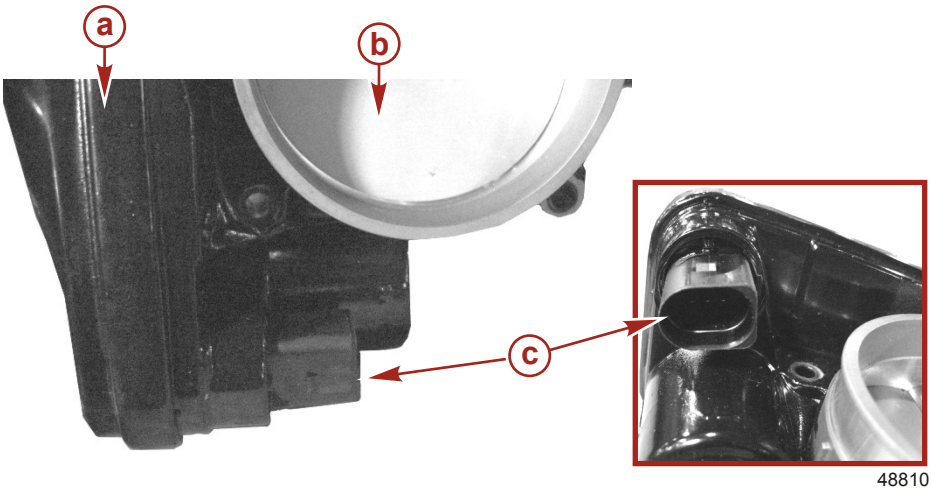
b. Remove the throttle cable from the throttle lever assembly.
c. Remove the nut and bolt securing the throttle lever assembly to the bracket.
d. Remove the throttle lever assembly from the bracket.



48809

a - TPS
b - Throttle lever assembly
c - Bolt
d - Nut
e - Bracket
f - Screws

3. On digital throttle and shift models (ETC), remove the engine harness connection from the ETC connector.



48810

a - ETC
b - Throttle body
c - ETC connector

4. Remove the throttle body retaining screws and remove the throttle body assembly. Some assemblies are equipped with an adapter. Refer to **Intake Plenum and Throttle Body**.
IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

Cleaning and Inspection

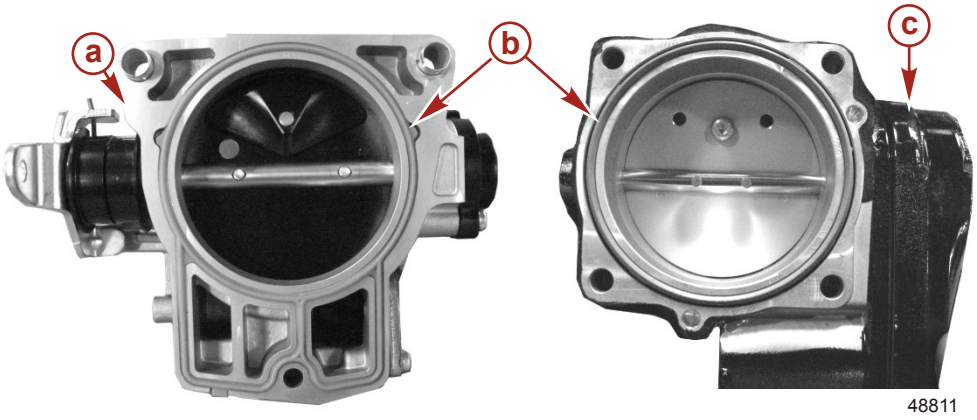
IMPORTANT: Do not use cleaners containing methyl ethyl ketone. They are not necessary for cleaning throttle bore and valve deposits.
IMPORTANT: Do not allow the throttle position sensor (TPS) to come into contact with solvent or cleaner.
IMPORTANT: Do not allow the electronic throttle control (ETC) to come into contact with solvent or cleaner.
IMPORTANT: Use care when removing gasket material from the intake manifold and throttle body.

1. Remove the sealing O-ring from the throttle body.
2. Inspect the sealing O-ring for cuts, or other imperfections that could affect seal.
3. Thoroughly clean the throttle body. Ensure that all passages are free of dirt and burrs.
4. Inspect mating surfaces for damage that could affect sealing.
5. Inspect the throttle body for cracks in the casting.
6. Inspect the throttle bore for marks that were made by the throttle plate rubbing against it. Replace the throttle body if such marks exist.

7. Inspect the throttle plates, linkage, return springs, etc., for damage, wear and foreign material.

Installation

1. Position the seal in the grove of the throttle body.



48811

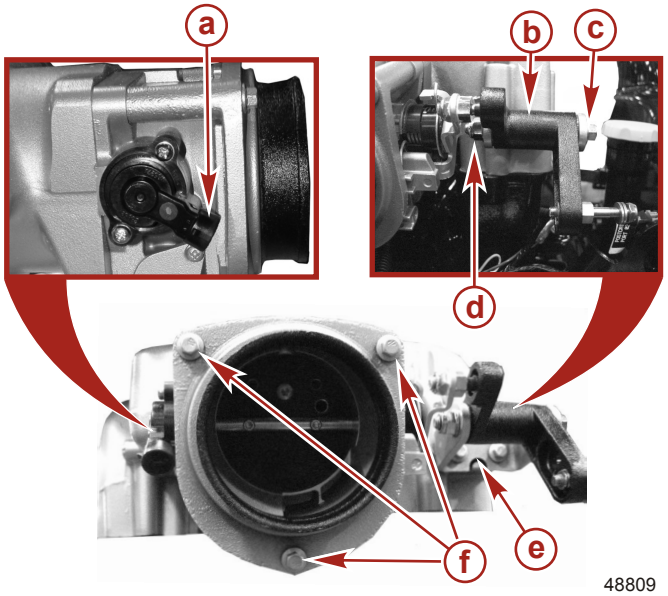
a - Mechanical throttle body
b - Seal
c - Electronic throttle body

2. If removed, place the adapter on the throttle body.
3. Install the throttle body assembly to the intake plenum and secure with screws. Refer to **Intake Plenum and Throttle Body**.

   NOTE: *The mechanical throttle body use three retaining screws, the electronic throttle body use four retaining screws, and the plemuns are specific to each.*
4. Tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Throttle body screw to plenum	14	120	–
Electronic throttle control (ETC) to plenum	11	96	–

5. On mechanical throttle and shift models:
   a. Connect the engine harness connector to the TPS.
   b. Install the throttle lever assembly to the bracket.
   c. Install the bolt through the throttle lever assembly and the bracket.
   d. Install the nut and tighten to specification.



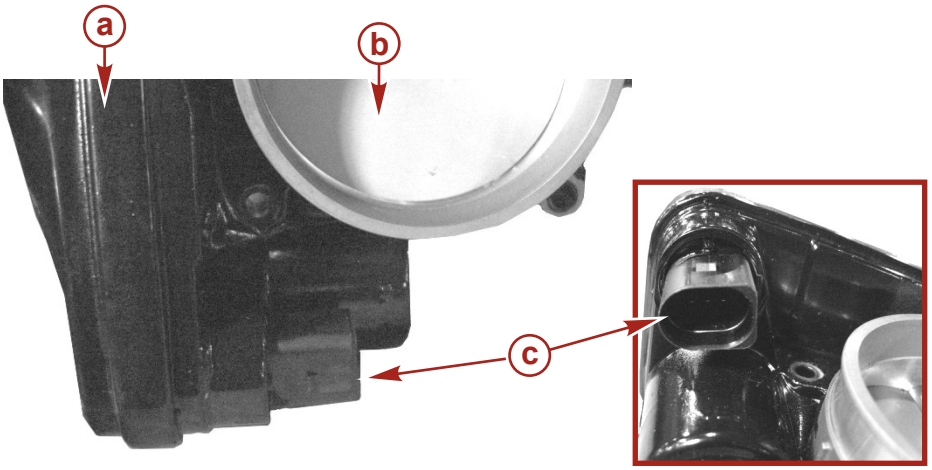
48809

a - TPS connector
b - Throttle lever assembly
c - Bolt
d - Nut
e - Bracket
f - Screws

Description	Nm	lb-in.	lb-ft
Throttle lever nut	24	–	18

   e. Connect the throttle linkage to the throttle body stud and install the throttle cable.

6. On digital throttle and shift models (ETC), conncect the engine harness to the ETC.



48810

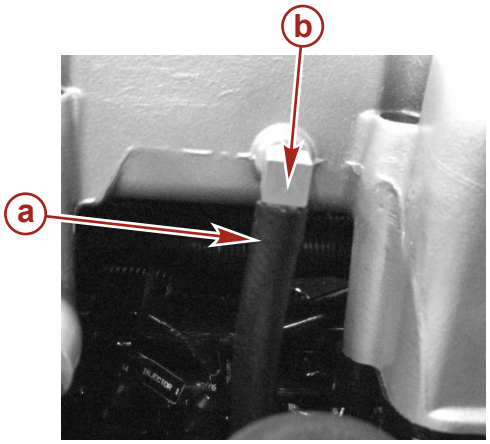
a - ETC
b - Throttle body
c - ETC connector

7. Install the flame arrestor, refer to **Flame Arrestor**.

Intake Plenum

Removal

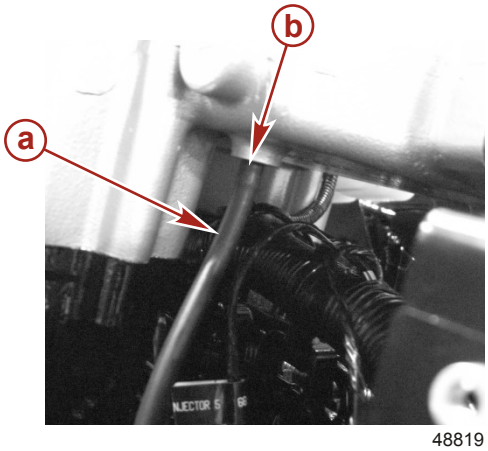
1. Remove the flame arrestor, refer to **Flame Arrestor**.
2. Remove the vacuum hose from the 90°fitting.



48818

a - Vacuum hose
b - 90° fitting

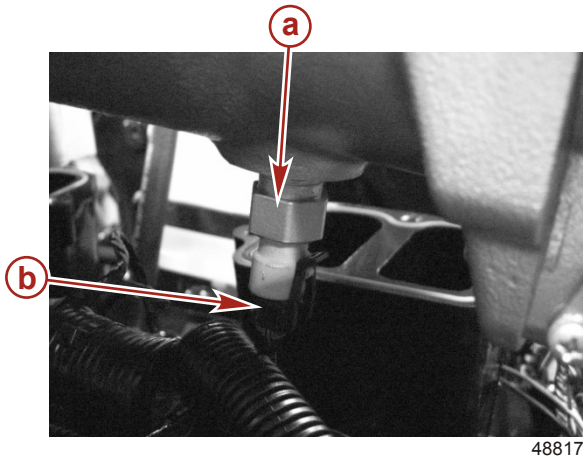
3. Remove the fuel vent hose from the barbed fitting.



48819

a - Fuel vent hose
b - Barbed fitting

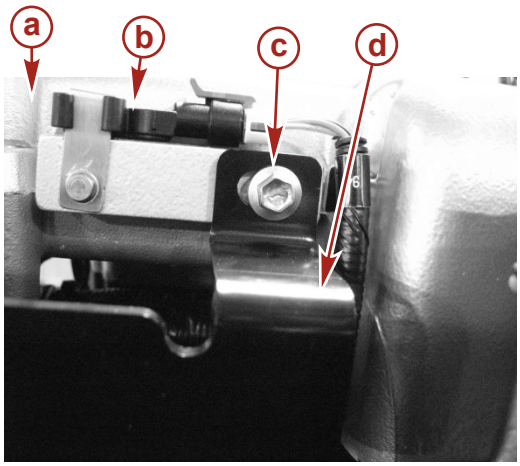
4. Remove the engine harness connections at Air Temp sensor.



48817

a - Air Temp sensor
b - Engine harness connection

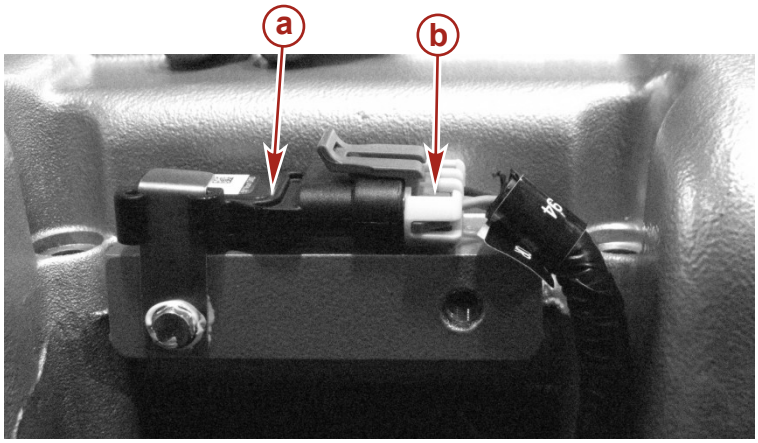
5. Remove and retain the screw securing the bracket on the plenum.



48813

a - Plenum
b - MAP
c - Screw
d - Bracket

6. Remove the engine harness connection at the MAP connector.

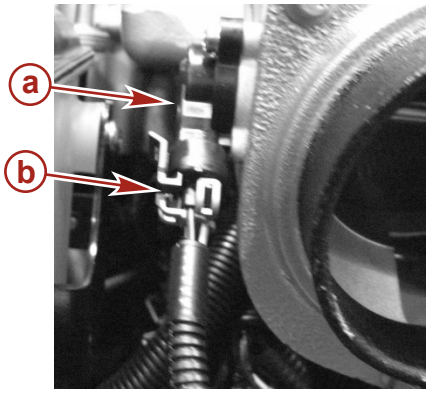


48816

a - MAP connector
b - Engine harness connection

7. Mechanical throttle and shift models:

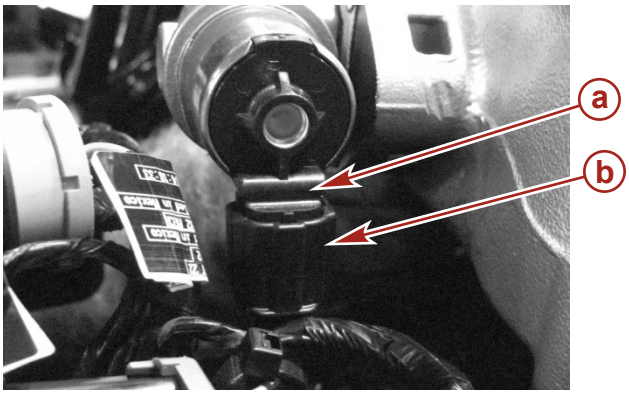
a. Remove the engine harness connection at the TPS connector.



48814

a - TPS connector
b - Engine harness connection

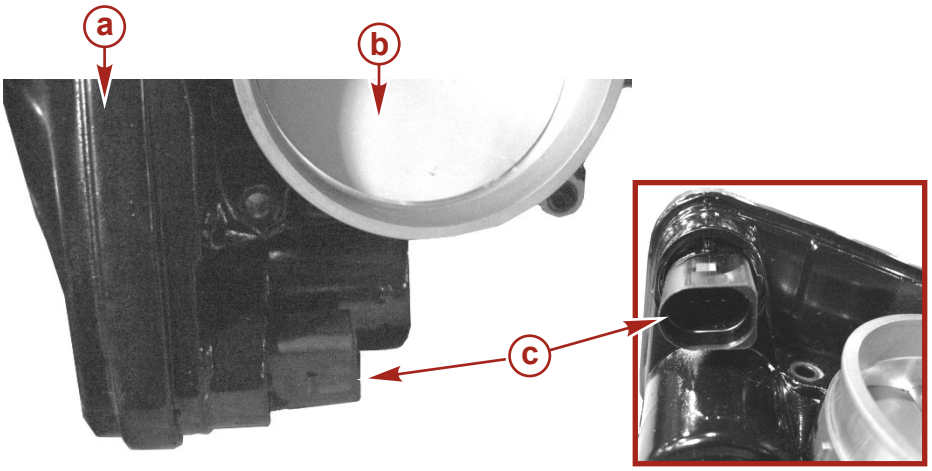
b. Remove the engine harness connection at the IAC connector.



48815

a - IAC connector
b - Engine harness connection

8. Digital throttle and shift models, remove the engine harness connection at the ETC connector.

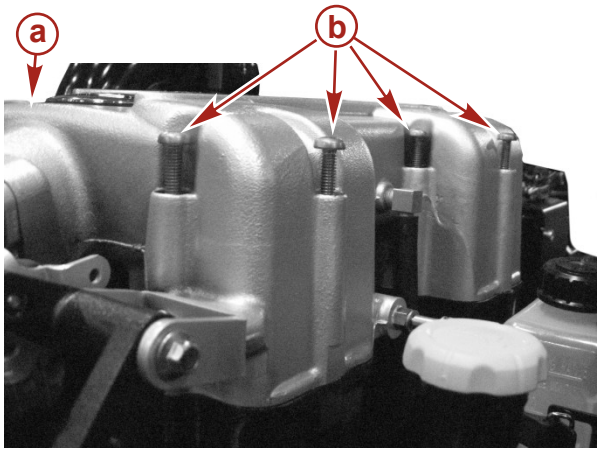


48810

a - ETC
b - Throttle body
c - ETC connector

9. If applicable, remove the throttle body, refer to **Throttle Body**.

10. Remove and retain the plenum screws and lift the plenum straight up.



48820

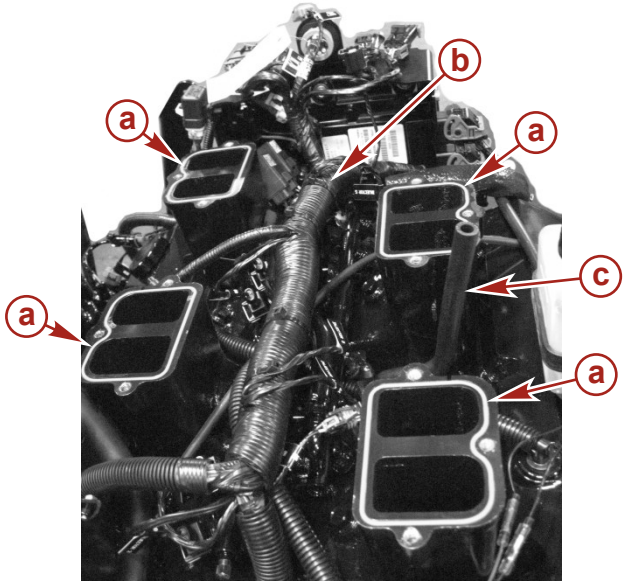
a - Plenum
b - Screw (12)

Cleaning and Inspection

1. Inspect the plenum for cracks in the casting.
2. Inspect the seals on the intake manifold for cuts or flat spots.
3. Inspect the mating surfaces for gashes, cuts, or other imperfections that could affect the seal.
4. Wash the casting with soapy water.

Installation

1. If removed, install the throttle body. Refer to **Throttle Body**.
2. Place a seal in the grove on each intake port on the intake manifold.
3. Ensure that the engine harness and components are positioned out of the way and the connections are easily accessible.

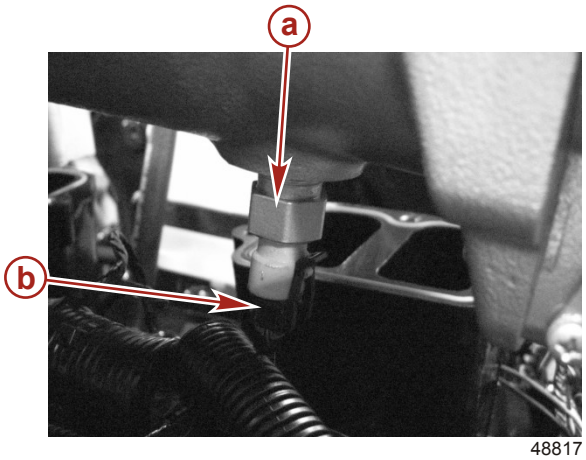


48821

a - Seal
b - Engine harness
c - Vacuum hose

4. Place the plenum on the seals on top the intake manifold.

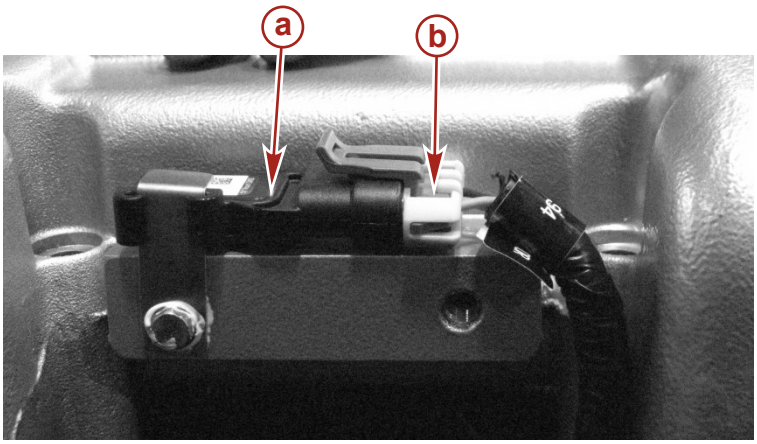
5. Install the engine harness connection to the Air Temp sensor.



48817

a - Air Temp sensor
b - Engine harness connection

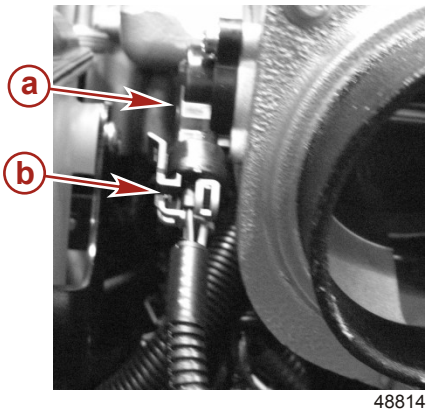
6. Install the engine harness connection to the MAP connector.



48816

a - MAP connector
b - Engine harness connection

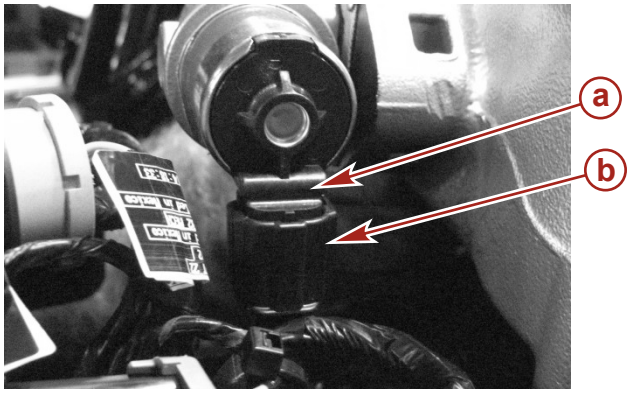
7. Mechanical throttle and shift models:
   a. Install the engine harness connection to the TPS connector.



48814

a - TPS connector
b - Engine harness connection

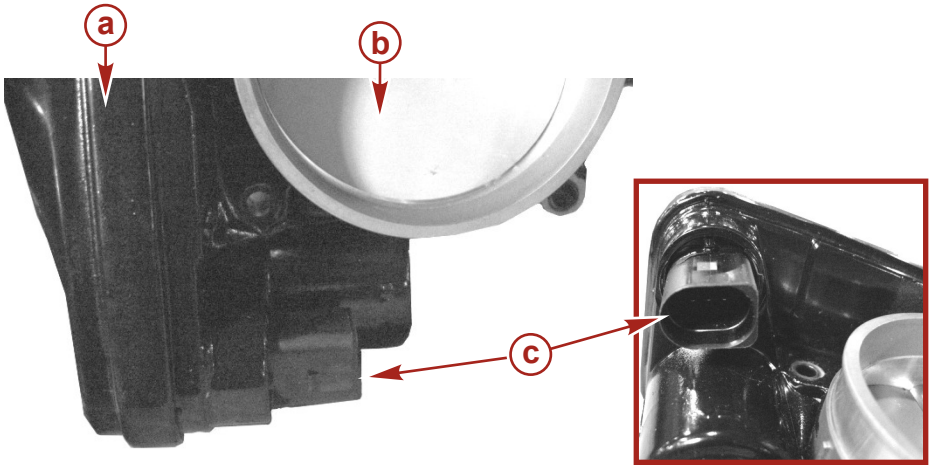
b. Install the engine harness connection to the IAC connector.



48815

a - IAC connector
b - Engine harness connection

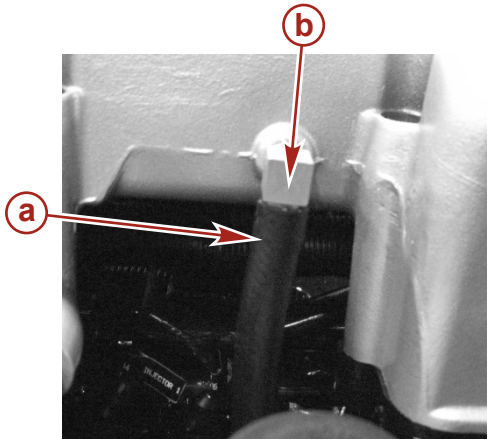
8. Digital throttle and shift models, install the engine harness connection to the ETC connector.



48810

a - ETC
b - Throttle body
c - ETC connector

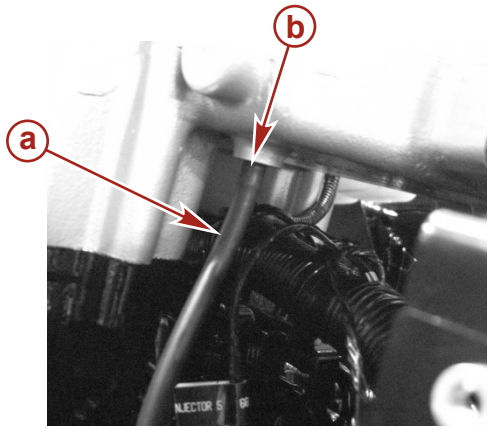
9. Push the vacuum hose onto the 90°fitting.



48818

a - Vacuum hose
b - 90° fitting

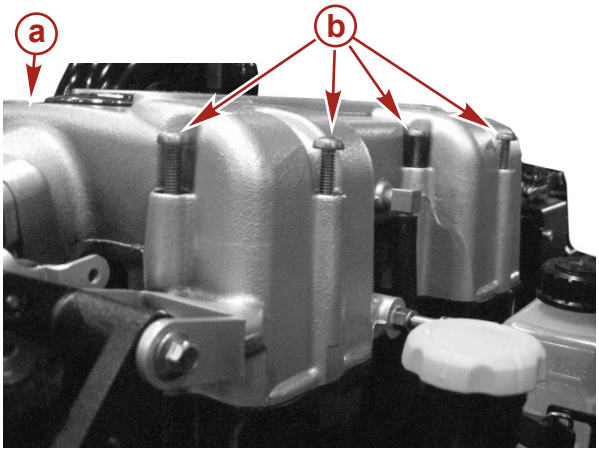
10. Push the fuel vent hose onto the barbed fitting.



48819

a - Fuel vent hose
b - Barbed fitting

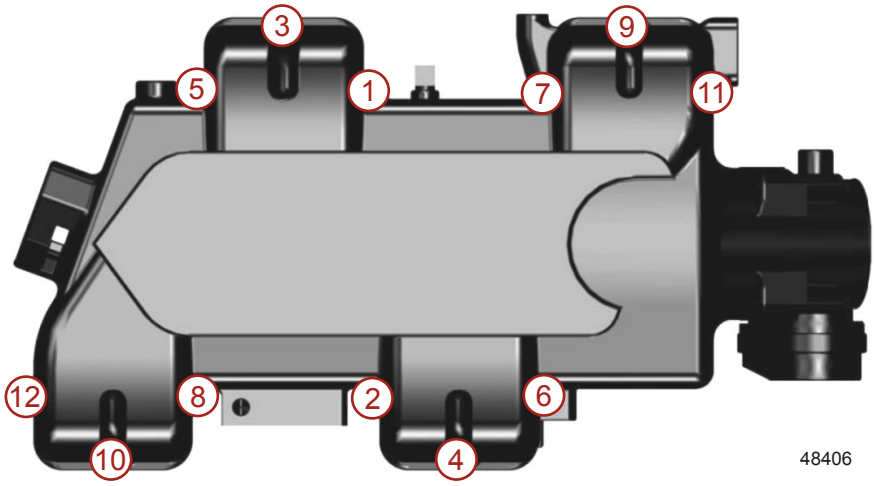
11. Install and hand start the screws.



48820

a - Plenum
b - Screw (12)

12. Tighten the screws to specification in the sequence shown.



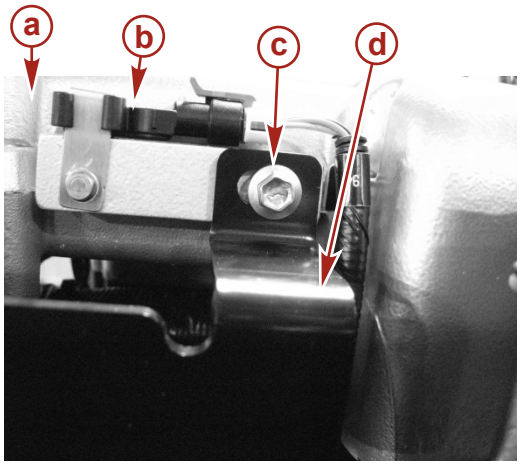
48406

Intake plenum torque sequence

Description	Nm	lb-in.	lb-ft
Intake plenum screw	24	–	18

13. Use the screw previously removed to install the bracket on the plenum.

14. Tighten the screw to specification.



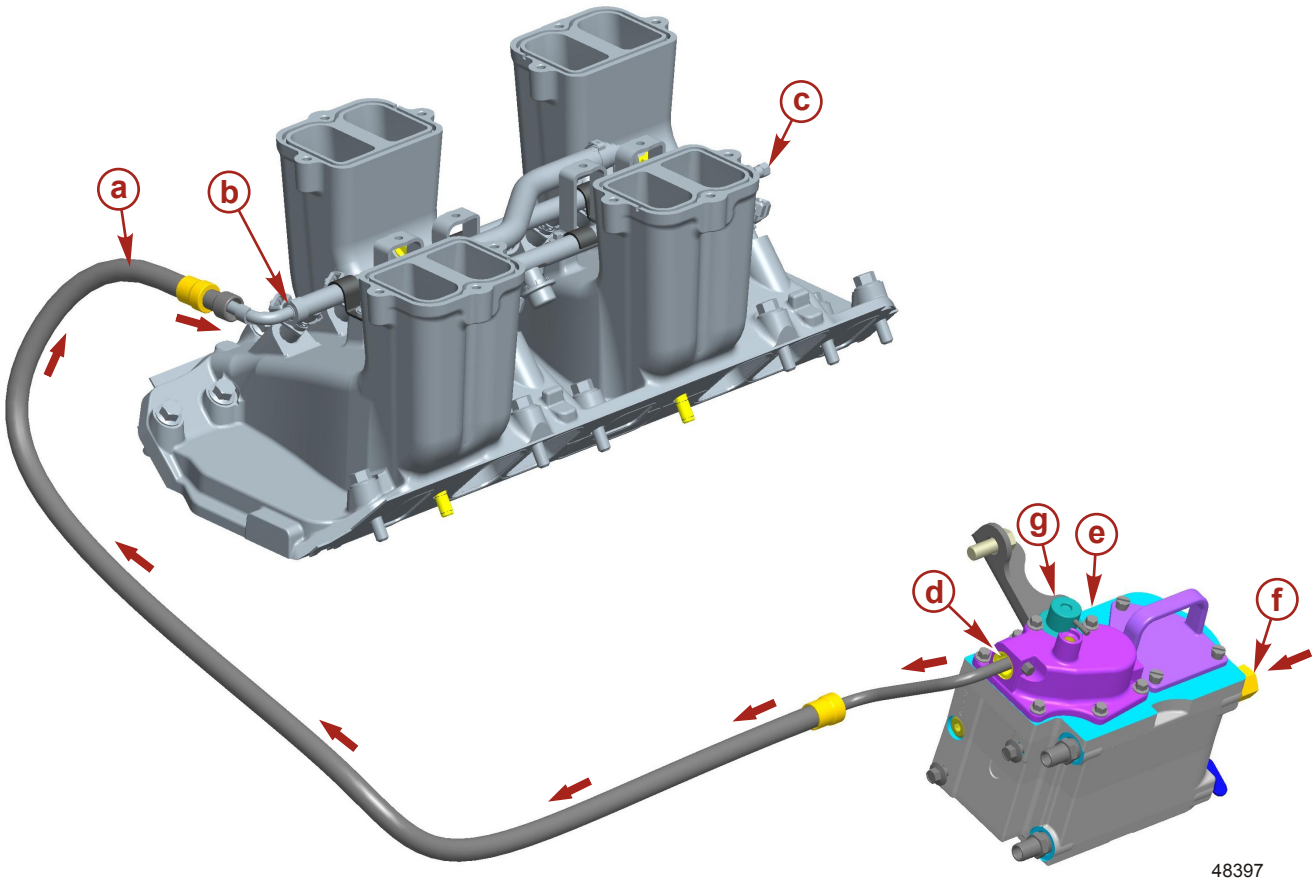
48813

a - Plenum
b - MAP
c - Screw
d - Bracket

Description	Nm	lb-in.	lb-ft
Bracket to plenum screw	19	–	14

Fuel Rail and Fuel Injectors

Fuel System Flow Diagram



- **a -** Fuel line with insulator
- **b -** Fuel line to fuel rail connection
- **c -** Fuel rail shrader valve cap
- **d -** Fuel line to Gen III Cool Fuel module connection
- **e -** Gen III Cool Fuel module
- **f -** Fuel inlet fitting
- **g -** Pressure regulator

Relieving Fuel System Pressure

⚠ CAUTION

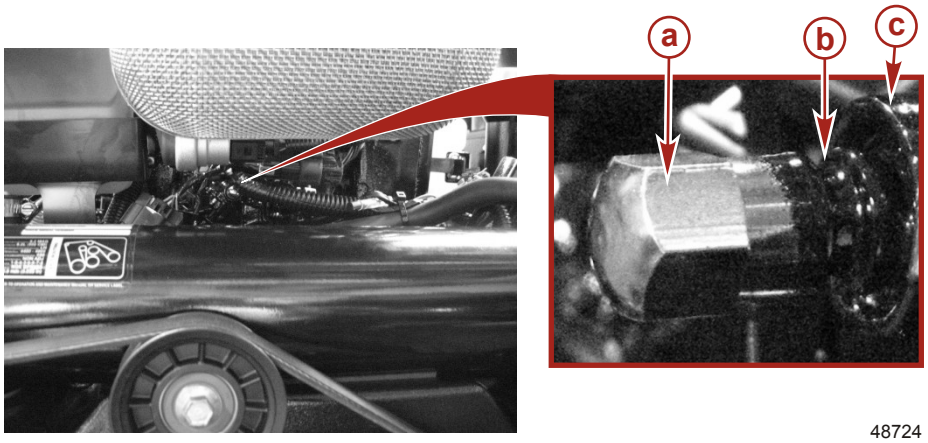
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

IMPORTANT: 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.

1. Shut off fuel supply.
2. Disconnect the negative (-) battery cable from the battery (usually black).
3. Disconnect the positive (+) battery cable from the battery (usually red).

   NOTE: *The schrader valve is accessible at the front of the engine under the flame arrestor.*
4. Relieve the fuel system pressure at the schrader valve:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the Schrader valve.

Fuel Pressure Gauge Kit	91-881833A03



48724

a - Cap
b - Schrader valve
c - Fuel rail

c. Place the fuel pressure gauge relief line into a suitable container.
d. Open the fuel pressure gauge relief valve to relieve pressure.

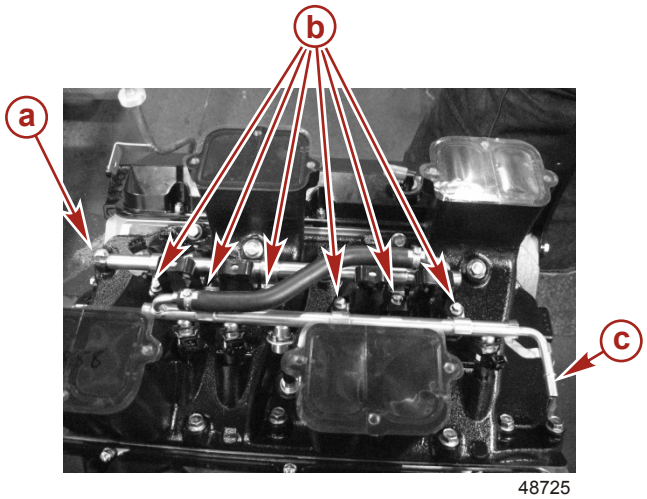
Fuel Rail

⚠ WARNING

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

Removal

1. Bleed the fuel pressure prior to disassembly of the fuel rail system, see Fuel Pressure Relief Procedure in this section.
2. Remove the plenum assembly.
3. Disconnect the electrical connector at each fuel injector.
4. Remove fuel inlet line from fuel rail fitting.
5. Remove the six fuel rail mounting screws.



48725

a - Schrader valve
b - Screw (6)
c - Inlet fuel line connection

6. Remove the port fuel rail by pulling evenly on the fuel rail to unseat all four of the injectors from the intake manifold.
7. Remove the starboard fuel rail by pulling evenly on the fuel rail to unseat all four of the injectors from the intake manifold and remove the fuel rail and injector assembly.

Cleaning and Inspection

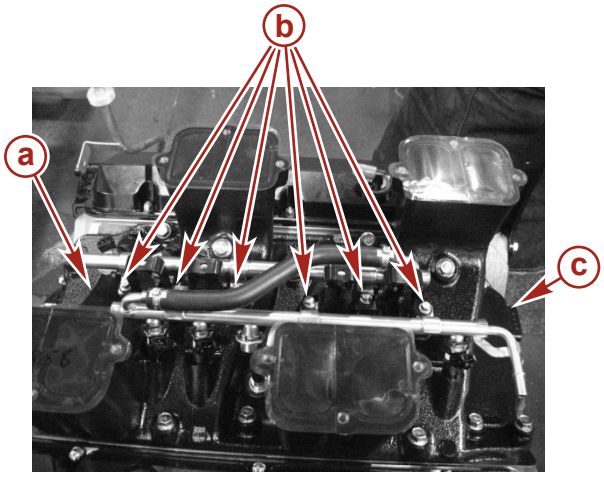
Replace the fuel rail if the injector seating area has pitting, nicks, burrs or irregularities.

Installation

NOTE: Before installing the fuel injectors, lubricate the new fuel injector o-rings with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector o-ring	92-858087K01

1. Install the fuel rail assembly onto the intake manifold.
2. Install the fuel rail mounting screws and tighten them to specification.



48765

a - intake manifold
b - Fuel rail mounting screw
c - Engine flywheel

Description	Nm	lb. in.	lb. ft.
Fuel rail mounting screw	11	96	–

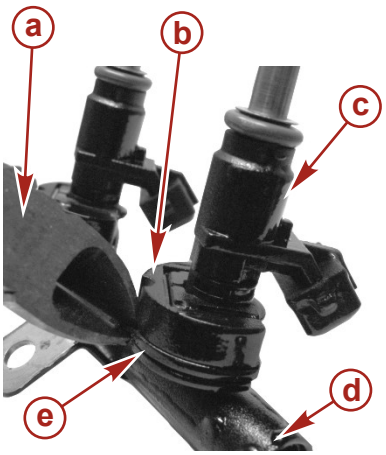
3. Connect and tighten securely the fuel inlet line to the elbow at the rear of the fuel rail.
4. Connect the electrical connectors to each fuel injector.
5. Install the plenum assembly.

Fuel Injector

Removal

IMPORTANT: Do not soak the fuel injector in any liquid cleaner or solvent.

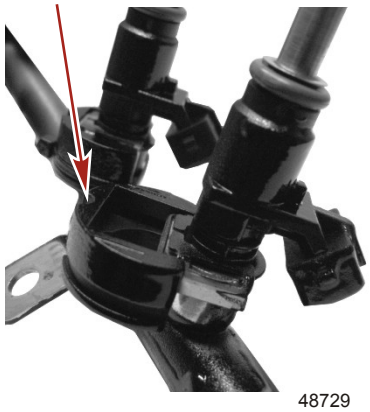
1. Remove the plenum and fuel rail as outlined in this section.
2. To remove the fuel injector housing.
   a. Cut the cable tie and remove it from the collar.



48728

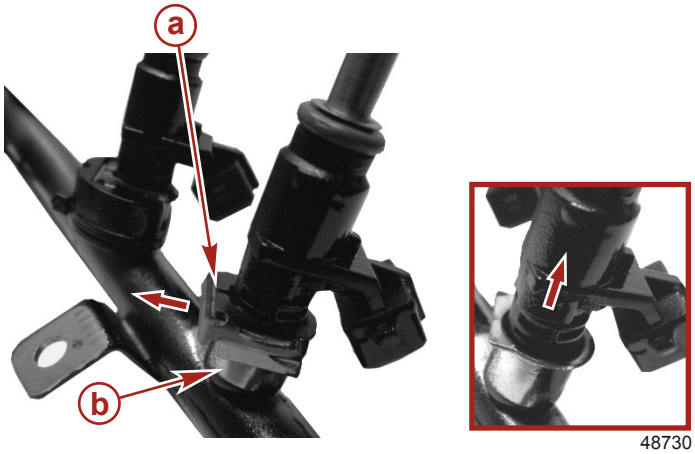
a - Tool
b - Collar
c - Fuel Injector housing
d - Fuel rail
e - Cable tie

b. Slide the collar off the assembly.



48729

c. Pull the retainer clip straight back to remove it from the groves in the injector housing.
d. Pull the injector straight up to remove it from the fuel rail housing.



48730

a - Retainer clip
b - Fuel rail housing

Installation

IMPORTANT: Always use genuine replacement parts. Other injectors may look identical but have different flow characteristics.

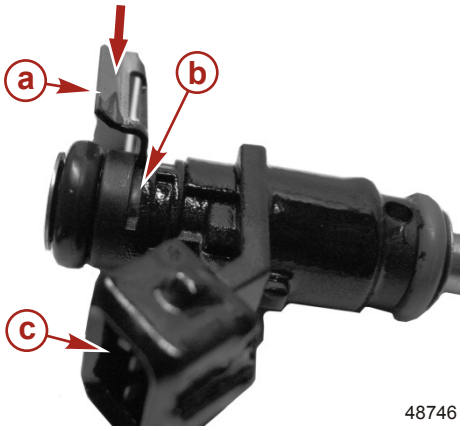
1. If replacing the O-rings, lubricate the O-rings and install on the fuel injector.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector O-rings	92-858087K01

2. To install the fuel injector to the fuel rail housing.
   a. Lightly lubricate the O-rings with engine oil.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel injector O-rings	92-858087K01

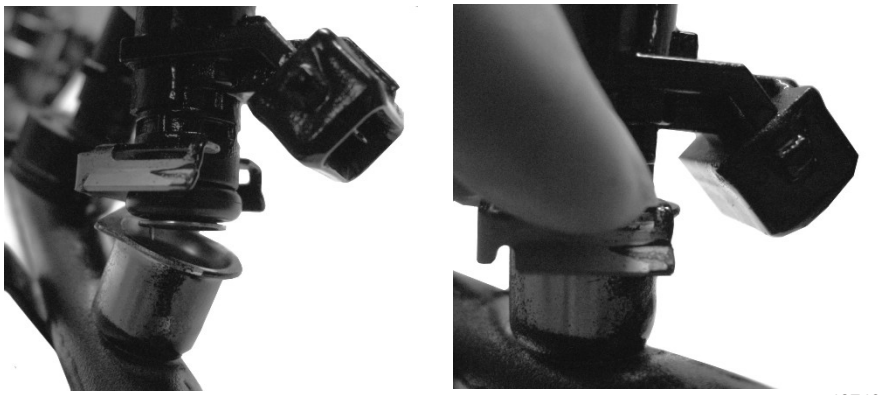
b. Place the retaining clip in the fuel injector grooves.



48746

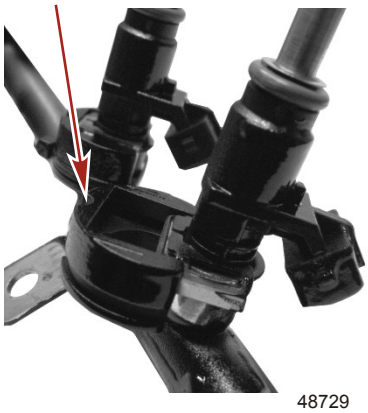
a - Retaining clip
b - Injector groves
c - Harness connector

c. Align the retaing clip and injector in the fuel rail housing and push the retaner clip down until it snapes in place on both sides of the retainer clip.



48749

d. Slide the collar over the retaining clip.



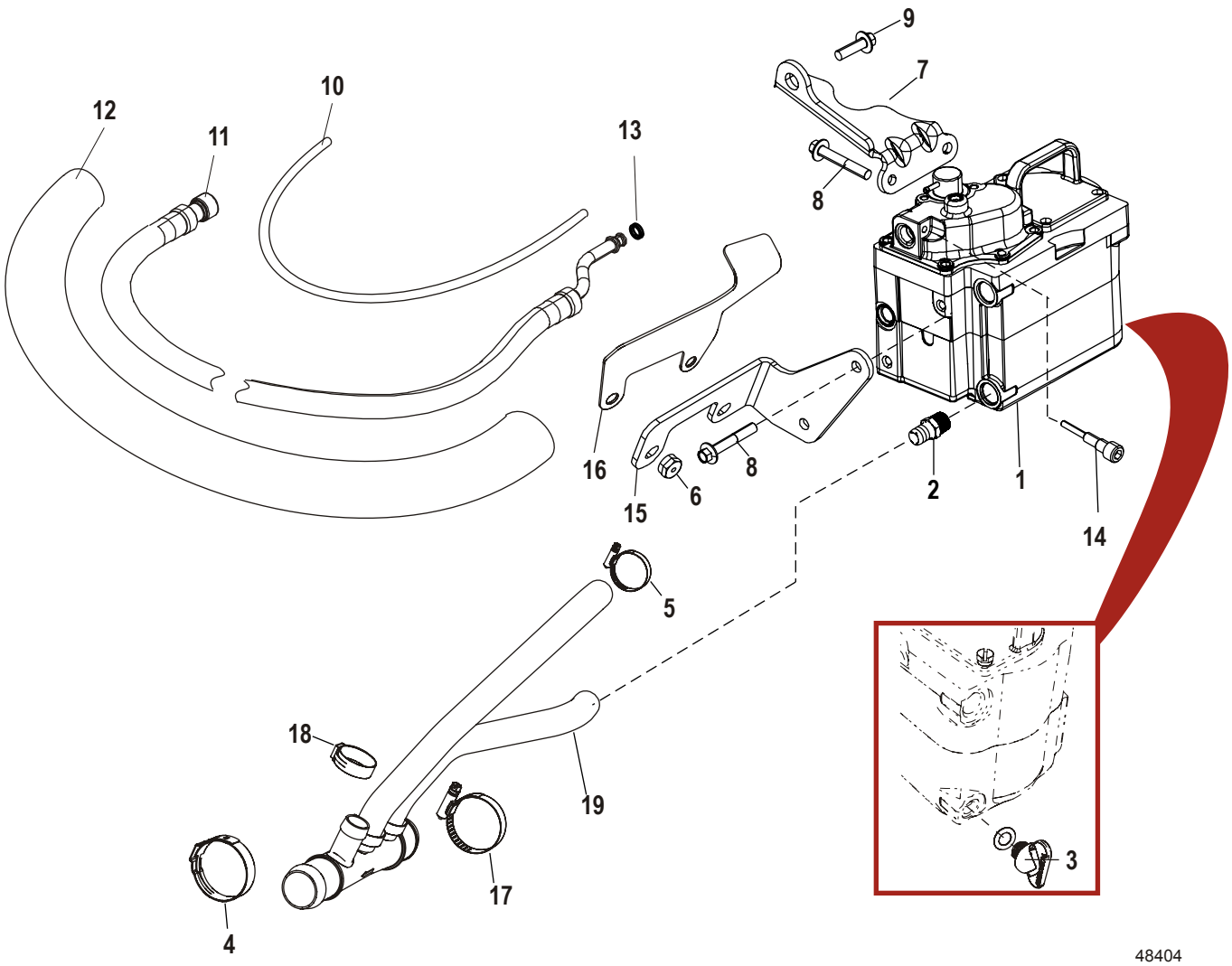
48729

e. Install a cable tie to secure the collar.

3. Install the fuel injectors, fuel rail, and plenum assembly.

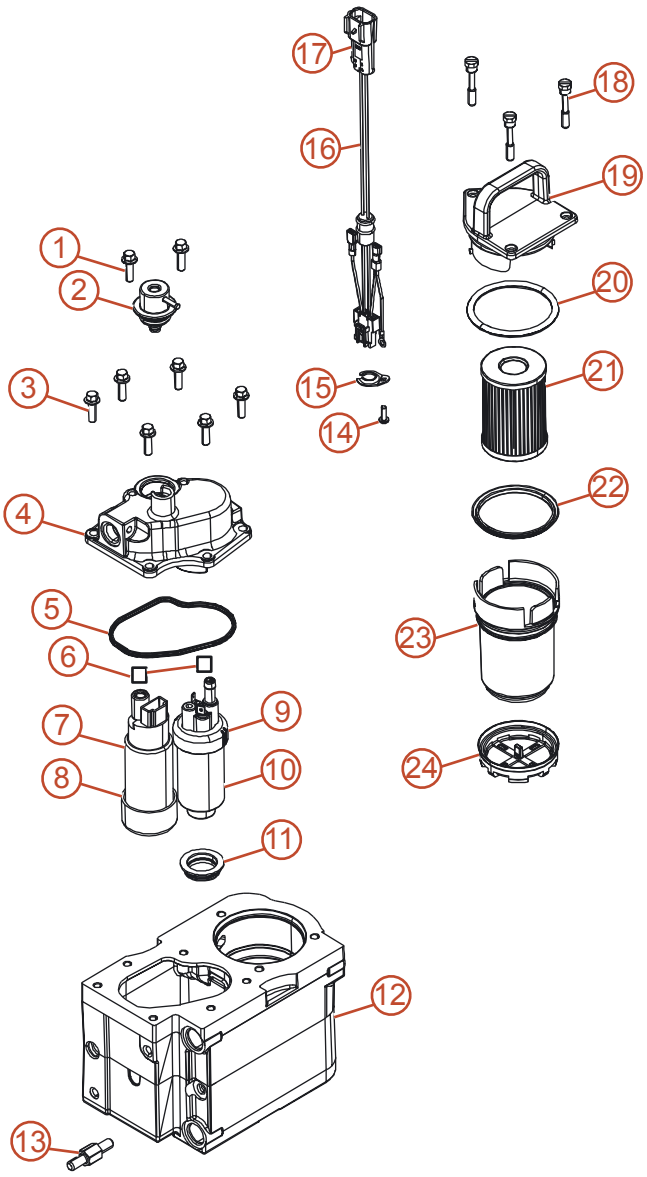
Gen III Cool Fuel

Gen III Cool Fuel System Exploded View



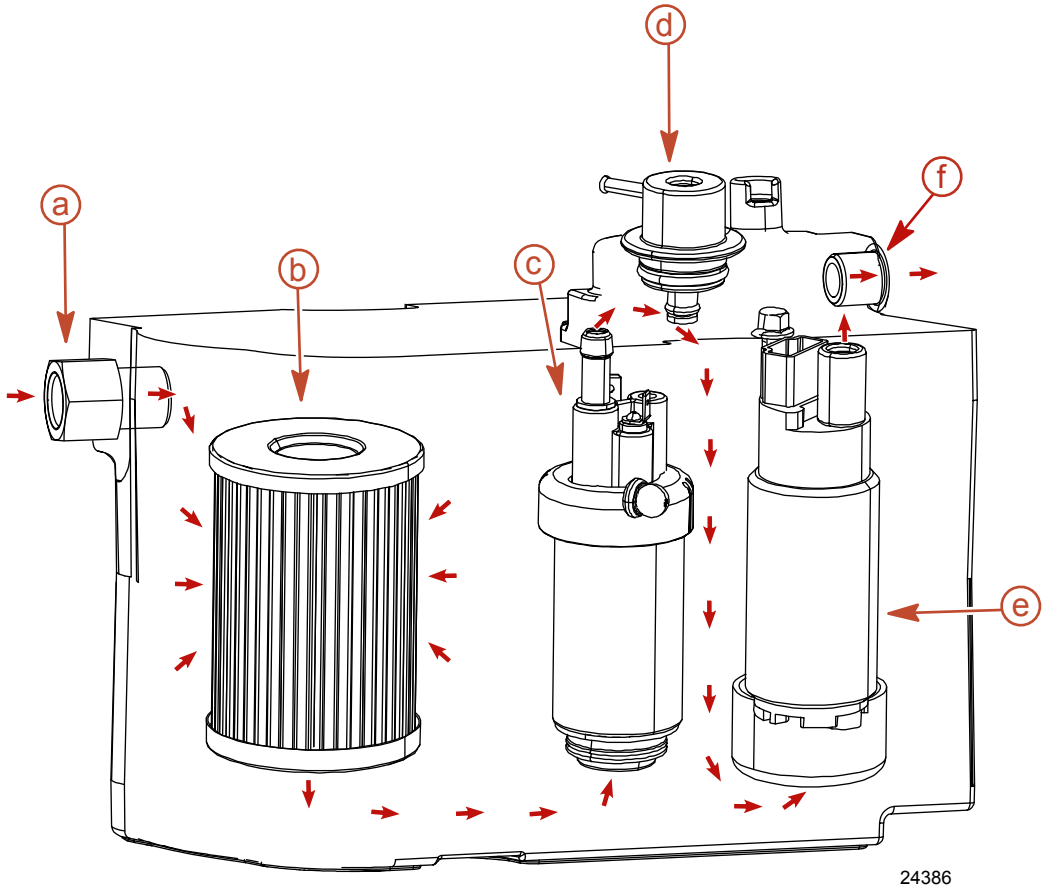
1 - Gen III Cool Fuel Module
2 - Fitting (2)
3 - Blue plug with O-ring
4 - Clamp
5 - Clamp
6 - Nut (2)
7 - Fuel module support bracket
8 - Screw (4)
9 - Screw
10 - Hose
11 - Fuel line (fuel module to fuel rail)
12 - Fuel line insulator sleeve
13 - Quad ring seal
14 - screw
15 - Bracket
16 - Shield (fuel line)
17 - Clamp
18 - Clamp
19 - Hose assembly (3-bib orifice meter)

Gen III Cool Fuel Module Exploded View



1 - Pressure regulator screws
2 - Pressure regulator
3 - Screws, top cover
4 - Top cover
5 - Seal, top cover
6 - Fuel pump outlet seal
7 - High-pressure fuel pump
8 - Isolator, high-pressure fuel pump
9 - Isolator, low-pressure fuel pump
10 - Low-pressure fuel pump
11 - Inlet seal, low-pressure fuel pump
12 - Cool Fuel Module housing
13 - Stud
14 - Screw, wire harness retainer
15 - Wire harness retainer
16 - Wire harness
17 - 2-pin electrical connector (plug)
18 - Screws, filter cap
19 - Filter cap
20 - O-ring
21 - Fuel filter
22 - Seal, filter cup
23 - Filter cup
24 - Filter disc

Gen III Cool Fuel Module Fuel Flow Diagram



a - Fuel inlet adapter fitting
b - Fuel filter element
c - Low-pressure fuel pump
d - Fuel pressure regulator
e - High-pressure fuel pump
f - Fuel outlet

Changing Water Separating Fuel Filter Element

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

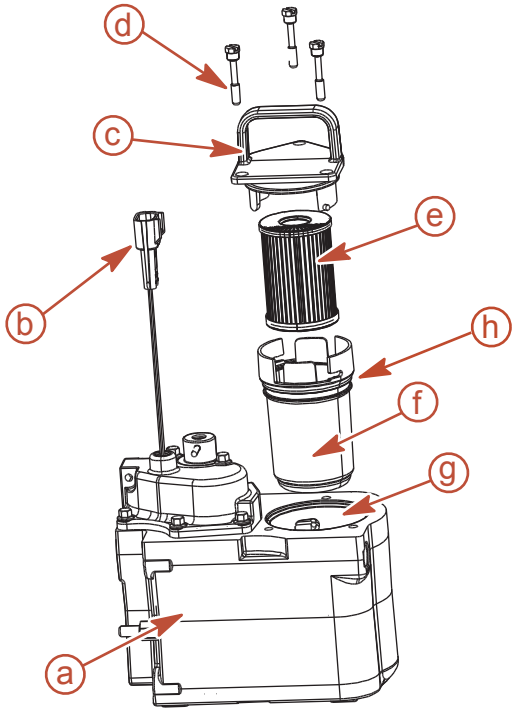
⚠ WARNING

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

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

   NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to 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 5 seconds to relieve fuel system pressure.
5. Turn key switch to off position.

6. 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.
7. Loosen each filter assembly retaining screw until the screw is disengaged from the Cool Fuel Module. Do not remove the filter assembly retaining screws from the filter cap.



8837

a - Cool Fuel Module
b - Cool Fuel Module harness
c - Filter cap
d - Filter assembly retaining screw
e - Fuel filter element
f - Filter cup
g - Cool Fuel Module filter reservoir
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 in a clockwise direction 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 that may be 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 new O-ring on the filter cup.
14. Attach the filter cap to the filter cup by grasping the filter cap and rotating it in a counter clockwise direction 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.
17. Open fuel supply valve, if equipped.

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

18. Reconnect the Cool Fuel Module harness to the engine wiring harness.
19. Supply cooling water to the engine.
20. Properly ventilate the engine compartment.

⚠ WARNING

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

21. Run the engine and check for any leaks. Stop the engine immediately if any leak exists, and correct before continuing.

Fuel Line

Removing the Fuel Line

⚠ WARNING

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

⚠ WARNING

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

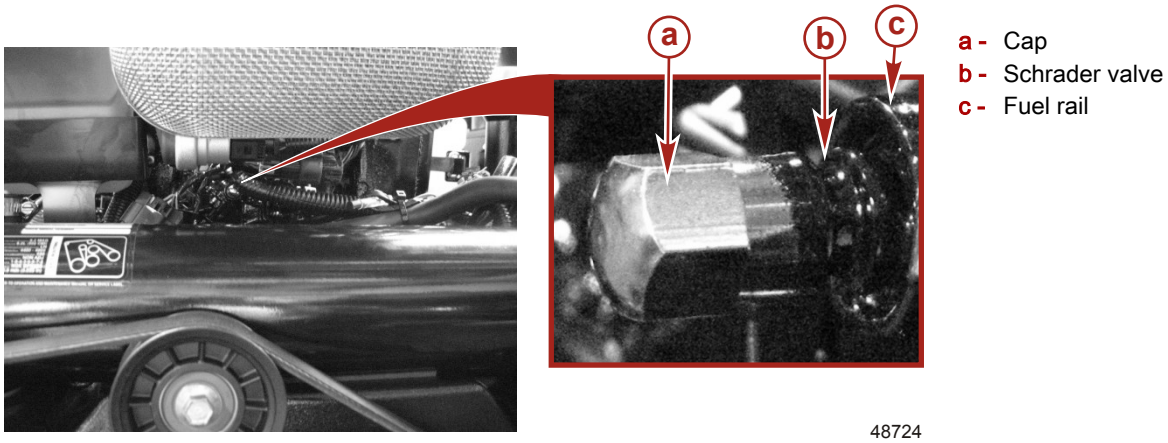
⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

IMPORTANT: 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.
IMPORTANT: Allow the engine to cool for at least 12 hours before removing the fuel line.

1. Shut off the fuel supply.
2. Disconnect the negative (-) battery cable from the battery (usually black).
3. Disconnect the positive (+) battery cable from the battery (usually red).
4. Place a shop towel or other suitable material under the fuel line fittings and connections to catch any fuel drips.
   NOTE: *The schrader valve is accessible at the front of the engine under the flame arrestor.*
5. Relieve the fuel system pressure:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the schrader valve.

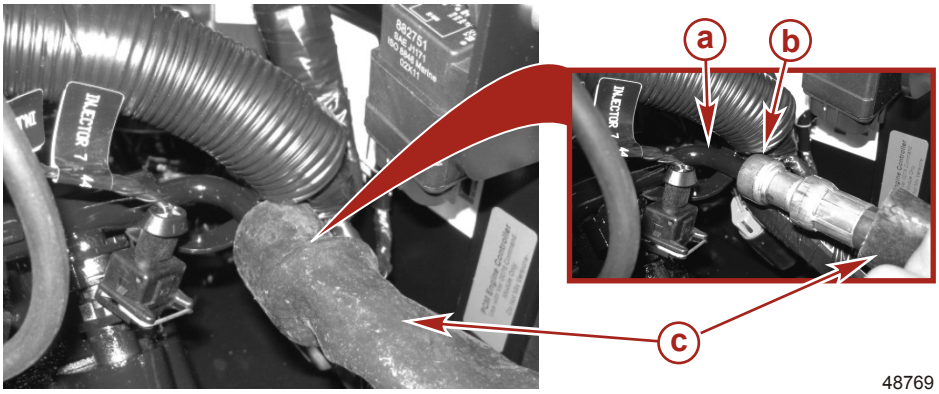
Fuel pressure gauge kit	**91-881883A2**



a - Cap
b - Schrader valve
c - Fuel rail

   c. Place the fuel pressure gauge relief line into an approved container.
   d. Open the fuel pressure gauge relief valve to relieve pressure.
6. Disconnect the fuel line from the fuel rail fitting:

a. Pull the heat-resistant sleeve back to expose the connection.

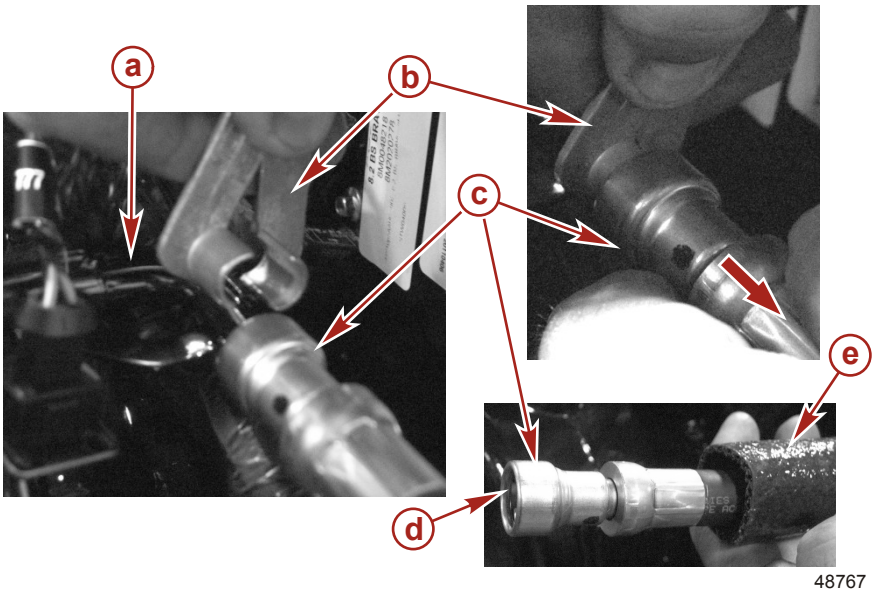


a - Fuel rail
b - Fuel line fitting
c - Heat-resistant sleeve

b. Position the fuel line disconnect tool at the fuel rail fuel line connection.

c. Squeeze the tool and push it into the fuel line fitting to release the quick connect and pull the fuel line straight backward to remove it from the fuel rail.

d. Drain any fuel remaining in the fuel line into a suitable container.

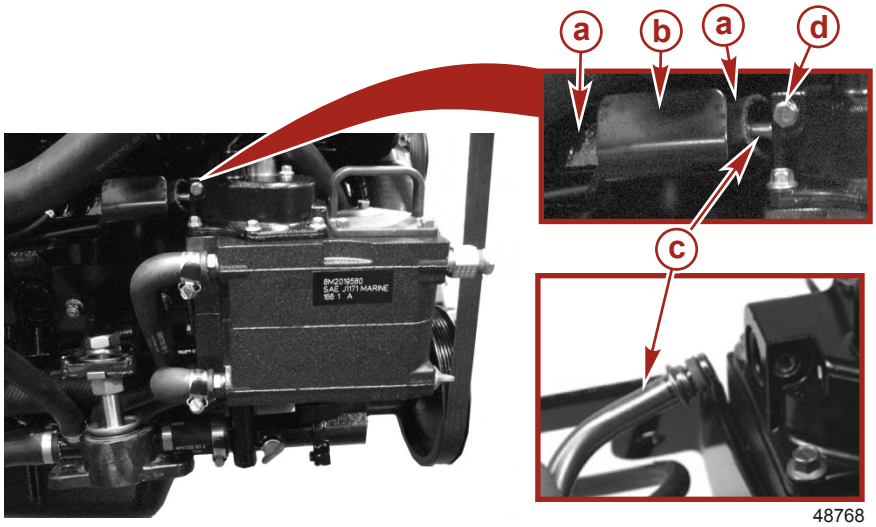


a - Fuel rail
b - Fuel line disconnect tool
c - Fuel line
d - Quick connect fitting
e - Heat-resistant sleeve

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

7. Disconnect the fuel line from the Gen III Cool Fuel Module:
   a. Remove the fuel line retainer screw.

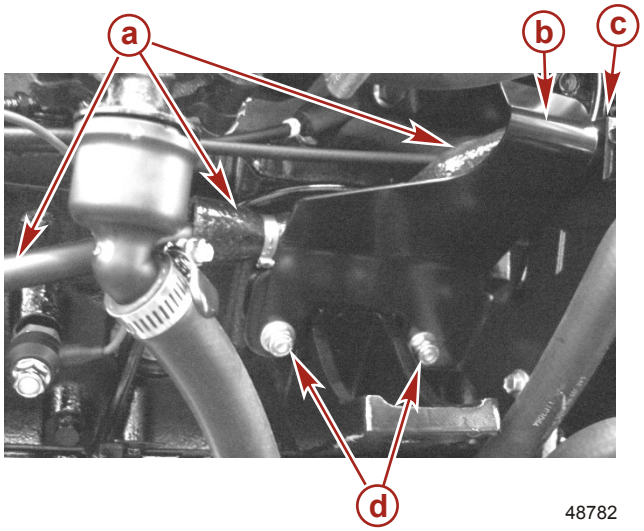
b. Carefully pull the fuel line straight out from the module and plug the line.



48768

a - Heat-resistant sleeve
b - Shield
c - Fuel line
d - Fuel line retainer screw

c. Remove the nuts at the engine mount and remove the shield.



48782

a - Fuel line
b - Shield
c - Fuel module
d - Nut

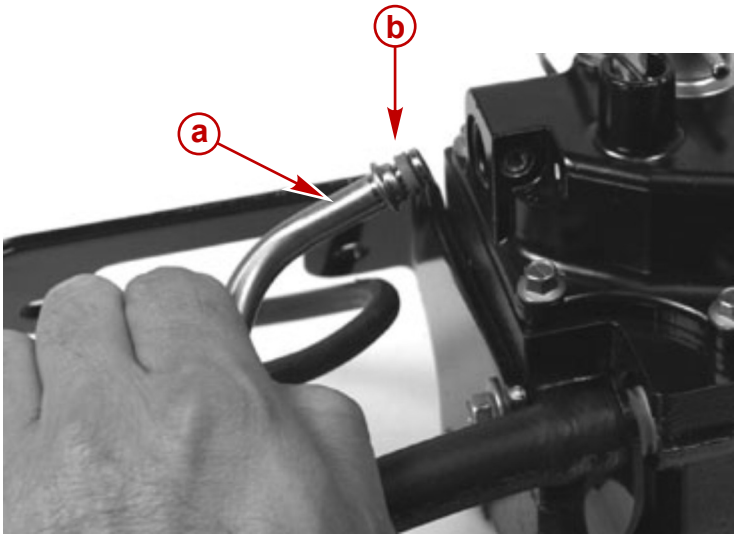
d. Following the fuel line and remove J-clips as necessary to remove the fuel line from the engine. Retain fasteners, note the routing, and clamp positions for installing the fuel line.

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.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel line O-ring	92-858087K01

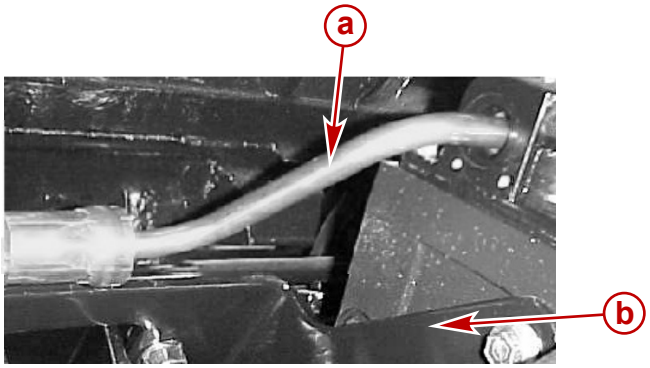
3. Install the O-ring on the fuel line connector as shown.



24580

a - Fuel outlet line
b - O-ring

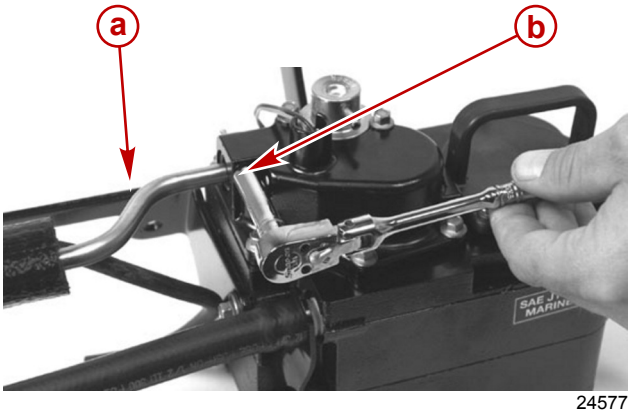
4. Carefully insert the fuel line into the Gen III Cool Fuel Module.
5. Rotate the fuel line toward the engine block as shown in the following photograph.



24390

Heat-resistant sleeve removed for visual clarity
a - Fuel line
b - Bracket

6. Install the fuel line retainer screw.
7. Tighten the screw to specification.



24577

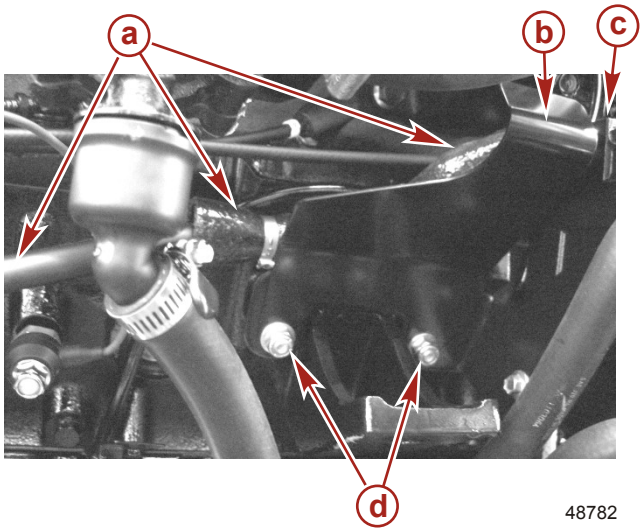
a - Fuel line
b - Screw

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.

8. Pull the heat-resistant sleeve over the fuel line to within 6 mm (1/4 in.) of the Gen III Cool Fuel Module.

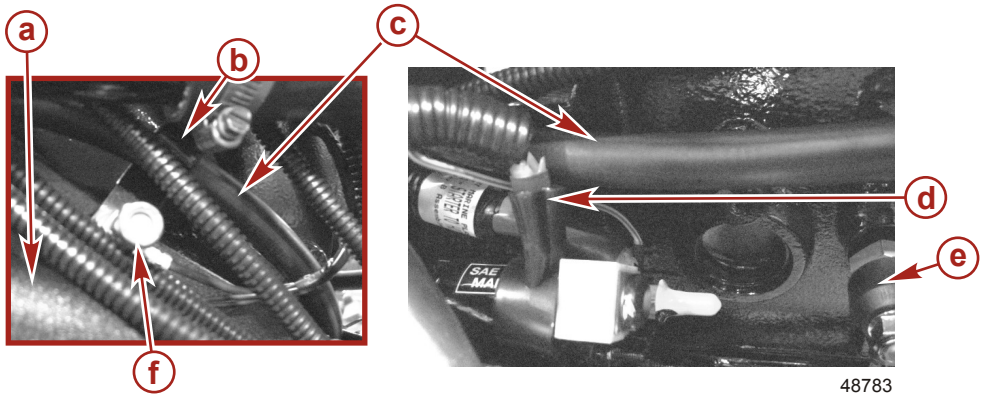
9. Install the shield to the engine mount. Ensure the heat-resistant sleeve and fuel line are properly positioned and line is not pinched when the nuts are tightened.
10. Tighten the nuts to specification.



a - Fuel line
b - Shield
c - Fuel module
d - Nut

Description	Nm	lb-in.	lb-ft
Sheild to engine mount nut	37	–	27

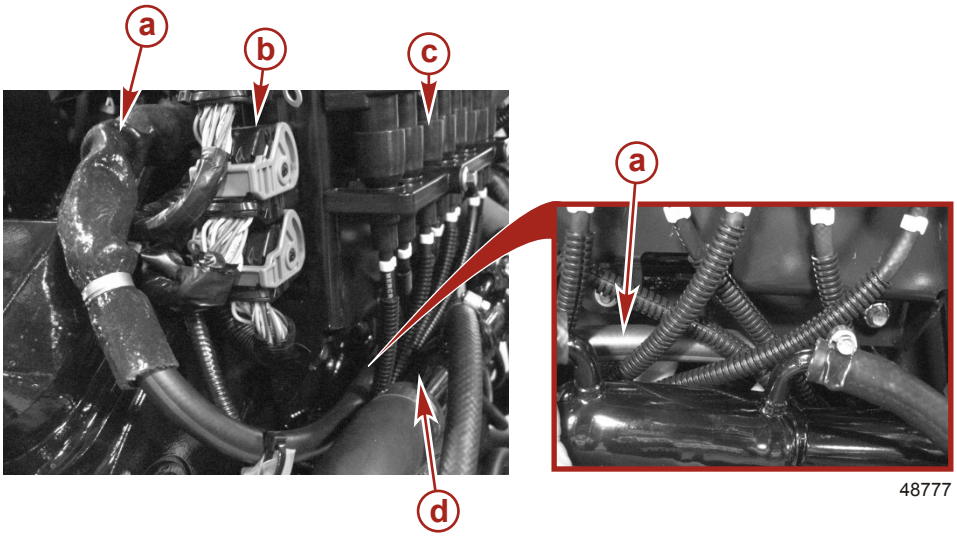
11. Route the fuel line along the block toward the top of the flywheel housing cover.
12. Secure the fuel line with the J-clip on the flywheel housing cover.



a - Flywheel housing cover
b - Jay clip
c - Fuel line
d - Hot stud wire on starter
e - Knock sensor
f - Nut

Description	Nm	lb. in.	lb. ft.
J-clip nut	48	–	36

13. Slide the fuel line behind the harness leads between the oil cooler and the coil pack then up to the fuel rail.

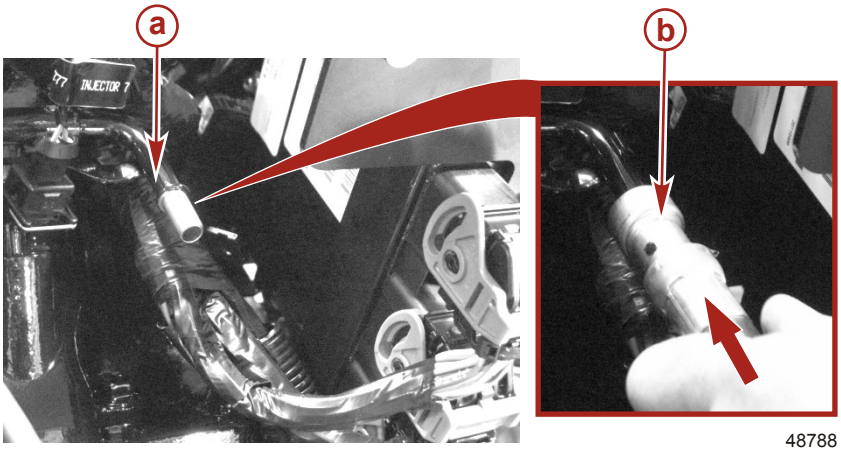


48777

a - Fuel line
b - ECM harness connectors
c - Coil pack
d - Oil cooler

Connecting the Fuel Line to the Fuel Rail

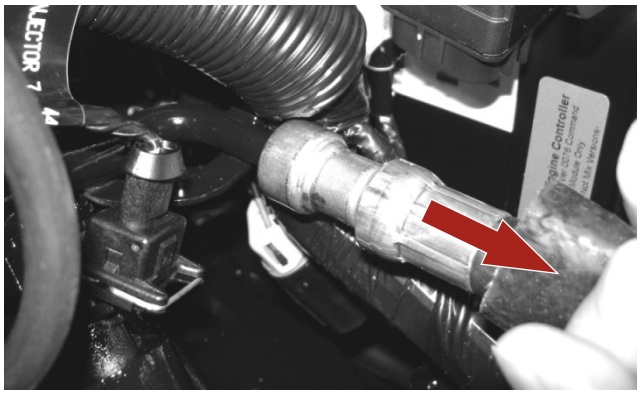
1. Ensure the fuel line is routed under the electrical harnessing and has no restrictions, compressions, or contact with sharp edges.
2. Push the fuel line fitting onto the fuel rail. Listen for a snap.



48788

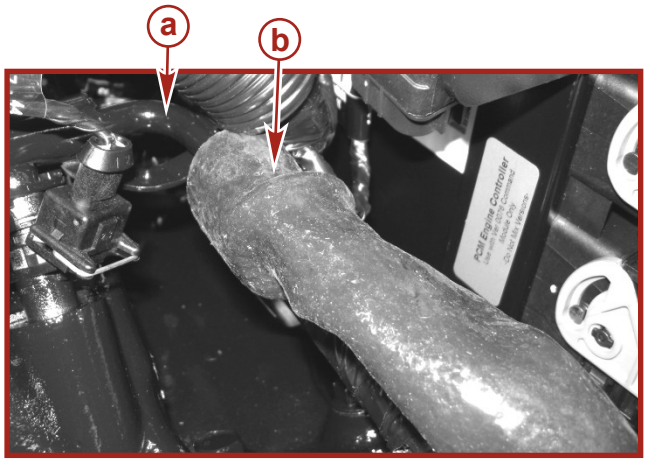
a - Fuel rail
b - Fuel line fitting

3. Test that the fuel line is properly seated by tugging firmly on the line.



48789

4. Pull the heat-resistant sleeve over the connection.



48790

a - Fuel rail
b - Heat-resistant sleeve

5. Ventilate the engine compartment.
6. Connect the positive (+) battery cable to the battery (usually red).
7. Connect the negative (-) battery cable to the battery (usually black).
8. 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.

Gen III Cool Fuel Module Removal

⚠ WARNING

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

⚠ WARNING

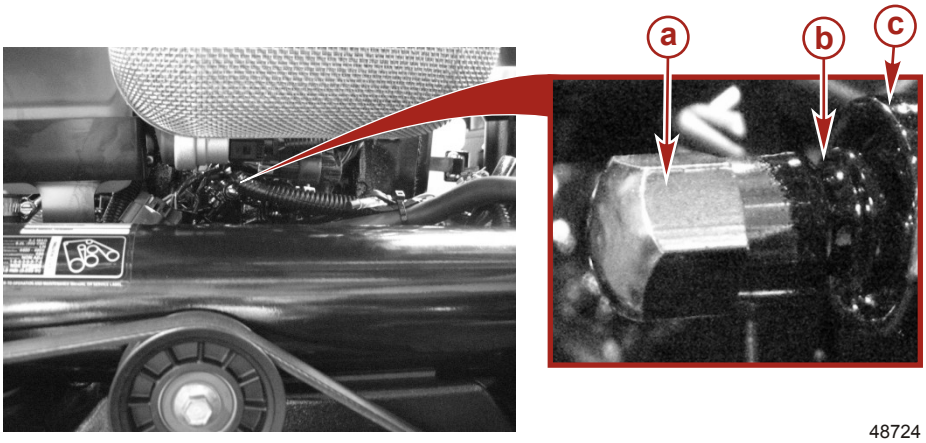
Fuel vapors trapped in the engine compartment may be an irritant, cause difficulty breathing, or may ignite resulting in a fire or explosion. Always ventilate the engine compartment before servicing the power package.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

1. Close the fuel supply valve (if equipped).
2. Close the seacock.
3. Disconnect the negative (-) battery cable from battery (usually black).
4. Disconnect the positive (+) battery cable from battery (usually red).
5. Relieve the fuel system pressure:
   a. Remove the cap from the schrader valve on the fuel rail.
   b. Connect a fuel pressure gauge kit to the schrader valve.

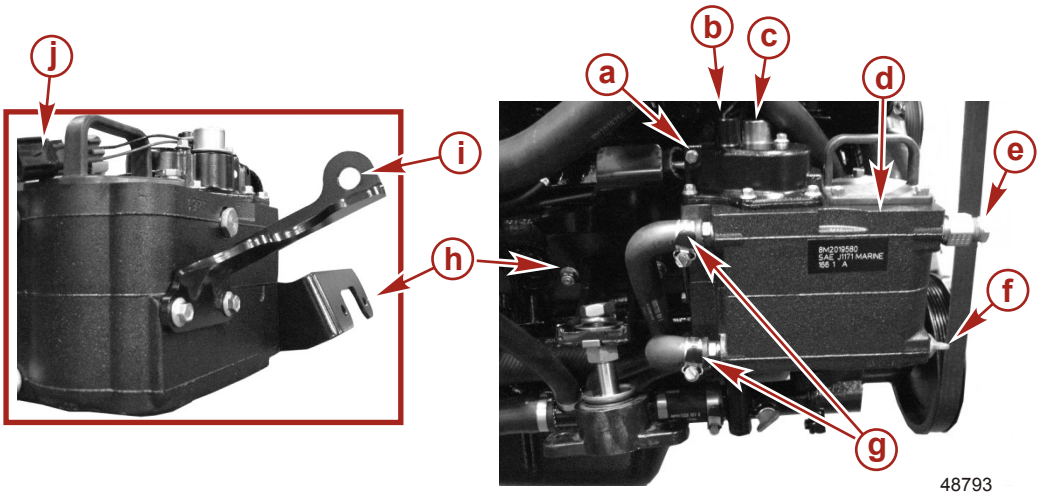
Fuel pressure gauge kit	91-881883A2



a - Cap
b - Schrader valve
c - Fuel rail

c. Place the fuel pressure gauge relief line into an approved container.
d. Open the fuel pressure gauge relief valve to relieve pressure.

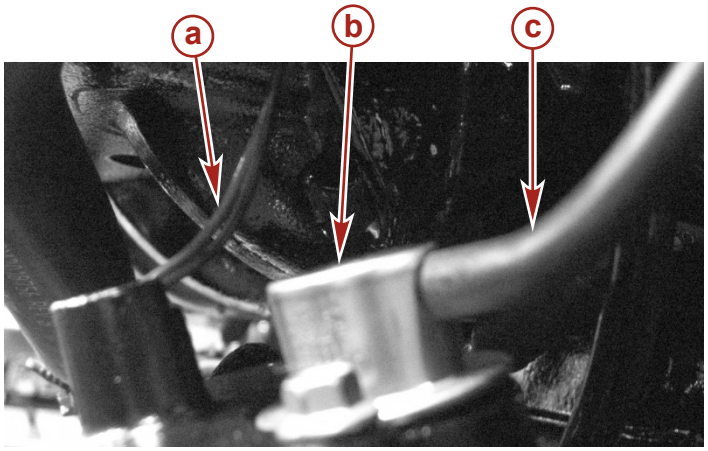
6. Locate the Gen III Cool Fuel Module.



a - Fuel outlet line retainer screw
b - Harness connector wires
c - Fuel pressure regulator
d - Gen III Cool Fuel Module
e - Fuel supply (inlet) fitting
f - Drain plug
g - Cooling hose
h - Mounting bracket to engine mount
i - Mounting bracket to front engine block
j - Harness connector

7. Disconnect the Gen III Cool Fuel Module 2-pin harness connector.

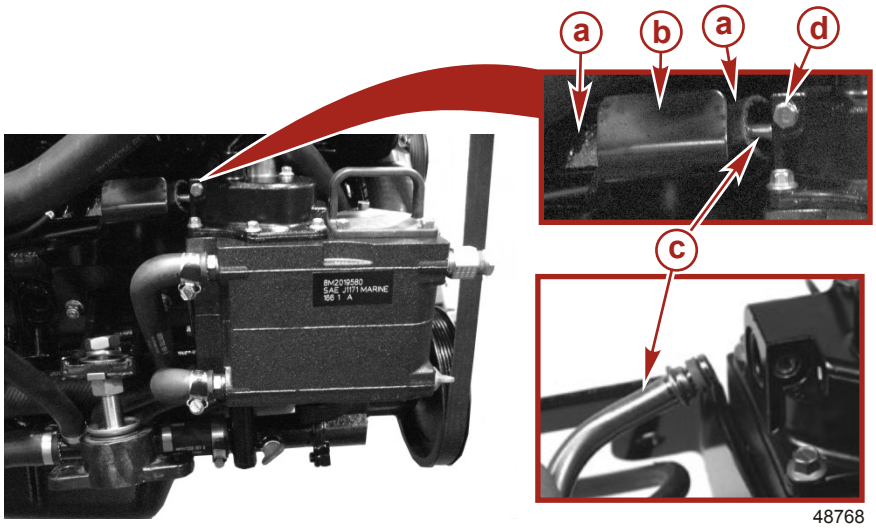
8. Remove the vacuum hose at the fuel pressure regulator on the Gen III Cool Fuel Module.



48799

a - Harness connector wires
b - Fuel pressure regulator
c - Vacuum hose

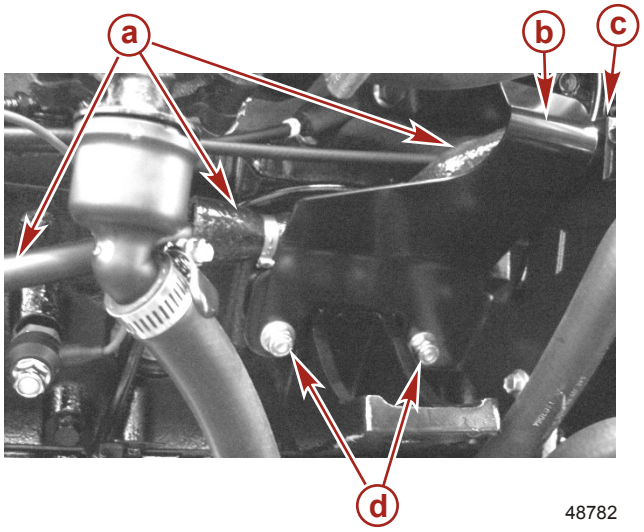
9. Disconnect the fuel supply (inlet) hose and plug the hose.
10. Disconnect the fuel line from the Gen III Cool Fuel Module:
    a. Remove the fuel line retainer screw.
    b. Carefully pull the fuel line straight out from the module and plug the line.



48768

a - Heat-resistant sleeve
b - Shield
c - Fuel line
d - Fuel line retainer screw

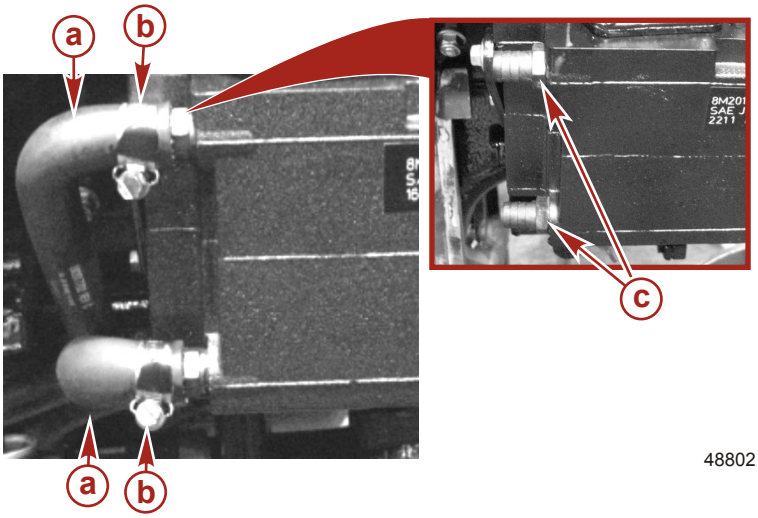
    c. Remove the nuts at the engine mount and remove the fuel line shield.



48782

a - Fuel line
b - Fuel line shield
c - Fuel module
d - Nut

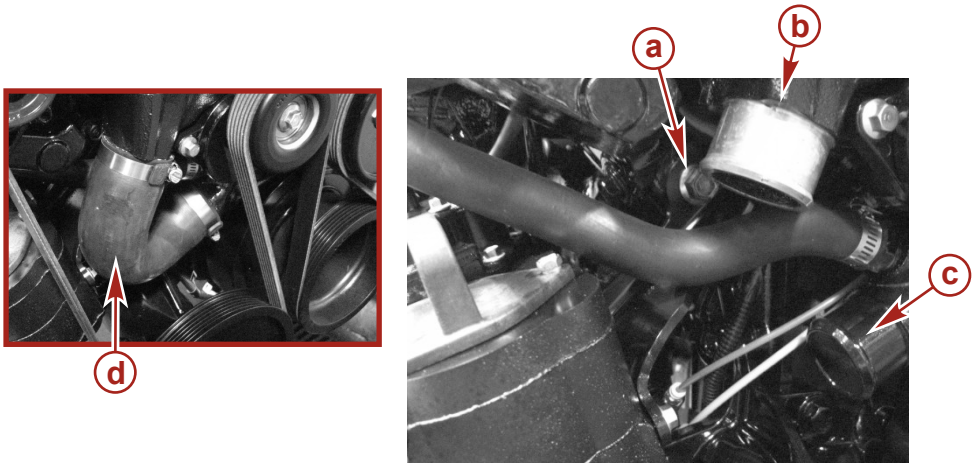
11. Loosen the hose clamps and remove the cooling hoses from the Gen III Cool Fuel Module.



a - Cooling hoses
b - Hose clamp
c - Hose fitting

48802

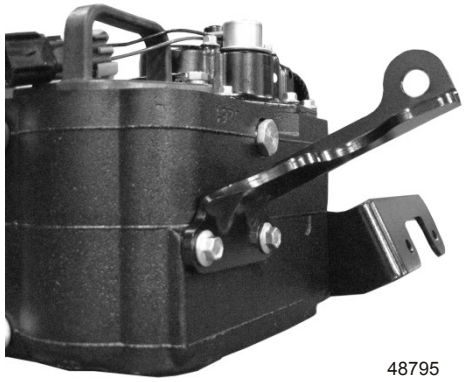
12. Remove the front bracket mounting screw from the front of the engine block. If this is not possible, drain the water from the engine and remove the coolant hose to gain access to the screw.



a - Screw
b - Crossover hose fitting
c - Engine circulation pump hose fitting
d - Coolant hose

48794

13. Carefully remove the Gen III Cool Fuel Module with its mounting brackets from engine.



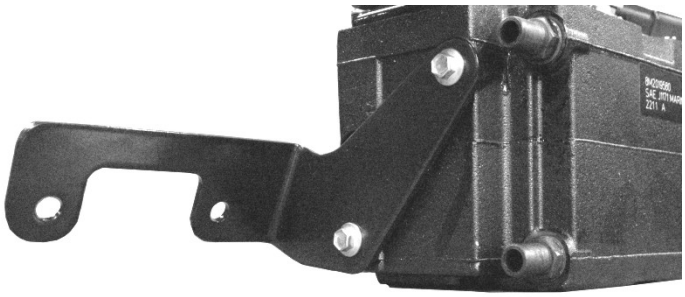
48795

Gen III Cool Fuel Module Disassembly

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

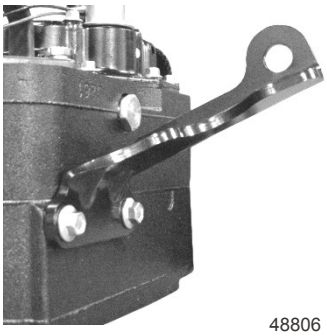
1. Remove the Gen III Cool Fuel Module from engine. Refer to **Gen III Cool Fuel Module Removal**.

2. Remove the primary mounting bracket from the Gen III Cool Fuel Module.



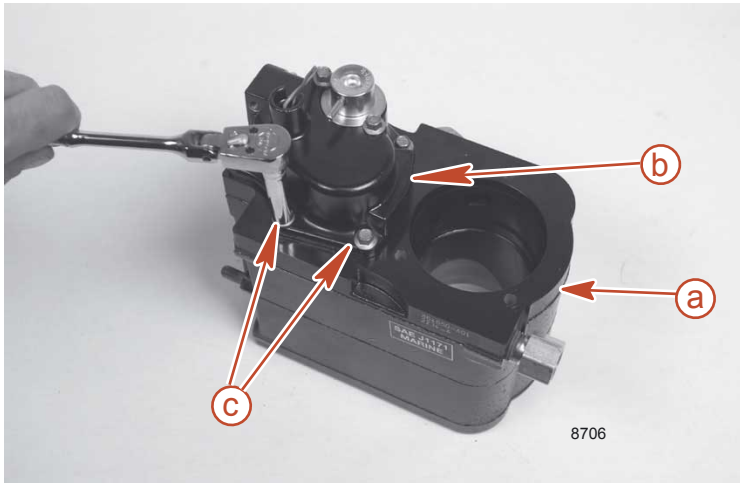
Primary Bracket

3. Remove the support bracket from the Gen III Cool Fuel Module.



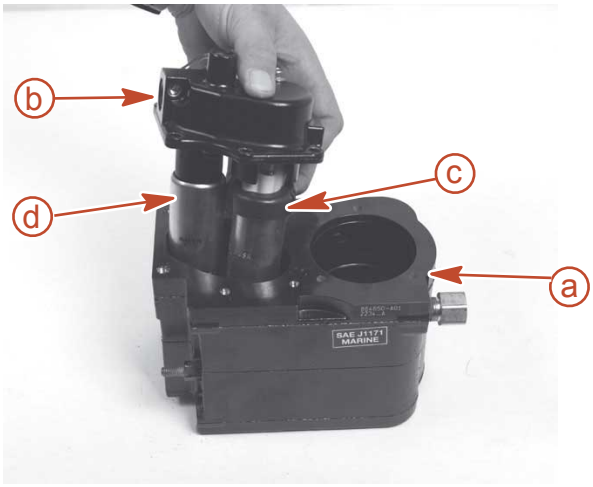
Support Bracket

4. Remove the filter assembly. Refer to **Changing Water Separating Fuel Filter Element**.
5. Remove the six screws holding top cover.



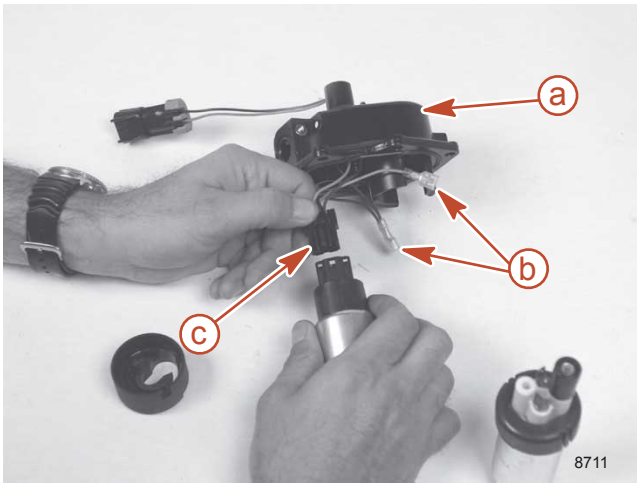
a - Gen III Cool Fuel Module
b - Top cover
c - Top cover screws (not all shown)

6. Pull top cover straight up.



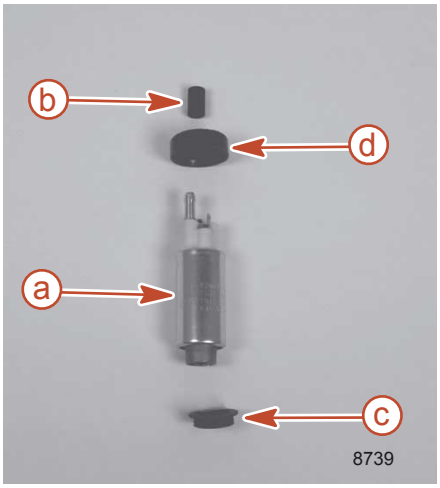
a - Gen III Cool Fuel Module
b - Top cover
c - Low-pressure fuel pump
d - High-pressure fuel pump

7. Disconnect electrical connections from the low-pressure and high-pressure pumps and remove the pumps from the top cover.

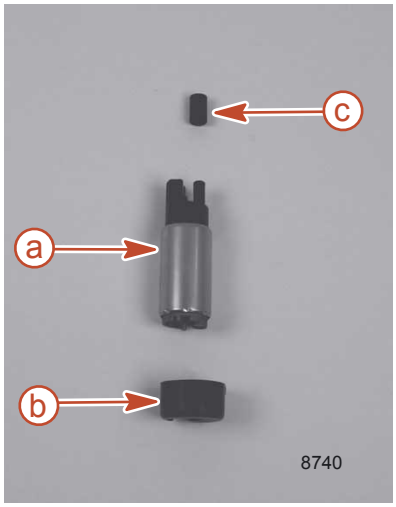


a - Top cover
b - Low-pressure fuel pump electrical connections
c - High-pressure fuel pump electrical connector

8. Remove seals and isolators from fuel pumps.



Low-pressure Fuel Pump
a - Low-pressure fuel pump
b - Outlet seal
c - Inlet seal
d - Isolator



High-pressure Fuel Pump

a - High-pressure fuel pump
b - Isolator
c - Outlet seal

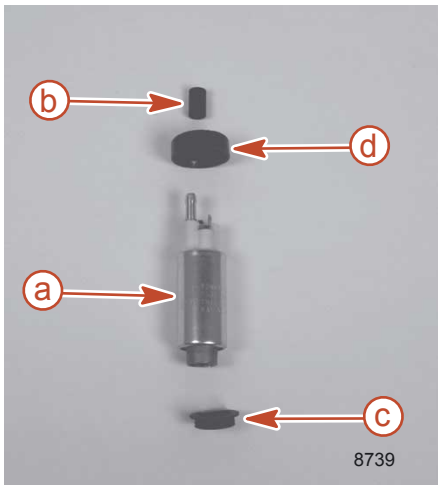
NOTE: *Fuel inlet seal for low-pressure pump may not come out with the pump when pump is removed from the Gen III Cool Fuel Module housing. Be sure to remove the seal from the housing before low-pressure fuel pump installation.*

9. Drain fuel from Gen III Cool Fuel Module into an approved container.

Gen III Cool Fuel Module Assembly

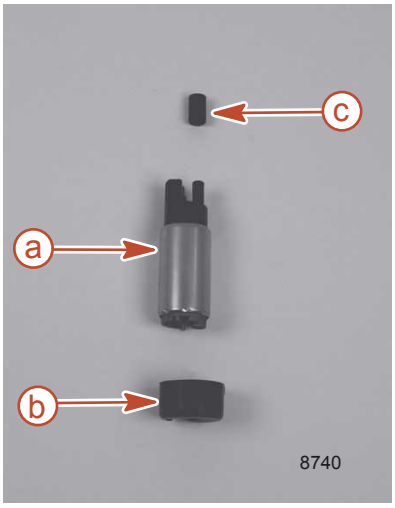
Top Cover and Fuel Pumps

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 Gen III 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

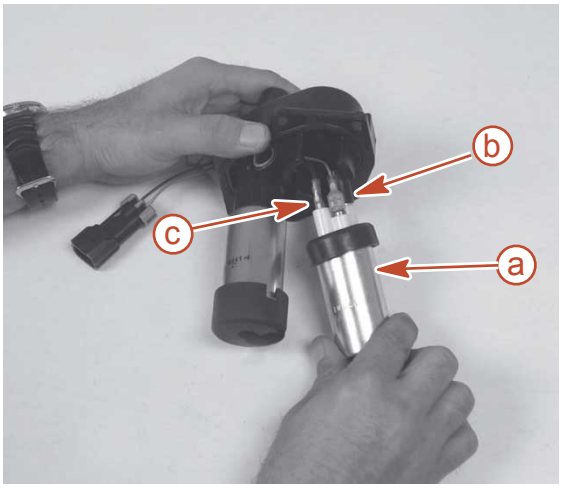
a - Low-pressure fuel pump
b - Outlet Seal
c - Inlet seal
d - Isolator



High-pressure fuel pump (low-pressure fuel pump removed for visual clarity)

- **a -** High-pressure fuel pump
- **b -** Isolator
- **c -** Outlet seal

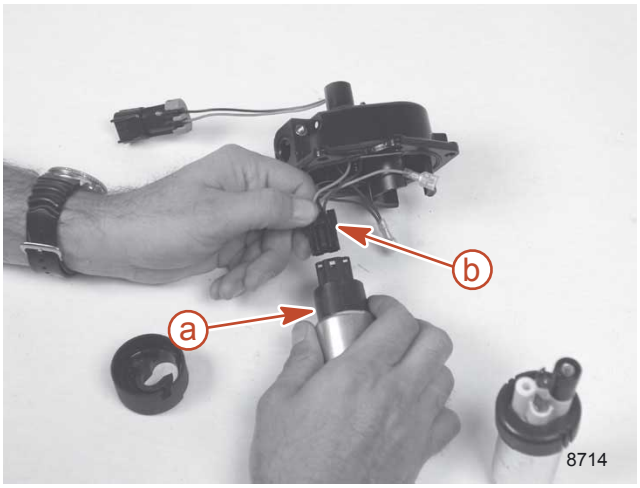
3. Connect the electrical connectors to the low-pressure pump. Red wire to positive terminal. Black wire to negative terminal. The fuel pump is marked (+) positive and (-) negative on the top of the pump. Spade connection sizes are matched to the appropriate connection as well.



Low-pressure fuel pump

- **a -** Low-pressure fuel pump
- **b -** Positive (+) electrical connection
- **c -** Negative (-) electrical connection

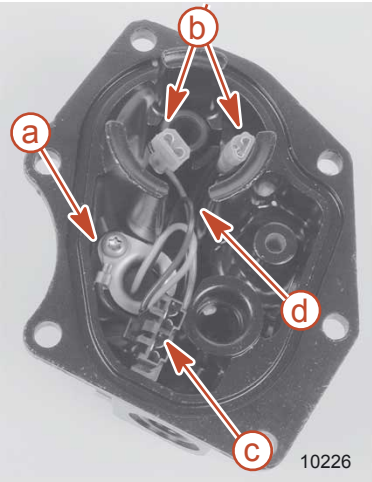
4. Connect the electrical connector to the high-pressure fuel pump.



High-pressure fuel pump (low-pressure pump disconnected for clarity)

- **a -** High-pressure fuel pump
- **b -** Electrical connector

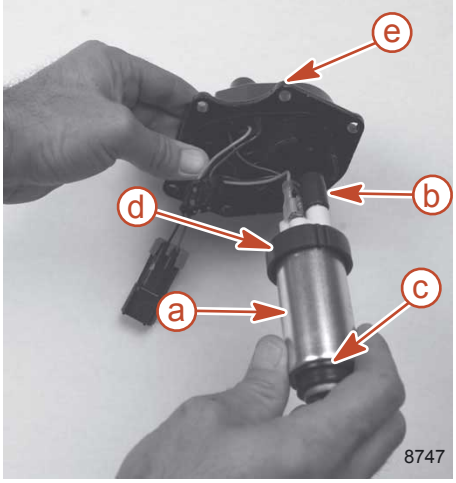
5. Route the wires as shown. Ensure that the ground wire terminal at the harness end is positioned against the outer wall of the casing. Low-pressure pump wiring must be routed through the slot and above the fuel pump. High-pressure pump wiring must also be routed above the fuel pump. Ensure that the wiring is not bound or pinched.



Fuel pumps not shown for visual clarity

- **a -** Ground wire terminal
- **b -** Low-pressure pump electrical connectors
- **c -** High-pressure pump electrical connector
- **d -** Slot (low-pressure pump wire routing)

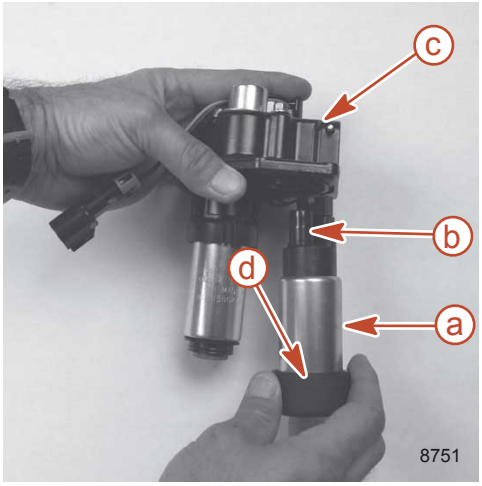
6. Insert the low-pressure pump into the top cover.



Low-pressure fuel pump installation

- **a -** Low-pressure fuel pump
- **b -** Outlet seal
- **c -** Inlet seal
- **d -** Isolator
- **e -** Top cover

7. Insert the high-pressure pump into the top cover.

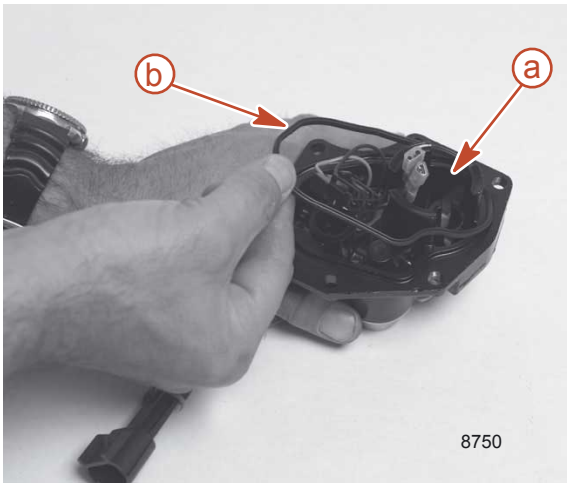


High-pressure fuel pump installation

- **a -** High-pressure fuel pump
- **b -** Outlet seal
- **c -** Top cover
- **d -** Isolator

8. Verify that the top cover seal is not damaged. Replace if necessary.

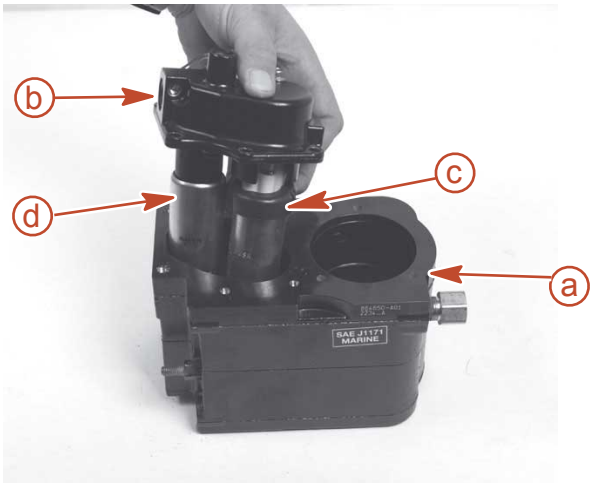
9. Place the top cover seal into the groove in the top cover.



Fuel pumps not shown for visual clarity

a - Gen III Cool Fuel Module top cover
b - Top cover seal

10. ***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 Gen III Cool Fuel Module housing.



a - Gen III Cool Fuel Module housing
b - Top cover
c - low-pressure pump
d - High-pressure pump

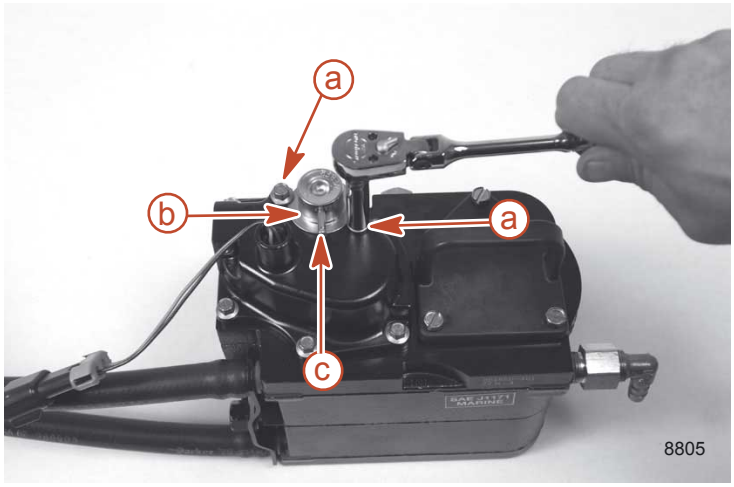
11. Install the top cover screws and hand-tighten.
12. Verify that the top cover is not bound and pull the cover gently into place with the top cover screws.
IMPORTANT: Be sure to tighten the top cover screws evenly when pulling the top cover down into place.
13. Torque top cover screws.

Description	Nm	lb. in.	lb. ft.
Top cover screws	14	124	–

14. Instal the filter assembly. Refer to **Changing Water Separating Fuel Filter Element**.

Fuel Pressure Regulator

1. Insert the fuel pressure regulator into the top cover with the hose barb facing the outboard side of the Gen III Cool Fuel Module.



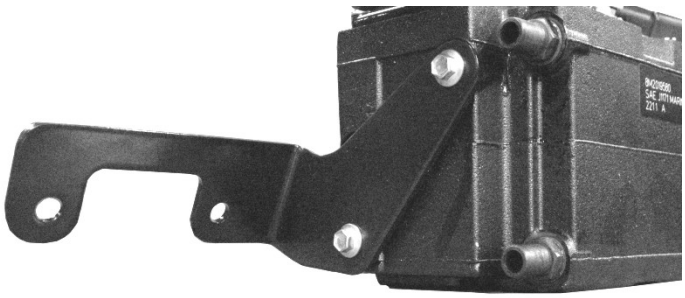
a - Fuel pressure regulator screws (2)
b - Fuel pressure regulator
c - Fuel pressure regulator vacuum hose barb

2. Install the (2) pressure regulator screws and torque to specification.

Description	Nm	lb. in.	lb. ft.
Pressure regulator screws	14	124	–

Mounting Brackets

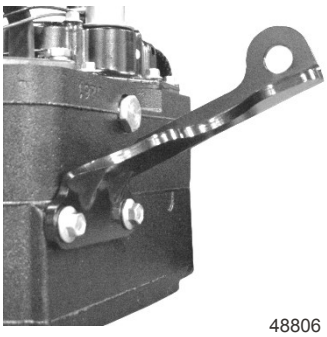
1. Install the primary mounting bracket to the Gen III Cool Fuel Module using the screws removed previously.
2. Tighten the screws to specification.



Primary bracket

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module primary bracket screws	23	–	17

3. Install the support mounting bracket to the Gen III Cool Fuel Module using the screws removed previously.
4. Tighten the screws to specification.

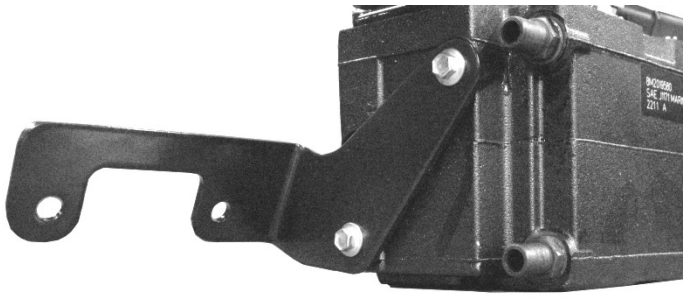


Support bracket

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module support bracket screws	23	–	17

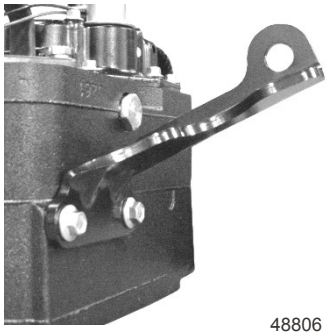
Gen III Cool Fuel Module Installation

1. Slide the Gen III Cool Fuel Module primary bracket over the studs on the engine mount.



Primary bracket

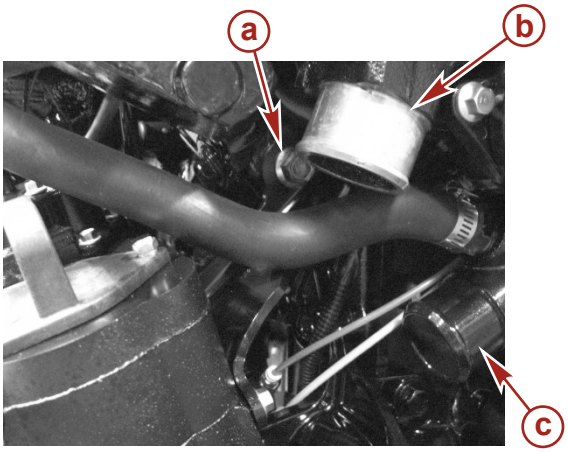
2. Install the mounting screw in the support bracket and into the front engine block.



48806

Support bracket

3. Tighten the screw to specification.



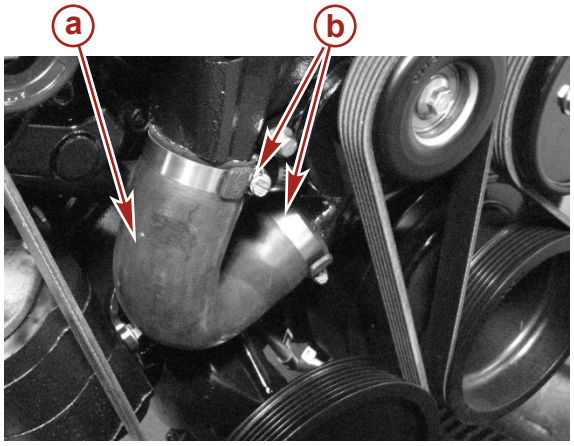
48800

a - Screw
b - Crossover hose fitting
c - Engine circulation pump hose fitting

Description	Nm	lb-in.	lb-ft
Gen III Cool Fuel Module support bracket screw	66	–	49

4. If removed, install the coolant hose and secure with hose clamps.

5. Tighten the hose clamps to specification.

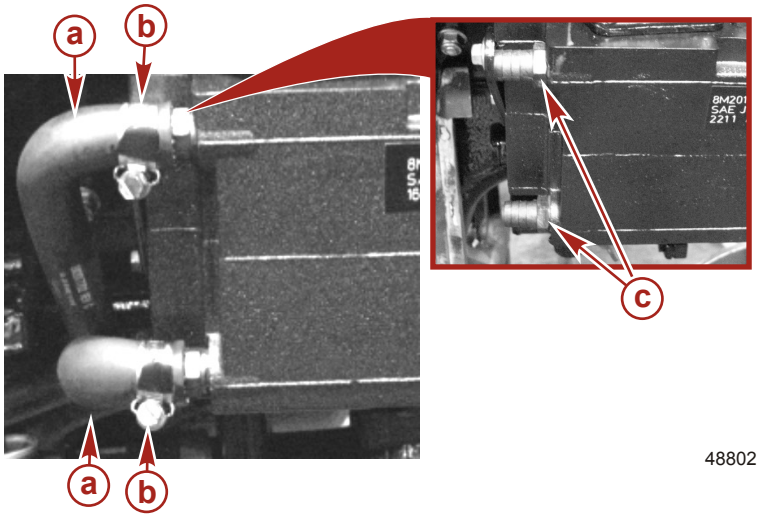


48801

a - Coolant hose
b - Hose clamps

Description	Nm	lb-in.	lb-ft
Hose clamp	3	26	–

6. Route the cooling hoses behind the engine mount and push the hose ends onto the hose fittings on the Gen III Cool Fuel Module.
7. Tighten the hose clamps to specification.



48802

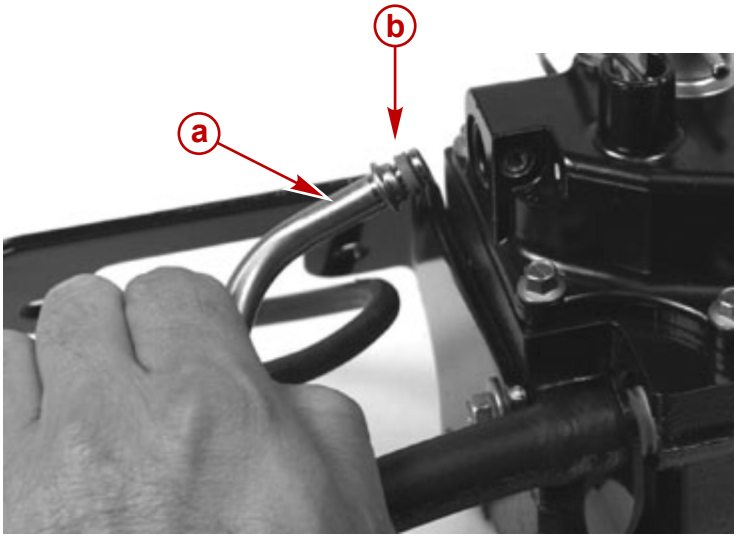
a - Cooling hoses
b - Hose clamp
c - Hose fitting

Description	Nm	lb-in.	lb-ft
Hose clamp	3	26	–

8. Install the fuel line as follows.
   a. Inspect the fuel line O-ring. Replace if damaged.
   b. Apply a thin layer of oil to the O-ring.

Tube Ref No.	Description	Where Used	Part No.
154	Mercury MerCruiser Full-Synthetic Engine Oil 20W-40, NMMA FC-W rated	Fuel line O-ring	92-858087K01

c. Install the O-ring on the fuel line connector as shown.

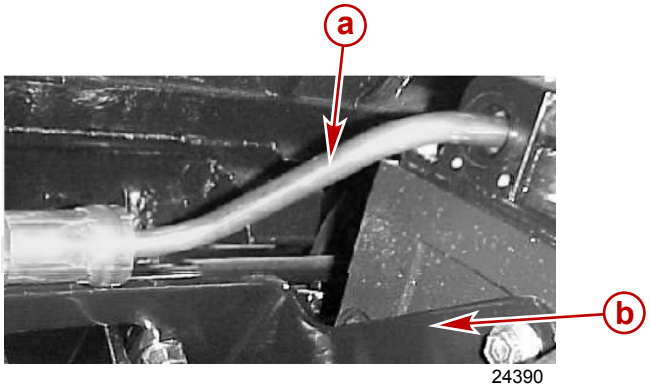


24580

a - Fuel outlet line
b - O-ring

d. Carefully insert the fuel line into the Gen III Cool Fuel Module.

e. Rotate the fuel line toward the engine block as shown in the following photograph.

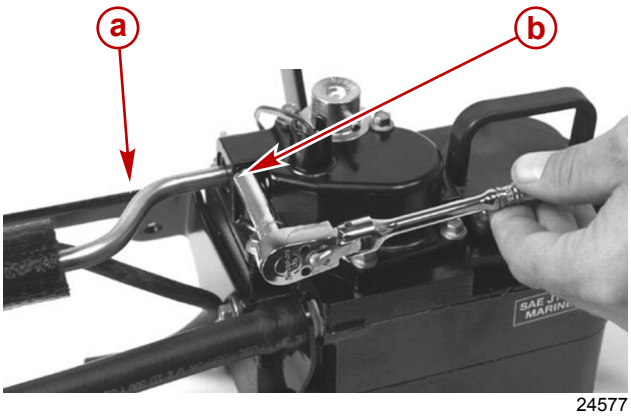


24390

Heat-resistant sleeve removed for visual clarity
a - Fuel line
b - Bracket

f. Install the fuel line retainer screw.

g. Tighten the screw to specification.



24577

a - Fuel line
b - Screw

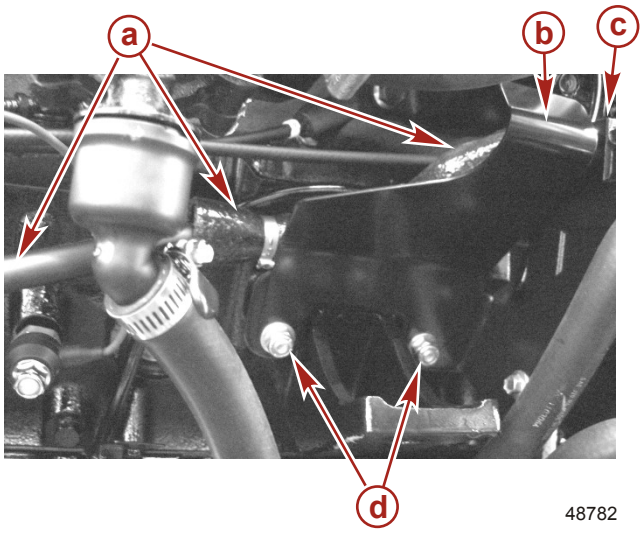
Description	Nm	lb. in.	lb. ft.
Fuel line retainer screw	9	80	–

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.

h. Pull the heat-resistant sleeve over the fuel line to within 6 mm (1/4 in.) of the Gen III Cool Fuel Module.

i. Install the fuel line shield to the engine mount. Ensure the heat-resistant sleeve and fuel line are properly positioned and line is not pinched when the nuts are tightened.

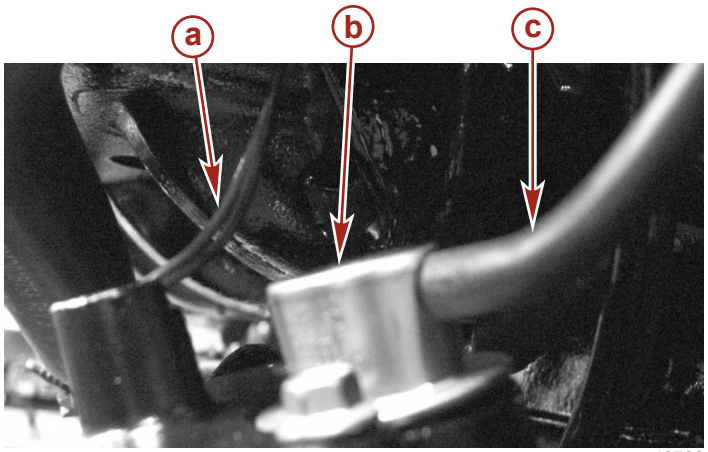
j. Tighten the nuts to specification.



a - Fuel line
b - Fuel line shield
c - Fuel module
d - Nut

Description	Nm	lb-in.	lb-ft
Shield to engine mount nut	37	–	27

9. Install a fuel supply line. Refer to **Fuel Supply Connection**.
10. Connect the Gen III Cool Fuel Module 2-pin harness connector to the engine harness.
11. Install the vacuum hose onto the fuel pressure regulator.



a - Harness connector wires
b - Fuel pressure regulator
c - Vacuum hose

12. Connect the positive (+) battery cable to the battery (usually red).
13. Connect the negative (-) battery cable to the battery (usually black).
14. Open the seacock, if equipped.
15. Open the fuel supply valve, if equipped.
16. Run the engine and check for any leaks. Stop the engine immediately if any leak exists and correct before continuing.

Fuel Supply Connection

⚠ WARNING

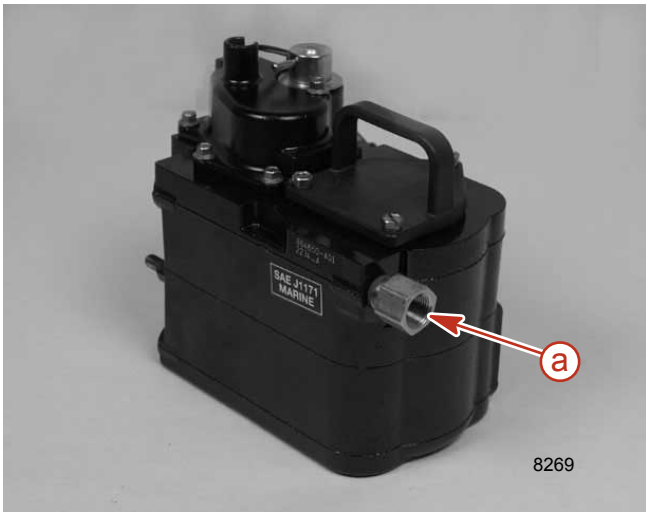
Improper installation of brass fittings or plugs into the fuel pump or fuel filter base can crack the casting, causing a fuel leak and possible fire or explosion. Always install fittings and plugs correctly, and do not tighten with power tools.

1. Install the fuel inlet adapter fitting:
   a. If the threads of the fuel inlet adapter fitting are not coated with pre-applied sealant, apply sealant to the threads.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel inlet fitting adapter	92-809822

b. Hand start the adapter fitting into the cool fuel module.

c. Tighten the adapter fitting to specification.



a - Fuel inlet adapter fitting

Description	Nm	lb. in.	lb. ft.
Fuel inlet adapter fitting	22	–	16

2. Install a fuel supply line fitting:

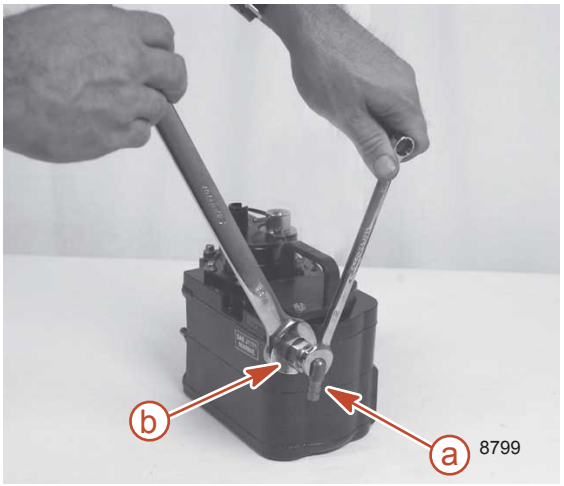
a. Apply sealant to the fuel supply line inlet fitting

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Fuel line inlet fitting to adapter.	92-809822

b. Install the fuel line inlet fitting by hand, finger-tight.

c. While holding the fuel inlet adapter fitting securely, tighten the fuel line inlet fitting 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 fitting.



Typical

a - Fuel line fitting (typical 90-degree hose barb)

b - Fuel inlet adapter fitting

Cooling System

Section 6A - Closed Cooling System

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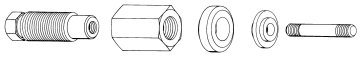
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bolt threads	92-809819
9	Loctite 567 PST Pipe Sealant	Connector threads Crossover mounting bolts Circulating pump mounting bolts	92-809822
19	Perfect Seal	Both sides of the poppet valve gasket O-rings	92-34227Q02
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821
68	Loctite 609	Retainer/seal	Obtain Locally
80	SAE Engine Oil 30W	Outer diameter of the bearings Seawater pump shaft	Obtain Locally
142	Loctite 598 RTV Sealant	Actuator housing wear plate	Obtain Locally

Special Tools

Pulley Pusher Installer	91-93656A1
 10047	Installs the pulley onto the power steering pump.

Power Steering Pump Pulley Remover	Kent Moore J-21239
 25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.

Pressure Cap and Cooling System Tester	Stant 12026
 48944	Adapter fits on the heat exchanger and aids in testing the pressure cap and cooling system

Belt Tension Gauge	Kent Moore BT-33-73-F
 39451	Measures serpentine belt deflection.

Specifications

Closed-Cooling System Capacity

All Models	Capacity	Fluid Type
Closed-cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water

Thermostat

All Models	Specification
Closed-cooling system thermostat	76° C (170° F)

Pressure Cap Rating

All Models	Specification
Closed-cooling system pressure cap	103 kPa (15 psi)

General Information

The 8.2 engine is fitted with a closed cooling system designed to keep the engine operating temperature at approximately 79º C (175º F) for optimum performance, fuel economy and durability. The Mercury MerCruiser closed cooling systems are sometimes called fresh water-cooling and use a combination of fresh water (antifreeze and water) and seawater for cooling. Refer to the cooling system flow diagram at the end of this section.

To monitor the cooling system, a temperature sensor is incorporated into the audio warning system, which alerts the operator of an abnormal condition if the temperature exceeds approximately 93º C (200º F).

NOTE: *This engine is not equipped with an analog temperature sender. When using analog gages an AGI box is required.*

The cooling system must receive a sufficient amount of seawater under all operating conditions to operate properly. The design and installation of the seawater supply system is the boat manufacturer's responsibility. Cooling system components must be constructed, sized, and installed in accordance with the following guidelines.

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

Seawater Supply System

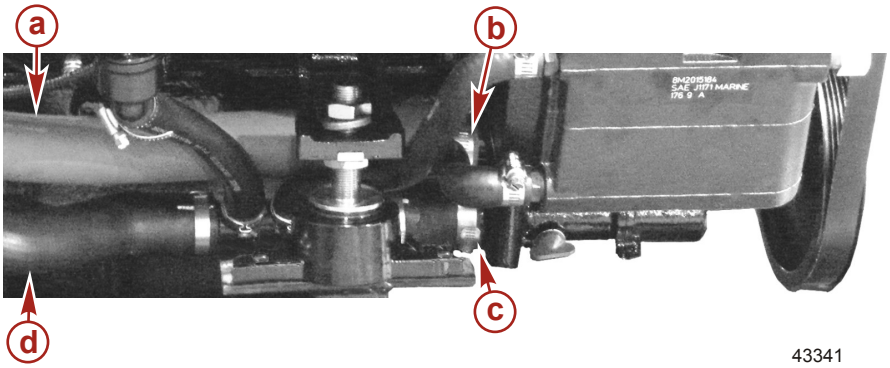
Seawater Supply Hose Specifications

Description	Hose and Connection	Vacuum
Seawater inlet hose	32 mm (1-1/4 in.) I.D. low restriction routing and connections	Able to support 34 kPa (10 in. Hg) (5 psi) of vacuum without collapsing hose
Seawater pickup		
Seacock (ABYC requirement)		
Sea strainer (optional)		

Seawater Inlet Hose

- A reinforced hose capable of supporting 34 kPa (10 in. Hg) (5 psi) vacuum must be used to prevent the seawater inlet hose from collapsing from pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible with the least number of bends to minimize restriction.
- All connections must be secured with hose clamps.

- Fasten the hose as appropriate to maintain proper routing and to prevent chafing or contact with other moving parts.



43341

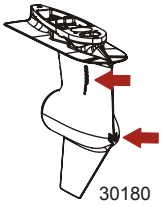
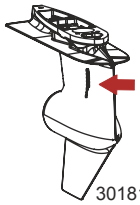
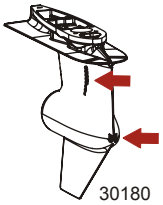
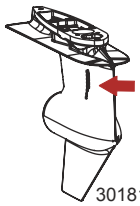
a - Seawater inlet hose
b - Hose clamp connection to pump inlet
c - Seawater outlet hose
d - Hose clamp connection to pump outlet

Sterndrive Seawater Supply

The 8.2 Bravo engine packages do not require additional seawater pickups if:

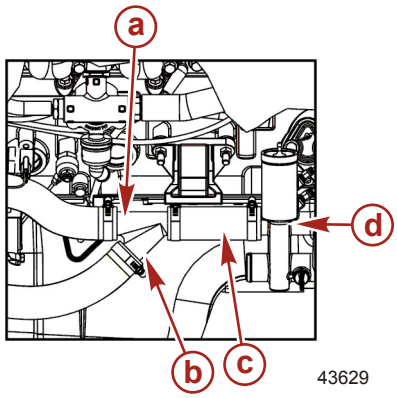
- The sterndrive gearcase has dual water pickups.
- The boat is capable of 64 km/h (40 mph) fully loaded and operated within the specified operating range.

The 8.2 Bravo Two sterndrive packages must have a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive side water pickups. Install the Y-fitting at the engine's seawater pump inlet. See **Installing the Y-Fitting**.

Seawater Pickups Required for 8.2 Engine Models with Bravo Sterndrive			
Boat speed with the maximum load operating within the specified range	**SeaCore Bravo has side water pickup**	**SeaCore Bravo has dual water pickup**	**Through-the-hull or through-the-transom seawater pickup**
64 km/h (40 mph) or greater		 30180	Not required, see **Installing the Seawater Supply Hose**
Less than 64 km/h (40 mph)	 30181	 30180	Required, see **Installing the Y-Fitting**
64 km/h (40 mph) or greater	 30181		Required, see **Installing the Y-Fitting**

Installing the Y-Fitting

All 8.2 engine models with Bravo Two sterndrive require a through-the-hull or through-the-transom seawater pickup and a Y-fitting at the engine seawater pump inlet port. The Y-fitting directs the seawater from the sterndrive and through-the-hull or through-the-transom seawater pickup to the engine's seawater pump to meet the minimum flow specifications.



- **a -** Y-fitting port to water inlet from sterndrive
- **b -** Y-fitting port to water inlet from through-the-hull or through-the-transom seawater pickup
- **c -** Hose 101.6 mm (4 in.) from seawater pump inlet to Y-fitting
- **d -** Engine seawater pump

NOTE: *The 8.2 engine models are not factory equipped with a Y-fitting, refer to* ***Mercury Parts Catalog, Closed Cooling Systems (Bravo)*** *to order one Y-fitting 864727, 3 hose clamps 815504222, and seawater supply bulk hose that meets MerCruiser specifications.*

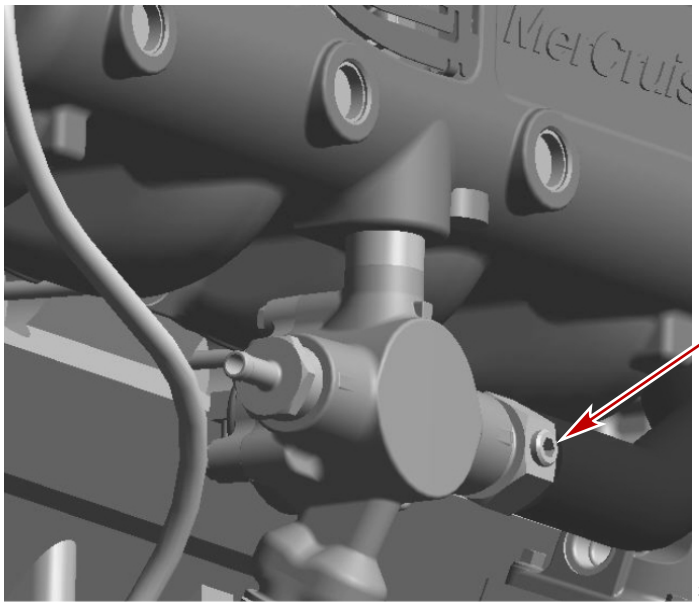
1. Cut a 101.6 mm (4 in.) length piece of the supply hose and install it to the seawater pump inlet and the Y-fitting.
2. Install a seawater supply hose to the Y-fitting and the sterndrive's water inlet at the transom. Cut off any excess hose as needed.
3. Install a seawater supply hose to the Y-fitting and the through-the-hull or through-the-transom seawater pickup. Cut off any excess hose as needed.
4. Properly secure all hoses to all fittings to prevent water leaking into the boat.

Propeller Shaft Log Seal Connection

NOTICE
Incorrectly installing the water supply hose to the shaft log seal can cause increased exhaust system corrosion or submersion or freeze damage due to siphoning. Position and securely fasten the water supply hose with a portion of the hose above the engine exhaust elbows.

1. Attach the shaft log seal cooling water hose to the access port in the reducer fitting, located on the poppet valve underneath the exhaust manifold. There are reducing fittings on the port and starboard manifolds.

IMPORTANT: Do not remove the reducer fitting, even if you are not using the shaft log seal. The reducer fitting has been carefully sized to maintain the proper pressure balance in the cooling system.



Shaft log seal access port

2. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows to prevent a siphoning action when the engine is not running
3. Fasten the hose securely to keep it properly positioned.

Installing the Hot Water Heater

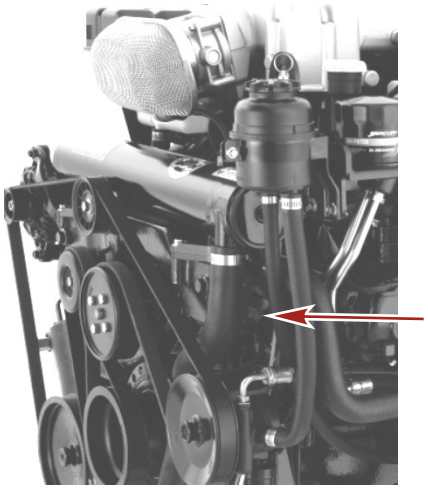
IMPORTANT: Hot water heater supply and return hoses must not exceed specification.

Hot Water Heater Hose Specification	
Supply hose	16 mm (5/8 in.)ID
Return hose	

When connecting a cabin heater or hot water heater:

- Use specified hot water heater supply and return hoses.
- Make the engine connections for the hot water heater only at the locations described in **Hose Connections**.
- Refer to the heater manufacturer's instructions for complete installation information and procedures.
- Do not reposition the engine temperature switch; it must remain where installed by the factory.
- Inspect the complete system for leaks after the heater is connected to the cooling system.

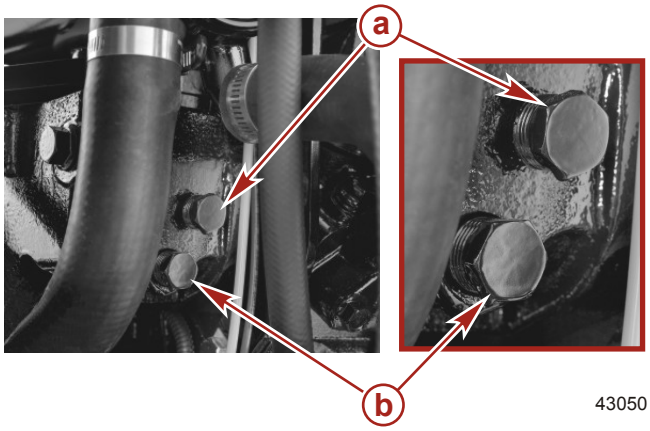
- Monitor the engine coolant temperature after the heater is connected.



43135

Location of the hot water heater connections

Connecting Hoses



43050

a - Heater supply (pipe plug)
b - Heater return (pipe plug)

NOTICE

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

1. Place a 4-liter (1 US gal) fluid catch container under the pipe plugs.
2. Remove the pipe plug from the heater supply and return locations on the engine. Properly dispose of the coolant.
3. Apply sealant to the threads of each hose connector and install. Tighten 1 to 2 turns beyond hand-tight.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Connector threads	92-809822

4. Install the supply and return heater hose to the appropriate connector and secure with a hose clamp.
5. Add clean coolant to the full level in the coolant reservoir. Secure the coolant pressure cap.

NOTICE

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

NOTICE

Blocking the coolant flow at the heater can cause reduced engine performance or overheating. Check for continuous coolant flow from the engine to the water circulating pump.

6. Supply cooling water to the engine.
7. If applicable, supply cooling water to the sterndrive.
8. Start the engine and check for leaks and adequate coolant flow.
9. Allow the engine to reach normal operating temperature. Ensure that engine temperature remains normal and that no leaks are present.

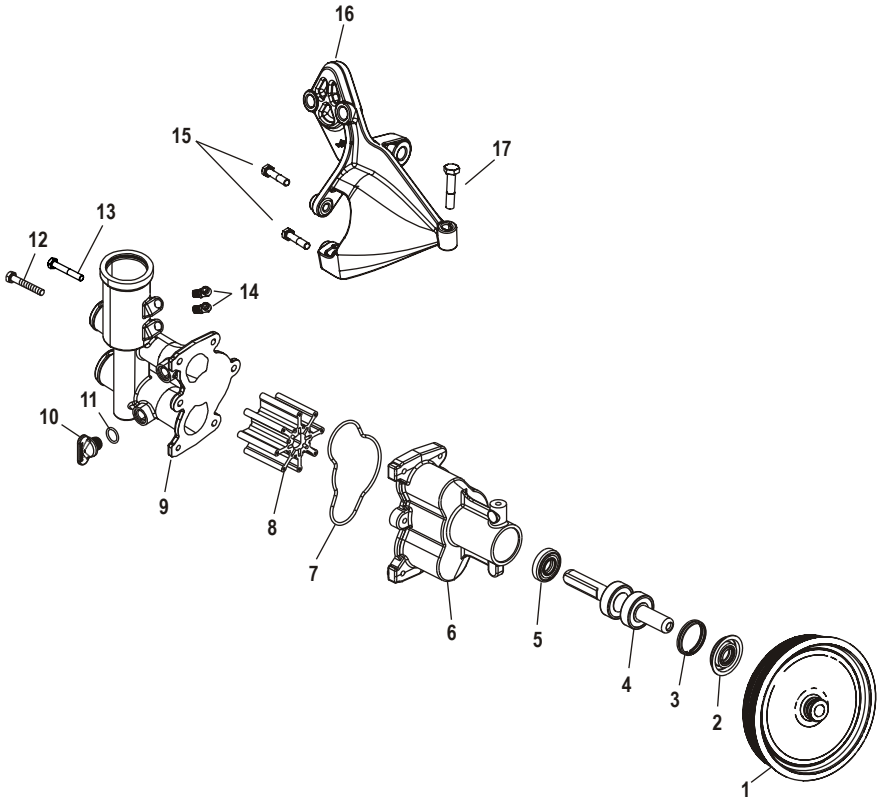
⚠ CAUTION

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

10. Stop the engine. If necessary, add new coolant to the full level in the coolant reservoir.

Seawater Pump Maintenance

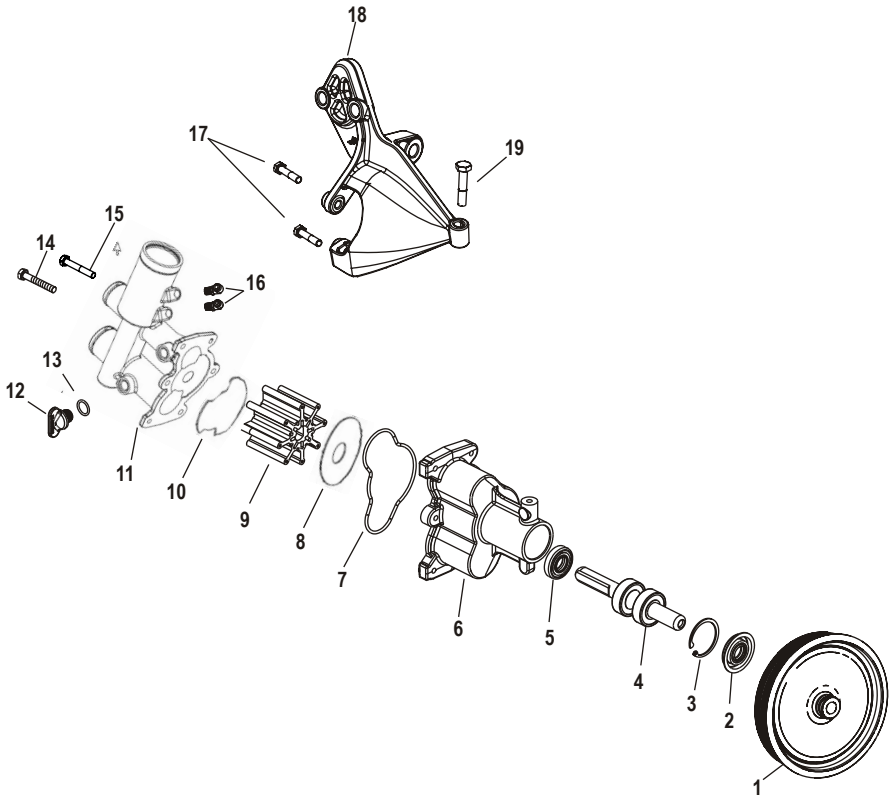
Seawater Pump Assembly



Seawater pump with air actuator

1 - Pulley
2 - Retainer seal
3 - Retainer ring
4 - Bearing shaft assembly
5 - Rear oil seal
6 - Seawater pump impeller housing
7 - O-ring
8 - Impeller
9 - Seawater pump actuator housing
10 - Drain plug
11 - O-ring
12 - Screw (M6 x 16)
13 - Screw (M6)
14 - Fitting (orange and gray)
15 - Screw (M6)
16 - Seawater pump bracket
17 - Screw (M6)

Seawater Pump Assembly With Wear Plate

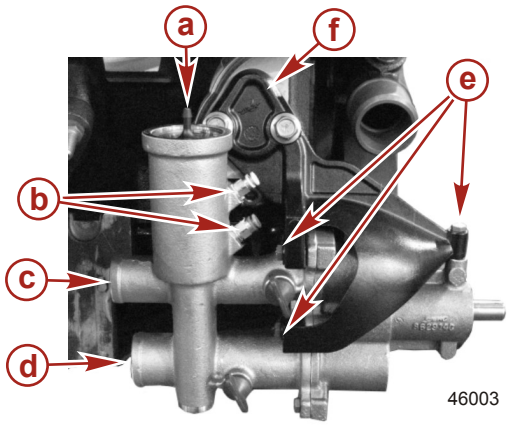


46198

1 - Pulley
2 - Retainer seal
3 - Retainer ring
4 - Bearing shaft assembly
5 - Rear oil seal
6 - Seawater pump impeller housing
7 - O-ring
8 - Impeller housing wear plate (if equipped)
9 - Impeller
10 - Actuator housing wear plate
11 - Seawater pump actuator housing
12 - Drain plug
13 - O-ring
14 - Screw (M6 x 16)
15 - Screw (M6)
16 - Fitting (orange and gray)
17 - Screw (M6)
18 - Seawater pump bracket
19 - Screw (M6)

Removal

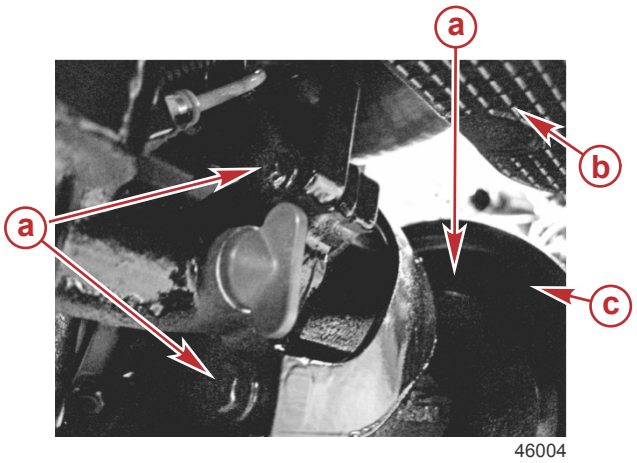
1. Drain the seawater section of the cooling system.
2. Remove the seawater inlet and outlet hoses from the aft side of the seawater pump.
3. Disconnect the vent hose from the top of the drain valve.
4. Disconnect the air hoses from the drain valve by pushing in and holding the plastic ring around the 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.
5. Remove the serpentine drive belt. Mark the direction of travel if the belt will be reused.
6. Remove the dual idler pulley bracket or the automatic tensioner bracket from the front of the engine.
   NOTE: *The seawater pump bracket mounts to the engine, sealing an opening on the engine block. The bracket should remain mounted to the engine whenever you are removing or installing the seawater pump.*
7. Remove the three screws securing the seawater pump to the bracket.
8. Remove the seawater pump from the bracket. Do not remove the bracket from the engine.



46003

Engine components and seawater pump pully removed for visual clarity

a - Drain valve vent hose fitting
b - Drain valve air hose fitting
c - Seawater inlet hose fitting
d - Seawater outlet hose fitting
e - Screw (seawater pump to bracket)
f - Seawater pump bracket on engine



46004

Seawater pump and pulley on the engine

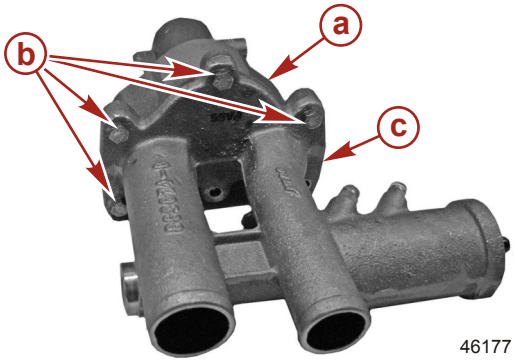
- **a -** Screw (seawater pump to bracket)
- **b -** Gen III fuel pump
- **c -** Seawater pump pulley

Disassembly

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the seawater pump pulley using an appropriate puller.
2. Remove the screws, and separate the impeller housing from the actuator housing.

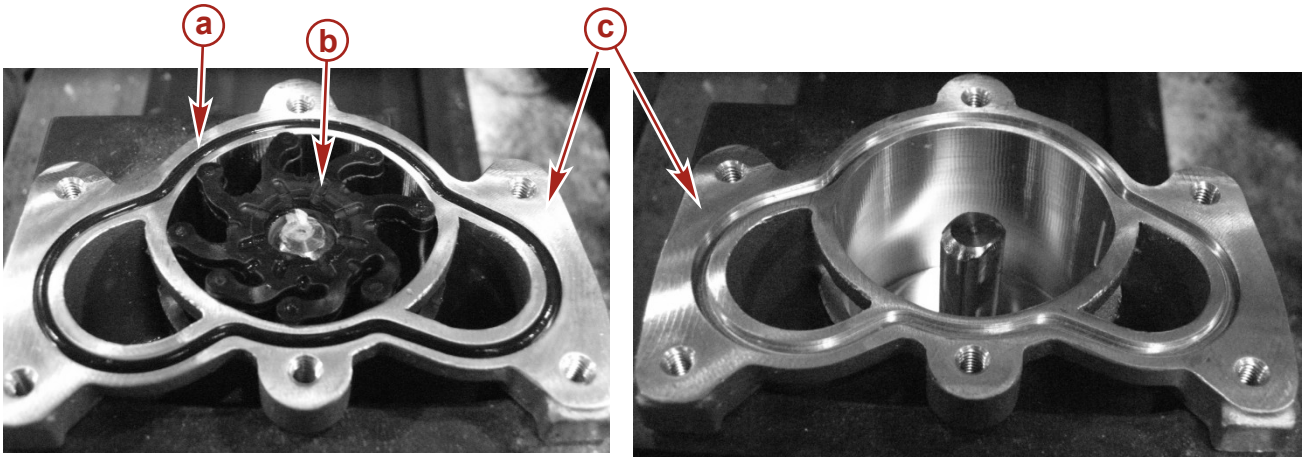


46177

Seawater pump assembly

- **a -** Impeller housing
- **b -** Screws
- **c -** Actuator housing

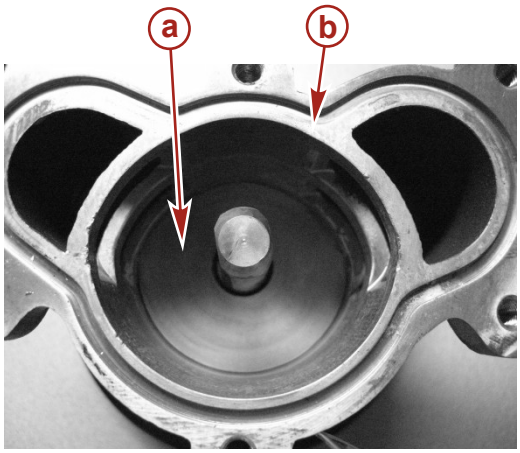
3. Remove the O-ring and the impeller.



46178

- **a -** O-ring
- **b -** Impeller
- **c -** Impeller housing

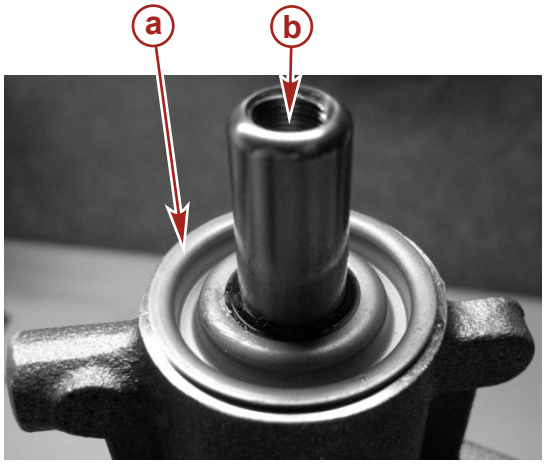
4. If equipped, remove the stainless steel plate.



46181

a - Stainless steel plate
b - Impeller housing

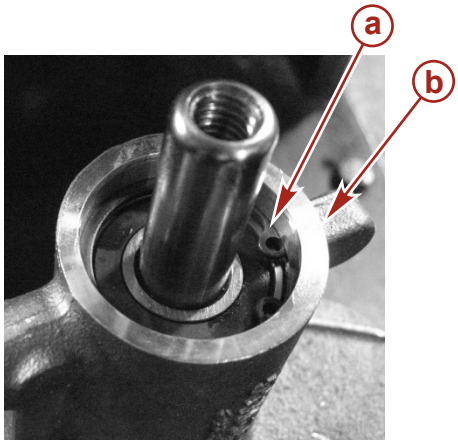
5. Remove the retainer seal.



46180

a - Retainer seal
b - Pulley end of bearing shaft

6. Remove the retainer ring.



46179

a - Retainer ring
b - Housing

7. Press the shaft and bearing assembly out of the housing from the impeller side.
8. Remove the rear oil seal.

Cleaning and Inspection

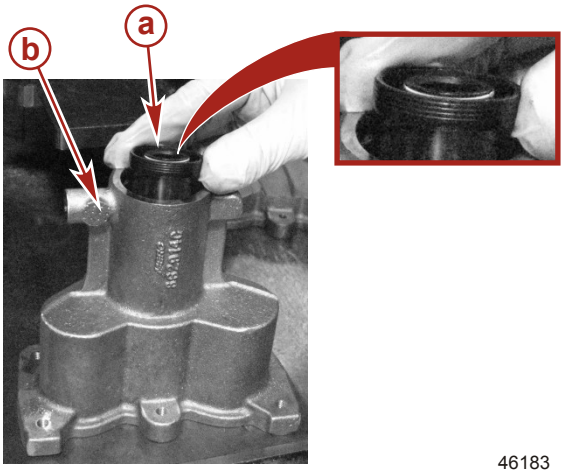
⚠ WARNING

Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air.

1. Clean the metal parts in solvent, and dry them with compressed air.
2. Clean all gasket material and sealant from the sealing surfaces.
3. Inspect the bearing housing. Examine its 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 damage or leaks.
5. Rotate the bearing shaft in the bearing housing. Replace the bearing shaft and bearing assembly if bearings feel rough or if either end of the shaft wobbles.
6. Inspect the impeller housing surfaces where the impeller rides. Replace the impeller housing if significant grooves exist.
7. Inspect the 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

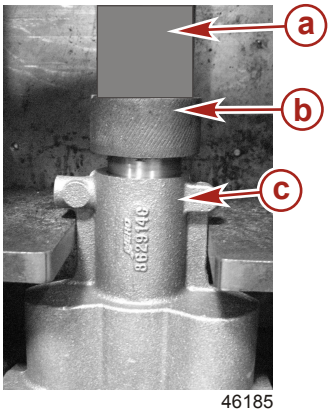
1. Install the rear seal with the spring toward the bearing shaft assembly.



46183

a - Spring on seal
b - Housing

2. Using a suitable mandrel, press the seal to seat it in the housing.



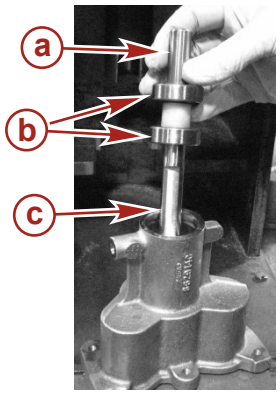
46185

a - Press
b - Suitable mandrel
c - Housing

3. **IMPORTANT: The bearing shaft assembly should slip easily into the bearing housing, using only minimal force.**
4. Lubricate the outer diameter of the bearings on the bearing shaft assembly.

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Outer diameter of the bearings	Obtain Locally

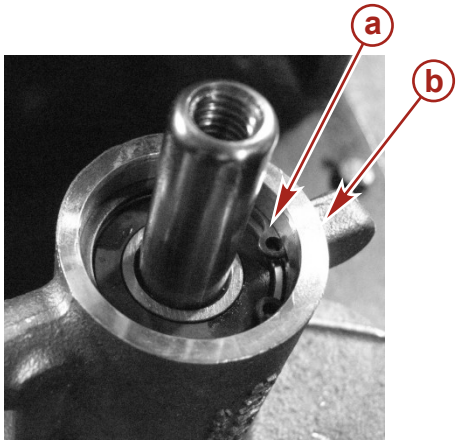
5. Install the bearing shaft assembly into the impeller housing. The end of the shaft with flat surfaces should extend into the impeller cavity. Clean any assembly lube or oil from the forward end of the impeller housing.



46186

a - Bearing shaft assembly
b - Outer diameter of the bearings
c - Shaft flat surfaces

6. Insert the retainer ring into the impeller housing.



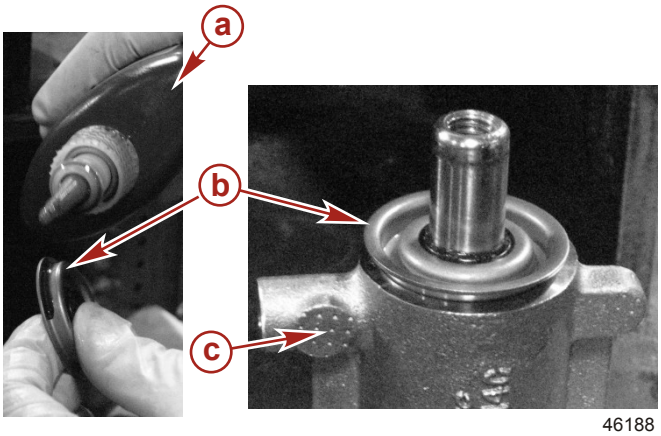
46179

a - Retainer ring
b - Housing

7. Apply adhesive to the outer diameter of the 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

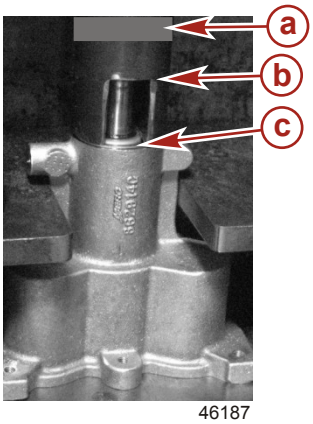
8. Install the retainer seal onto the bearing shaft assembly and slide it down until it contacts the end of the impeller housing.



46188

a - Sealant
b - Retainer seal
c - Housing

9. Press the retainer seal into place. Wipe away excess adhesive.

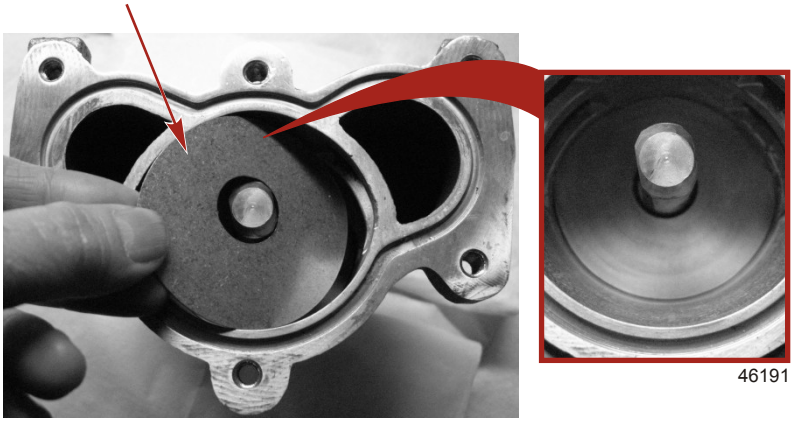


46187

a - Press
b - Suitable mandrel
c - Retainer seal

IMPORTANT: Only use the 0.030 in. inner wear plate in conjunction with the 0.030 in. shorter impeller. This impeller is marked orange on alternate vanes. The plate and shorter impeller come as a set when a new impeller is ordered.

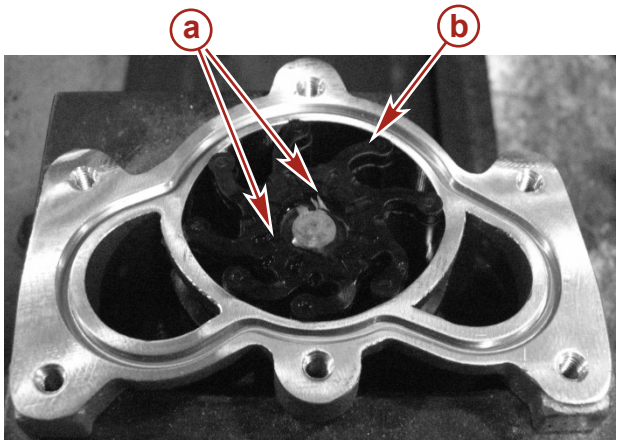
10. If equipped, install the stainless steel plate into the impeller cavity.



46191

Stainless steel 0.030 in. inner wear plate

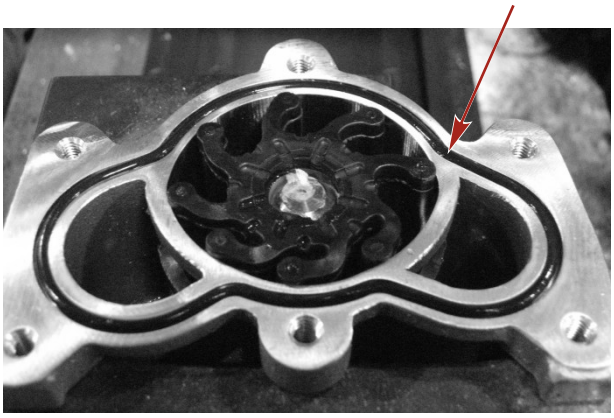
11. Lubricate the impeller with soapy water. Align the flat surfaces of the impeller hub and bearing shaft and install the impeller into the impeller cavity.



46189

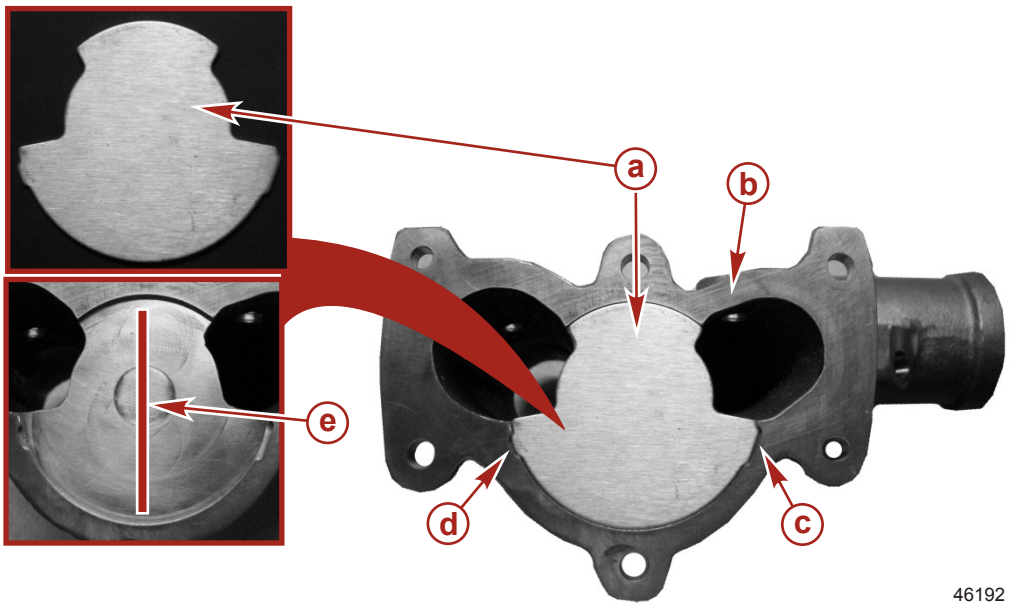
a - Flat surfaces
b - Impeller

12. Install the O-ring into the groove in the impeller housing rear face.



46190

13. If you have the design shown below, apply a 1/8-inch wide bead of adhesive across the actuator housing; then place the stainless steel wear plate on the housing with the tabs aligned. Bolt the assembly to the pump within five minutes.



a - Stainless steel wear plate
b - Actuator housing
c - Large tab
d - Small tab
e - Adhesive on housing

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Actuator housing wear plate	Obtain Locally

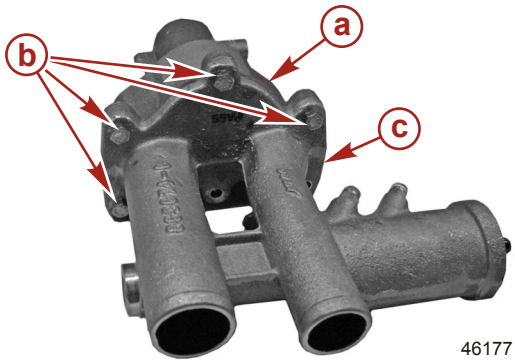
IMPORTANT: The following actuator housing styles will mate with both impeller styles.

a - Actuator housing style with milled even surface
b - Actuator housing style with wear plate

14. Align and install the actuator housing on the impeller housing assembly.
15. Screws that are reused may require loctite. Apply adhesive to the threads of the screws as necessary.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

16. Install the four screws and tighten to specification.



Seawater pump assembly
- **a -** Impeller housing
- **b -** Screws
- **c -** Actuator housing

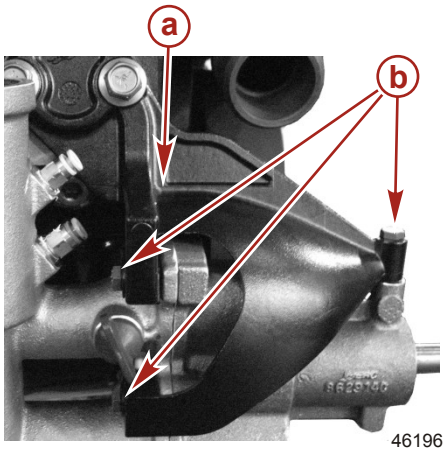
Description	Nm	lb. in.	lb. ft.
Impeller housing cover or the seawater pump actuator housing screw	10	88	–

Installation

1. Screws that are reused may require loctite. Apply adhesive to the threads of the three seawater pump bracket screws as necessary.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Impeller housing cover or seawater pump actuator housing screw	92-809821

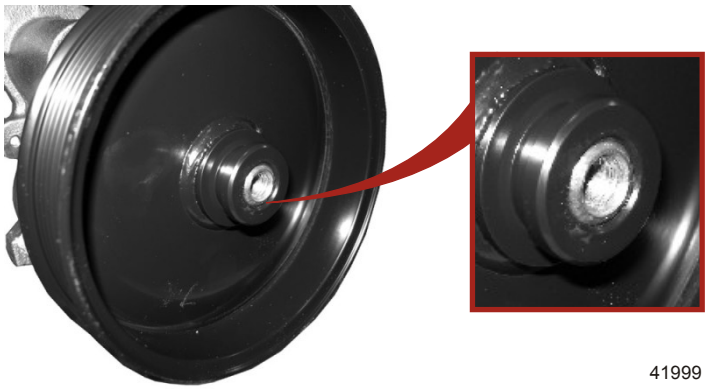
2. Install the seawater pump assembly onto the bracket on the engine. Hand-start two screws through the bracket and into the seawater pump assembly. Hand-start the screw that attaches the seawater pump bracket to the top of the seawater pump assembly.
3. Tighten the three screws to specification.



- **a -** Bracket
- **b -** Screw

Description	Nm	lb. in.	lb. ft.
Seawater pump bracket screws	10	88	–

4. Lubricate the seawater pump shaft and install the seawater pump pulley onto the shaft using an appropriate pulley installer. Ensure that the end of the shaft is even with the face of pulley hub.



Seawater pump pulley installed

Tube Ref No.	Description	Where Used	Part No.
80	SAE Engine Oil 30W	Seawater pump shaft	Obtain Locally

Pulley Pusher Installer	91-93656A1
Power Steering Pump Pulley Remover	Kent Moore J-21239

5. If removed, install the blue drain plugs in the seawater pump cover or actuator housing.
6. Install the dual idler pulley bracket or idler/tensioner bracket onto the studs in front of the cylinder block using the nuts previously removed.
7. Tighten the nuts to the specified torque.

Description	Nm	lb. in.	lb. ft.
Idler pulley bracket or idler/tensioner bracket	50	–	37

8. Install the seawater inlet and outlet hoses. Tighten the hose clamps securely.
9. 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.*
10. 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 the engine serpentine belt is to be reused, it should be installed in the same direction of rotation as before.
11. Install the serpentine drive belt.

NOTICE

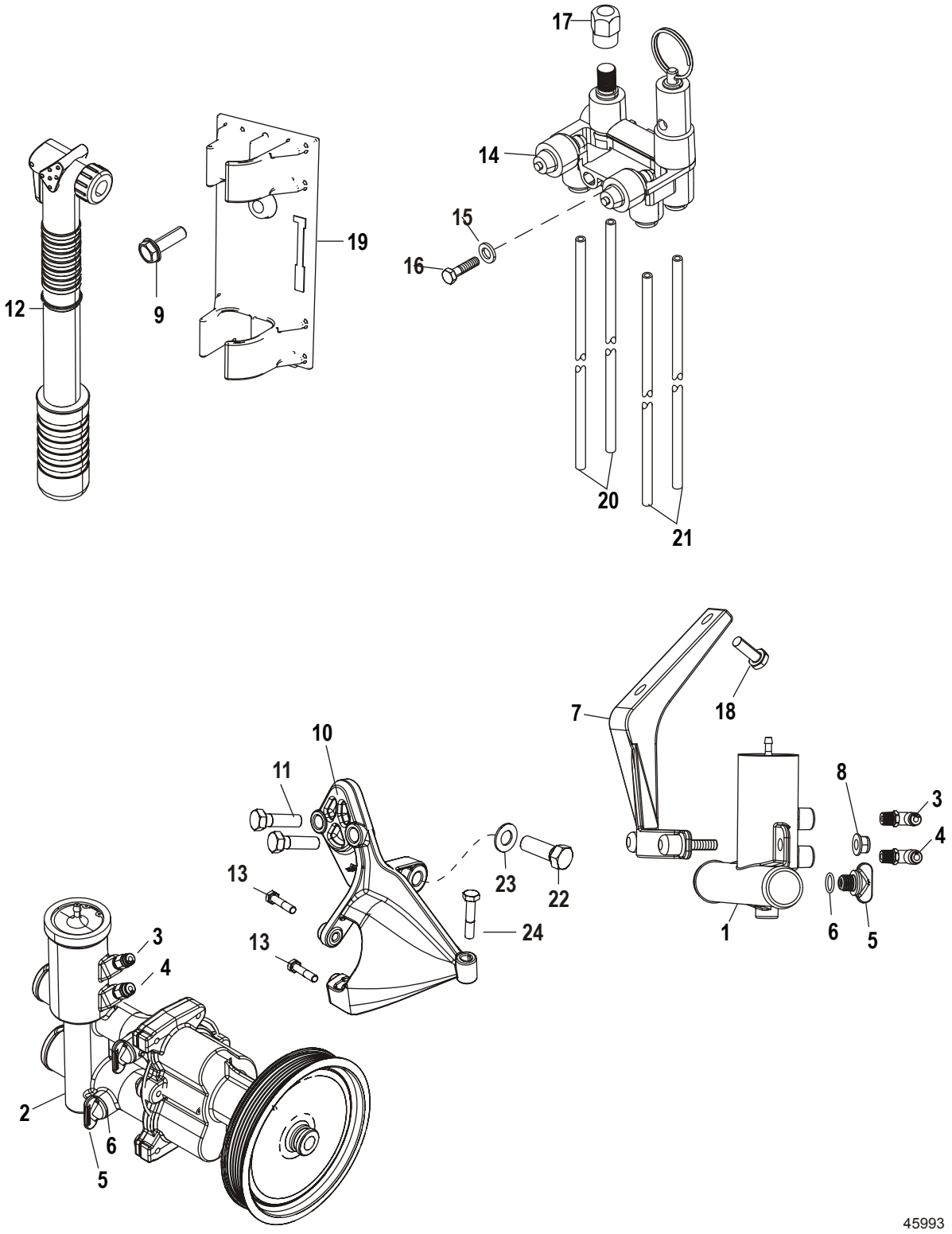
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

12. Supply cooling water.
13. Start the engine and check for leaks.

Notes:

Air-Actuated Drain System

Air-Actuated Drain System Exploded View



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	Screw (#12-11 x .750)
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	Washer
16	2	Screw
17	1	Service point cap
18	1	Screw
19	1	Air pump bracket
20	2	Green air line
21	2	Gray air line
22	1	Screw (.437 - 14 x 1.250)
23	1	Washer (.453 x .875 x .060)
24	1	Screw

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

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

⚠ CAUTION

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

1. Remove the boat from the water.
2. Using the hand pump or other air source, pump air into the system until both of the green indicators extend and the manual release valve opens to relieve excess pressure. If one or both of the green indicators have not extended when the relief valve opens, the corresponding air-actuated drain valve has not opened and may be seized.
3. Release the compressed air from 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

Removing the snap ring from the top of the air-actuated drain valve can allow the components to come apart forcefully, resulting in injury or product damage. Do not try to repair the valve or remove the snap ring.

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

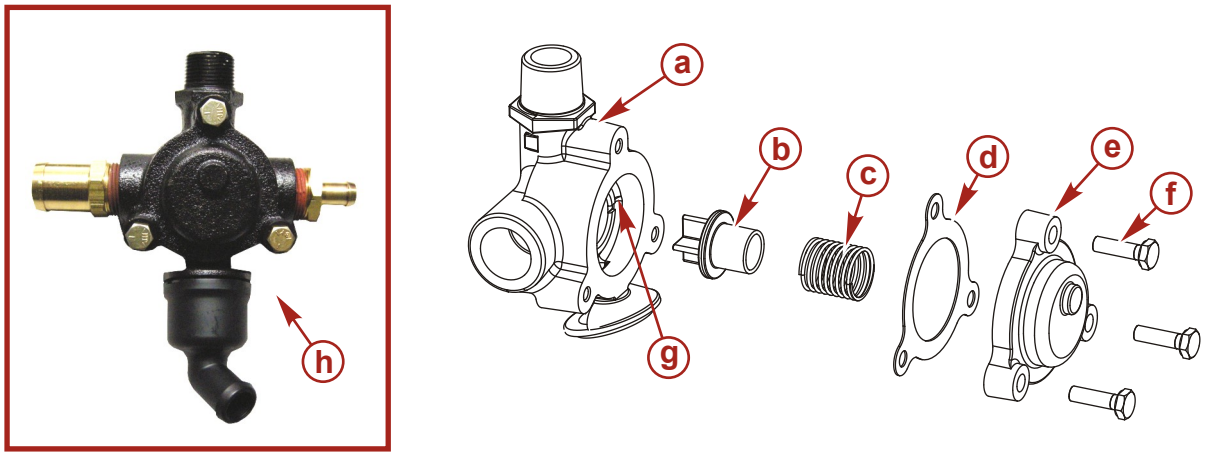
Connect the vent hose to top of drain valve. Route the vent hose the same as it was before removal.

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 Poppet Valve

Disassembly

1. Drain the water from the engine's seawater cooling passages.
2. Disconnect the hoses from the poppet valve housing.
3. Remove the screws and thermostat cap.
4. Remove the spring, gasket, and poppet.



a - Poppet valve housing
b - Poppet
c - Spring
d - Poppet cover gasket
e - Thermostat cap
f - Screw
g - Bypass slot
h - Poppet valve assembly

5. Discard the existing gasket.

Inspection

1. Inspect the bypass slot. If the passage is clogged, clean it. If the passage is rusted, replace the valve.
2. Check all parts for excessive wear. Replace as necessary.

Assembly

Different engine models use different, color-coded springs. Ensure that you install the correct spring.

Model	Spring Color
8.2 models	Silver

1. Remove all gasket material from the mating surfaces on the housing.
2. Coat both sides of a new gasket with Perfect Seal.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	Both sides of the poppet valve gasket	92-34227Q02

3. Install the new components. Tighten the screws to specification.
4. Connect the inlet and outlet hoses. Tighten the hose clamps to specification.

Description	Nm	lb-in.	lb-ft
Poppet valve cap screws	11	8	–
Hose clamps	3	26	–

5. Start the engine and check for leaks.

Exhaust Manifold Drain Check Valve

General Information

Some engine models are equipped with drain check valves located on the port and starboard exhaust manifolds. The drain check valve is a non-serviceable item.

47230

Closed Cooling

Description

Closed cooling is a standard feature on some models and is available as an accessory or a factory installed option on others. When closed cooling is used, a mixture of antifreeze and water is circulated through the water jackets in the engine block, cylinder heads, and—on some applications—the exhaust manifolds to dissipate the heat. Refer to Water Flow Diagrams. This coolant is then passed though a heat exchanger. Here the coolant rejects heat to seawater (water in which the boat is being operated), which is simultaneously being passed through the exchanger. The heat is then carried away by the seawater and discharged overboard via the exhaust elbows. The design of the heat exchanger allows for the transfer of heat, while ensuring that the two coolants are separated. In this manner, the expensive engine components are never exposed to seawater, which can be corrosive in salty, polluted, or mineral laden water areas.

Mercury MerCruiser's closed cooling systems are developed by the same people who design our engines to ensure compatibility and the same high quality standards. Our systems employ several exclusive features to provide unsurpassed cooling efficiency and durability. An exclusive double-acting thermostat is used on V6 and V8 models, which provides increased coolant velocity through the engine and heat exchanger to prevent hot spots and improve performance. Mercury MerCruiser's heat exchangers also incorporate several state-of-the-art designs to enhance the heat transfer between the coolants for an additional margin of cooling capacity. Features like these allow our systems to continually operate at WOT in water temperatures up to 38 °C (100 °F), where most after-market systems fall short of this mark. This additional cooling capacity translates into longer cooling system life with fewer problems regardless of where the boat is operated. Contact your sales representative to order your closed cooling systems factory installed or refer to the Mercury Precision Parts and Accessories Guide to obtain the part numbers for the accessory kits.

Antifreeze Recommendations

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Factory installed closed cooling systems come filled with an extended life antifreeze. This coolant allows for a service interval of 5 years or 1000 hours (whichever occurs first), versus 2 years or 400 hours for standard antifreeze. When adding coolant to these systems (i.e. when filling coolant recovery bottle, installing hot water heater), we recommend that only an extended-life antifreeze be used. Mixing this coolant with even a small amount of regular antifreeze will require that the service interval be reduced 2 years. If you are installing closed cooling kits at your facility, we would also encourage you to use the extended Life coolant to allow your customer to take advantage of the reduced maintenance costs.

Pre-mixed extended life coolant is available from Quicksilver or can be purchased at most automotive stores and other locations where antifreeze is sold. Extended-life coolant is available from Texaco under the name Havoline Extended Life Dex Cool. Prestone also offers a version of this antifreeze called Extended Life 5/100. Only coolants that state that they are compatible with Dex Cool should be used. Extended-life coolants can be identified by their orange color (vs. green for standard coolant) and their corresponding orange cap on the container.

All antifreeze should be mixed 50/50 with pure water (Quicksilver coolant is already pre-mixed). If installing closed cooling kits at your facility, be sure to observe the special filling procedure in the installation instructions.

IMPORTANT: All capacities are approximate fluid measures.

All Models	Capacity	Fluid Type
Seawater cooling system (winterization use only)	20 L (21 US qt)	Propylene glycol and purified water
Closed cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

NOTICE

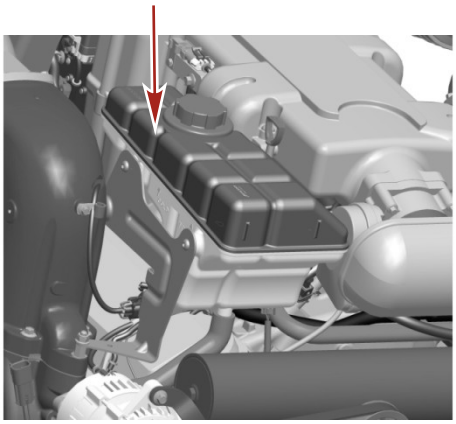
Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

Coolant Recovery System

All Mercury MerCruiser systems with closed cooling are equipped with a coolant recovery system that must be installed by the boat manufacturer. The coolant recovery bottle mounting location must meet these requirements:

- Install within approximately 122 cm (4 ft.) of the heat exchanger filler neck to allow connection with tubing provided.
- Install so the bottle is even with or slightly above the heat exchanger filler neck.

- The recovery bottle must be accessible for observing level and servicing coolant.



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Coolant recovery bottle

Changing Coolant

Coolant Recommendations

NOTICE

Using propylene glycol antifreeze in the closed cooling system can damage the cooling system or the engine. Fill the closed cooling system with an ethylene glycol antifreeze solution suitable to the lowest temperature to which the engine will be exposed.

NOTE: *The closed cooling system comes filled with Extended Life 5/100 Coolant. This antifreeze requires draining and replacing every five years or every 1000 hours of operation, whichever comes first. Mixing coolants that do not meet the same specification will require more frequent replacement intervals.*

Draining

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the coolant into a suitable container.

Cleaning and Flushing

The closed-cooling system should be cleaned at least once every five years or whenever decreased cooling efficiency is experienced.

NOTE: *The five-year time frame is based on using Extended Life Coolant. Refer to the coolant manufacturer's change intervals when other coolants are used.*

An automotive cooling system cleaning solution may be used to remove the rust, scale or other foreign material. Always follow the manufacturer's instructions supplied with the cleaner.

Flush in the opposite direction of the normal coolant flow to flush out the deposits that are lodged in the coolers or the heat exchanger. Refer to the instructions that accompany the flushing device.

Filling

⚠ CAUTION

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

NOTE: *The closed cooling system comes filled with Extended Life 5/100 Coolant. This antifreeze requires draining and replacing every five years or every 1000 hours of operation, whichever comes first. Mixing coolants that do not meet the same specification will require more frequent replacement intervals.*

1. Remove the pressure cap from the coolant reservoir.
2. Fill the reservoir to the "FULL" mark with the recommended coolant solution.

All Models	Capacity	Fluid Type
Closed-cooling system	14.3 L (15 US qt)	Mercury Extended Life Coolant Antifreeze or extended life ethylene glycol 5/100 antifreeze mixed 50/50 with purified water

3. Replace the pressure cap.

NOTICE

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

4. With the engine running:
   - ☐ Check the hose connections, fittings, and gaskets for leaks.
   - ☐ Monitor the engine coolant temperature. If the coolant temperature exceeds the normal operating temperature of 76° C (170° F), stop the engine immediately and determine the cause.

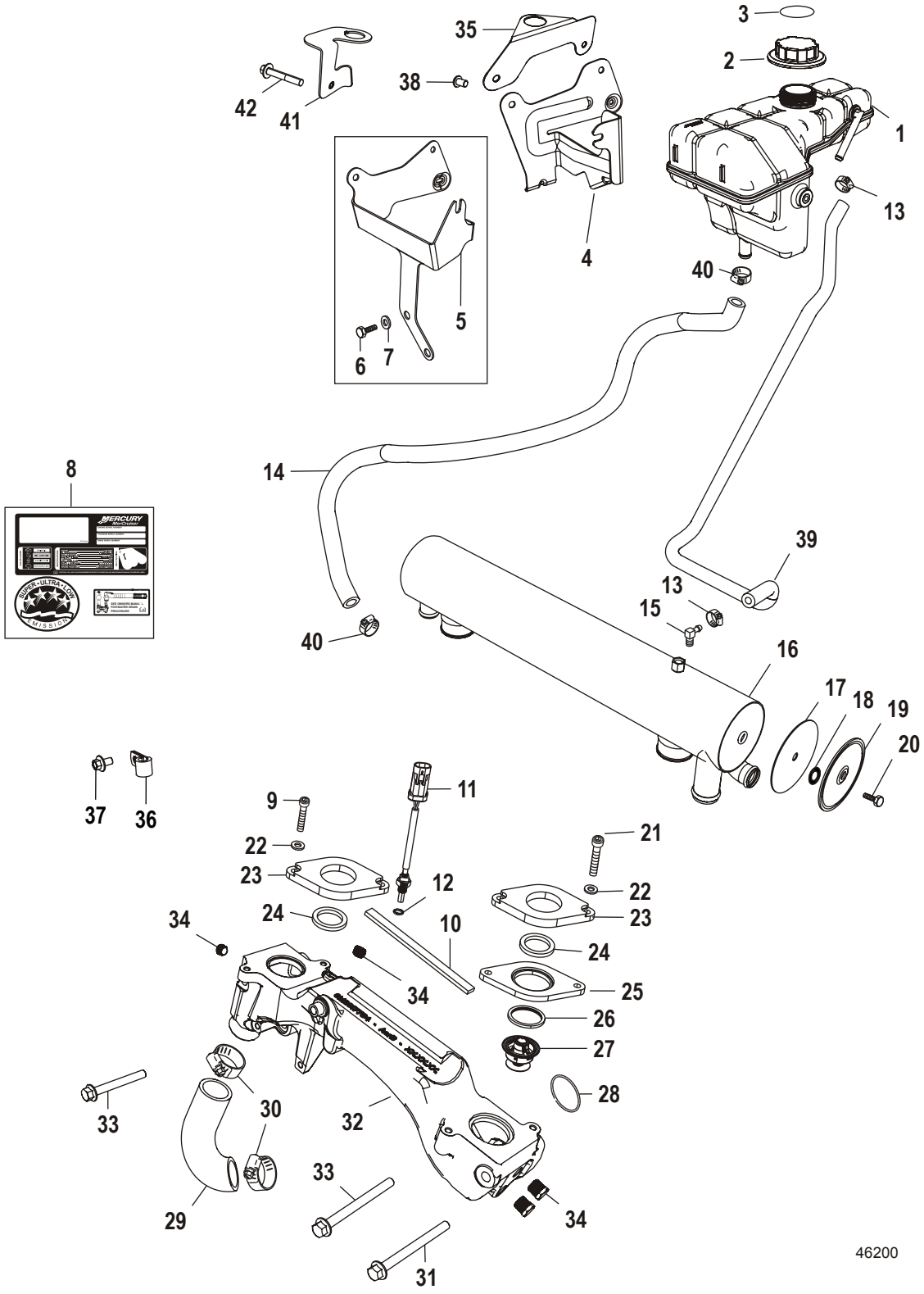
⚠ CAUTION

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

5. Stop the engine and add coolant to bring the coolant level to the "FULL" mark, if necessary.

Closed Cooling System

Closed-Cooling System Exploded View



Ref. No.	Qty.	Description
1	1	Coolant reservoir
2	1	Coolant reservoir cap
3	1	Engine coolant decal
4	1	Coolant reservoir bracket (SN 1A351717 and below)
5	1	Coolant reservoir bracket (SN 1A351718 and above)
6	2	Screw
7	2	Washer
8	1	Decal set
9	2	Screw
10	2	Foam strip
11	1	Coolant temperature sensor
12	1	O-ring
13	2	Worm gear clamp
14	1	Reservoir-to-circulating-pump hose
15	1	Heat exchanger
16	1	90-degree elbow fitting
17	1	Heat exchanger
18	1	O-ring
19	1	Cover
20	1	Screw (0.375-16 x 0.750)
21	2	Screw (M8 x 30)
22	4	Washer
23	2	Heat exchanger plate
24	2	Quad ring
25	1	Heat exchanger plate
26	1	Thermostat seal
27	1	Thermostat
28	2	O-ring
29	1	Crossover to water circulating pump hose
30	2	Worm gear hose clamp
31	1	Screw
32	1	Coolant crossover
33	2	Lower crossover screw
34	4	Brass pipe plug
35	1	Flush mount bracket
36	1	Clip
37	1	Stainless steel screw (M6 x 12)
38	1-3	Screw (M8 x 1.25)
39	1	Coolant bleed hose
40	2	Worm gear clamp
41	1	Flush mount bracket (MIE V-drive)
42	1	Flush mount bracket screw (M8 x 20) (MIE V-drive)

Closed-Cooling System Tests

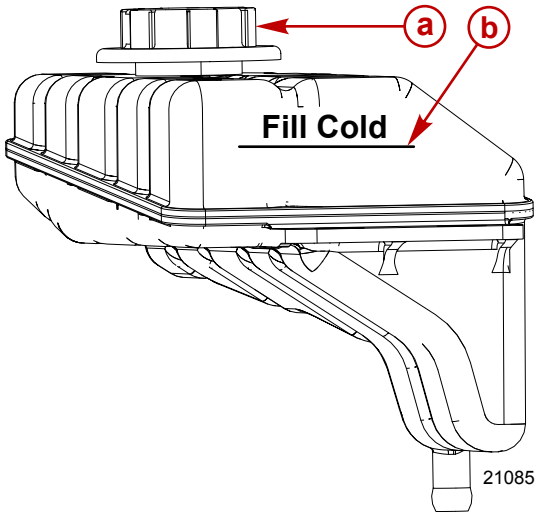
Pressure Test

The pressure cap is designed to maintain 103 kPa (15 psi) of pressure in the closed-cooling system. A pressurized system forces coolant into otherwise hard-to-reach areas of the engine. The pressure cap must be cleaned and inspected periodically to ensure proper operation of the cooling system.

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir. Wash the cap with clean water to remove any deposits or debris. Inspect the cap for cuts, cracks, or other signs of deterioration. Replace the cap if necessary.
2. Clean the sealing surfaces on the coolant reservoir. Inspect the surfaces for any damage or deposits that may prevent the cap from sealing properly.
3. Adjust the coolant level to the "FULL" mark on the coolant reservoir.



a - Pressure cap
b - Fill line

4. Attach a suitable pressure tester to the reservoir and pressurize the system to the amount specified in the following table.

Pressure Cap and Cooling System Tester	Stant 12026

NOTE: *An automotive radiator tester can be used to pressurize the closed-cooling system. Follow the instructions in the tester kit.*

Pressure cap rating	Test pressure
103 kPa (15 psi)	131 kPa (19 psi)

5. Monitor the gauge reading for approximately two minutes. If the pressure decreases, complete the following steps to locate the source of the leak.
6. While maintaining the specified pressure on the closed-cooling system, visually inspect the cooling system hoses, gaskets, drain plugs, petcocks, core plugs, and circulating pump seals for leaks. A bubbling or hissing sound may be heard at the source of the leak.
7. If there is no visual indication of a leak, the engine is leaking internally, and normally it is the result of one or more of the following:
   - A loose cylinder head bolt or a damaged head gasket
   - A loose intake manifold bolt or a damaged manifold gasket
   - A cracked, warped, or porous cylinder head or block
   - A cracked or porous exhaust manifold
8. To locate the source of the internal leak:
   a. Start the engine. Repressurize the system to the previously specified amount while monitoring the pressure gauge on the tester. If the gauge needle vibrates, the compression or combustion pressure is leaking into the closed cooling system from the combustion chamber.

b. Stop the engine. Remove and examine each spark plug. A spark plug that is perfectly clean or has a milky appearance indicates the presence of coolant.

c. Drain the oil from the engine. The oil will appear milky if there is coolant present. If any coolant is present, the engine will have to be disassembled and inspected.

Coolant Alkalinity Test

⚠ CAUTION

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

The coolant in the closed-cooling system should be changed according to the **Maintenance Schedule** recommendations, and the coolant 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 need not be replaced.
4. If the pink litmus paper remains pink, the coolant is not alkaline and must be replaced, refer to **Changing Coolant.**

Heat Exchanger and Crossover Assembly

Heat Exchanger

Internal Leaks

An internal leak will cause the coolant to enter the seawater system when the pressure in the closed-cooling system is greater than the pressure in the seawater system.

1. Remove a seawater hose from the heat exchanger. Do not drain the heat exchanger.
2. Pressurize the closed-cooling system with a suitable pressure tester.

   NOTE: *An automotive radiator tester can be used to pressurize the closed-cooling system.*

Pressure Cap Rating	Test Pressure
103 kPa (15 psi)	131 kPa (19 psi)

3. If seawater begins to flow from the hose fitting, one or more of the tubes inside the heat exchanger is leaking and the heat exchanger needs to be replaced.

Water Blockage

⚠ CAUTION

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

IMPORTANT: The seawater flows through the tubes in the heat exchanger and the coolant flows around the tubes.
One way to determine whether the closed-cooling side of the heat exchanger is blocked is to feel the heat exchanger during the engine warm-up period. As the engine reaches normal operating temperature, the thermostat will open and start to direct the coolant from the port side of the heat exchanger across to the starboard side of the heat exchanger. The temperature change can be felt approximately 76 mm (3 in.) inboard from either end of the heat exchanger.

1. Remove the end caps and visually inspect the tubes for a blockage. If the tubes are corroded or blocked, clean the water passages by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
2. Disconnect the closed-cooling system hoses from the heat exchanger and inspect the tubes just inside the hose fitting.

   NOTE: *If the tubes are coated with mineral deposits, the deposits will act as an insulator and reduce the cooling efficiency of the heat exchanger. This may be the result of not changing the antifreeze at the proper intervals or diluting the antifreeze with water that was not de-ionized or distilled.*
3. The closed-cooling side of the heat exchanger cannot be thoroughly inspected. The heat exchanger must be replaced if it is suspected of being blocked or if the cooling efficiency is compromised.

Heat Exchanger and Crossover

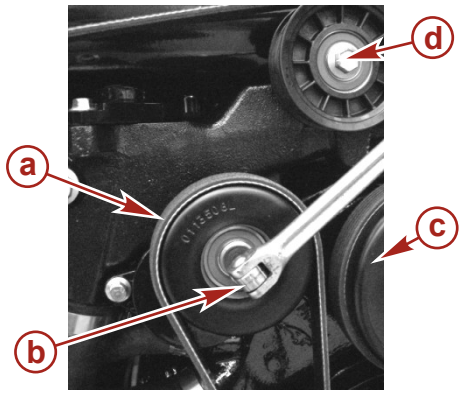
Removal

⚠ CAUTION

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

IMPORTANT: The heat exchanger is removed with the crossover as an assembly.

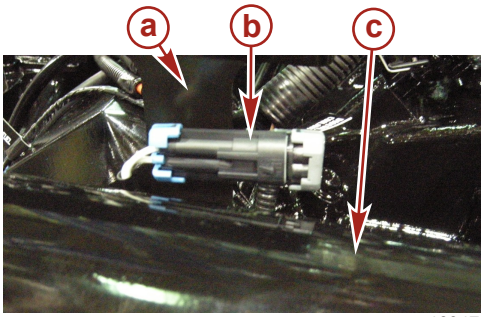
1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts. Drain the coolant into a suitable container.
3. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner away from the belt until it stops.
   IMPORTANT: If a belt is to be reused, it should be reinstalled with the same direction of rotation.
4. Remove the serpentine belt from the idler pulley; then slowly relieve the tension on the breaker bar and remove the belt.



43776

a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley

5. Disconnect the coolant temperature sender connector from the engine harness.

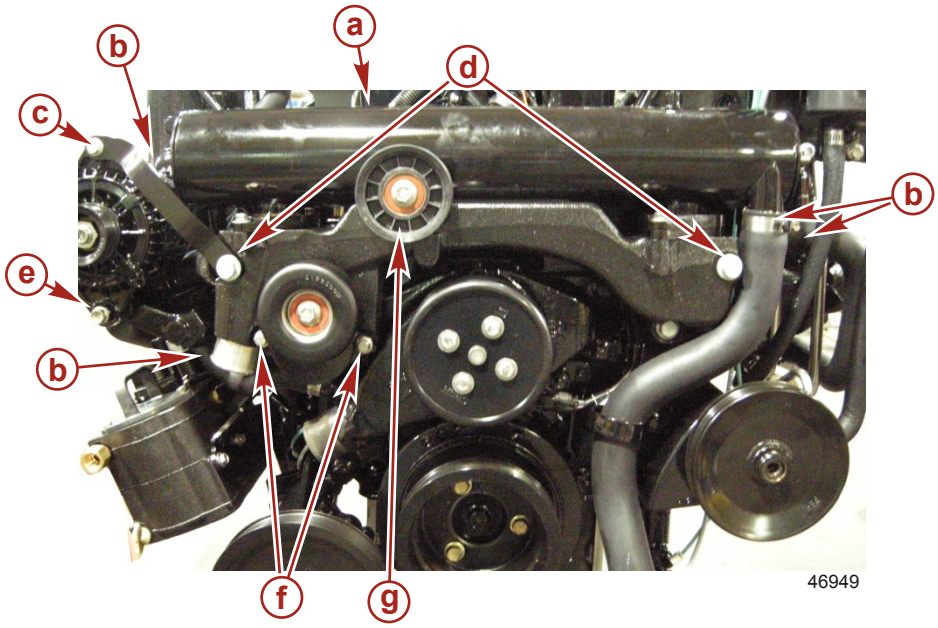


46947

a - Reservoir bracket
b - Coolant temperature sender connector
c - Heat exchanger

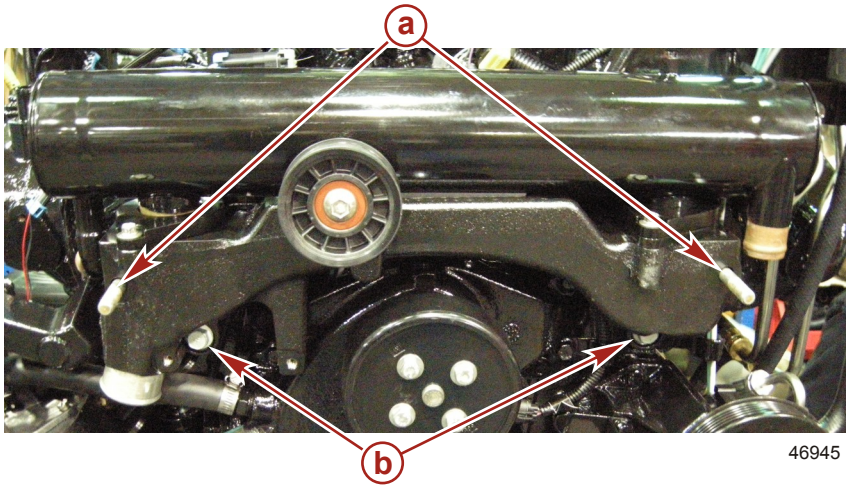
6. Remove the harness connections from the alternator.
7. Loosen the top and bottom alternator mounting bolts.
8. Remove the upper bolts securing the crossover to the cylinder heads, and install suitable alignment studs to temporarily secure the assembly during removal.
9. Rotate the alternator away from the heat exchanger.
10. Disconnect all of the hoses connected to the heat exchanger and the crossover.
11. If you are replacing the crossover, remove the idler pulley from the crossover.

12. Remove the tensioner pulley mounting bolts and tensioner pulley from the crossover.



a - Coolant temperature sender
b - Hose
c - Upper alternator bolt
d - Upper crossover bolt
e - Bottom alternator bolt
f - Tensioner pulley bolt
g - Idler pulley

13. Remove the lower mounting bolts securing the crossover.
14. Pull the crossover and heat exchanger assembly from the engine.



a - Alignment stud
b - Lower mounting bolt

Assembly and Mating Surface Inspection

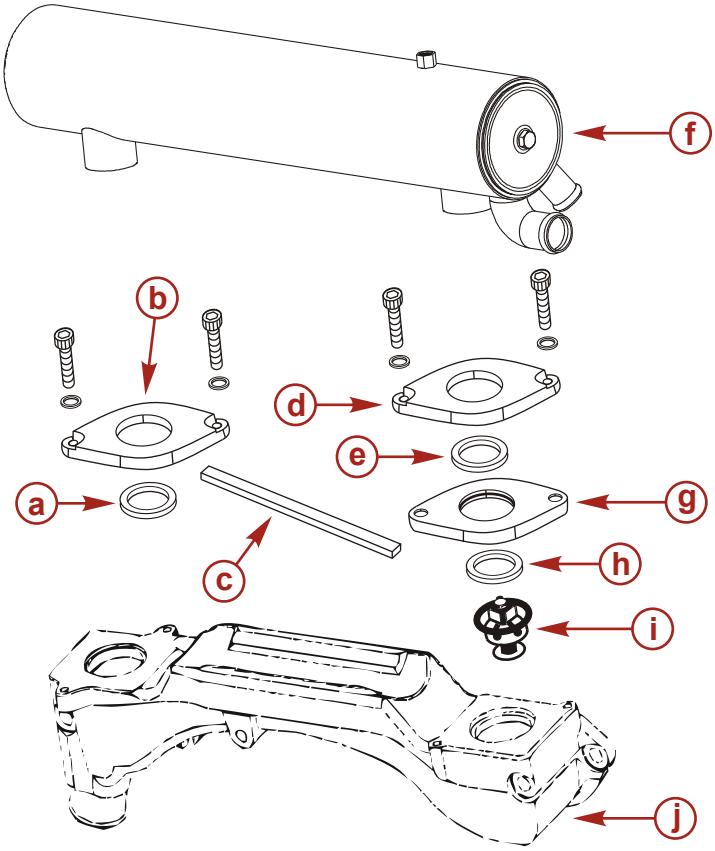
1. Clean the seal grooves with acetone or equivalent and inspect sealing surfaces for cracks or pitting.

   NOTE: *If any leak in the seal area resulted from a cracked or pitted seal surface, the cylinder head or crossover will have to be replaced.*
2. Inspect pipe plugs for cracks.
3. Inspect hose connections for wear and debris, clean or repair as needed.

Heat-Exchanger-to-Crossover Disassembly

1. Remove the heat exchanger retainer bolts.

2. Lift the heat exchanger off of the crossover and remove the thermostat assembly.

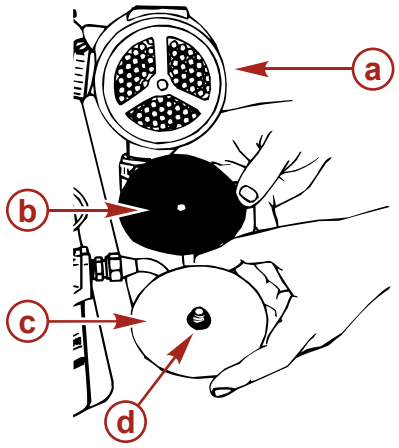


6746

a - Starboard heat exchanger seal
b - Starboard plate
c - Foam strip
d - Port upper plate
e - Port heat exchanger seal
f - Heat exchanger
g - Port lower plate
h - Thermostat seal
i - Thermostat
j - Crossover

Hear Exchanger Inspection, Cleaning, and Repair

1. Remove the end plates attached to each end of the heat exchanger.
2. Discard the O-rings and gaskets.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - O-ring

3. Inspect the tubes for damage.
   IMPORTANT: Clean the seawater section once every two years or whenever decreased cooling efficiency is suspected.
4. Clean the seawater section.
   a. Remove any gasket material from the end plates and heat exchanger.
   b. Clean each water passage with a suitable size wire brush.
   c. Remove the loose particles from the water passages with compressed air.
5. If applicable, repair a leaking tube.

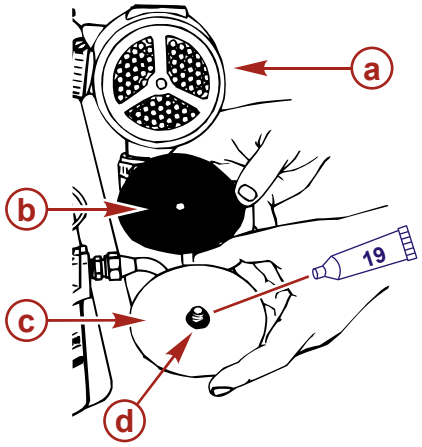
IMPORTANT: Repairing a leaking tube in the heat exchanger is a short term fix. Replace the heat exchanger as soon as practical. Do not close more than three tubes.

a. Clean and air dry the surface.
b. Protect the other joints in the vicinity of the repair.
c. Braze the tube shut at both ends with BCUP 2 rod or silver solder.

IMPORTANT: Always install new seals whenever the end covers have been removed from the heat exchanger.

6. Apply sealant to both sides of the O-ring.
7. Assemble the bolt, end plate, and O-ring as shown.

NOTE: *Be sure to install the O-ring between the end plate and the gasket.*



6748

a - Heat exchanger
b - Gasket
c - End cap
d - O-ring

8. Install the gasket between the heat exchanger and end plate assembly.
9. Hand-start the bolt and tighten to specification.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bolt threads	92-809819
19	Perfect Seal	O-rings	92-34227Q02

Description	Nm	lb. in.	lb. ft.
End plate bolts	6	54	–

Thermostat Testing

NOTE: *If coolant flow is restricted or fails to occur, repeatedly insert a wire into the drain holes to ensure that there are no obstructions in the passages.*

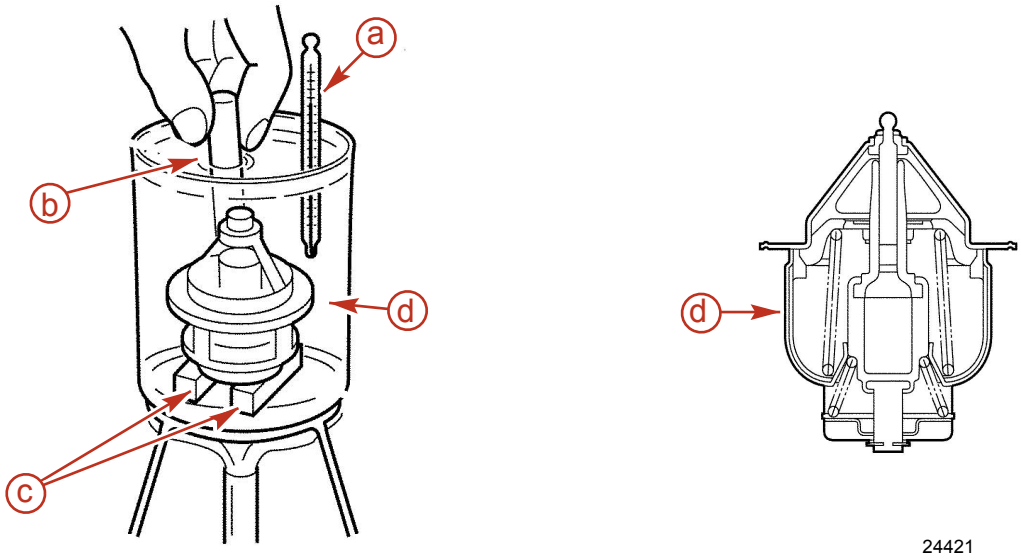
Cleaning and Inspection

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
c - Wooden blocks
d - Thermostat

Heat Exchanger to Crossover Assembly

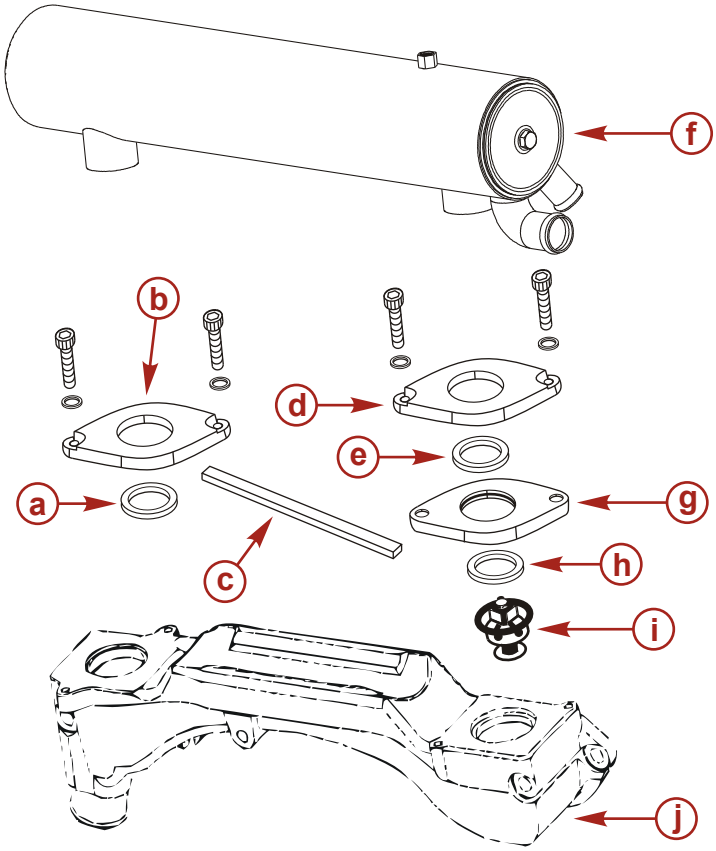
IMPORTANT: Always install a new thermostat and new seals whenever the heat exchanger has been removed from the crossover.

1. Generously lubricate the inner and outer diameters of the port and starboard heat exchanger seals with Parker SuperLube.

Description	Where Used	Part No.
Parker SuperLube	Heat exchanger seals	Obtain locally

2. Inspect the foam strips that are located on the raised supports of the crossover. If they are missing or damaged, replace them before installing the heat exchanger.
3. Install a new split-ring seal around the perimeter of the thermostat and position the thermostat into the port seal groove of the crossover. Place the lower port plate over the thermostat. The lower port plate has a seal groove on both sides.
4. Place the port and starboard upper plates onto the stems of the heat exchanger with the seal grooves facing away from the heat exchanger. Place the seals onto the stems, make sure that the seals are within the recessed area of the stem.
5. Place the heat exchanger into crossover fittings. Be careful not to pinch any wiring or hoses that are routed between the heat exchanger and the intake manifold.
6. Install and evenly tighten the heat exchanger retainer bolts.

Description	Nm	lb. in.	lb. ft.
Allen head retaining bolts	20	–	15



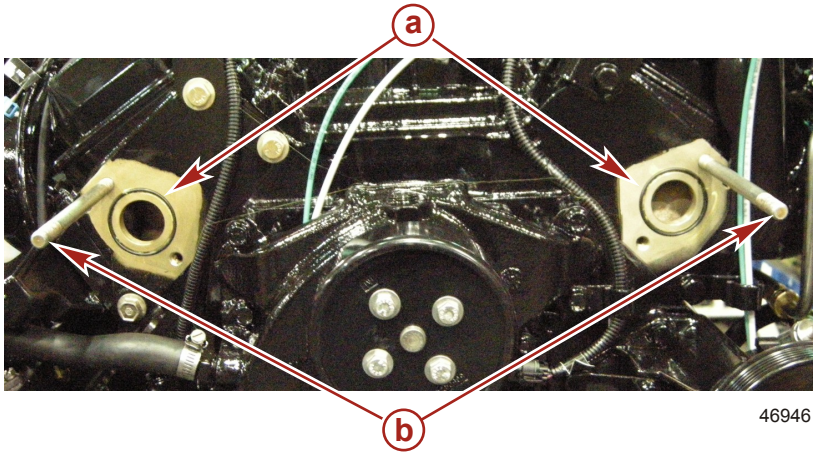
6746

a - Starboard heat exchanger seal
b - Starboard plate
c - Foam strip
d - Port upper plate
e - Port heat exchanger seal
f - Heat exchanger
g - Port lower plate
h - Thermostat seal
i - Thermostat
j - Crossover

Installation

IMPORTANT: The heat exchanger is installed with the crossover as an assembly.
IMPORTANT: Always use new seals when you are installing the crossover.

1. Install the alignment studs if removed.
2. Coat one side of the crossover-to-cylinder head O-rings with bellows adhesive and position them in the seal grooves.



46946

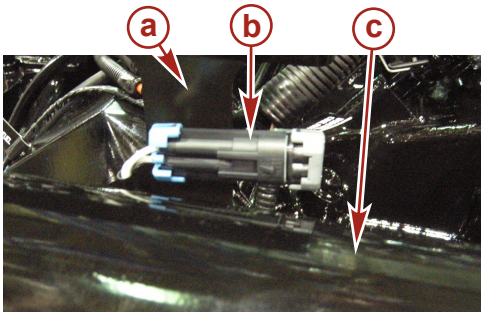
a - O-rings
b - Alignment studs

3. Carefully slide the assembly over the alignment studs and hand-start the bottom two bolts in the crossover.
4. Remove the alignment studs and install the upper mounting bolts.
5. Tighten all crossover mounting bolts to specification.

Description	Nm	lb. in.	lb. ft.
Crossover mounting bolts	66	–	49

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Crossover mounting bolts	92-809822

6. Connect the engine harness to the coolant temperature sender.



46947

a - Reservoir bracket
b - Coolant temperature sender connector
c - Heat exchanger

7. Connect all the hoses. Tighten all hose clamps securely.
8. Align the tensioner assembly to the mount holes in the crossover and hand-start the two bolts previously removed. Push the tensioner upward and hold it in place while tightening the bolts to specification.

Description	Nm	lb-in.	lb-ft
Tensioner assembly to crossover	19	–	14

9. Install the tensioner pulley onto the shaft of the tensioner and hand-start the bolt.
10. Install the idler pulley onto the upper shaft on the crossover and hand-start the bolt.
11. Tighten the idler and tensioner pulley bolts to specifications.

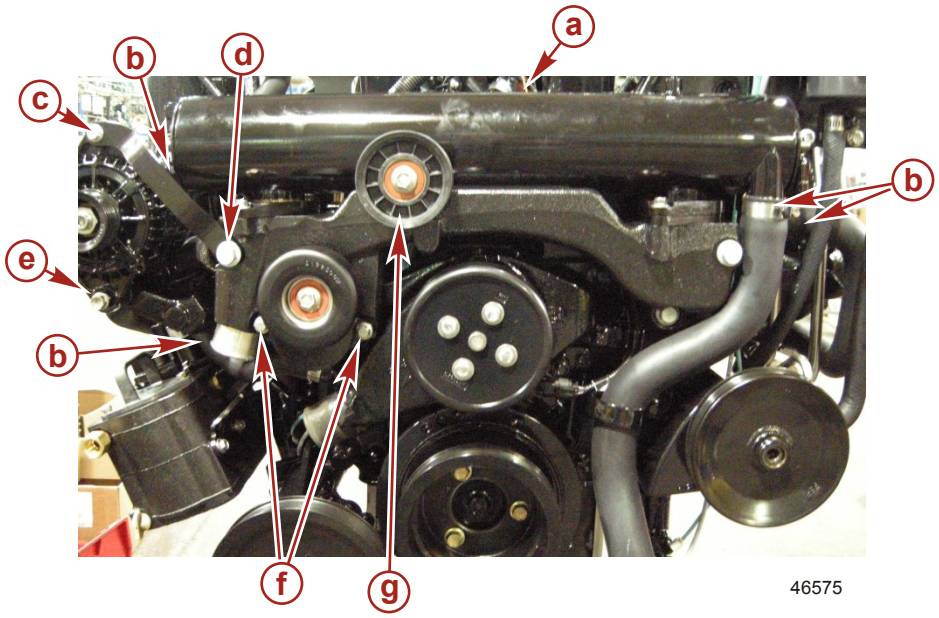
Description	Nm	lb-in.	lb-ft
Bolt on idler pulley	35	–	26
Bolt on tensioner pulley			

12. Install the bolt securing the alternator brace to the crossover and tighten to specification.

Description	Nm	lb-in.	lb-ft
Bolt on alternator to crossover	27	–	20

13. Tighten the bolts securing the alternator to specification.

Description	Nm	lb-in.	lb-ft
Alternator to bracket bolts	27	–	20



a - Coolant temperature sender
b - Hose
c - Bolt top alternator
d - Bolt alternator brace
e - Bolt bottom alternator
f - Tensioner pulley assembly
g - Idler pulley

14. Install the serpentine belt. Refer to **Serpentine Belt Routing and Tension Adjustment.**
15. Refill the closed cooling system.

NOTICE

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

16. Start the engine and check for leaks.

Circulating Pump and Serpentine Belt

Circulating Pump

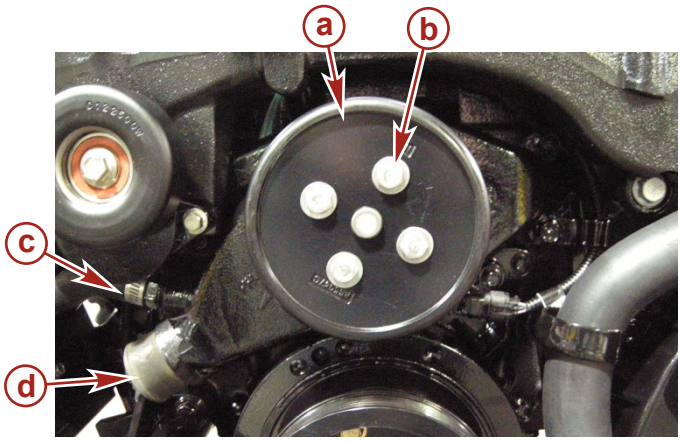
Removal

⚠ CAUTION

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

1. Remove the pressure cap from the coolant reservoir.
2. Remove both hex head drain plugs, which are located approximately 152 mm (6 in.) behind the engine mounts.
3. Drain the coolant into a suitable container and dispose of the coolant according to the local recycling regulations.
4. Loosen the bolts securing the circulating pump pulley.
5. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner away from the belt until it stops.
6. Remove the belt and return the tensioner to its original position.

7. Remove the pulley bolts and pulley from the pump.



46576

a - Pulley
b - Bolts
c - Sensor
d - Circular pump hose fitting

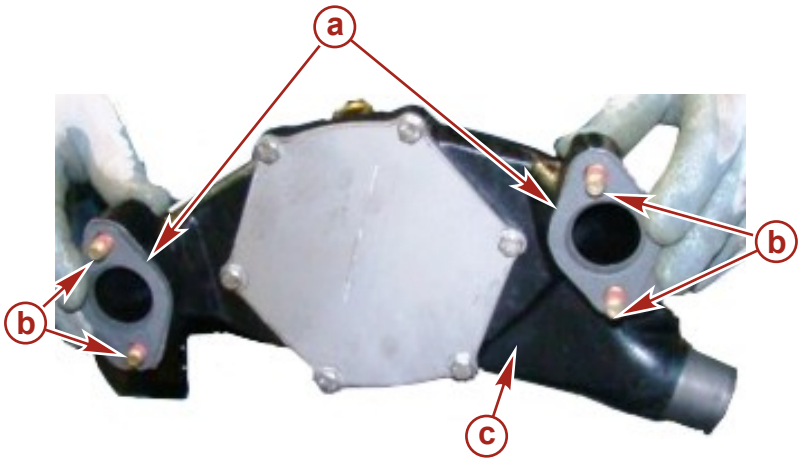
8. Remove the heat exchanger and crossover assembly. Refer to **Heat Exchanger and Crossover Assembly**.
9. Disconnect the reservoir hose at the pump.
10. Remove the pump mounting bolts.
11. Remove the pump and the gaskets.

Cleaning and Inspection

1. Clean the gasket surfaces on the water pump and engine block.
2. Inspect the pump pulley for damage. Replace the pulley if damaged.
3. Replace the circulating pump if the passages are blocked, the impeller is cracked or eroded, or if the impeller shaft or bearings have any side play.

Installation

1. Place the bolts in the pump mount holes. Add the J-clip in the location it was removed from.
2. Align the gaskets on the pump.

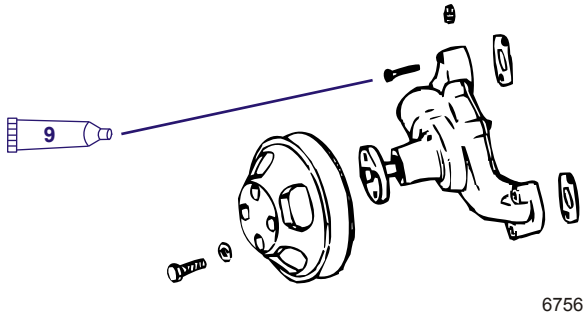


46577

a - Gasket
b - Bolt
c - Back side of circulating pump

3. Position the gaskets and circulating pump on the cylinder block.
4. Insert the bolts and tighten them to specification.

NOTE: *Circulating pump mounting bolts that are not precoated with sealant require sealant on threads before installation.*



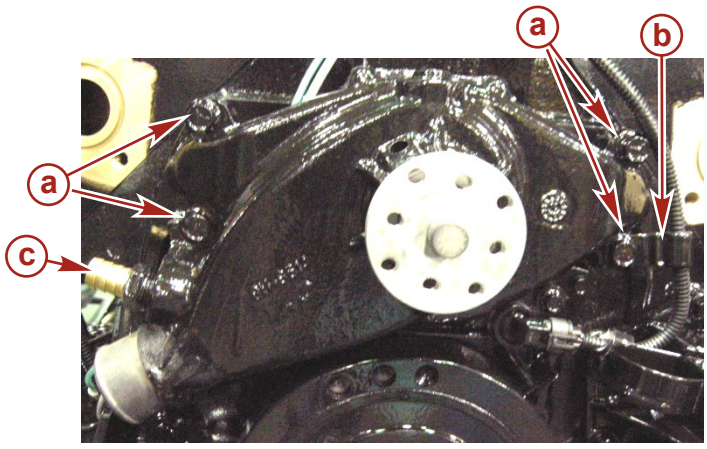
6756

Typical

Description	Nm	lb. in.	lb. ft.
Circulating pump mounting bolts	41	–	30

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Circulating pump mounting bolts	92-809822

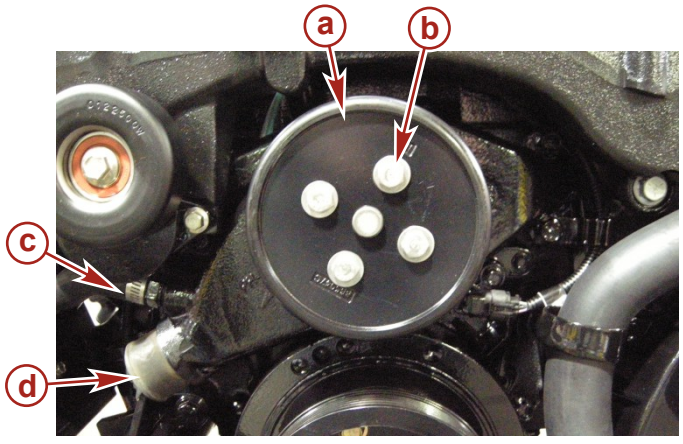
5. If applicable, remove the brass hose fitting from the pump that was removed and install it to the new replacement pump.
6. Install the reservoir hose on the hose fitting on the pump.



46578

a - Circulating pump mounting bolt
b - J-clip
c - Hose fitting

7. Install the heat exchanger and crossover assembly. Refer to **Heat Exchanger and Crossover Assembly**.
8. Install all hoses previously removed and tighten the hose clamps.
9. Install the pump pulley and bolts. Tighten the bolts to specification.



46576

a - Pulley
b - Bolts
c - Sensor
d - Circular pump hose fitting

Description	Nm	lb-in.	lb-ft
Circulating pump pulley bolts	47	–	35

10. Install the serpentine belt. Refer to **Serpentine Belt Routing and Tension Adjustment**.

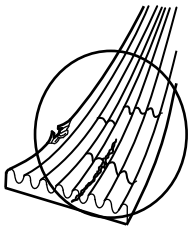
Serpentine Belt Routing and Tension Adjustment

⚠ WARNING

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

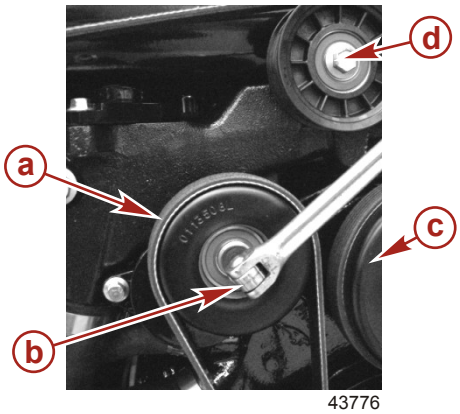
1. inspect the drive belt for:
   - Excessive wear
   - Proper tension
   - Fraying
   - Glazed surfaces
   - Cracks

   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.*



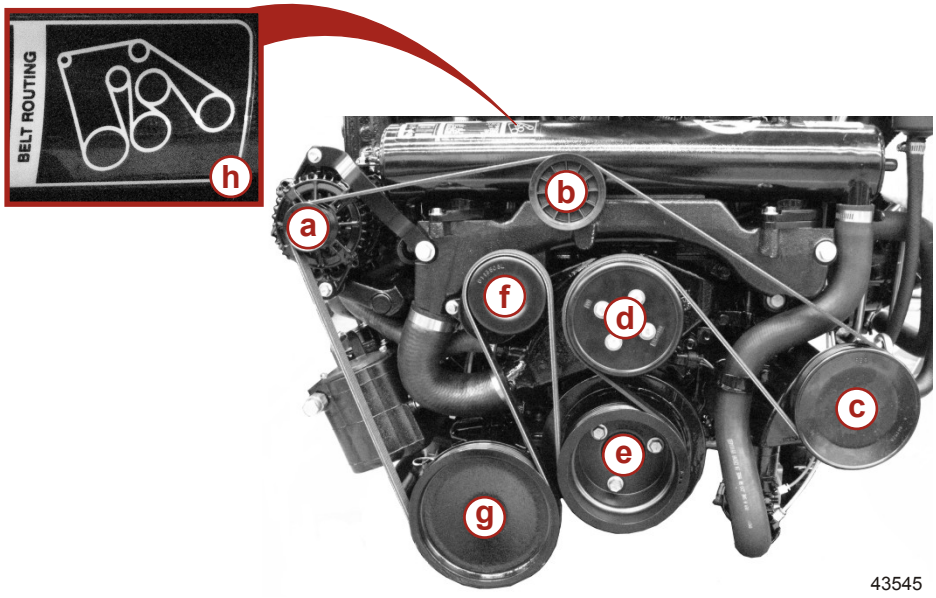
21062

2. Route the serpentine belt according to the belt routing diagram.
3. Use a breaker bar and appropriate socket to rotate the tensioner away from the belt until it stops.
4. Route and install the belt on the idler pulley and slowly relieve the tension on the breaker bar. Ensure that the belt stays positioned properly.



43776

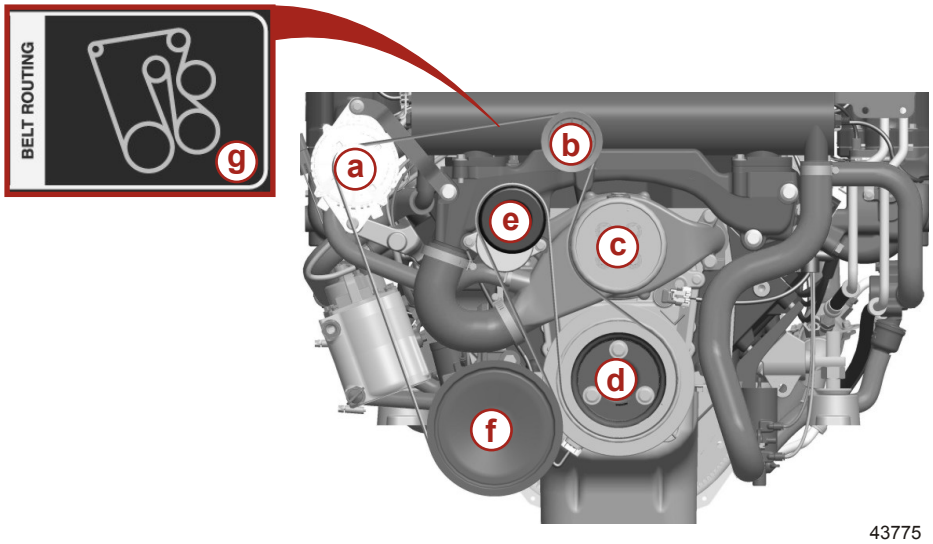
a - Tensioner pulley
b - Socket and breaker bar
c - Water circulating pump pulley
d - Idler pulley



43545

MCM Models

- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Power steering pump pulley
- **d -** Water circulating pump pulley
- **e -** Crankshaft pulley
- **f -** Tensioner pulley
- **g -** Seawater pump pulley
- **h -** Belt routing diagram



43775

MIE Models

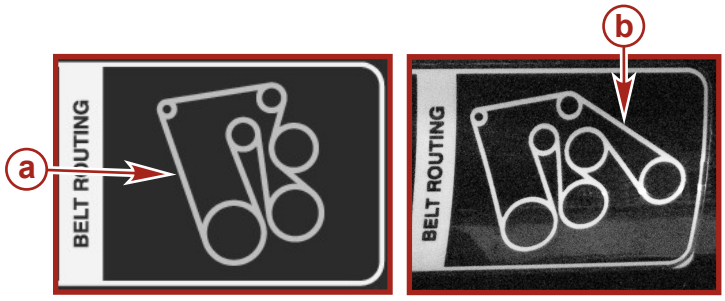
- **a -** Alternator pulley
- **b -** Idler pulley
- **c -** Water circulating pump pulley
- **d -** Crankshaft pulley
- **e -** Tensioner pulley
- **f -** Seawater pump pulley
- **g -** Belt routing

5. Check the belt tension.

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

Belt Tension Gauge	Kent Moore BT-33-73-F

Description	
Deflection	13 mm (1/2 in.)



47236

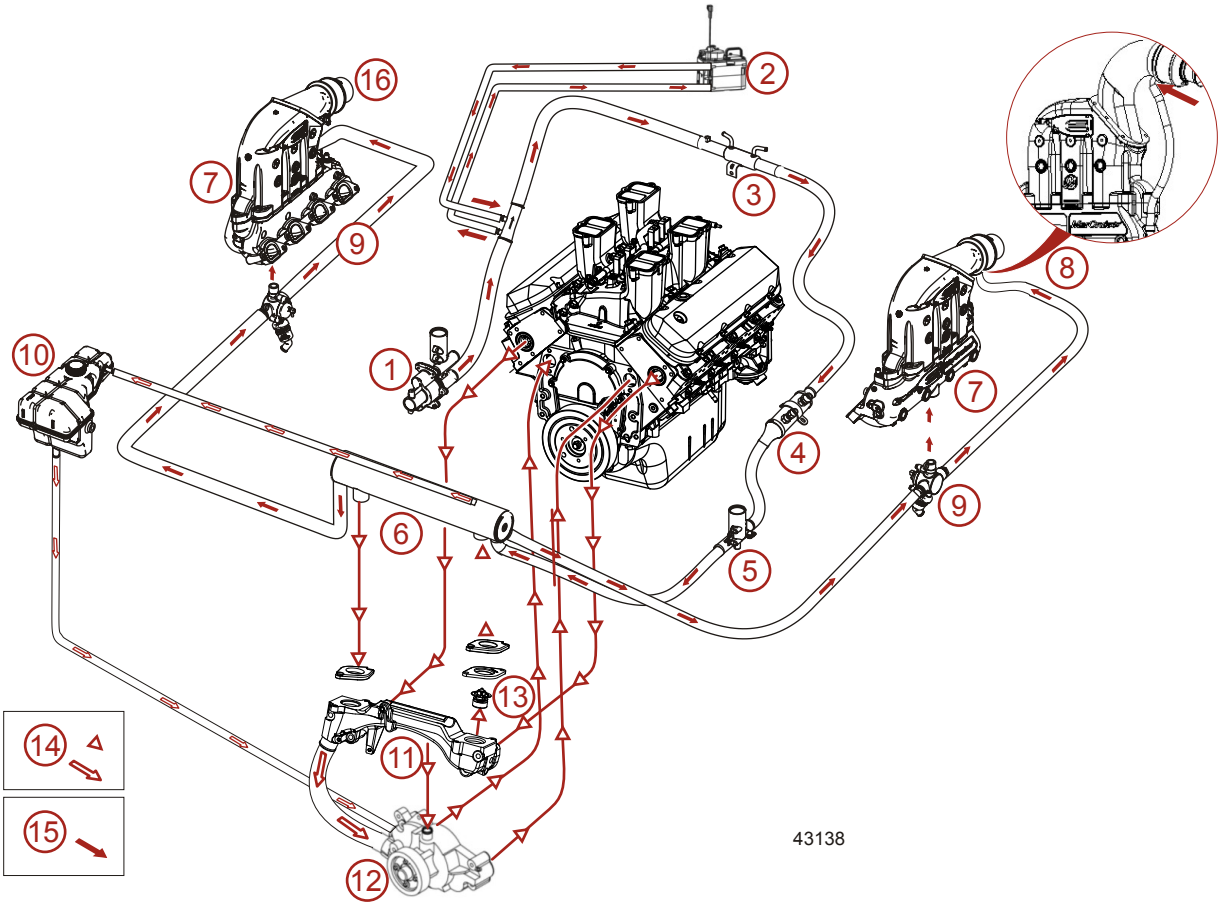
Measure deflection

- **a -** MIE models
- **b -** MCM models

Water Flow Diagram

8.2 Sterndrive Models—Water Flow Diagram

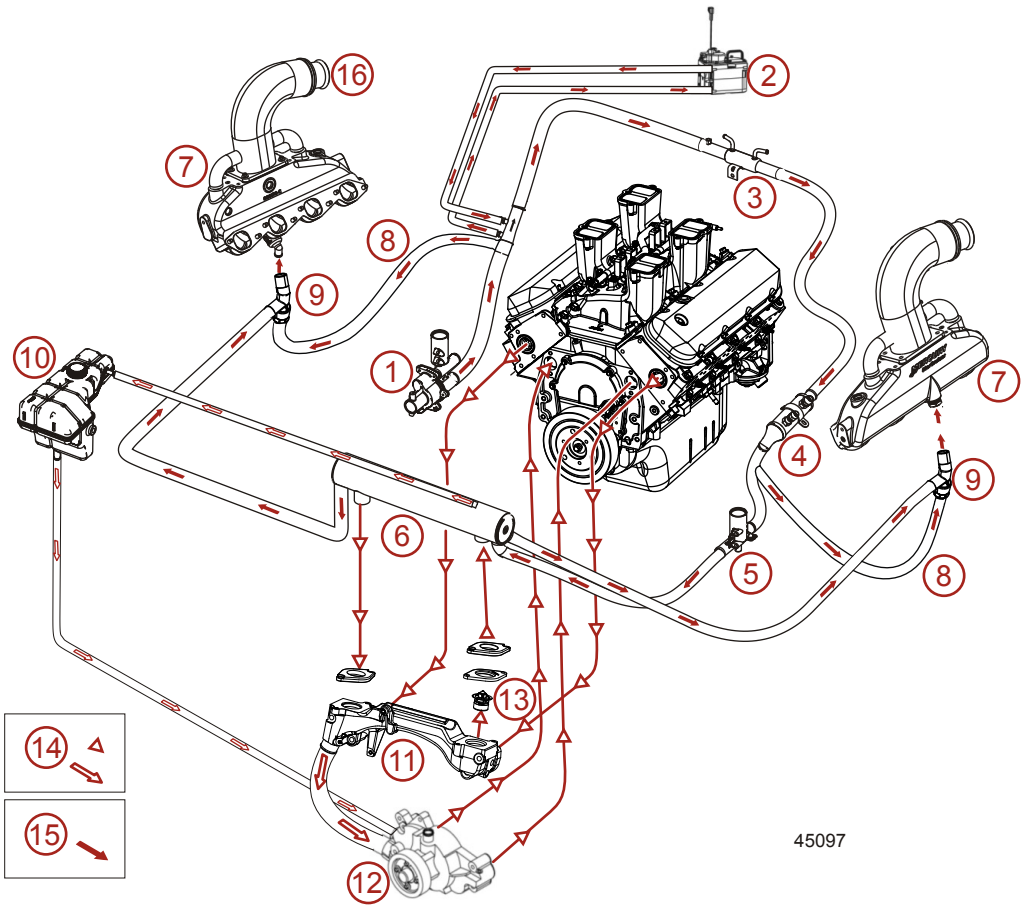
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Power steering cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Water Flow Diagram—8.2 Mag and 8.2 Mag H.O. Models

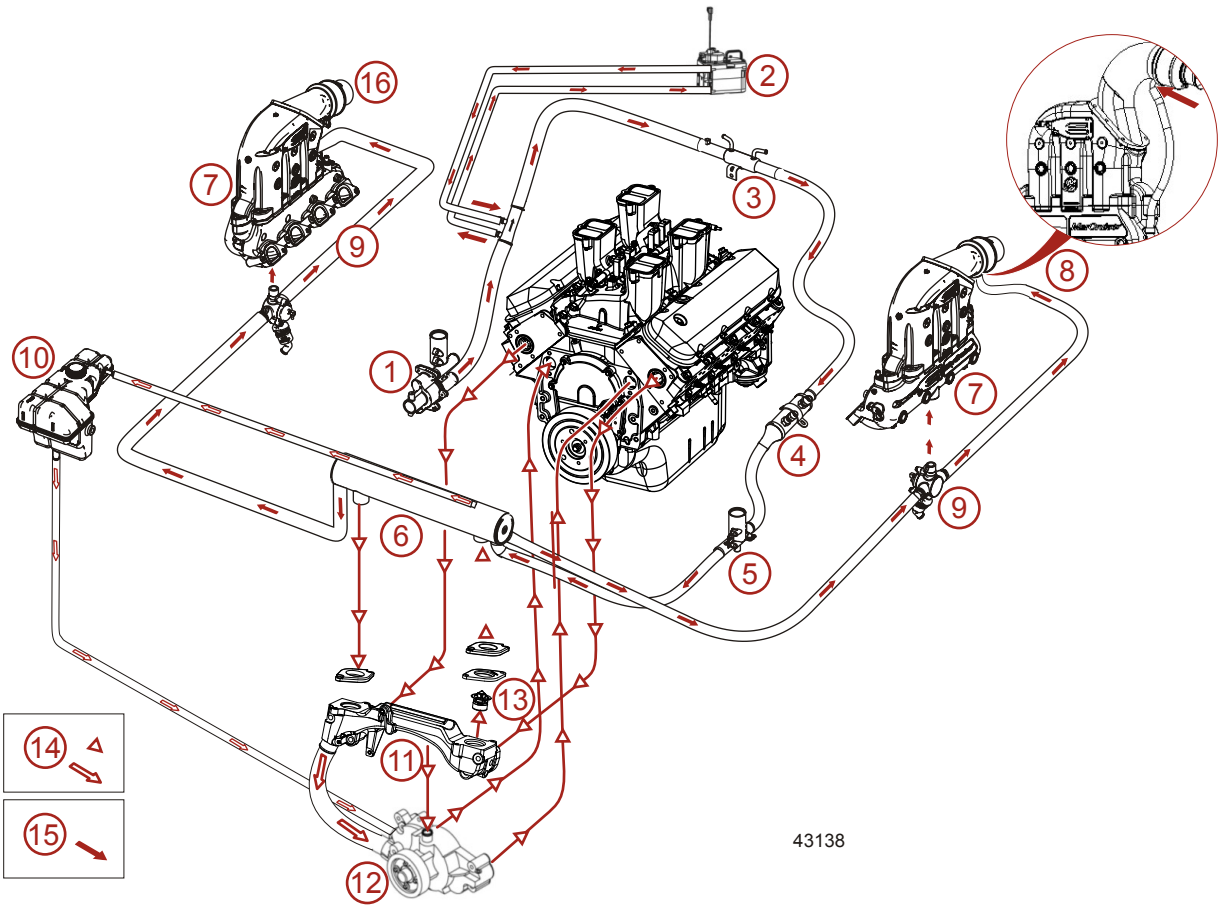
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and starboard water drain valve
2 - Fuel supply module
3 - Steering fluid cooler
4 - Oil cooler
5 - Port seawater drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Exhaust water drain hose (only functions during seawater drain)
9 - Check valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Ethylene coolant flow
15 - Seawater flow
16 - Exhaust outlet

Water Flow Diagram—8.2 H.O. and Horizon 8.2 Models With Emissions Control

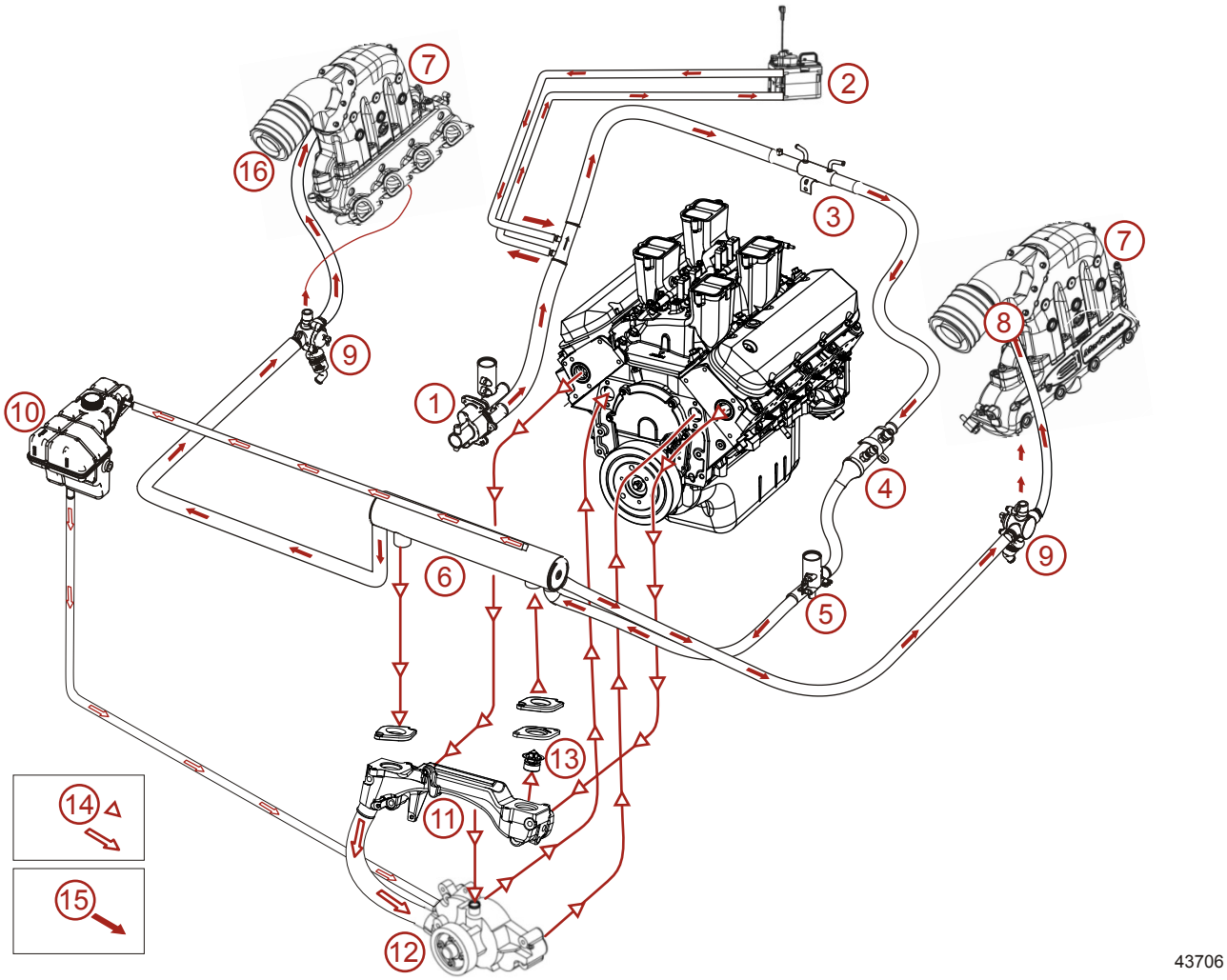
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Transmission cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Water Flow Diagram—8.2 V-Drive Models With Emissions Control

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



1 - Seawater pump and water drain valve
2 - Cool fuel module
3 - Transmission cooler
4 - Oil cooler
5 - Water drain valve
6 - Heat exchanger
7 - Exhaust manifold
8 - Water bypass
9 - Poppet valve
10 - Coolant reservoir
11 - Crossover
12 - Water circulating pump
13 - Thermostat
14 - Glycol coolant flow
15 - Raw water flow
16 - Exhaust outlet

Notes:

Exhaust System

Section 7A - Models With Emissions Control

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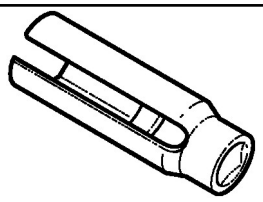
- Removal..... 7A-25
- Installation..... 7A-25

7A

Special Tools

Kent-Moore Oxygen Sensor Socket	KN-46577
 32314	Kent-Moore socket (or equivalent 7/8 in. automotive oxygen sensor socket) Aids in the removal and installation of oxygen sensors on products equipped with Emissions Control.

General Information

Exhaust System Caution

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boat builder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Exhaust Emissions Sampling

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

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

45323

Access area for exhaust gas sampling

Preventing Contamination of the Emissions Control System

Catalyst and oxygen sensors can become contaminated, leading to component failure. Phosphorus, found in some marine-grade oils, and other compounds will damage or destroy a catalyst's ability to clean the exhaust. Catalyst-friendly oil, like Mercury Full Synthetic MerCruiser Engine Oil, prevents this damage. Approved synthetic oils must be used in MerCruiser engines with Emissions Control.

NOTICE

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

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

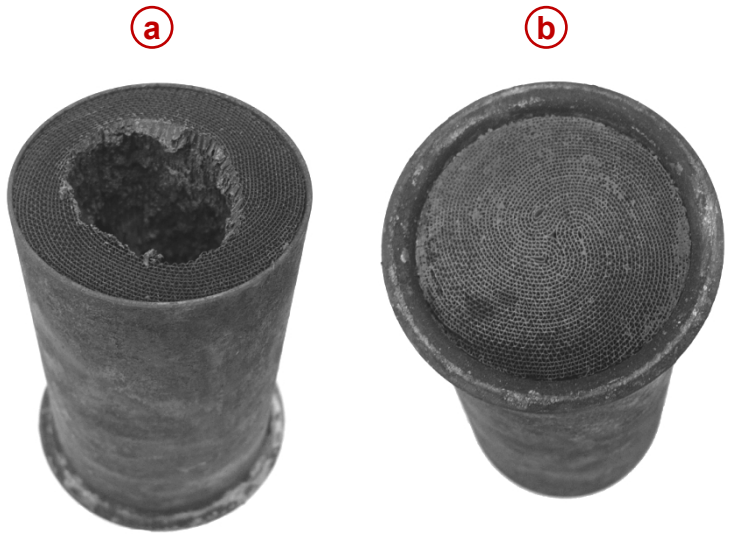
Determining Catalyst Health

Inspect the catalyst for damage whenever disassembling the exhaust system or if computer diagnostic software determines that an oxygen sensor's values are out of range. Examples of damaged catalysts are shown below.

When inspecting catalysts for damage, be aware of the following:

- In many cases, the damage may not be apparent on the upstream end. Check both the upstream and downstream sides of the catalyst.
- Replace the catalyst if it appears damaged in any way.

Damaged Catalysts



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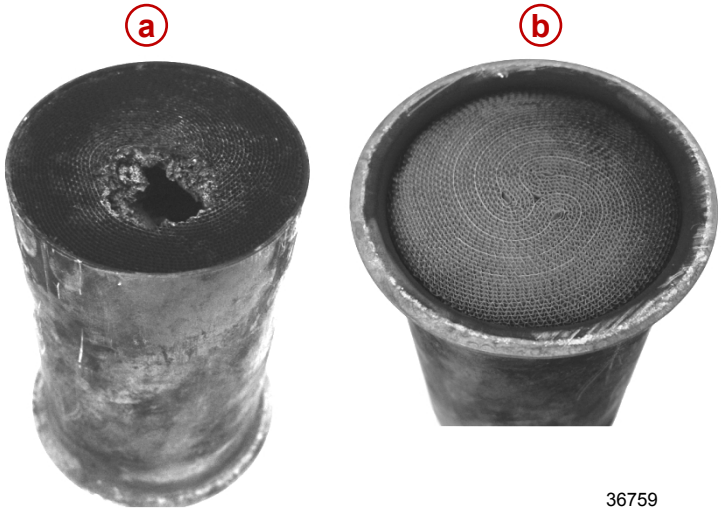
Catalyst damage due to a faulty coil

a - Upstream side of catalyst

b - Downstream side of catalyst



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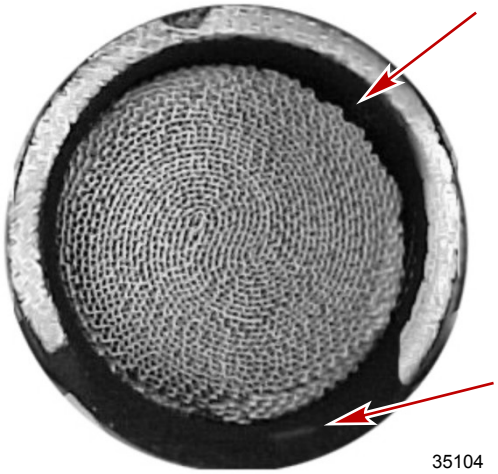
Catalyst damage due to a faulty coil wire

a - Upstream side of catalyst

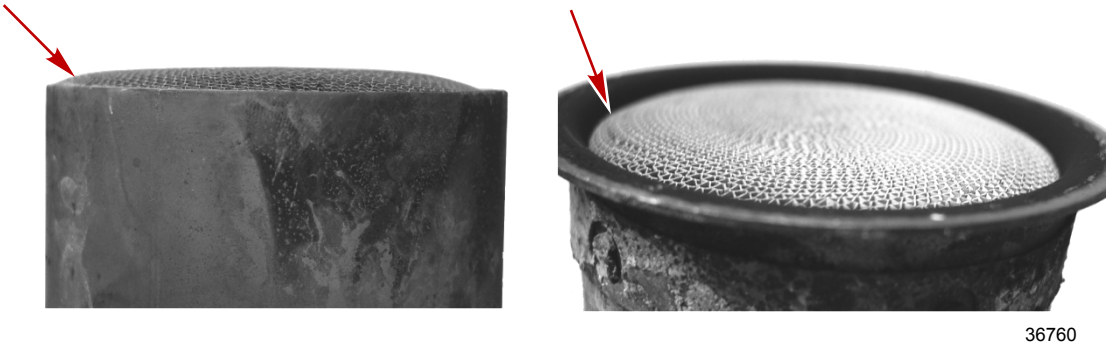
b - Downstream side of catalyst



Catalyst damage due to running out of fuel

Normal Conditions

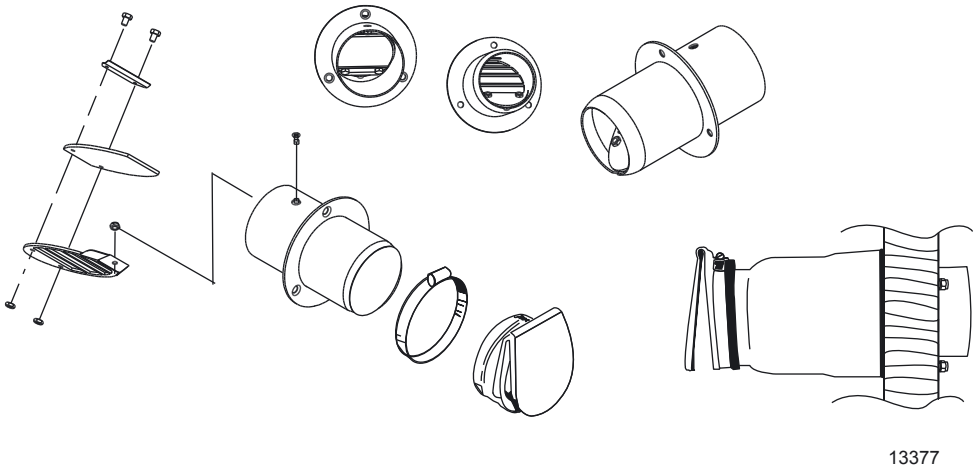
Catalysts that have experienced substantial run times may exhibit a raised substrate, as shown below. This is a normal condition called "crowning", and it does not indicate a damaged catalyst.



Crowning (normal)

Through-Hull Exhaust Fittings

Exhaust fittings (flanges, outlets) must be equipped with an internal shutter and external flapper to prevent water intrusion problems. This is a requirement on all applications except water lift mufflers, where it is still recommended. A variety of fittings are available through the Mercury Precision Parts and Accessories Guide.



Reference Note

Refer to the appropriate **Mercury MerCruiser Product Applications Manual** for more in depth diagnosis and set up installation of the exhaust systems.

Measuring Exhaust Elbow Height

General Information

Install exhaust elbows within specification to prevent water intrusion. Install exhaust elbow risers as needed to obtain the proper exhaust elbow height and exhaust angle. Risers must not exceed 203 mm (8 in.). Take all measurements with the boat in the water and loaded to simulate the maximum loading conditions for normal operation.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not the water line outside of the boat. Refer to Water Lift Muffler for instructions.
IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boat builders must communicate any load distribution conditions that affect the exhaust system, such as maximum occupancy of the swim platform, to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Model	Minimum Exhaust Elbow Height
8.2 Sterndrive Models	33 cm (13 in.)
8.2 Inboard Models	38 cm (15 in.)

Model	Minimum Exhaust Hose Slope within 46 cm (18 in.) of engine	Minimum Exhaust Hose Slope Remainder of system (if applicable)
8.2	10°	3°

If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to Mercury Precision Parts' **Accessories Guide** for part numbers.

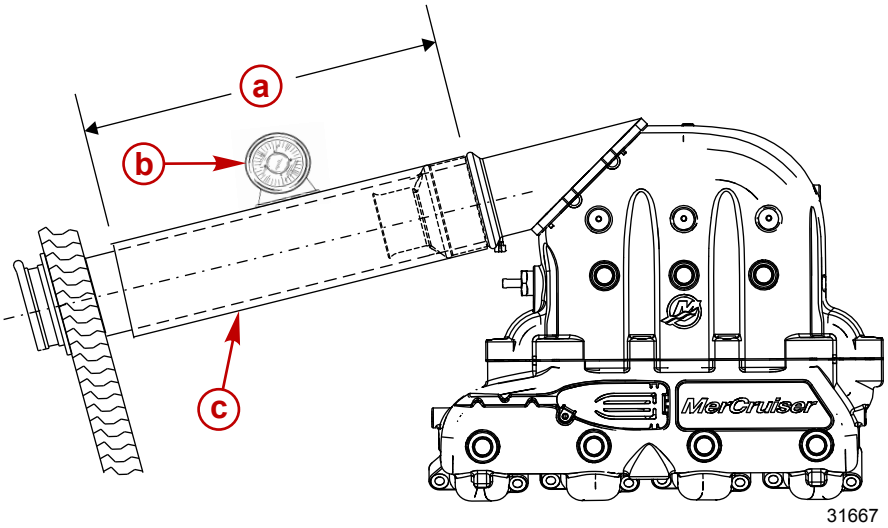
The maximum exhaust riser height is specified in the table below.

Maximum Exhaust Riser Height			
Model	**Low**	**Medium**	**High**
8.2	51 mm (2 in.)	102 mm (4 in.) 152 mm (6 in.)	203 mm (8 in.)

Model	Exhaust Hose or Tube length
8.2 Sterndrive Models	30 cm (12 in.)
8.2 Inboard Models	46 cm (18 in.)

Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet, continuing along each section to the exhaust exit point of the boat. Perform all exhaust angle measurements with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. See **Loading Requirements**.



Typical Exhaust

- **a -** Length of exhaust hose or tube
- **b -** Inclinometer
- **c -** Exhaust hose or tube

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on non-production boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**
- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**
- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boat builder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at OEM boat builders must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long that do not have a maximum rated swim platform weight capacity, must add181.45 kg (400 lb) to the swim platform .

c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.

d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity must add 226.80 kg (500 lb) to the swim platform.

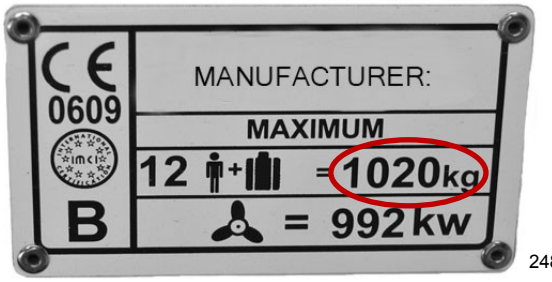
Loading the Boat (Boats with a Capacity Plate)

For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lb. Persons, Gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb.) per person. This gives the whole number and remainder of 74.84 kg (165 lb.) persons to load onto the boat.
3. Put the remainder of a person in the next available seat. See **Boat loading diagram**.



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CE Capacity Plate

24861

USCG Capacity Plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.

9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: *The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.*

NOTE: *The following example is provided as a reference.*

Example

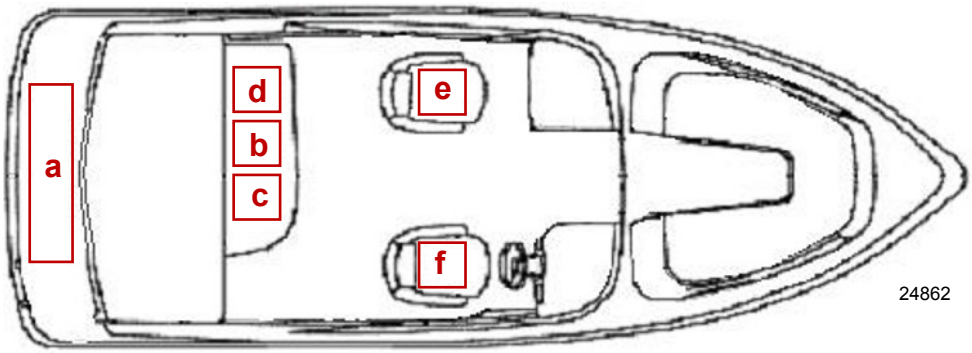
NOTE: *This example uses a boat that is less than 8.84 m (29 ft.) long, not including a boat that is 8.84 m (29 ft.) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 Kg (400 lb.) to the swim platform*

NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb. – 400 lb. = 700 lb.
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat
   - 700 lb. ÷ 165 lb. = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight
   - 0.24 × 165 lb. = 40 lb.

   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
5. Using the totals in this example, load four 165-lb. persons and one 40-lb. person onto boat seating with 400 lb. on the swim platform.

- 400 lb. + 165 lb. = 565 lb.
- 565 lb. + 165 lb. = 730 lb.
- 730 lb. + 165 lb. = 895 lb.
- 895 lb. + 165 lb. = 1060 lb.
- 1060 lb. + 40 lb. = 1100 lb.



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats Without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb. per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb. (MerCruiser person weight) = XXXX lb. maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb. per person. This gives the number of 165-lb. persons to load onto the boat. Round up to next whole number. See **Example 3**.
   IMPORTANT: To account for cargo, add a weight of 25 lb. per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb. by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

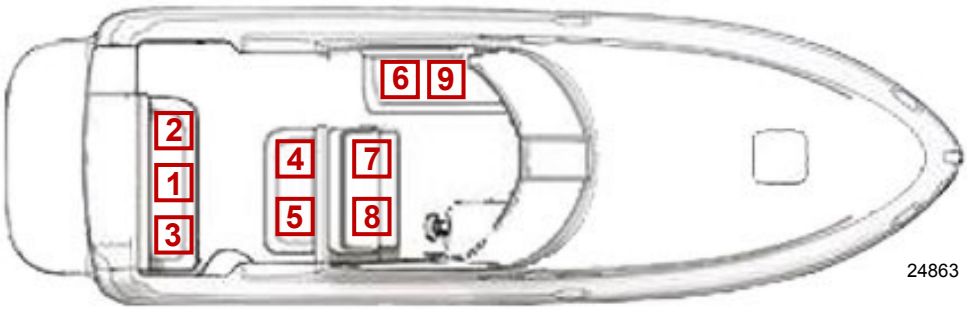
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: *The following example is provided as a reference.*
This example uses a boat that is 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 Kg (500 lb.) to the swim platform .

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



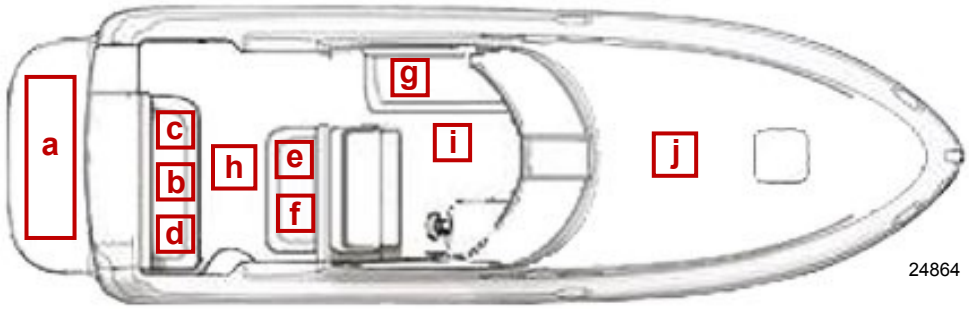
Designated Seating Diagram

This example uses 9 persons as the maximum passenger load.

NOTE: Use 0.50 lb. as the break point to round up or down to obtain a whole pound.

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb. = 225 lb.
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%
   a. 225 lb. × 50% = 112.50 lb.
   b. 112.50 lb. rounded up = 113 lb.
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%
   - 225 lb. × 25% = 56.25 lb.
   - 56.25 lb. rounded down = 56 lb.
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb. (MerCruiser person weight) to get a 1485 lb. (total passenger load)
   - 9 passengers × 165 lb. = 1485 lb.
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb. – 500 lb. = 985 lb.
7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb. ÷ 165 lb. = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb. cargo in the aft storage, 113 lb. cargo in the center storage, and 56 lb. cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb. passengers, onto the boat with 500 lb. on the swim platform.

- 500 lb. + 225 lb. = 725 lb.
- 725 lb. + 165 lb. = 890 lb.
- 890 lb. + 165 lb. = 1055 lb.
- 1055 lb. + 165 lb. = 1220 lb.
- 1220 lb. + 165 lb. = 1385 lb.
- 1385 lb. + 165 lb. = 1550 lb.
- 1550 lb. + 165 lb. = 1715 lb.

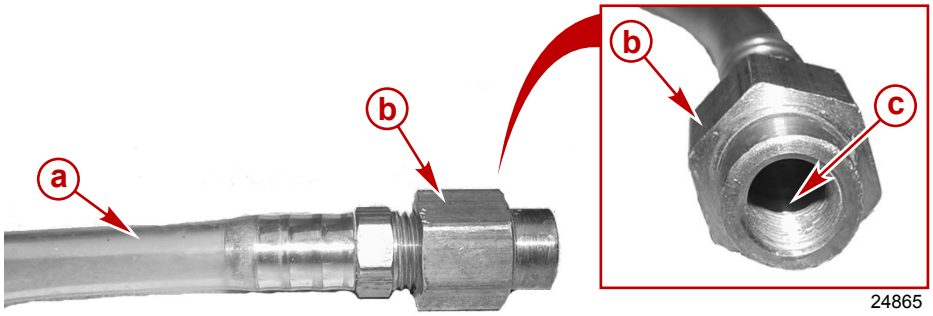


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

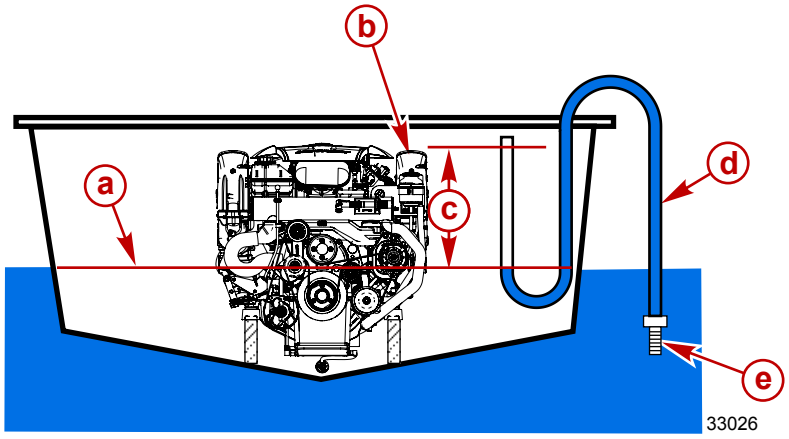
1. Obtain an 8–10 mm (5/16–3/8 in.) inner diameter (ID) clear hose approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.
4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust manifold collector and elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



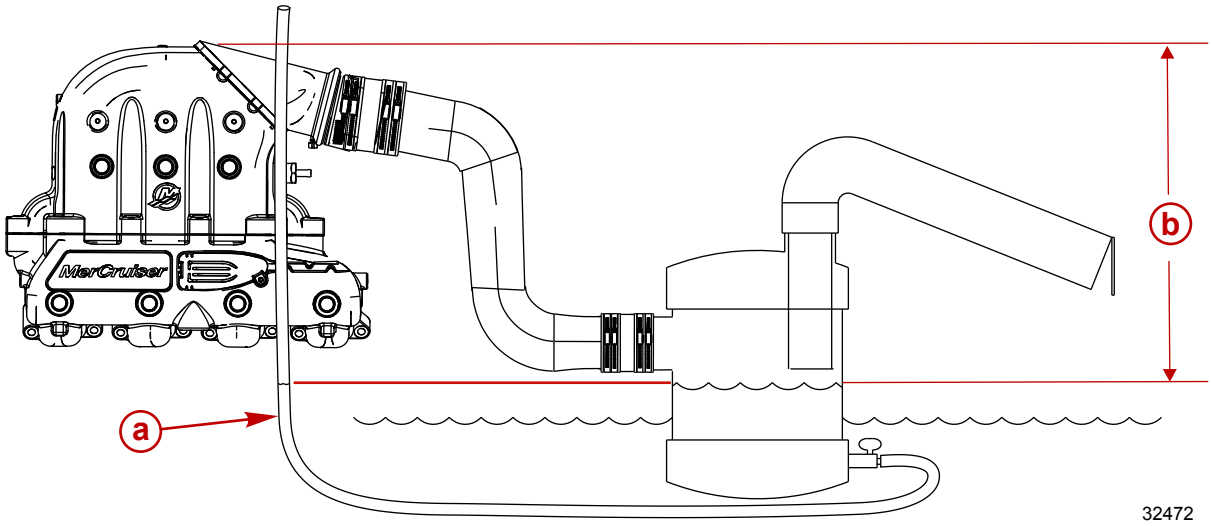
a - Waterline
b - Top of exhaust elbow
c - Waterline to top of exhaust elbow measurement
d - Clear hose
e - Weight

Clear Hose Measurement Method From Seacock or Muffler Drain

IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.
IMPORTANT: The engine must have been operated previously to fill the muffler with water.
IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.

7. Slowly take the finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep the hose close to the exhaust elbow and as vertical as possible.
8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height. The maximum riser height is 20.3 cm (8 in.) on 8.2 models.

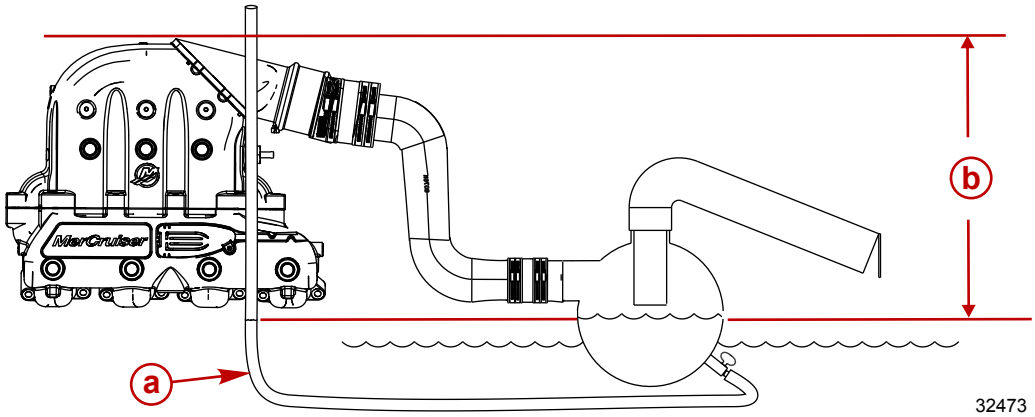


Typical vertical water lift muffler

a - Clear hose for measuring waterline

b - Minimum exhaust elbow height with maximum load

IMPORTANT: Horizontal waterlift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



Typical horizontal water lift muffler

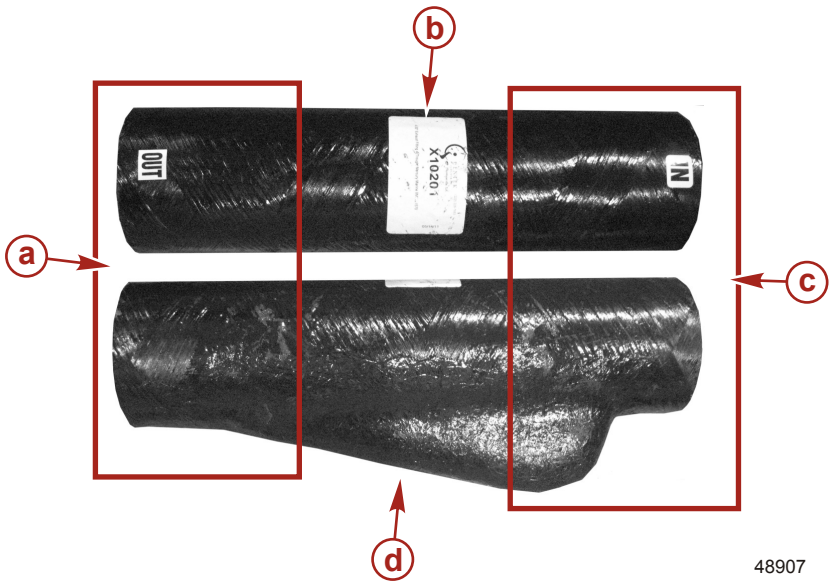
a - Clear hose for measuring waterline

b - Minimum exhaust elbow height with maximum load

Exhaust Diverter Tube on 8.2 Inboard

IMPORTANT: MerCruiser specifies a minimum distance of 457 mm (18 in.) from the exhaust elbow to the exhaust hose.

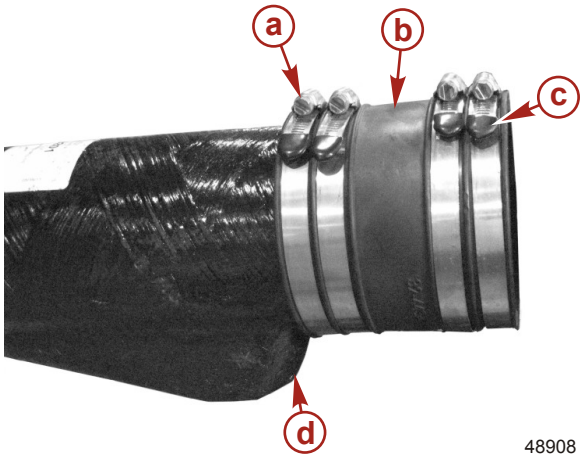
IMPORTANT: To function properly, the end of the tube marked "IN" is positioned toward the engine exhaust elbow with the deepest portion of the diverter tube facing straight down. Do not cut or modify the diverter tube.



48907

- **a -** End of diverter tube marked "OUT"
- **b -** Top view of diverter tube
- **c -** End of diverter tube marked "IN"
- **d -** Side view of diverter tube

1. Install the exhaust tube on the inlet side of the diverter tube.
   a. Place four hose clamps on the exhaust tube with the screw heads facing the same direction.
   b. Install a hose clamp cover on the hose clamps.
   c. Push the exhaust tube onto the end of the diverter tube marked "IN".

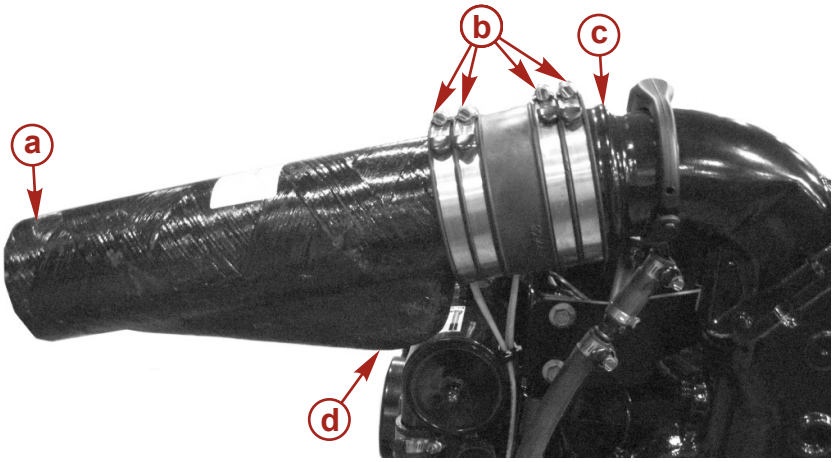


48908

- **a -** Hose clamp (4)
- **b -** Exhaust tube
- **c -** Rubber tips
- **d -** End of diverter tube marked "IN"

2. Install the exhaust tube and diverter tube assembly on the exhaust elbow on the engine. Position the deepest portion of the tube facing straight down.
3. Ensure that the screw head on the hose clamps are facing toward the outside of the engine and the exhaust tube is against the ridge on the exhaust elbow.

4. Tighten the hose clamps to specification.



48910

Side view

- **a -** End of diverter tube marked "OUT"
- **b -** Hose clamp (4)
- **c -** Ridge
- **d -** Correct straight down position of deepest portion

Description	Nm	lb-in.	lb-ft
Hose clamp	4	35	–

Inboard and Service Exhaust Elbow

This elbow is installed on the 8.2 inboard models at the factory and will supersede all exhaust elbows for 8.2 service replacement parts, including the 8.2 sterndrive models.

The elbow is not installed on the 8.2 sterndrive models at the factory but is used as a replacement part through the service department.

49547

8.2 Inboard and service exhaust elbow

Risers on Emission Controlled Models

Additional Parts Required—Intermediate Exhaust Elbow Kit

IMPORTANT: Standard sterndrive applications with through-the-propeller exhaust systems require intermediate exhaust elbow kits. See the following table for your specific application.

NOTE: *The exhaust elbow riser kit 0 mm (0 in.) is only available for the 8.2 L Inboard V-drive models.*

Riser Extension Height	Exhaust Elbow Riser Kit	Required Intermediate Exhaust Elbow Kit (Order Separately)
0 mm (0 in.)	8M0062050 (Inboard V-drive models)	–
54 mm (2 in.)	8M0062051	44267A05
108 mm (4 in.)	8M0062052	44267A06
161 mm (6 in.)	8M0062053	44267A07
215 mm (8 in.)	8M0062054	44267A08

Parts List

These kits contain two of each listed riser, hose, and gasket.

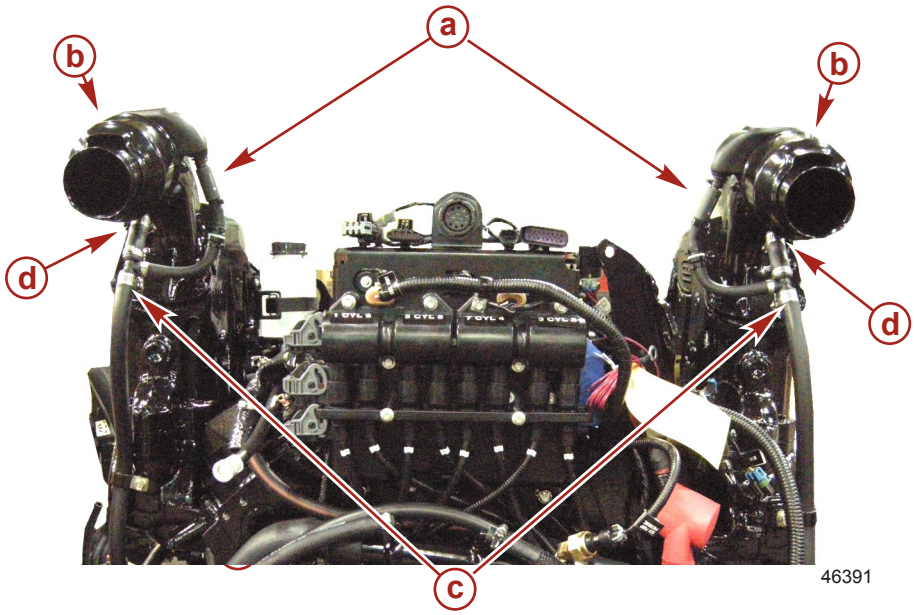
Kit Number	Riser Extension Height	Riser Part Number	Hose Part Number	Riser Gasket Part Number
8M0062050	0 mm (0 in.)	8M8027561	32-807498400	27-8M2003931
8M0062051	51 mm (2 in.)	8M8027562	32-807498400	27-8M2003931
8M0062052	108 mm (4 in.)	8M8027564	32-807498400	27-8M2003931
8M0062053	161 mm (6 in.)	8M8027566	32-8M2012906	27-8M2003931
8M0062054	215 mm (8 in.)	8M8027568	32-8M2012906	27-8M2003931

Vent Valve

IMPORTANT: The vent valve and vacuum breaker valve on each exhaust elbow must be replaced once every three years or every 300 hours of operation.

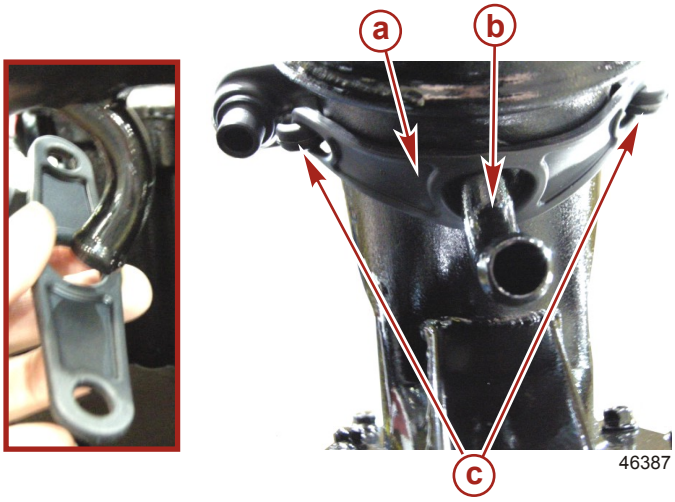
Removal

1. Remove the worm-gear hose clamp and hose at the T-fitting and the water fitting on the exhaust elbow.



a - Vacuum breaker valve
b - Air inlet hole
c - Worm-gear hose clamp at T-fitting
d - Worm-gear hose clamp at the water fitting

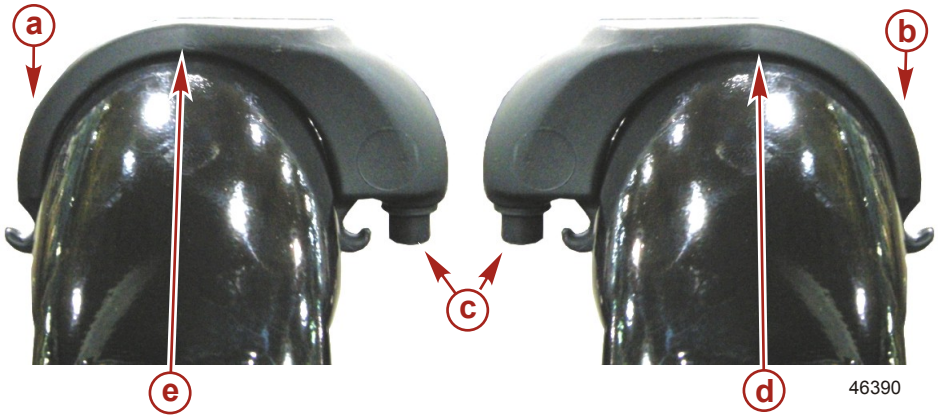
2. Remove the rubber strap from the water fitting on the exhaust elbow and the reservoir hooks.



a - Rubber strap
b - Water fitting
c - Reservoir hook

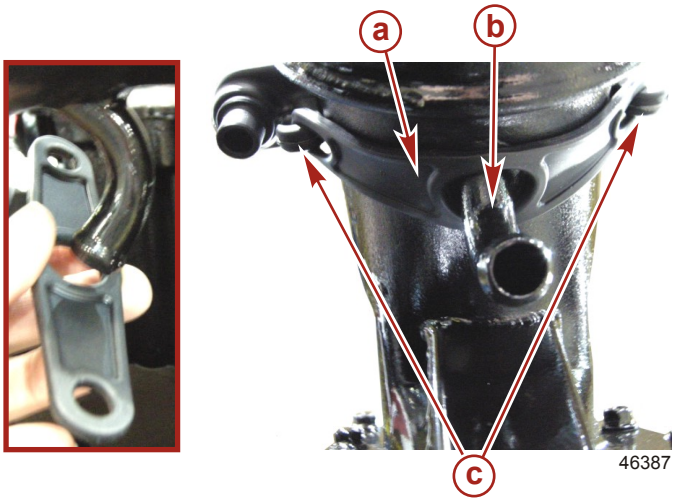
Installation

1. Push the reservoir onto the exhaust elbow with the air inlet hole toward the outside of the engine. Position the reservoir above the water fitting on the exhaust elbow.



a - Air inlet hole starboard
b - Air inlet hole port
c - Grommet
d - Reservoir port
e - Reservoir starboard

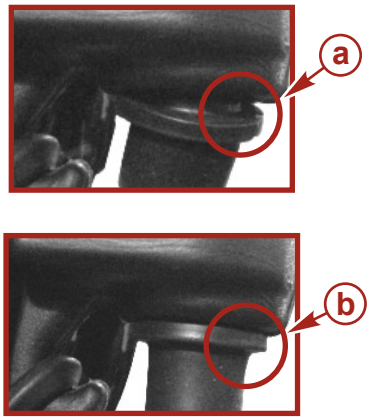
2. Place the center hole of the rubber strap over the water fitting on the exhaust elbow, stretch the strap around the bottom side of the exhaust elbow, and attach it to the reservoir hooks.



a - Rubber strap
b - Water fitting
c - Reservoir hook

3. Insert the vacuum breaker valve fitting into the grommet until the valve is seated against the grommet.
4. With a hose clamp on the hose assembly, push the hose end of the vent assembly over the water fitting on the exhaust elbow. Position the T-fitting to face inboard and slightly forward.

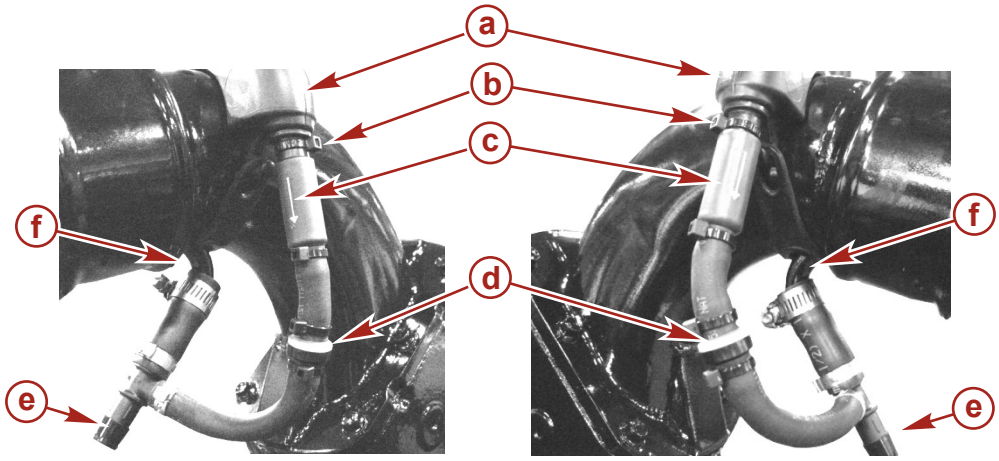
5. Inspect the grommet-to-reservoir area to ensure that there is no side-load pulling on the grommet. The grommet should be relaxed and fully seated against the reservoir. Position the T-fitting portion of the assembly as necessary to ensure proper assembly.



a - Incorrect assembly
b - Correct assembly

46444

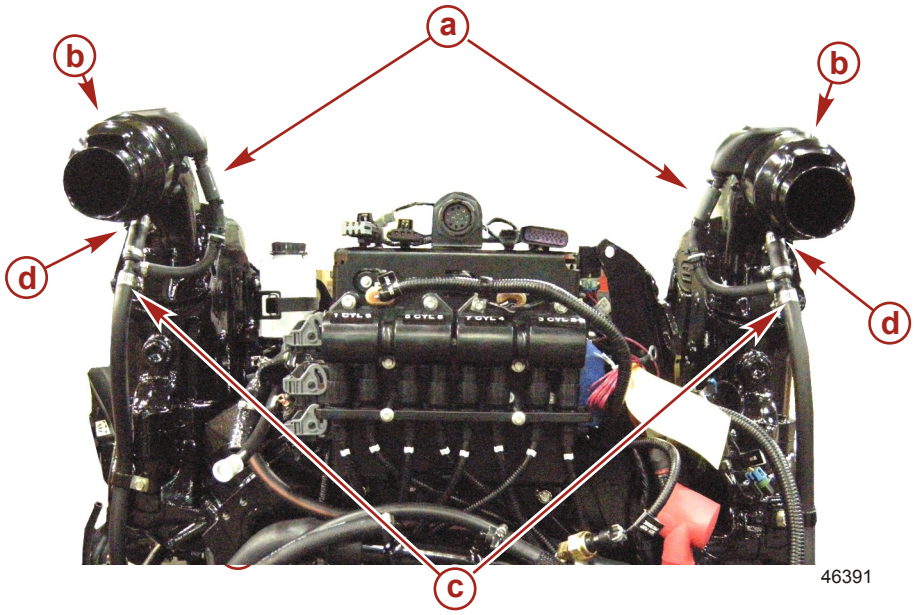
6. Install the cable tie over the grommet at the vacuum breaker valve fitting.



a - Reservoir
b - Cable tie
c - Vacuum breaker valve
d - Check valve
e - T-fitting
f - Water fitting on exhaust elbow

46386

7. With the hose clamp on the bypass hose, insert the T-fitting into the bypass hose.
8. Tighten the worm-gear hose clamps to specification at the T-fitting and at the water fitting on the exhaust elbow.



a - Vacuum breaker valve
b - Air inlet hole
c - Worm-gear hose clamp at T-fitting
d - Worm-gear hose clamp at the water fitting

46391

Description	Nm	lb-in.	lb-ft
Worm-gear hose clamp	4	35	–

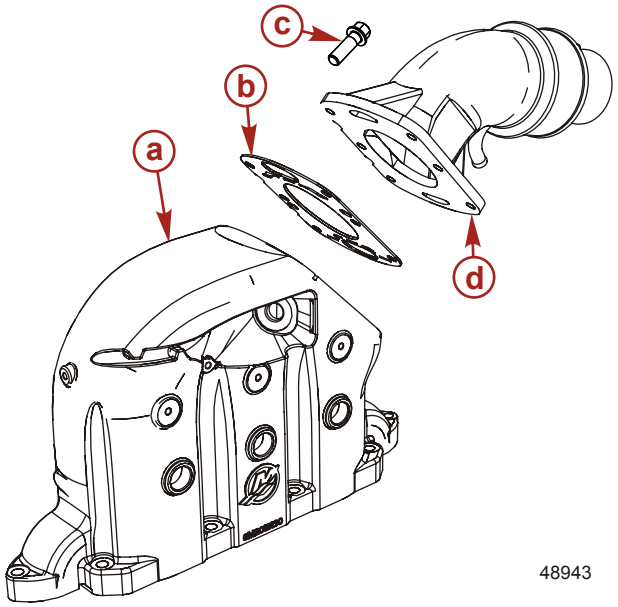
9. Install the cover on the hose clamp.

Riser Removal

⚠ WARNING

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

1. Turn off the engine and allow it to cool.
2. Remove the negative battery cable.
   IMPORTANT: Some water may remain in the exhaust manifold. Drain the exhaust elbow risers prior to removing components.
3. Drain any remaining water from the exhaust collector, exhaust elbow, and exhaust elbow riser assembly.
4. Remove the exhaust bellows from the exhaust elbow riser.
5. Remove and retain the six screws securing the exhaust elbow riser.
6. Remove the exhaust elbow riser.

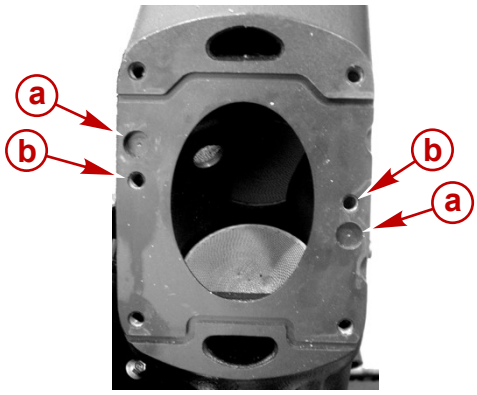


a - Exhaust collector
b - Gasket
c - Screw (6)
d - Exhaust elbow riser

Riser Installation

IMPORTANT: Foreign material on hot catalysts can damage the catalysts and their ability to work properly. Prevent material from falling into the exhaust collector. If material does fall into the exhaust collector, use care when removing the material to prevent damaging the catalysts.

1. Remove the gasket. Discard the gasket and clean the mating surface of the exhaust collector.

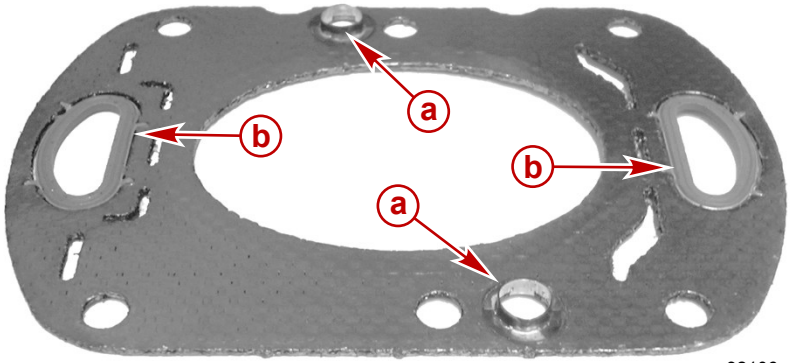


32108

ECT exhaust collector mating surface

a - Dowel holes
b - Fastener holes

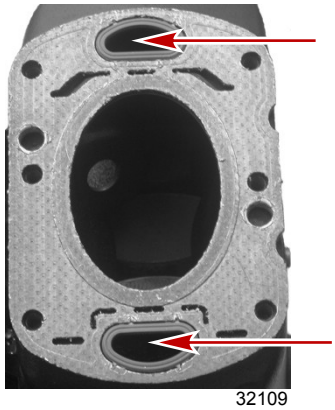
2. Insert the exhaust gasket dowels into the dowel holes on the exhaust collector mating surface.



32106

a - Dowels
b - Water port gaskets

3. With the dowels fully seated in the dowel holes, the water ports on the exhaust collector align with the water port gaskets. If misaligned, rotate the gasket 180°.

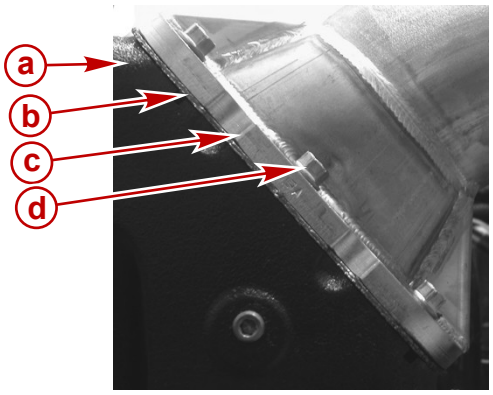


32109

Water ports

4. Align the new riser with the screw holes and install the six screws.

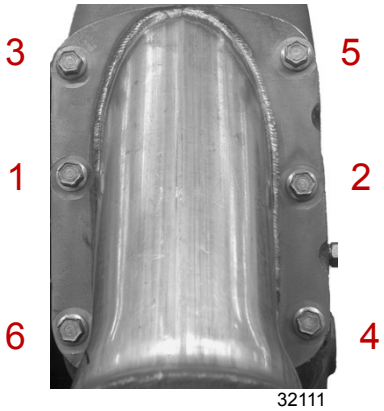
IMPORTANT: Always use the correct screws to achieve the required clamp load.



32110

a - Exhaust collector
b - Exhaust gasket
c - Exhaust riser
d - Screw

5. Tighten the screws to specifications in the following numbered sequence.



32111

Description	Nm	lb. in.	lb. ft.
Exhaust riser screw	30	–	22

6. On standard sterndrive applications with through-the-propeller exhaust:
   a. Install the new intermediate exhaust elbow components, ordered separately.
   b. Install exhaust bellows onto the exhaust riser and new intermediate exhaust elbow. Torque both hose clamps on each joint.
   c. Install exhaust bellows onto the exhaust pipe and new intermediate exhaust elbow. Torque both hose clamps on each joint.
7. On exhaust systems with waterlift or through-the-hull exhausts, reconnect the exhaust system. Torque both hose clamps on each joint.

Description	Nm	lb. in.	lb. ft.
Hose clamps	4	35	–

8. Install additional hoses on the exhaust riser, if applicable.
9. Connect the negative battery cable. Tighten securely.

NOTICE

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

10. Supply water to the engine. Start the engine and check for fuel, exhaust, or water leaks.

Collectors

Removal

⚠ CAUTION

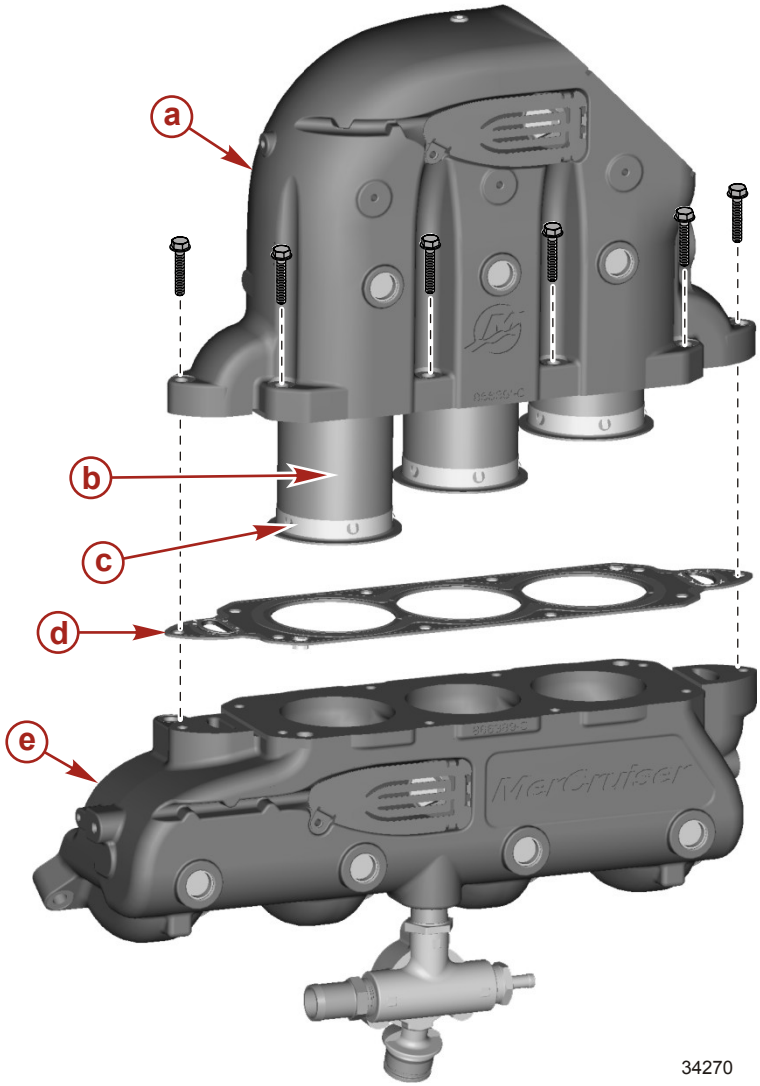
A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

NOTICE

Exposing the catalyst to foreign materials such as silicone, oils, or fiberglass can chemically alter the precious metal coating of the catalyst and compromise its ability to convert exhaust gases. Handle catalyst components in a clean environment only.

1. Remove the negative battery cable.
2. Turn the engine off and allow it to cool.
3. Remove the exhaust tip or riser as described in **Risers**.
   IMPORTANT: Some water may remain in the exhaust manifold. Drain the exhaust tips prior to removing components.
4. Drain any remaining water from the exhaust collector, exhaust elbow, and exhaust tip assembly.
5. Disconnect the temperature sensor and the two oxygen sensors from the engine harness.
6. Disconnect the cooling water inlet hose from the aft end of the collector.
7. Remove the 10 bolts securing the collector to the manifold.
   IMPORTANT: The catalyst retaining rings use friction to keep the catlyst in the collector during installation and removal. Over time, the clamping force of these rings may weaken, causing the catalysts to fall from the collector during assembly or disassembly. Take care not to drop the catalysts and replace the retaining rings before installation.

8. Lift the exhaust collector carefully to prevent the catalysts from falling due to loose retaining rings.



Port exhaust manifold and collector

- **a -** Exhaust collector
- **b -** Catalyst
- **c -** Retaining ring
- **d -** Gasket
- **e -** Exhaust manifold

9. Discard the gasket and current retaining rings.
10. Repeat this procedure for the other manifold as necessary.

Installation

NOTICE

Exposing the catalyst to foreign materials such as silicone, oils, or fiberglass can chemically alter the precious metal coating of the catalyst and compromise its ability to convert exhaust gases. Handle catalyst components in a clean environment only.

1. Remove any gasket material from all mating surfaces on the manifold and collector.
2. Install a new gasket.
   IMPORTANT: The catalyst retaining rings use friction to retain the catlyst in the collector for assembly. Over time, the interference fit of these rings may weaken, causing the catalysts to fall from the collector. Take care not to drop the catalysts during assembly or disassembly and replace the retaining rings before installation.
3. Replace any worn or loose catalyst retaining rings.
4. Secure the catalysts into the collector. The retaining rings should prevent the catalysts from falling.
5. Install the collector onto the manifold and gasket. Tighten the 10 retaining bolts to specification.

Description	Nm	lb-in.	lb-ft
Exhaust collector bolts (10)	27	–	20

6. Repeat this procedure for the other manifold as necessary.

7. To install the risers, refer to **Risers**.
8. Connect the negative battery cable. Tighten securely.

NOTICE

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

9. Supply water to the engine. Start the engine and check for fuel, exhaust, or water leaks.

Manifold

Removal

⚠ WARNING

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

1. Remove the exhaust elbow riser as described in **Risers**.
2. Remove the collector as described in **Collectors**.
3. Disconnect any cooling hoses from the manifold.
4. Remove any other components that are mounted to the exhaust manifold.
5. Disconnect the oxygen sensor from the engine harness.
6. Disconnect the temperature sensor from the engine harness.
7. Remove two bolts at opposite ends of the exhaust manifold and install an alignment pin in each bolt hole.
8. Remove the remaining exhaust manifold bolts.
9. Remove the exhaust manifold assembly.
10. Remove and discard the current gasket.

Cleaning and Inspection

IMPORTANT: Exhaust gaskets are not reusable.

1. Clean any gasket material from all surfaces.
2. Check the water passages for foreign material. The passages must be clean for efficient cooling.
3. Inspect all parts for damage or wear. Repair or replace as necessary.
4. To test the exhaust manifold, use block-off plates, plugs, or short hoses with plugged ends. One block-off plate must have a threaded hole for attaching a compressed air hose. Use new gaskets when installing block-off plates. Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water. Air bubbles indicate a leak.
5. Inspect all sealing surfaces carefully. Machined surfaces must be clean and free of all marks and deep scratches or exhaust leaks may result.
6. Ensure that all mating surfaces are flat.

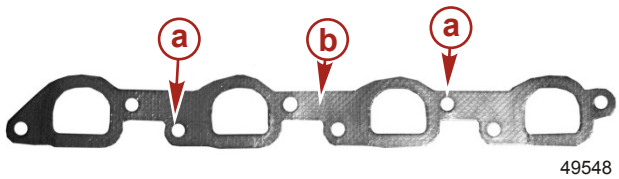
Description	Maximum overall difference
Surface flatness	0.13 mm (0.005 in.) with not more than a 0.02 mm (0.002 in.) difference within 25 mm (1 in.)

NOTE: *The maximum material that can be removed is 0.25 mm (0.01 in.) to flatten a gasket surface.*

7. Inspect the condition of the metal around the exhaust outlet in the casting. Inspect for damage caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser, if equipped. Replace all damaged parts.

Installation

1. Hand -tighten two alignment pins (if available) into the cylinder head. You may use the manifold location holes matching the gasket shown.



a - Alignment pin position
b - Gasket

2. Place the new exhaust manifold gasket on the cylinder head. Allow the alignment pins to hold the gasket in place.
3. Install the exhaust manifold onto the cylinder head. Tighten the bolts to specification.

Description	Nm	lb-in.	lb-ft
Exhaust manifold bolts (8)	47	–	35

4. Install any components previously removed.
5. Install the collector as described in **Collectors**.
6. Install the riser or tip as described in **Risers**.
7. Install all coolant and exhaust hoses.
8. Connect the oxygen sensor to the engine harness.
9. Connect the battery cables to the battery. Tighten securely.
10. Start the engine and check for fuel, exhaust, and water leaks.

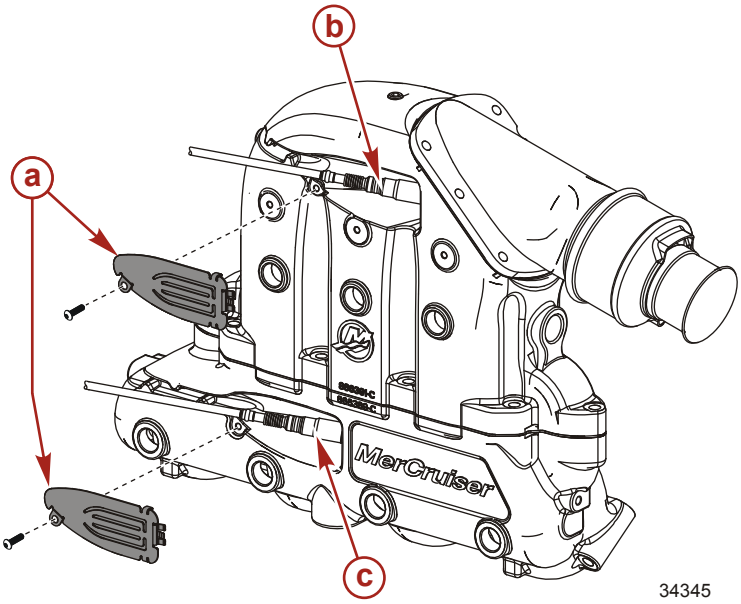
Oxygen Sensor

Removal

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the sensor from the engine harness.
2. Loosen the screw securing the oxygen sensor cover to the collector, and remove the cover.



a - Oxygen sensor cover
b - Post-catalyst oxygen sensor
c - Pre-catalyst oxygen sensor

3. Remove the oxygen sensors, as needed.

Kent-Moore Oxygen Sensor Socket	KN-46577

Installation

1. Use the oxygen sensor tool to install the oxygen sensor. Tighten the sensor to specification.

Kent-Moore Oxygen Sensor Socket	KN-46577

2. Install the oxygen sensor cover so it is flush against the collector. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
Oxygen sensor	50	–	37
Oxygen sensor cover screw	3.5	31	–

3. Connect the sensor to the engine harness.

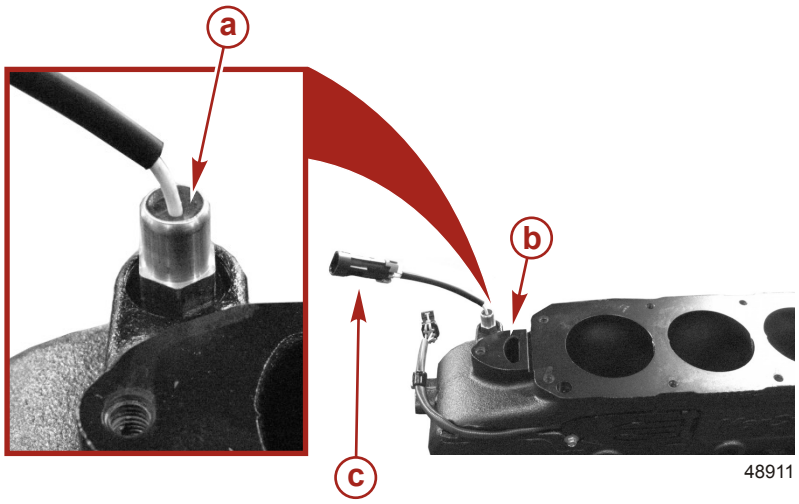
Exhaust Manifold Coolant Temperature (EMCT) Sensor

Removal

⚠ CAUTION

A hot oxygen sensor can cause burns. Do not touch the sensor without first allowing it to cool. Always allow engine components time to reach a safe temperature before installing or servicing engine or drive components.

1. Disconnect the EMCT sensor connector from the engine harness.
2. Remove the EMCT sensor from the exhaust manifold.

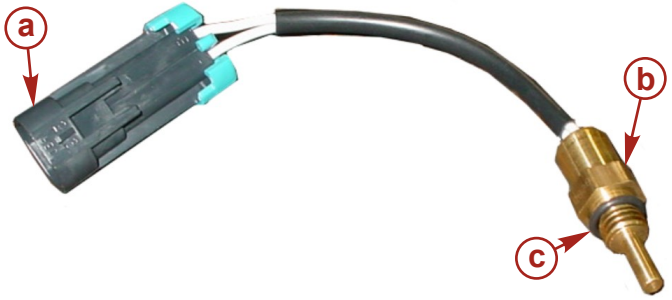


48911

a - Sensor
b - Exhaust manifold
c - EMCT sensor connector

Installation

1. Verify that the O-ring is on the EMCT sensor.

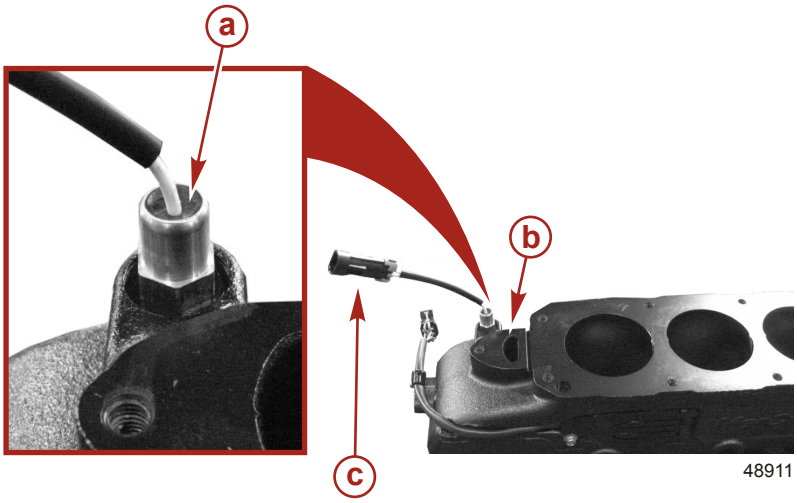


48912

a - EMCT sensor connector
b - EMCT sensor
c - O-ring

2. Hand-start the EMCT sensor into the exhaust manifold.

3. Tighten the EMCT sensor to specification.



a - Sensor
b - Exhaust manifold
c - EMCT sensor connector

Description	Nm	lb-in.	lb-ft
Sensor	8	–	6

4. Connect the EMCT sensor connector to the engine harness.

Exhaust System

Section 7B - Models Without Emissions Control

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B

Exhaust System

Exhaust System Caution

NOTICE

Improperly designing, installing, or modifying the engine's exhaust system can introduce seawater or water from condensation into the combustion chambers, damaging the engine. The installing dealer or boat builder is responsible for proper installation of the exhaust system as explained in the installation instructions for the product. Engine damage resulting from water ingestion is not covered by the product warranty, unless the damage is the result of a defective part supplied by the engine manufacturer.

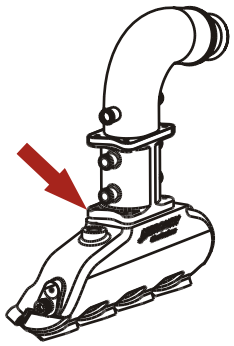
Exhaust System Connections

IMPORTANT: The exhaust system supplied by Mercury MerCruiser is compliant with the ABYC Standard P-1. If components are used in any portion of the exhaust system that modify the design of the supplied system, it is the boat builder's responsibility to ensure that the new system complies with the ABYC Standards. Exhaust system connections to components other than those supplied by Mercury MerCruiser must use two stainless steel clamps with a minimum width of 13 mm (1/2 in.) at each joint.

Exhaust Emissions Sampling

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

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



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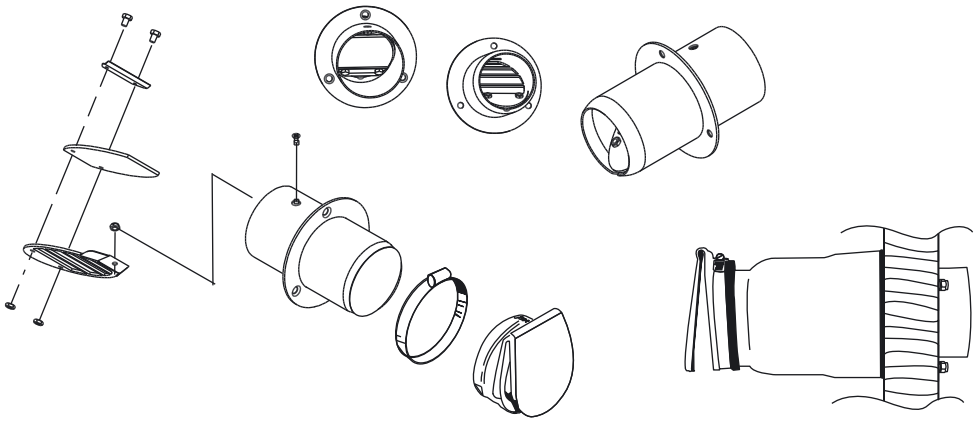
Access area for exhaust gas sampling—Non-Emission Controlled 8.2 MAG and 8.2 MAG H.O. Models

Through-Hull Exhaust Fittings

Exhaust fittings (flanges, outlets) must be equipped with an internal shutter and external flapper to prevent water intrusion problems. This is a requirement on all applications except water lift mufflers, where it is still recommended. A variety of fittings are available through the Mercury Precision Parts and Accessories Guide.



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Reference Note

Refer to the appropriate **Mercury MerCruiser Product Applications Manual** for more in depth diagnosis and set up installation of the exhaust systems.

Measuring Exhaust Elbow Height

General Information

Install exhaust elbows within the specified height dimensions to prevent water intrusion. Install exhaust elbow risers as needed to obtain the proper exhaust elbow height and exhaust angle. Risers cannot exceed 203.2 mm (8 in.) . Take all measurements with the boat in the water and loaded to simulate the maximum loading conditions for normal operation.

IMPORTANT: If installing a water lift muffler, measure the elbow height to the waterline inside the water lift muffler, not the water line outside of the boat. Refer to Water Lift Muffler for instructions.
IMPORTANT: The boat manufacturer is responsible for load distribution recommendations. Boat builders must communicate any load distribution conditions that affect the exhaust system such as maximum occupancy of the swim platform to the operator in the owner's manual.

Measurements for all loading conditions must meet the following specifications:

Model	Minimum Exhaust Elbow Height
8.2	381 mm (15 in.)

Model	Minimum Exhaust Hose Slope within 45.7 cm (18 in.) of engine	Minimum Exhaust Hose Slope Remainder of system (if applicable)
8.2	10°	3°

If the exhaust elbow height or exhaust angle is insufficient, modify the exhaust system or install the appropriate exhaust riser. Refer to the appropriate **Mercury Precision Parts and Accessory Guide** for part numbers.

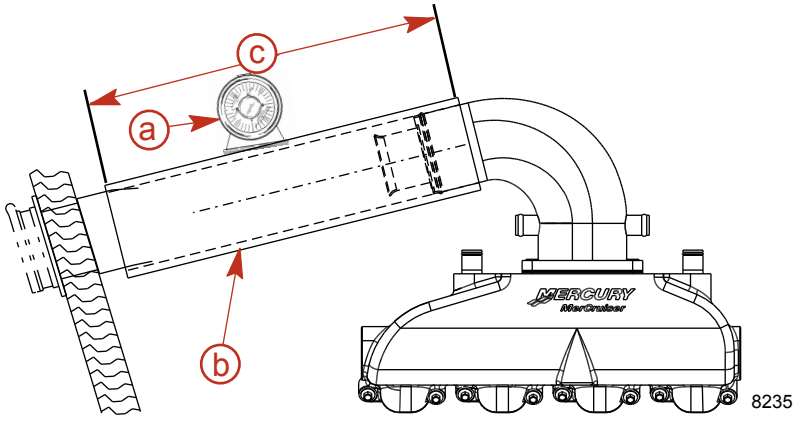
The maximum exhaust riser height is specified in the table below.

Maximum Exhaust Riser Height			
Model	**Low**	**Medium**	**High**
8.2	51 mm (2 in.)	152 mm (6 in.)	203 mm (8 in.)

Model	Exhaust Hose or Tube length
8.2 Sterndrive Models	30 cm (12 in.)
8.2 Inboard Models	46 cm (18 in.)

Exhaust Angle Measurement

Measure the exhaust angle of each section of the exhaust system using an inclinometer as shown in the diagram below. Begin the measurement at the exhaust elbow outlet continuing along each section to the exhaust exit point of the boat. Perform all exhaust angle measurements with the boat at rest in the water. Perform the first set of measurements without a load in the boat. Perform the second set of measurements with the boat fully loaded. See **Loading Requirements**.



a - Inclinometer
b - Exhaust hose or tube
c - Length of exhaust hose or tube

Boat Requirements

IMPORTANT: Consider the following requirements before performing the exhaust elbow waterline height measurement. No prototype hulls or light layup hulls should be considered. Any measurement performed on non-production boats, prototype hulls, or light layup hulls could be inaccurate and could result in product damage.

- All boats that display a CE certification capacity plate **must use the maximum capacity as stated on the CE certification capacity plate to perform the exhaust elbow waterline measurement.**
- All boats that only display the US Coast Guard (USCG) capacity plate **must use the maximum capacity as stated on the USCG capacity plate to perform the exhaust elbow waterline measurement.**
- For boats that do not have a capacity plate, the maximum capacity load is the number of persons that can sit on designated seating plus cargo excluding cabin space.
- Measurements used for official Mercury MerCruiser audit at the OEM boat builder must be performed on current production boats. No prototype hulls or light layup hulls will be considered for official audit purposes.
- Measurements used for official Mercury MerCruiser audit at OEM boat builders must use the CE certification maximum load for any boat model that will be sold outside of the United States.

Loading Requirements

1. Fill the fuel tanks, fresh water tanks or holding tanks, ballast tanks, and heater tanks to simulate fully loaded condition.
2. Weights can be used to simulate these load conditions if desired. Place weights in the corresponding area for which the load is being replaced. Refer to the following conversions.
   - 1 U.S. gallon of water = 8.3 lb
   - 1 liter of water = 1 kg
   - 1 U.S. gallon of gasoline = 6 lb
   - 1 liter of gasoline = 0.72 kg
3. For the purpose of MerCruiser waterline height measurements:
   - One person is equivalent to 74.84 kg (165 lb)
   - Cargo per person is equivalent to 11.34 kg (25 lb)
4. Add weight for any additional boat options: extra battery, battery charger, tower, arch, generator, ballast tanks, ballast sacks, television, carpet, anchor, stereo/entertainment equipment, washer/dryer, safe, etc.
5. If a swim platform is an option, the swim platform must be installed for the waterline height measurement. Use the following guide to determine the correct swim platform load:
   a. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   b. Boats less than 8.84 m (29 ft) long, not including boats that are 8.84 m (29 ft) long that do not have a maximum rated swim platform weight capacity, must add181.45 kg (400 lb) to the swim platform .
   c. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, must add the maximum rated swim platform weight capacity to the swim platform.
   d. Boats 8.84 m (29 ft) long and greater than 8.84 m (29 ft) long, that do not have a maximum rated swim platform weight capacity must add 226.80 kg (500 lb) to the swim platform.

Loading the Boat (Boats with a Capacity Plate)

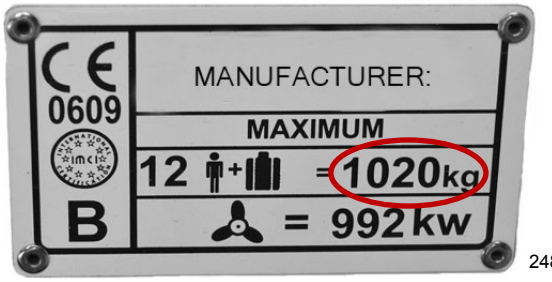
For boats with a capacity plate, use the maximum load for persons and gear as listed on the capacity plate to determine the number of persons to place onto the boat for exhaust elbow waterline height measurements.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples listed below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Take the maximum capacity weight as listed on the capacity plate (XXXX lb. Persons, Gear) and subtract the swim platform load, if applicable.
2. Next divide the weight by 74.84 kg (165 lb.) per person. This gives the whole number and remainder of 74.84 kg (165 lb.) persons to load onto the boat.

3. Put the remainder of a person in the next available seat. See **Boat loading diagram**.



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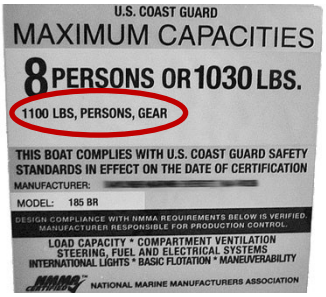
CE Capacity Plate



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USCG Capacity Plate

IMPORTANT: If there is not enough seating for the number of people, treat the leftover weight as cargo. Load cargo weight onto the boat before loading passenger weight.

4. If applicable, load cargo (leftover persons weight) onto the boat. Distribute cargo as described below.
IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

5. Perform the first measurement with the swim platform loaded and the person taking the waterline measurement on the boat.
6. Load the swim platform if equipped.
7. Measure the exhaust elbow waterline height.
IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
8. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
9. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

NOTE: *The total weight loaded onto the boat must not exceed the maximum capacity displayed on the capacity plate.*

NOTE: *The following example is provided as a reference.*

Example

NOTE: *This example uses a boat that is less than 8.84 m (29 ft.) long, not including a boat that is 8.84 m (29 ft.) long that does not have a maximum rated swim platform weight capacity, and must add 181.45 Kg (400 lb.) to the swim platform*

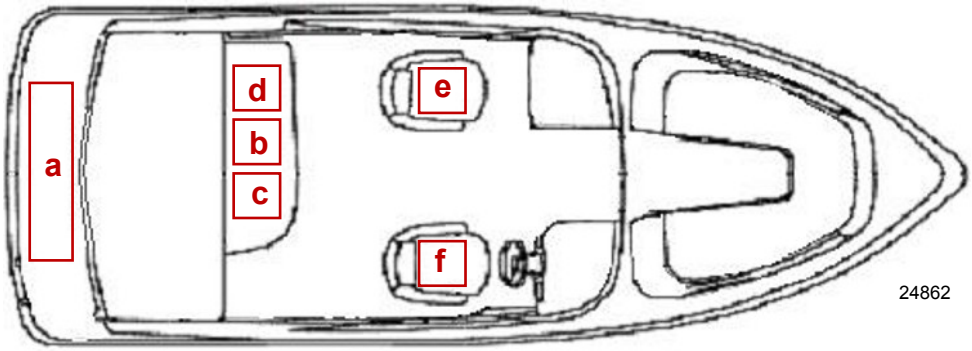
NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. Maximum load (persons and gear) from capacity plate – swim platform load = remaining weight to be placed in the boat.
   - 1100 lb. – 400 lb. = 700 lb.
2. Remaining weight to be placed in the boat ÷ MerCruiser person weight = number of persons to load onto the boat
   - 700 lb. ÷ 165 lb. = 4.24 persons
3. Total number of persons – number of whole persons = remaining persons
   - 4.24 persons – 4 persons = 0.24 remaining persons
4. Remainder persons ÷ MerCruiser person weight = remainder MerCruiser person weight
   - 0.24 × 165 lb. = 40 lb.

IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.

5. Using the totals in this example, load four 165-lb. persons and one 40-lb. person onto boat seating with 400 lb. on the swim platform.

- 400 lb. + 165 lb. = 565 lb.
- 565 lb. + 165 lb. = 730 lb.
- 730 lb. + 165 lb. = 895 lb.
- 895 lb. + 165 lb. = 1060 lb.
- 1060 lb. + 40 lb. = 1100 lb.



Boat loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - Remainder MerCruiser person weight (five)

Loading the Boat (Boats Without a Capacity Plate)

For boats that do not display a capacity plate, the number of persons to be loaded onto the boat for measuring purposes is the number of persons that can sit on designated seating excluding cabin space. An additional weight of 25 lb. per person is to be added to the boat before loading passenger weight onto the boat.

IMPORTANT: Use 20 inches for average passenger seat width when measuring bench seating. Round up or down at 0.5 to obtain a whole person. See the examples below.

- 48 in. (bench seat length) ÷ 20 in. (seat width) = 2.4 persons. 2.4 persons rounded down = 2 persons.
- 55 in. (bench seat length) ÷ 20 in. (seat width) = 2.75 persons. 2.75 persons rounded up = 3 persons.

1. Total number of persons that can sit on designated seating excluding cabin space × MerCruiser person weight = maximum passenger load for measurement.
   - Number of persons × 165 lb. (MerCruiser person weight) = XXXX lb. maximum passenger load.
2. Maximum passenger load from the calculation above – swim platform load if applicable.
3. Divide the weight by 165 lb. per person. This gives the number of 165-lb. persons to load onto the boat. Round up to next whole number. See **Example 3**.
   IMPORTANT: To account for cargo, add a weight of 25 lb. per person to the boat before loading passenger weight onto the boat.
4. Calculate the cargo by multiplying 25 lb. by the number of persons that can sit on designated seating excluding cabin space. See **Example**.
5. Load the cargo onto the boat. Distribute cargo as described below.
   IMPORTANT: If the boat configuration does not allow for aft, center, and bow storage, choose the storage application from the Optional Cargo Distribution table that best applies to your boat configuration.

Preferred Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	50%	25%

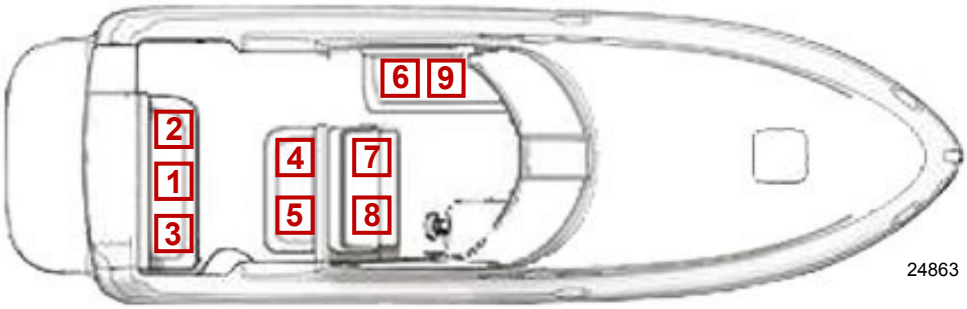
Optional Cargo Distribution		
Aft storage	**Center storage**	**Bow storage**
25%	75%	None
None	75%	25%
50%	None	50%
None	100%	None
100%	None	None
None	None	100%

6. Perform the first measurement with the swim platform loaded and the person measuring the waterline on the boat.
7. Load the swim platform if equipped.
8. Measure the exhaust elbow waterline height.
   IMPORTANT: View all boat seating as rows that are parallel to the transom of the boat.
9. Load a person weight into a seat, and measure the exhaust elbow waterline height after each person weight is loaded onto the boat. Repeat until a person weight is is loaded into each seat in that row.
10. Continue the process moving forward toward the bow of the boat to the next row of seats until a person weight is loaded into each seat.

Example

NOTE: *The following example is provided as a reference.*
This example uses a boat that is 8.84 m (29 ft.) long and greater than 8.84 m (29 ft.) long, that does not have a maximum rated swim platform weight capacity, and must add 226.80 Kg (500 lb.) to the swim platform .

IMPORTANT: The Designated Seating Diagram following illustrates the number of passengers that can sit on designated seating excluding cabin space.



Designated Seating Diagram

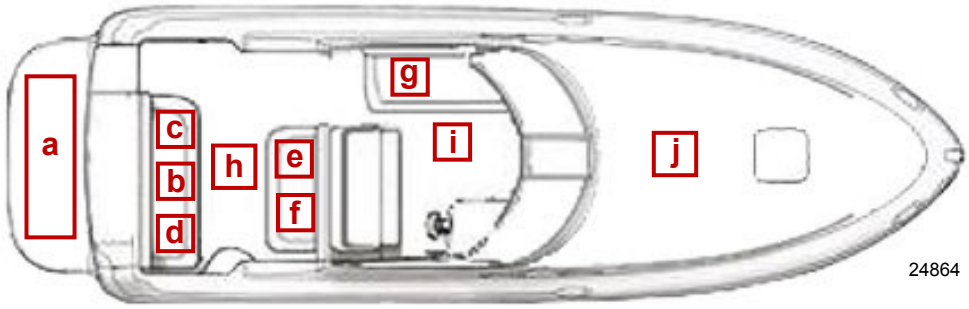
This example uses 9 persons as the maximum passenger load.

NOTE: *Use 0.50 lb. as the break point to round up or down to obtain a whole pound.*

1. To determine the maximum cargo load multiply the maximum passenger load by the maximum cargo weight per passenger.
   - 9 passengers × 25 lb. = 225 lb.
2. To determine the preferred cargo distribution for aft, center, and bow storage:
   a. To determine the maximum aft storage cargo weight, multiply the maximum cargo weight by 25%
3. To determine the maximum center storage cargo weight, multiply the maximum cargo weight by 50%
   a. 225 lb. × 50% = 112.50 lb.
   b. 112.50 lb. rounded up = 113 lb.
4. To determine the maximum bow storage cargo weight, multiply the maximum cargo weight by 25%
   - 225 lb. × 25% = 56.25 lb.
   - 56.25 lb. rounded down = 56 lb.
5. To determine the maximum number of passengers to load onto the boat, multiply 9 passengers by 165 lb. (MerCruiser person weight) to get a 1485 lb. (total passenger load)
   - 9 passengers × 165 lb. = 1485 lb.
6. Subtract the swim platform load from the total passenger load to get the remaining weight to be placed in the boat.
   - 1485 lb. – 500 lb. = 985 lb.

7. Divide the remaining weight to be placed onto the boat by the MerCruiser person weight to get the maximum number of passengers to load onto the boat.
   - 985 lb. ÷ 165 lb. = 5.9 passengers
   - 5.90 passengers rounded up = 6 passengers
8. Using the totals in this example load 56 lb. cargo in the aft storage, 113 lb. cargo in the center storage, and 56 lb. cargo in the bow storage onto the boat before adding passenger weight. Then, load six 165 lb. passengers, onto the boat with 500 lb. on the swim platform.

- 500 lb. + 225 lb. = 725 lb.
- 725 lb. + 165 lb. = 890 lb.
- 890 lb. + 165 lb. = 1055 lb.
- 1055 lb. + 165 lb. = 1220 lb.
- 1220 lb. + 165 lb. = 1385 lb.
- 1385 lb. + 165 lb. = 1550 lb.
- 1550 lb. + 165 lb. = 1715 lb.

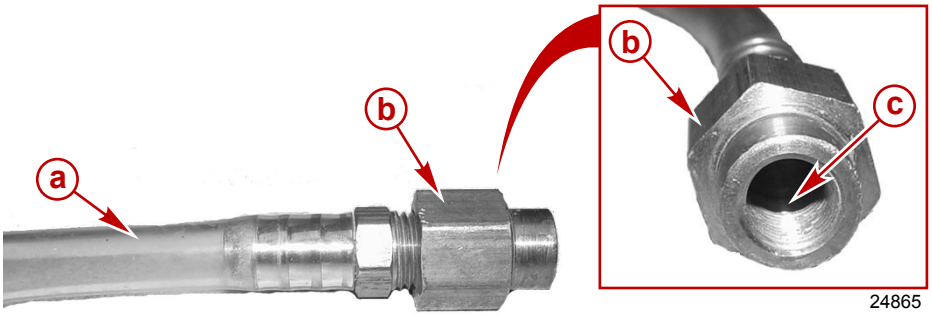


Cargo, swim platform, and passenger weight loading diagram

a - Swim platform load
b - MerCruiser person weight (one)
c - MerCruiser person weight (two)
d - MerCruiser person weight (three)
e - MerCruiser person weight (four)
f - MerCruiser person weight (five)
g - MerCruiser person weight (six)
h - Aft storage
i - Center storage
j - Bow storage

Clear Hose Measurement Method

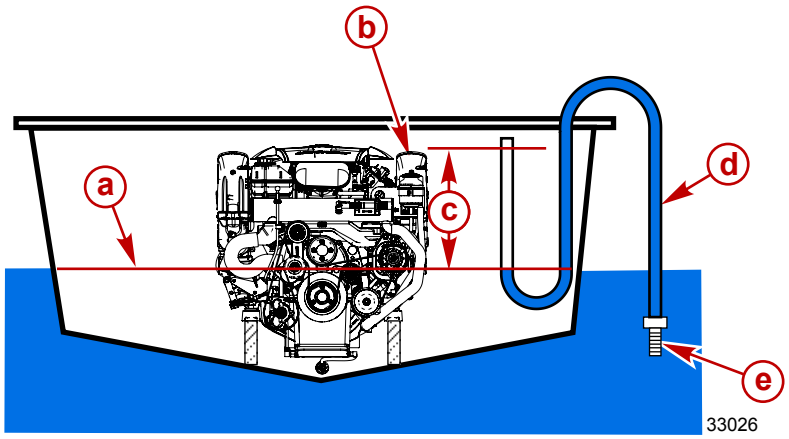
1. Obtain an 8–10 mm (5/16–3/8 in.) inner diameter (ID) clear hose approximately 4.5 m (15 ft.) long. Install a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline. The fitting or weight must not restrict water from filling the clear hose.



a - Clear hose
b - Fitting
c - Unrestricted opening

IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

2. Put the weighted end of the clear hose over the side of the boat (port or starboard) that is sitting lower in the water.
3. Submerge the clear hose until completely filled with water.
4. Place a finger over the open end of the clear hose before removing it from the water.
5. Coil the excess clear hose into the bottom of the boat bilge. Keep the coil of clear hose below the waterline.
6. Keeping the clear hose in line with the engine's exhaust elbow, lift the end of the clear hose up to the highest point of the exhaust manifold collector and elbow.
7. Slowly take the finger off of the end of the clear hose to let the water level stabilize. The water will seek the level of the water outside of the boat. Keep the clear hose close to the exhaust elbow and as vertical as possible.



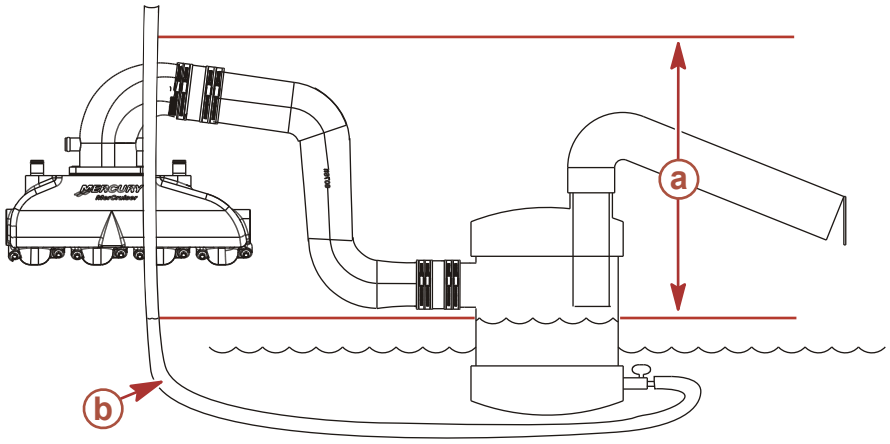
- **a -** Waterline
- **b -** Top of exhaust elbow
- **c -** Waterline to top of exhaust elbow measurement
- **d -** Clear hose
- **e -** Weight

Clear Hose Measurement Method From Seacock or Muffler Drain

IMPORTANT: Measure the exhaust elbow height to the waterline inside of the water lift muffler (instead of the water line outside of the boat) on applications so equipped.
IMPORTANT: The engine must have been operated previously to fill the muffler with water.
IMPORTANT: On engines equipped with more than one exhaust elbow, perform the exhaust elbow waterline height measurement on the side that sits lower in the water.

1. Attach a clear hose to the muffler drain point or seacock drain point.
2. Start the engine to fill the muffler and hose.
3. If attached to the seacock drain, open the seacock.
4. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow.
5. Coil excess hose in the bilge of the boat, keeping it below the water line.
6. Lower the open end of the hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.
7. Slowly take the finger off of the end of the hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep the hose close to the exhaust elbow and as vertical as possible.

8. The measurement between the water in the hose and the top of the exhaust elbow is the exhaust elbow height. The maximum riser height is 20.3 cm (8 in.) on 8.2 models.



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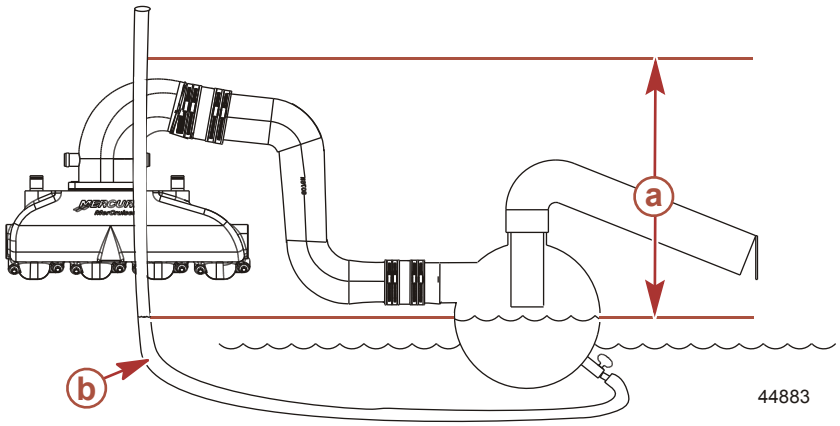
Typical vertical water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

IMPORTANT: Horizontal waterlift mufflers are permitted for use only if the bottom of the muffler is below the crankshaft centerline.



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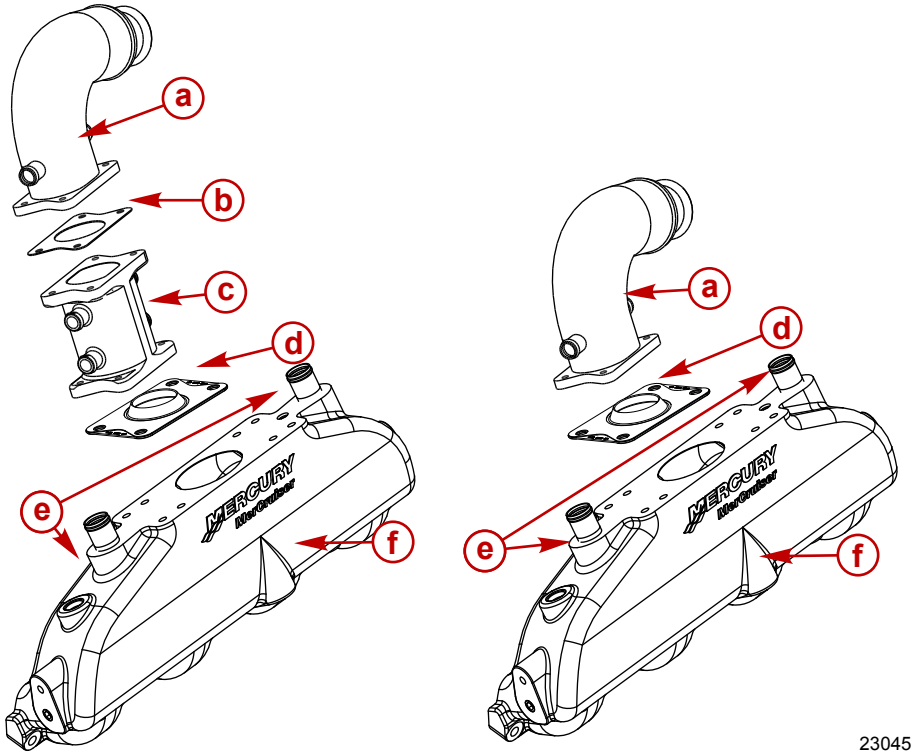
Typical horizontal water lift muffler

a - Minimum exhaust elbow height with maximum load

b - Clear hose for measuring waterline

Manifold and Elbow

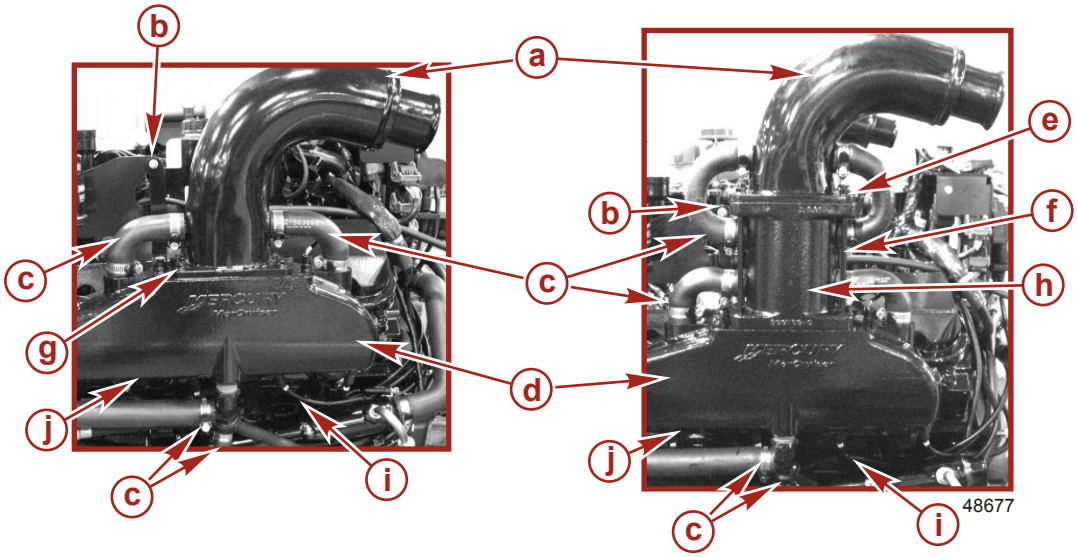
Exploded View



- **a -** Exhaust elbow
- **b -** Elbow gasket
- **c -** Riser
- **d -** Turbulator plate and gasket elbow flange
- **e -** Fittings
- **f -** Exhaust manifold

Replacing the Manifold

Removal



- **a -** Exhaust elbow
- **b -** L-bracket bolt
- **c -** Hose and clamps
- **d -** Exhaust manifold
- **e -** Nut and washer (4)
- **f -** Stud (4)
- **g -** Cap screw (4)
- **h -** Exhaust riser
- **i -** Spark plug wire (4)
- **j -** Bolt (8)

1. Drain the seawater system.
2. Disconnect the spark plug leads. Tag the leads as required to ensure that they are reconnected at the proper cylinders.
3. Remove the top screw from the L-bracket, leaving the bracket attached to the manifold.
4. Remove the water hoses from the water fitting at the bottom of the exhaust manifold. Retain the hose clamps.
5. Remove the exhaust elbow hoses. Retain hose and hose clamps for reuse.
6. Remove the cap screws securing the exhaust elbow and remove the elbow from the exhaust manifold. The elbow and screws can be reused if not damaged.
7. On models with a six-inch riser, remove the nuts and washers from the studs. Then remove the exhaust elbow and riser from the exhaust manifold. Retain the elbow, riser, and fasteners for reuse.
8. Remove two bolts, at opposite ends, securing the exhaust manifold to the cylinder head and install the alignment pins to support the weight.
9. Remove the remaining bolts and carefully remove the exhaust manifold. Do not allow the manifold to contact the spark plugs.

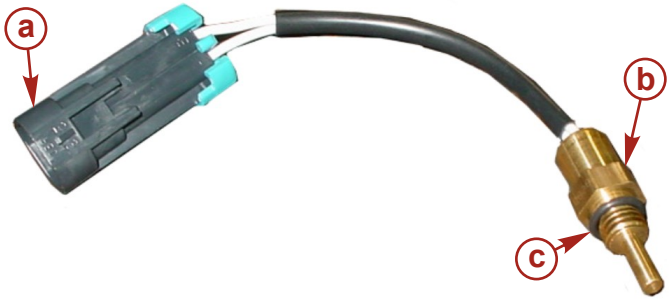
Inspection and Cleaning

1. Clean the gasket surface on the cylinder head and on the bottom of the exhaust elbow.
2. Clean all remaining gasket surfaces.
3. Inspect and replace any damaged stud, washer, or nut that was removed.
4. Replace any spark plug that is damaged during the removal or installation of the manifold.

Installation

1. If replacing the manifold, remove the exhaust manifold coolant temperature (EMCT) sensor, L-bracket, and the water drain fitting from the manifold. Note the orientation of the water drain fitting and the L-bracket, and install them in the new manifold.

a. Verify that the O-ring is on the EMCT sensor.



48912

a - Temperature sensor connector
b - Temperature sensor
c - O-ring

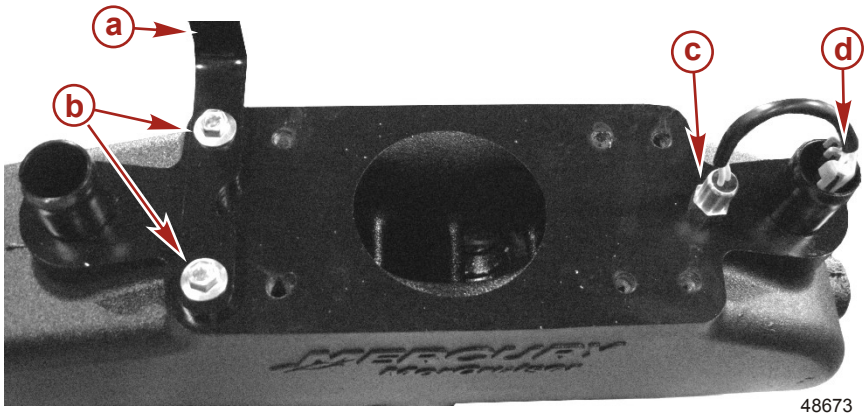
b. Hand-start the EMCT sensor in the manifold.

c. Tighten the sensor to specification and position the connector temporarily out of the way.

Description	Nm	lb-in.	lb-ft
EMCT sensor	8	–	6

d. Install the L-bracket on the manifold with two mounting screws.

e. Tighten the screws to specification.

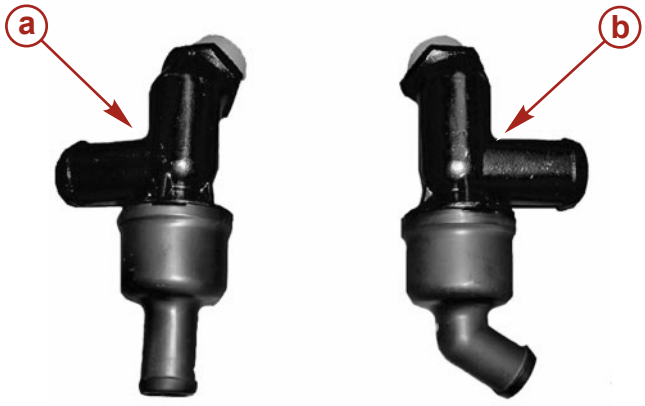


48673

a - L-bracket
b - L-bracket screw
c - EMCT sensor
d - EMCT sensor connector (temporarily out of the way)

Description	Nm	lb-in.	lb-ft
L-bracket screw to manifold	27	–	20

f. Install the water drain fitting at the bottom of the manifold. Orient the fitting similar to the original fitting to match up with the water hoses.

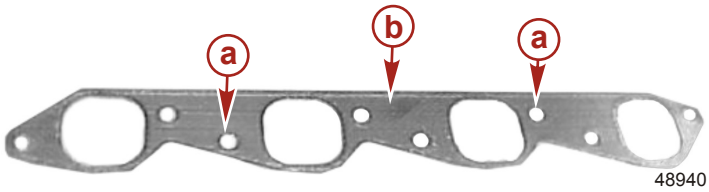


34342

a - Port manifold drain fitting
b - Starboard manifold drain fitting

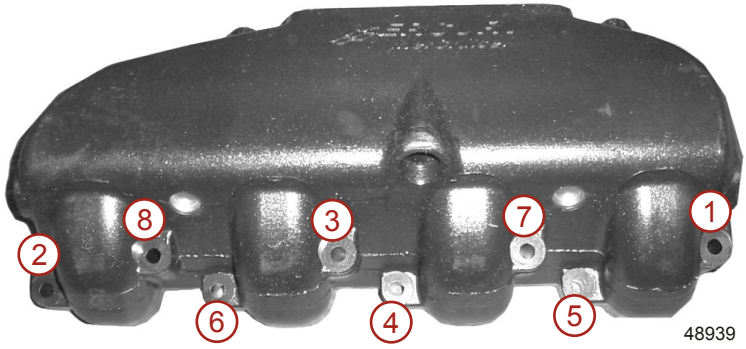
g. If discarding the manifold on models with a six-inch riser, remove and retain the studs from the old exhaust manifold.

2. Hand-tighten two alignment pins (if available) into the manifold location holes matching the gasket shown.



a - Alignment pin position
b - Gasket

3. Place the new exhaust manifold gasket on the cylinder head. Allow the alignment pins to hold the gasket in place.
4. Attach the new exhaust manifold to the head using hex head cap screws.
   NOTE: *Install the short screws in the recessed location holes and the long screws in the raised location holes.*
5. Remove the alignment pins once you have secured the manifold with at least two screws.
6. Tighten the screws to specification in the sequence shown below.

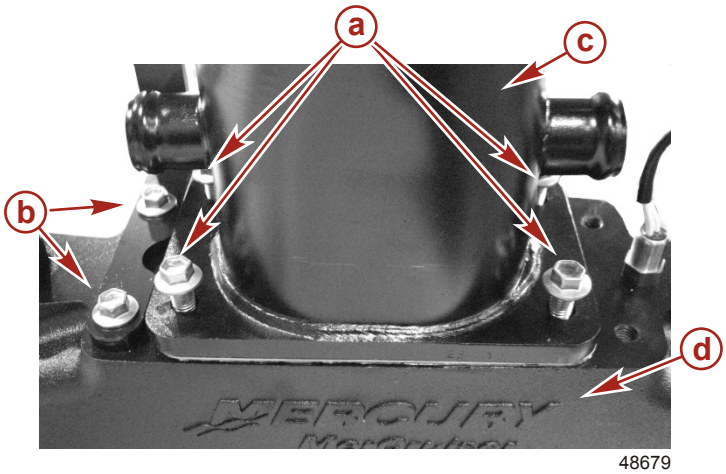


Description		Nm	lb-in.	lb-ft
Manifold to head cap screws	**First**	20	–	15
	Second	47	–	35
	Final	47	–	35

7. Install the L-bracket top screw on the plenum. Tighten the screw to specification.

Description	Nm	lb-in.	lb-ft
L-bracket to plenum screw	27	–	20

8. Install a new turbulator plate.
9. Install the exhaust elbow on the manifold. Tighten the cap screws to specification.

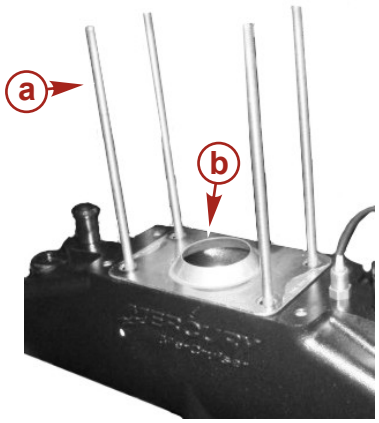


a - Exhaust elbow bolts
b - L-bracket bolts
c - Exhaust elbow
d - Exhaust manifold

Description	Nm	lb-in.	lb-ft
Cap screws	27	–	20

10. On models with six inch risers:

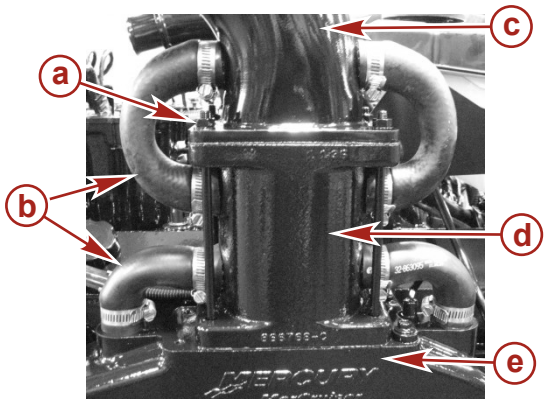
a. Install the studs in the corresponding holes in the exhaust manifold. Tighten the studs until the threads are bottomed out in the manifold.



48942

a - Studs
b - Turbulator gasket

b. Install the riser on the turbulator gasket on the manifold.
c. Install the gasket on the riser.
d. Place the exhaust elbow on the gasket on the riser.
e. Install a washer and nut on each stud.
f. Tighten the nuts to specification.



48697

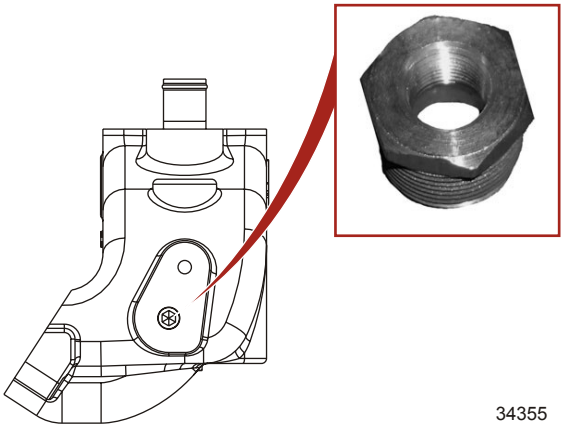
a - Nuts and washers (4 each)
b - Hose and clamps
c - Exhaust elbow
d - Exhaust riser
e - Exhaust manifold

Description	Nm	lb-in.	lb-ft
Exhaust elbow nuts	27	–	20

11. Connect the EMCT sensor to the engine harness.
12. Install the spark plug wires.

Inboard Applications

An adapter fitting is supplied for inboard applications that use a shaft log cooler hose. Remove the appropriate plug from the end of the manifold. Install the adapter and install the shaft log fitting from the original manifold system.



Location of adapter fitting

Exhaust System

Section 7C - Exhaust Collectors

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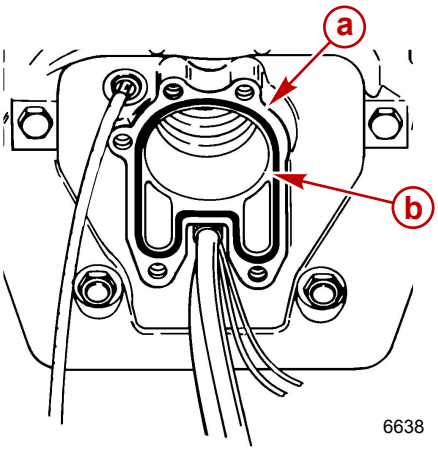
Exhaust Resonator—Inboard Models....7C-6

7C

Component Replacement

To replace any components in the exhaust system, adhere to the following:

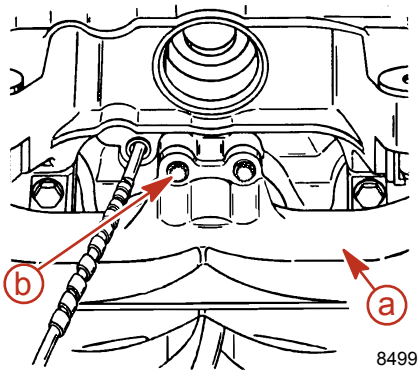
- All mating surfaces must be clean.
- The O-ring must remain in the groove to properly seal the joints to prevent leakage.
- Tighten all clamps securely.



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)

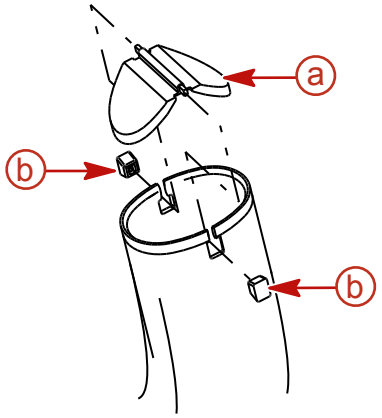
Description	Nm	lb. in.	lb. ft.
Exhaust pipe screw	34		25

Water Shutter Replacement—Sterndrive Models

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.

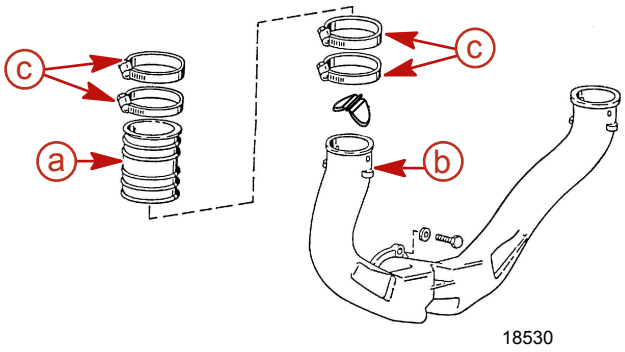
3. Install the water shutter into the Y pipe. Ensure that the water shutter is seated into the rubber grommets.



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.

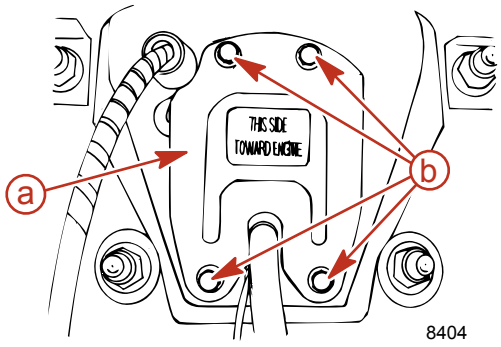


18530

Description	Nm	lb. in.	lb. ft.
Hose clamp (exhaust tube)	4	35	

Through-Transom Exhaust

IMPORTANT: A block off plate must be installed when using through the transom exhaust or below swim platform kits.



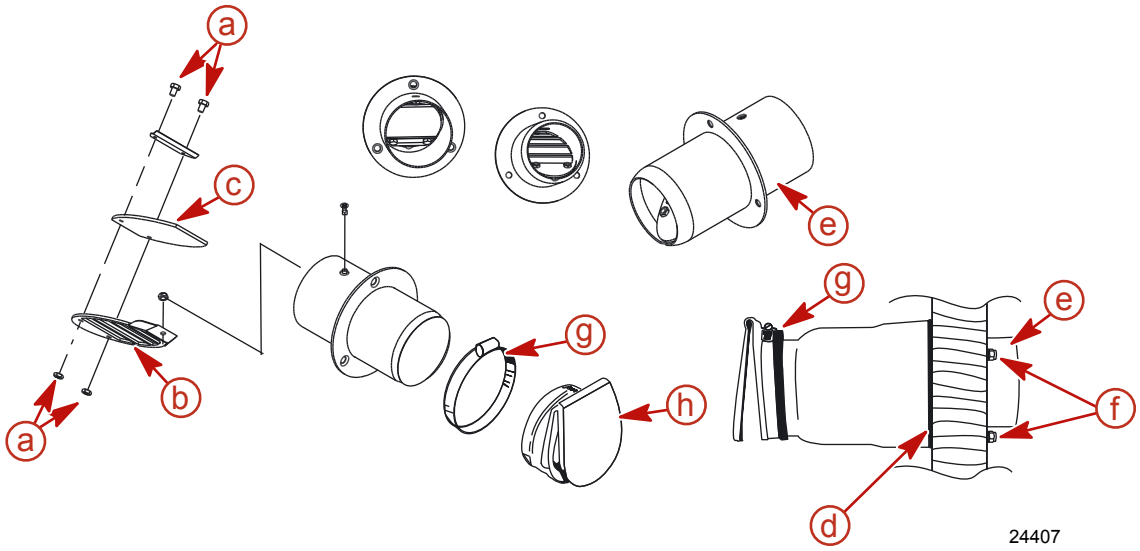
8404

a - Block off plate
b - Bolts (4)

Water Shutter Replacement—Through Transom Models

1. Remove the clamp securing the external cover (flapper) to the exhaust flange.
2. Remove the external cover (flapper).

3. Remove the internal water shutter.
4. Install the new shutter. Tighten the screws and nuts securely.
5. Reinstall the water shutter in the exhaust flange to the transom exhaust.
6. Reinstall the external flapper. Tighten the clamp securely.



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)

Preferred Exhaust System

Most Mercury MerCruiser sterndrive engines were developed and tested for the Y-pipe or through the propeller exhaust systems. The only exceptions to this are the 8.2 models. However, by using the Y-pipe system, you limit the potential for water intrusion due to the exhaust system design.

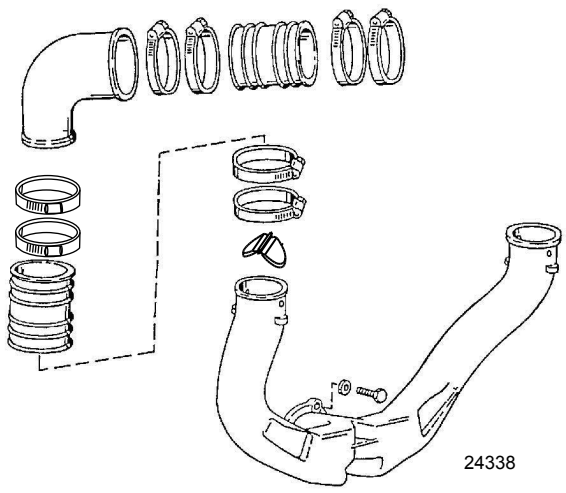
Magnum Bravo Model Exhaust Recommendation

Use through-the-transom exhaust for maximum performance from the Magnum Bravo Models. Install a block-off plate and remove the exhaust bellows on the transom assembly. 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.

Exhaust Pipe Kit

If noise regulations do not allow the use of through-the-transom exhaust, an Exhaust Pipe Kit (807130A21) and the specified intermediate exhaust elbow riser kit must be installed for through-the-prop exhaust. This kit also contains an exhaust tube that is used in place of the exhaust bellows.

IMPORTANT: To comply with the EU (European Union) Noise Emission Standard under Mercury's EU Noise Certification, the 8.2 sterndrive engines must have installed and use the exhaust pipe kit (807130A21) with a specified intermediate exhaust elbow riser kit. Installation and use of any other exhaust components will require individual certification of the installation by the governing authority.



Exhaust pipe kit and intermediate exhaust elbow riser kit

Description	Part Number
Intermediate exhaust elbow riser kit 50 mm (2 in.)	879288A13
Intermediate exhaust elbow riser kit 101 mm (4 in.)	879288A14
Intermediate exhaust elbow riser kit 152 mm (6 in.)	879288A15
Intermediate exhaust elbow riser kit 203 mm (8 in.)	879288A16

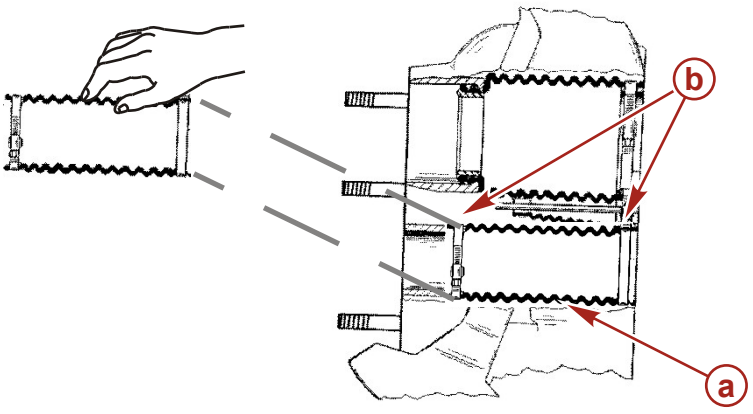
Exhaust Tube Installation

NOTE: *Installing the exhaust tube will increase exhaust noise.*

IMPORTANT: Remove the exhaust bellows and install an exhaust tube on the transom assembly when:

- **The 8.2 engine package is equipped with a Bravo sterndrive and through-the-propeller exhaust.**
- **The exhaust system can be switched to either through-the-propeller or through-the-transom exhaust.**

1. Remove and discard the clamps and exhaust bellows from the gimbal housing.



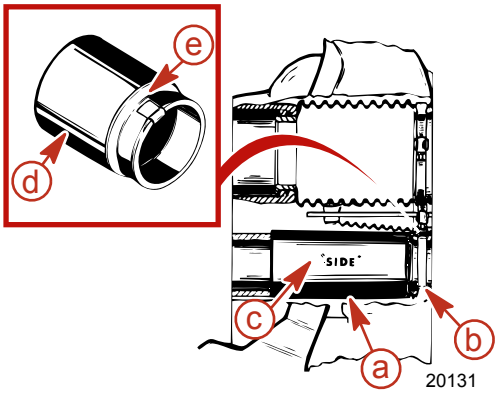
a - Exhaust bellows
b - Clamps

IMPORTANT: Failure to install the grounding clip may lead to corrosion of the exhaust tube, damaging it. Always install the grounding clip.

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 the right and left sides.
4. Install the clamp.
5. Tighten the clamp securely.

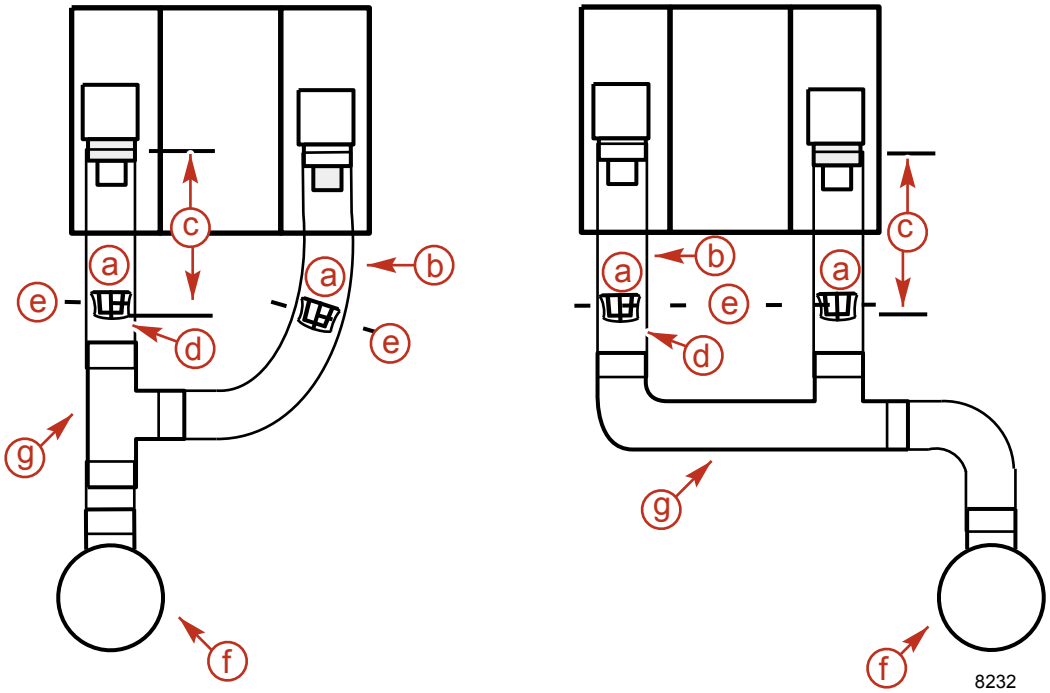


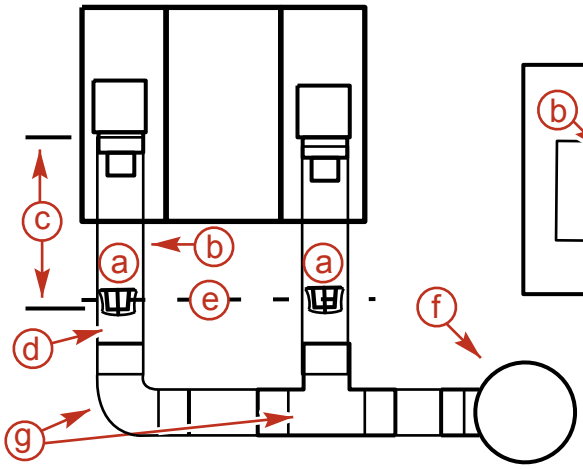
a - Exhaust tube
b - Clamp
c - "SIDE" marking
d - Exhaust tube
e - Grounding clip

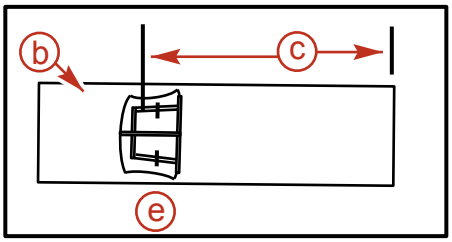
Exhaust Resonator—Inboard Models

IMPORTANT: Exhaust resonators can be used on all models with through the transom exhaust. The exhaust resonators kit 86022A1 is purchased separately for each engine.

- The exhaust resonator is positioned with the inside flat surface at the preferred distance of 432 mm (17 in.) from the front edge of the exhaust hose but no closer than 51 mm (2 in.) to the exhaust outlet. The 432 mm (17 in.) dimension can be reduced, if necessary, to a MINIMUM of 330 mm (13 in.). This dimension must be the same on both exhaust outlets.







a - Exhaust resonator
b - Exhaust hose
c - Dimension to inside flat surface of resonator approximately 432 mm (17 in.)
d - No less than 51 mm (2 in.) between collector and resonator
e - Clamp - positioned around center of resonator
f - Exhaust muffler
g - Collector

Exhaust system tuning can be affected by various factors that are beyond the control of Mercury MerCruiser. Following are several factors that can affect exhaust system tuning:

- Type and configuration of exhaust outlet.
- Length of exhaust hose.
- Amount of back-pressure in exhaust system. Refer to the appropriate **Mercury MerCruiser Product Applications Manual**.

Notes:

Transmission

Section 8A - ZF Marine Transmissions—HSW 63A, 63IV, 80A

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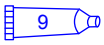
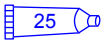
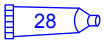
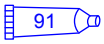
8A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 567 PST Pipe Sealant	Transmission fluid temperature switch threads and the service port plug	92-809822
	Liquid Neoprene	Neutral start switch wire connections Exposed electrical terminals and connections.	92- 25711 3
	Dexron III Automatic	Transmission	Obtain Locally
	Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A 1

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)[1.]	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[1.]	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.)	

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

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.

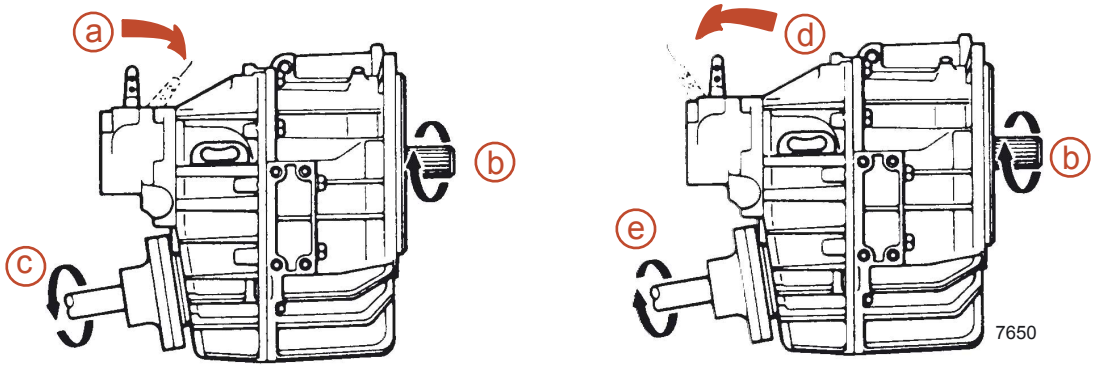
Precautions

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.

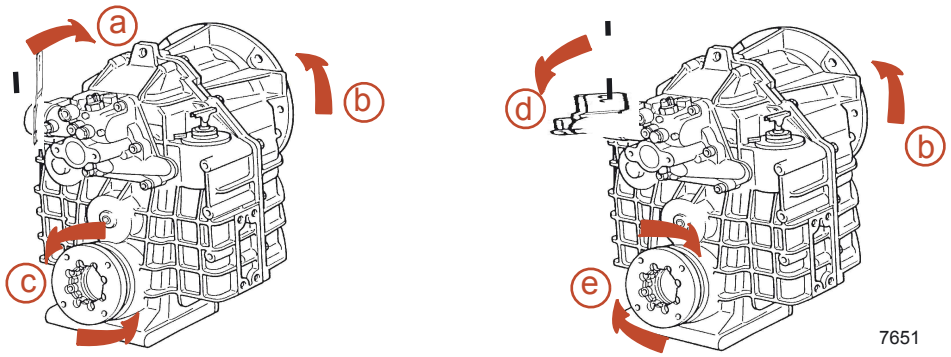
Transmission And Propeller Rotation

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)
b - Transmission input shaft rotation direction (LH)
c - Transmission output shaft rotation direction (RH)
d - Direction of shift lever engagement (away from flywheel)
e - Transmission output and propeller shaft rotation direction (LH)



ZF Marine 63IV—V-drive transmissions

- **a -** Direction of shift lever engagement (toward flywheel)
- **b -** Transmission input shaft rotation direction (LH)
- **c -** Transmission output shaft rotation direction (LH)
- **d -** Direction of shift lever engagement (away from flywheel)
- **e -** Transmission output and propeller shaft rotation direction (RH)

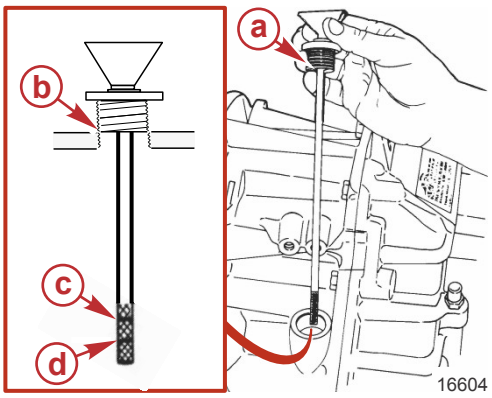
Transmission Fluid

Checking

1. Confirm that there is fluid in the transmission:
   a. When checking the fluid level, insert the dipstick into the threaded hole but do not screw it in. Remove the dipstick and check the fluid level indicated.

      NOTE: *The fluid level may be slightly over the maximum mark, as some of the fluid from the transmission fluid cooler and hoses may have drained back into the transmission.*

   b. Add transmission fluid to bring the level up to the maximum mark on the dipstick, if necessary.



- **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

2. Start the engine and operate at 1500 RPM for two minutes to fill all the hydraulic circuits.
   IMPORTANT: Failure to operate the engine immediately prior to checking the level will result in inaccurate readings.
3. Stop the engine and **immediately** check the fluid level with the dipstick resting in but not threaded into the threaded hole.
4. If the fluid is low, add transmission fluid as described in **Filling**.

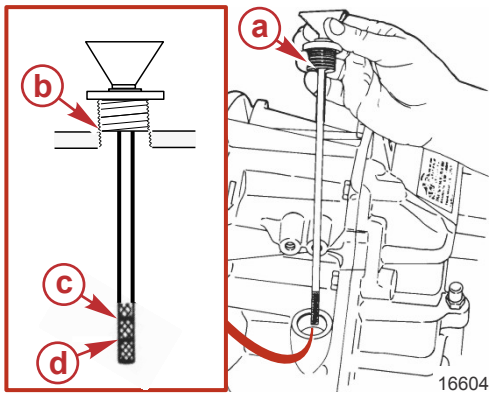
Tube Ref No.	Description	Where Used	Part No.
28	Dexron III Automatic	Transmission	Obtain Locally

5. Insert the dipstick into the threaded hole and hand-tighten.

Filling

1. 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.



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

Manufacturer	Model	Capacity (see note)	Fluid Type
ZF Marine (Hurth)	45A	3.0 L (3-1/4 US qt)	Dexron III Automatic Transmission Fluid
	63A	4.5 L (4-3/4 US qt)	
	63IV	4.9 L (5-1/4 US qt)	
NOTE: *Always use the dipstick to determine the exact quantity of oil or fluid required.*			

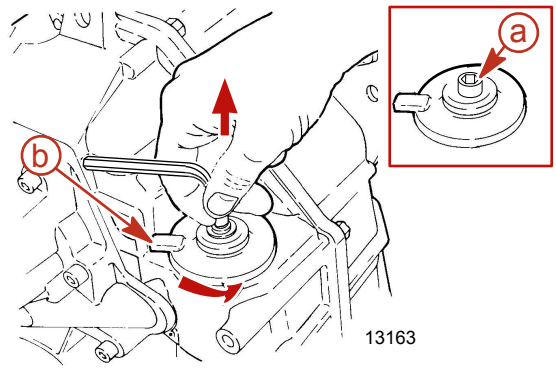
2. Install the dipstick.
3. Check the fluid level as described in **Checking**.

Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

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

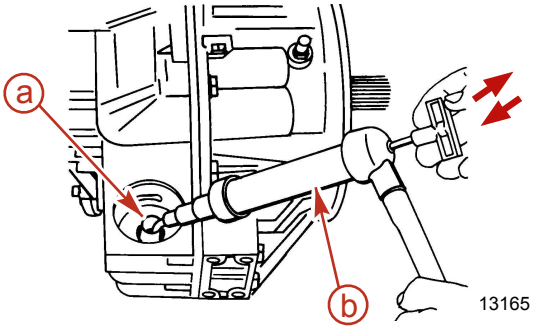
1. Clean the exterior of the transmission around the fluid filter assembly.
2. Use a 6 mm Allen wrench and remove the fluid filter assembly by turning the assembly nut counterclockwise and pulling at the same time.



a - Fluid filter assembly
b - Assembly nut

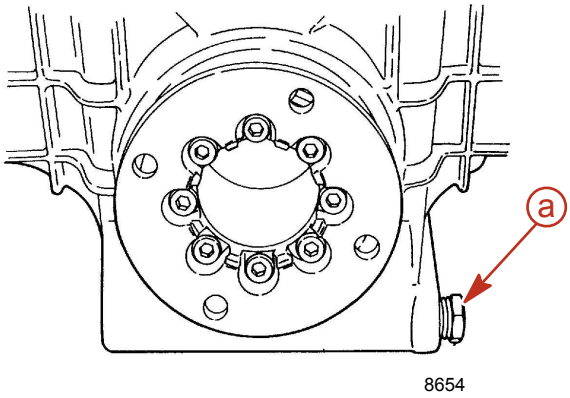
3. **On 63A and 45A transmissions:**
   a. Push the hose of a suction pump through the suction pipe and down to the bottom of the housing.

b. Pump the fluid from the housing into a suitable container. Dispose of the fluid properly.



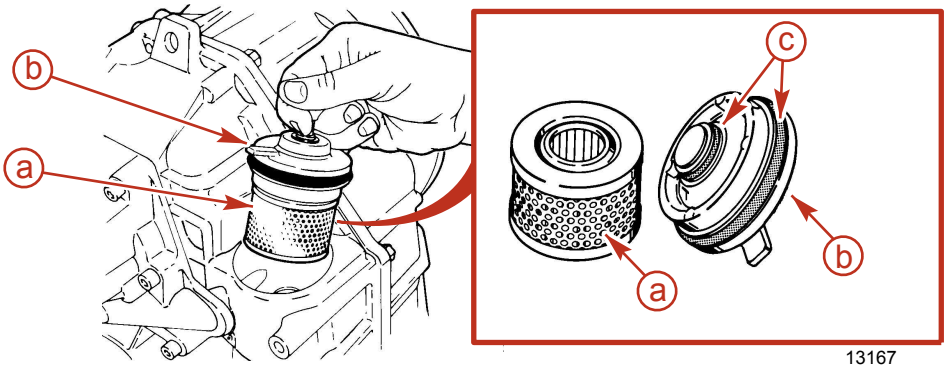
a - Suction pipe
b - Suction pump

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.



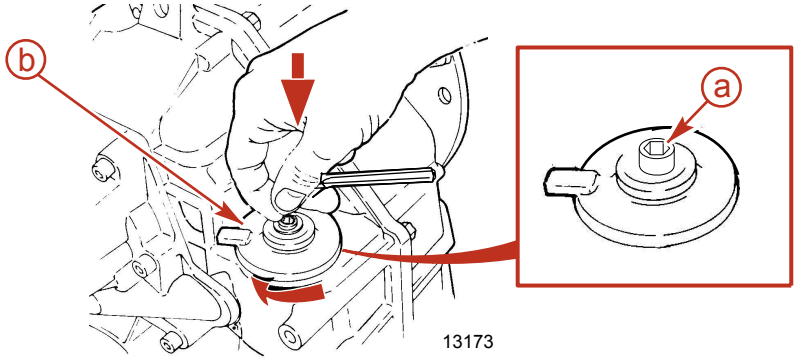
a - Filter element
b - Cover
c - O-rings

NOTICE

Improper installation of the transmission fluid filter assembly may cause the fluid to foam or leak out, resulting in decreased efficiency and damage to the transmission. Properly seat the transmission fluid filter during installation.

9. Install the fluid filter assembly in the transmission cavity by turning it clockwise and pushing at the same time.

10. Using a 6 mm Allen wrench, turn the filter assembly nut clockwise to tighten.



a - Fluid filter assembly
b - Assembly nut

11. Tighten the filter assembly nut to specification.

Description	Nm	lb. in.	lb. ft.
Filter assembly nut	6.5	60	–

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

Removal

⚠ WARNING

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

NOTICE

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

NOTE: *The following procedure describes 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.

NOTICE

The weight of an unsupported transmission can bend the transmission input shaft or damage the engine coupler. Do not permit the splines of the input shaft or coupler to support the weight of the transmission. Completely support the transmission during removal, and until the attaching hardware is secured during installation.

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	92-802869A 1

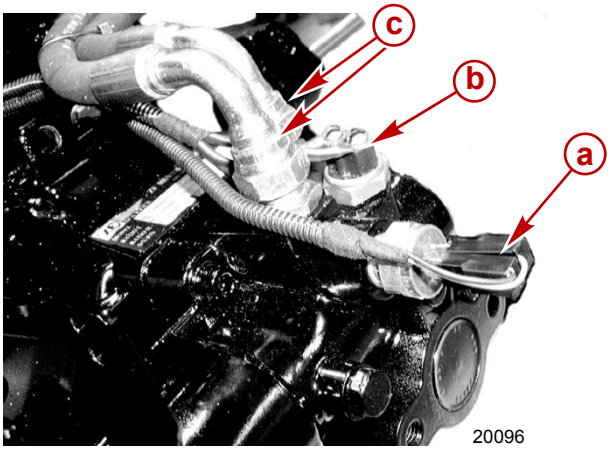
3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Push the transmission into place and secure with attaching hardware.

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.



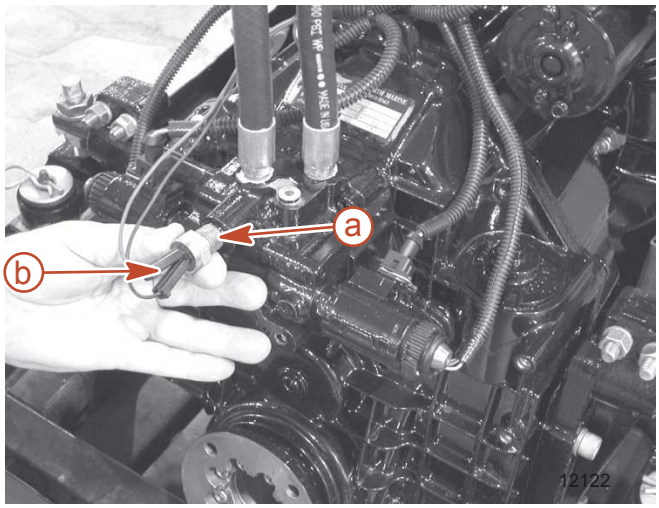
Typical
- **a -** Fluid temperature switch
- **b -** Neutral start switch
- **c -** Transmission fluid cooler hose fitting

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

IMPORTANT: Improper shift cable 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.

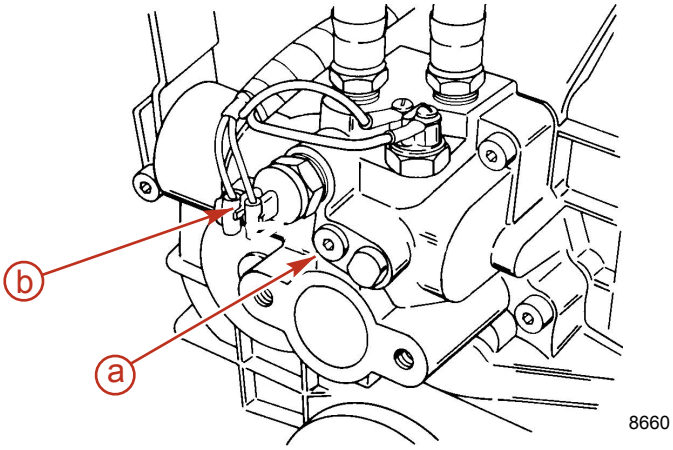
Description	Nm	lb. in.	lb. ft.
Propeller shaft coupler to transmission output flange bolt	68		50

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.

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.

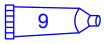


Typical ZF Marine transmission
a - Service port plug—Port **A**
b - Fluid temperature switch—Port **B**

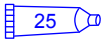
5. Operate the boat with a normal load on board.
6. Ensure that the fluid temperature and shifting pressure are as specified.

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.
	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.
	Liquid Neoprene	Exposed electrical terminals and connections.	92- 25711 3

12. Upon first operation, check for leaks.

Power-Assisted Steering System

Section 9A - Power-Assisted Steering Pump and Related Components

Table of Contents

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Power-Assisted Steering System—Fluid Level..... 9A-4
Power-Assisted Steering—Hydraulic Hoses 9A-5
Steering System Test.....9A-11
Power-Assisted Steering System Pressure Test..... 9A-11
Power-Assisted Steering Pump Pressure Test.....9A-13

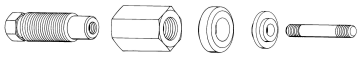
9
A

Lubricants, Sealants, Adhesives

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

Special Tools

Power Steering Pump Pulley Remover	Kent Moore J-21239
25952	Removes the pulley on the DHB power steering pumps and water pumps with smaller shafts.

Pulley Pusher Installer	91- 93656A 1
 10047	Installs the pulley onto the power steering pump.

Power Steering Test Gauge Kit	91-38053A05
10804	Tests the power-assisted steering system pressure.

Power-Assisted Steering Pump

Removal

IMPORTANT: In the event of an internal pump failure the entire power-assisted steering system must be replaced.
IMPORTANT: The pumps are non-repairable units and are replaced with new units when they are found to be defective.

⚠ WARNING

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

⚠ CAUTION

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

1. Disconnect the 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

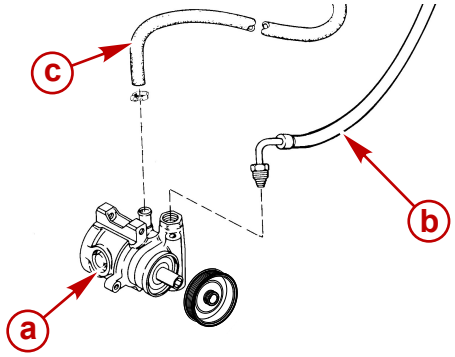
Contamination can damage the hydraulic system or cause the system to malfunction. Failure of power trim or steering components can result in injury or product damage. Ensure that the work area, shop tools and all components are clean and lint free during reassembly.

5. Drain the fluid from the power-assisted steering pump and reservoir into a suitable container.
6. Do not reuse the fluid. Dispose of the fluid properly.

NOTICE

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

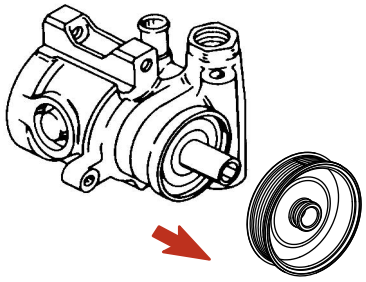
7. Remove the reservoir hose and pressure hose from the power-assisted steering pump. Cap or plug all open hydraulic connections.



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

Power Steering Pump Pulley Remover	Kent Moore J-21239

Inspection

IMPORTANT: Always replace the O-ring on the pressure hose fitting.

1. Inspect the power-assisted steering pump pulley for warping and excessive wear.
2. Inspect the pressure hose fitting.
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.

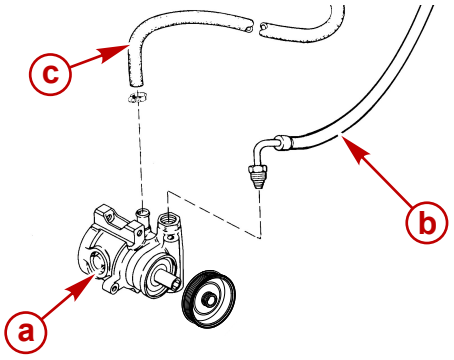
Installation

1. Install a new O-ring on the pressure hose fitting.
2. Remove the caps or plugs from the hydraulic connections.
3. Install the reservoir hose and pressure hose onto the power-assisted steering pump. Ensure that the new O-ring is in position on the pressure hose fitting.

4. Tighten the fitting to specification.

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31	–	23

5. Tighten the reservoir hose clamp securely.



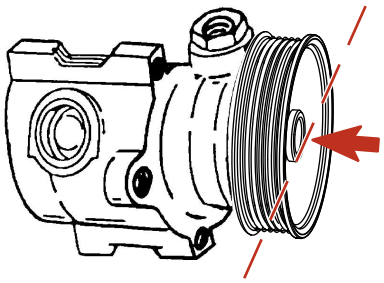
21775

a - Power-assisted steering pump
b - Pressure hose
c - Reservoir hose

6. Install the reservoir onto the reservoir bracket.
7. Install the power-assisted steering pump onto the pump bracket using the three screws retained in removal.
8. Tighten the screws to specification.

Description	Nm	lb. in.	lb. ft.
Power-assisted steering pump to pump bracket screw	26	–	19

9. Using the tool listed or 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

Pulley Pusher Installer	91- 93656A 1

10. Drain any remaining fluid out of the power-assisted steering reservoir into an approved container.
11. Do not reuse the fluid. Dispose of the old fluid properly.
12. Fill the power-assisted steering reservoir with the specified fluid.

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

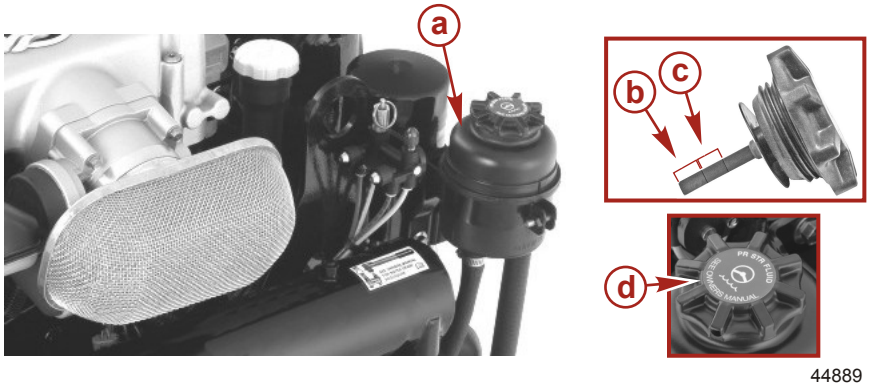
13. Connect the battery cables.
14. Install the serpentine drive belt.

Power-Assisted Steering System—Fluid Level

Checking

1. Stop the engine and center the sterndrive.

2. Remove the fill cap from the power steering fluid reservoir and observe the level. The oil level should be at the lower mark when the engine is cold and at the upper mark when the engine is warm.



44889

a - Reservoir
b - Add range
c - Operating range
d - Fill cap

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

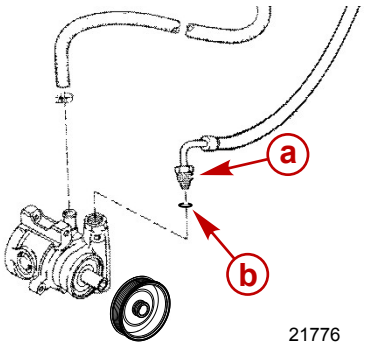
IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid from leaking.
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

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.

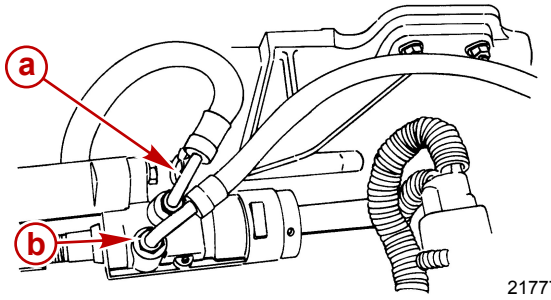


21776

a - Pressure hose fitting
b - O-ring

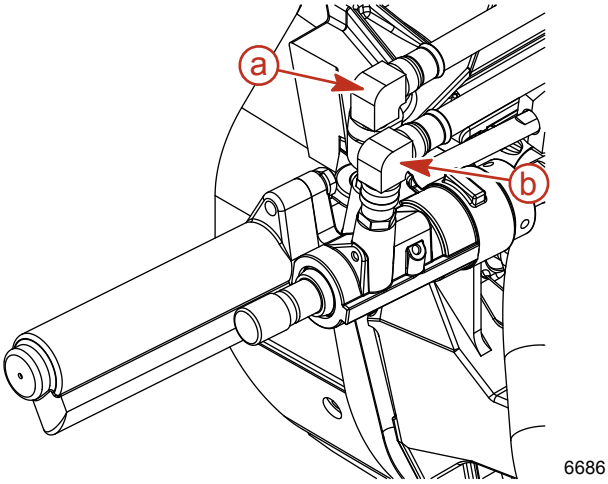
2. Remove and discard the O-ring.
3. **On models with standard fittings:**
   a. Disconnect the pressure hose from the control valve at the transom.

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.

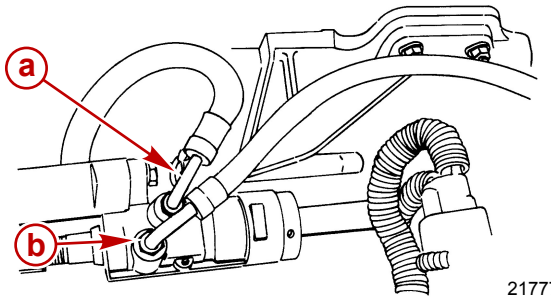


a - Pressure hose
b - Return hose

Installation

IMPORTANT: Route hoses as shown below to prevent kinks, which can damage hoses or fittings.
IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

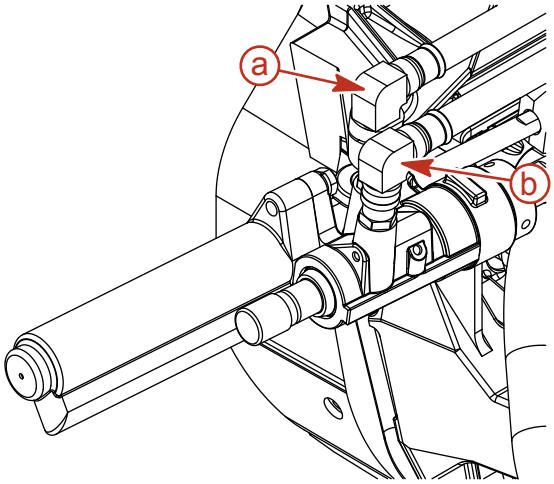
1. Route the pressure hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
   a. Ensure that the O-ring is in position on the pressure hose fitting.
   b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.



a - Pressure hose fitting
b - Return hose fitting

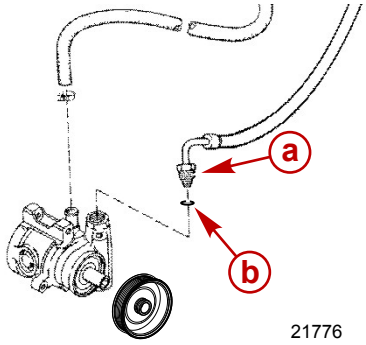
Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

3. **On models with quick-connect fittings,** install the pressure 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. Ensure that the O-ring is in position on the pressure hose fitting at the power-assisted steering pump.
5. Install the threaded hose fitting into the power-assisted steering pump. Torque the fitting.



a - Pressure hose fitting
b - O-ring

Description	Nm	lb. in.	lb. ft.
Pressure hose fitting	31		23

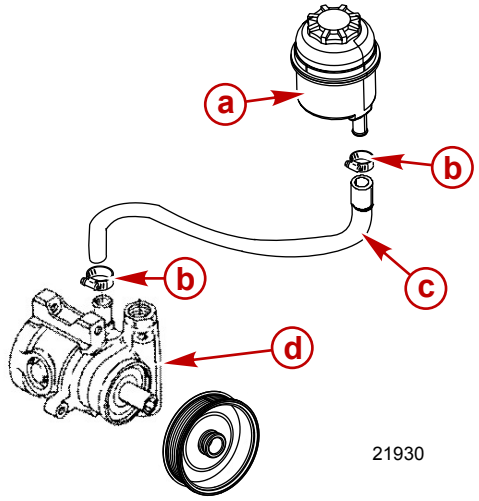
6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

Reservoir Hose (Reservoir to Pump)

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 clamps on the reservoir hose at the reservoir and the power-assisted steering pump. Remove the hose.

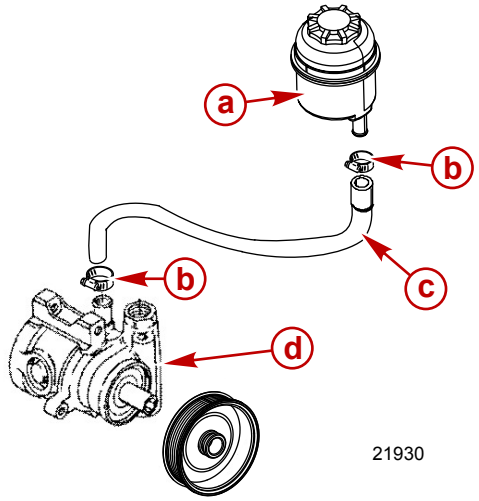


a - Reservoir
b - Hose clamp
c - Reservoir hose
d - Power-assisted steering pump

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

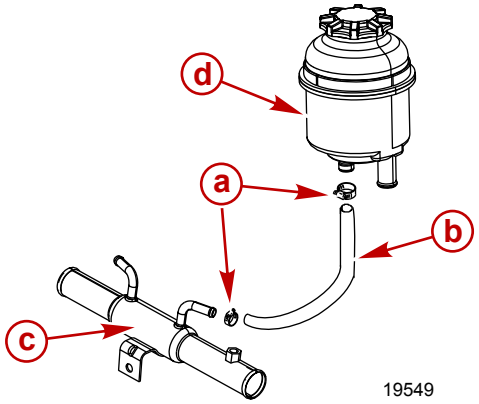
Return Hose (Cooler-To-Reservoir)

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.

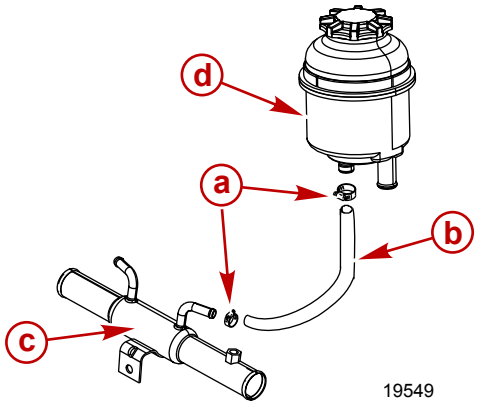


a - Hose clamp
b - Return hose
c - Fluid cooler
d - Reservoir

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.



a - Hose clamp
b - Return hose
c - Fluid cooler
d - Reservoir

3. Fill the power-assisted steering system with the specified fluid. See **Section 1B.**

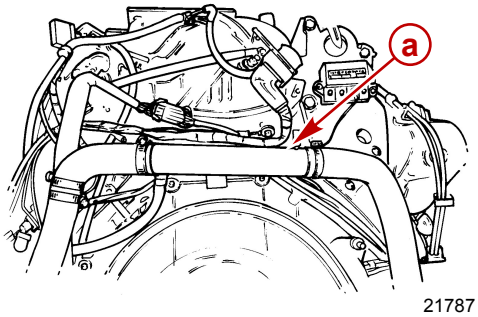
Return Hose (Control Valve-to-Cooler)

Removal

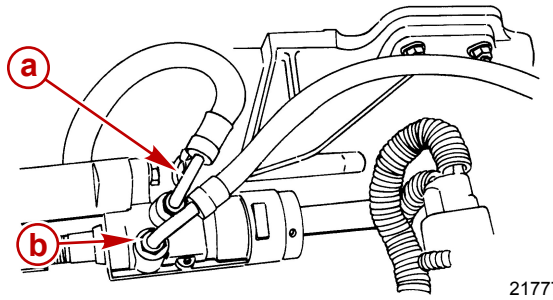
NOTE: *Catch any fluid that drains from the power-assisted steering pump, hoses, fluid reservoir, or fluid cooler in a suitable container.*

1. Loosen the hose clamp and remove the hose from the fluid cooler.

a - Return hose

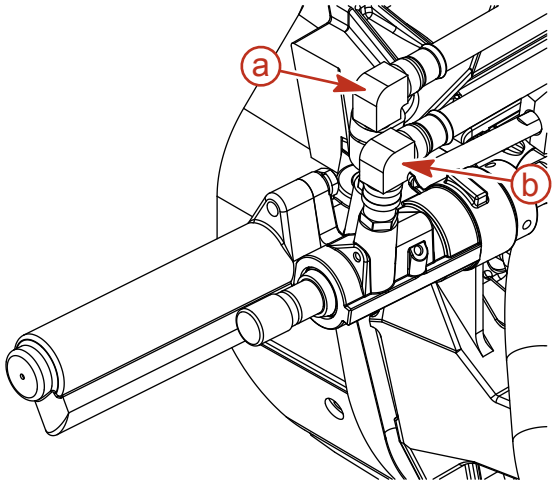


2. **On models with standard fittings,**disconnect the return hose from the control valve at the transom.



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.



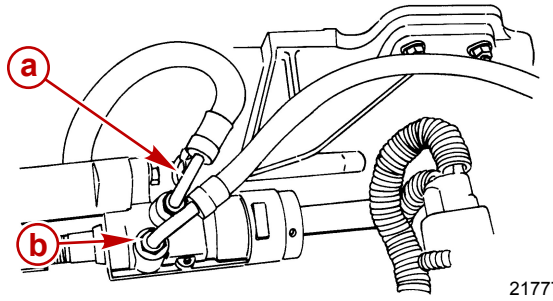
a - Pressure hose
b - Return hose

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.

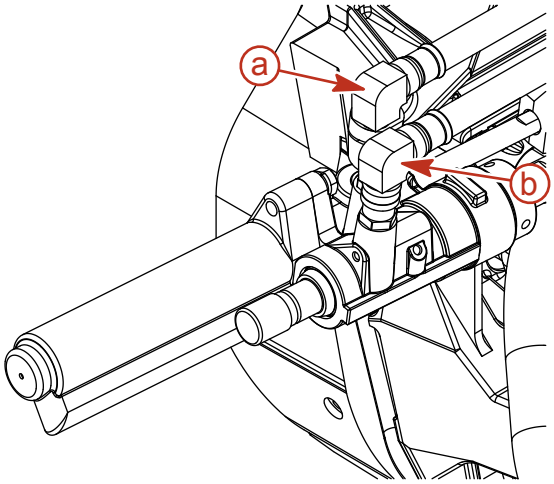
1. Route the return hose to the control valve at the transom in the same position as prior to removal.
2. **On models with standard fittings:**
   a. Ensure that the O-ring is in position on the return hose fitting.
   b. Install the threaded hose fitting into the control valve at the transom. Torque the fitting.



a - Pressure hose
b - Return hose

Description	Nm	lb. in.	lb. ft.
Return hose fitting	31		23

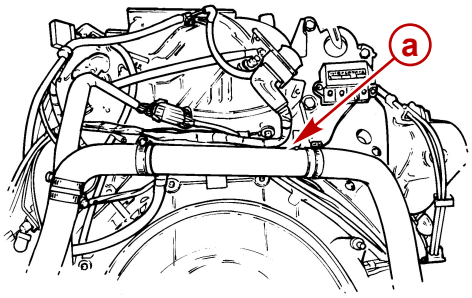
3. **On models with quick-connect fittings,** install the return hose onto the quick-connect fitting on the control valve at the transom. Ensure that the quick-connect fitting snaps into place.



6686

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

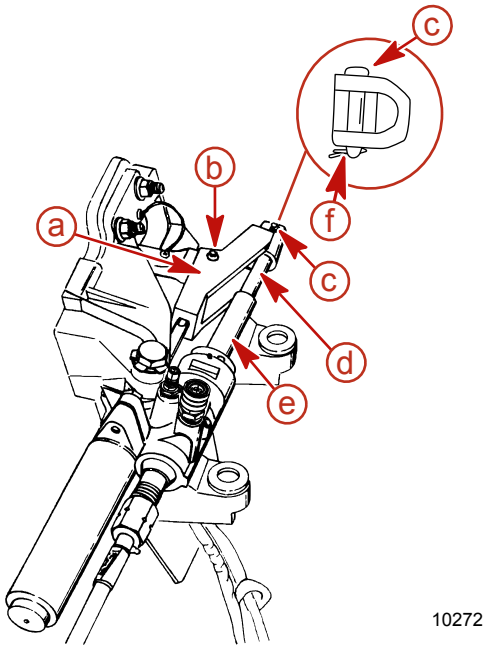
6. Fill the power-assisted steering system with the specified fluid. See **Section 1B**.

Steering System Test

Power-Assisted Steering System Pressure Test

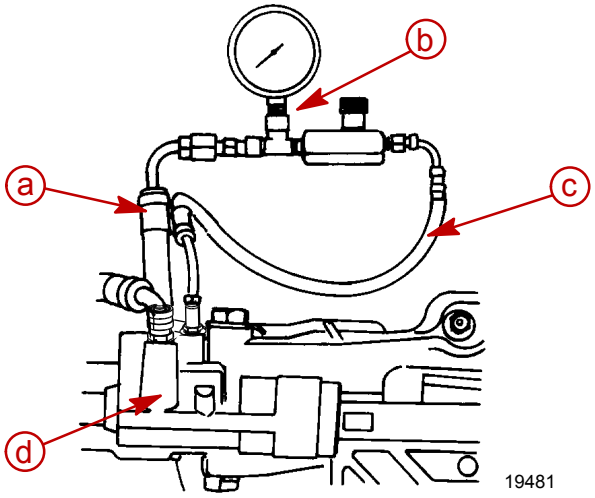
The following procedure is arranged so that a defective part can be detected through the process of elimination. Follow the order of the instructions so that the power-assisted steering system can be tested effectively.

1. Remove the front and rear clevis pins.



- **a -** Clevis
- **b -** Rear clevis pin (steering lever)
- **c -** Front clevis pin
- **d -** Steering cable end
- **e -** Cable guide tube
- **f -** Cotter pins

2. Retract the cable into the cable guide tube.
3. Assemble and install the test gauge between the high-pressure hose from the pump and the valve.



- **a -** Pump pressure hose
- **b -** Test gauge assembly
- **c -** Gauge-to-control-valve hose
- **d -** Control valve

Power Steering Test Gauge Kit	91-38053A05

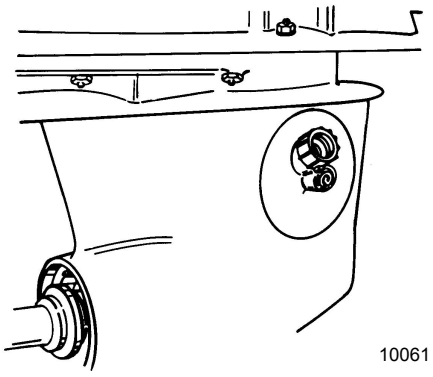
4. Open the valve on the gauge completely.

NOTICE

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

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups****.*

5. Connect a flush test device to the sterndrive. Partially open the water tap (approximately half of maximum) and allow the cooling system to fill completely. The cooling system is full when water is discharged through the propeller. Do not use full water tap pressure.



Standard Bravo shown

6. Start the engine and operate at 1000–1500 RPM until the engine reaches normal operating temperature.
7. With the engine at idle speed, the test gauge reading should be between 483 and 862 kPa (70 and 125 psi). If not, proceed as follows:

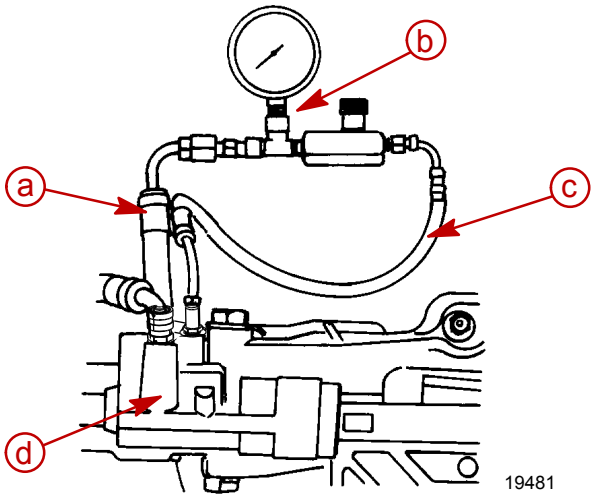
NOTICE

Excessive operation can cause product damage. Do not lug the pump at maximum pressure for more than 5 seconds.

8. Push in and then pull the steering cable momentarily. Movement in each direction should cause the gauge to show an instant increase in pressure.
9. Push the steering cable in until the booster cylinder piston rod is fully retracted. With the piston rod in this position, momentarily push the steering cable in until its maximum pressure reading is reached.
   - If the pressure is above 6897 kPa (1000 psi), system pressure is good.
   - If the pressure is below 6897 kPa (1000 psi), conduct the **Power-Assisted Steering Pump Pressure Test**.

Power-Assisted Steering Pump Pressure Test

1. Install a test gauge between the high-pressure hose from the pump and the valve.



- **a -** Pump pressure hose
- **b -** Test gauge assembly
- **c -** Gauge-to-control-valve hose
- **d -** Control valve

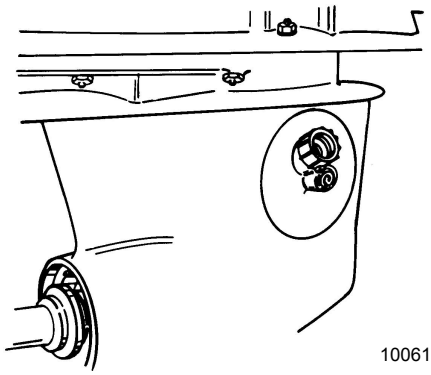
Power Steering Test Gauge Kit	91-38053A05

NOTICE

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

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups****.*

2. Connect a flush test device to the sterndrive. Partially open water tap (approximately half of maximum) and allow water to enter the cooling system. Do not use full water tap pressure.



Standard Bravo shown

3. Start the engine and operate at 1000–1500 RPM until the engine reaches normal operating temperature.
IMPORTANT: The test gauge valve blocks the flow of pressurized fluid when closed. To avoid damage to the pump, do not close the test gauge valve longer than five seconds during testing.
4. Close the test gauge valve just long enough to obtain maximum pressure reading.
5. Close and open the valve three times. Record the highest pressure reading attained each time:
   a. **If pressure readings are between 9308 and 9997 kPa (1350 and 1450 psi) and are within a range of 345 kPa (50 psi)**, the pump is within specifications. If the pump tests OK, but system pressure was low (as tested under **Power-Assisted Steering System Pressure Test**) replace the control valve assembly.
   b. **If pressure readings are between 9308 and 9997 kPa (1350 and 1450 psi) but are not within a 345 kPa (50 psi) range**, the power-assisted steering pump flow control valve is sticking or the pump hydraulic system is dirty.
   c. **If pressure readings are constant, but below 8963 kPa 1300 psi**, replace the power-assisted steering pump.