Manual Outline

MERCURY

Service Manual

200 OptiMax Jet Drive

Starting Serial Number 0E435816 for Powerhead
Starting Serial Number 0E379931 for Pump Unit

MERCURY

200 OptiMax Jet Drive

Starting Powerhead S/N 0E435816
Starting Pump Unit S/N 0E379931
90-8M0050731 MAY 2011

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.

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.

1
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Important Information

Section 1A - Specifications

Table of Contents

General Specifications

Model Specifications	
Kilowatts (horsepower)	149.1 kW (200 hp)
Weight	
Powerhead	116.6 kg (257 lb)
Pump unit	49 kg (110 lb)
Displacement (all HP)	2.5 liter (153 in³)
RPM	
Idle	900–1000 RPM
WOT	5150–5650 RPM
RPM limit (Guardian)	6300 RPM
Induction system	Throttle body aspiration
Fuel system	Computer controlled sequential multi-port electronic direct fuel injection
Ignition system	SmartCraft propulsion control module (PCM) digital inductive
Charging system	Regulated belt-driven 60 amp alternator
Cooling system	Water-cooled
Lubrication system	Multi-port oil injection
Engine oil reservoir capacity	0.71 liter (0.44 US quart)
Engine control system	SmartCraft propulsion control module (PCM)

Maintenance Specifications

Maintenance Specifications	
Recommended fuel type	Unleaded 87 octane minimum
Recommended oil	TC-W3 Premium Plus or OptiMax 2-Cycle Outboard Oil
Oil tank capacity	
Engine reservoir capacity	0.71 liter (0.44 US quart)
External tank	11.4 liter (12 US quart)
Spark plug type	NGK IZFR6J
Spark plug gap	0.8 mm (0.031 in.)
Battery rating	1000 marine cranking amp (minimum) 800 cold cranking amp (minimum) 180 amp hours (minimum)
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
At 5500 RPM (boat on plane)	69–103 kPa (10–15 psi)

Ignition Specifications

Ignition Specifications	
Type	Digital inductive
Spark plug	NGK IZFR6J
Spark plug gap	1.1 mm (0.043 in.)
Maximum timing	Not adjustable; PCM controlled
Idle timing	Not adjustable; PCM controlled
Throttle position sensor	
At idle	0.4–1.3 VDC
At WOT	4.0–4.7 VDC

Charging and Starting Specifications

Charging and Starting Specifications at 21 °C (70 °F)	
Alternator output (regulated)	
Output at the battery at 2000 RPM	28–36 A
Output at the alternator at 2000 RPM	42–48 A
Voltage set point	14.5 ± 0.25 volts
Regulator current draw[1.]	
Ignition switch "OFF"	0.585 mA
Ignition switch "ON"	150.0 mA
Starter draw	
Under load	200 A
No load	65 A
Average engine RPM when cranking	300–325 RPM
Starter solenoid current at 12.6 volts	
Pull in coil	40 A
Hold in coil	10 A
Start solenoid current draw	4 A
Starter brush length (minimum)	6.35 mm (0.25 in.)
Battery rating (minimum)	
Marine cranking amperes	1000
Cold cranking amperes	800
Ampere hour (Ah)	180

1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Fuel Specifications

Fuel Specifications	
Fuel	Gasoline with oil injection
Recommended gasoline	Unleaded 87 octane minimum
Recommended oil	Direct fuel injected (DFI) 2-cycle Outboard Oil or Premium Plus 2-cycle TC-W3 Outboard Oil
Gasoline/oil ratio	
At idle	300–400:1
At wide-open throttle	40:1

Fuel Lift Pump Specifications

Fuel Lift Pump Specifications	
Fuel lift pump pressure at idle	
Normal	6.9–13.8 kPa (1–2 psi)
Maximum	68.9 kPa (10 psi)
Fuel lift pump amps	1–2 A

Fuel Rail Specifications

Fuel System Specifications	
Fuel pressure	751.5 ± 14 kPa (109 ± 2 psi)
Air pressure	655 ± 14 kPa (95 ± 2 psi)
Tracker valve spring pressure	103.5 kPa (15 psi)
Fuel injector ohm resistance	1.8 ± 0.1 Ω
Direct injector ohm resistance	1.3 ± 0.3 Ω
Direct injector color	Gray
Fuel rail water cooling	None

Fuel System Specifications

Fuel Lift Pump Specifications	
Fuel lift pump pressure at idle	
Normal	6.9–13.8 kPa (1–2 psi)
Maximum	69 kPa (10 psi)
Fuel lift pump amps	1–2 A

Low-Pressure Boost Pump Specifications	
Low-pressure boost pump pressure at idle	41–62 kPa (6–9 psi)
Low-pressure boost pump amps	1–2 A

Fuel System Specifications	
High-pressure fuel pump pressure	751.5 ± 14 kPa (109 ± 2 psi)
Air pressure	655 ± 14 kPa (95 ± 2 psi)
Fuel/air differential	103.5 kPa (15 psi)
High-pressure fuel pump amp	10–14 A
High-pressure fuel pump ohm resistance	1.0–1.8 Ω
Fuel injector ohm resistance	1.8 ± 0.1 Ω
Direct injector ohm resistance	1.3 ± 0.3 Ω

Air Compressor Specifications

Air Compressor Specifications	
Air compressor type	Reciprocating piston Single cylinder, oil lubricated, water-cooled
Air compressor output	655 ± 14 kPa (95 ± 2 psi)
Displacement	116 cc (7.07 cid)
Cylinder bore	65.0 mm (2.559 in.)
Cylinder bore taper (maximum)	0.025 mm (0.001 in.)
Cylinder bore out of round (maximum)	0.025 mm (0.001 in.)
Cylinder bore type	Cast iron
Stroke	34.9 mm (1.374 in.)
Piston type	Aluminum
Piston diameter	64.97 ± 0.010 mm (2.5578 ± 0.0004 in.)
Ring end gap	
Top ring	0.15–0.25 mm (0.006–0.0010 in.)
Middle ring	0.15–0.25 mm (0.006–0.0010 in.)
Bottom ring	0.10–0.35 mm (0.004–0.014 in.)
Reed stand open (maximum)	0.25 mm (0.0010 in.)

Powerhead Specifications

Powerhead Specifications	
Number of cylinders	6
Displacement	2.5 liter (153 in³)
Stroke	67.3 mm (2.65 in.)
Standard cylinder bore diameter	88.925 mm (3.501 in.)
Cylinder bore maximum taper (service)	0.076 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.076 mm (0.003 in.)
Oversize cylinder bore diameter - 0.038 mm (0.015 in.)	88.963 mm (3.516 in.)
Cylinder liner type	Cast iron
Compression	620–758 kPa (90–110 psi)[1.]
Crankshaft	
Maximum runout	0.152 mm (0.006 in.)
Piston type	Aluminum
Piston skirt standard diameter	88.6968–88.7222 mm (3.492–3.493 in.)
Piston skirt oversize diameter - 0.038 mm (0.015 in.)	88.0778–89.1032 mm (3.507–3.508 in.)
Reed stand open (maximum)	0.51 mm (0.020 in.)
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
At 5500 RPM (boat on plane)	69–103 kPa (10–15 psi)

Cooling System Specifications

Cooling System Specifications	
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
Temperature sensor	
Between black and each tan/black wire	Refer to **Temperature Sensors**
Between each lead and ground	Refer to **Temperature Sensors**

Wear Ring/Impeller Specifications

Wear Ring/Impeller Specifications	
Wear ring bore diameter	184.73–184.98 mm (7.273–7.283 in.)
Impeller outside diameter	183.52–183.77 mm (7.225–7.235 in.)
Clearance between wear ring and impeller	0.96–1.47 mm (0.038–0.058 in.)

1. When performing cylinder compression test, place lanyard switch in the "OFF" position to prevent operation of direct injectors or remove fuse controlling fuel and direct injectors.

Important Information

Section 1B - Maintenance

Table of Contents

Maintenance Specifications

Maintenance Specifications	
Recommended fuel type	Unleaded 87 octane minimum
Recommended oil	TC-W3 Premium Plus or OptiMax 2-Cycle Outboard Oil
Oil tank capacity	
Engine reservoir capacity	0.71 liter (0.44 US quart)
External tank	11.4 liter (12 US quart)
Spark plug type	NGK IZFR6J
Spark plug gap	0.8 mm (0.031 in.)
Battery rating	1000 marine cranking amp (minimum) 800 cold cranking amp (minimum) 180 amp hours (minimum)
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
At 5500 RPM (boat on plane)	69–103 kPa (10–15 psi)

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Nozzle screws	92-809819
9	Loctite 567 PST Pipe Sealant	Stator fill/drain plug and vent plug threads	92-809822
		Stator drain and fill plugs	
66	Loctite 242 Threadlocker	Water intake grate screws	92-809821
		Stator bolts and ride plate screws	
87	High Performance Gear Lubricant	Drive housing and stator assembly fill lubricant	92-858064K01
95	2-4-C with Teflon	Tensioner pulley grease fitting	92-802859A 1

Inspection and Maintenance Schedule

Prior to Every Use

- Check that lanyard stop switch stops the engine.
- Visually inspect the fuel system for deterioration or leaks.
- Check the engine compartment and use your nose to detect any fuel fumes.
- Check the throttle, shift, and steering system for binding or loose components.

After Each Saltwater or Polluted Water Use

- Flush all internal passages with fresh water.
- Wash the jet pump exterior with fresh water.

Every 10 Hours or Once A Month, Whichever Occurs First

- Check bilge siphon system. See **Bilge Siphon Inspection**.
- Inspect cable bellows for wear, rub marks, or leaks.
- Inspect battery and connections. See **Battery Inspection**.
- Check tightness of bolts, nuts, and other fasteners.
- Check exhaust hoses for holes or distortion due to overheating.

Every 50 Hours or Once A Month, Whichever Occurs First

- Check level and condition of drive housing and stator lubricant. See **Drive Housing Lubricant**.
- Check the corrosion control anodes. Replace if over 50% corroded. See **Corrosion Control Anodes**.
- Check tightness of bolts, nuts, and other fasteners.

Every 100 Hours or Once A Month, Whichever Occurs First

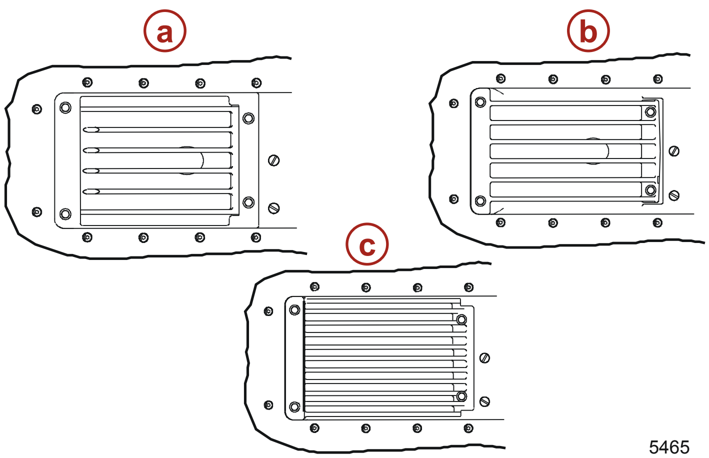
- Replace spark plugs at first 100 hours or first year. After that, inspect spark plugs every 100 hours or once yearly. Replace spark plugs as needed. See **Spark Plug Inspection and Replacement**.
- Drain and replace drive housing lubricant. See **Drive Housing Lubricant**.
- Drain and replace stator housing lubricant. See **Stator Assembly Lubricant**.
- Remove impeller and lubricate impeller shaft with Quicksilver or Mercury Precision 2-4-C w/Teflon to prevent impeller from seizing to the shaft.
- Inspect alternator belt. See **Alternator Belt Inspection**.
- Lubricate the belt tensioned pivot shaft. See **Belt Tensioner Idler Pulley Lubrication**.
- Replace engine fuel line filter. See **Fuel System**.
- Replace water separating fuel filter. See **Fuel System**.
- Replace compressor air intake filter. See **Compressor Air Intake Filter**.

Before Periods of Storage

- Refer to the **Storage** section.

Clearing A Clogged Water Intake

The hydro-surge (weed) grate and casted aluminum grate are intended for general use. The rock grate is intended for use if operating the jet drive in rocky, shallow conditions.



a - Hydro-surge grate
b - Casted aluminum grate
c - Rock grate

Manual Clearing

⚠ WARNING

Avoid injury resulting from contacting the rotating impeller or having hair, clothing, or loose objects drawn into the water intake and wrapping around the impeller shaft. Stay away from the water intake and never insert an object into the water intake or water outlet nozzle when the engine is running.

If weeds or debris clog the water intake, turn the engine off and completely clean out the blockage to return the unit to proper running order.

1. Turn off the engine and remove the key from the ignition switch. The pump impeller still spins and pumps water when the engine is running, even when in neutral.
2. Clean debris from the entire jet drive unit (water intake, impeller, and nozzle). If the jet drive cannot be easily cleaned, return the boat to the trailer or to a boat lift before performing any further work.
3. It may be necessary to remove the water intake grate from the bottom of the jet drive to clean debris from the water intake. Remove the water intake grate by removing the four screws. Reinstall the water intake grate with the same four screws. Apply Loctite 242 to the threads of the screws. Tighten the screws to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Water intake grate screws	92-809821

Description	Nm	lb-in.	lb-ft
Front screws	23	200	
Rear screws	8.5	75	

IMPORTANT: Do not operate the jet drive without the water intake grate installed.

Hydro-Surge Grate

The hydro-surge grate is spring-loaded. If the intake gets plugged, the pump suction will pull open the grate, and the water will push the blockage pass the grate and clear the intake.

If operating the boat at slow speeds in weedy areas, the water intake grate can become plugged with weeds. A plugged grate causes the pump to cavitate during acceleration (over-revving without thrusting the boat).

If the grate becomes plugged:

1. Slowly advance the throttle to get the boat up on plane, making sure not to cavitate the pump.
2. Continue to advance the throttle until the boat is running at top speed. The force of the water should clear the pump of any remaining weeds.

Fuel System

⚠ WARNING

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

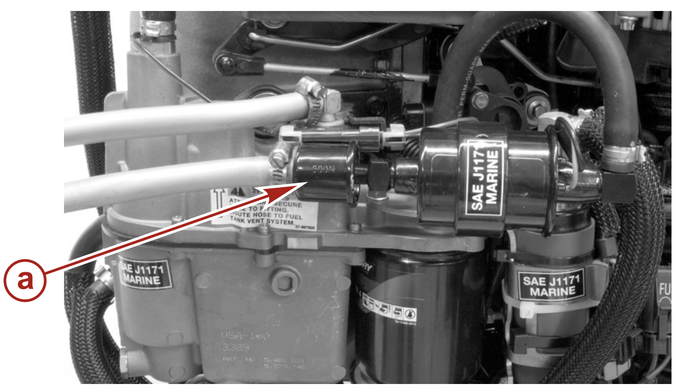
Before servicing any part of the fuel system, stop the engine and disconnect the battery. Drain the fuel system completely. Use an approved container to collect and store fuel. Wipe up any spillage immediately. Material used to contain spillage must be disposed of in an approved receptacle. Any fuel system service must be performed in a well-ventilated area. Inspect any completed service work for signs of fuel leakage.

Fuel Line Inspection

Visually inspect the fuel line for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions are found, the fuel line must be replaced.

Fuel Line Filter

Replace the fuel filter once a season or every 100 hours of use.



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a - Fuel filter

IMPORTANT: Visually inspect for fuel leakage from the filter connections.

Water Separating Fuel Filter

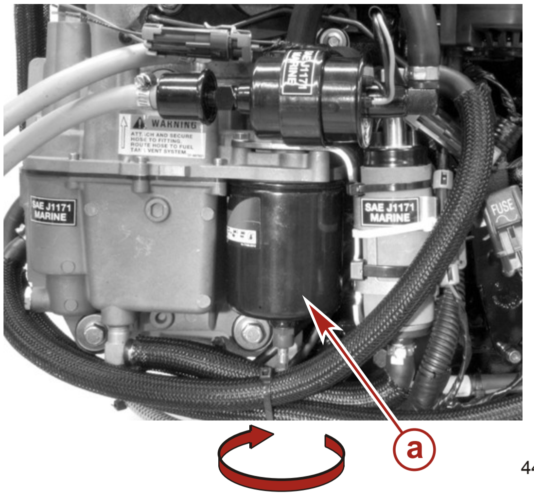
This filter removes moisture and debris from the fuel. If the filter becomes filled with water, the water can be removed. If the filter becomes plugged with debris, replace the filter. The warning system engages when water in the fuel filter reaches the full level. Refer to **Section 2A - Warning Horn Signals**.

Refer to the **Inspection and Maintenance Schedule** for the proper maintenance interval.

Remove and replace filter as follows:

1. Turn ignition key switch to the "OFF" position.

2. Disconnect the wire from the bottom of the filter. Remove the filter (a) by turning the filter in the direction of the arrow (clockwise). Tip the filter to drain the fluid into a suitable container.



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a - Water separating fuel filter

3. Lubricate the sealing ring on the filter with oil. Thread on the filter and tighten securely by hand. Reconnect the wire to the filter.

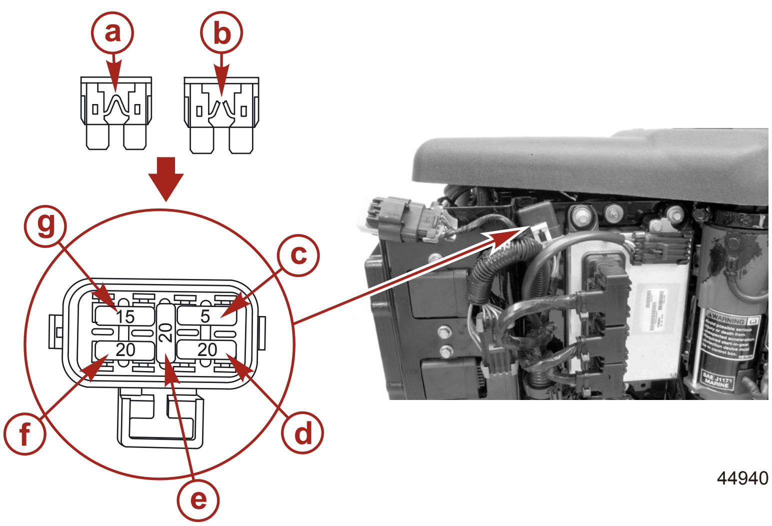
Fuses

IMPORTANT: Always carry spare 5 and 20 amp fuses.

The electrical wiring circuits on the engine are protected from overload by fuses in the wiring. If a fuse is open, try to locate and correct the cause of the overload. If the cause is not found, the fuse may open again.

1. Open the fuse holder and look at the silver colored band inside the fuse. If the band is broken, replace the fuse.
2. Replace the fuse with a new fuse with the same rating.

The fuses and circuits are identified as follows:



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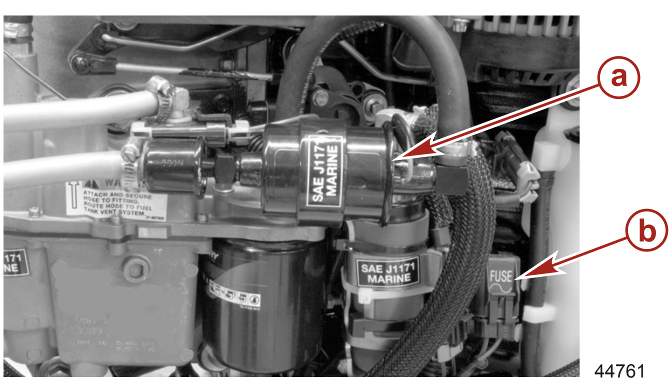
a - Good fuse
b - Blown fuse
c - SmartCraft data bus circuit - 5 amp fuse
d - Ignition system circuit - 20 amp fuse
e - Spare fuse
f - Electric fuel pump (VST)/ECM driver power/ oil pump circuit - 20 amp fuse
g - Main power relay - 15 amp fuse



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a - Lift pump
b - Lift pump circuit - 5 amp fuse

Battery Inspection

The battery should be inspected at periodic intervals to ensure proper engine starting capability.

IMPORTANT: Read the safety and maintenance instructions which accompany your battery.

1. Turn off the engine before servicing the battery.
2. Ensure the battery is secure against movement.
3. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
4. Ensure the battery is equipped with a nonconductive shield to prevent accidental shorting of battery terminals.

Battery Information

⚠ WARNING

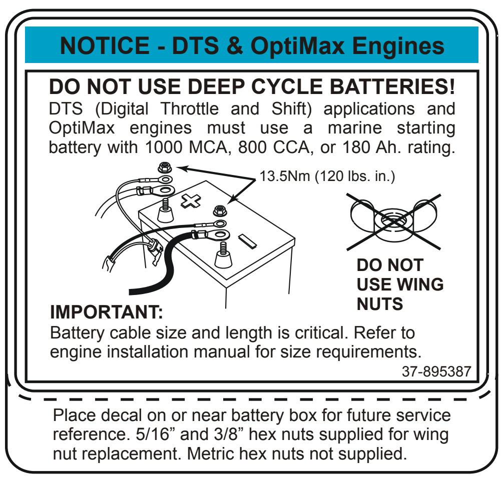
Failure to properly secure the battery leads can result in a loss of power to the Digital Throttle and Shift (DTS) system, leading to serious injury or death due to loss of boat control. Secure the battery leads to the battery posts with hex nuts to avoid loose connections.

- Do not use deep-cycle batteries. Engines must use a marine starting battery with 1000 MCA, 800 CCA, or 180 Ah.
- When connecting the engine battery, hex nuts must be used to secure battery leads to battery posts. Torque nuts to specification.

Description	Nm	lb-in.	lb-ft
Hex nuts	13.5	120	

IMPORTANT: Battery cable size and length is critical. Refer to engine installation manual for size requirements.

The decal needs to be placed on or near the battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut is supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



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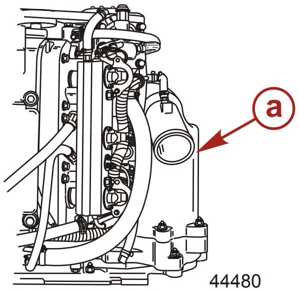
Spark Plug Inspection and Replacement

⚠ WARNING

Damaged spark plug boots may emit sparks which can ignite fuel vapors under the engine cowl, resulting in serious injury or death from a fire or explosion. To avoid damaging the spark plug boots, do not use any sharp object or metal tool to remove the spark plug boots.

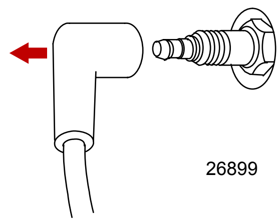
1. Loosen the hoses from the expansion chamber. Remove the six nuts that secures the expansion chamber. Remove the expansion chamber.

2. Open J-clips to move fuel/air lines out of the way.

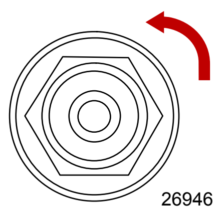


a - Expansion chamber

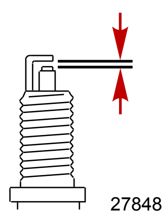
3. Remove the spark plug boots by twisting the rubber boots slightly and pull off.



4. Remove the spark plugs to inspect. Replace the spark plug if the electrode is worn or the insulator is rough, cracked, broken, blistered, or fouled.



5. Set the spark plug gap to specifications.



Spark Plug Gap	1.1 mm (0.043 in.)

6. Before installing spark plugs, clean off any dirt on the spark plug seats. Install plugs finger-tight, and then tighten 1/4 turn or tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plug	27		20

7. Inspect the expansion chamber gasket on the adapter plate. Do not remove the gasket from the adapter plate. Replace if damaged.
8. Install the expansion chamber. Tighten the mounting nuts to the specified torque. Install the hoses to the expansion chamber and secure with clamps.
9. Inspect the exhaust system for leaks.

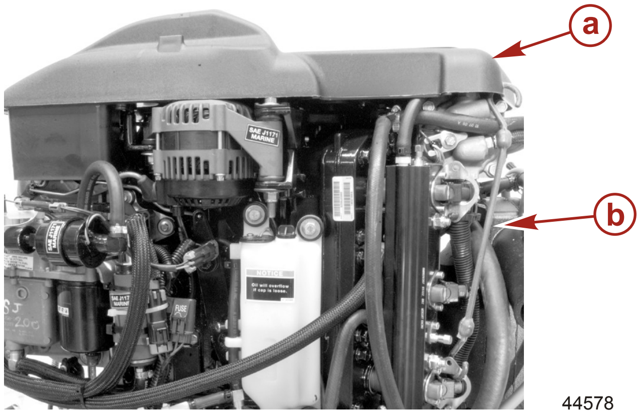
Description	Nm	lb-in.	lb-ft
Expansion chamber mounting nuts	27		20

Flywheel Cover Removal and Installation

Removal

1. Detach the retaining strap.

2. Remove the cover by lifting off from the back of the engine.



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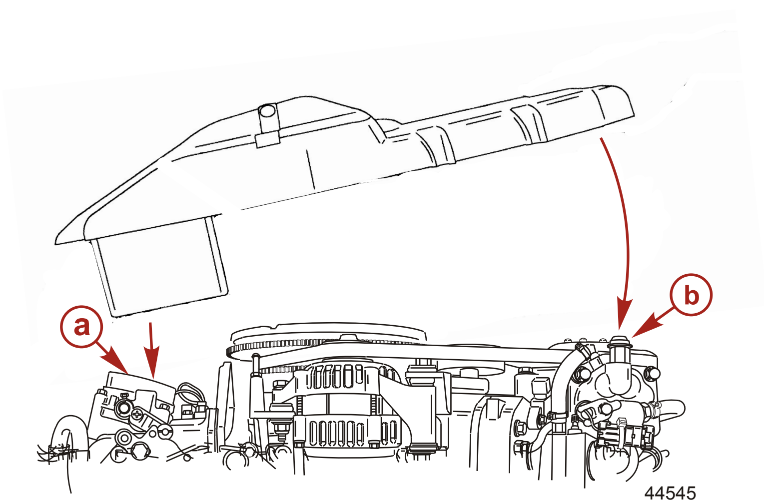
a - Flywheel cover
b - Retaining strap

Installation

1. Lower the cover opening onto the air plenum intake flange. Tilt the cover side to side until the cover slides down onto the intake flange.
2. Push the cover down onto the alignment pins and onto the air intake tube for the air compressor.



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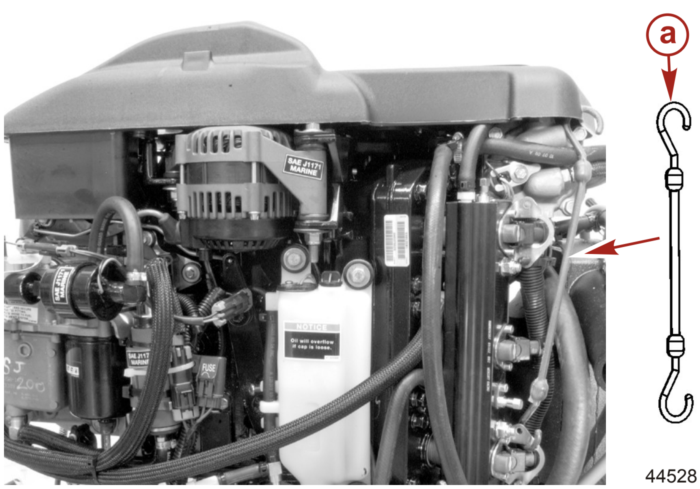
a - Air plenum intake flange
b - Air intake tube for the air compressor

3. Attach the retaining strap to the cover.



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a - Retaining strap

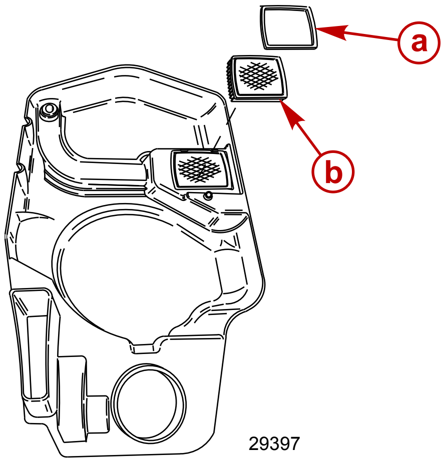
Compressor Air Intake Filter

The filter should be changed every 100 hours of operation, or once a season.

IMPORTANT: Never run the engine without the air filter.

Removal

1. Remove flywheel cover from engine.
2. Snap out the retainer and remove filter.



a - Retainer
b - Filter

Installation

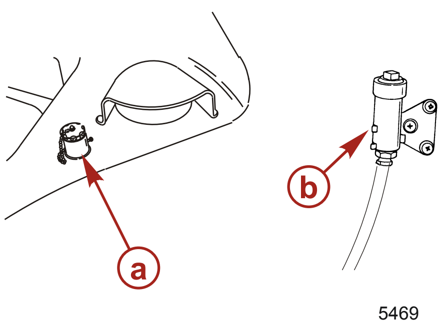
1. Install filter into cover.
2. Secure filter into cover with retainer.

Flushing the Cooling System

Flushing the cooling system is essential after each use in saltwater, after the boat has run aground, or when the overheat warning horn sounds. When using the flushing attachment, ensure that the water is turned all the way on and flowing through the engine before starting.

IMPORTANT: When using the flushing attachment do not run the engine above idle.

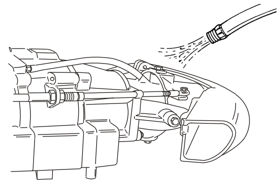
⚠ CAUTION
Never start or run the jet drive without water circulating through the cooling system to prevent damage to the unit.



a - Flushing attachment (hull mount)
b - Flushing attachment (engine compartment mount)

1. Locate the flush adapter in the boat. Some boats may have the adapter mounted in the hull or mounted in the engine compartment.
2. With engine "OFF," remove the cap from the flush adapter and attach a water hose.
   IMPORTANT: Do not run the engine above idle when flushing.
3. Turn the water on all the way. Start the engine and flush the engine block for at least 10 minutes.
   NOTE: An insufficient flow of water to the engine may cause the engine to overheat. If the warning horn sounds, stop the engine immediately and allow to cool.
4. Stop the engine, turn off the water, and remove the water hose from the flush adapter. Install the cap and tighten securely.

5. Flush the outer surfaces of the water outlet nozzle with a water stream.



5470

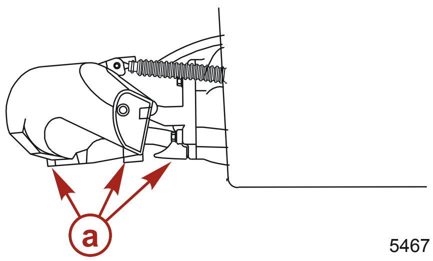
Corrosion Control Anodes

NOTICE

Anodes made of insufficiently pure aluminum alloys may not adequately protect critical drive components from corrosion. We recommend using anodes sold through Mercury Precision Parts only.

Anodes help protect the power package against galvanic corrosion by sacrificing its metal to be slowly eroded instead of other metals.

This model has three corrosion control anodes: One on the bottom of the nozzle, one on the reverse gate, and one under the rudder. Anodes help protect the Mercury Jet Drive against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the Mercury Jet Drive metals.



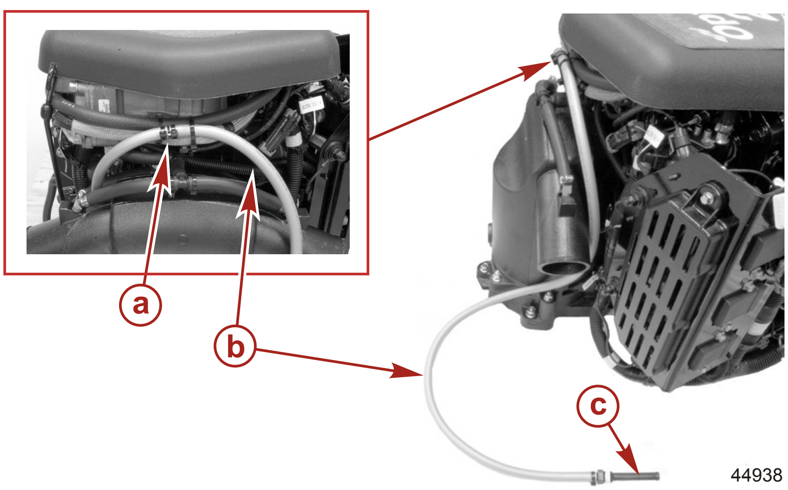
5467

a - Anodes

All anodes require periodic inspection, especially in saltwater. Inspect anodes periodically (refer to the **Inspection and Maintenance Schedule**). Replace any anodes before they are 50% corroded. Never paint or apply protective coating on the anode, as effectiveness of the anode will be reduced.

Bilge Siphon Inspection

Inspect the bilge siphon system at periodic intervals to ensure maximum performance.



44938

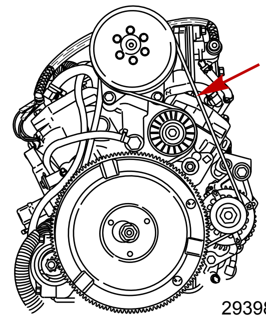
a - Siphon break
b - Bilge hose
c - Bilge water pickup screen

1. Inspect the pickup screen for foreign material. Clean if necessary.
2. Inspect the hole in the siphon break for blockage. Clean with a small wire if necessary.
3. Ensure that the siphon break is secured above the waterline.

Alternator Belt Inspection

Inspect the alternator belt and have it replaced by an authorized dealer if any of the following conditions are found:

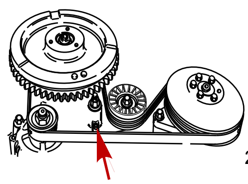
- Cracks or deterioration in the rubber portion of the belt.
- Belt surfaces rough or uneven.
- Signs of wear on edges or outer surfaces of belt.



29398

Belt Tensioner Idler Pulley Lubrication

Lubricate through the fitting with 2-4-C with Teflon.



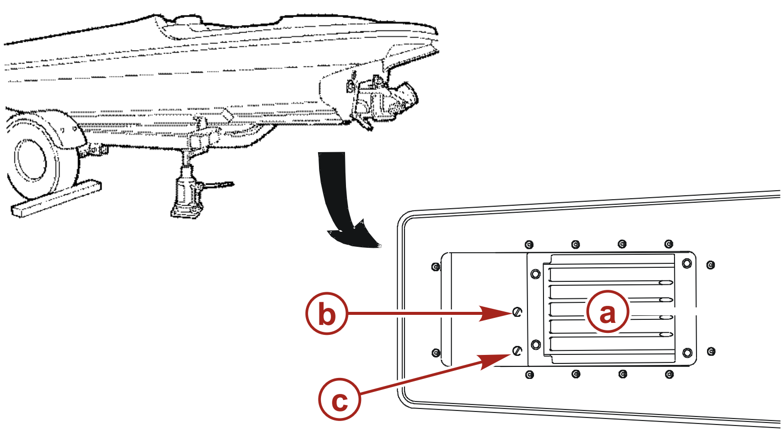
29399

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Tensioner pulley grease fitting	92-802859A 1

Drive Housing Lubricant

Draining Lubricant

NOTE: When draining the drive housing lubricant, visually check for water in the lubricant. It may have settled to the bottom and will drain before the lubricant or it may have mixed with the lubricant, giving it a milky color. In either case, have the drive housing checked by your authorized Mercury Marine dealer. Water in the lubricant can cause premature gear or bearing failure or, in freezing weather, damage to the drive housing.



5472

a - Drive housing (bottom view)
b - Fill/drain screw
c - Vent screw

1. Place a drain pan below the drive.
2. Remove the fill/drain screw.
3. Remove the vent screw to drain the lubricant.

Adding Lubricant

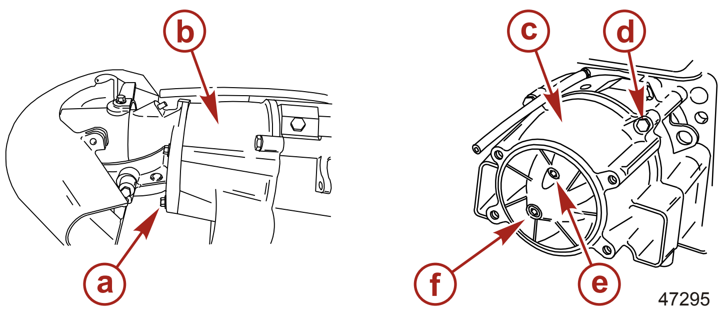
Fluid Type	Capacity
High Performance Gear Lube	725 cc (24 oz)

1. Insert the nozzle of the gear lubricant tube in the drive housing's fill/drain hole.
2. Add lubricant to the point of overflow.
3. Install the vent screw. Ensure that the screw gasket is in place.
4. Remove the nozzle of the tube and install the fill/drain screw with the gasket.

Stator Assembly Lubricant

Draining Lubricant

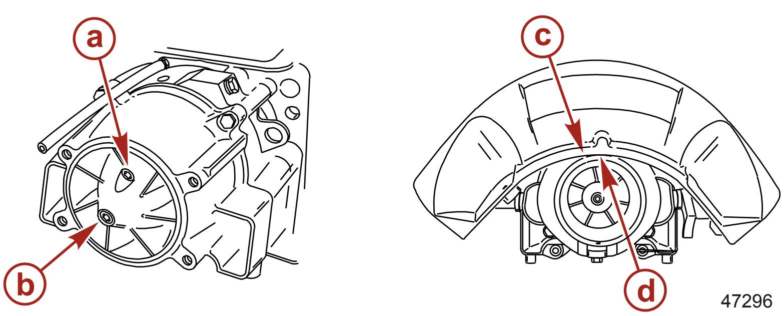
NOTE: When draining stator lubricant, visually check for water in the lubricant. It may have settled to the bottom and will drain before the lubricant, or it may have mixed with the lubricant giving it a milky color. In either case, have the stator checked by your authorized Mercury Marine dealer. Water in the lubricant can cause premature bearing failure or, in freezing weather, damage to the stator.



a - Screws securing nozzle assembly (4)
b - Nozzle assembly
c - Stator assembly
d - Screws securing stator assembly (4)
e - Vent plug
f - Fill/drain hole and plug

1. Disconnect the shift and steering cables from the reverse gate and rudder. Be careful not to change adjustments.
2. Remove the four screws securing the nozzle assembly to the stator.
3. Remove the nozzle.
4. Remove the four screws securing the stator assembly to the drive housing and the two screws to the ride plate.
5. Remove the stator.
6. Remove the stator fill/drain and vent plugs.
7. Tip the stator to drain the remaining lubricant out the fill hole.

Adding or Refilling Lubricant



a - Vent plug
b - Fill hole
c - Reverse gate (bottom edge)
d - Rudder (outside diameter)

Fluid Type	Capacity
High Performance Gear Lube	562 ml (19 fl oz)

1. Install the stator to the pump. Be careful when sliding the shaft past the seals to prevent damage to the seals. Apply Loctite 242 Threadlocker to the four stator bolts and the two ride plate screws. Tighten the screws to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Stator bolts and ride plate screws	92-809821

Description	Nm	lb-in.	lb-ft
Stator bolts	47		35
Ride plate screws	8.5	75	

2. Apply Loctite 567 PST Pipe Sealant to the plug threads.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Stator fill/drain plug and vent plug threads	92-809822

3. Insert the nozzle of the lubricant tube in the fill hole on the stator.
4. Add lubricant until it appears at the vent hole.
5. Install the vent plug.
6. Remove the nozzle of the lubricant tube and install the fill/drain plug.
7. Apply Loctite 271 Threadlocker to four nozzle screws. Install the nozzle assembly and anode. Secure with four screws. Tighten the screws to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Nozzle screws	92-809819

Description	Nm	lb-in.	lb-ft
Nozzle screws	47		35

8. Connect the steering and shift cables.
9. Shift and steer the unit through the entire range and check for any binding or stiffness. Correct adjustments as necessary.
10. Shift to forward position and check that the reverse gate is not preloaded. You should be able to slightly rock the reverse gate up and down. Excessive play requires shift cable adjustment.
11. Check that the bottom edge of the reverse gate is above the outside diameter of the rudder. If the reverse gate is below the outer diameter of the rudder, do not operate the boat. See an authorized Mercury Marine dealer for proper adjustment.
    IMPORTANT: Adjust the shift cable so that the reverse gate does not interfere with water flow coming out of the rudder. If the reverse gate is hanging in the water flow, a strong vibration may be felt in the control box and failure of the forward stop or other components will result.

Submerged Power Package

A submerged power package requires prompt service by an authorized dealer after recovery. This immediate attention is necessary once the engine is exposed to the atmosphere to minimize internal corrosion damage to the engine.

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out of season storage or prolonged storage (two months or longer).

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.

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

Fill the fuel system (tank, hoses, fuel pumps, and fuel injection systems) with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with the following instructions.

1. Portable fuel tank - Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into the fuel tank. Tip the fuel tank back and forth to mix stabilizer with the fuel.
2. Permanently installed fuel tank - Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately 1 liter (1 US quart) of gasoline. Pour this mixture into the fuel tank.

3. Place the outboard in water or connect a flushing attachment for circulating cooling water. Run the engine at 2000 RPM for 25 minutes to allow the treated fuel to fill the fuel system.

Protecting Internal Engine Components

NOTE: Make sure the fuel system has been prepared for storage.

1. Remove the spark plugs and using Oil Syringe 803976T, add approximately 30 ml (1 oz) of 2-cycle TC-W3 engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Install the spark plugs.
2. Remove the water separating fuel filter and empty the contents into a suitable container. Replace the fuel filter annually, or every 100 hours of operation, or if a large amount of fuel contamination is present.

Protecting Jet Pump Components

IMPORTANT: Check and fill the drive housing and stator assembly with High Performance Gear Lubricant before storage to protect against possible water leakage into the housings. Inspect the seals on the drive housing fill and drain plugs. Apply Loctite 567 Pipe Sealant to the threads of the stator drain and fill plugs. Tighten all plugs securely.

- Drain and fill the drive housing and stator assembly with High Performance Gear Lubricant. Refer to **Drive Housing Lubricant** and **Stator Assembly Lubricant**.
- Lubricate all lubrication points.
- Touch-up any paint nicks. See your dealer for touch-up paint.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Stator drain and fill plugs	92-809822
87	High Performance Gear Lubricant	Drive housing and stator assembly fill lubricant	92-858064K01

Positioning Outboard for Storage

Store outboard in an upright (vertical) position to allow water to drain out of the outboard.

NOTICE

Storing the outboard in a tilted position can damage the outboard. Water trapped in the cooling passages or rain water collected in the propeller exhaust outlet in the gearcase can freeze. Store the outboard in the full down position.

Battery Storage

- Follow the battery manufacturer's instructions for storage and recharging.
- Remove the battery from the boat and check water level. Recharge if necessary.
- Store the battery in a cool, dry place.
- Periodically check the water level and recharge the battery during storage.

Important Information

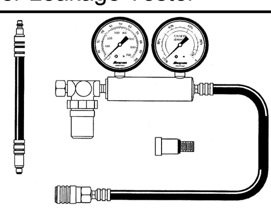
Section 1C - General Information

Table of Contents

General Specifications

Model Specifications	
Kilowatts (horsepower)	149.1 kW (200 hp)
Weight	
Powerhead	116.6 kg (257 lb)
Pump unit	49 kg (110 lb)
Displacement (all HP)	2.5 liter (153 in³)
RPM	
Idle	900–1000 RPM
WOT	5150–5650 RPM
RPM limit (Guardian)	6300 RPM
Induction system	Throttle body aspiration
Fuel system	Computer controlled sequential multi-port electronic direct fuel injection
Ignition system	SmartCraft propulsion control module (PCM) digital inductive
Charging system	Regulated belt-driven 60 amp alternator
Cooling system	Water-cooled
Lubrication system	Multi-port oil injection
Engine oil reservoir capacity	0.71 liter (0.44 US quart)
Engine control system	SmartCraft propulsion control module (PCM)

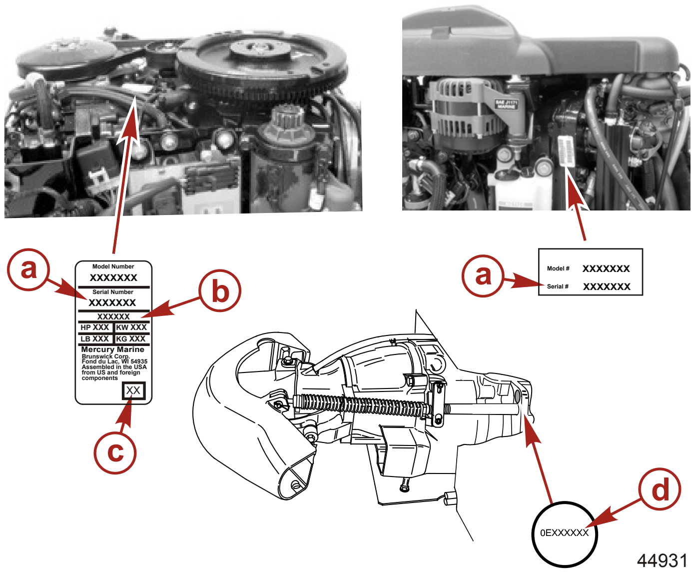
Special Tools

Cylinder Leakage Tester	Snap-On EEPV309A
 11604	Aids in checking cylinder leakdown.

Serial Number Location

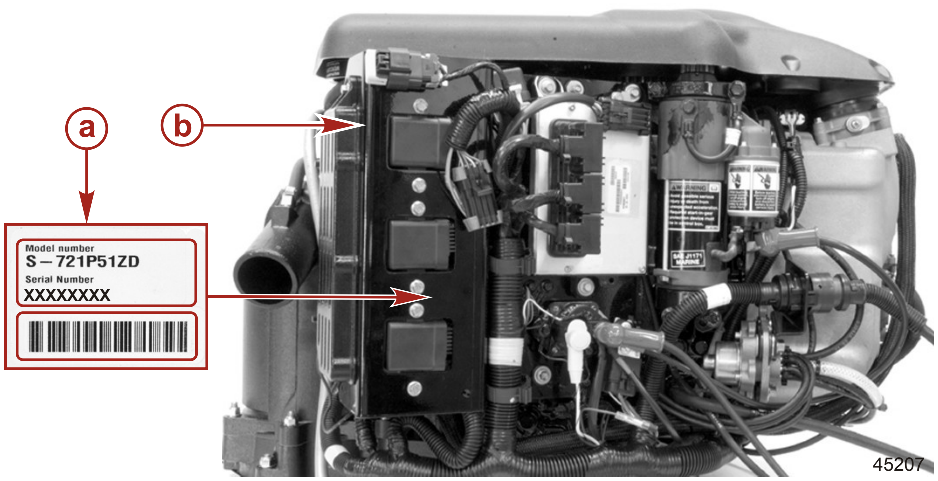
Engine and Jet Pump

It is important to record these numbers for future reference. The jet pump and engine serial numbers are different and unique. The engine serial number is located aft of the flywheel cover. The pump unit serial number is stamped on the starboard side of the pump housing.



- **a -** Engine serial number
- **b -** Model designation
- **c -** Year of manufacture
- **d -** Pump serial number

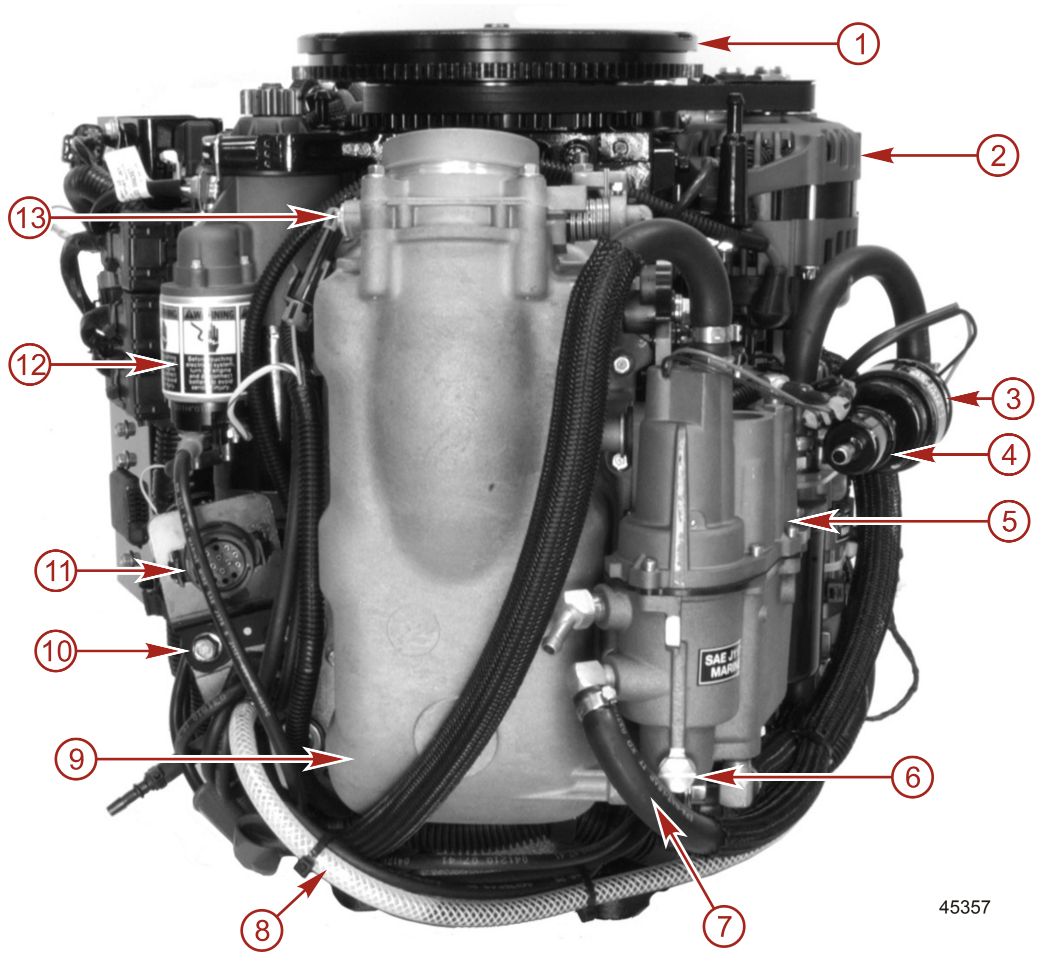
IMPORTANT: For convenience, stickers listing the pump model and serial number and the bar code information are supplied in an envelope affixed to the pump unit. The pump unit serial number stickers must be taken out of the envelope and applied to the electrical plate.



- **a -** Pump unit model and serial number stickers (2)
- **b -** Electrical plate

Powerhead Views

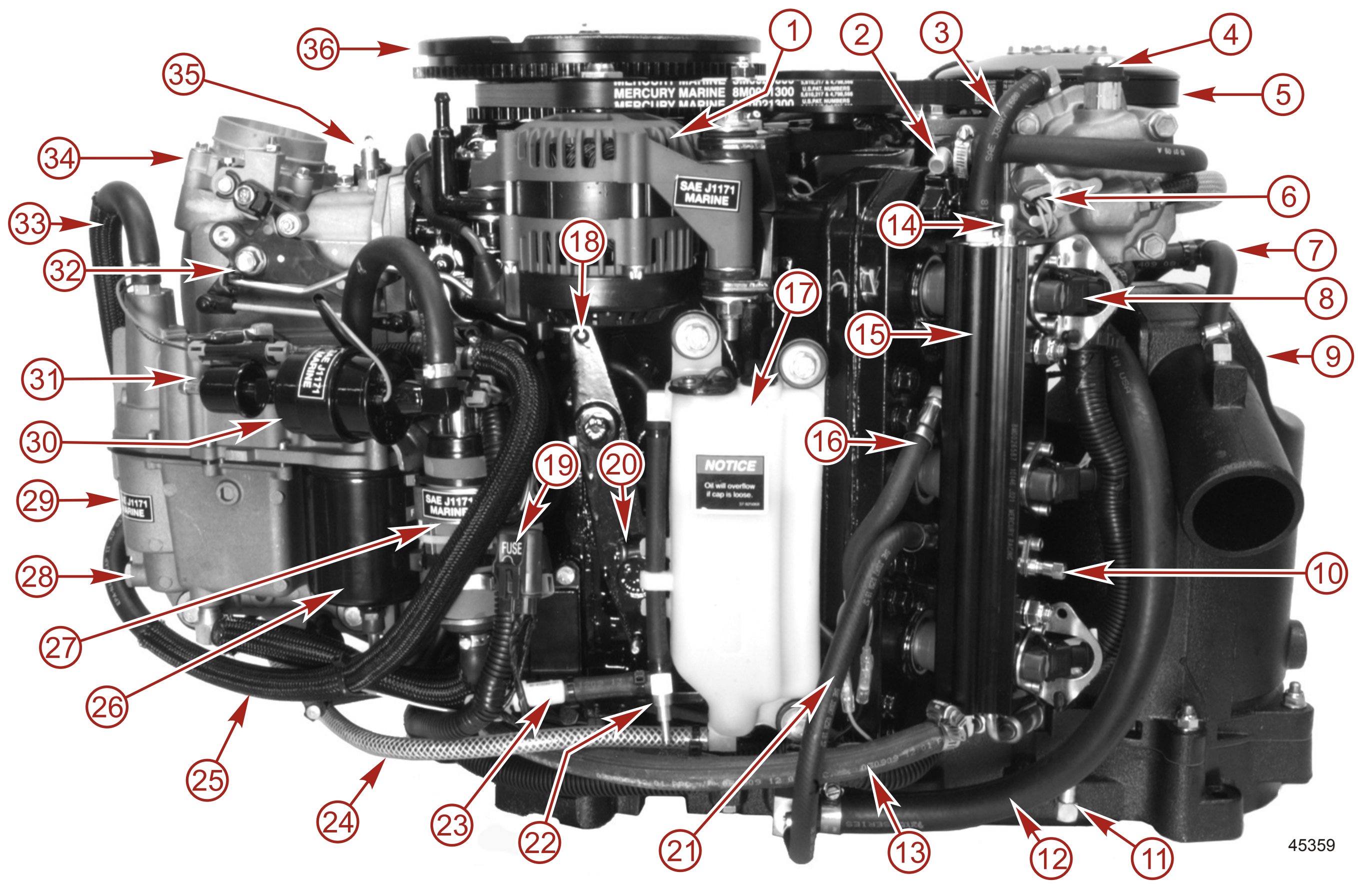
200 OptiMax SportJet Powerhead Front View



1 - Flywheel
2 - Alternator
3 - Fuel lift pump
4 - Fuel filter
5 - Vapor separator tank (VST)
6 - VST drain plug
7 - VST fuel inlet hose
8 - Oil pump inlet hose
9 - Expansion chamber
10 - Oil pump
11 - 14 pin engine harness connector
12 - Starter motor solenoid
13 - Manifold absolute pressure (MAP) sensor

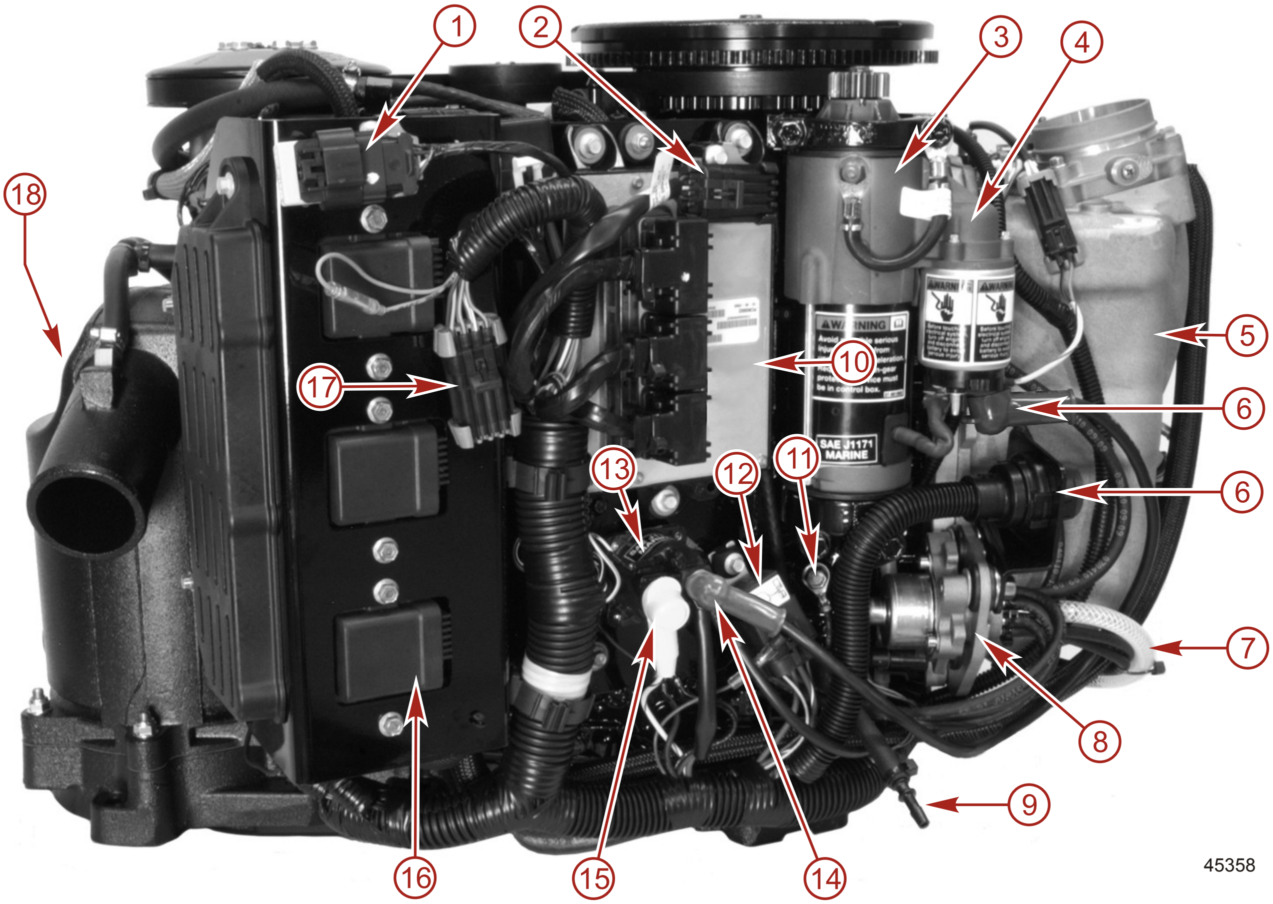
Notes:

200 OptiMax SportJet Powerhead Port View



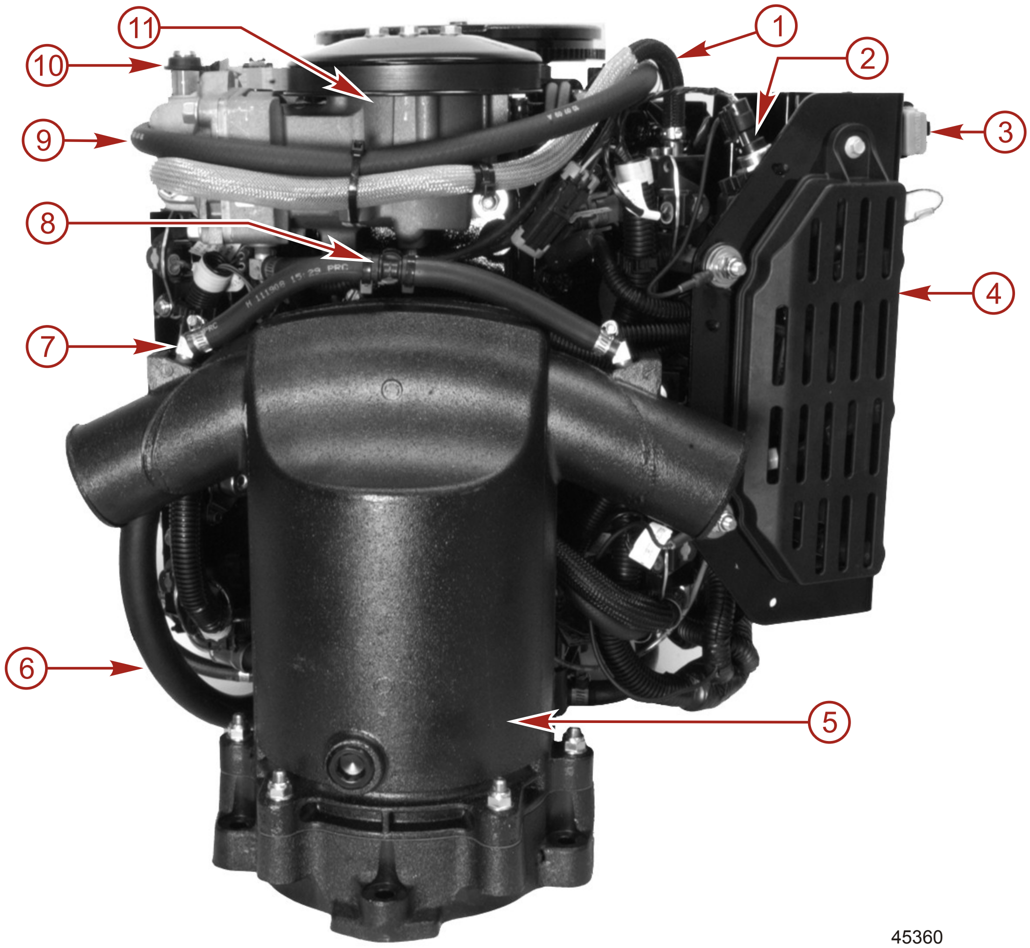
1 - Alternator
2 - Water bypass fitting
3 - Compressor coolant hose
4 - Air compressor inlet
5 - Air compressor
6 - Air compressor temperature sensor
7 - Exhaust pipe cooling hose
8 - Fuel injector
9 - Expansion chamber
10 - Air pressure test fitting
11 - Bilge siphon hose
12 - Expansion chamber coolant hose
13 - Fuel rail water inlet hose
14 - Air pressure test fitting
15 - Fuel hose
16 - Excess fuel return to vapor separator
17 - Oil reservoir
18 - Throttle lever
19 - Fuse cover
20 - Throttle stop
21 - Excess air hose to adapter plate
22 - 2 psi check valve
23 - Inlet oil hose filter
24 - Oil reservoir hose
25 - Low-pressure fuel pump outlet hose
26 - Water/fuel separator
27 - Low-pressure electric fuel pump
28 - Drain fitting
29 - Vapor separator tank (VST)
30 - Fuel lift electric pump
31 - Fuel filter
32 - Throttle cam
33 - 90 psi fuel outlet hose
34 - Throttle plate assembly
35 - Air temperature sensor
36 - Flywheel

200 OptiMax SportJet Powerhead Starboard View



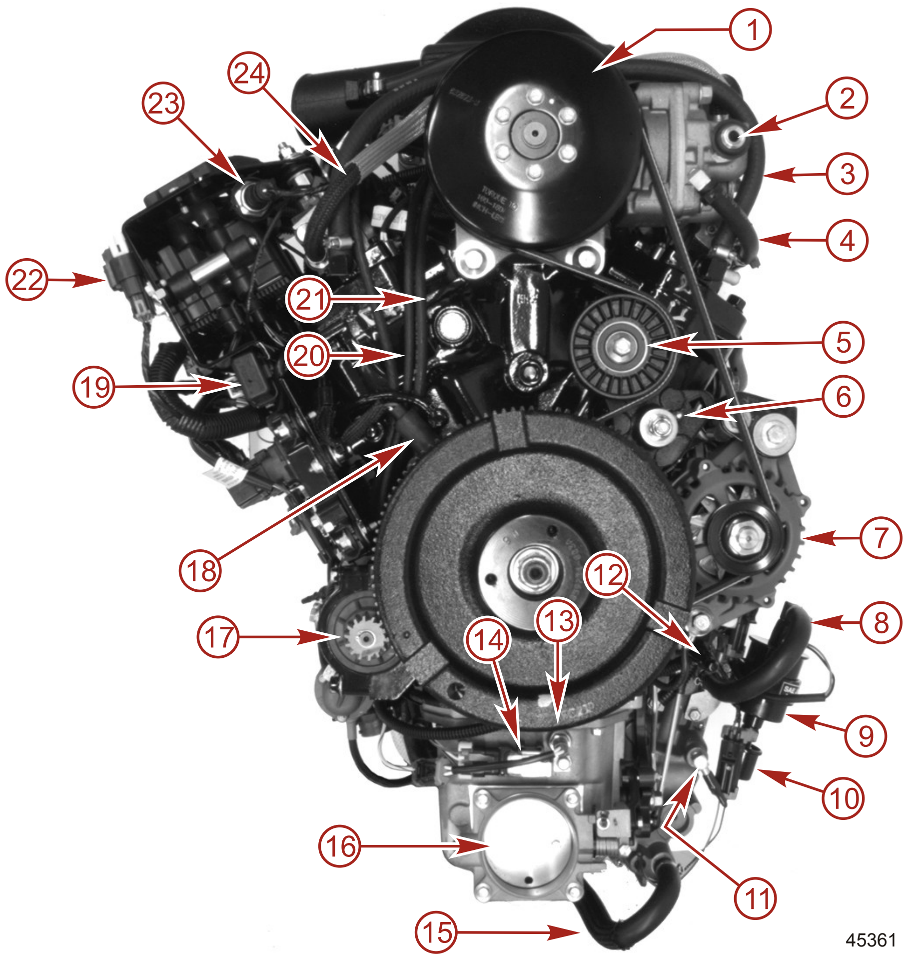
1 - SmartCraft connector
2 - CDS connector
3 - Starter motor
4 - Starter motor solenoid
5 - Air handler assembly
6 - Positive 12 volt cable
7 - Oil pump inlet hose
8 - Oil pump
9 - Fuel inlet hose
10 - Engine control module (ECM)
11 - Negative battery cable
12 - Main power relay
13 - Start solenoid
14 - Positive 12 volt starter cable
15 - Positive battery cable
16 - Ignition coil
17 - Oil/fuel/paddle wheel sensor connector
18 - Expansion chamber

200 OptiMax SportJet Powerhead Aft View



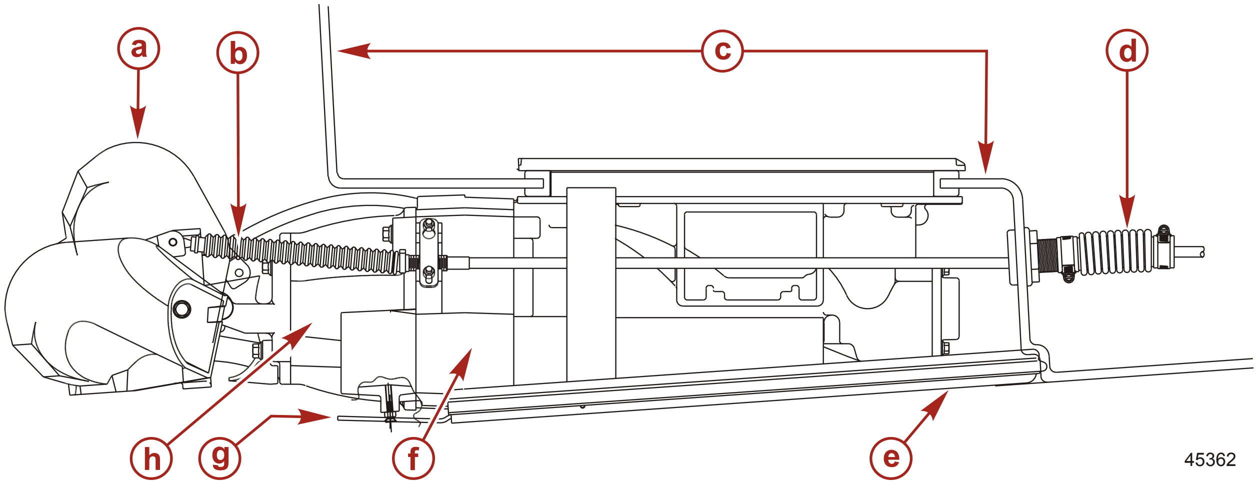
1 - 80 psi air hose
2 - Water pressure sensor
3 - SmartCraft connector
4 - Cover
5 - Expansion chamber
6 - Expansion chamber coolant hose
7 - Exhaust pipe coolant hose
8 - T-fitting
9 - Water bypass hose
10 - Air compressor inlet
11 - Air compressor

200 OptiMax SportJet Powerhead Top View



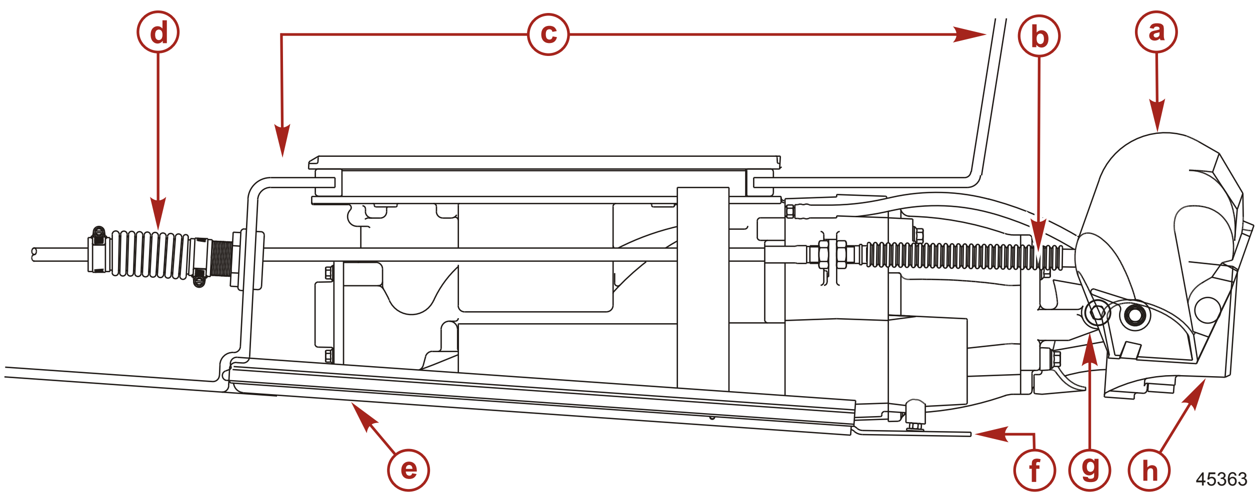
1 - Air compressor pulley
2 - Air compressor inlet
3 - Water bypass hose
4 - Air compressor coolant hose
5 - Belt tensioner
6 - Tensioner grease fitting
7 - Alternator
8 - Fuel inlet to fuel/separator
9 - Fuel lift pump
10 - Fuel filter
11 - Vapor separator tank (VST) vent fitting
12 - Throttle position sensor (TPS)
13 - Air temperature sensor
14 - Manifold absolute pressure (MAP) sensor
15 - 90 psi fuel hose to fuel rail
16 - Throttle plate assembly
17 - Starter motor
18 - Crankshaft position sensor (CPS)
19 - Fuse cover
20 - Oil return hose from air compressor
21 - Oil hose to air compressor
22 - SmartCraft connector
23 - Water pressure sensor
24 - 80 psi air hose to fuel rail

Mercury Jet Pump Starboard View



- a - Reverse gate
- b - Shift cable assembly
- c - Hull
- d - Shift cable assembly/through-the-hull fitting
- e - Water intake
- f - Wear ring
- g - Trim plate
- h - Stator

Mercury Jet Pump Port View



- a - Reverse gate
- b - Steering cable assembly
- c - Hull
- d - Steering cable assembly/through-the-hull fitting
- e - Water intake
- f - Trim plate
- g - Forward stop
- h - Rudder

Conditions Affecting Performance

Weather

It is a known fact that weather conditions exert a profound effect on the power output of internal combustion engines. Established horsepower ratings refer to the power the engine will produce at its rated RPM under a specific combination of weather conditions.

Corporations internationally have settled on adoption of International Standards Organization (ISO) engine test standards, as set forth in ISO 3046 standardizing the computation of horsepower from data obtained on the dynamometer. All values are corrected to the power the engine will produce at sea level, at 30% relative humidity, at 25 °C (77 °F) temperature, and a barometric pressure of 29.61 inches of mercury (in. Hg).

Summer conditions of high temperature, low barometric pressure, and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds as much as 3 to 5 km/h (2 to 3 MPH) in some cases. Nothing will regain this speed for the boater but cooler, dry weather.

Pointing out the consequences of weather effects, an engine running on a hot, humid day may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk day. The horsepower that any internal combustion engine produces, depends upon the density of the air that it consumes. The density of air is dependent upon the ambient air temperature, the barometric pressure, and the humidity (water vapor) content.

Weight Distribution (Passengers and Gear) Inside the Boat

Shifting weight to rear (stern):

- Generally increases speed and engine RPM
- Causes bow to bounce in choppy water
- Increases danger of following wave splashing into the boat when coming off plane
- At extremes, can cause the boat to porpoise

Shifting weight to front (bow):

- Improves ease of planing
- Improves rough water ride
- At extremes, can cause the boat to veer back and forth (bow steer)

Bottom of Boat

For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in the fore and aft direction.

- **Hook:** Exists when the bottom is concave in fore and aft direction when viewed from the side. When the boat is planing, hook causes more lift on the bottom near the transom and allows the bow to drop, thus greatly increasing wetted surface and reducing boat speed. Hook frequently is caused by supporting the boat too far ahead of the transom while hauling on a trailer or during storage.
- **Rocker:** The reverse of hook and much less common. Rocker exists if the bottom is convex in fore and aft direction when viewed from the side, and boat has strong tendency to porpoise.
- **Surface roughness:** Moss, barnacles, etc., on the boat or corrosion of the motor's gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.
- **Jet Unit:** If the unit is left in the water, marine vegetation may accumulate over a period of time. This growth must be removed from the unit before operation, as it may clog the water inlet holes in the gear housing and cause the engine to overheat.

Water Absorption

It is imperative that all through-the-hull fasteners be coated with a quality marine sealer at time of installation. Water intrusion into the transom core and/or inner hull will result in additional boat weight (reduced boat performance), hull decay, and eventual structural failure.

Cavitation

Cavitation occurs when water flow cannot follow the contour of a fast-moving underwater object. Cavitation is caused by water vapor bubbles forming either from sharp turns or from an irregularity in the impeller blade itself. These vapor bubbles flow back and collapse when striking the surface of the impeller blade resulting in erosion of the impeller blade surface. If allowed to continue, eventual blade failure will occur. Common causes of cavitation are:

- Weeds or other debris snagged on the water intake grate
- Bent impeller blades
- Raised burrs or sharp edges on the impeller
- Sharp turns of the boat

Ventilation

Ventilation occurs when air is drawn from the water's surface (excessive trim out angle) or from the engine exhaust flow (in reverse) into the impeller blades. These air bubbles strike the impeller blade surface and cause erosion of the blade surface. If allowed to continue, eventual blade failure (breakage) will occur.

Detonation

Detonation in a 2-cycle engine resembles the pinging heard in an automobile engine. It can be otherwise described as a tin-like rattling or plinking sound.

Detonation is the explosion of the unburned fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine. These shock waves often find or create a weakness: the dome of a piston, cylinder head or gasket, piston rings or piston ring lands, piston pin and roller bearings.

A few of the most common causes of detonation in marine applications are as follows:

- Over-advanced ignition timing
- Use of low octane gasoline
- Lean fuel mixture at or near wide-open throttle
- Spark plugs: heat range too hot, incorrect reach, cross-firing
- Deteriorated or inadequate engine cooling system
- Combustion chamber deposits: result in higher compression ratio

Detonation usually can be prevented if:

- The engine is correctly set up
- Regular maintenance is scheduled

Following Complete Submersion

Saltwater Submersion

Due to the corrosive effect of saltwater on internal engine components, complete disassembly is necessary before any attempt is made to start the engine.

Submerged While Running

When an engine is submerged while running, the possibility of internal engine damage is greatly increased. If, after engine is recovered and with spark plugs removed, the engine fails to turn over freely when turning the flywheel, the possibility of internal damage (bent connecting rod and/or bent crankshaft) exists. If this is the case, the powerhead must be disassembled.

Submerged Engine (Freshwater)

IMPORTANT: Engine should be run within two hours after recovery, or serious internal damage may occur. If unable to start engine in this period, disassemble the engine and clean all parts. Apply oil as soon as possible.

NOTE: If sand has entered the air intake on the engine, do not attempt to start the engine. Sand will cause internal engine damage. Disassembly is required to clean all internal engine components of sand.

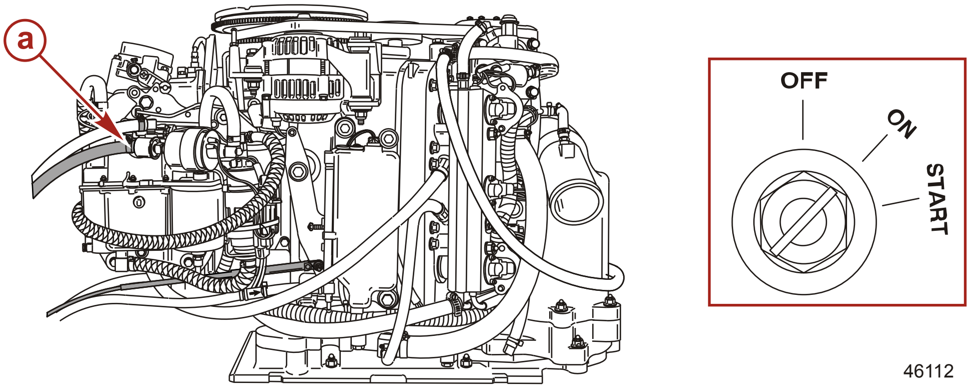
1. Recover the engine from the water as quickly as possible.
2. Clean the exterior of powerhead with fresh water.
3. Dry all wiring and electrical components using compressed air.
4. Drain the water from the fuel system as follows:
   a. Disconnect the remote fuel hose from the engine.
   b. Remove the drain plug from the vapor separator and drain the fuel/water. Install the plug after draining.
   c. Remove the fuel hose from the bottom of the port side fuel rail and drain the fuel/water. Install the hose.
   d. Remove the water separating fuel filter and empty the contents.
5. Drain the water from the air compressor system as follows:
   a. Dry or replace the air filter for the compressor.
   b. Remove the air outlet hose for the air compressor and drain the water from the compressor and hose. Install the hose.
   c. Remove the air pressure hose from the bottom of the port side fuel rail and drain the water. Install the hose.
6. Drain the water from the engine as follows:
   a. Remove the throttle plate assembly (four bolts). Tilt up the outboard and sponge the water out of the air plenum.
   b. Remove the spark plugs from the engine.
   c. Rotate the flywheel manually to blow out any water from the cylinders.

d. Add approximately 30 ml (1 oz) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Install the spark plugs.

7. Drain the water from the oil injection system as follows:
    a. Remove the remote oil hose (black without blue stripe) from the pulse fitting on the starboard side of the engine.
    b. Drain any water from the hose and connect.
    c. If water was present in the hose, check for water in the remote oil tank. Drain the tank if water is present.
8. Disassemble the engine starter motor and dry components.
9. Prime the oil injection pump as follows:

    IMPORTANT: Fill the engine fuel system with fuel before priming the oil injection pump to prevent damage to the fuel pump during the priming process.

    a. Connect the fuel hose to the fuel lift pump.
    b. Use the **Method 2 - Computer Diagnostic System Oil Pump Prime** procedure. This method should be used when the break-in clock does not need to be reset. Follow the procedures in the computer diagnostic system for priming the oil pump. Refer to **Section 3C - Priming the Oil Injection Pump**.



a - Fuel hose to fuel lift pump

NOTE: Audible click from the oil pump will tell you the pump is priming. It may take a few minutes for the pump to complete the priming process.

10. Attempt to start the engine, using a fresh fuel source. If the engine starts, it should be run for at least one hour to eliminate any water in the engine.
11. If the engine fails to start, determine the cause (fuel, electrical, or mechanical).

Compression Check

1. Remove spark plugs.
2. Install compression gauge in spark plug hole.
3. Hold throttle plate at WOT.
4. Pull on the recoil rope or crank the engine over until the compression reading peaks on the gauge. Record the reading.
5. Check and record compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15%. A reading below 827.4 kPa (120 psi) might indicate a total engine wear problem. **The following chart, is not a representation of compression values specific to the engine that is actually tested. It is only an example.**

Compression Test Differences		
Condition	Maximum Reading	Minimum Reading
Good	1241 kPa (180 psi)	1062 kPa (154 psi)
Bad	1172 kPa (170 psi)	972.2 kPa (141 psi)

6. To find the maximum allowable minimum compression reading difference, use this formula; highest compression reading x 0.85 = the lowest allowable difference. 1241 kPa x 0.85 = 1054.85 kPa (180 x 0.85 = 153 psi).
7. Compression check is important because an engine with low or uneven compression cannot be tuned successfully to give peak performance. It is essential, therefore, that improper compression be corrected before proceeding with an engine tune-up.
8. Cylinder scoring: If powerhead shows any indication of overheating, such as discolored or scorched paint, visually inspect cylinders for scoring or other damage as outlined in **Section 4 - Powerhead.**

Cylinder Leakage Testing

IMPORTANT: Refer to the Master Specifications for the firing order of the engine.

NOTE: Cylinder leakage testing, along with compression testing, can help pinpoint the source of a mechanical failure by gauging the amount of leakage in a cylinder. Refer to the manufacturer's tester instructions for proper testing procedures.

Cylinder Leakage Tester	Snap-On EEPV309A

1. Remove all of the spark plugs from cylinders except for cylinder #1.
2. Rotate the engine clockwise until resistance is felt.
3. Continue to rotate flywheel so the timing marks on the flywheel and cylinder block are in alignment. This will be the compression stroke for cylinder #1.
4. Remove the spark plug from cylinder #1.
5. Complete the cylinder leak-down test on the #1 spark plug hole.
6. After testing cylinder #1, install a dial indicator on the next firing order sequence cylinder.
7. Rotate the flywheel so the piston is at TDC.
8. Complete the cylinder leak-down test.
9. Complete the procedure in sequence on the remaining cylinders.

Analysis

Due to standard tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important the cylinders have somewhat consistent reading between them. Differences of 15–30% indicate excessive leakage. Larger engines have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, check that the piston is at top dead center of its compression stroke. Leakage will occur if the piston is below the exhaust port and the intake port.

To determine the cause of high percentage leaks, locate where the air is escaping from. Listen for air escaping through the intake and exhaust.

Air Escaping from	Possible Reason
Air induction	Cylinder liner/piston damaged, carbon fouled rings, reed valve damaged
Exhaust system	Cylinder liner/piston damaged, carbon fouled rings

Shipping of Hazardous Material (HazMat) and Engine/Components Containing Hazardous Material

Outboard Service Bulletin 2008-07

There are a number of United States regulations regarding the shipment of hazardous material. These regulations apply not only to shipments within the United States, but to import and export shipments as well. It is important to comply with all of these regulations. This bulletin is intended to provide you with some basic information about some of these regulations, and provide you with information about resources from which you can obtain additional information. It is also intended to draw your attention to the importance of proper packaging, labeling, and shipping of hazardous material; as well as any engine or engine component that contains hazardous material like gasoline or other fluids such as crankcase oil, gearcase oil, and hydraulic fluid. There are also requirements for training personnel that deal with the shipment of hazardous material. This bulletin is intended to draw your attention to some of the shipping regulations that we are aware of that might apply to your business, it is not a complete review of all of the laws and regulations that apply to the shipment of hazardous materials. Please do not treat it as such.

NOTE: You, as the shipper of record, are responsible for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials.

Overview of Regulations

The Hazardous Materials Regulations (HMR) specify requirements for the safe transportation of hazardous materials in commerce by rail car, aircraft, vessel, and motor vehicle. These comprehensive regulations govern transportation-related activities. In general, the HMR prescribe requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials. The HMR are enforced by Pipeline Hazardous Material Safety Administration (PHMSA), Department of Transportation (DOT), Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and the United States Coast Guard (USCG).

Overview of Training Requirements

Current U.S. Department of Transportation (DOT) regulations require initial training (and recurrent training) of all employees who perform work functions covered by the Hazardous Materials Regulations. Any employee who works in a shipping, receiving, or material handling area; or who may be involved in preparing or transporting hazardous materials, is required to have training. Hazardous materials transportation training is available from ShipMate, Inc. The training modules on CD-ROM or online contain an interactive training program which satisfies the DOT requirement for general awareness, general safety, and HazMat security training. A comprehensive exam is offered and Certificates of Completion are generated upon successful completion of the program. The CD-ROM and online Web-Based Training may be purchased from ShipMate, Inc. This also includes an electronic version of the 49 CFR Hazardous Materials Regulations, the current Emergency Response Guidebook, and full access to ShipMate's technical staff to assist you in properly preparing hazardous materials for transport. ShipMate, Inc. may be reached at 1-310-370-3600 or on the web at http://www.shipmate.com.

*NOTE: The DOT training program does **NOT** include a test of any type and contains a lot of material which is not relevant (e.g. cargo tanks). In addition, you would have to purchase the 49 CFR and the Emergency Response Guidebook separately. Further, the DOT program provides no support – technical or otherwise. For further information, view the DOT website at http://www.dot.gov.*

Shipping of Complete Engines and Major Assemblies

Complete engines cannot be transported without going through additional preparation first. Electronic fuel injection (EFI) and direct fuel injection (DFI) engines must have the fuel system drained of fuel, not run dry because of possible damage to electric fuel pumps. Carbureted engines must be completely run dry and have stalled due to lack of fuel. All engines must have any remaining fluids/oils drained (including engine and gearcase oil) and hydraulic fluids (including power trim fluid) and disconnected fluid pipes that previously contained fluid must be sealed with leakproof caps that are positively retained. Major assemblies such as gearcases, dressed powerheads, or other components containing any fluids must be also drained prior to shipping.

More Information on Hazardous Material

More information on hazardous material, regulations, packaging, training, etc. can be found by going to the ShipMate website: http://www.shipmate.com or by calling or writing to:

ShipMate, Inc.
18436 Hawthorne Blvd., Suite 201
Torrance, CA 90504
USA
Telephone + 1 (310) 370-3600
Fax + 1 (310) 370-5700
E-mail: shipmate@shipmate.com

Decal Application

Decal Removal

1. Mark decal location before removal to assure proper alignment of new decal.
2. Carefully soften decal and decal adhesive with a heat gun or heat blower while removing old decal.
3. Clean decal contact area with a 1:1 mixture of isopropyl alcohol and water.
4. Thoroughly dry decal contact area and check for a completely cleaned surface.

Application Instructions

NOTE: The following decal installation instructions are provided for a wet installation. All decals should be applied wet.

Tools Required

- Plastic squeegee
- Stick pin
- Dishwashing liquid detergent without ammonia. Do not use a soap that contains petroleum based solvents.

NOTE: Placement of decals using the wet application will allow time to position decal. Read entire installation instructions on this technique before proceeding.

Temperature

IMPORTANT: Installation of vinyl decals should not be attempted while in direct sunlight. Air and surface temperature should be between 15 °C (60 °F) and 38 °C (100 °F) for best application.

Surface Preparation

IMPORTANT: Do not use a soap that contains petroleum based solvents to clean application surface.

Clean entire application surface with mild dishwashing liquid and water. Rinse surface thoroughly with clean water.

1. Mix 16 ml (1/2 oz) of dishwashing liquid in 4 liter (1 US gal) of cool water to use as a wetting solution.

   NOTE: *Leave the protective masking on the face of the decal until the final steps of decal installation. This will ensure the vinyl decal keeps its shape during installation.*
2. Place the decal face down on a clean work surface and remove the paper backing from adhesive side of the decal.
3. Using a spray bottle, flood the entire adhesive side of the decal with the premixed wetting solution.
4. Flood the area where the decal will be positioned with the wetting solution.
5. Position the prewetted decal on the wetted surface and slide into position.
6. Starting at the center of the decal, lightly squeegee out the air bubbles and wetting solution with overlapping strokes to the outer edge of the decal. Continue going over the decal surface until all wrinkles are gone and adhesive bonds to the cowl surface.
7. Wipe the decal surface with a soft paper towel or cloth.
8. Wait 10–15 minutes.
9. Starting at one corner, carefully and slowly pull the masking off the decal surface at a 180° angle.

NOTE: *To remove any remaining bubbles, pierce the decal at one end of the bubble with stick pin and press out the entrapped air or wetting solution with your thumb, moving toward the puncture.*

Notes:

Important Information

Section 1D - Jet Installation

Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 454 Prism Instant Adhesive Gel	Front portion of grommet	
19	Perfect Seal	End threads and the cable conduit end	92-34227Q02
25	Liquid Neoprene	Battery cable connections	92- 25711 3
34	Special Lubricant 101	Driveshaft splines	92-802865Q02
151	Marine Sealer	Through-the-hull fitting (threads and under the head)	92-858080K01

General Information

Notice to Installer

Throughout this publication, Warnings and Cautions (accompanied by the International Hazard Symbol) are used to alert the installer 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: Indicates information or instructions that are necessary for a particular step or action.

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

This installation section has been written and published by the service department of Mercury Marine to aid installers when installing the products described herein.

It is assumed that these personnel are familiar with the installation procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. Also, that they have been trained in the recommended installation procedures of these products which includes 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 by which an installation might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses an installation procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the installation procedure selected.

All information, illustrations, and specifications contained in this section are based on the latest product information available at time of publication.

Torque Specifications

Description	Nm	lb-in.	lb-ft
Powerhead to pump (10 mm fasteners)	47		35
Reverse stop screw	14	124	
Forward stop screw	14	124	

Description	Nm	lb-in.	lb-ft
Ride plate-to-pump screws	8.5	75	
Pump cover to pump housing nuts	47		35

Before Starting the Engine

NOTICE

Lack of oil pressure in the system can cause severe internal engine damage during start-up. Prime the oil injection pump on new or rebuilt engines or after performing maintenance on the oiling system.

Refer to **Priming the Oil Injection Pump** for instructions.

Important Information

Fuel Requirements

Do not use premixed gas and oil in this engine. The engine automatically receives extra oil during engine break-in. Use a fresh supply of the recommended gasoline during engine break-in and after engine break-in.

Oil Recommendation

Mercury OptiMax/DFI or Quicksilver DFI 2-Cycle Engine Oil is recommended for your engine. If Mercury OptiMax/DFI or Quicksilver DFI 2-Cycle Engine Oil is not available, we recommend using Mercury or Quicksilver TC-W3 Premium Plus 2-Cycle Oil. Severe engine damage may result from use of an inferior oil.

OptiMax Oil or Premium Plus TC-W3 is a higher grade oil that provides increased lubrication and extra resistance to carbon buildup when used with good or varying grades of gasoline.

IMPORTANT: Oil must be NMMA certified TC-W3 2-Cycle oil.

Periodically consult with your dealer to get the latest gasoline and oil recommendations. If Mercury Precision or Quicksilver 2-Cycle Outboard Oil is not available, substitute another brand of 2-Cycle outboard oil that is NMMA Certified TC-W3. The use of an inferior 2-Cycle outboard oil can reduce engine durability. Damage from use of inferior oil may not be covered under the limited warranty.

Avoiding Fuel Flow Restriction

IMPORTANT: Adding components to the fuel supply system (filters, valves, fittings, etc.) may restrict the fuel flow. This may cause engine stalling at low speed, and/or a lean fuel condition at high RPM that could cause engine damage.

Boat Horsepower Capacity

WARNING

Exceeding the boat's maximum horsepower rating can cause serious injury or death. Overpowering the boat can affect boat control and flotation characteristics or break the transom. Do not install an engine that exceeds the boat's maximum power rating.

Do not overpower or overload your boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.

U.S. COAST GUARD CAPACITY	
MAXIMUM HORSEPOWER	XXX
MAXIMUM PERSON CAPACITY (POUNDS)	XXX
MAXIMUM WEIGHT CAPACITY	XXX

26777

Start in Gear Protection

⚠ WARNING

Starting the engine with the drive in gear can cause serious injury or death. Never operate a boat that does not have a neutral-safety-protection device.

The remote control connected to the outboard must be equipped with a start in neutral only protection device. This prevents the engine from starting in gear.

Selecting Accessories for Your Outboard

Genuine Mercury Precision or Quicksilver Accessories have been specifically designed and tested for this outboard.

Some accessories not manufactured or sold by Mercury Marine are not designed to be safely used with this outboard or outboard operating system. Acquire and read the installation, operation, and maintenance manuals for all selected accessories.

Fuel System

Fuel Tanks

Portable Fuel Tank

Select a suitable location in the boat within the engine fuel line length limitations and secure the tank in place.

Permanent Fuel Tank

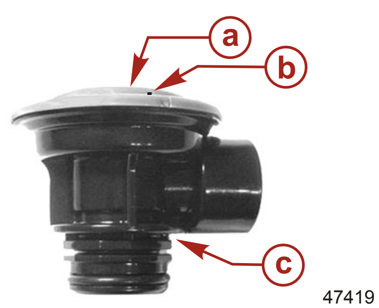
Permanent fuel tanks should be installed in accordance with industry and federal safety standards, which include recommendations applicable to grounding, anti-siphon protection, ventilation, etc.

Integrated Fuel Demand Valve (iFDV) Requirement

Whenever a permanent pressurized fuel tank is used, an integrated fuel demand valve is required to be installed in the top of the fuel tank via an O-ring seal.

The integrated fuel demand valve prevents pressurized fuel from entering the engine and causing a fuel system overflow or possible fuel spillage.

The integrated fuel demand valve has a manual release. The manual release can be used (pushed in) to open (bypass) the valve in case of a fuel blockage in the valve.



Integrated fuel demand valve

a - Manual release
b - Vent/water drain hole
c - O-ring seal

Low Permeation Fuel Hose - Outboard

To meet the Environmental Protection Agency (EPA) regulations, any outboard engine built on or after January 1, 2009, for sale, sold, or offered for sale in the United States must use a low permeation fuel hose between the fuel tank and the first fuel line connection on the outboard.

- Low permeation fuel hose is USCG Type B1-15, or Type A1-15 defined as not exceeding 15 g/m²/24 h with CE 10 fuel at 23 °C as specified in SAE J 1527 – marine fuel hoses.
- The rule defines it as the first connection on the engine, which means the stub hose or pigtail that is factory installed does not need to be low permeation.
- If the OEM/boatbuilder supplies the hose, they should use low permeation hose.
- Outboard engines manufactured prior to January 1, 2009 that are installed on boats after January 1, 2009 are not required to use low permeation fuel hose.
- If the OEM/boatbuilder has inventory of non-low permeation hose, they are allowed to use it up prior to changing over to low permeation hose. Stockpiling is not allowed.
- Any non-low permeation fuel hoses and hose kits that were produced prior to January 1, 2009, can still be sold as service parts until inventory is depleted. However, they cannot be used to rig engines produced in 2009 and beyond.

- Mercury and Mariner engines that are supplied with a fuel hose, regardless of production date, will have the correct fuel hose to meet EPA regulations.

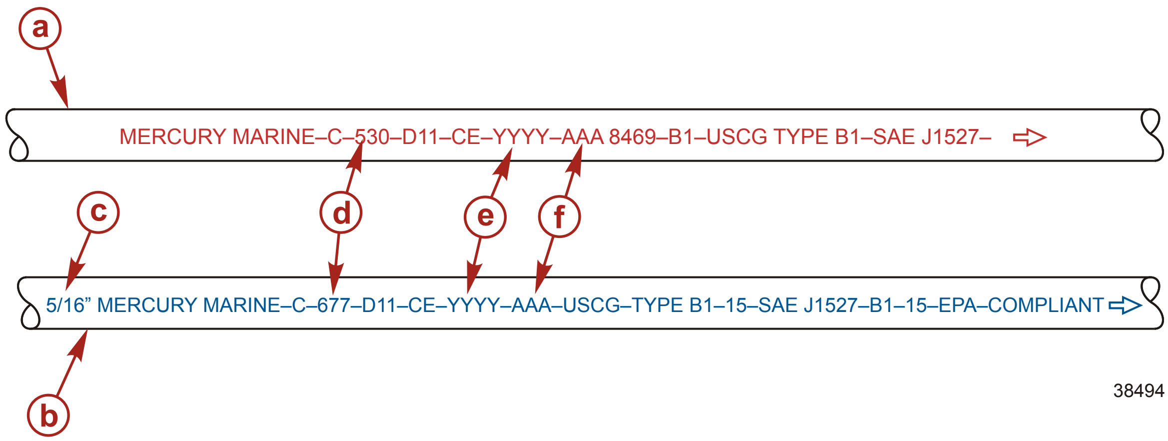
Low Permeation Fuel Hose from Mercury Marine

The light gray fuel hose that is typically used to connect between the outboard and fuel supply in the boat, will now be available in low permeation. This includes the fuel hoses shipped with engines manufactured on or after January 1, 2009.

The new hose will remain light gray in color. Other changes to the new fuel hose include:

- An inner liner resistant to chemicals and alcohol fuels.
- An outside PVC jacket with increased UV resistance to prevent browning of the exterior surface.

The new low permeation fuel hose from Mercury Marine will have a different compound number printed on the hose. The red print on the older non-low permeation hose will change to the blue print on the new low permeation hose.



a - Non-low permeation hose
b - Low permeation hose
c - Hose inside diameter (I.D.)
d - Compound number or type
e - Year of manufacture
f - Supplier identification

NOTE: The non-low permeation bulk hose rolls and kits will NOT directly supersede to the low permeation hose.

Reference Service Bulletin 2008-11.

Fuel Requirements

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

Fuel Ratings

Mercury engines will operate satisfactorily when using a major brand of unleaded gasoline meeting the following specifications:

USA and Canada—having 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—having a posted pump Octane Rating of 90 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) Gasolines (USA Only)

This type of gasoline is required in certain areas of the USA. The two types of oxygenates used in these fuels is alcohol (Ethanol) or ether (MTBE or ETBE). If ethanol is the oxygenate that is used in the gasoline in your area, refer to **Gasolines Containing Alcohol**.

These reformulated gasolines are acceptable for use in your Mercury engine.

Gasolines Containing Alcohol

If the gasoline in your area contains either methanol (methyl alcohol) or ethanol (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with methanol. Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on Mercury engines will withstand up to 10% alcohol content in the gasoline. We do not know what percentage of alcohol the boat's fuel system will withstand. The boat manufacturer must have specific recommendations on the boat's fuel system components (fuel tanks, fuel lines, and fittings). Be aware that gasolines containing alcohol may increase:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through rubber fuel lines
- Difficulty starting and operating the engine

⚠ 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.

Because of possible adverse effects of alcohol in gasoline, we recommend only alcohol-free gasoline when possible. If the only fuel available contains alcohol or if you do not know whether the fuel contains alcohol, inspect for leaks and abnormalities more frequently.

IMPORTANT: When operating a Mercury engine on gasoline containing alcohol, do not store the gasoline in the fuel tank for long periods. Whereas 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. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Installation Requirements

Installation

IMPORTANT: Jet Drive is considered an inboard engine. The boat it is installed in must meet industry standards (ABYC, NMMA, etc.), federal standards, and Coast Guard regulations for inboard engine installations.

Battery/Battery Cables

IMPORTANT: Boating industry standards (NMMA, ABYC, SAE, USCG, EUs, RCD, and so on), federal standards, and United States Coast Guard regulations must be adhered to when installing the battery. Be sure the battery cable installation meets the pull test requirements and that the positive battery terminal is properly insulated in accordance with regulations.
IMPORTANT: It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.
IMPORTANT: Engine electrical system is negative (–) ground.

Selecting the Battery

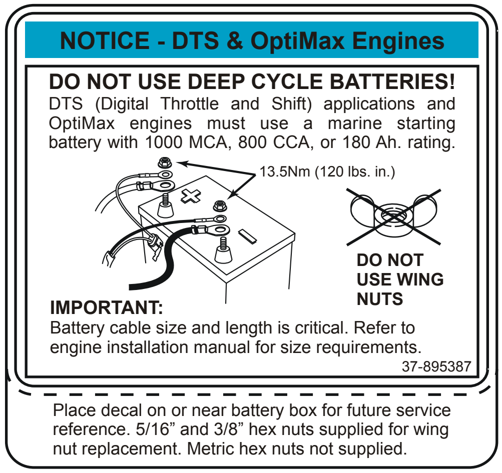
⚠ CAUTION

Hex nuts must be used to secure battery leads to the battery posts to avoid loss of electrical power.

- Do not use deep cycle batteries. Engines must use a marine starting battery with 1000 MCA, 800 CCA, or 180 Ah.
- When connecting the engine battery, the hex nuts must be used to secure the battery leads to the battery posts. Tighten the nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Hex nuts	13.5	120	

The decal needs to be placed on or near the battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut are supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



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Selecting the Battery Cables

Select battery cables that meet the following specifications:

- Battery cables must comply with SAE J1127 or comparable standards.
- Battery cable terminals must be soldered to cable ends to ensure good electrical contact, using electrical grade (resin flux) solder only. Some form of mechanical connection (such as swage or crimp) is also recommended, and is required if length of solder connection is less than 1-1/2 times the diameter of the stranded area of the cable (ABYC standard).
- Battery should be located as close to engine as possible.
- Select proper gauge cable. The length in the chart is for one way, from battery to engine. Use the longest length cable (positive or negative) when making a selection from the chart.

Battery Cable Length	Minimum Cable Gauge
1.1 m (up to 3-1/2 ft)	25 mm² (4)
1.1–1.8 m (3-1/2–6 ft)	35 mm² (2)
1.8–2.3 m (6–7-1/2 ft)	50 mm² (1)
2.3–2.9 m (7-1/2– 9-1/2 ft)	50 mm² (0)
2.9–3.7 m (9-1/2–12 ft)	70 mm² (00)
3.7–4.6 m (12–15 ft)	95 mm² (000)
4.6–5.8 m (15–19 ft)	120 mm² (0000)

Boat Construction

IMPORTANT: All applicable U.S. Coast Guard regulations for inboard engines must be complied with when constructing engine compartment.

Care must be exercised in the design and construction of the engine compartment. Seams must be located so that any rain water or splash, which may leak through the seams, is directed away from the engine and its air intake. Also, the passenger compartment drainage system should not be routed directly to the engine compartment. Water that runs on or is splashed in the air intake may enter the engine and cause serious damage to internal engine parts.

IMPORTANT: Mercury Marine will not honor any warranty claim for engine damage as a result of water entry.

Engine Compartment Ventilation

The engine compartment must provide a sufficient volume of air for engine breathing and also must vent any fumes in accordance with industry standards (ABYC, NMMA, etc.), federal standards, and U.S. Coast Guard regulations for inboard engines. Pressure differential between the engine compartment and atmospheric pressure must not exceed 51 mm (2 in.) of water (measured with a manometer) at the maximum air flow rate.

Engine Compartment Specifications	
Engine Air Requirements at Wide-Open Throttle	**Physical Engine Volume**[1.]
0.260 m^3/sec (552 ft^3/min)	40.4 L (1.41 ft^3)

For serviceability, Mercury Marine recommends allowing an additional 15 cm (6 in.) minimum of clearance between the powerhead and the engine compartment walls (per side).

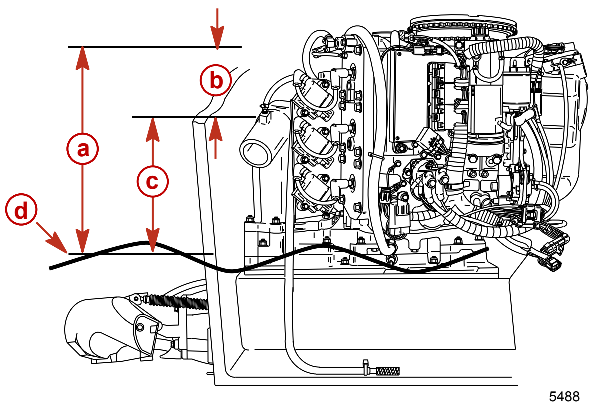
Exhaust and Engine Height

IMPORTANT: It is the responsibility of the boat manufacturer, or installing dealer, to properly locate the engine. Improper installation may allow water to enter the expansion chamber and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by Mercury Marine Limited Warranty, unless this damage is the result of defective parts.

The engine must be properly located to ensure that water will not enter the engine through the exhaust system.

To determine the correct engine height:

1. With the boat at rest in the water and fully loaded, measure between the waterline and the top of the transom measurement "a."
2. Measure between the highest point on the expansion chamber and the top of the transom measurement "b."
3. Subtract measurement "b" from measurement "a" to find the distance between the highest point on the expansion chamber and the waterline, when fully loaded. This is measurement "c."
4. Compare results to the chart below. If measurement "c" is less than specified, alter the boat construction to properly lower the waterline relative to the exhaust chamber.



a - Distance between the waterline and the top of the transom
b - Distance between the highest point on the expansion chamber and the top of the transom
c - Distance between the highest point on the expansion chamber and the waterline
d - Waterline at rest (at maximum load)

Measurement "c"	20.3 cm (8 in.) minimum

Fuel Delivery System

Low Permeation Fuel Hose Requirement

Required for Mercury Jet Drives manufactured for sale, sold, or offered for sale in the United States.

- The Environmental Protection Agency (EPA) requires that any Mercury Jet Drives manufactured after January 1, 2009 must use a low permeation fuel hose for the primary fuel hose connecting the fuel tank to the outboard.
- Low permeation hose is USCG Type B1-15 or Type A1-15, defined as not exceeding 15/gm^2/24 h with CE 10 fuel at 23 °C as specified in SAE J 1527 - marine fuel hose.

⚠ WARNING

Improper boat design and construction may result in serious injury or death. Adhere to all applicable marine regulations (United States Coast Guard [USCG], European Union–Recreational Craft Directive [EU-RCD], etc.) and the standards they reference (American Boat and Yacht Council [ABYC], Society of Automotive Engineers [SAE], International Standards Organization [ISO], etc.) when designing and constructing the boat and other components, such as the engine compartment, fuel delivery system, or exhaust system.

1. Fuel pickup should be at least 25 mm (1 in.) from the bottom of the fuel tank to prevent picking up impurities.
2. Fuel lines used must be U.S. Coast Guard approved (USCG type A1), fittings and lines must not be smaller than 8 mm (5/16 in.) inside diameter.
3. On installations requiring long lines or numerous fittings, larger size lines should be used.

1. Physical engine volume is used in flotation calculations and is representative of the amount of flotation the engine provides.

4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine fuel pump to absorb deflection when engine is running.
7. A primer bulb is not necessary with this application. If a primer bulb is used, it must be U.S. Coast Guard approved for inboard engine installations.
8. The vapor separator must be vented to fuel tank. The vent hose must comply with U.S. Coast Guard/ABYC regulations.

Instrumentation

NOTE: Check the charging capability of the engine. The electrical load of the boat should not exceed this capacity.

We recommend the use of Mercury Precision or Quicksilver instrumentation and wiring harnesses. Refer to **Mercury Precision Parts Accessories Guide** for selection.

If other than Mercury Precision or Quicksilver electrical accessories are to be used, it is good practice to use waterproof ignition components (ignition switch, lanyard stop switch, etc.). A typical jet boat of this nature will see water splashed on these components. Therefore, precautions must be taken to avoid ignition failure due to shorting out of ignition components.

A warning horn must be incorporated in the wiring harness (see wiring diagram) to alert the user of an overheat, low oil condition, or oil pump failure.

IMPORTANT: If a warning horn system is not installed by the boat manufacturer, Mercury Marine will not honor any warranty claims for engine damage as a result of overheating or lack of engine oil.

Route instrumentation wiring harness back to the engine, making sure that the harness does not rub or get pinched. If an extension harness is required, be sure to secure connection properly. Fasten harnesses to the boat at least every 460 mm (18 in.) using appropriate fasteners.

Remote Control and Cables

The remote control must provide the following required features:

- Start in gear protection
- Neutral RPM limit at 2000 RPM. This applies to dual lever remote controls as well as single lever remote controls.
- High strength mechanism to accommodate loads transmitted to the remote control
- Shift cable travel of 76 mm ± 3 mm (3 in. ± 1/8 in.)
- Ability to use 40 series shift cable

The remote control must meet the above criteria as well as the design criteria outlined in the ABYC manual pertaining to Mini-Jet Boats (Standard P-23).

Shift Cable

The shift cable to be used must meet the following criteria:

- 40 series shift cable
- 40 series bulkhead fitting at output end
- Allow for a minimum of 76 mm (3 in.) of travel
- A means of attaching and locking the cable to the shift cable bracket (provided)
- Cable end at pump must allow for a 1/4 inch clevis pin and cotter pin (all provided) to connect cable to the reverse gate
- Protected against water intrusion and/or corrosion as the cable end (at the pump) is submersed in water with the boat at rest

The shift cable end (at the pump) is submersed in water. It should be sealed against water intrusion, protected against corrosion, and be able to withstand the shift loads imparted on it by the reverse gate.

Follow shift cable adjustment procedure for proper adjustment.

Throttle Cable

The throttle cable must have one end compatible with the control box. The other end must have Mercury style connectors.

Follow throttle cable adjustment procedures for proper adjustment.

Steering Helm and Cable

The steering helm must limit steering cable travel to 88.9 mm ± 2.5 mm (3-1/2 in. ± 1/8 in.).

Steering Cable

The steering cable to be used must meet the following criteria:

- 60 series steering cable
- 60 series bulkhead fitting at output end

- Allow for a minimum of 95.3 mm (3.75 in.) of travel
- Cable end at pump must allow for a 5/16 in. threaded adapter shouldered through bolt and locknut to connect the cable to the steering arm
- A means of attaching and locking the cable to the steering cable bracket (provided)
- Protected against water intrusion and/or corrosion as the cable end (at the pump) is submersed in water with the boat at rest
- The steering cable should be able to withstand the steering loads imparted on it by the rudder

METHOD FOR CONTROLLING LOCATION AND SIZE

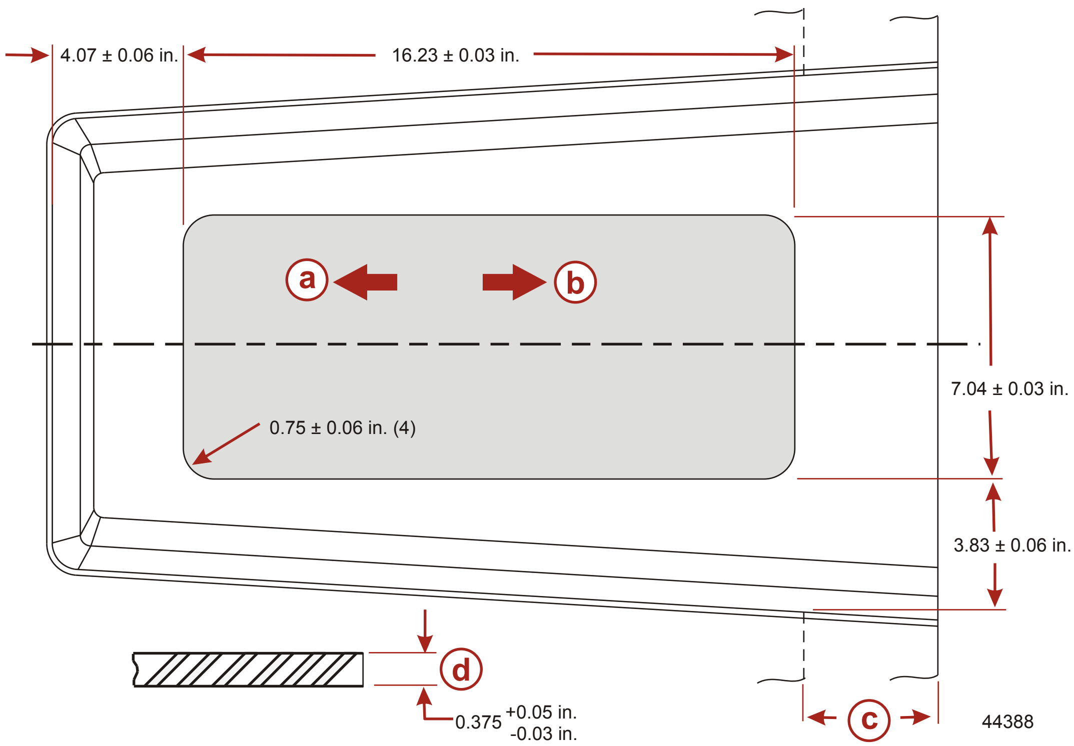
Mercury Marine recommends that the tunnel opening be done as a part of the manufacture of the tunnel. This will ensure consistency of location as well as size.

Installing the Jet Pump

⚠ CAUTION

The location, dimensions, and thickness of the hull cut-out opening is critical for preventing water and exhaust intrusion, excessive engine or pump vibration, and power package assembly movement. Ensure the location, dimensions, and thickness of the hull cut-out opening are witin the recommended specifications prior to installing the jet pump assembly.

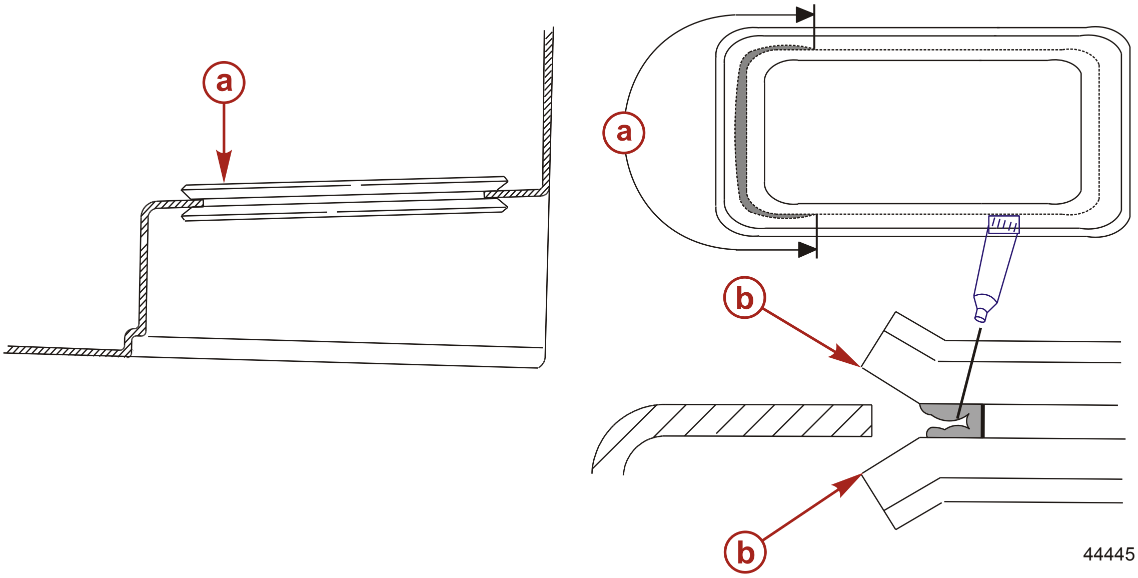
1. Ensure the location, dimensions, and thickness of the hull opening are within the recommended specifications.



a - Forward
b - Aft
c - Transom range
d - Hull opening thickness

2. Install the tunnel grommet in the cutout of the boat by gluing the front portion of the grommet to the tunnel with Loctite 454 or equivalent.

IMPORTANT: Avoid gluing the flexible sealing lips to the tunnel.

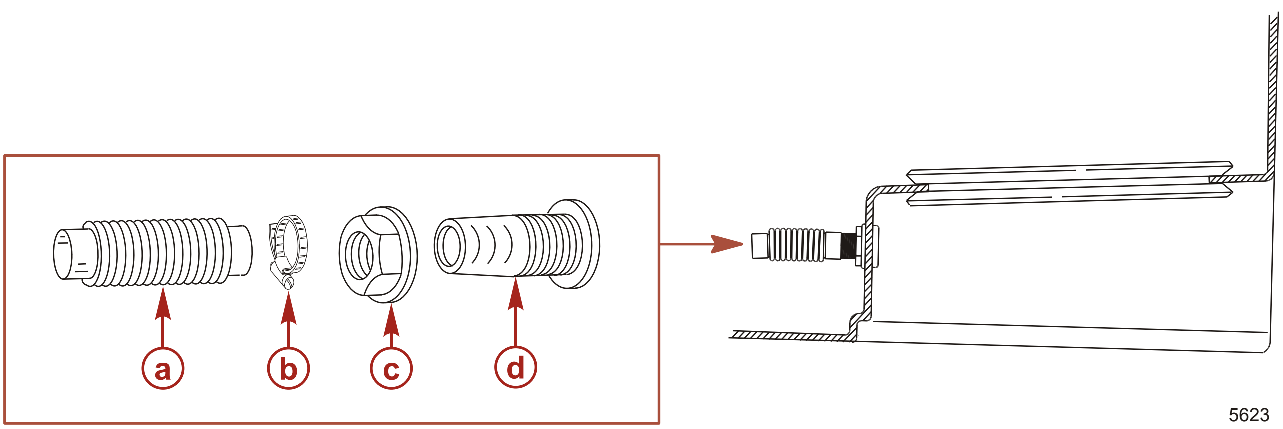


44445

a - Glue front portion of grommet
b - Flexible sealing lips to tunnel

Tube Ref No.	Description	Where Used	Part No.
	Loctite 454 Prism Instant Adhesive Gel	Front portion of grommet	

3. Install the through-the-hull fitting bellow assemblies into the tunnel. Tighten securely.

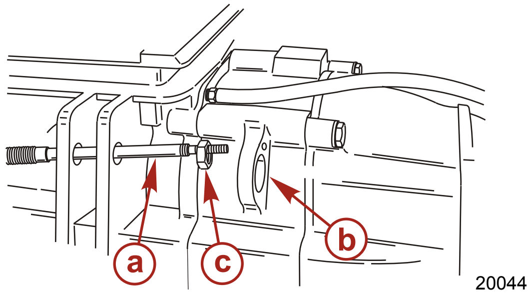


5623

a - Bellows
b - Clamp
c - Nut
d - Through-the-hull fitting

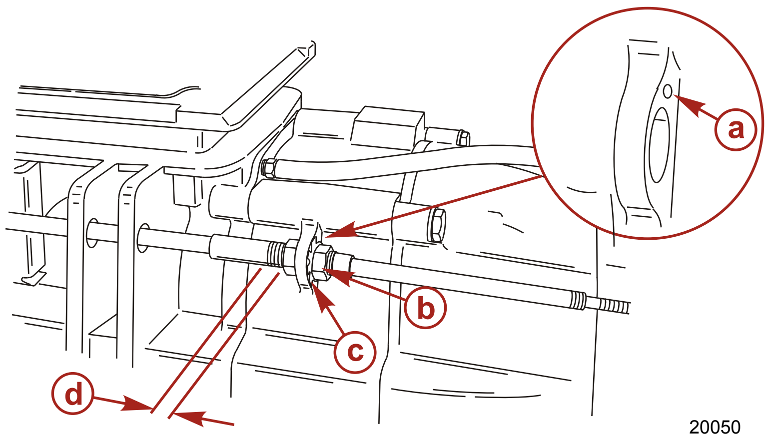
4. Insert the steering cable through the port side through-the-hull fitting and bellows.
5. Route the steering cable through the holes in the port side flange on the side of the pump housing.

6. Install a nut on the steering cable and route the cable through the flange on the side of the wear ring.



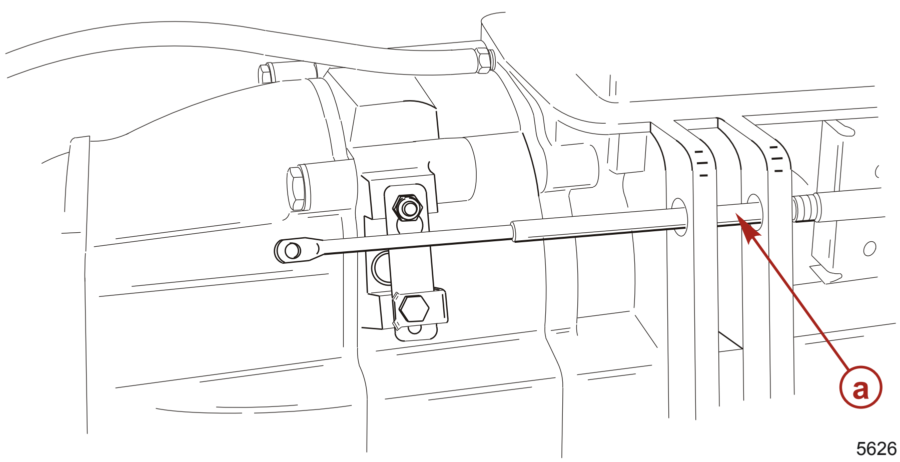
a - Steering cable
b - Flange on the wear ring
c - Nut

7. Install the tab washer and outer nut on the steering cable.
8. Locate the bent tab on the tab washer into the tab hole. Set the steering cable to the dimension shown. Do not tighten the nuts until after the final steering adjustment is made.



a - Tab hole
b - Nut
c - Tab washer
d - 6.4 mm (0.25 in.)

9. Insert the shift cable through the starboard side through-the-hull fitting and bellows.
10. Route the shift cable through the holes in the starboard flange on the side of the pump housing.

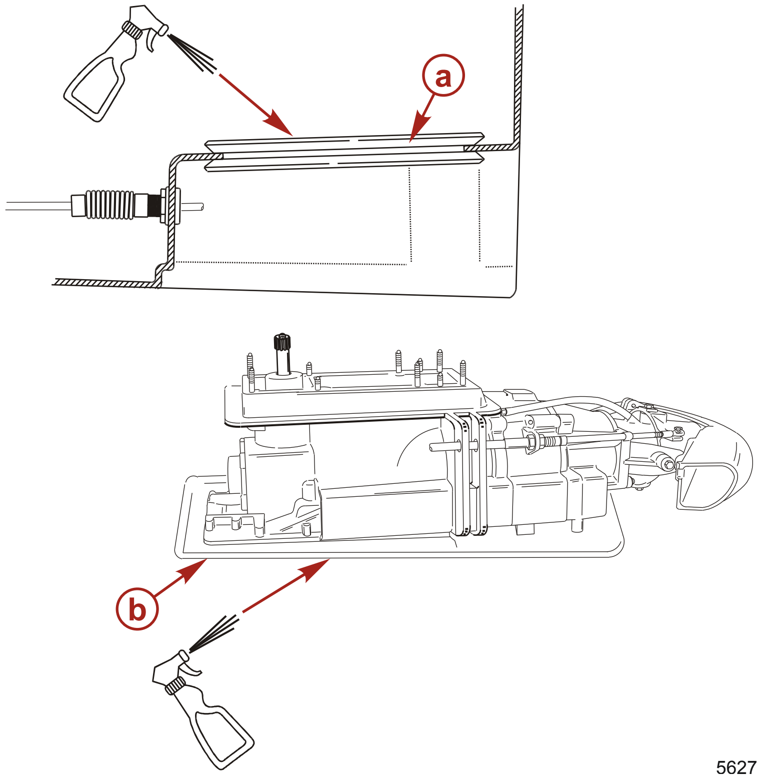


a - Shift cable

IMPORTANT: Ensure that the shift lever in the control box is set for 76 mm (3 in.) of travel.

NOTE: *It is easier to adjust the shift and steering cables before installing the pump unit in the boat.*

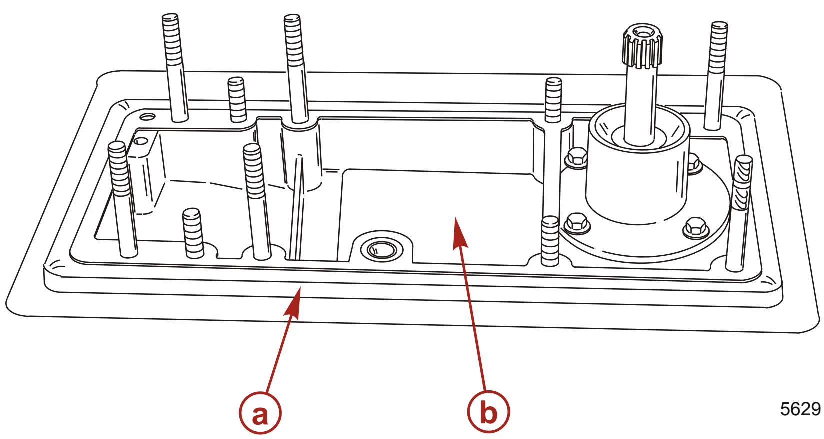
11. Spray soapy water on the inside surface of the tunnel grommet and on the ride plate seal.



a - Tunnel grommet
b - Ride plate seal

NOTE: *When installing the pump in the tunnel, ensure that cables are below the tunnel grommet flange on the pump to prevent pinching of the cables between the pump and boat.*

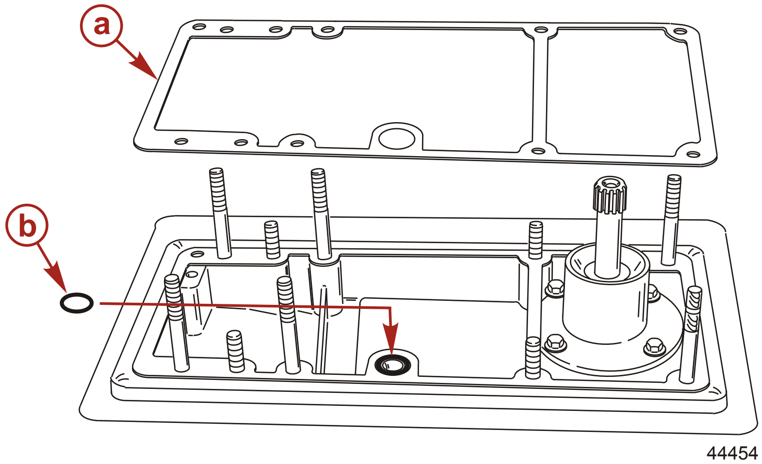
12. Install the jet pump by pushing the unit through the opening in the tunnel grommet. The ride plate seal should fit snug in the boat tunnel without any gaps along the perimeter.



a - Tunnel grommet
b - Jet pump

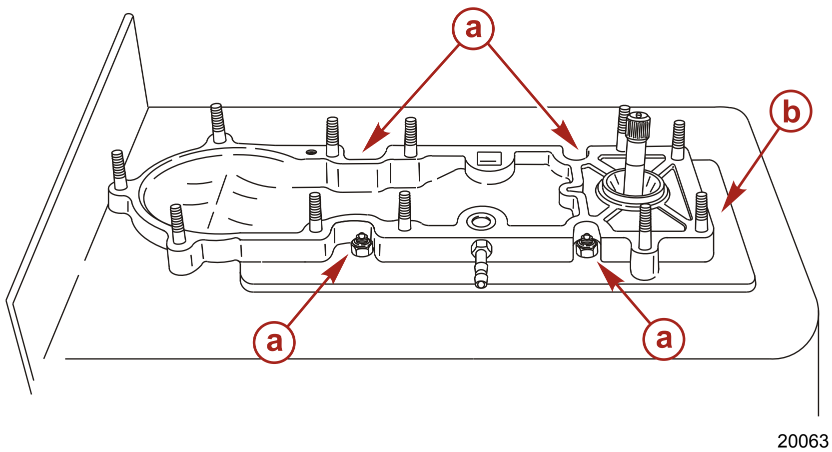
NOTE: *Before installing the drive housing cover, check the ride plate seal for proper fit in the tunnel.*

13. Install the gasket and O-ring seal on the jet pump.



a - Gasket
b - O-ring seal

14. Install the drive housing cover on the jet pump with four M10 x 1.5 nuts. Tighten the nuts to the specified torque.

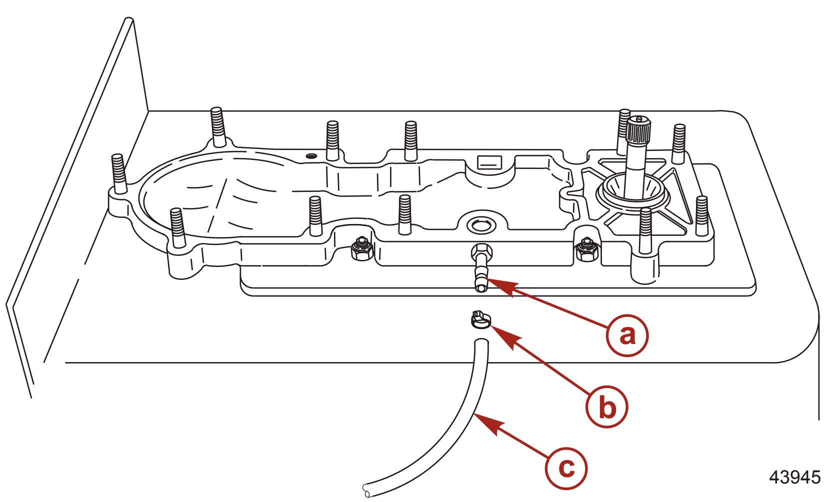


a - M10 x 1.5 nut (4)
b - Drive housing cover

Description	Nm	lb-in.	lb-ft
M10 x 1.5 nuts	47		35

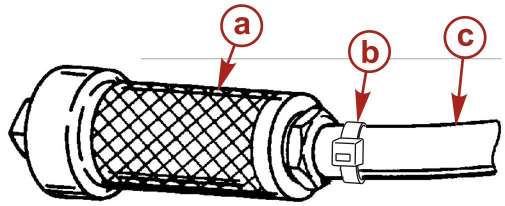
Installing the Flush Kit

1. Attach the flush hose to the fitting and fasten with a cable tie. Failure to fasten the hose will allow water to fill the boat.



a - Fitting
b - Cable tie
c - Flush hose

2. Attach the other end of the flush hose to the flush adapter. Fasten with a cable tie clamp as shown.



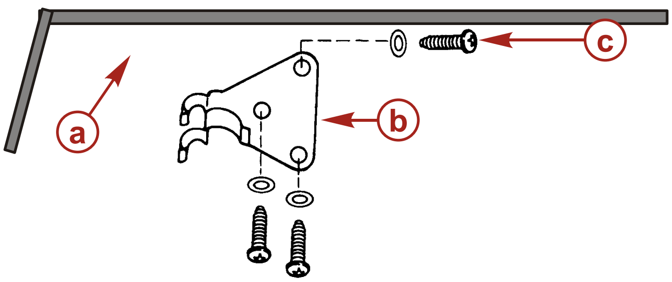
43949

a - Flush adapter
b - Cable tie
c - Flush hose

IMPORTANT: Before mounting the flush adapter bracket, route the adapter and hose to the selected mounting location. Hose routing must not interfere with throttle or control linkage.

NOTE: Mount the flush adapter bracket in an area of the motor compartment that has a mounting surface thicker than the depth of the mounting bracket screws.

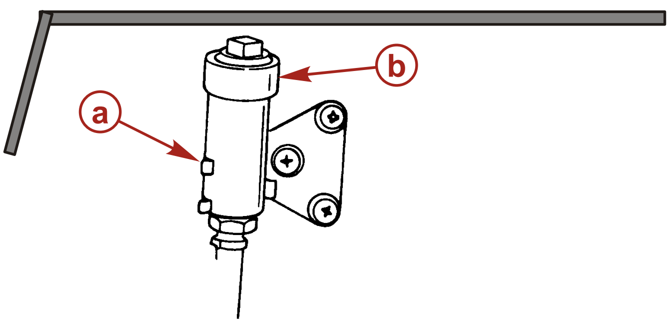
3. Locate an easily accessible area within the motor compartment to mount the flush adapter bracket. Secure the bracket to the mounting surface with the three screws provided.



5613

a - Mounting surface
b - Bracket
c - Screw (3)

4. Snap the flush adapter into the bracket as shown.



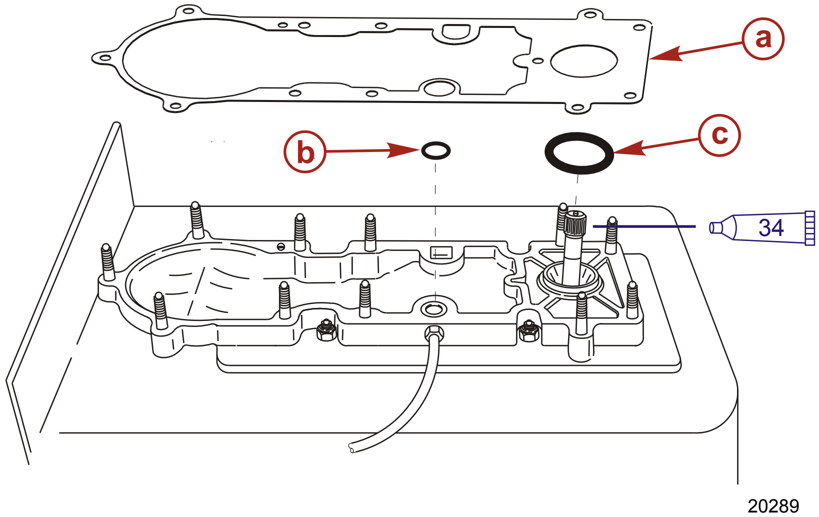
5619

a - Bracket
b - Flush adapter

Installing the Powerhead

1. Install the water inlet O-ring and driveshaft opening O-ring.
2. Install the powerhead gasket on the drive housing cover.
3. Check that the slinger is on the driveshaft.

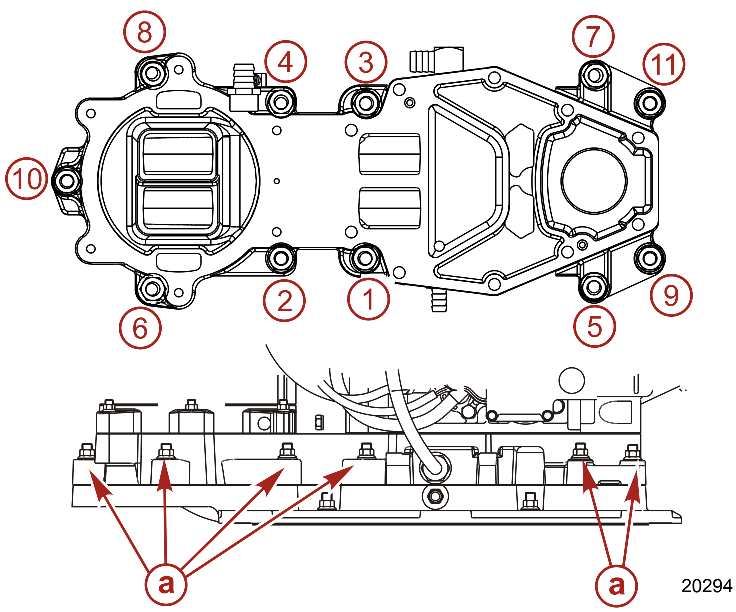
4. Lubricate the driveshaft splines with Special Lubricant 101.



a - Powerhead gasket
b - Water inlet O-ring
c - Driveshaft opening O-ring

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

5. Lower the powerhead onto the drive housing cover. Align the driveshaft splines with the crankshaft.
6. Secure the powerhead to the drive housing cover with eleven M10 x 1.5 nuts. Follow the torque sequence shown and tighten the nuts to the specified torque.



a - M10 x 1.5 nuts (11)

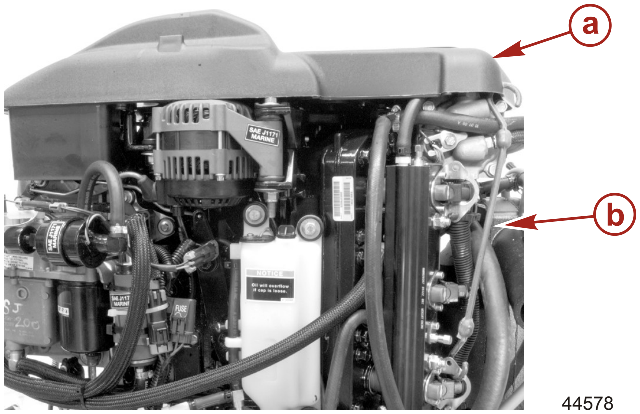
Description		Nm	lb-in.	lb-ft
M10 x 1.5 nuts	**First torque**	27		20
	Final torque	47		35

Flywheel Cover Removal and Installation

Removal

1. Detach the retaining strap.

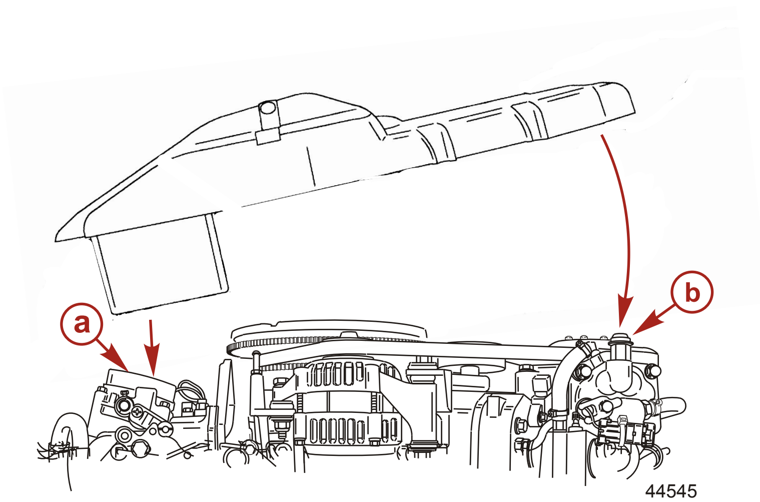
2. Remove the cover by lifting off from the back of the engine.



a - Flywheel cover
b - Retaining strap

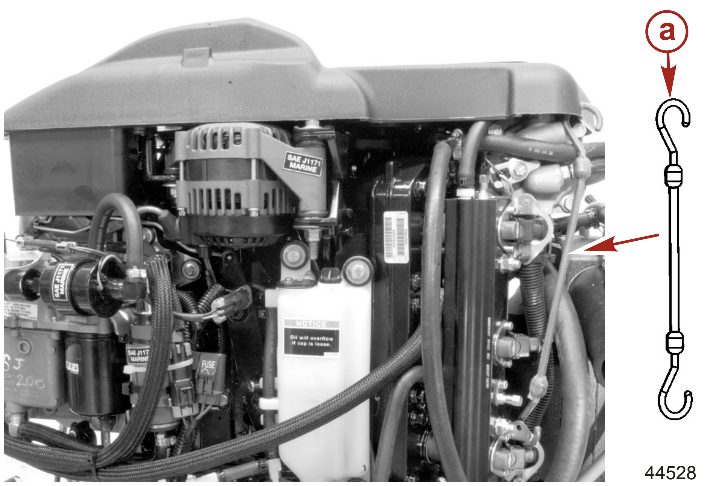
Installation

1. Lower the cover opening onto the air plenum intake flange. Tilt the cover side to side until the cover slides down onto the intake flange.
2. Push the cover down onto the alignment pins and onto the air intake tube for the air compressor.



a - Air plenum intake flange
b - Air intake tube for the air compressor

3. Attach the retaining strap to the cover.

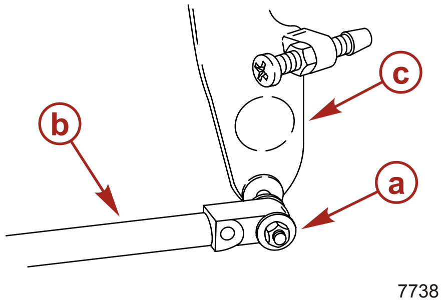


a - Retaining strap

Installing the Throttle Cable

1. Shift the remote control into the neutral position.

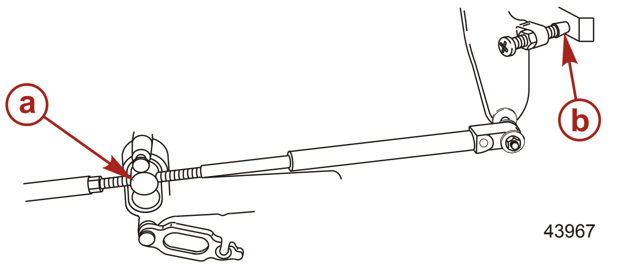
2. Attach the throttle cable to the throttle lever. Secure with a washer and locknut. Tighten to the specified value.



a - Washer and locknut
b - Throttle cable
c - Throttle lever

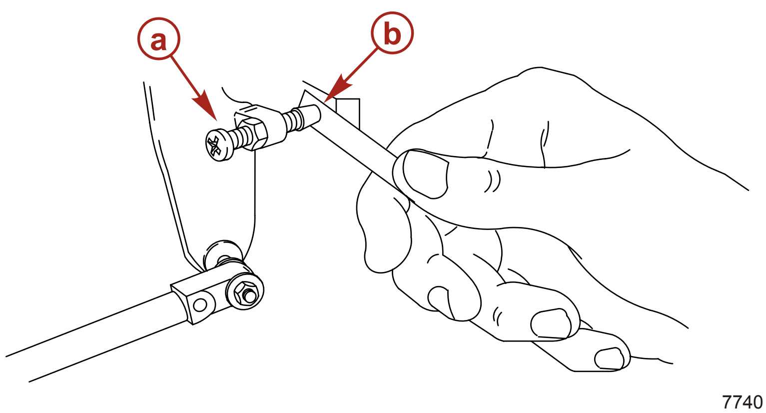
Description	Nm	lb-in.	lb-ft
Throttle cable locknut	Tighten, then loosen 1/4 turn		

3. Adjust the cable barrel so that the installed throttle cable will hold the idle stop screw against the stop.



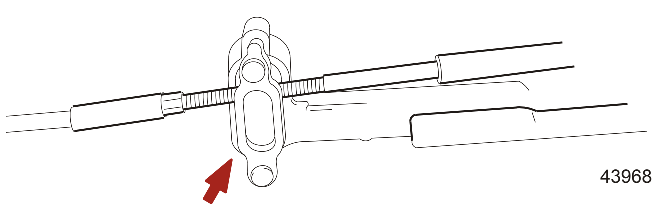
a - Cable barrel
b - Idle stop screw

4. Check the throttle cable adjustment as follows:
   a. Shift the jet drive into gear a few times to activate the throttle linkage.
   b. Return the remote control to neutral.
   c. Place a thin piece of paper between the idle adjustment screw and the idle stop. The adjustment is correct when the paper can be removed without tearing, but has some drag on it.
   IMPORTANT: The idle stop screw must be touching the stop.
   d. Adjust the cable barrel if necessary.



a - Idle stop screw
b - Idle stop

5. Lock the barrel holder in place with the cable latch.

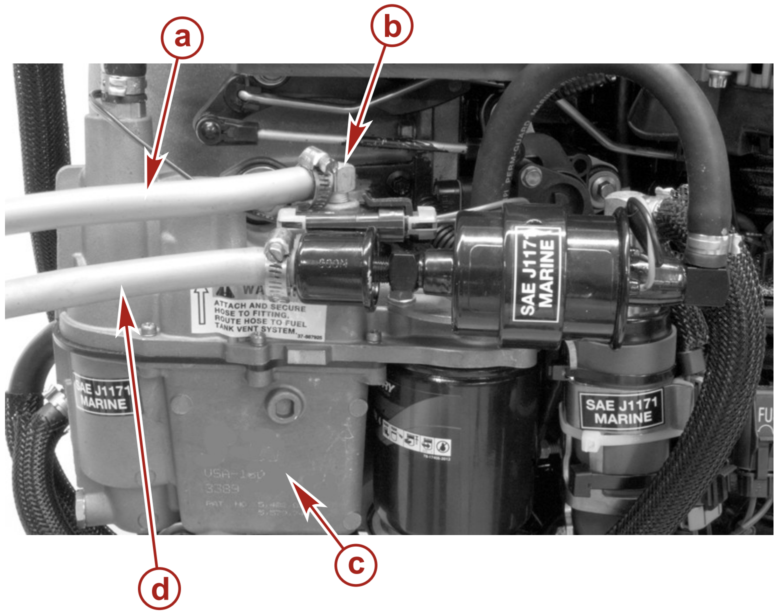


Fuel Hose and Vent Hose Connections

1. Connect the fuel hose to the fuel inlet fitting. Secure the hose to the fitting with a U.S. Coast Guard approved hose clamp (183.532).

NOTE: The vapor separator tank (VST) must be vented to the fuel tank. The vent hose must comply with the U.S. Coast Guard/ABYC regulations.

2. Connect a vent hose between the fuel tank and the fitting on the vapor separator tank. Secure the hose to the fitting with a U.S. Coast Guard approved hose clamp (183.532).



44238

a - Vent hose
b - Fitting on the vapor separator tank
c - Vapor separator tank
d - Fuel hose

Battery Cable Connections

IMPORTANT: Boating industry standards (NMMA, ABYC, SAE, USCG, EUs, RCD, and so on), federal standards, and United States Coast Guard regulations must be adhered to when installing the battery. Be sure the battery cable installation meets the pull test requirements and that the positive battery terminal is properly insulated in accordance with regulations.

IMPORTANT: It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.

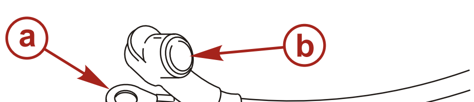
IMPORTANT: Engine electrical system is negative (–) ground.

Battery Cable Installation Requirements

1. Battery cables must be routed above normal bilge water levels throughout their length.
2. Battery cables must be routed to avoid contact with metallic fuel system components.
3. The positive battery cable must be routed to avoid contact with any portion of the engine or drive train.
4. Cables that are exposed to physical damage must be protected by a conduit, raceways, tape, etc.
5. Cables that pass through bulkheads or other structural members must be protected against chafing with grommets, etc.

Battery Cable Connections

1. Slide the protector boot (provided) onto the positive (+) battery cable.

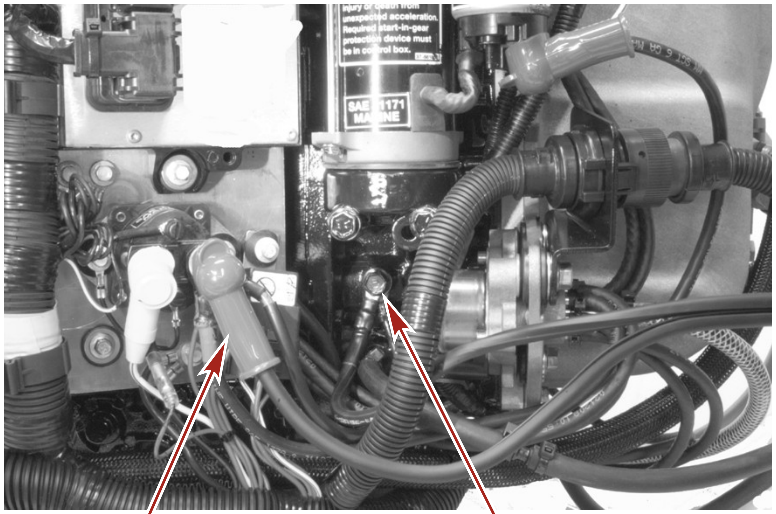


20301

a - Positive battery cable
b - Protector boot

2. Fasten the positive (+) battery cable to the positive terminal (red wires) on the starter solenoid. Seal the connection with Liquid Neoprene. Position the protector boot over the connection.

3. Fasten the negative (–) battery cable to the grounding bolt located on the engine block below the starter motor. Seal the connection with Liquid Neoprene.



a

b

44239

a - Positive battery cable attaching location
b - Negative battery cable attaching location

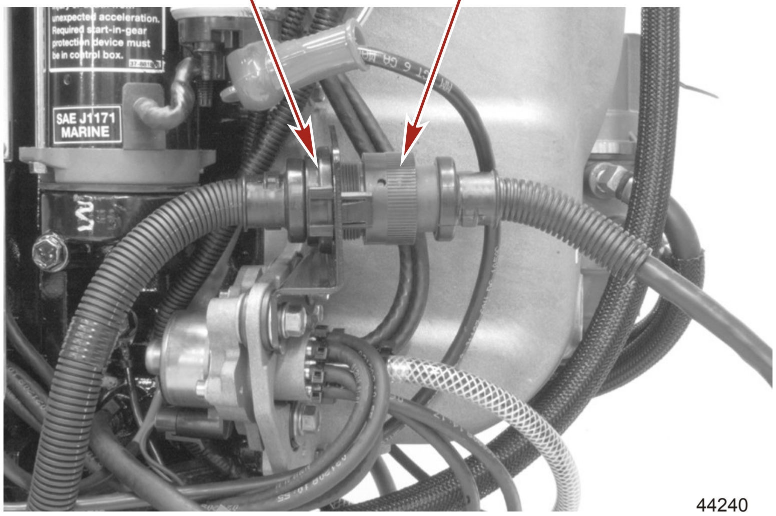
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Battery cable connections	92- 25711 3

Remote Harness Connection

Connect the remote 14 pin wiring harness to the 14 pin connector located on the engine.

a

b

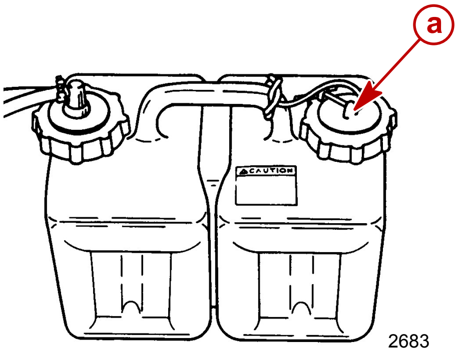


44240

a - 14 pin connector
b - Remote 14 pin wiring harness

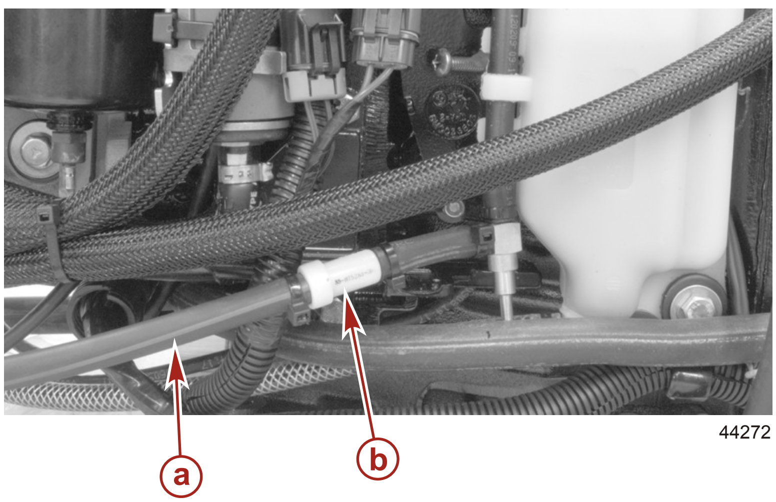
Oil Injection Hose Connections

1. Mount and restrain the oil tank in a suitable location where the hoses are able to extend to the hose fittings on the engine.



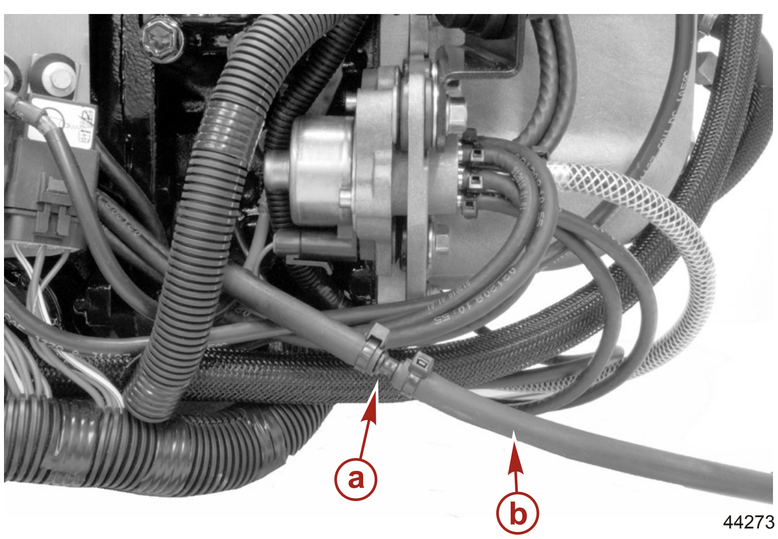
a - Oil tank

2. Arrange the hoses so they will not get pinched, kinked, sharply bent, or stretched.
3. Remove the shipping cap from the fitting on the oil filter and connect the oil hose with the blue stripe to the fitting. Secure the hose to the fitting with a cable tie.



a - Oil hose with blue stripe
b - Oil filter

4. Remove the shipping cap from the hose fitting on the starboard side of the engine and connect the oil hose without the blue stripe to the fitting. Secure the hose to the fitting with a cable tie.



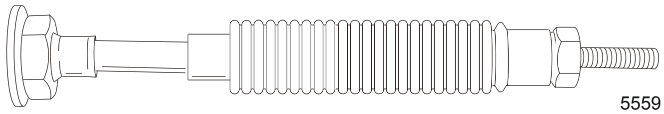
a - Hose fitting
b - Oil hose without blue stripe

Steering Cable Adjustment

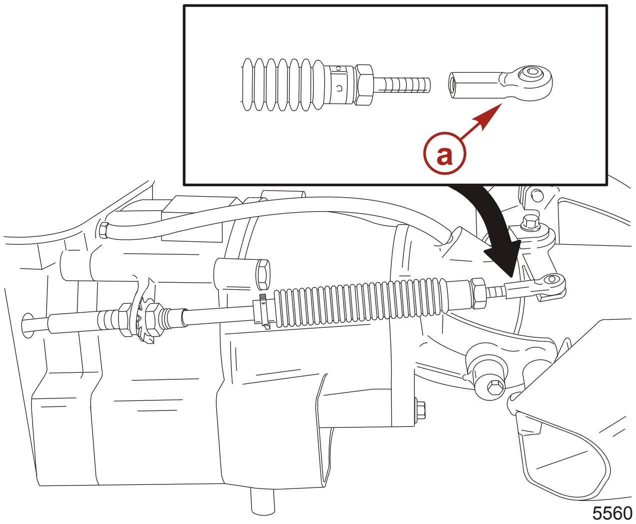
1. Slide the bellows assembly over the cable and thread completely onto the cable. Do not tighten at this time.

⚠ WARNING

Proper installation and maintenance is essential for the steering system to function. Use only the recommended hardware when installing the steering system. Follow all installation specifications and recommended maintenance procedures.



2. Thread the cable end adapter onto the steering cable 14 turns to allow for adjustment.



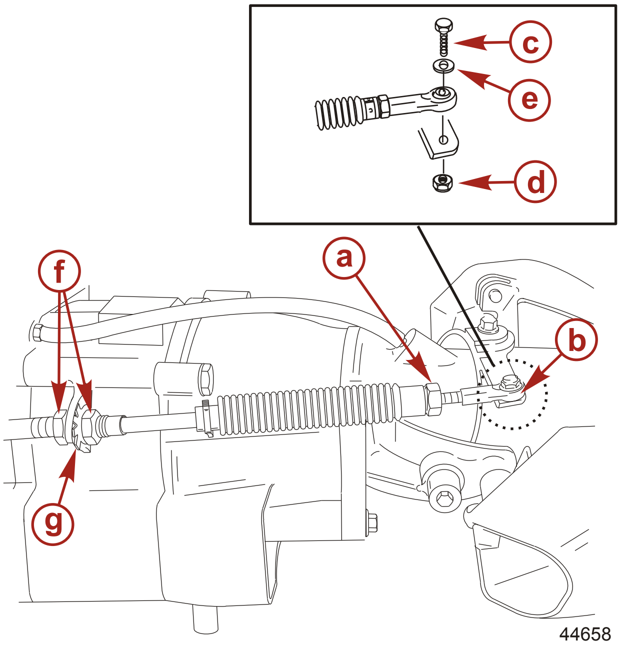
a - Cable end adapter

⚠ WARNING

The cable end adapter must be threaded fully on the steering cable. Failure to thread the adapter on the steering cable a minimum of nine (9) turns could result in the cable end adapter disengaging, leading to a loss of steering control of the boat and possible personal injury or death.

3. Center the rudder assembly on the nozzle.
4. Center the steering wheel by turning the wheel lock to lock and positioning the wheel midway between each lock.
5. Adjust the cable end adapter until the through-the-hole in the adapter lines up with the threaded hole in the steering arm. This is the steering cable fine adjustment. The cable end adapter must be installed on the steering cable a minimum of nine turns.
6. Attach the steering cable to the steering arm with bolt, washer, and locknut. Tighten the locknut to the specified torque.
7. Tighten the cable nuts.
8. Check the steering adjustment to ensure that the rudder does not bottom out before the helm stops at its maximum travel limit in either direction. Correct if required.

9. Secure the cable nut with the tab washer by bending a tab over the flat of the cable nut.

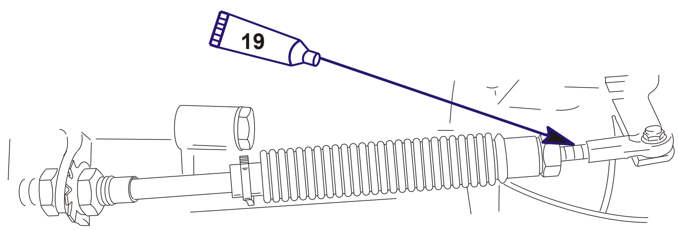


44658

a - Bellows nut
b - Steering arm
c - Bolt
d - Locknut
e - Flat washer
f - Cable nuts
g - Tab washer - bend tab against cable nut

Description	Nm	lb-in.	lb-ft
Locknut	8	70	

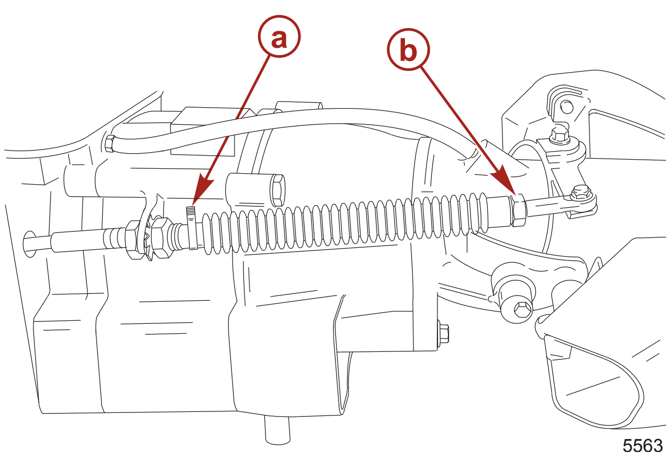
10. Apply Perfect Seal to the exposed threads.



5562

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	End threads and the cable conduit end	92-34227Q02

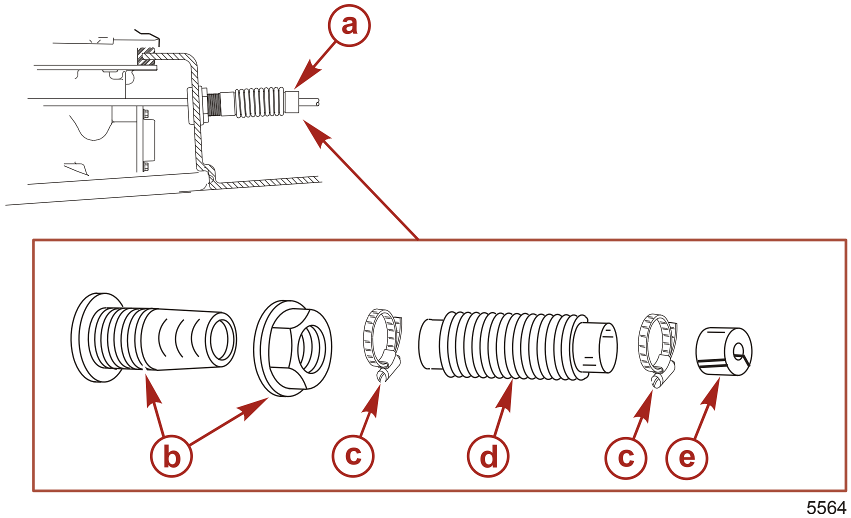
11. Loosen the bellows nut and tighten against the cable end adapter.
12. Turn the rudder to port to compress the bellows as much as possible.
13. Pull the bellows over the cable conduit and secure with the bellows clamp.



5563

a - Bellows clamp
b - Bellows nut tight against cable end adapter

14. Secure the bellows to the through-the-hull fitting with a clamp. Slide the slit adapter over the cable. Apply Perfect Seal to the slit and push the slit adapter into the bellows. Secure with a clamp.



a - Steering cable, through-the-hull fitting, and bellows assembly
b - Through-the-hull fitting and nut
c - Clamp
d - Bellows
e - Slit adapter

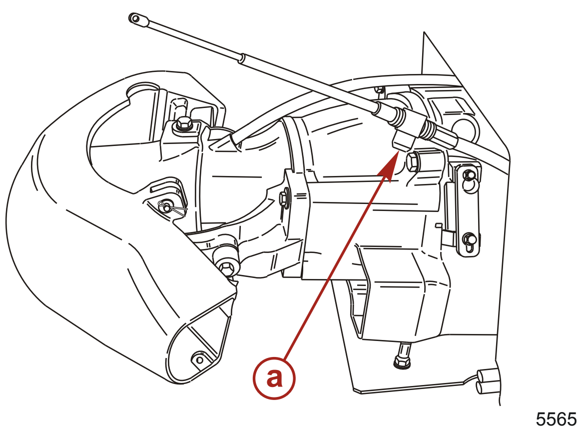
Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	End threads and the cable conduit end	92-34227Q02

Shift Cable Adjustment

NOTICE

Pre-load in forward or reverse position can damage the stop, the shift cable, or the control box components. Adjust the shift cable to prevent the reverse gate from loading against the forward or reverse stop.

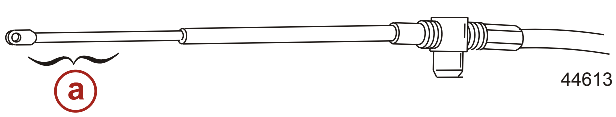
1. Thread the cable barrel onto the shift cable.



a - Cable barrel

2. Use a degreaser to clean off all oil film from the area on the shift cable indicated following.

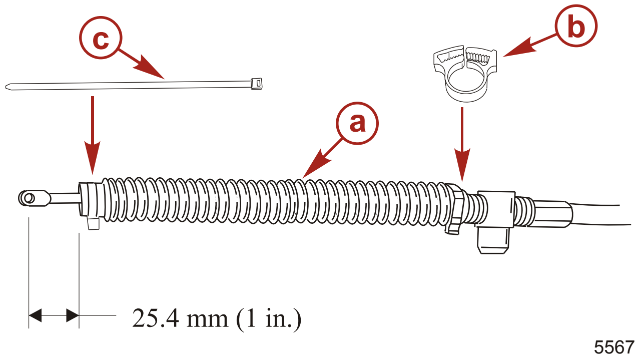
   NOTE: Removing the oil film from the shift cable is necessary to prevent the bellows from sliding on the cable.



a - Remove oil film from this area

3. Slide the bellows over the shift cable end.

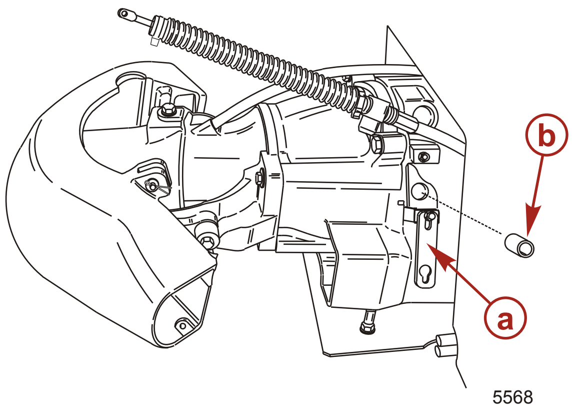
4. Position and install the bellows onto the cable conduit as shown. Fasten the ends with a clamp and cable tie.



- a - Bellows
- b - Clamp
- c - Cable tie

5. Loosen the locknuts and unfasten the top end of the shift cable retainer.

   NOTE: Locknuts do not have to be removed to open the shift cable retainer.

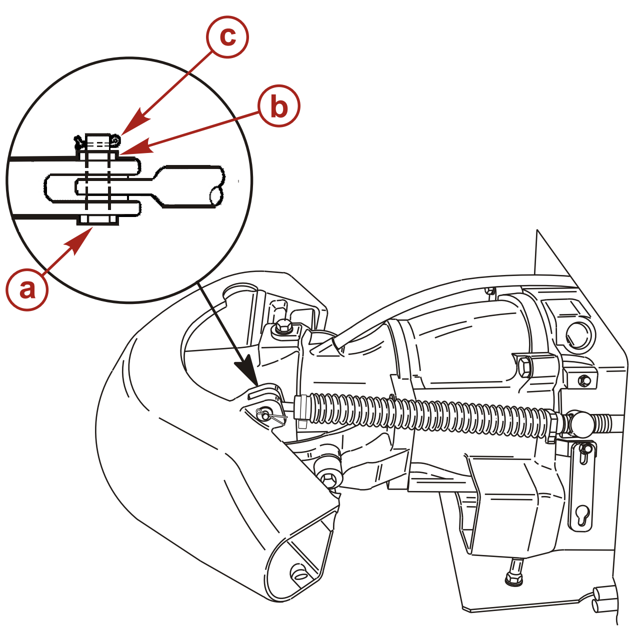


- a - Shift cable retainer
- b - Plastic barrel holder

6. Install the shift cable end in the slot of the reverse gate and secure with the clevis pin, flat washer, and cotter pin. Bend the ends of the cotter pin to secure.

⚠ WARNING

If not properly installed, the reverse gate can interfere with water coming off the rudder, suddenly and unexpectedly slowing the boat. This can cause serious injury or death from occupants being thrown within or out of the boat. Adjust the shift cable to prevent the reverse gate from interfering with water flow off the rudder.

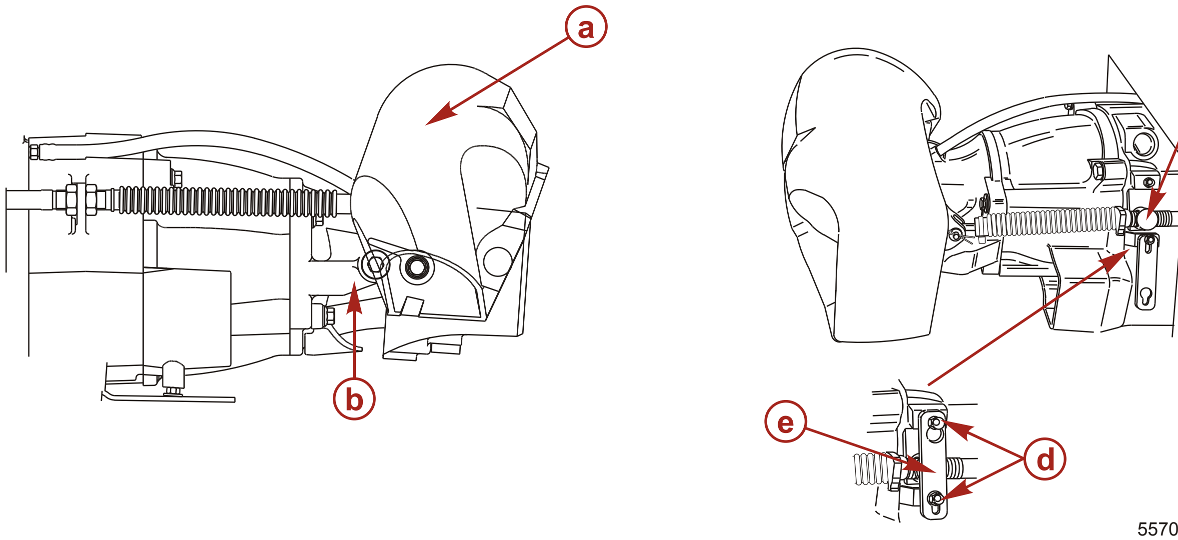


- a - Clevis pin
- b - Flat washer
- c - Cotter pin

7. Adjust shift cable as follows:
   a. Shift the control box into the forward shift position.
   b. Position the reverse gate against the forward stop. With the reverse gate at this position, adjust the cable barrel to fit into the barrel holder with slight tension of the reverse gate against the stop.
   c. After adjusting the shift cable, secure the cable barrel in place with the shift cable retainer.
   d. Tighten the locknuts to fasten the retainer.

⚠ WARNING

Failure to use correct fasteners can adversely affect boat control, leading to serious injury or death. Fasten the shift cable retainer with self-locking nylon insert locknuts only. Do not replace the locknuts with common nuts (non-locking), as they could vibrate off and disengage the shift cable.



a - Reverse gate
b - Forward stop
c - Cable barrel
d - Locknuts
e - Shift cable retainer

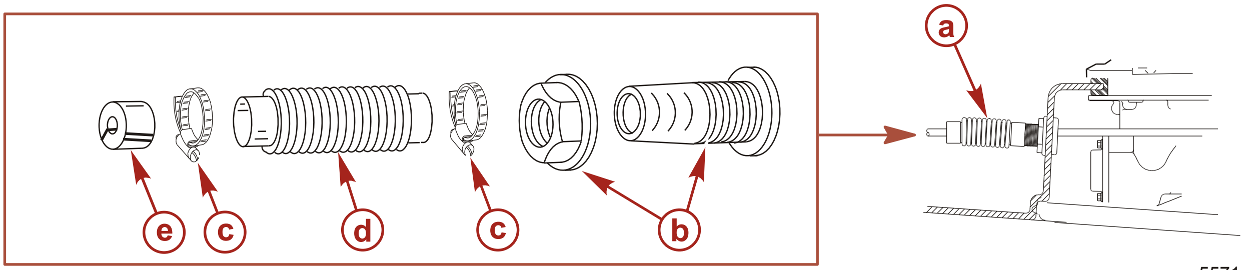
8. Shift the control box into the reverse shift position. Adjust the reverse stop, located on the starboard side of the nozzle, so that the stop just touches the reverse gate with the control handle in the reverse position. Tighten the reverse stop screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Reverse stop screw	14	124	

9. Check the shift cable/reverse gate adjustment as follows:
   a. Shift the control box from the forward position to reverse position two to three times.
   b. Return the control handle back to forward.
   c. Pull back on the reverse gate gently to take slack out of the cable. Check for the correct clearance between the reverse gate and rudder. If necessary, readjust the cable barrel.

Reverse gate to rudder clearance	9.5–12.7 mm (3/8–1/2 in.)

10. Secure the bellows to the through-the-hull fitting with a clamp. Slide the slit adapter over the cable. Apply Perfect Seal to the slit and push the slit adapter into the bellows. Secure with a clamp.



a - Steering cable, through-the-hull fitting, and bellows assembly
b - Through-the-hull fitting and nut
c - Clamp
d - Bellows
e - Slit adapter

NOTE: Check for proper placement of the slit adapter around the cable. Placement of the wrong slit adapter may result in a leak.

Tube Ref No.	Description	Where Used	Part No.
19	Perfect Seal	End threads and the cable conduit end	92-34227Q02

Filling the Fuel System

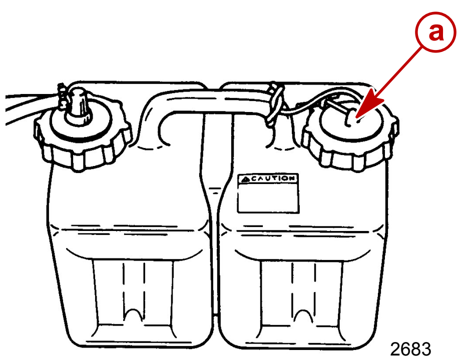
NOTE: For initial start on a new engine or for an engine that ran out of fuel, or drained of fuel, the fuel system should be filled as follows:

Turn the ignition key switch to the "ON" position for three seconds and then turn the key switch back to the "OFF" position for five seconds. Continue this procedure five times. This will allow the electric fuel pump to fill the fuel system.

Filling the Oil System

Filling the Oil Tanks

1. Remove the fill cap from the remote oil tank and fill the tank with the recommended oil. Install the fill cap and tighten securely.

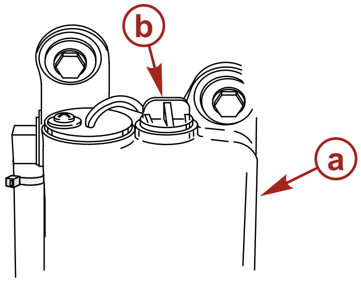


a - Fill cap

IMPORTANT: Do not remove the vent cap from the engine-mounted oil reservoir tank when filling the tank. Removal of the vent cap may damage the threads in the oil reservoir tank. Damaged threads may result in future oil leakage.

2. Check the oil level in the engine-mounted oil reservoir tank. The tank must contain at least 118 ml (4 oz) of oil prior to starting the engine.

3. If the oil level is less than 118 ml (4 oz), loosen the vent cap. Use a squirt can and fill the tank with at least 118 ml (4 oz) of the recommended oil. Tighten the vent cap.

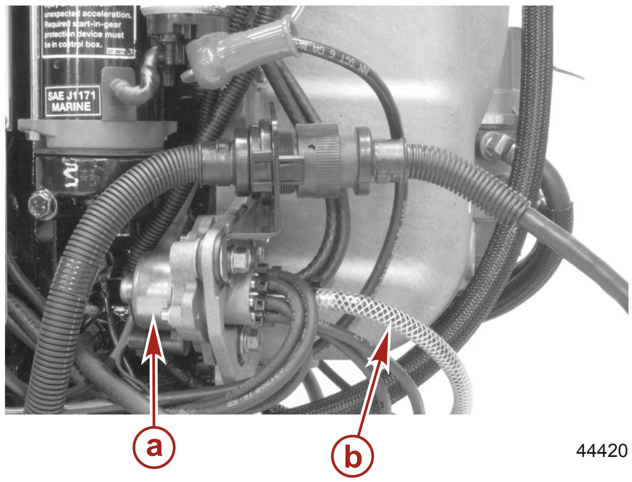


7745

a - Engine-mounted oil reservoir tank
b - Vent cap

Priming the Oil Pump (if required)

Visually check to see if the oil pump requires priming. To determine if the oil pump requires priming, check the oil supply hose between the engine oil reservoir tank and the oil pump. If there are no air bubbles in the hose, it is not necessary to prime the oil pump. If air bubbles are present, it will be necessary to prime the oil pump.



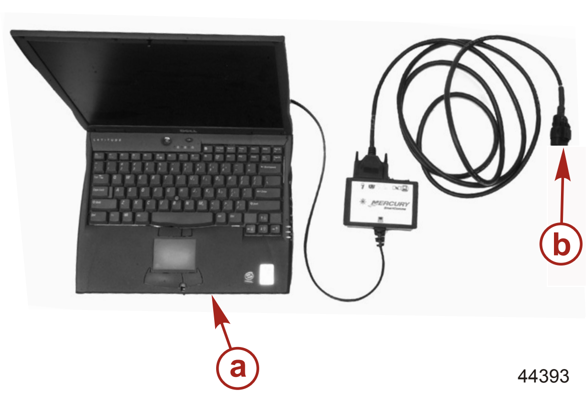
44420

a - Oil pump
b - Oil supply hose

Priming the Oil Pump

NOTE: Prime the oil system using the computer diagnostic system (CDS).

1. Connect the computer diagnostic system (CDS) to the 10 pin plug on the side of the engine.

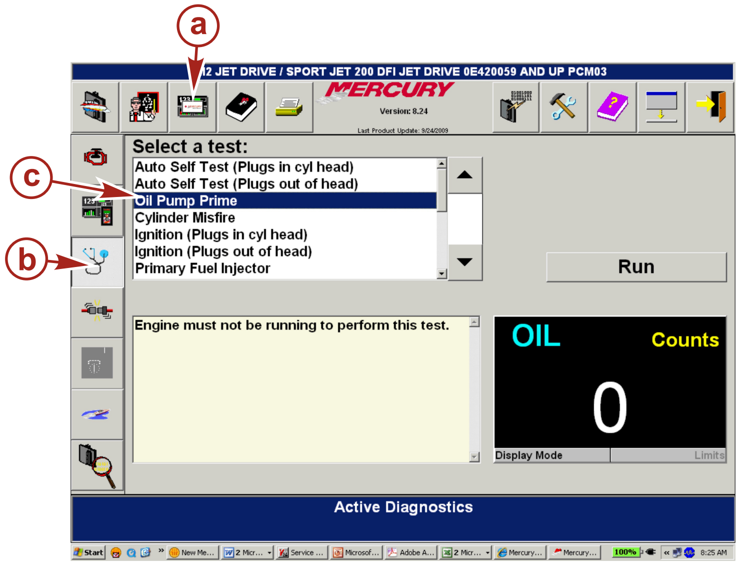


44393

a - Computer diagnostic system (CDS)
b - Connect to engine

2. Select model M2 Jet Drive 200 DFI drive.
3. Look at the main menu on the CDS screen and click on the **Toolbox** icon. This will open the **Toolbox** menu.
4. From the **Toolbox** menu, click on the **Active Diagnostics** icon.
5. Scroll through the **Active Diagnostic** menu and select the **Oil Pump Prime** test.
6. Follow the on screen instructions and complete the oil pump prime procedure.

7. Priming the pump will remove any air that may be in the pump, oil supply hose, or internal passages.



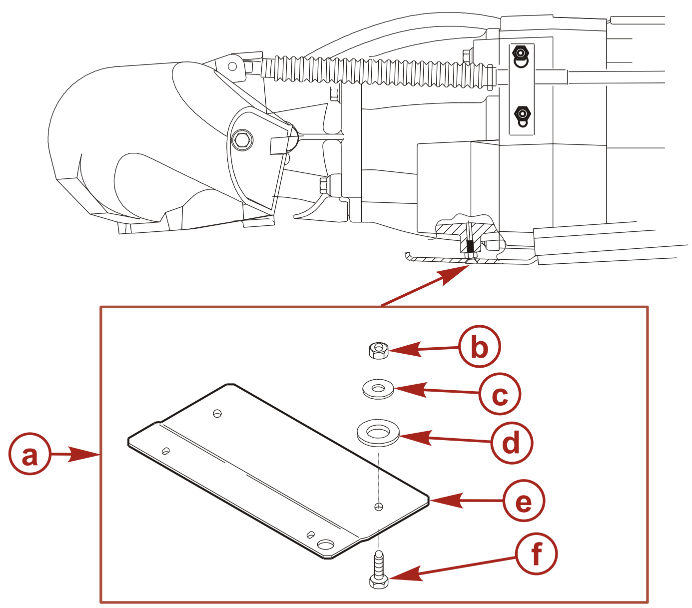
44392

a - Toolbox icon
b - Active Diagnostics icon
c - Oil Pump Prime test

Trim Plate Adjustment

The jet drive unit trim plate is factory set for general applications. Should a particular boat experience porpoising problems, the trim plate can be adjusted as follows:

1. Loosen both jam nuts on the trim plate (one starboard and one port).



5666

a - Trim plate components (one each side)
b - Jam nut
c - Small diameter washer
d - Large diameter washer
e - Plate
f - Screw

2. Turn both screws the exact same number of turns. Tighten both jam nuts against the trim plate. The distance from top of nut to bottom of boss should be equal on both sides.

⚠ WARNING

Adjusting the trim plate may affect boat handling, resulting in sensitive steering or reduced turning ability. Boat handling characteristics also vary with the load distribution in the boat. Use caution after adjusting and check for acceptable handling characteristics under all loading conditions.

Features

Bilge Siphon Feature

The sport jet incorporates an automatic bilge siphoning feature. The bilge siphon is working whenever the engine is operating above idle speeds. Maximum performance of the bilge siphon is achieved above 3000 RPM. A hose is attached to the jet pump nozzle, routed to the engine compartment, and placed in the bilge. Water exiting the nozzle creates a suction, or vacuum, in the hose, creating the bilge siphon, and drawing water out of the boat.

⚠ CAUTION

Fasten the bilge siphon hose so that the siphon break is positioned above the waterline. Positioning the siphon break incorrectly can result in siphoning water directly into the boat. Excess water in the bilge can damage the engine or cause the boat to sink.

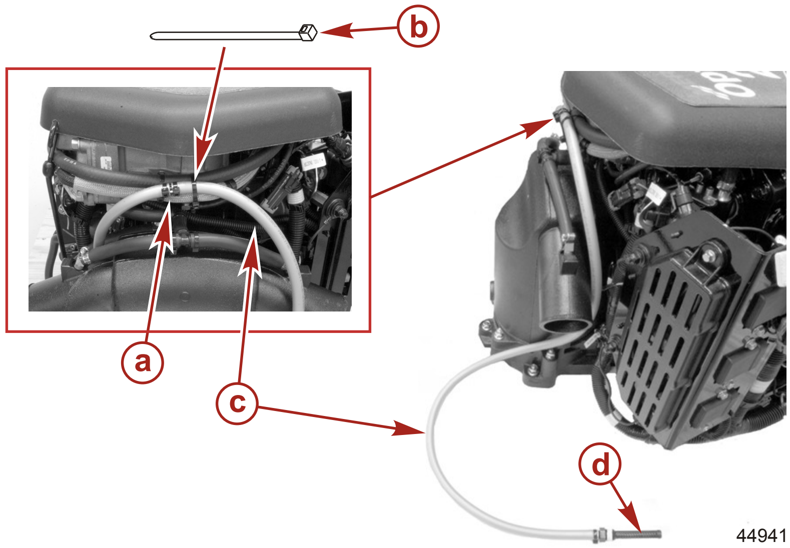
Installing the Bilge Siphon

⚠ WARNING

Installing the bilge siphon incorrectly can result in siphoning water directly into the boat can sink the vessel, causing product damage, serious injury, or death. Always install the bilge siphon break above the water line and keep the hole open.

1. Uncoil the siphon hose from the exhaust manifold.
2. Use a cable tie and fasten the bilge hose so that the siphon break is located above the waterline at the highest point.
3. Place the pickup screen in the bilge.

NOTE: The siphon break must be located above the waterline at the highest point and secured with a cable tie. The siphon break has a 0.580 mm (0.020 in.) hole, which must be kept open.

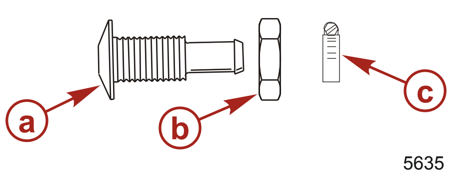


a - Siphon break
b - Cable tie
c - Bilge siphon hose
d - Pickup screen

Water Bypass System

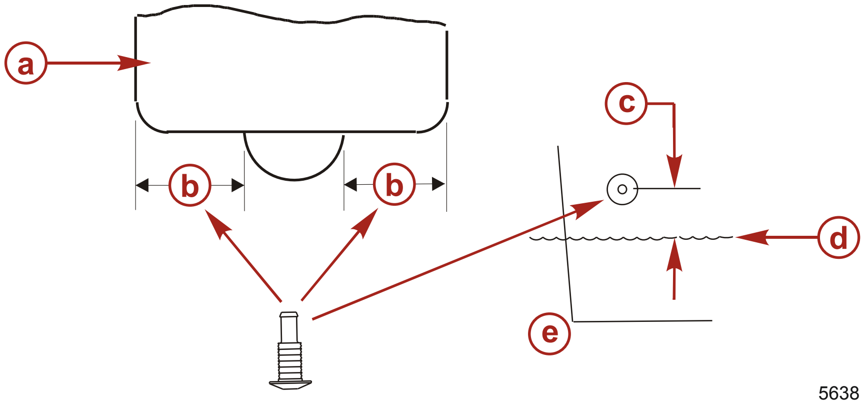
The water bypass system is designed to improve powerhead cooling at idle speed.

1. Locate the water bypass components (provided).



a - Through-the-hull fitting
b - Brass nut
c - Hose clamp

2. Select the mounting location for the through-the-hull fitting as follows:

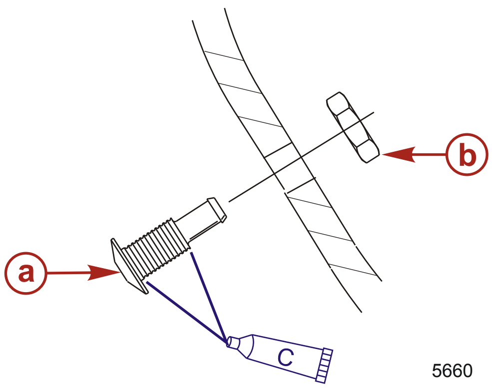


5638

- a - Transom (top view)
- b - Mounting zones
- c - 50 mm (2 in.) minimum
- d - Waterline
- e - Transom (back view)

    - The through-the-hull fitting must be mounted in either side of the transom within the mounting zones "b."
    - The through-the-hull fitting must be located at a minimum of 50 mm (2 in.) above the waterline when the boat is fully loaded.
    - The water bypass hose must slope down towards the through-the-hull fitting at a minimum rate of 25 mm (1 in.) drop per 30 mm (12 in.) of hose.
    - The through-the-hull fitting should be positioned, so the water spray will be pointed downward.

3. After the location has been selected for the through-the-hull fitting, drill a 14.3 mm (9/16 in.) diameter hole.
4. Apply Marine Sealer to the entire length of threads and under the head of the through-the-hull fitting. Fasten the fitting into the transom with the brass nut provided.



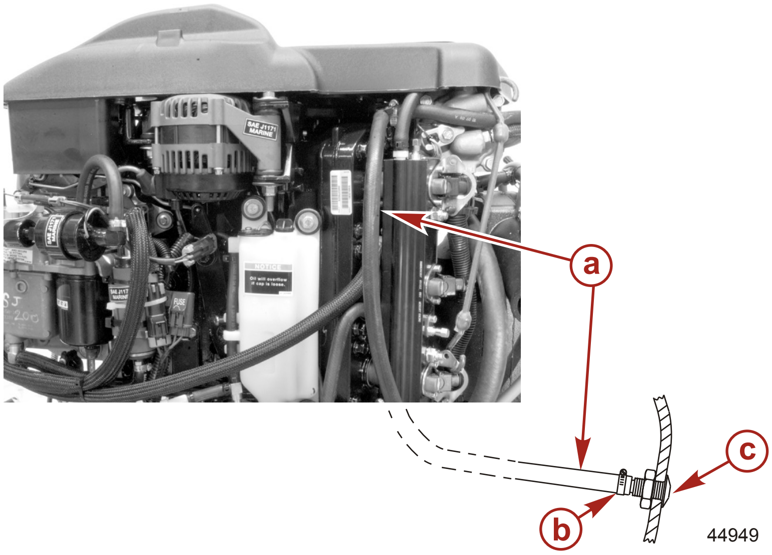
5660

- a - Through-the-hull fitting
- b - Brass nut
- c - Marine Sealer

Tube Ref No.	Description	Where Used	Part No.
151	Marine Sealer	Through-the-hull fitting (threads and under the head)	92-858080K01

5. Connect a water bypass hose (not provided) to the fitting on the engine. Secure the connection with a hose clamp.
6. Connect the water bypass hose to the through-the-hull fitting with the hose clamp provided.

7. Ensure that the hose slopes at a minimum rate of 25 mm (1 in.) drop per 30 mm (12 in.) of hose.



a - Water bypass hose
b - Hose clamp
c - Through-the-hull fitting

Installing the Exhaust System

General Exhaust System Notes

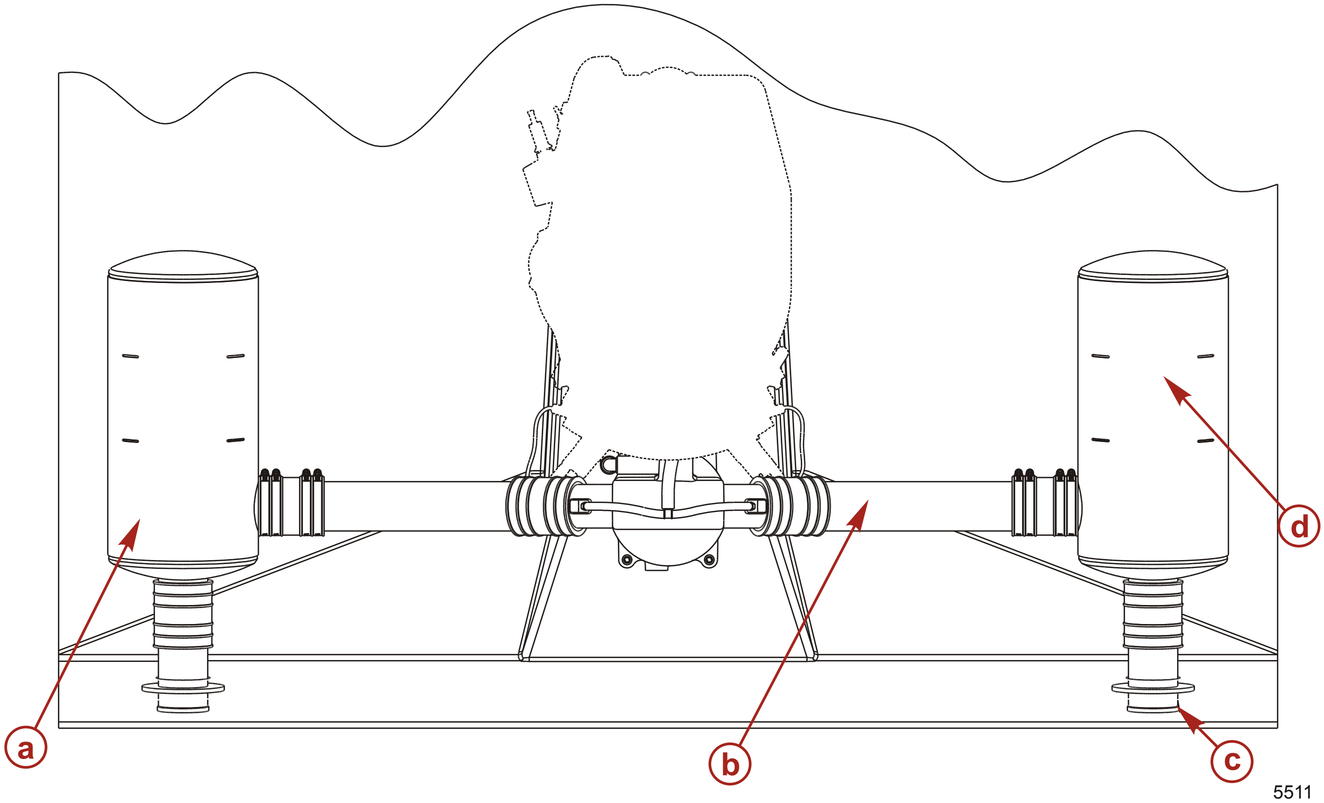
IMPORTANT: Failure to follow current marine industry guidelines (NMMA, ABYC, U.S. Coast Guard, etc.) when installing aftermarket mufflers can result in product damage. Secure all mufflers according to current marine industry standards to prevent movement during engine operation.

- Exhaust system application must meet ABYC standard P-1 for marine exhaust installations.
- The entire exhaust system must meet 1309.99 kPa (190 psi) burst pressure.
- All rubberized exhaust system components must meet SAE J-2006 standards for marine exhaust hoses.
- The mufflers and exhaust hoses must be adequately supported for proper orientation and to prevent overstressing the exhaust components. The support requirements will vary with exhaust system design and the amount of G-forces to be encountered.
- Rubber hose should be connected to pipes with flares or beads or barbs to prevent the hose from sliding off the pipe under pressure.

Measuring the Exhaust Outlet

1. Fill all fuel, oil, and water tanks to maximum capacity.
2. Add the maximum allowable cargo weight to the boat in areas where it will be stored.
3. Add 86 kg (190 lb) in all locations where each passenger will sit during normal operation.
4. Using the diagrams below, measure to ensure location of muffler outlets.
5. Move the load weight and cargo weight to the stern of the boat to simulate the greatest stern down attitude the boat will encounter, such as when loading.
6. Check the muffler outlet measurements.
7. Check the exhaust system slope to ensure 5° downhill slope.

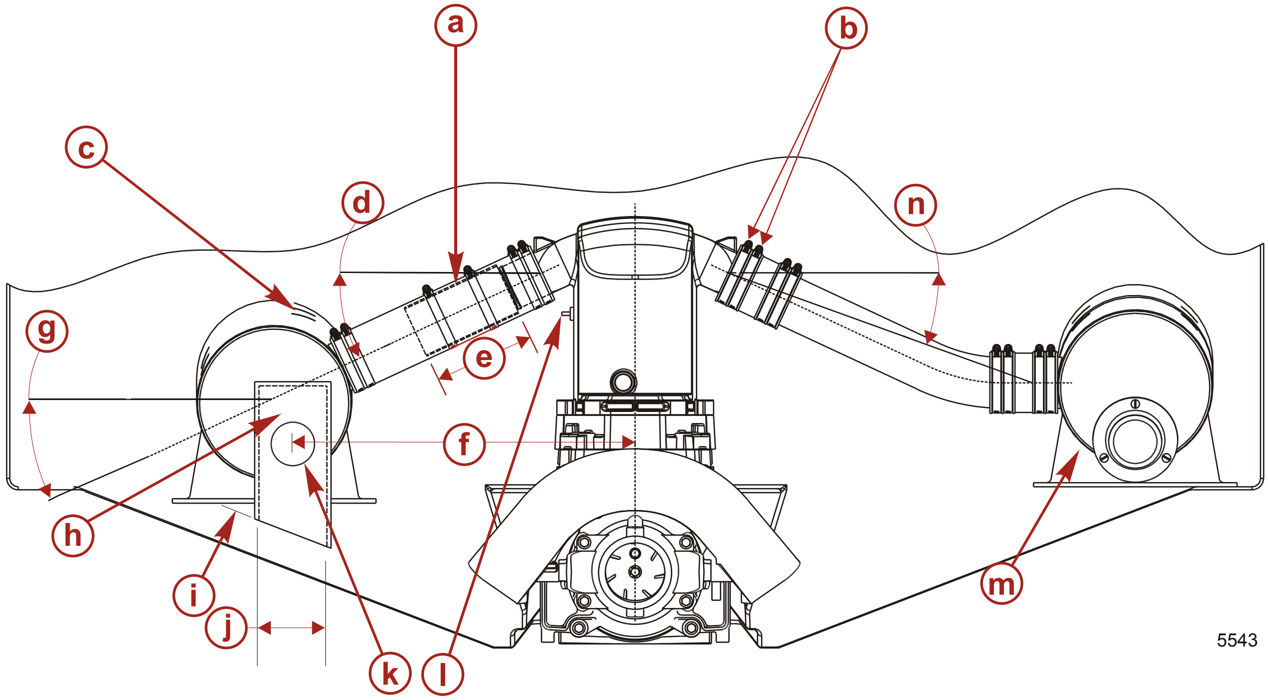
Top View



a - 878147-A1 muffler assembly, port 22.8 cm (9.0 in.) with 7.6 cm (3.0 in.) outlet
b - 7.6 cm (3.0 in.) O.D. tubing
c - 57885-A1 flange assembly (two required)
d - 878148-A1 muffler assembly, starboard 22.8 cm (9.0 in) with 7.6 cm (3.0 in.) outlet

- Connection piping between the expansion chamber and muffler must be made of 7.6 cm (3.0 in.) O.D. tubing. Tubing must be either 5052 or 6061 (14 gauge) aluminum or type 304 (14 gauge) stainless steel to protect against corrosion.
- Flange assembly (two required) or equivalent through transom fittings may extend 12.7 cm (5 in.) below the waterline for quiet idle operation. Exhausting under a swim platform or other horizontal surface may cause transmission of noise and vibration to the boat during operation.

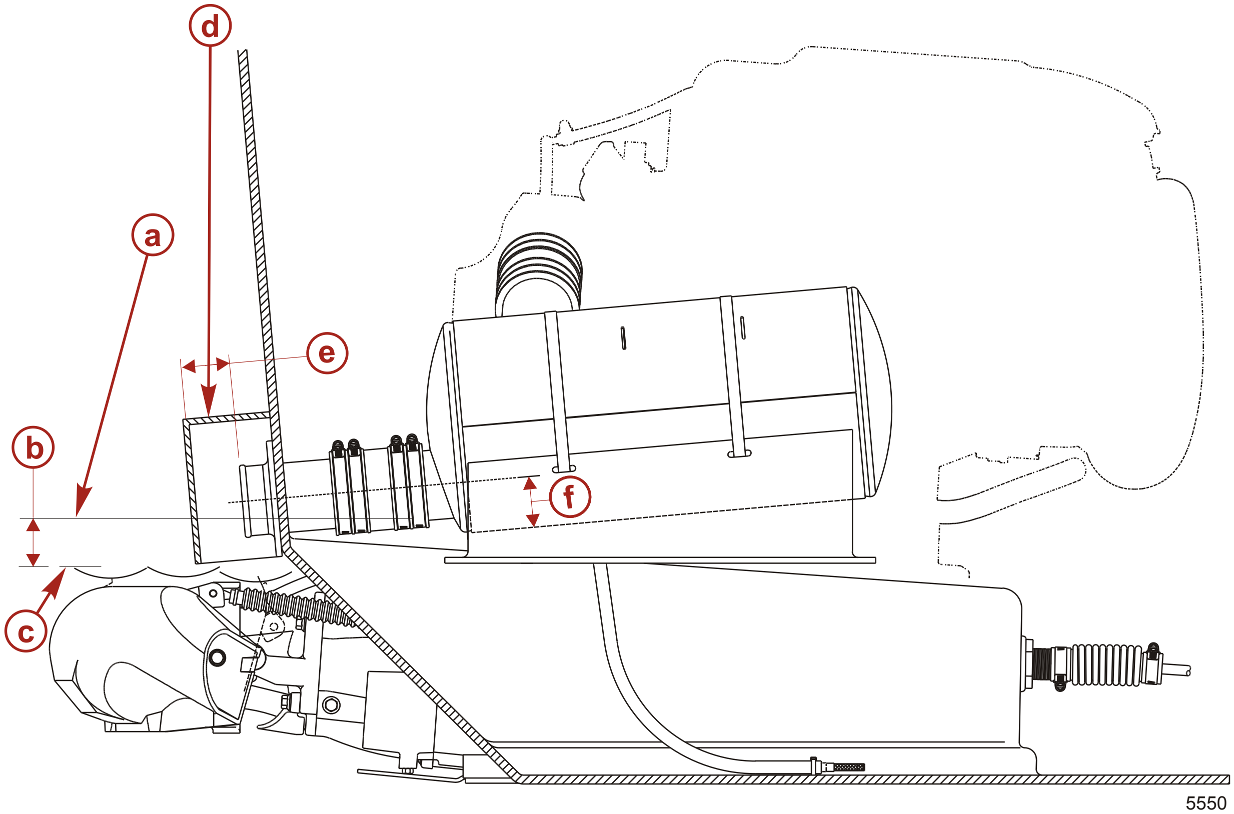
Aft View



a - Alternate installation
b - Typical recommended installation - 54-815504, 256 stainless steel clamp or equivalent
c - Muffler
d - 25° outlet angle of expansion chamber
e - 15.2 cm (6.0 in.) minimum
f - Reference maximum practical
g - 25° maximum from horizontal
h - Optional exhaust outlet cover
i - 5.1 cm (2.0 in.) minimum
j - 10.2 cm (4.0 in.)
k - Exhaust termination
l - Expansion chamber
m - Rubber mounts
n - 10° minimum angle from expansion chamber outlet to muffler inlet

- If rubber hosing is to be used for connection between the expansion chamber and the muffler, an inner sleeve made of 6061-T6, 14 gauge aluminum tubing must be used as liner and secured with two stainless steel hose clamps P/N 54-815504 or equivalent.
- Mufflers may be mounted using straight piping.
- All exhaust hoses and/or tubes must be secured with two clamps at each connection.
- To minimize the backflow of exhaust gases into the cockpit or interior of boat, the exhaust termination should be located as far outboard of the centerline as practical.
- Final system installation shall be reviewed by a Mercury Marine field representative using a modified expansion chamber to ensure back pressure does not exceed 10.3 kg (1.8 psi) at 304.8 m (1000 ft) above sea level or less. This test needs to be performed with the boat in the water and under way. No special loading of the boat is required. However, the engine must be capable of reaching the specified WOT engine speed. Maximum RPM must be verified using an accurate service tachometer.
- Exhaust system components should be rubber mounted, independently supported, and restrained to minimize noise transmission to the boat and stress on exhaust system components.

Side View

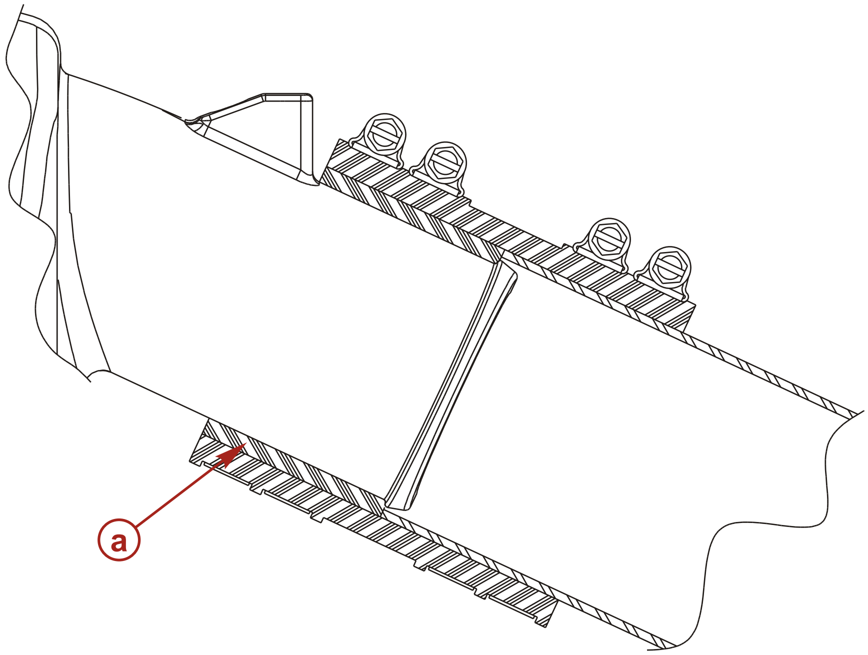


a - Bottom edge of the muffler outlet tube
b - 5.1 cm (2.0 in.)
c - Waterline
d - Covers
e - 5.1 cm (2.0 in.)
f - 5° outlet angle

- Measure the bottom edge of the muffler outlet tube to ensure that the lowest possible location of the bottom edge of the muffler tube never gets within 5.1 cm (2.0 in.) of the maximum depth waterline.
- When installing muffler assemblies, a 5.1 cm (2.0 in.) minimum distance between bottom of muffler and waterline must be kept. This minimum distance must be calculated with boat under its maximum load. Tilt muffler assemblies back towards outlet to ensure self-draining.
- Covers may be placed over exhaust outlets to reduce exhaust noise and may extend 10 cm (5 in.) or less below waterline when boat is at rest.

Side View of Expansion Chamber Outlet Pipe and Exhaust Pipe Connection

IMPORTANT: A spacer must be used with all 7.6 cm (3.0 in.) tube applications. A spacer having a 6.73 cm (2.65 in.) I.D. and a 7.6 cm (3.0 in.) O.D. needs to be installed over the expansion chamber outlets.

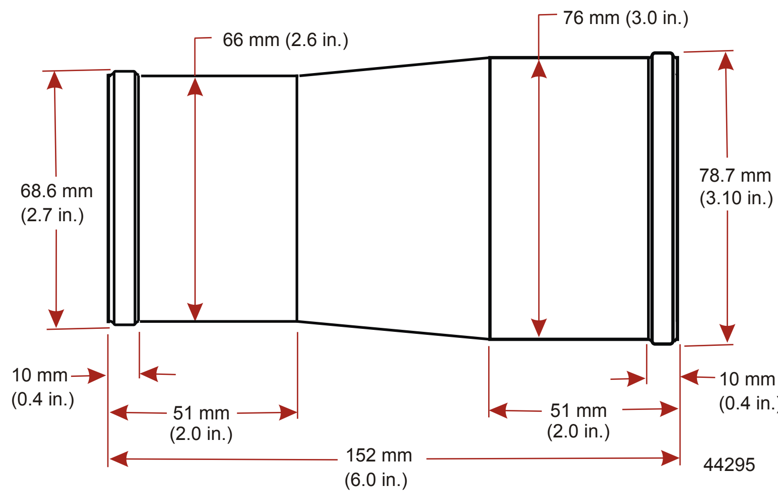


a - Spacer

Inner Sleeve Liner Fabrication

An inner sleeve liner is required when using a rubber hosing to connect the muffler to the expansion chamber. The inner sleeve liner gets installed inside the rubber hosing. Refer to **Aft View** for installation location and requirements.

Material: 6061-T6, 14 gauge aluminum.



Recommended Predelivery Engine Break-in Procedure

NOTE: Do not use premixed gas and oil in this engine. Use straight gasoline during break-in and after engine break-in.

The recommended predelivery engine break-in procedure for the sport jet engine is important to ensure proper performance and maximum life from the engine. The following break-in procedure allows the pistons to ease into conformance with the cylinder bore.

The engine automatically receives extra oil during the first hours of operation. This extra oil mode will complete in about ten hours.

Engine Break-in Procedure	
Step 1: First 40 minutes - Keep the boat on the trailer. Place the boat and trailer in water that is deep enough to submerge the water intake grate. Keep the bow attached and tight to the trailer, but remove or loosen the rear straps to allow the boat to float at the rear. Run the engine at the listed run time and at the RPM speed.	
Run Time	**Engine RPM Speed**
First 10 minutes	2500 RPM
Next 10 minutes	3000 RPM
Next 5 minutes	3500 RPM
Next 5 minutes	4000 RPM
Next 5 minutes	4500 RPM
Next 5 minutes	5000 RPM
Step 2: Next 14 minutes - Remove the boat from the trailer and run on the water. The run times for the first four wide-open-throttle encounters is very critical. Keep the run time within the given range. Run the engine at the listed run time and RPM speed.	
Run Time	**Engine RPM Speed**
First 10 seconds ± 3 seconds	wide-open throttle 5600 RPM
Next 20 seconds	3500 RPM
Next 20 seconds ± 3 seconds	wide-open throttle 5600 RPM
Next 40 seconds	3500-4000 RPM
Next 30 seconds ± 3 seconds	wide-open throttle 5600 RPM
Next 1½ minutes	3500-4000 RPM
Next 45 seconds ± 3 seconds	wide-open throttle 5600 RPM
Next 1½ minutes	3500-4000 RPM
Next 4¼ minutes	wide-open throttle 5600 RPM

Predelivery Inspection

Not Applicable	Check/ Adjust	CHECK BEFORE RUNNING	Not Applicable	Check/ Adjust	ON THE WATER TEST
☐	☐	Water hose connection torqued	☐	☐	Idle_______ RPM, within specifications
☐	☐	Cover plate and adapter plate fasteners torqued	☐	☐	Forward - Neutral - Reverse operational
☐	☐	Battery meets engine specification	☐	☐	Steering operation throughout range
☐	☐	Battery charged and secure	☐	☐	Acceleration test
☐	☐	All electrical connections tight	☐	☐	WOT_______ RPM
☐	☐	All fuel connections tight	☐	☐	Ignition timing set to specs
☐	☐	Throttle, shift, and steering system adjusted correctly and fasteners torqued	☐	☐	Boat handling
☐	☐	Shift cable adjusted to keep the reverse gate above the rudder in forward with slack pulled out of cable and against stop	☐	☐	**AFTER ON WATER TEST**
☐	☐	Pump housing oil level full	☐	☐	Torque adapter plate fasteners
☐	☐	Oil injection reservoir full and bled	☐	☐	No fuel, oil, water, or exhaust leaks
☐	☐	Warning system operational	☐	☐	Check shift cable adjustment. Readjust as necessary.
		ON WATER TEST			
☐	☐	Starter neutral safety switch operational			
☐	☐	Lanyard stop switch operational			
☐	☐	All gauges read properly			
☐	☐	No fuel leaks			
☐	☐	No oil leaks			
☐	☐	No water leaks			
☐	☐	No exhaust leaks			

Electrical

Section 2A - Ignition

2
A

Table of Contents

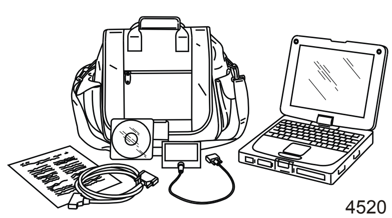
Ignition Specifications

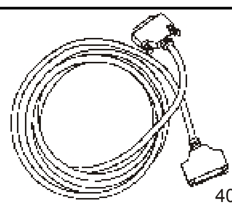
Ignition Specifications	
Type	Digital inductive
Spark plug	NGK IZFR6J
Spark plug gap	1.1 mm (0.043 in.)
Maximum timing	Not adjustable; PCM controlled
Idle timing	Not adjustable; PCM controlled
Throttle position sensor	
At idle	0.4–1.3 VDC
At WOT	4.0–4.7 VDC

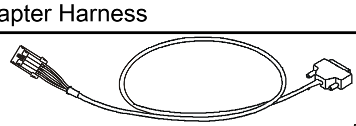
Lubricant, Sealant, Adhesives

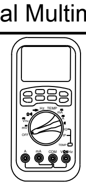
Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Cylinder head coolant temperature sensor threads	92-809822
25	Liquid Neoprene	All ring terminal connections	92- 25711 3

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

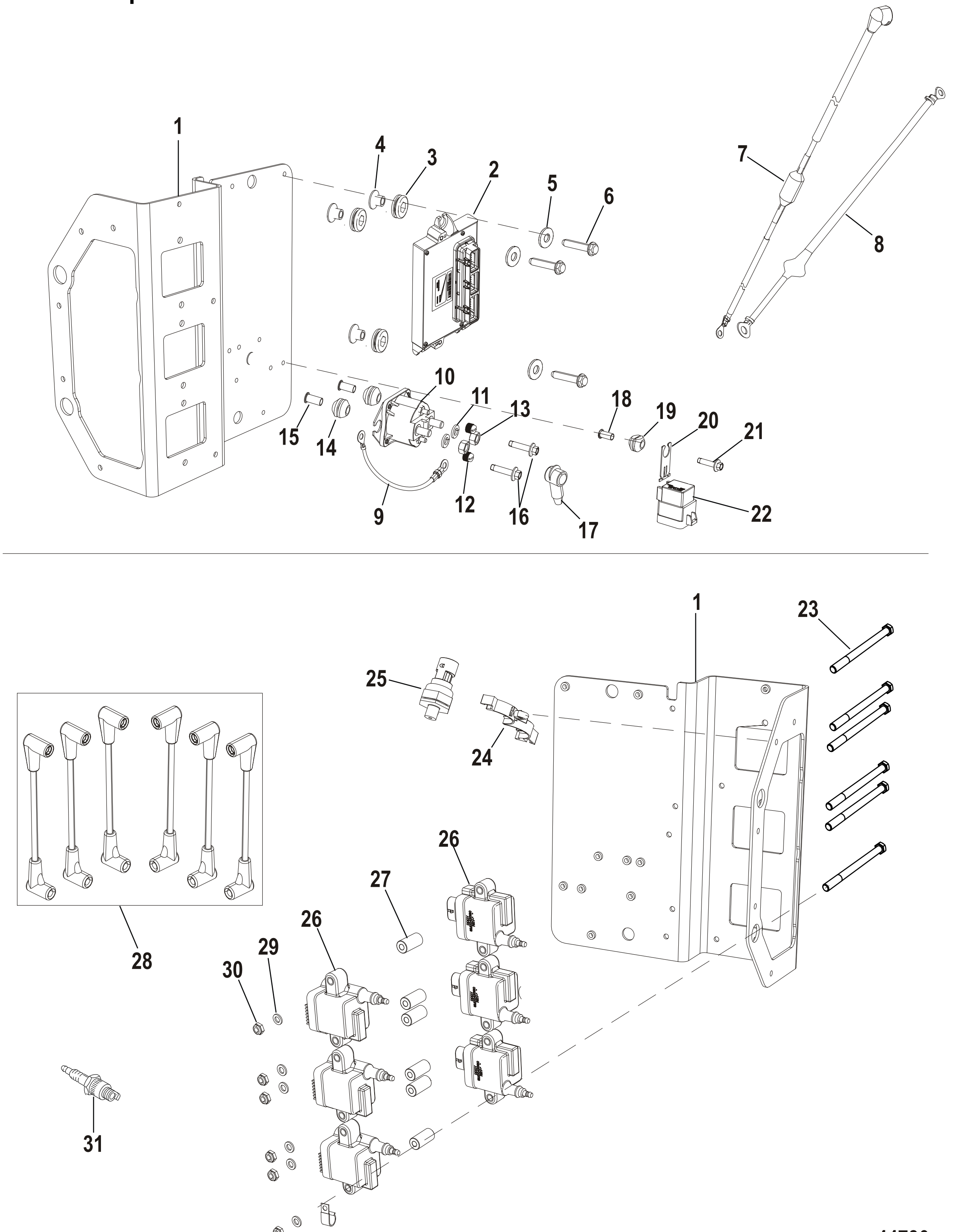
Extension Cable	84-825003A 1
 4012	Data link extension harness (3.05 m [10 ft.]) between the adapter harness and the Digital Diagnostic Terminal or Computer Diagnostic System (CDS).

Adapter Harness	84-822560A13
 5826	Data link harness between engine and computer diagnostic system (CDS).

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.

Notes:

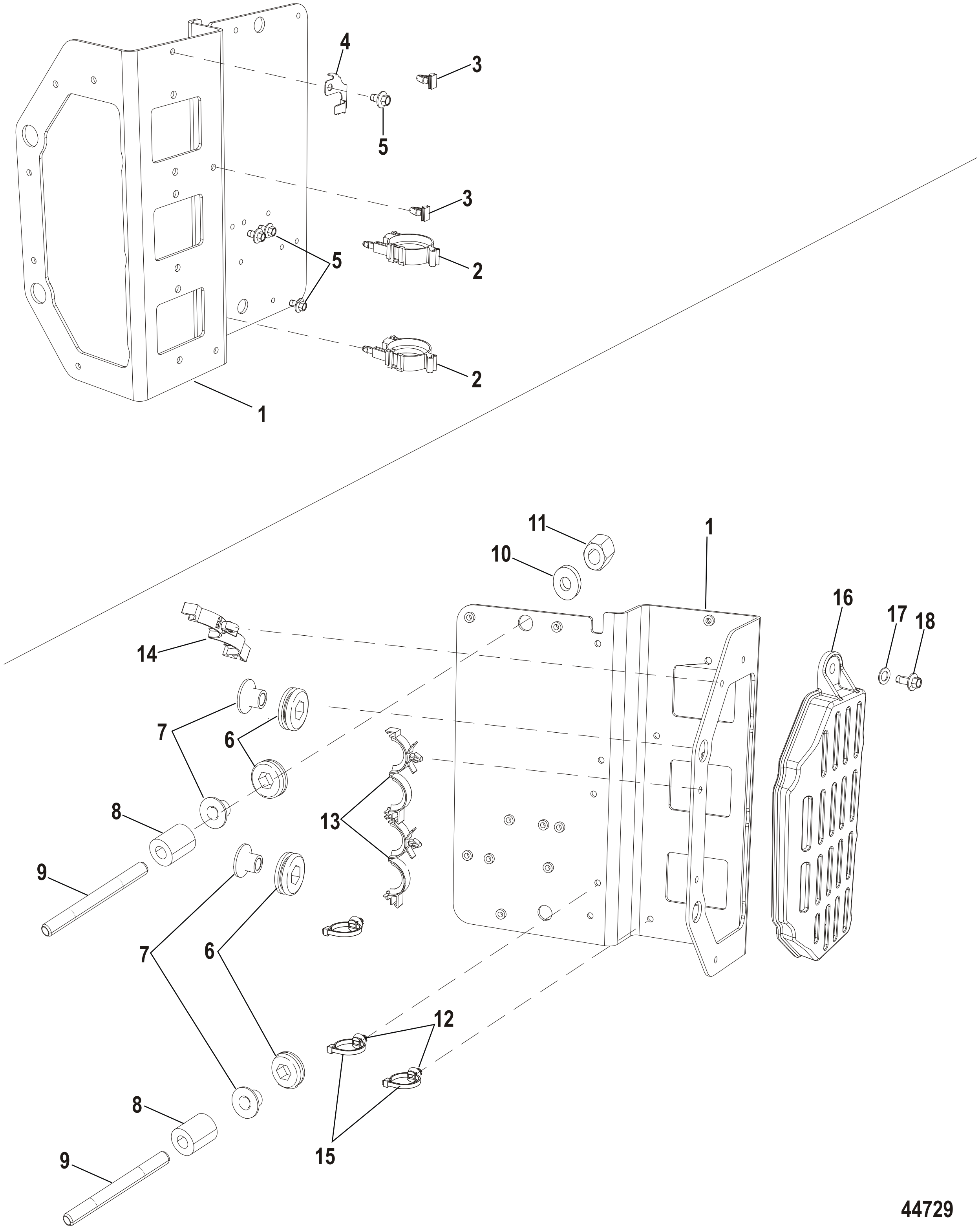
Electrical Components



Electrical Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Electrical plate			
2	1	Propulsion control module (PCM)			
3	3	Grommet			
4	3	Bushing			
5	3	Washer			
6	3	Screw (M6 x 25)	11.5	102	
7	1	100 amp fuse harness assembly			
8	1	Starter cable assembly			
9	1	Black cable assembly			
10	1	Solenoid assembly			
11	2	Lockwasher			
12	2	Cap nut and nut (10-32)			
13	2	Nut (5/16-18)	7	62	
14	2	Grommet			
15	2	Bushing			
16	2	Screw (M6 x 25)	11	97	
17	1	Yellow insulator boot			
18	1	Bushing			
19	1	Grommet			
20	1	Bracket			
21	1	Screw (M6 x 25)	7	62	
22	1	Main power relay assembly			
23	6	Screw (1/4-20 x 3-1/4)	7	62	
24	1	Clip			
25	1	Water pressure sensor			
26	6	Ignition coil			
27	6	Spacer			
28	1	High-tension cable set (six cables)			
29	6	Washer			
30	6	Nut (1/4-20)	11	97	
31	6	Spark plug	27		20

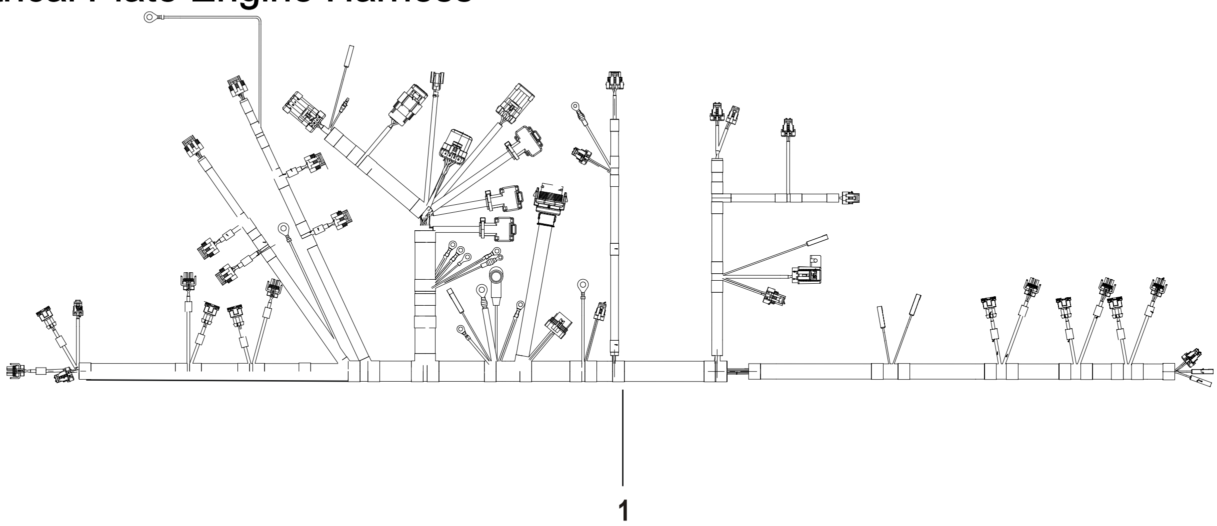
Electrical Plate Hardware

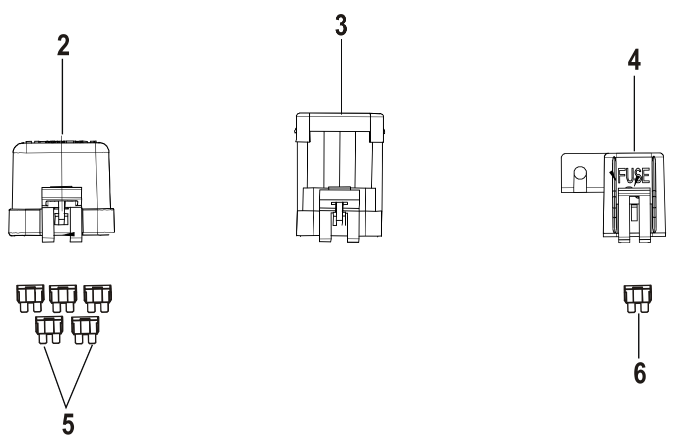


Electrical Plate Hardware

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Electrical plate			
2	2	Clip			
3	2	Clip			
4	2	Clip			
5	4	Screw (M6 x 10)	4	35	
6	4	Grommet			
7	4	Bushing			
8	2	Bushing			
9	2	Stud (M6 x 50)			
10	2	Washer			
11	2	Nut (M6)	7	62	
12	3	Cable tie clip			
13	2	Clip			
14	1	Clip			
15	AR	Cable tie			
16	1	Cover			
17	1	Sleeve			
18	1	Flange screw (M6 x 14)	7	62	

Electrical Plate Engine Harness





44731

Electrical Plate Engine Harness

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Engine harness			
2	1	Fuse cover			
3	1	Weather cap connector			
4	1	Fuse cover			
5	3	Fuse (20 A, yellow)			
	1	Fuse (15 A, blue)			
	1	Fuse (5 A, brown)			
6	1	Fuse (5 A, brown)			

Troubleshooting without a Computer Diagnostic System (CDS)

Troubleshooting without the computer diagnostic system (CDS) is limited to checking resistance on some of the sensors.

Typical failures usually do not involve the PCM. Connectors, setup, or mechanical wear are most likely at fault.

- Verify the ignition spark plug boots are securely installed (pushed in) onto the spark plugs.
- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.

IMPORTANT: Disconnecting a sensor while the engine is running may result in a fault recording in the PCM Fault History. Use the CDS to view the PCM fault history when troubleshooting/repair is completed.

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the PCM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires, or pins pushed back into the connector. Verify the connectors are properly seated.
- Inspect the harness for damage: pinched or cut wires and chafing.
- Secure the grounds and all connections involving ring terminals. Apply Liquid Neoprene to all ring terminal connections.

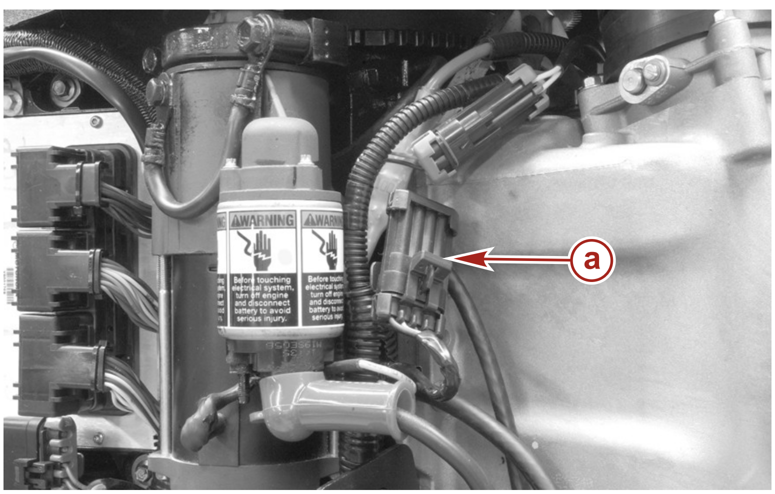
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	All ring terminal connections	92- 25711 3

- Inspect the fuel pump harness connector for corrosion, loose wires, or pins pushed back into the connector.
- Check the fuel pump pressure.
- Check the air compressor air pressure.

Troubleshooting with the Computer Diagnostic System (CDS)

The computer diagnostic system (CDS) is designed to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

Attach the diagnostic cable to the PCM diagnostic connector. This will enable the technician to monitor sensors, PCM data values, and the real time status of the switches. Use the 3 m (10 ft.) extension cable between the CDS diagnostic connector and the PCM adapter to monitor the engine system while at the helm.



a - Diagnostic terminal connector

39106

The PCM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time, and then can be played back to review the recorded information.

Refer to the computer diagnostic system reference manual for complete diagnostic procedures.

Computer Diagnostic System (CDS)	Order through SPX
Extension Cable	84-825003A 1
Adapter Harness	84-822560A13

Troubleshooting Guide

1. Engine Cranks, but Will Not Start	
Cause	**Action**
1.0 Lanyard stop switch in wrong position	Reset lanyard stop switch.
1.1 Weak battery or bad starter motor, battery voltage drops below 8 volts while cranking (PCM cuts out below 8 volts) (fuel pump requires 9 volts)	Replace/charge battery. Inspect condition of starter motor. Check condition of battery terminals and cables.
1.2 Low air pressure in rail (less than 70 psi at cranking)	Inspect air system for leaks. Inspect air filter for plugging (air pressure measured on port rail). Inspect air compressor reed valves, if necessary.
1.3 No fuel	Check that primer bulb is firm. Key-on engine to verify fuel pump runs for two seconds and then turns off. Measure fuel pressure (valve on port rail). Fuel pressure should be 96.5 kPa ± 6.9 kPa (14.0 ± 1.0 psi) greater than the air pressure.
1.4 Low fuel pressure	Check fuel pressure from low pressure electric fuel pump 137.9 kPa–206.8 kPa (20–30 psi). Check for fuel leaks. If fuel pressure leaks down faster than air pressure, seals on fuel pump may be leaking. Check air system pressure, see **1.2.**
1.5 Flywheel misaligned during installation	Remove flywheel and inspect.
1.6 Blown fuse	Replace fuse. Inspect engine harness and electrical components.
1.7 Main power relay not functioning	Listen for relay to click when the key switch is turned on.
1.8 Spark plugs[1.]	Remove fuel pump fuse. Unplug all direct injector connectors. Remove spark plugs, one at a time, from each cylinder. Connect spark plug leads to spark gap tester. Crank engine, or use CDS output load test, for each ignition coil and observe spark. If no spark is present, replace appropriate ignition coil. If spark is present, replace spark plugs.
1.9 PCM not functioning	Injection system: Listen for injector ticking when cranking or connect spare injector to each respective harness. Ticking should start after two cranking revolutions. Ignition system: - Check for proper operation by using an inductive timing light. - Check battery voltage while the engine is cranking, there should be no less than 8 VDC at the power stud. - Check for blown fuse. - Check battery voltage to fuse from main power relay (purple). - Check for shorted stop wire (black/yellow). A PCM with internal coil drivers can cause a loss of spark on all cylinders if the internal coil drivers were damaged by a shorted ignition coil. Test all ignition coils before replacing the PCM.
1.9A Crankshaft position sensor not functioning	Check crankshaft position sensor. Defective PCM. Check battery voltage while the engine is cranking, there should be no less than 8 VDC at the power stud.

1. Spark jumping the gap from all cylinders at the same time in the spark gap tool may cause interference in the PCM. The interference may cause the absence of spark on some cylinders and a false diagnosis of a no spark condition. Crank engine over with only one spark plug wire connected to spark gap tool at a time or use CDS to fire one cylinder at a time.

2. Engine Cranks, Starts, and Stalls	
Cause	Action
2.0 Low air pressure in rail	Refer to **1.2**.
2.1 Low fuel pressure in rail	Refer to **1.3** and **1.4**.
2.2 Abnormally high friction in engine	Check for scuffed piston or other sources of high friction.
2.3 Air in fuel system/lines	Refer to **1.3**. Crank and start engine several times to purge.
2.4 TPS malfunction	Check motion of throttle arm. Stop nuts should contact block at idle and WOT. Check TPS setup.
2.5 Remote control to engine harness connection is poor	Clean and inspect male and female connectors.

3. Engine Idle is Rough	
Cause	Action
3.1 Low air pressure in rail (less than 79 ± 2 psi while running)	Refer to **1.2**.
3.2 Fouled spark plug	Replace spark plug: - If carbon bridges electrode gap or if it is completely black. - If it is not firing and is wet with fuel. *NOTE: If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston.* - Wrong spark plug.
3.3 Failed direct injector	Refer to specifications for ohm test.
3.4 Failed fuel injector	Refer to specifications for ohm test.
3.5 Bad coil/weak spark	Refer to specifications for ohm test.
3.6 Flywheel misaligned during installation	Remove flywheel and inspect.

4. Engine Idles Fast (RPM > 700) or Surges	
Cause	Action
4.1 Broken fuel pressure regulator or tracker diaphragm	Measure fuel pressure. Remove and inspect diaphragms (a special tool is required for assembly).
4.2 Fuel leak	Check for fuel entering induction manifold or air compressor inlet. Fuel pump diaphragm leaking and/or vapor separator tank is flooding.
4.3 Tracker valve spring missing	Inspect tracker valve for proper assembly.
4.4 Improper setup	Check throttle cable and cam roller adjustment.

5. Engine Runs Rough Below 3000 RPM	
Cause	Action
5.1 Fouled spark plug	Refer to **3.2**.
5.2 Low air pressure in rail	Refer to **1.2**.
5.3 Throttle incorrectly adjusted	Check throttle cam setup on induction manifold. Inspect linkage and roller. If throttle plate stop screws have been tampered with, contact Mercury Marine Service Department for correct adjustment procedures.
5.4 Bad coil/weak spark	Refer to **3.5**.
5.5 TPS malfunction	Refer to **2.4**.

6. Engine Runs Rough Above 3000 RPM	
Cause	Action
6.1 Fouled spark plug	Refer to **3.2**.
6.2 Speed reduction	Refer to **7.4 and 7.5**.
6.3 Low air pressure in rails	Refer to **1.2**.
6.4 TPS malfunction	Refer to **2.4**.

7. Speed Reduction (RPM reduced)	
Cause	Action
7.1 Low battery voltage (PCM cuts out below 8 volts) (fuel pump requires 9 volts)	Check battery and/or alternator. Check electrical connections.
7.2 Overheat condition (engine and/or air compressor)	Check water pump impeller/cooling system.
7.3 Oil pump electrical failure	Check electrical connection.
7.4 TPS failure If TPS fails, RPM is reduced to idle	Check electrical connection.
7.5 CPS failure If CPS fails, the engine will run rough or stop running	Refer to **Crankshaft Position Sensor Test.**

8. Engine RPM Reduced to Idle Only	
Cause	Action
8.1 TPS failed	Refer to **2.4**. Use CDS to monitor system.

9. Loss of Spark on One Cylinder	
Cause	Action
9.1 Loose wire or pin connectors between PCM and coil primary	Check connectors.
9.2 Faulty ignition coil	Replace coil.
9.3 Faulty spark plug	Replace spark plug.
9.4 Faulty spark plug wire	Replace spark plug wire.[2]

Wire Color Code Abbreviations

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

2. If the spark plug is partially fouled or the plug gap is too small, the CDS may indicate the incorrect cylinder as having an ignition fault. Example: If the CDS indicates an ignition fault on cylinder #3, the problem may be on the prior cylinder in the firing order - I.E. cylinder number #2.

Theory of Operation - Internal Ignition Coil Driver Models

When the ignition key is turned to the "RUN" position, battery voltage is supplied to the electrical system through the main power relay. If the propulsion control module (PCM) does not sense engine rotation within a certain time period, the relay is turned off. Engine rotation will engage the relay. When the main power relay is closed, voltage is supplied through the 20 amp ignition fuse to the positive terminal on all of the ignition coils. Each coil contains an internal driver circuit. The driver circuit switches the primary current on for a given time period (dwell), and then switches it off, collapsing the coil magnetic field creating a spark. The crankshaft position sensor (CPS) reads the position pattern on the flywheel, which allows the PCM to monitor the position of the crankshaft while the engine is running. At the proper time for ignition spark, the PCM sends a signal to the coil driver to dwell and then provide spark. When the engine is operating at lower RPM, this process is repeated in quick succession to provide a multi-strike spark for each combustion event. The number of strikes per event is varied, depending on RPM and load requirements. The spark plug irridium electrode and ground extends into the combustion chamber.

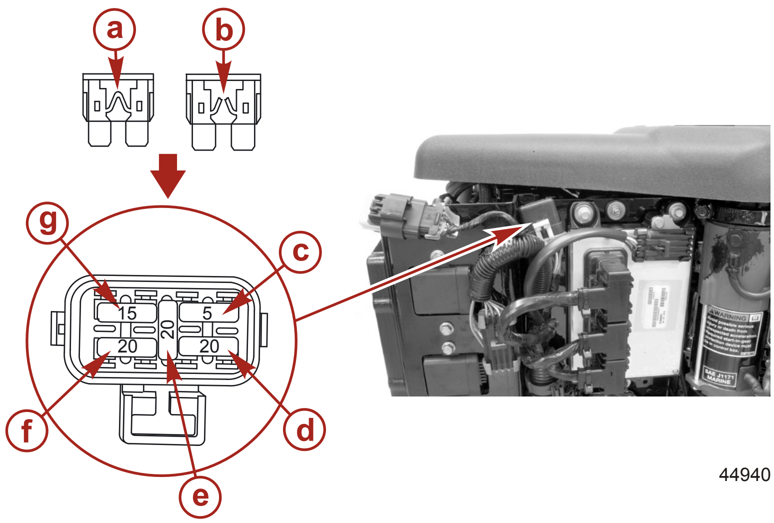
Fuses

IMPORTANT: Always carry spare 5 and 20 amp fuses.

The electrical wiring circuits on the engine are protected from overload by fuses in the wiring. If a fuse is open, try to locate and correct the cause of the overload. If the cause is not found, the fuse may open again.

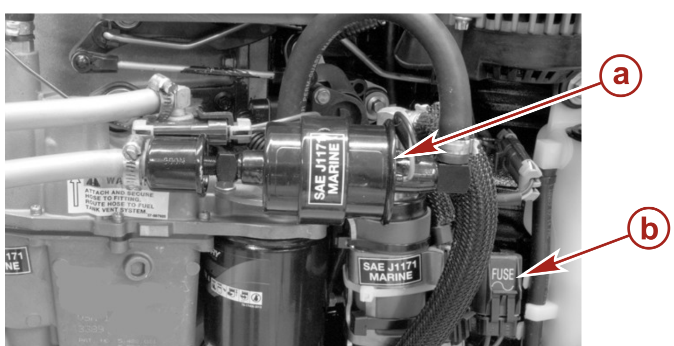
1. Open the fuse holder and look at the silver colored band inside the fuse. If the band is broken, replace the fuse.
2. Replace the fuse with a new fuse with the same rating.

The fuses and circuits are identified as follows:



44940

- a - Good fuse
- b - Blown fuse
- c - SmartCraft data bus circuit - 5 amp fuse
- d - Ignition system circuit - 20 amp fuse
- e - Spare fuse
- f - Electric fuel pump (VST)/ECM driver power/ oil pump circuit - 20 amp fuse
- g - Main power relay - 15 amp fuse

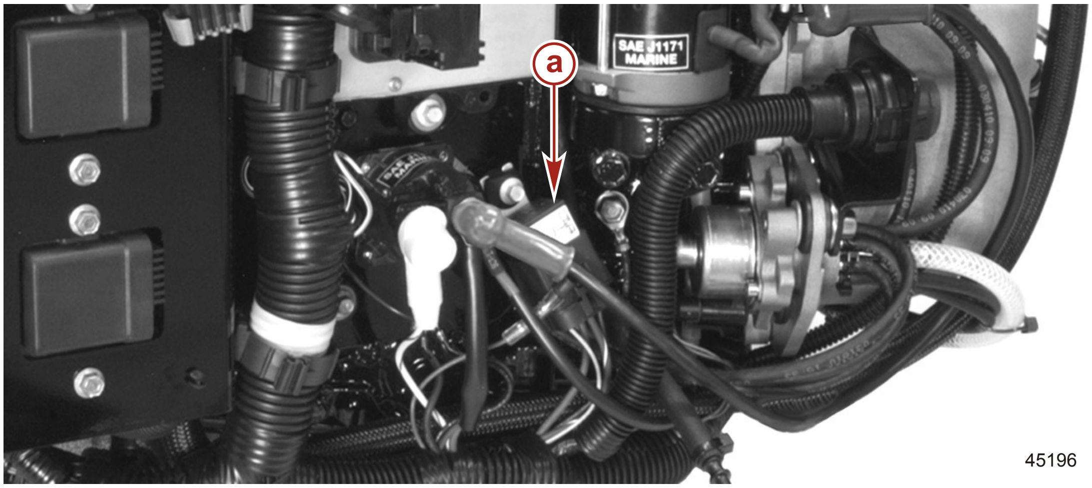


44761

- a - Lift pump
- b - Lift pump circuit - 5 amp fuse

Main Power Relay (MPR)

The main power relay (MPR) is located on the starboard side of the engine. The MPR is controlled by the PCM. After the first system power up, the MPR is active for approximately five seconds. The PCM will deactivate the MPR unless the crankshaft position sensor signals the PCM to initiate the MPR. The main power relay supplies 12 volts to the low-pressure fuel pump, high-pressure fuel pump, oil pump, ignition coils, and the fuel injectors.



a - Main power relay (MPR)

Main Power Relay Test

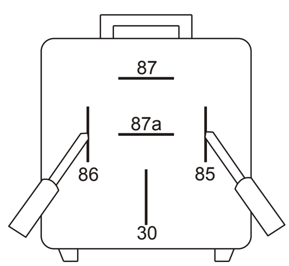
The main power relay can be tested with the computer diagnostic system (CDS).

Computer Diagnostic System (CDS)	Order through SPX
Adapter Harness	84-822560A13
Extension Cable	84-825003A 1

Use the DMT 2004 digital multimeter for all of the following tests.

DMT 2004 Digital Multimeter	91-892647A01

1. Disconnect the engine harness from the main power relay.
2. Perform a visual inspection of the main power relay spade terminals. Look for loose or corroded spade terminals.
3. Measure the resistance between the main power relay coil terminals 85 (red/purple) and terminal 86 (yellow/purple). Replace the relay if the resistance is not within the specifications.



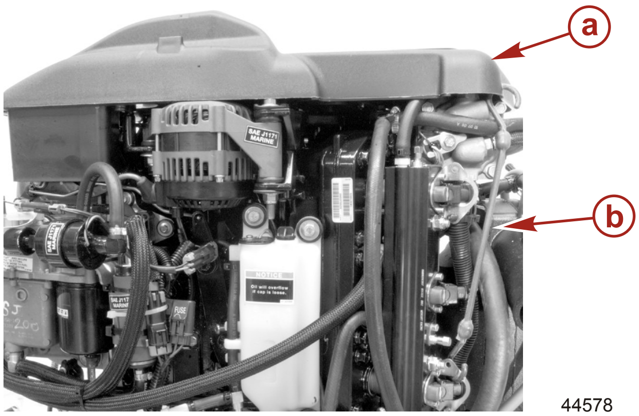
Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Terminal 85	Terminal 86	Auto ohms	85 ± 10 ohms

Flywheel

Flywheel Cover Removal and Installation

Removal

1. Detach the retaining strap.
2. Remove the cover by lifting off from the back of the engine.

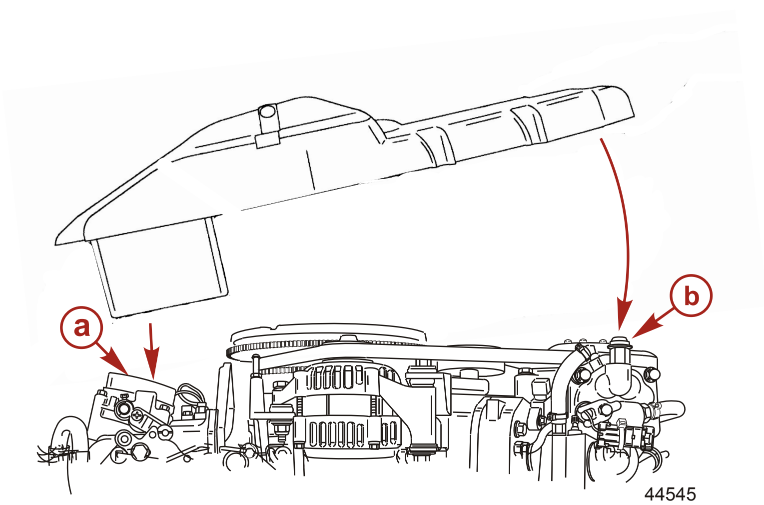


44578

a - Flywheel cover
b - Retaining strap

Installation

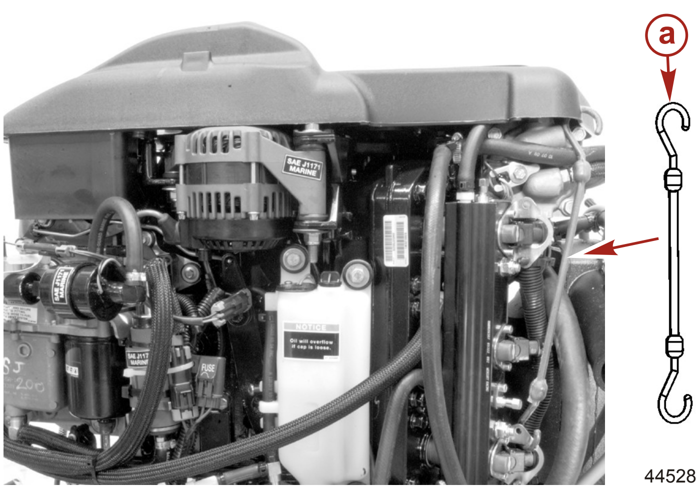
1. Lower the cover opening onto the air plenum intake flange. Tilt the cover side to side until the cover slides down onto the intake flange.
2. Push the cover down onto the alignment pins and onto the air intake tube for the air compressor.



44545

a - Air plenum intake flange
b - Air intake tube for the air compressor

3. Attach the retaining strap to the cover.



44528

a - Retaining strap

Propulsion Control Module (PCM)

The PCM requires 8 VDC minimum to operate. If the PCM should fail, the engine will stop running. Some inputs to the PCM can be monitored and tested using the computer diagnostic system (CDS).

Computer Diagnostic System (CDS)	Order through SPX

The PCM controls the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure, manifold air temperature, and cylinder block coolant temperature.
- Directly controls the ground circuit to: fuel injectors, direct injectors, ignition coil driver, main power relay activation, diagnostics, Engine Guardian, tachometer link (analog tachometer output or link gauge driver).
- Indirectly controls the positive circuit to: fuel injectors, ignition coils, main power relay activation.

When the key switch is moved to the "RUN" position, but the engine is not started, the PCM completes the ground circuit for the main power relay and a 5 VDC reference to the engine sensors. The PCM monitors engine sensors, SmartCraft vessel sensors, and will transmit fault information from these sensors to the helm. Once the engine has started, the PCM controls and monitors all engine functions.

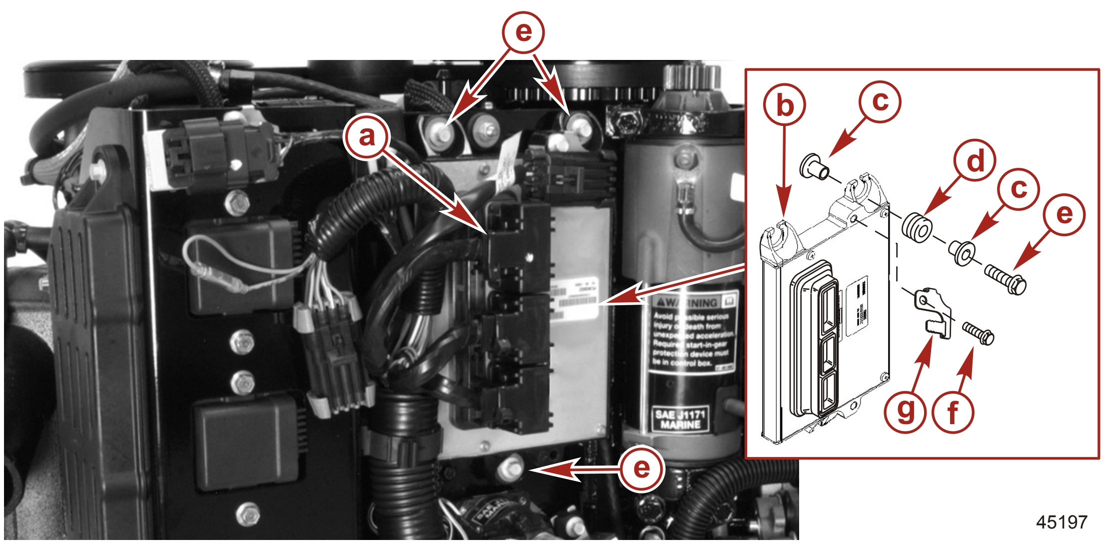
Propulsion Control Module (PCM) Removal and Installation

PCM 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 batteries.
2. Disconnect the engine harness connectors from the PCM.
3. Remove the screw securing the bracket to the PCM.
4. Remove the three screws securing the PCM to the cylinder block.



45197

a - Engine harness connector (3)
b - PCM
c - Bushing (6)
d - Grommet (3)
e - Screw (M6 x 25) (3)
f - Screw (M6 x 14)
g - Fuse holder bracket

PCM Installation

1. Secure the PCM to the powerhead with the M6 x 25 screws, bushings, and grommets. Tighten the screws to the specified torque.
2. Secure the bracket to the PCM with a M6 x 14 screw. Tighten the screw to the specified torque.
3. Connect the engine harness connectors to the PCM.

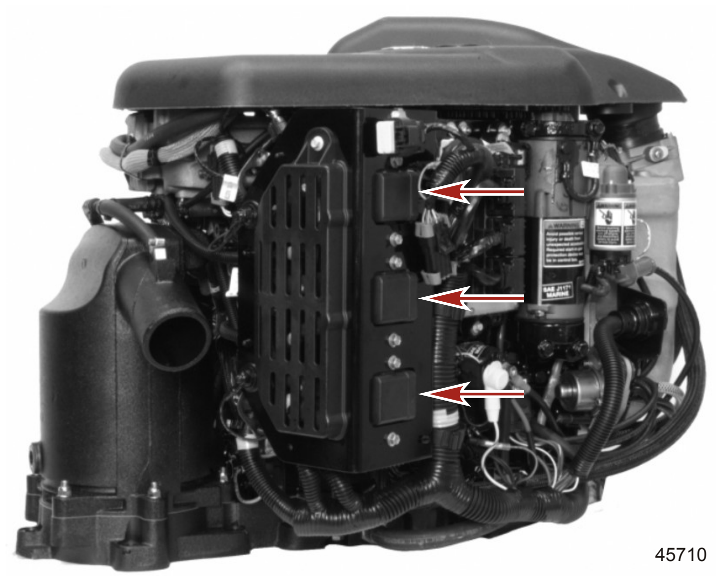
Description	Nm	lb-in.	lb-ft
Screw (M6 x 25) (3)	11.5	102	
Screw (M6 x 14)	11.5	102	

4. Connect the battery cables to the batteries.

Ignition Coils

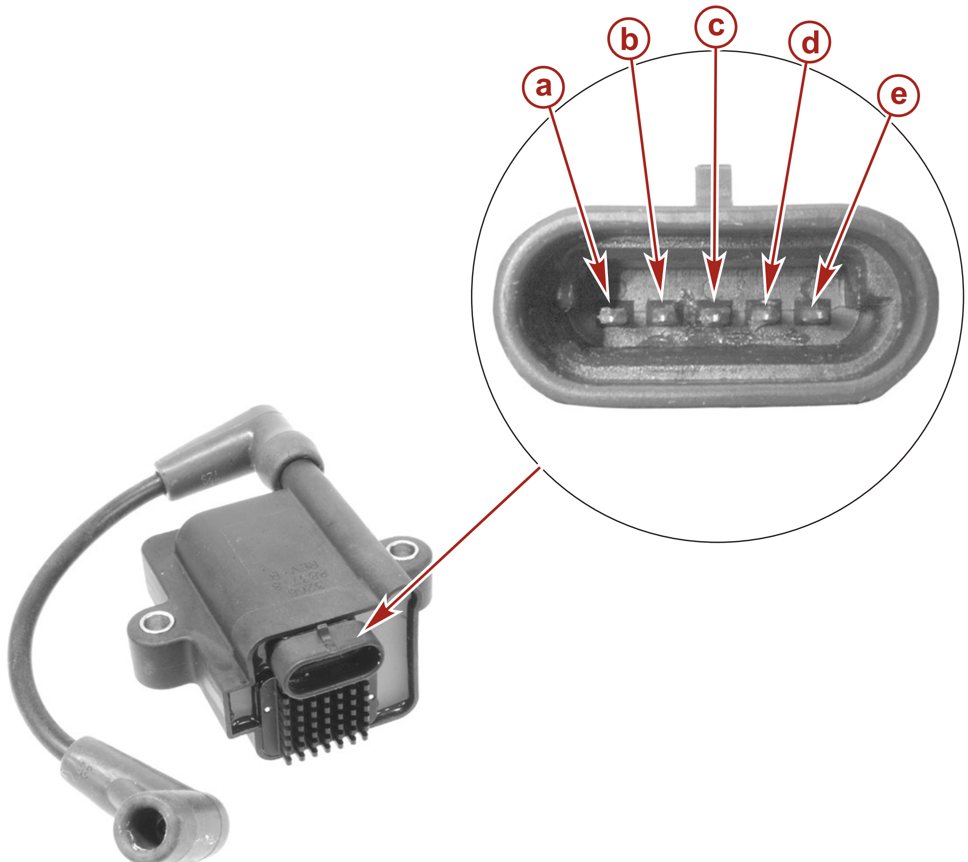
Ignition Coil Test

The ignition coils used on OptiMax engines use an internal electronic spark trigger (EST) ignition coil driver. Battery voltage is supplied to the ignition coils and coil drivers when the main power relay is engaged. The crankshaft position sensor sends a position signal to the propulsion control module. The propulsion control module calculates the exact position of the crankshaft and determines when to remove the trigger signal from the coil driver of each ignition coil. The coil driver opens the coil primary ground circuit collapsing a magnetic field across the coil secondary winding which induces a high voltage charge (50,000 volts) that fires the spark plug.



Ignition Coil Resistance Test

Remove the ignition coils from the electrical plate. Refer to **Ignition Coil Removal**.



36993

Black Meter Lead							
		Secondary Tower	EST Pin A	EST Pin B	Secondary Low Pin C	Primary Ground Pin D	Battery + Pin E
Red Meter Lead	Secondary Tower	X	No Continuity	No Continuity	2–8 megaohm	No Continuity	No Continuity
	EST Pin A	No Continuity	X	8500–12000 ohm	No Continuity	29000–50000 ohm	11000–21000 ohm
	EST Low Pin B	No Continuity	8500–12000 ohm	X	No Continuity	39000–51000 ohm	21000–31000 ohm
	Secondary Low Pin C	No Continuity	No Continuity	No Continuity	X	No Continuity	No Continuity
	Primary Ground Pin D	No Continuity	20000–50000 ohm	31000–51000 ohm	No Continuity	X	13000–23000 ohm
	Battery + Pin E	No Continuity	11000–21000 ohm	21000–31000 ohm	No Continuity	13000–23000 ohm	X

EST = Electronic spark trigger

EST Low = Return ground path for the trigger signal to the ECM

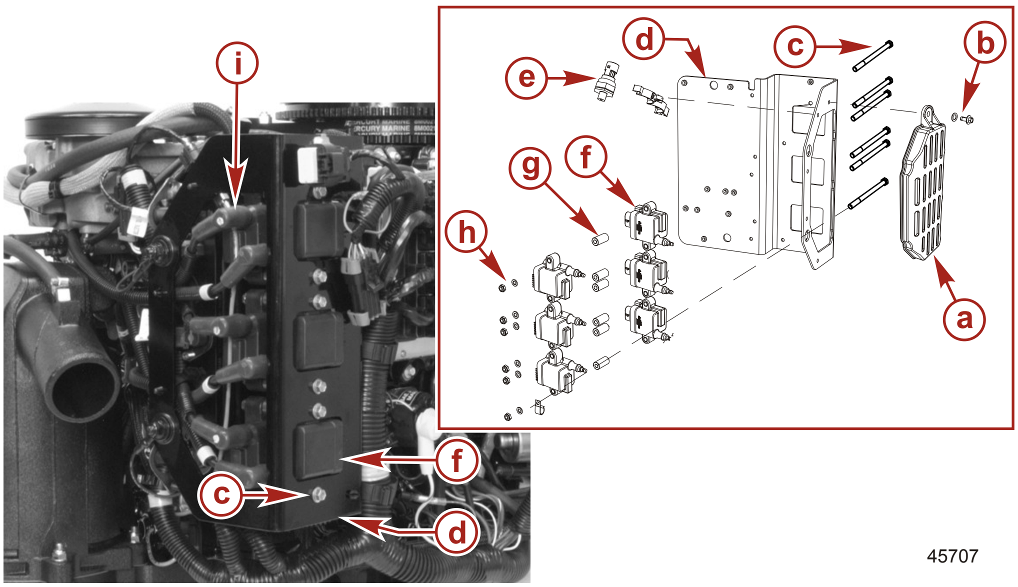
Ignition Coil Removal and Installation

Ignition Coil 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 flywheel cover.
2. Disconnect both battery cables from the batteries.
3. Remove the coil cover.
4. Disconnect the engine coil harness from the ignition coil.
5. Disconnect the spark plug lead from the ignition coil.
6. Remove the screw and nut securing the ignition coil.



a - Coil cover
b - Sleeve and screw (M6 x 14, flange)
c - Screw (1/4-20 x 3-1/4) (6)
d - Electrical plate
e - Water pressure sensor
f - Ignition coil (6)
g - Spacer (6)
h - Nut and washer (6 each)
i - Spark plug lead (6)

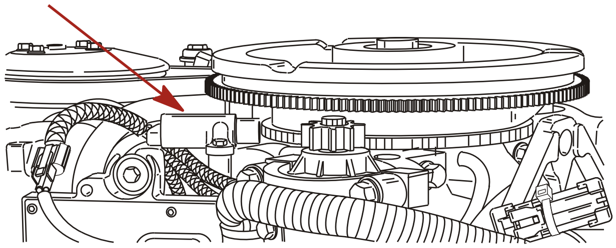
Ignition Coil Installation

1. Secure the ignition coil to the electrical plate. Tighten the screws and nuts to the specified torque.
2. Connect the engine coil harness to the ignition coil.
3. Connect the spark plug lead from the ignition coil to the spark plug.
4. Install the coil cover. Tighten the screw to the specified torque.
5. Install the flywheel cover.

Description	Nm	lb-in.	lb-ft
Screw (1/4-20 x 3-1/4) (6)	7	62	
Screw (M6 x 14, flange)	7	62	

6. Connect the battery cables to the batteries.

Crankshaft Position Sensor (CPS)



15146

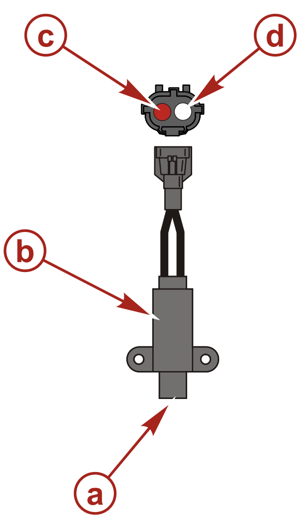
The crankshaft position sensor is located at the top of the cylinder block next to the flywheel. The sensor contains a magnet which is positioned next to the flywheel's lower ring gear. This ring gear has missing teeth at specific locations. The close proximity of the crankshaft position sensor magnet to the teeth allows a magnetic field to be created each time a tooth passes the sensor. This field collapses and creates an AC voltage pulse. This AC pulse is sent to the propulsion control module (PCM). The timing and frequency of these pulses allows the PCM to regulate ignition and fuel injector timing. If the crankshaft position sensor fails, the engine will run rough or stop running.

Crankshaft Position Sensor Test

1. Perform a visual inspection of the sensor. The tip of the sensor must be flush across the end; if not, replace the sensor.
2. The tip of the sensor must be clear of metal debris (ring gear filings).

   NOTE: A magnet is mounted in the sensor tip. If the magnet is missing, the sensor will not operate properly.
3. Inspect the flywheel pattern for:
   - Excessive corrosion
   - The teeth should have square edges
   - Only one open space on either side of the pattern groups
4. Replace the flywheel if it does not meet inspection requirements.
5. Inspect the sensor pins and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor; and loose, broken, or corroded wires at the connector.
6. Disconnect the engine harness connector from the sensor. Use the DMT 2004 digital multimeter to measure the resistance across the sensor pins. Replace the sensor if out of specification.

   NOTE: If the engine problem occurs above 3000 RPM (runs rough, no high RPM), the ohm test of the crankshaft position sensor may be good, but the crankshaft position sensor can still be defective.



17025

a - Magnet
b - CPS
c - Pin 1
d - Pin 2

DMT 2004 Digital Multimeter	91-892647A01

Crankshaft Position Sensor	
Resistance at 20 °C (68 °F)	300–350 ohms

Crankshaft Position Sensor (CPS) Removal and Installation

⚠ WARNING

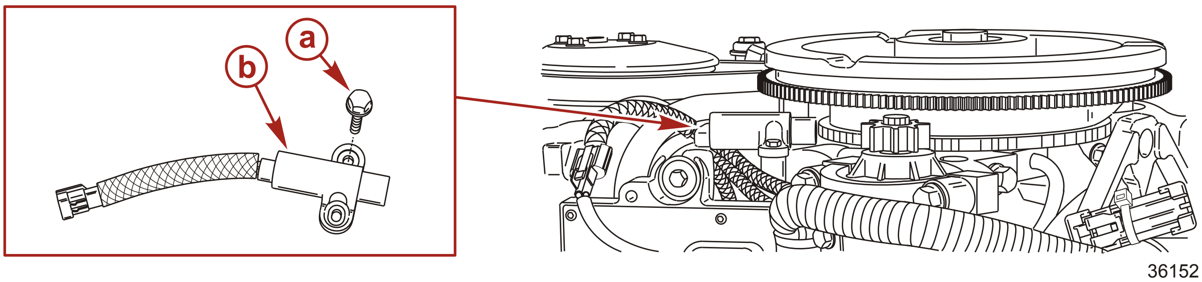
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

Removal

1. Disconnect both battery cables from the batteries.
2. Disconnect the engine harness from the CPS.
3. Remove the two screws securing the CPS to the cylinder block.

Installation

1. Install the CPS onto the cylinder block and secure with two M5 x 16 screws. Tighten the screws to the specified torque.
2. Connect the engine harness to the CPS.



a - Screw (M5 x 16) (2)
b - Crankshaft position sensor (CPS)

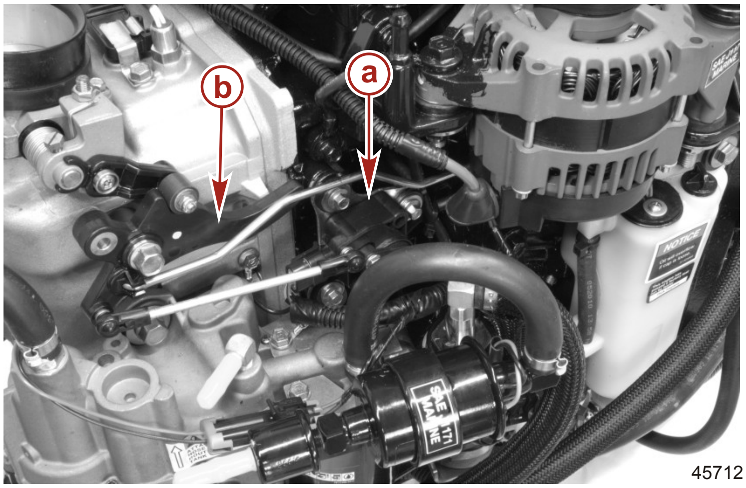
Description	Nm	lb-in.	lb-ft
Screw (M5 x 16)	5.5	49	

3. Connect the battery cables to the batteries.

Throttle Position Sensor (TPS)

The throttle position sensor (TPS) transmits throttle angle information to the propulsion control module (PCM). The PCM uses the throttle angle information, along with other sensors, to regulate fuel injector volume (pulse width) and ignition timing. Should the sensor fail, a warning horn will sound and engine RPM will be reduced. The TPS is not adjustable. The TPS position can be monitored with the computer diagnostic system. Voltage change should be smooth from idle to wide-open throttle. If the voltage change is erratic, the TPS is defective.

Throttle Position Sensor Specifications	
Model year 2001 and newer	
Idle	0.4–1.3 VDC
Wide-open throttle	4.0–4.7 VDC



45712

a - Throttle position sensor
b - Throttle cam

Throttle Position Sensor (TPS) Troubleshooting

If the throttle position sensor is out of the intended operating range when the engine is started, the propulsion control module (PCM) will sense that the throttle position sensor (TPS) has failed. The warning horn will sound, check engine light will illuminate, CDS will indicate failed TPS, and the engine will go into RPM reduction. When the engine is started, the throttle arm on the engine must be against the throttle stop screw. Do not move throttle or fast idle control lever forward.

- Check the throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Preload the throttle cable barrel one or two turns if necessary.
- Verify the driver is not pushing on the throttle (if foot throttle is used) or advancing the throttle only on the control box.
- Check the throttle cam to roller adjustment. If the roller is not down in the pocket/valley area on the cam, there is a tendency for the roller to ride up or down on the cam which causes the TPS link arm to push/pull on the TPS lever resulting changing values.

Throttle Position Sensor (TPS) Removal and Installation

Throttle Position Sensor Removal

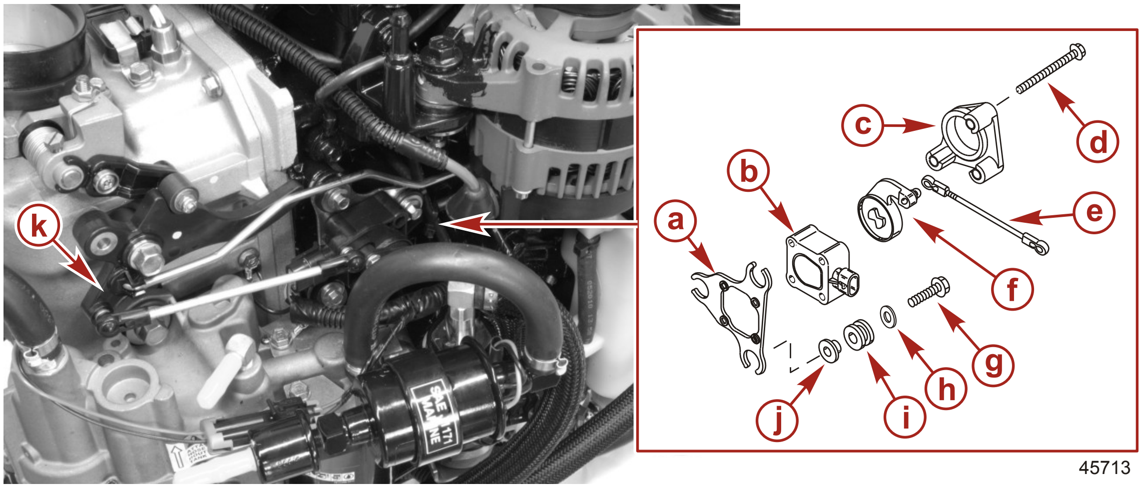
⚠ WARNING
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing,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

1. Disconnect both battery cables from the batteries.
2. Disconnect the engine harness from the TPS.
3. Remove the TPS link arm assembly from the TPS lever.
4. Remove the three M6 x 25 screws securing the TPS and cover to the crankcase.

Throttle Position Sensor Installation

1. Secure the TPS to the crankcase with three M6 x 25 screws. Tighten the screws to the specified torque.

2. Install the TPS link arm assembly onto the TPS lever. Verify the TPS lever is engaged with the TPS.



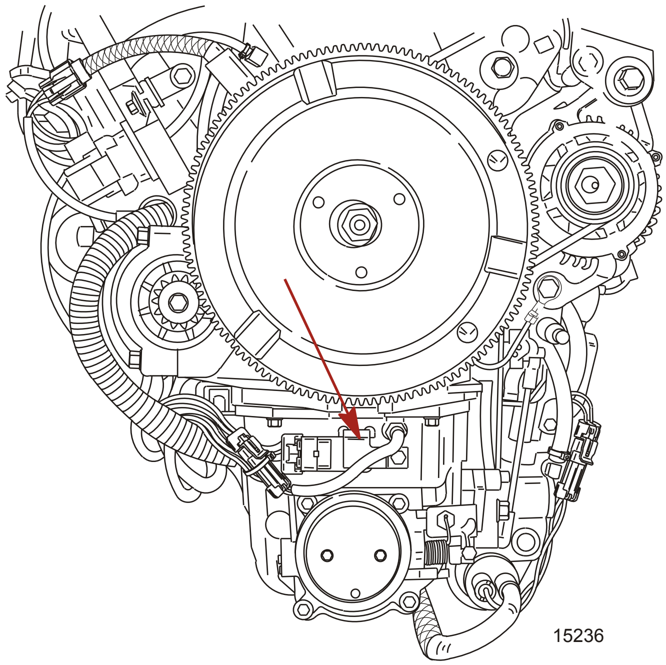
- a - Sensor bracket
- b - TPS
- c - TPS cover
- d - Screw (10-32 x 2) (3)
- e - Throttle link arm assembly
- f - TPS lever
- g - Screw (M6 x 25) (3)
- h - Washer (3)
- i - Grommet (3)
- j - Bushing (3)
- k - Throttle cam

Description	Nm	lb-in.	lb-ft
Screw (M6 x 25)	11.5	102	
Screw (10-32 x 2)	4	35	

3. Connect the engine harness to the TPS.
4. Connect the battery cables to the batteries.

Manifold Absolute Pressure (MAP) Sensor

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure. It is located at the top of the intake manifold. When the key is turned "ON" the MAP sensor reads the ambient atmospheric pressure. This information is used by the PCM as an indication of altitude and is referred to as BARRO. The manifold absolute pressure will change as a result of engine load and speed changes.



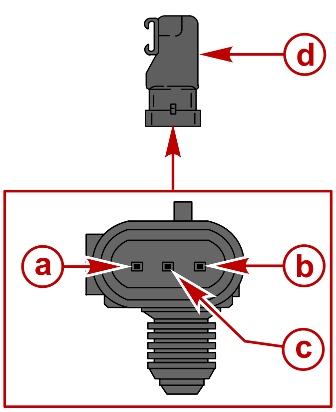
15236

Manifold Absolute Pressure Sensor Test

1. Start the engine and connect the CDS to the engine. If the MAP sensor does not appear to be indicating a pressure change, shake or move the sensor harness and connector. If the pressure begins to change, look for broken, loose, or corroded wires.

Computer Diagnostic System (CDS)	Order through SPX
Adapter Harness	84-822560A13
Extension Cable	84-825003A 1

2. Turn the ignition key switch to the "OFF" position. Disconnect the engine harness connector from the MAP sensor.
3. Visually inspect the MAP sensor pins and the wires coming from the connector. Look for broken, bent, or corroded pins at the MAP sensor; and loose, broken, or corroded wires at the engine harness connector.
4. Use the DMT 2004 digital multimeter to perform an ohm check between the MAP sensor pins A, B, and C.



a - Pin C
b - Pin A
c - Pin B
d - MAP sensor

23432

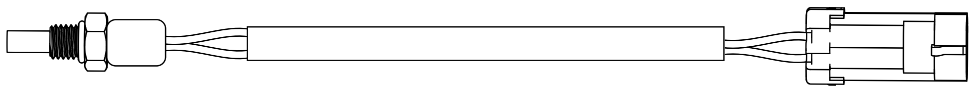
DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	**Black**		at 20 °C (68 °F)
A	B	Auto	4.28 kΩ ± 30%
A	C	Auto	98.6 kΩ ± 30%
B	A	Auto	4.28 kΩ ± 30%
B	C	Auto	102.6 kΩ ± 30%
C	A	Auto	98.6 kΩ ± 30%
C	B	Auto	102.6 kΩ ± 30%

5. If the ohm check of the MAP sensor indicates that the MAP sensor is serviceable, perform an ohm check on the wiring between the MAP sensor connector and the PCM.

Temperature Sensors

Cylinder Head Coolant Temperature Sensor

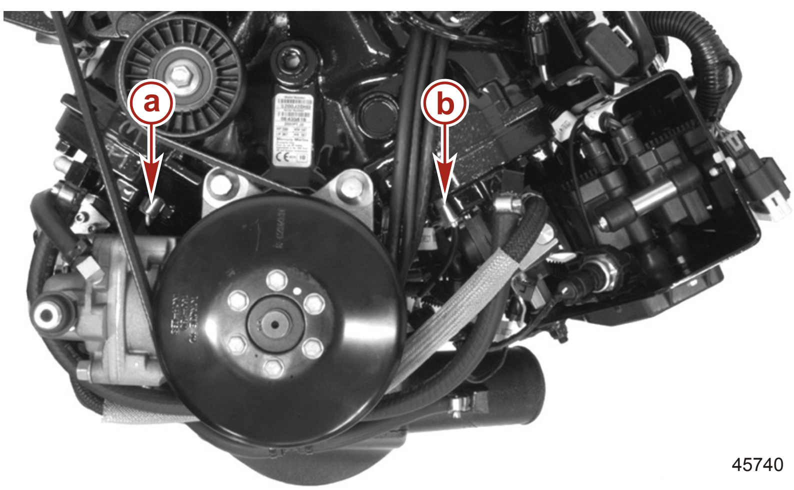


31760

The cylinder head coolant temperature sensor is a thermistor immersed in the engine coolant stream. Each cylinder head has a sensor and it is located near the top of the cylinder head. It supplies the PCM with temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the head. Low coolant temperature produces high resistance, while high temperature causes low resistance. The normal resistance value for the sensor at 20 °C (68 °F) is 12.5 kΩ ± 10%.

Cylinder Head Coolant Temperature Sensor Test

The PCM monitors the cylinder head coolant temperature sensors when the ignition key is in the run position. The computer diagnostic system (CDS) can provide a numerical readout of the head temperature before and after the engine is started. With the engine not running, cylinder head coolant temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in head coolant temperature to approximately 40–50 °C (104–122 °F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine block temperature.



45740

a - Port cylinder head sensor
b - Starboard cylinder head temperature sensor

1. With the engine running and the CDS connected to the engine, if the cylinder head coolant temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Order through SPX

2. Disconnect the engine harness connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor; and loose, broken, or corroded wires at the connector.

4. The sensor can be tested with an ohmmeter by heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Cylinder Head Coolant Temperature Sensor Ohm Test					
Centigrade	-10 °C	20 °C	40 °C	65 °C	95 °C
Fahrenheit	14 °F	68 °F	104 °F	150 °F	203 °F
Ohms	55.3 kΩ ± 10%	12.5 kΩ ± 10%	5.3 kΩ ± 10%	2.08 kΩ ± 10%	787 Ω ± 10%

5. If the ohm check of the cylinder head coolant temperature sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM.
6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the CDS.

Cylinder Head Coolant Temperature Sensor Removal

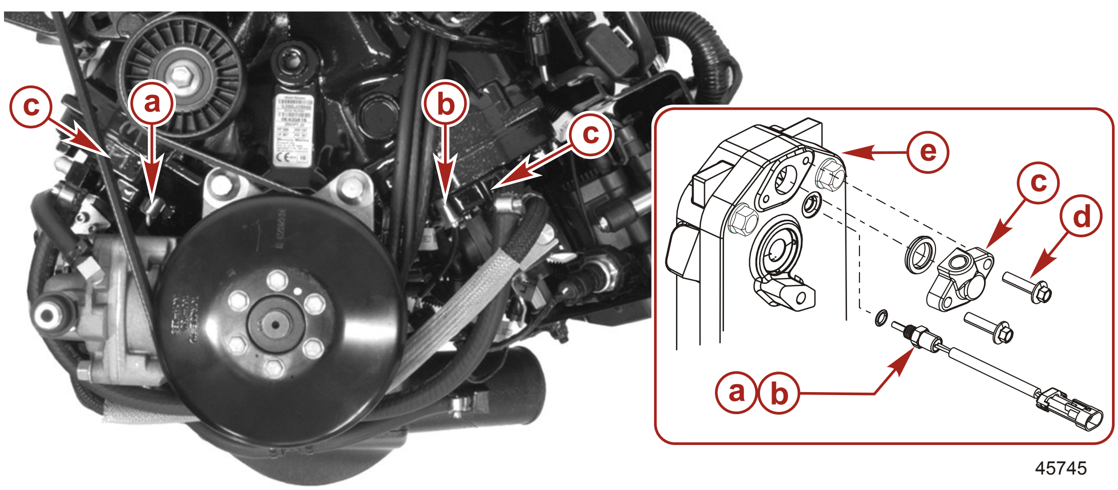
1. Disconnect the engine harness connector from the sensor harness connector.
2. Remove the two screws securing the thermostat covers to the cylinder head.
3. Remove the cover and O-ring.
4. Remove the sensor from the cylinder block.

Cylinder Head Coolant Temperature Sensor Installation

1. Inspect the sensor O-ring for cuts or abrasions. Replace the O-ring as required.
2. Apply Loctite 567 PST Pipe Sealant to the threads of the sensor.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Cylinder head coolant temperature sensor threads	92-809822

3. Install the sensor with the O-ring into the cylinder block. Tighten the sensor to the specified torque.
4. Connect the engine harness connector to the sensor.
5. Install the cover and O-ring onto the cylinder head. Tighten the screws to the specified torque.



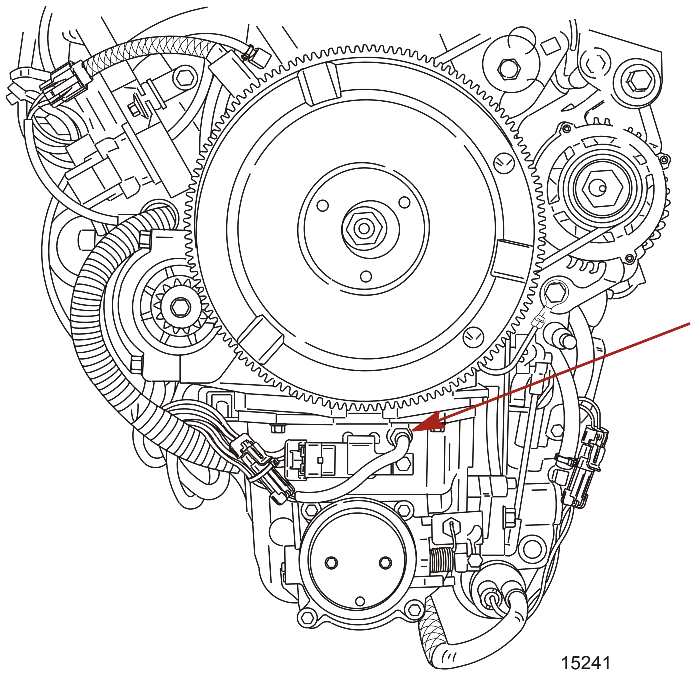
45745

- **a -** Port temperature sensor
- **b -** Starboard temperature sensor
- **c -** Cover
- **d -** Screw (M6 x 25) (2)
- **e -** Cylinder head

Description	Nm	lb-in.	lb-ft
Temperature sensor	15	133	
Cover screws	13.5	120	

Manifold Intake Air Temperature (MAT) Sensor

The manifold intake air temperature sensor is a thermistor that controls a signal voltage to the PCM. It is located on the intake manifold. It informs the PCM of the air temperature inside the intake manifold. The PCM adjusts the fuel injection duration needed to run the engine at optimum efficiency according to the MAT information. When intake air is cold, the sensor resistance is high. As the air temperature rises, resistance lowers.



Manifold Intake Air Temperature Sensor Test

The computer diagnostic system (CDS) will determine the proper functioning of the MAT sensor by providing a numerical readout of the sensor temperature before and after the engine is started. With the engine not running, intake air temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in air intake temperature. Outside air temperature will directly affect the engine manifold air intake temperature.

1. With the engine running and the CDS connected to the engine, if the MAT sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose, or corroded wire.

Computer Diagnostic System (CDS)	Order through SPX

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor; and loose, broken, or corroded wires at the connector.
4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Manifold Intake Air Temperature Sensor Ohm Test					
Centigrade	-10 °C	20 °C	40 °C	65 °C	95 °C
Fahrenheit	14 °F	68 °F	104 °F	150 °F	203 °F
Ohms	55.3 kΩ ± 10%	12.5 kΩ ± 10%	5.3 kΩ ± 10%	2.08 kΩ ± 10%	787 Ω ± 10%

5. If the wiring is serviceable, replace the PCM and recheck the sensor function using the CDS.

Guardian Protection System

The Guardian Protection System monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

If a sensor fails, the PCM will compensate so the engine will not go into a rich condition. Disconnecting a sensor for troubleshooting, may have no noticeable effect and be misleading the diagnosis of the engine. All sensor failures will be recorded and stored in the PCM.

IMPORTANT: The Guardian System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian System is designed to 1) warn the boat operator that the engine is operating under adverse conditions and 2) reduce power by limiting maximum RPM in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Guardian System Activation

Condition	Result
Engine overheat	Engine power level can be reduced to any percentage down to a fast idle, if overheat condition persists.
Air compressor overheat	Warning horn is activated, but there is no power reduction.
Block water pressure low	Engine power level can be reduced to any percentage down to a fast idle, if overheat condition persists.
Throttle position sensor failure	If the throttle position sensor fails or becomes disconnected, power will be limited to a maximum of approximately 4500 RPM. When the TPS is in the fail mode, the PCM will use the MAP sensor for a reference to determine fuel calibration.
Temperature sensor (cylinder head and air compressor) failure	If a temperature sensor should fail or become disconnected, power will be limited to a maximum of approximately 4500 RPM.
Battery voltage (too high or too low)	Battery voltage greater than 16 volts or less than 10 volts will result in engine output power being reduced. The higher or lower the voltage is outside of these parameters, the greater the percentage of power reduction. In an extreme case, power could be reduced to a fast idle.
Oil pump failure	If the oil pump fails or an open circuit occurs between the pump and the PCM, engine power will be reduced to a fast idle.

Engine Overspeed Protection System

The system is activated when the engine speed exceeds the maximum allowable RPM.

Overspeed activation for the outboard will result in the warning horn sounding continuously and the engine speed automatically being reduced to within allowable limits.

Warning Horn Signals

When the key switch is turned to the "ON" position, the horn will be audible for a moment as a test to show the horn is working.

The warning horn will emit either a continuous beep or intermittent short beeps. This will alert the operator and help identify the following listed situations. For visual display of the specific engine functions and additional engine data, refer to the helm-mounted SmartCraft product for more information.

Warning Horn		
Function	**Sound**	**Description**
Start up	One beep	Normal system test.
Low oil reserve	Four beeps every two minutes	Oil level is low in the engine-mounted oil reservoir. Refill the engine-mounted oil reservoir and the remote oil tank.
Water in fuel	Four beeps every two minutes	Water in the water separating fuel filter reaches the full level. Water can be removed from the filter.
Cooling system problem	Continuous	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. The Guardian System must be reset before engine will operate at higher speeds. Moving throttle lever back to idle resets the system.
Oil level is critically low	Continuous	Engine Guardian System is activated. Power will be limited. The oil level is critically low in the engine-mounted oil reservoir. Refill the engine-mounted oil reservoir and the remote oil tank.
Oil pump failure	Continuous	Engine Guardian System is activated. Power will be limited. The warning horn is activated if the oil pump stops functioning electrically. No lubricating oil is supplied to the engine.
Engine overspeed	Continuous	The warning horn is activated any time engine speed exceeds the maximum allowable RPM. The system will limit the engine speed within the allowable range. Engine overspeed indicates a condition that should be corrected.
Sensor out of range	Continuous	Engine Guardian System is activated. Power will be limited.
	Intermittent beep	

Electrical

Section 2B - Charging and Starting System

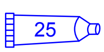
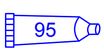
2
B

Table of Contents

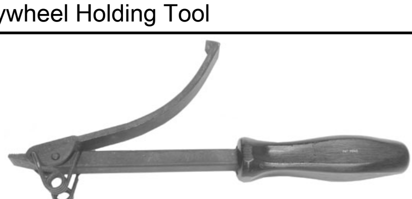
Charging and Starting Specifications

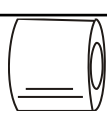
Charging and Starting Specifications at 21 °C (70 °F)	
Alternator output (regulated)	
Output at the battery at 2000 RPM	28–36 A
Output at the alternator at 2000 RPM	42–48 A
Voltage set point	14.5 ± 0.25 volts
Regulator current draw[1.]	
Ignition switch "OFF"	0.585 mA
Ignition switch "ON"	150.0 mA
Starter draw	
Under load	200 A
No load	65 A
Average engine RPM when cranking	300–325 RPM
Starter solenoid current at 12.6 volts	
Pull in coil	40 A
Hold in coil	10 A
Start solenoid current draw	4 A
Starter brush length (minimum)	6.35 mm (0.25 in.)
Battery rating (minimum)	
Marine cranking amperes	1000
Cold cranking amperes	800
Ampere hour (Ah)	180

Lubricants, Sealants, Adhesives

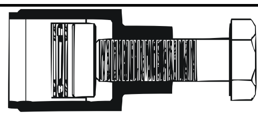
Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Starter brush lead connection	92- 25711 3
		Starter ground wire connection	
	2-4-C with Teflon	Bushing and belt tensioner arm assembly	92-802859A 1
		Battery terminal bolts	
		Belt tensioner	
		Solenoid actuating plunger	

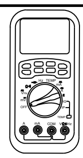
Special Tools

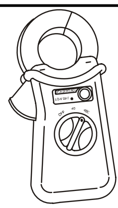
Flywheel Holding Tool	91- 52344
 4738	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler

Protector Cap	91- 24161
 13445	Protects the crankshaft when removing the flywheel; use with flywheel puller (91-849154T 1)

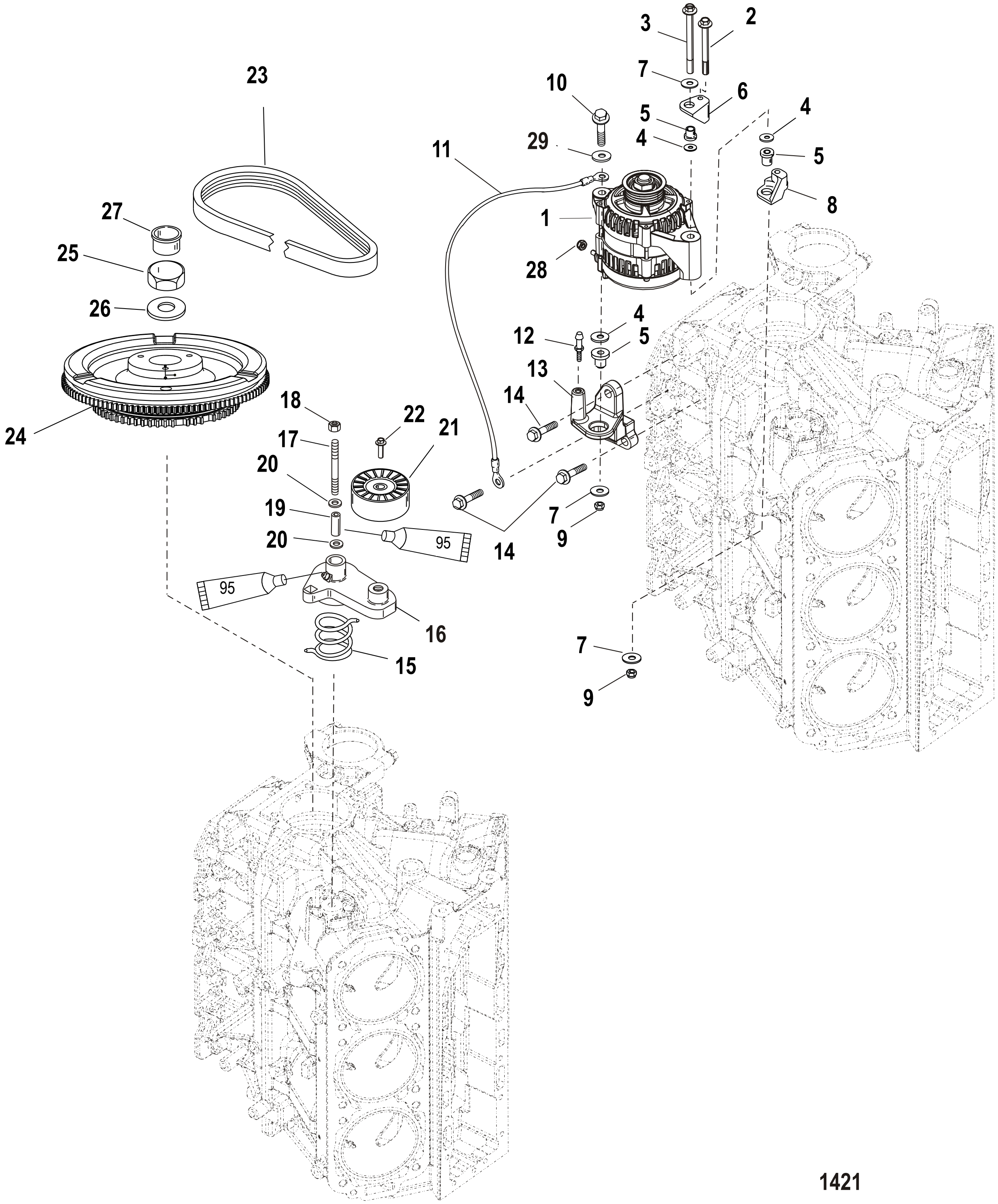
1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Flywheel Puller	91-849154T 1
 7617	Removes the flywheel from the crankshaft

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.

Clamp-on Current Probe	91-802650 1
 4006	Measures the current output of battery charging systems or current draw of electric motors.

Flywheel/Alternator

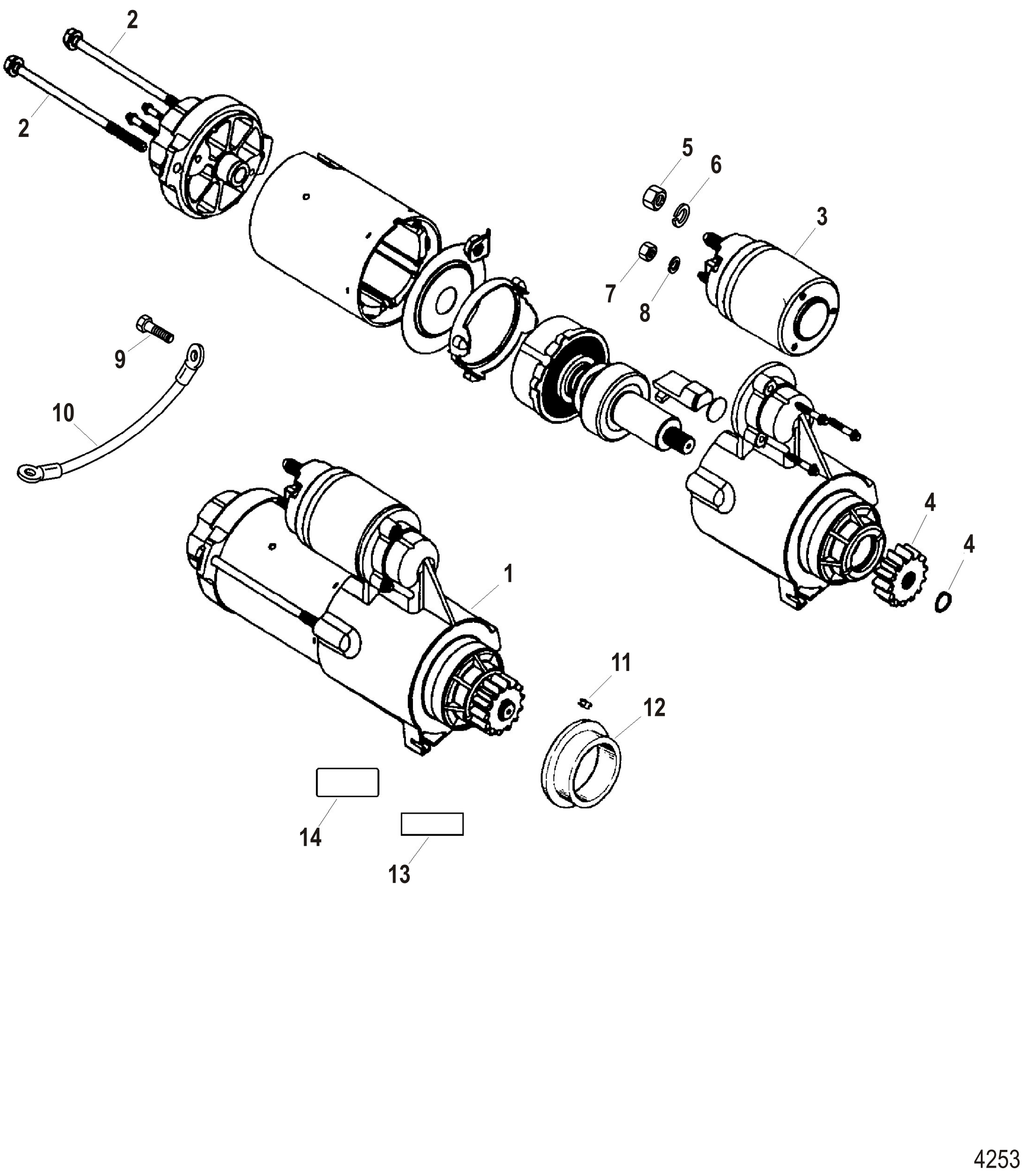


Flywheel/Alternator

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Alternator			
2	1	Bolt (M10 x 100) (stainless steel)	75		55
3	1	Bolt (M10 x 120) (stainless steel)	54		40
4	3	Washer (0.390 x 1.00 x 0.06)			
5	3	Mount			
6	1	Bracket			
7	3	Washer (0.406 x 1.250 x 0.089)			
8	1	Bracket			
9	2	Nut (M10)	54		40
10	1	Bolt (M10 x 55)	54		40
11	1	Cable assembly			
12	1	Pin			
13	1	Bracket			
14	3	Screw (0.312-18 x 1 in.) (stainless steel with nylon patch)	20	180	15
15	1	Spring			
16	1	Belt tensioner arm assembly			
17	1	Stud (M10 x 85)			
18	1	Nut (M10)	20	180	15
19	1	Bushing			
20	2	Washer			
21	1	Pulley assembly			
22	1	Screw (M10 x 35) (stainless steel)	34		25
23	1	Belt			
24	1	Flywheel			
25	1	Nut (0.625-18)	170		125
26	1	Washer (0.641 x 1.250 x 0.190)			
27	1	Yellow plug			
28	1	Nut (M6) (stainless steel)	7	62	
29	1	Washer			

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Bushing and belt tensioner arm assembly	92-802859A 1

Starter Motor Components



Starter Motor Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Starter motor assembly			
2	2	Through bolt	12.5	110	
3	1	Solenoid kit			
4	1	Gear kit			
5	1	Nut (M8) (stainless steel)	9	80	
6	1	Lockwasher (0.312)			
7	1	Nut (M5) (stainless steel)	2.5	22	
8	1	Lockwasher (M5)			
9	1	Screw and lockwasher (0.250-20 x 0.625) (stainless steel)	11	97	
10	1	Cable assembly (6.0 in.) (black)			
11	1	Rubber stop			
12	2	Starter motor collar			
13	1	Start in gear caution decal			
14	1	High voltage warning decal			

Wire Color Code Abbreviations

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

Battery

Battery Cable Test

This test is used to determine if there is excessive resistance in the battery's positive or negative cables, or if the cable is sized properly to carry the necessary current needed to crank the engine at the proper RPM.

IMPORTANT: This test must be performed while the key switch is in the "START" position. Ignore any voltage readings taken without the circuit under load.

⚠ WARNING
Moving parts can cause serious injury or death. Wear eye protection and keep hands, hair, and clothing away from moving parts when performing tests or checking adjustments on an operating engine.

1. Perform a load test on the battery following the instructions supplied with the load tester. Ensure the battery is brought to a full charge after being tested.
2. With the key switch in the "START" position, measure the voltage across the battery posts, not the cable clamps. Record the voltage reading. If the voltage is less than 10 VDC, replace the battery.

   NOTE: The voltage reading in step 2 is the base voltage. The base voltage reading will be compared to the voltage readings obtained in the following steps.
3. With the key switch in the "START" position, measure the voltage from the battery positive post (not the cable clamp) to the starter post (the stud where the battery positive cable is connected). Record the voltage reading.
4. With the key switch in the "START" position, measure the voltage from the starter case to the battery negative post (not the cable clamp). Record the voltage reading.
5. If the voltage reading in step 3 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.
6. If the voltage reading in step 4 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.

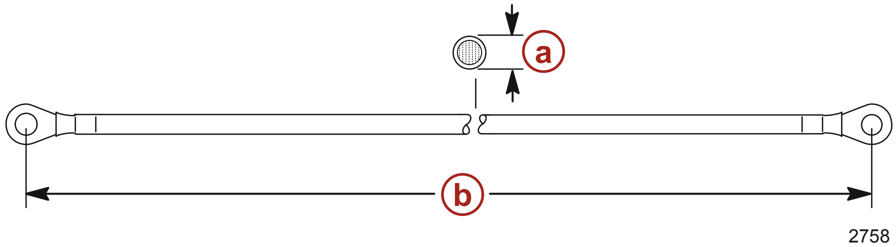
Resistance in the cables can cause a voltage drop and limit current to the starter. If corrosion is present, or if the starter is worn, there may not be enough amperage to turn the starter motor.

NOTE: If the voltage at the starter is less than 11 VDC, the engine may not start.

Battery Cable Size for Outboard DTS Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

NOTE: If longer battery cables are required, the wire gauge size must increase. See the following chart for correct wire gauge size.



a - Wire gauge size
b - Battery cable length

Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)	Cable Length	Copper Battery Cable Wire Gauge Size Number (SAE)
	Verado and OptiMax DTS Engines		Verado and OptiMax DTS Engines
2.4 m (8 ft)	-	**7.6 m (25 ft)**	1
2.7 m (9 ft)	-	**7.9 m (26 ft)**	1/0
3.0 m (10 ft)	-	**8.2 m (27 ft)**	1/0
3.4 m (11 ft)	-	**8.5 m (28 ft)**	1/0
3.7 m (12 ft)	4	**8.8 m (29 ft)**	1/0
4.0 m (13 ft)	2	**9.1 m (30 ft)**	1/0
4.3 m (14 ft)	2	**9.4 m (31 ft)**	1/0
4.6 m (15 ft)	2	**9.8 m (32 ft)**	1/0
4.9 m (16 ft)	2	**10.1 m (33 ft)**	2/0
5.2 m (17 ft)	2	**10.4 m (34 ft)**	2/0
5.5 m (18 ft)	2	**10.7 m (35 ft)**	2/0
5.8 m (19 ft)	2	**11.0 m (36 ft)**	2/0
6.1 m (20 ft)	2	**11.3 m (37 ft)**	2/0
6.4 m (21 ft)	1	**11.6 m (38 ft)**	2/0
6.7 m (22 ft)	1	**11.9 m (39 ft)**	2/0
7.0 m (23 ft)	1	**12.2 m (40 ft)**	2/0
7.3 m (24 ft)	1		

Replacement Parts

⚠ 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.

IMPORTANT: Deep-cycle batteries are not suitable for use as engine starting batteries or for use as accessory batteries that are connected to high output engine charging systems. Deep-cycle battery life may be shortened by high output engine charging systems. Refer to individual battery manufacturer instructions for specific battery charging procedures and applications.

Recommended Battery

USA and Canada (SAE) specifications: A 12 volt marine starting battery with a minimum marine cranking amperage (MCA) rating of 800 amperes with a minimum reserve capacity rating of 135RC should be used.

International (EN) specifications: A 12 volt marine starting battery with a minimum cold cranking amperage (CCA) rating of 975 amperes with a minimum of 65 ampere hour (Ah) rating should be used.

IMPORTANT: For DTS products, each engine must be equipped with its own starting battery. If your boat application requires additional battery loads for boat accessories or marine electronics, it is recommended that an auxiliary battery or batteries be installed.

Battery Precautions

⚠ 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.

When charging batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through holes in the vent plugs and may form an explosive atmosphere around the battery if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion, which may shatter the battery.

The following precautions should be observed to prevent an explosion:

1. Do not smoke near batteries being charged or which have been charged very recently.
2. Do not break live circuits at terminals of batteries, because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. Do not reverse polarity of battery terminal to cable connections.

Charging a Discharged Battery

⚠ 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.

The following basic rules apply to any battery charging situation:

1. Any battery may be charged at any rate (in amperes), or as long as spewing of electrolyte (from violent gassing) does not occur, and for as long as electrolyte temperature does not exceed 52 °C (125 °F). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 52 °C (125 °F), charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2 hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260–1.275, corrected for electrolyte temperature with electrolyte level at 4.8 mm (3/16 in.) over plate, unless electrolyte loss has occurred (from age or overfilling), in which case, specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check the battery voltage while cranking the engine with an electric starting motor at ambient air temperature of 23.8 °C (75 °F), place the red (+) lead of the tester on the positive (+) battery terminal and the black (–) lead of the tester on the negative (–) battery terminal. If the voltage drops below 10-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage, either in winter storage or in dealer stock, if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate, and dirt from the top surface by running water over top of the battery. Be sure, however, the vent caps are tight beforehand and blow off all excess water thoroughly with compressed air. Check water level, making sure the plates are covered.
2. When adding distilled water to the battery, be extremely careful not to fill more than 4.8 mm (3/16 in.) above perforated baffles inside the battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling the battery will cause the electrolyte to overflow (if filled beyond 4.8 mm [3/16 in.] above baffles).
3. Grease terminal bolts well with 2-4-C with Teflon and store the battery in a cool-dry place. Remove the battery from storage every 30–45 days, check the water level, and put on charge for 5 or 6 amps. Do not fast charge.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Battery terminal bolts	92-802859A 1

4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.

5. Repeat preceding charging procedure every 30–45 days, as long as the battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place the battery back in service, remove excess grease from the terminals (a small amount is desirable on terminals at all times), recharge again, as necessary, and reinstall the battery.

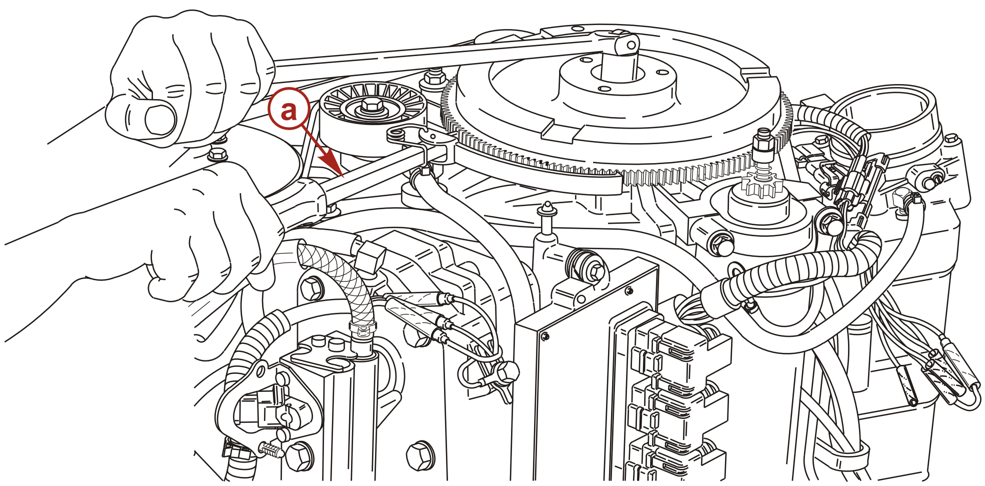
Flywheel Removal and Installation

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 of the battery cables from the batteries.
2. Remove the flywheel cover from the engine.
3. Remove the alternator belt.
4. Disconnect the spark plug leads from the spark plugs.
5. Hold the flywheel with the flywheel holder and remove the flywheel nut and washer.

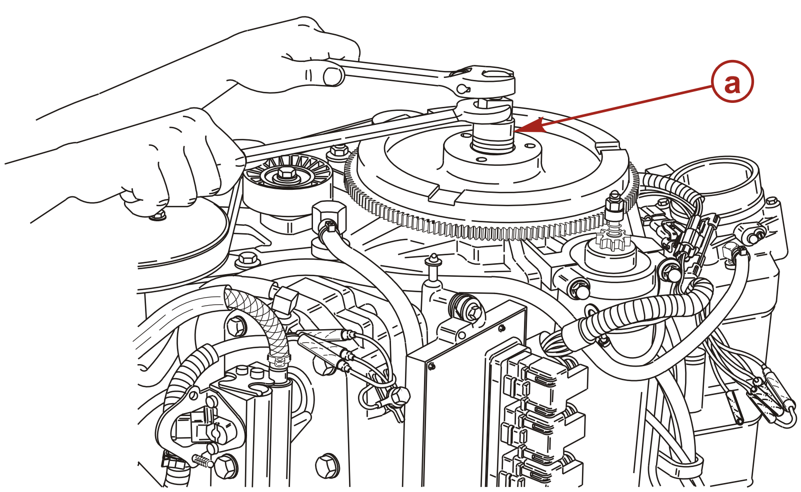


a - Flywheel holder

15314

Flywheel Holding Tool	91- 52344

6. Install a crankshaft protector cap on the end of the crankshaft and install the flywheel puller.
7. Hold the flywheel puller with a wrench and tighten the bolt until the flywheel is loose.



a - Flywheel puller

15315

Protector Cap	91- 24161

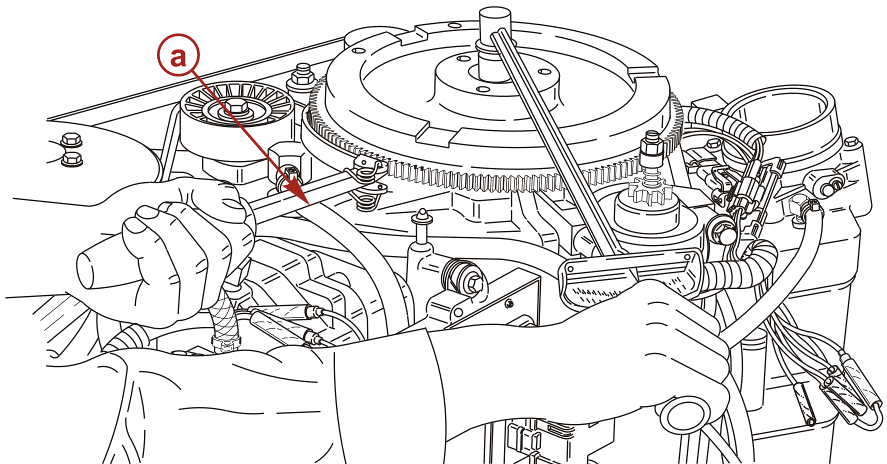
Flywheel Puller	91-849154T 1

8. Remove the flywheel and inspect the flywheel for cracks or damage.

Installation

IMPORTANT: Clean the flywheel/crankshaft taper with a mild solvent and assemble dry.

1. Align the flywheel with the master crankshaft spline and install the flywheel.
2. Install the washer and nut.
3. Hold the flywheel with the flywheel holding tool and tighten the flywheel nut to the specified torque.



15316

a - Flywheel holder

Description	Nm	lb-in.	lb-ft
Flywheel nut	170		125

Flywheel Holding Tool	91- 52344

4. Install the alternator belt.

Alternator System

Alternator Description

The alternator employs a rotor that is supported in two end frames by ball bearings, and is driven at 2.8 times engine speed. The rotor contains a field winding enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes which make continuous sliding contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

The 3-phase stator is mounted directly over the rotor pole pieces and between the two end frames. It consists of three windings wound 120 degrees electrically out of phase on the inside of a laminated core.

The rectifier bridge contains six diodes which allows current to flow from the ground, through the stator, and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge changes this alternating current to direct current which appears at the output terminal. The diode trio is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by a transistorized voltage regulator that senses the voltage at the battery, and regulates the field current to maintain alternator voltage for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes prevent the battery from discharging back through the stator.

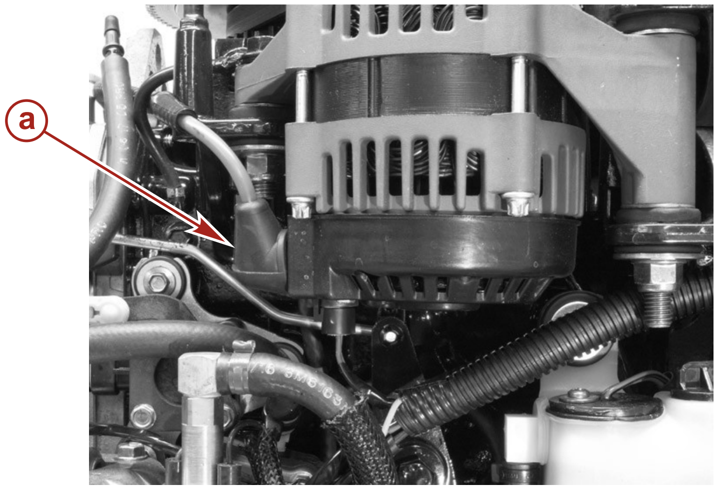
A small amount of current is supplied by the excitation circuit in the regulator to the rotor field to initially start the alternator charging. Once the alternator begins to produce output, field current is supplied solely by the diode trio.

The alternator is equipped with two fans which induce air flow through the alternator to remove heat created by the rectifier and stator.

Diagnosis of Alternator System on the Engine

1. If the battery is undercharged, verify the condition is not caused by excessive accessory current draw or by accessories which have been accidentally left on.
2. Check the physical condition and the state of the battery charge. The battery must be 75% (1.230 specific gravity) or greater to obtain valid results in the following tests. Charge the battery if it does not show the minimum 75% state of charge.
3. Inspect the entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly the battery cable clamps and battery terminals.
4. The alternator mounting bracket has rubber isolation mounts. Ensure the alternator ground cable is secured to the alternator and the cylinder block.

   IMPORTANT: The red fusible link cable on the alternator must be tight. A discolored insulator sleeve indicates the lead was loose and becoming hot. Verify the fusible link cable attaching locknut is torqued to specification.

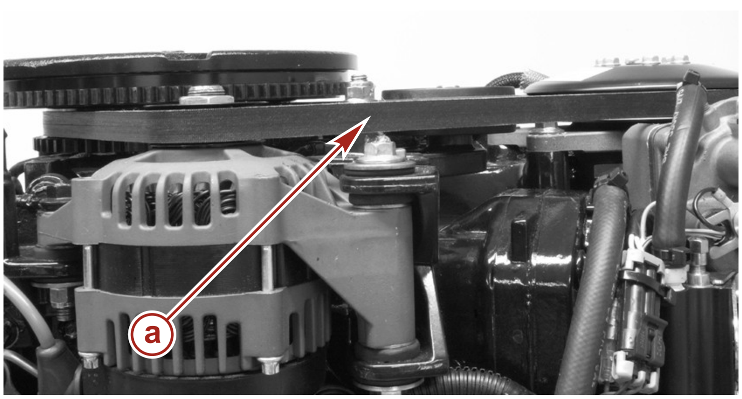


32031

a - Terminal insulator sleeve (hidden under boot)

Description	Nm	lb-in.	lb-ft
Nut (M6)	7	62	

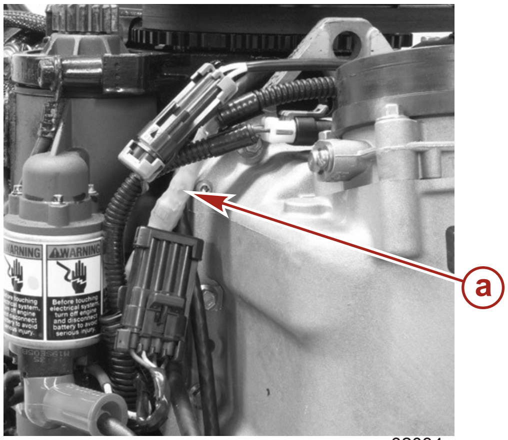
5. Check the belt for excessive wear, cracks, glazed surfaces, and fraying. Belt tension is maintained by a belt tensioner assembly.



32032

a - Belt

6. Inspect the 100 amp fusible link located on the starboard side of the engine. If the fusible link is blown, check the battery leads for reversed polarity connection before replacing the fusible link.



32034

a - 100 amp fusible link

Alternator System Circuitry Test

1. Check the belt condition and tension.
2. Check the wire connections at the alternator for tightness and corrosion.
3. Check the alternator ground wire for tightness at the alternator and cylinder block.
4. Check the wire connections at the battery for tightness and corrosion.
5. Check the battery condition. The battery should be fully charged.

Output Circuit

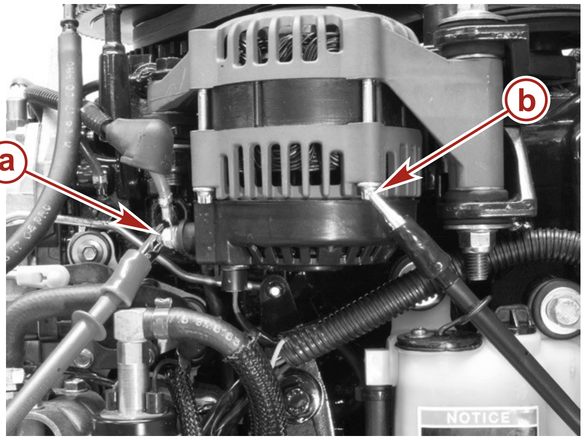
Perform the following tests with a DMT 2004 digital multimeter to ensure the circuits between the alternator and all components within the charging system are in good condition.

DMT 2004 Digital Multimeter	91-892647A01

1. Connect the DMT positive (+) lead to the positive (+) battery terminal.
2. Connect the DMT negative (–) lead to the negative (–) battery terminal.
3. Supply cooling water to the engine.
4. Start the engine and increase the engine speed to 1300 RPM.
5. Observe the voltage reading.
6. If the reading is between 13.5 and 14.8 volts, switch the DMT to the AC volt position. A reading of 0.25 AC volts or less indicates the alternator diodes are functional. A reading above 0.25 AC volts indicates the diodes are faulty and the alternator must be replaced.

   NOTE: *A voltage reading between 13.5 and 14.8 volts are for starting systems without a battery isolator installed. A battery isolator will have a parasitic voltage drop and the alternator will compensate for the voltage drop. The output voltage may be as high as 19 volts.*
   A very high voltage level measured at the output terminal of the alternator may be an indication of an open circuit between the output terminal and the battery. A blown fusible link is the most likely cause for an open circuit.
   The reason for the high voltage reading is the alternator sense circuit is indicating reduced battery voltage and causes the alternator to increase voltage output due to the blown fusible link. The voltage output could be as high as 27 volts. This higher voltage is sometimes interpreted as a failed regulator and the complete alternator is mistakenly replaced.
7. If the reading is below 13.5 volts:
   a. Connect the positive (+) DMT lead to the alternator output stud.
   b. Connect the negative (–) DMT lead to a ground on the alternator.
   c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained or if the reading varies, inspect the wiring harness for loose connections, corrosion, breaks, or shorts. Repair or replace the harness as required.

8. If the reading is above 15 volts at the battery without a battery isolator installed, the alternator is overcharging and must be replaced.

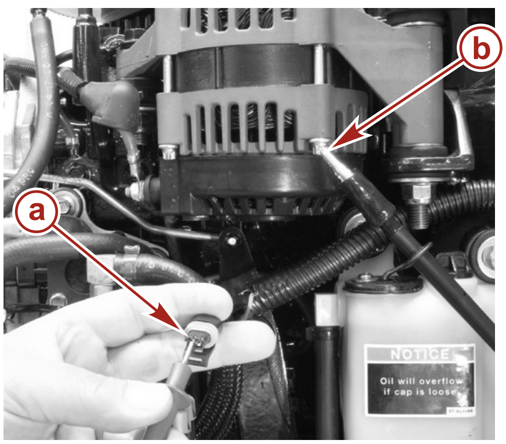


32042

a - Alternator output stud
b - Alternator ground

Sensing Circuit

1. Unplug the red and purple excitation/sensing wire connector from the alternator.
2. Connect the positive (+) DMT lead to the red pin and the negative (–) DMT lead to the alternator ground.
3. The DMT should indicate the battery voltage. If battery voltage is not present, check the red lead for a loose or dirty connection, or damaged wiring.



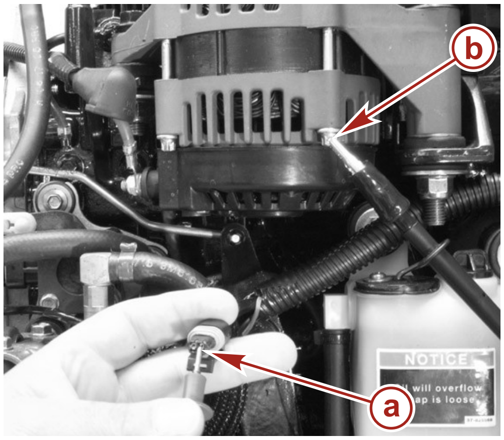
32044

a - Sensing circuit red lead
b - Alternator ground

Excitation Circuit

1. Unplug the red and purple excitation/sensing wire connector from the alternator.
2. Connect the positive (+) DMT lead to the purple pin and the negative (–) DMT lead to the alternator ground.

3. Turn the ignition key to the "ON" position. The DMT should indicate battery voltage. If battery voltage is not present, check the purple lead for a loose or dirty connection, damaged wiring, or a malfunctioning main power relay.



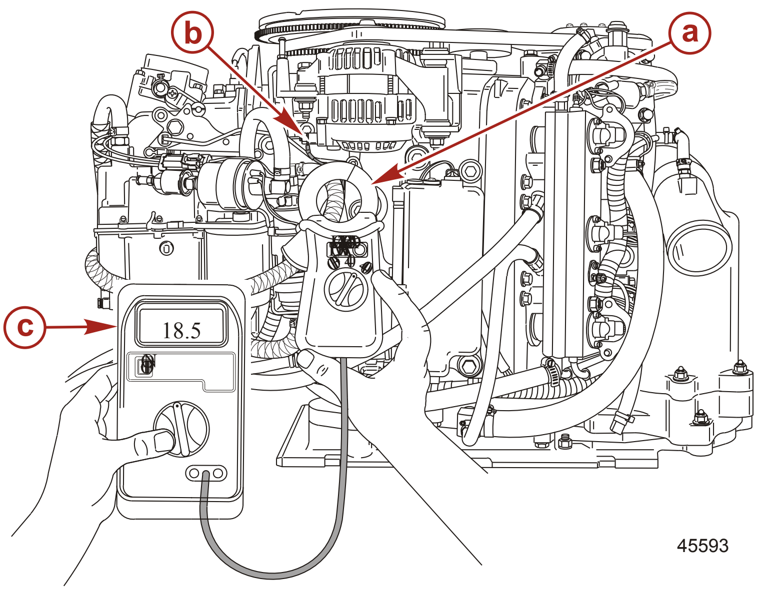
32045

a - Excitation circuit purple lead
b - Alternator ground

Current Output

IMPORTANT: Before conducting current output test, ensure that all boat electrical accessories are turned off.

1. With the engine shut off, install ammeter with clamp-on current probe (capable of reading 60+ amperes) onto the alternator charging conductor (10 AWG red wire).
2. Start the engine and allow to warm up.
3. Battery voltage should be between 14.0 and 15.0 VDC for all engine RPM's.
4. Supply an external load to the battery until the battery voltage drops to 13 volts or less.
5. Alternator output current should correspond with the table below.



45593

a - Ammeter (DMT 2004 digital tachometer multimeter)
b - Clamp-on current probe
c - Alternator charging conductor (10 AWG red wire)

DMT 2004 Digital Multimeter	91-892647A01
Clamp-on Current Probe	91-802650 1

Alternator Current Output at 21 °C (70 °F)	
Engine Speed	**Current Output - Amps (± 3)**
1000	28
2000	45
3000	50
4000	52
5000	53

Current Output Troubleshooting	
Current output is low	Battery cables are loose or corroded
	Defective battery (open circuit)
	Defective alternator
Current output is high	Accessories turned on
	Defective battery (internal short)
	Defective alternator

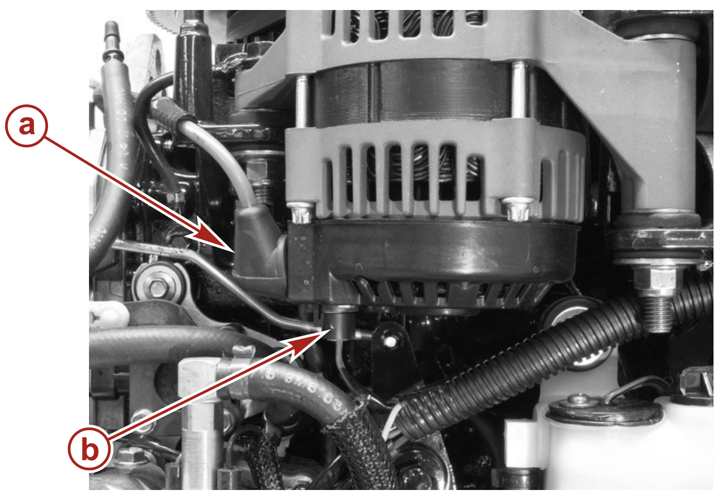
Alternator Removal and Installation

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.

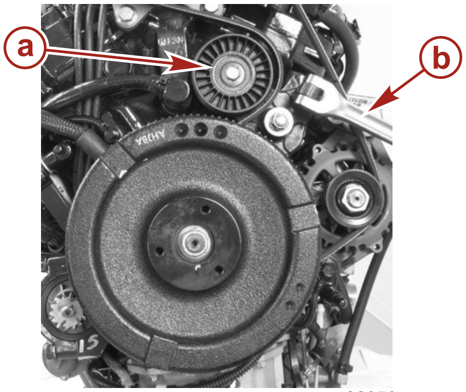
1. Disconnect the battery cables from the battery.
2. Disconnect the fusible link cable from the alternator output terminal.
3. Disconnect the excitation/sensing wire connector from the alternator.



32049

a - Fusible link cable
b - Excitation/sensing wire connector

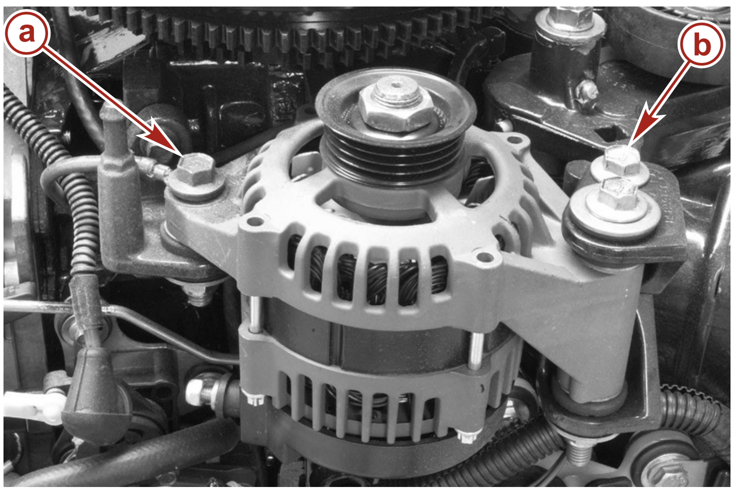
4. Use a breaker bar to relieve the tension on the alternator belt and remove the alternator belt.



32050

a - Belt tensioner assembly
b - Breaker bar

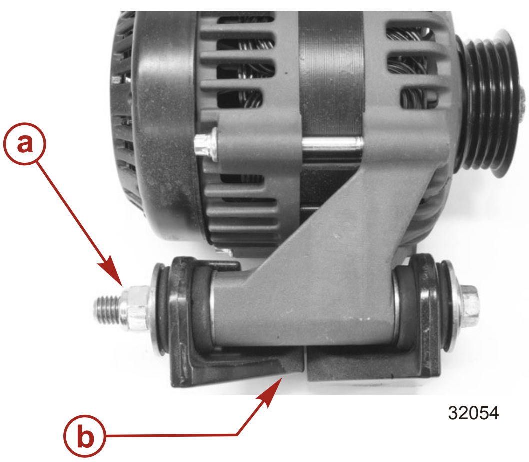
5. Remove the M10 x 55 bolt and nut securing the alternator ground wire and alternator to the cylinder block.
6. Remove the M10 x 100 bolt securing the alternator to the cylinder block.



32051

a - Bolt (M10 x 55) and nut
b - Bolt (M10 x 100)

7. Remove the M10 x 120 bolt and nut securing the isolation brackets to the alternator.

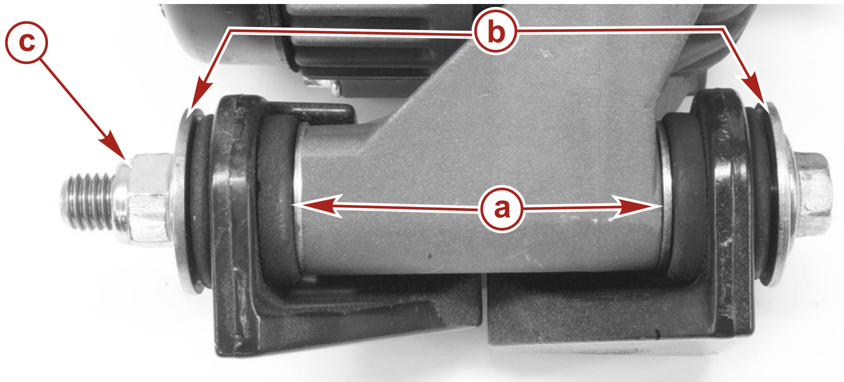


32054

a - Bolt (M10 x 120) and nut
b - Isolation brackets

Installation

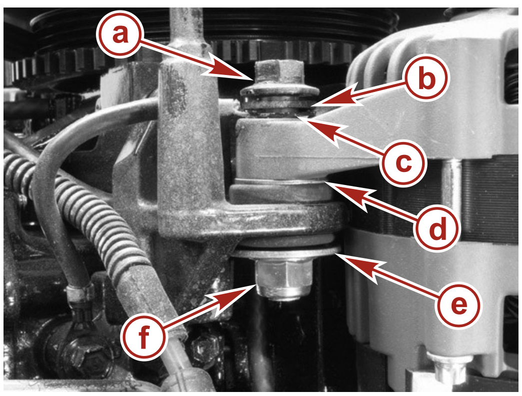
1. Install the isolation brackets onto the alternator. Verify there are washers between the isolation bracket grommets and the alternator. Secure the isolation brackets to the alternator with large washers and a M10 x 120 bolt and nut. Do not tighten the bolt and nut at this time.



32055

a - Washers between the isolation bracket grommets
b - Large washers
c - Bolt (M10 x 120) and nut

2. Install a washer onto the M10 x 55 alternator bolt. Install the alternator ground wire onto the alternator bolt.
3. Install a washer between the alternator and the isolation bracket grommet.
4. Secure the alternator to the isolation bracket with the M10 x 55 bolt, a large washer, and nut. Do not tighten the bolt and nut at this time.

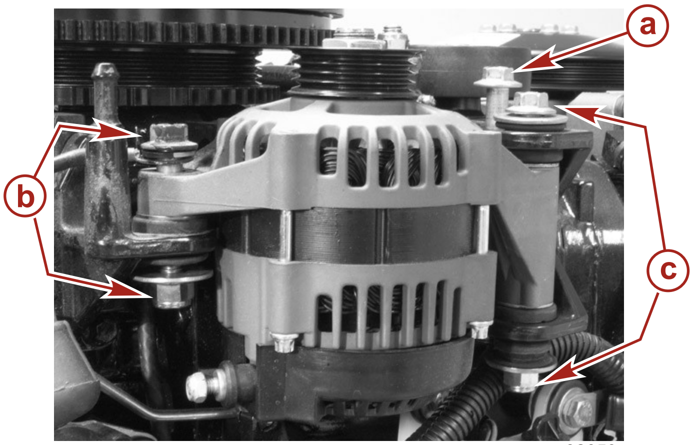


32056

a - Bolt (M10 x 55)
b - Washer
c - Alternator ground wire
d - Washer
e - Large washer
f - Nut

5. Secure the alternator isolation brackets to the cylinder block with a M10 x 100 bolt. Tighten the bolt to the specified torque.
6. Tighten the M10 x 55 bolt and nut to the specified torque.

7. Tighten the M10 x 120 bolt and nut to the specified torque.

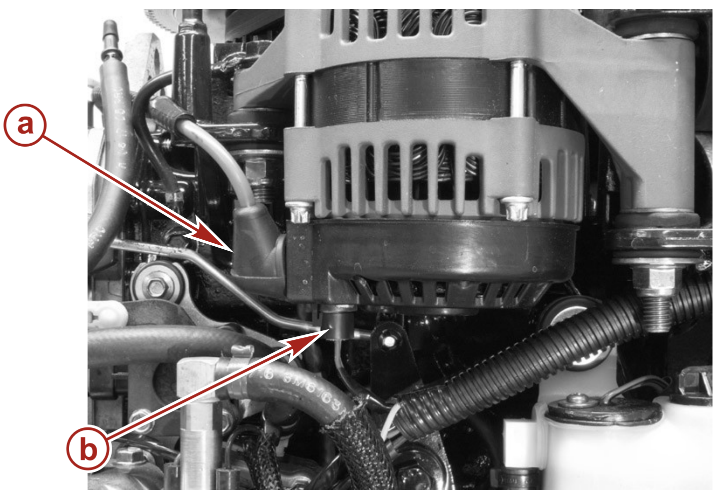


32059

- a - Bolt (M10 x 100)
- b - Bolt (M10 x 55) and nut
- c - Bolt (M10 x 120) and nut

Description	Nm	lb-in.	lb-ft
Bolt (M10 x 100)	75		55
Bolt (M10 x 55) and nut	54		40
Bolt (M10 x 120) and nut	54		40

8. Connect the excitation/sensing wire connector to the alternator.
9. Connect the fusible link cable to the alternator output terminal. Secure the fusible link cable with a M6 nut. Tighten the nut to the specified torque. Protect the alternator output terminal with the insulator boot.

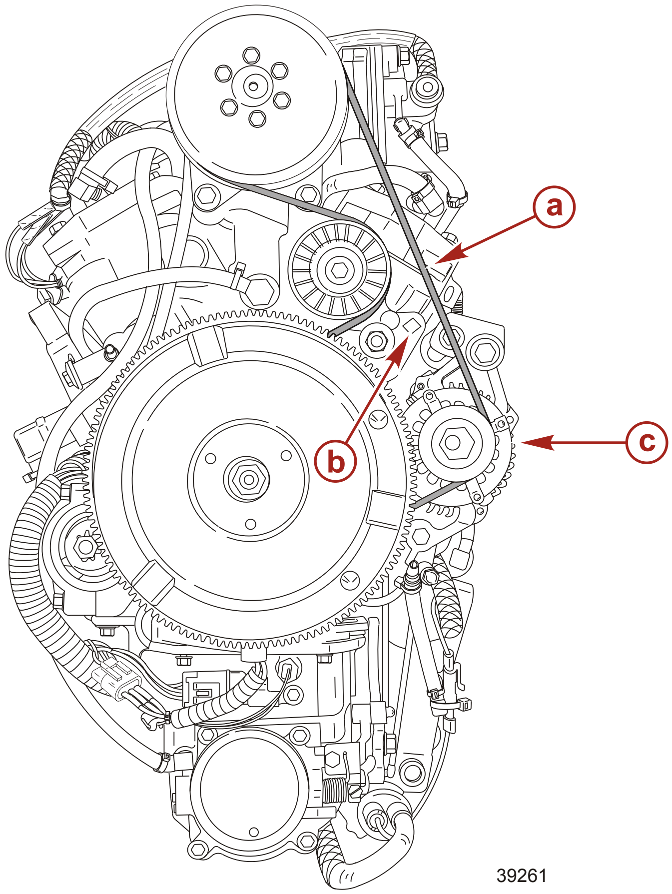


32049

- a - Fusible link cable
- b - Excitation/sensing wire connector

Description	Nm	lb-in.	lb-ft
Nut (M6)	7	62	

10. Use a breaker bar to move the belt tensioner and install the alternator belt. Install the belt with the lettering facing up.



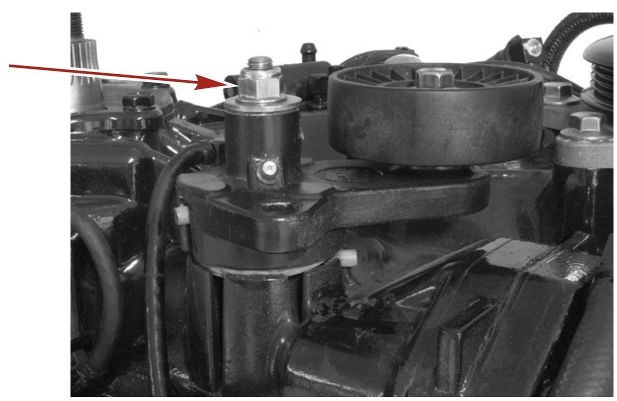
a - Belt
b - Breaker bar tensioner slot
c - Alternator

Belt Tensioner Removal and Installation

NOTE: The following procedure shows the alternator removed from the powerhead for installation clarity. It is not necessary to remove the alternator to remove and install the belt tensioner.

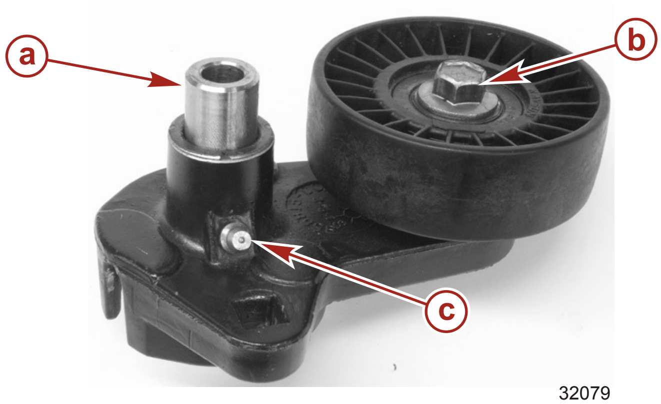
Removal

1. Remove the alternator belt.
2. Remove the flywheel.
3. Remove the nut and washer securing the belt tensioner to the cylinder block. Remove the belt tensioner, spring, and washer.



4. Remove the bushing from the belt tensioner.

5. Remove the screw securing the pulley to the belt tensioner.

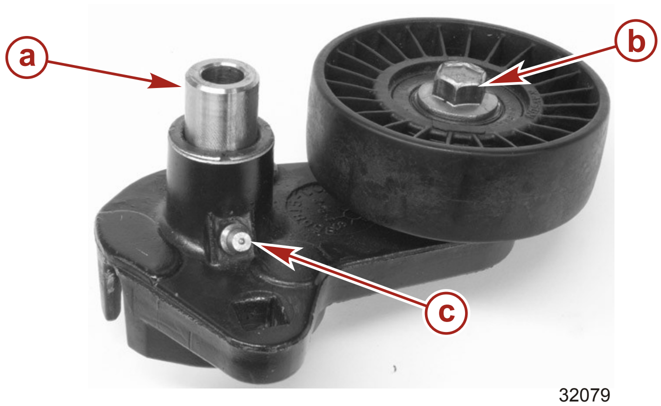


32079

a - Bushing
b - Screw securing the pulley
c - Grease fitting

Installation

1. Install the pulley to the belt tensioner and secure with a M10 x 35 screw. Tighten the screw to the specified torque.
2. Lubricate the belt tensioner bushing with 2-4-C with Teflon. Install the bushing into the belt tensioner.
3. Replace the grease fitting if damaged or corroded.



32079

a - Bushing
b - Screw securing the pulley
c - Grease fitting

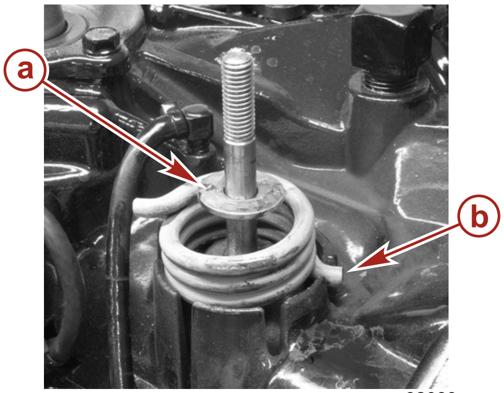
Description	Nm	lb-in.	lb-ft
Screw (M10 x 35)	34		25

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Belt tensioner	92-802859A 1

4. Lubricate the washer with 2-4-C with Teflon and install onto the belt tensioner stud.

   NOTE: Lubricate the belt tensioner spring contact surfaces on the tensioner arm with 2-4-C with Teflon. The grease fitting on the tensioner assembly does not apply lubricant to this area.

5. Install the belt tensioner spring. Verify the end of the spring is in the aft facing slot on the cylinder block.

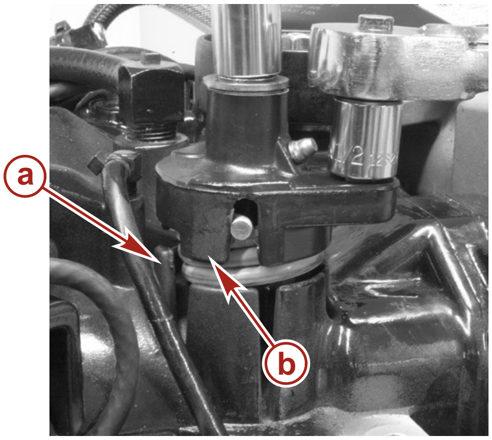


32083

a - Washer
b - End of the spring facing aft

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Belt tensioner	92-802859A 1

6. Install the belt tensioner assembly onto the stud and spring. Retain the belt tensioner assembly with a washer and nut.
7. Use a breaker bar to compress the belt tensioner spring. Verify the belt tensioner assembly stop is clear of the cylinder block stop. Tighten the nut to the specified torque.



32084

a - Cylinder block stop
b - Belt tensioner stop

Description	Nm	lb-in.	lb-ft
Nut (M10)	20	180	15

8. Lubricate the belt tensioner assembly with 2-4-C with Teflon through the grease fitting.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Belt tensioner	92-802859A 1

Starter System

Starter Removal and Installation

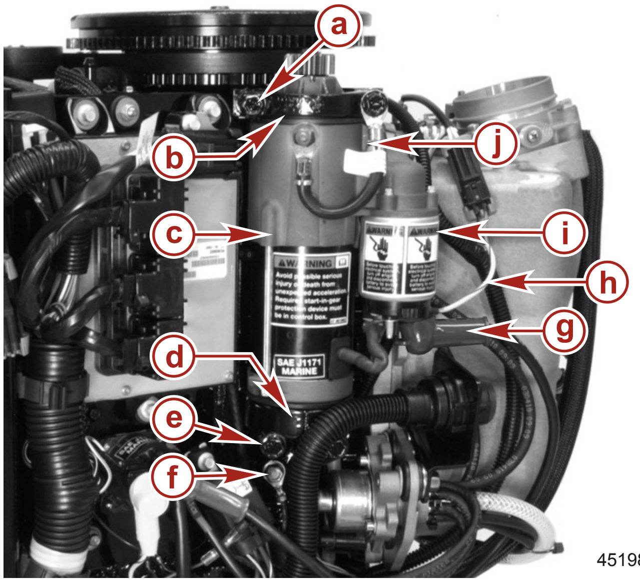
Starter Removal

⚠ 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. Disconnect the wires from the starter solenoid.

3. Remove the starter mounting bolts and remove the starter from the engine.

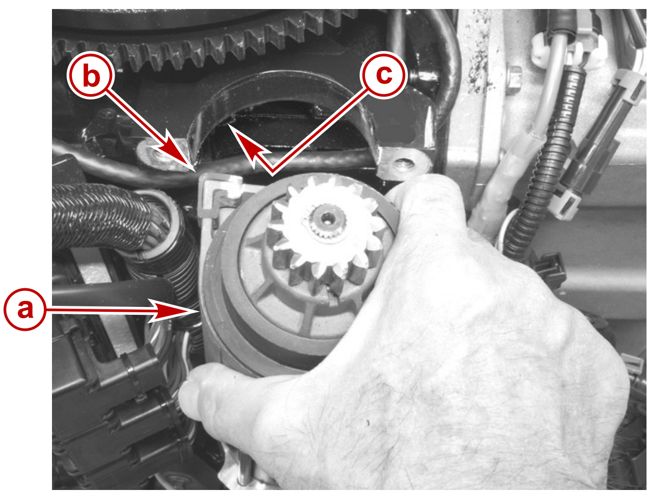


45198

- a - Upper mounting bolts (0.312-18 x 1.50)
- b - Bracket
- c - Starter motor
- d - Cover
- e - Lower mounting bolts (0.312-18 x 2.00)
- f - Ground cable
- g - Positive cable (black cable with yellow sleeve, M8 nut)
- h - Yellow/red wire
- i - Starter solenoid
- j - Starter ground cable

Starter Installation

1. Align the locating tab on the starter with the slot in the cylinder block.

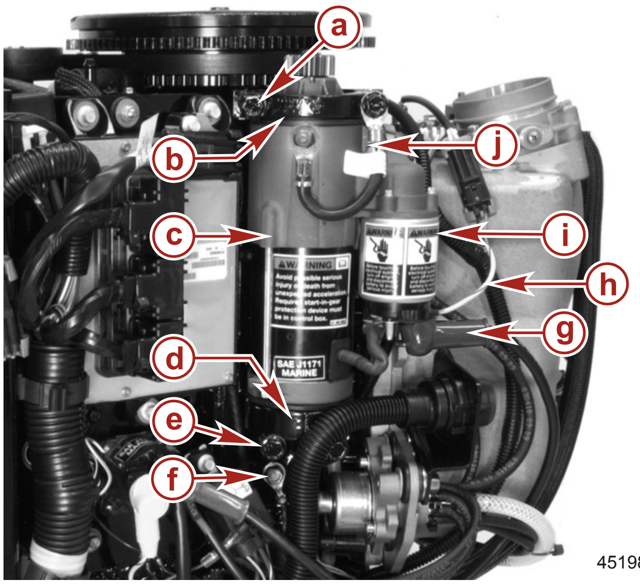


39621

- a - Starter
- b - Locating tab
- c - Slot (hidden)

2. Install the starter onto the cylinder block.
3. Secure the starter to the cylinder block with a bracket, cover, and four bolts. The upper right bolt must have the starter ground cable installed. Tighten the bolts to the specified torque.
4. Install the yellow/red exciter wire to the starter solenoid with a M5 nut. Tighten the nut to the specified torque.

5. Attach the black cable with the yellow sleeve to the starter solenoid with a M8 nut. Tighten the nut to the specified torque. Cover the nut with the red boot.



a - Upper mounting bolts (0.312-18 x 1.50)
b - Bracket
c - Starter motor
d - Cover
e - Lower mounting bolts (0.312-18 x 2.00)
f - Ground cable
g - Positive cable (black cable with yellow sleeve, M8 nut)
h - Yellow/red wire
i - Starter solenoid
j - Starter ground cable

Description	Nm	lb-in.	lb-ft
Mounting bolts (0.312-18)	24		17.7
Nut (M5)	2.5	22	
Nut (M8)	9	80	

6. Connect the battery cables to the battery.

Starter Circuit Troubleshooting

Before troubleshooting the starter circuit, verify the following conditions:

- The battery is fully charged
- The remote control lever or tiller handle shift control is in neutral
- All power and ground terminal connections are tight and free of corrosion
- Check all cables and wiring for frayed or worn insulation
- Check all of the fuses related to the operation of the engine

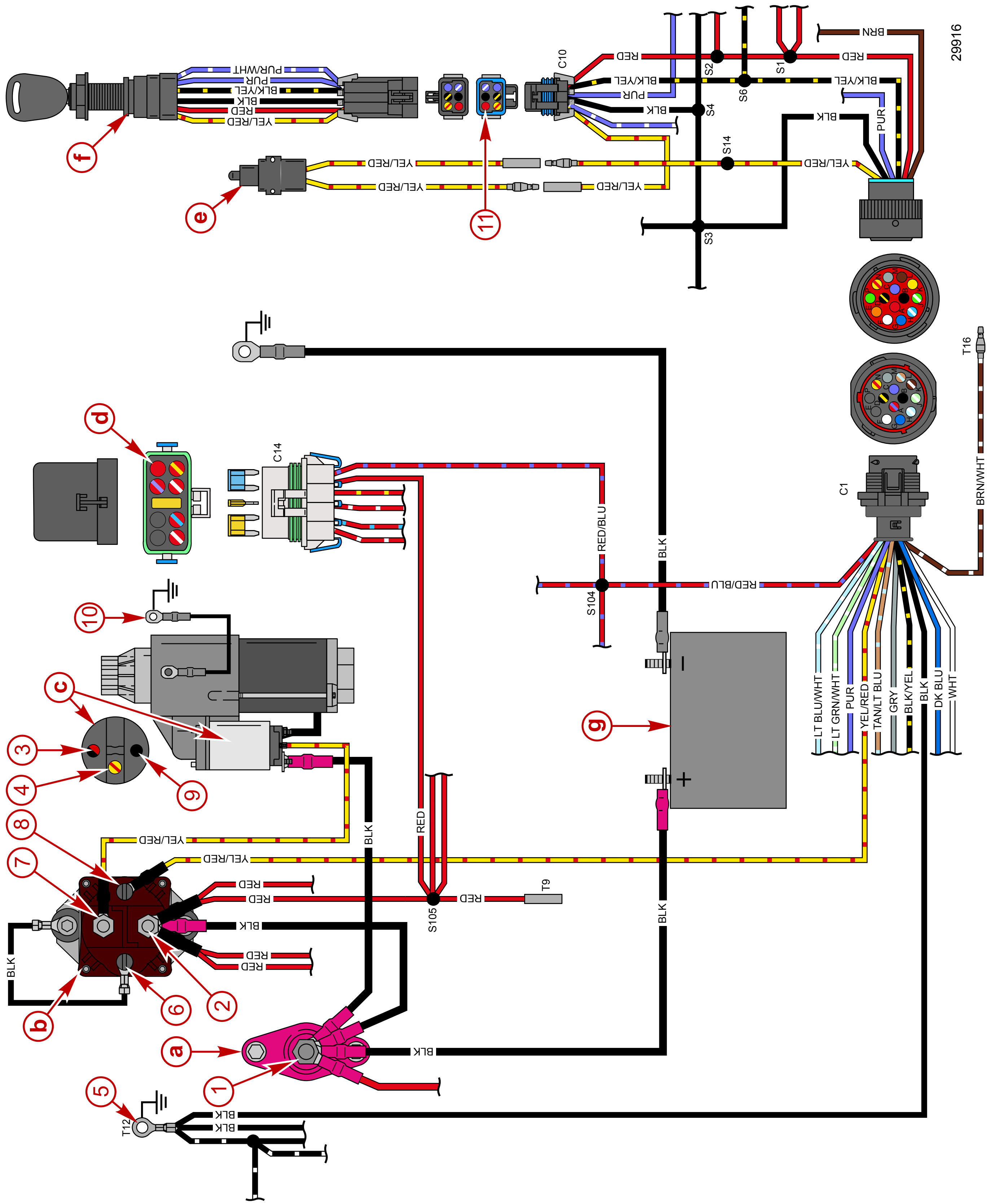
Use the DMT 2004 digital multimeter or an equivalent auto range digital meter for all of the tests.

DMT 2004 Digital Multimeter	91-892647A01

Some of the tests require the battery voltage be removed from the starter solenoid to prevent unexpected engine cranking.

The following starter circuit troubleshooting chart will assist in locating any malfunction in the starting circuitry. Do not skip any of the testing sequence procedures unless advised to do so.

Starter Circuit Troubleshooting



- a - Power stud
- b - Start solenoid
- c - Starter solenoid
- d - 15 amp harness fuse
- e - Neutral start switch (tiller handle or remote control)
- f - Key switch
- g - Battery

Starter Motor Does Not Turn		
Test Number	**Procedure**	**Test Results**
1	Set the meter to read voltage, auto range. Measure the voltage between the starting battery terminals.	Battery voltage should be 12.6 volts or higher. Battery voltage less than 12.6 volts: Check the condition of the battery and load test the battery.
	Measure the battery voltage between test point 1 (power stud) and a common powerhead ground.	Voltage reading should be the same as the battery. Voltage reading less than the battery: • Ensure the battery cables are the correct wire gauge for the cable length. • Ensure the battery cable connections are tight on the battery and on the powerhead. • Ensure the battery cables are not corroded.
	Measure the battery voltage between test point 2 (start solenoid) and a common powerhead ground.	Voltage reading should be the same as test point 1. Voltage reading less than test point 1: • Ensure the nuts are torqued to specifications at test points 2 and 3. • Ensure the cable connection is not corroded.
	Measure the battery voltage between test point 3 (starter solenoid battery power cable) and a common powerhead ground.	Voltage reading should be the same as test point 2. Voltage reading less than test point 2: • Ensure the nuts are torqued to specifications at test points 3 and 4. • Ensure the cable connection is not corroded.
Disconnect the low-pressure and high-pressure electric fuel pumps from the engine harness. This will prevent the fuel pumps from activation. Disconnect the crankshaft position sensor from the powerhead wire harness. This will prevent the engine from starting. ***NOTE:** The disconnection of the harnesses will store failure codes in the PCM. The failure codes must be erased after completing the troubleshooting procedure.*		
2	Check for battery voltage at test point 4, between the starter solenoid yellow/red wire terminal and a common powerhead ground. Turn the key switch to the "START" position.	Battery voltage is indicated and the starter solenoid clicks: Check the battery voltage at test point 9. • Battery voltage is greater than 9.5 volts - the starter motor is defective. • Battery voltage is less than 9.5 volts - the starter solenoid is defective.
		Battery voltage is indicated and the solenoid does not click: Check the starter ground at test point 10. • The ground is good - the starter is defective. • The starter ground has high resistance or is open - clean the ground cable connection or replace the ground cable.
		No battery voltage indicated: proceed to Test 3
Disconnect the battery voltage supply cable at the starter solenoid test point 3. This will prevent the starter motor from cranking the powerhead.		

Starter Motor Does Not Turn		
Test Number	**Procedure**	**Test Results**
3	Set the meter to read ohms, auto range. Connect the meter at test point 5, between the common powerhead ground and the battery negative post.	No continuity - There is an open circuit between the battery negative post and the powerhead. • Check for a loose or corroded battery negative cable connection at the powerhead and the battery. • Check for an open battery negative cable.
		Continuity indicated - proceed to Test 4.
4	Set the meter to read volts, auto range. Disconnect the black ground wire on the start solenoid at test point 6. Connect the meter between the start solenoid ground wire terminal and a common powerhead ground. Turn the key switch to the "START" position.	Battery voltage indicated: Check the black ground wire for a poor connection to the common powerhead ground. Reconnect the ground wire to the start solenoid and proceed to Test 5.
		No battery voltage indicated: Reconnect the ground wire to the start solenoid and proceed to Test 5.
5	Connect the meter at test point 8, between the start solenoid and a common powerhead ground. Turn the key switch to the "START" position.	Battery voltage indicated: Proceed to Test 6.
		No battery voltage indicated: • The neutral start switch is open. • The yellow/red wire is open between the key switch and the start solenoid. • The key switch is defective.
6	Connect the meter at test point 7, between the start solenoid and a common powerhead ground. Turn the key switch to the "START" position.	Battery voltage indicated and the starter solenoid does not click. • The starter solenoid is defective. • The wire between the start solenoid and the starter solenoid is open or corroded. Check for continuity between test points 4 and 7.
		No battery voltage indicated: Proceed to Test 7.
7	Disconnect the key switch and check for battery voltage at test point 11, the red wire (pin A), and a common powerhead ground.	Battery voltage indicated: Key switch is defective.
		No battery voltage indicated: Check the 15 amp harness fuse.

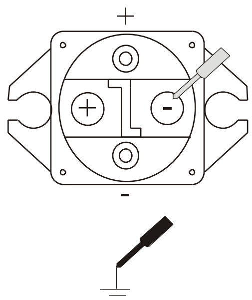
Starter Will Not Stay Engaged (Chatter)		
Test Number	**Procedure**	**Test Results**
1	Disconnect the yellow/red exciter wire from the starter solenoid at test point 4. Measure the resistance between the exciter terminal of the starter solenoid and the starter solenoid metal housing.	Starter solenoid hold-in coil resistance is 1.2 Ω ± 10%. • Starter solenoid hold-in coil is good. Proceed to Test 2.
		Starter solenoid hold-in coil resistance is in excess of 1.2 Ω ± 10%. • Starter solenoid hold-in coil is defective.
2	Remove the starter motor brush lead from the starter solenoid at test point 9. Measure the resistance between the exciter terminal of the starter solenoid and the starter solenoid brush lead terminal.	Starter solenoid pull-in coil resistance is 0.3 Ω ± 10%. • Starter solenoid pull-in coil is good. • Ensure battery is fully charged.
		Starter solenoid pull-in coil resistance is in excess of 0.3 Ω ± 10%. Starter solenoid pull-in coil is defective.

Start Solenoid Test

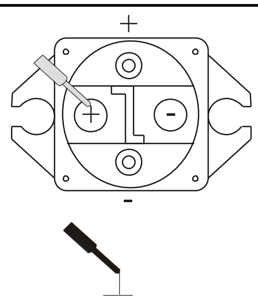
IMPORTANT: Before testing the solenoid:

- **Ensure all battery cable connections are free of corrosion and secured to a fully charged battery.**
- **Ensure all connections to the solenoid are secure and free of corrosion.**

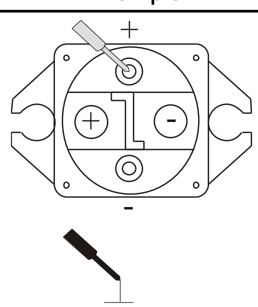
1. Measure the voltage at the positive (+) copper terminal. Place the red meter lead to the positive (+) copper terminal and the black meter lead to engine ground. Turn the key switch to "START" and crank the engine. This test should result in battery voltage for 2–3 seconds. If so, the solenoid is operational; no further testing is required. If battery voltage is weak, or is not present, proceed to step two.

Example	Description	Reading
 7719	Place the red lead to the negative (–) copper terminal. Place the black lead to engine ground. Crank the engine.	Battery voltage for 2–3 seconds

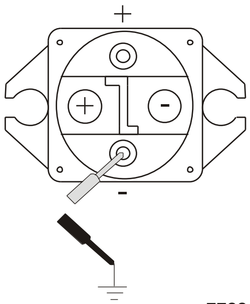
2. Measure the voltage between the positive (+) copper terminal and ground. Place the red meter lead to the positive (+) copper terminal and the black meter lead to engine ground. This test should result in battery voltage. If so, proceed to step three. If not, inspect the cables and connections leading to the positive (+) terminals. If no problems are found, replace the solenoid.

Example	Description	Reading
 7720	Connect the red lead to the positive (+) pin. Place the black lead to engine ground.	Battery voltage

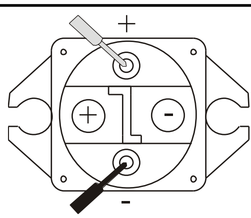
3. Measure the voltage between the positive (+) silver terminal and engine ground. Place the red meter lead to the positive (+) silver terminal and the black meter lead to engine ground. This test should result in battery voltage. If so, proceed to step four. If not, inspect the circuit and connections leading to the positive (+) terminal. If no problems are found, replace the solenoid.

Example	Description	Reading
 7721	Connect the red lead to the positive (+) pin. Place the other lead to engine ground. Crank the engine.	Battery voltage for 2–3 seconds

4. Use an ohmmeter to check for continuity between the negative (–) silver terminal and engine ground. If this test passes, proceed to step five. If not, inspect the ground wire for fault. If no problems are found, replace the solenoid.

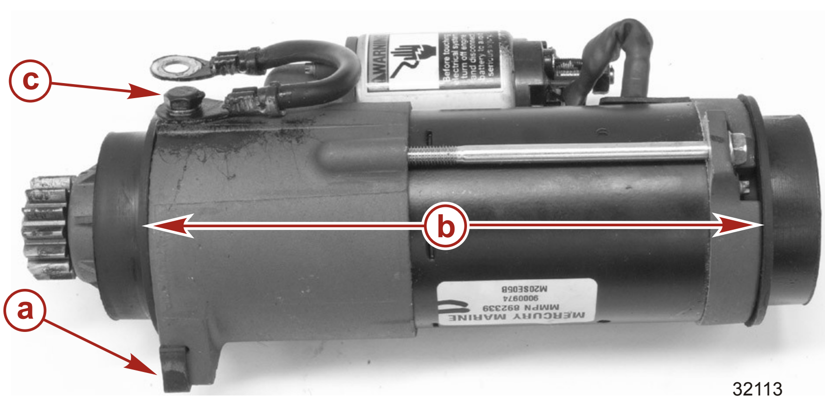
Example	Description	Reading
 7722	Connect a meter lead on the negative (–) silver terminal and the other lead to engine ground.	Continuity

5. If all previous tests pass, remove all push-on terminal connectors from the start solenoid and use an ohmmeter to measure the resistance across the silver terminals.

Example	Description	Reading
 7733	Connect a meter lead on each silver pin.	2.5–2.75 Ω

Starter Disassembly (Solenoid Driven Bendix)

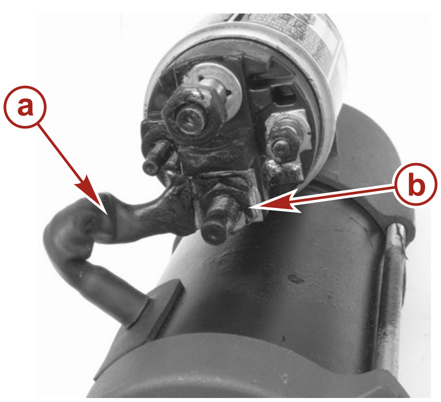
1. Remove the two collars, rubber stops, and the screw securing the starter ground wire.



32113

a - Rubber stops (2)
b - Collars (2)
c - Screw securing ground wire

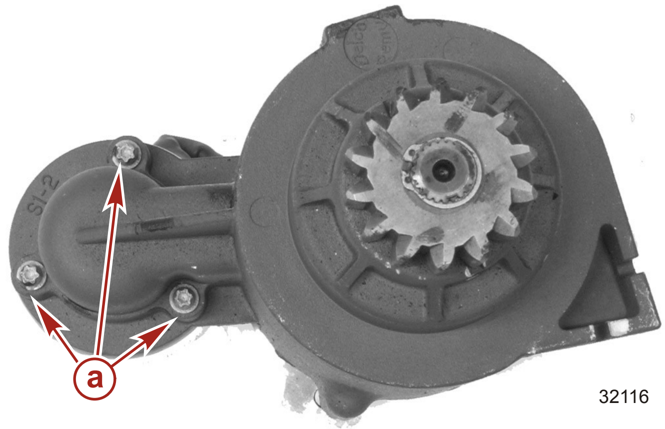
2. Remove the nut and lockwasher securing the starter brush lead to the solenoid. Remove the starter brush lead from the solenoid.



32114

a - Starter brush lead
b - Nut and lockwasher

3. Remove the three screws securing the solenoid to the starter. Remove the solenoid from the starter.

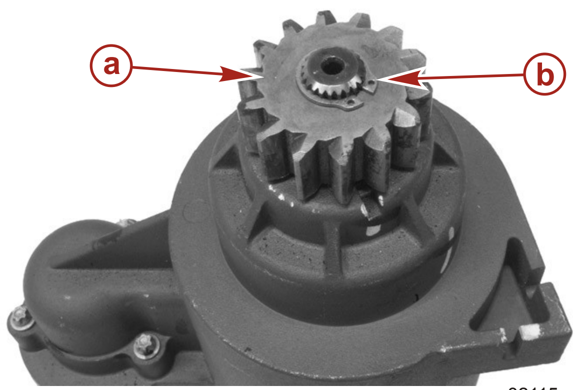


a - Screws

Pinion Gear Removal

1. Remove and discard the snap ring securing the pinion gear to the starter shaft.
2. Remove the pinion gear from the starter shaft.

   NOTE: *The removal of the pinion gear may require the use of a small gear puller.*

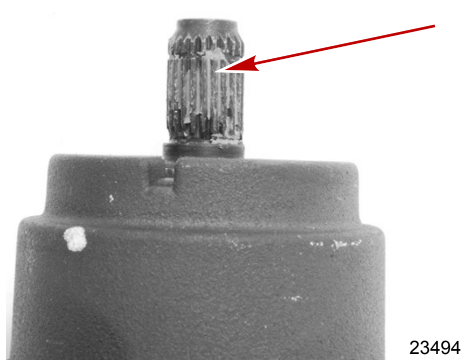


a - Pinion gear
b - Snap ring

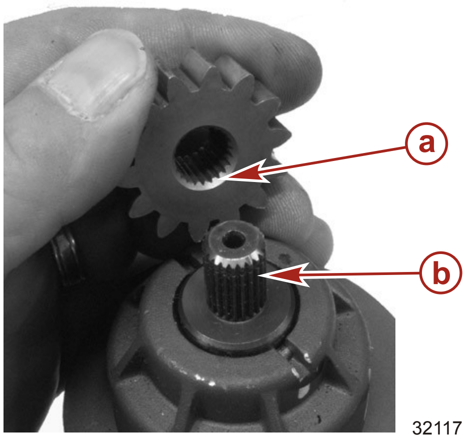
Starter Assembly (Solenoid Driven Bendix)

Pinion Gear Installation

1. Verify the starter shaft splines are clear of debris. Use a razor blade to clear debris from the root area of the starter shaft splines.



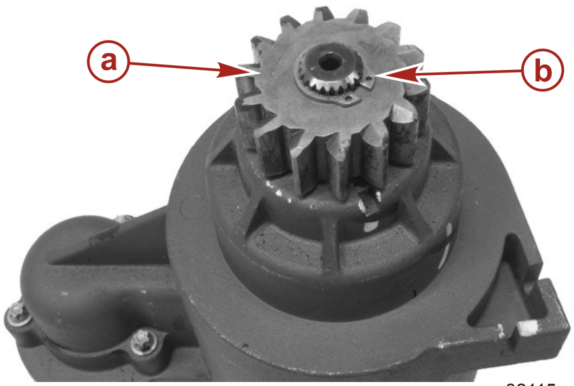
2. Install the pinion gear with the taper side towards the starter assembly.



32117

a - Pinion gear taper
b - Starter shaft splines

3. Lightly tap the pinion gear onto the starter shaft splines and secure with a new snap ring.
   IMPORTANT: Always install a new snap ring to retain the pinion gear.

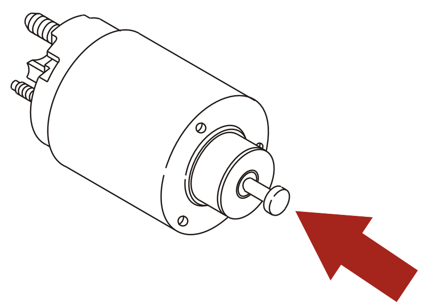


32115

a - Pinion gear
b - Snap ring

Solenoid Installation

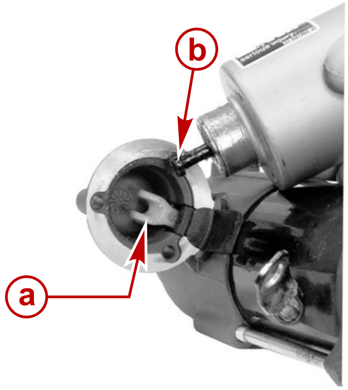
1. Push the solenoid actuating plunger into the solenoid. When released, the solenoid actuating plunger should return to a fully extended position.



18282

2. Lubricate the end of the solenoid actuating plunger with 2-4-C with Teflon.

3. Insert the solenoid actuating plunger end into the fork of the solenoid arm.

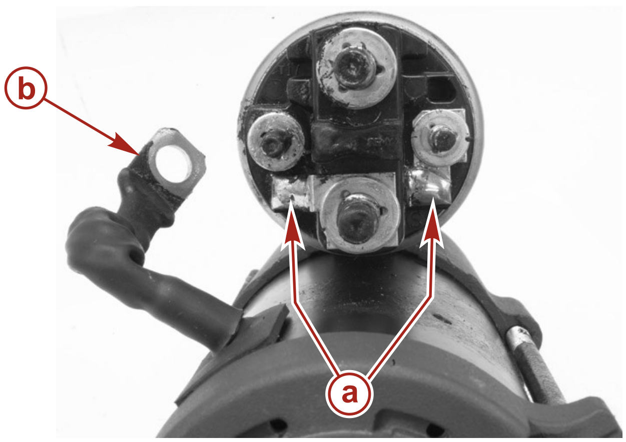


23485

a - Fork of the solenoid arm
b - Solenoid actuating plunger

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Solenoid actuating plunger	92-802859A 1

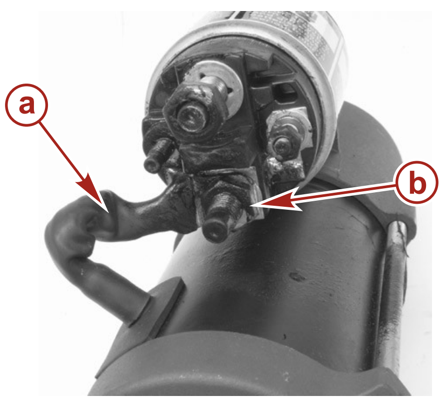
4. Align the solenoid so the two solder joints are closest to starter assembly.



32118

a - Solder joints
b - Starter brush lead

5. Install the starter brush lead onto the solenoid terminal and secure with a lockwasher and nut. Tighten the nut to the specified torque.
6. Apply Liquid Neoprene to the starter brush lead connection to prevent corrosion.



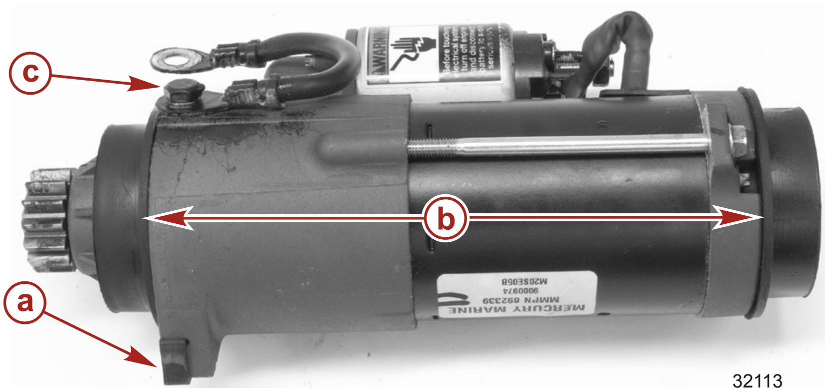
32114

a - Starter brush lead
b - Nut and lockwasher

Description	Nm	lb-in.	lb-ft
Nut	9	80	

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter brush lead connection	92- 25711 3

7. Install the two collars and the rubber stops.
8. Secure the starter ground wire with a 0.250-20 x 0.625 stainless steel screw and washer. Tighten the screw to the specified torque. Apply Liquid Neoprene to the connection to prevent corrosion.



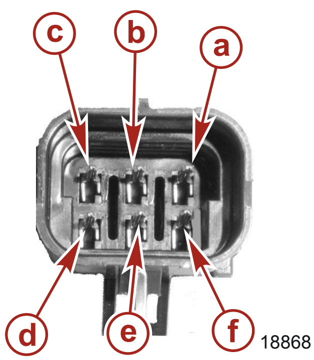
a - Rubber stops (2)
b - Collars (2)
c - Screw securing ground wire

Description	Nm	lb-in.	lb-ft
Stainless steel screw and washer (0.250-20 x 0.625)	11	97	

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Starter ground wire connection	92- 25711 3

Key Switch Test

Three Position Key Switch



a - Pin A
b - Pin B
c - Pin C
d - Pin D
e - Pin E
f - Pin F

Ref. No.	Pin	Wire Color	Description
a	A	Red	12 volts
b	B	Black	Ground
c, d	C, D	Purple	Run
e	E	Black/yellow	Off
f	F	Yellow/red	Start

Meter Test Leads		Key Position	Reading (Ω)
Red	Black		
Pin B	Pin E	Off	Continuity
Pin A	Pin F	Run	Continuity
Pin A	Pin C, D		
Pin A	Pin F	Start	Continuity
Pin F	Pin C, D		Continuity
Pin A	Pin C, D		Continuity

Four Position Key Switch

11559

a - Pin A
b - Pin B
c - Pin C
d - Pin D
e - Pin E
f - Pin F

Ref. No.	Pin	Wire Color	Description
a	A	Red	12 volts
b	B	Black	Ground
c	C	Purple/white	Accessory
d	D	Purple	Run
e	E	Black/yellow	Off
f	F	Yellow/red	Start

Meter Test Leads		Key Position	Reading (Ω)
Red	**Black**		
Pin B	Pin E	Off	Continuity
Pin A	Pin C	Accessories	Continuity
Pin A	Pin F	Run	Continuity
Pin A	Pin C		
Pin A	Pin F	Start	Continuity
Pin F	Pin D		Continuity
Pin A	Pin D		Continuity
Pin A	Pin C		Continuity

Notes:

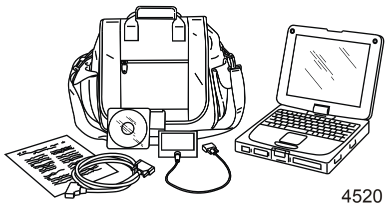
Electrical

Section 2C - Timing, Synchronizing, and Adjusting

2
C

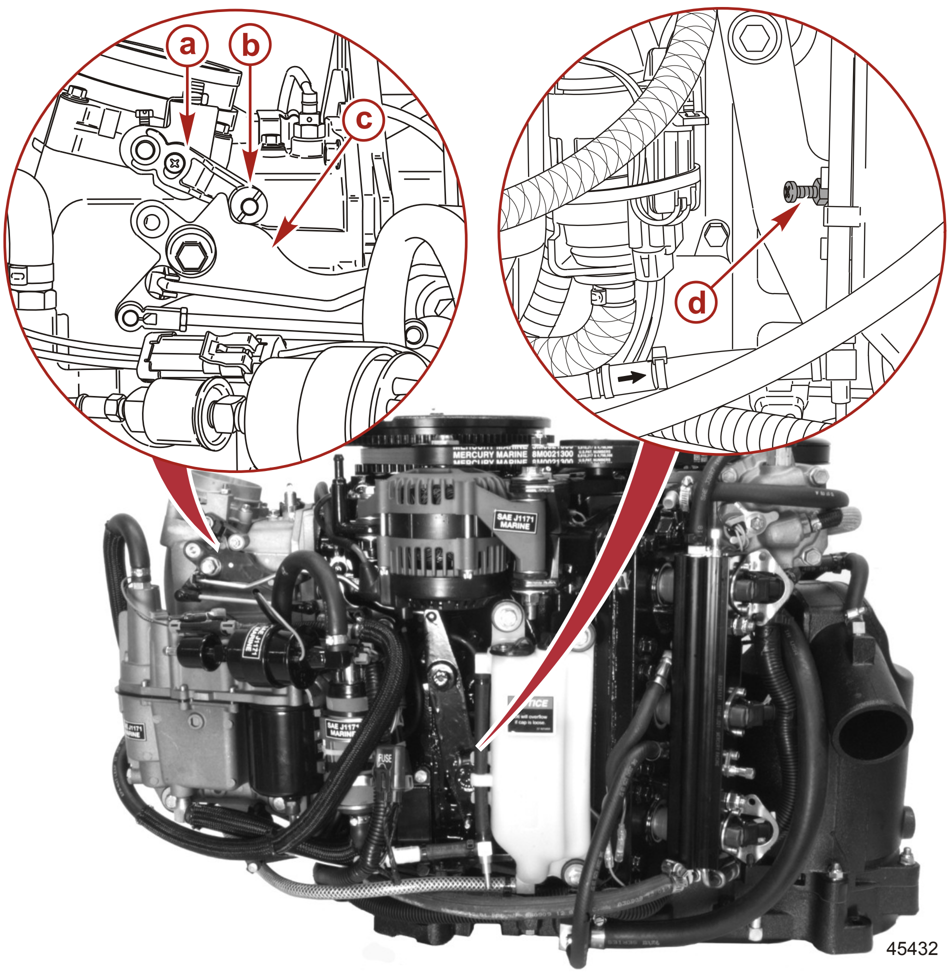
Table of Contents

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

Throttle Cam Adjustment

1. Loosen the roller arm screw.
2. Allow the cam roller to rest on the throttle cam. Adjust the idle stop screw on the throttle arm to align the cam roller in the pocket of the throttle cam.
3. Verify there is 0.127 ± 0.127 mm (0.005 ± 0.005 in.) clearance between the cam roller and throttle cam. Tighten the roller arm screw.



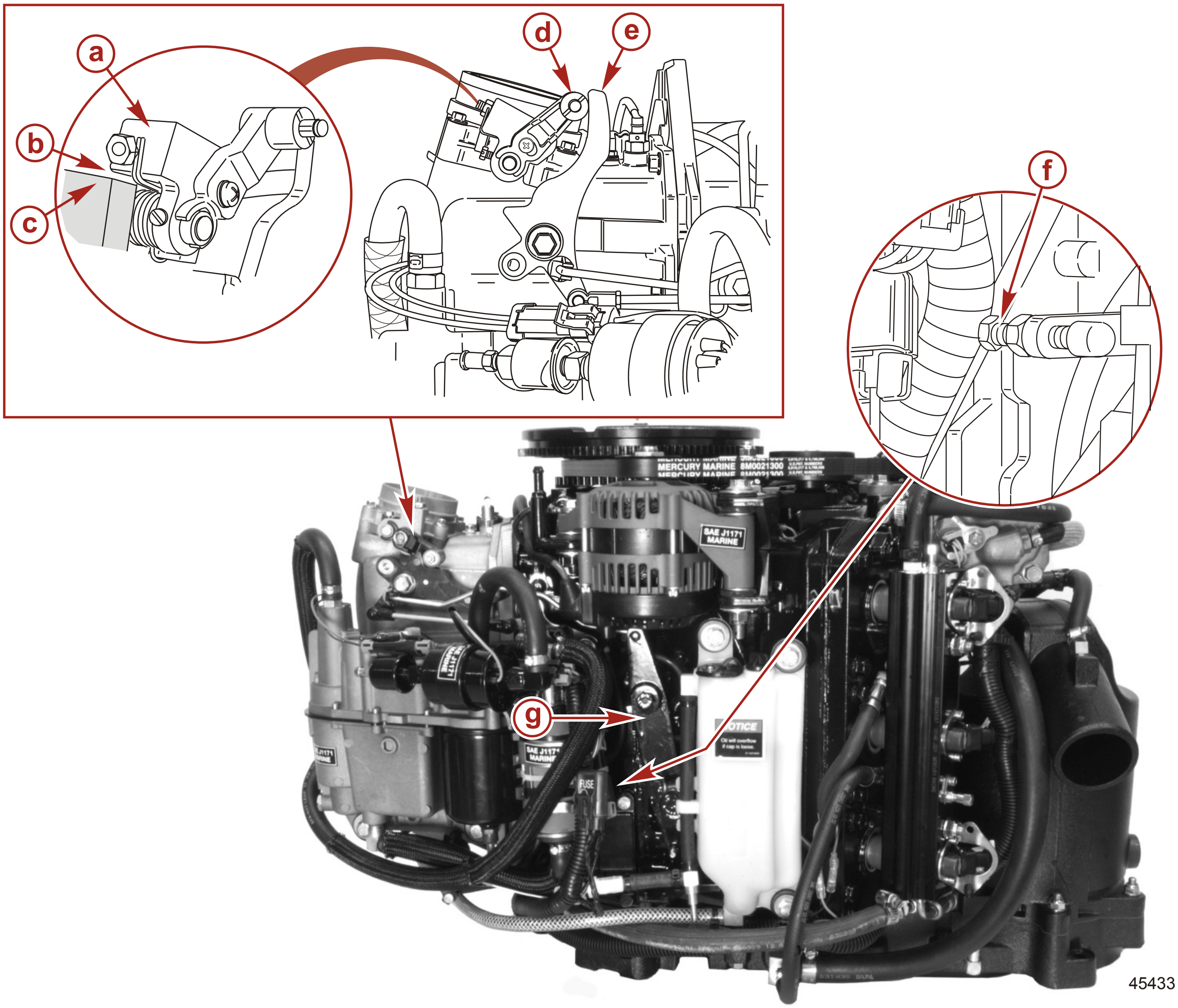
45432

a - Roller arm screw
b - Roller
c - Throttle cam
d - Idle stop screw

Maximum Throttle

1. Hold the throttle arm against the throttle stop screw.
2. Adjust the throttle stop screw behind the electric fuel pump to allow full throttle valve opening while maintaining a 0.508 mm (0.020 in.) clearance between the arm of the throttle shaft and the stop on the throttle body.

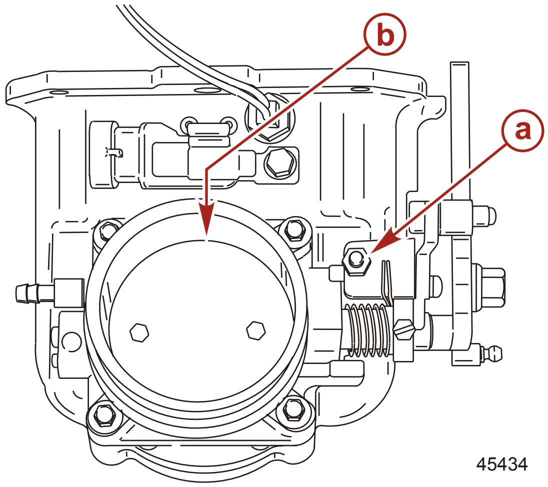
3. Tighten the jam nut on the throttle stop screw.
4. Verify the roller can be lifted off the cam at full throttle to prevent the linkage from binding. Adjust the throttle stop screw, if necessary.



- a - Throttle shaft arm
- b - 0.508 mm (0.020 in.) clearance
- c - Stop on attenuator box
- d - Roller
- e - Throttle cam
- f - Throttle stop screw
- g - Throttle arm

Throttle Plate Stop Screw

IMPORTANT: Do not adjust the throttle plate stop screw from the factory setting. However, should the throttle plate require adjustment, use the throttle plate stop screw to set the throttle plate clearance to 0.7937 mm (0.031 in.) with a #68 drill bit.

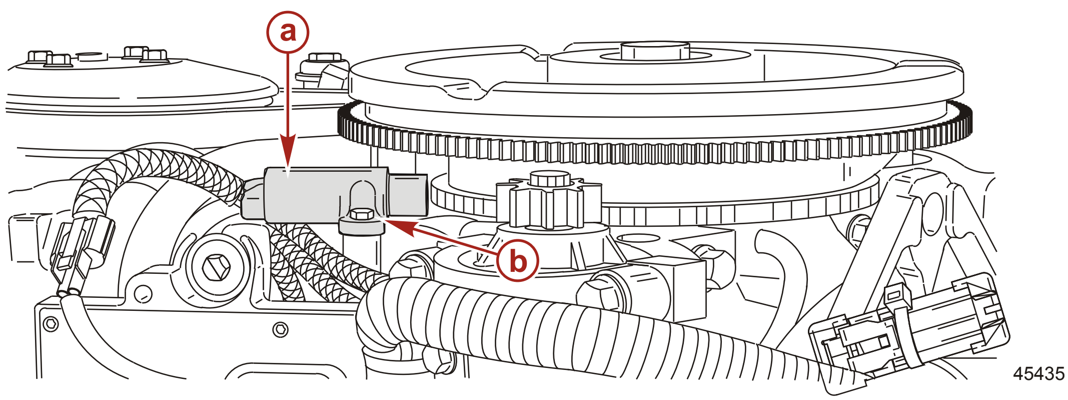


a - Throttle plate stop screw
b - Throttle plate clearance

Crankshaft Position Sensor Air Gap

IMPORTANT: The crankshaft position sensor air gap (between flywheel tooth and sensor) is not adjustable. Visually inspect sensor for damage from foreign debris. Replace sensor as required.

1. Remove flywheel cover. **Refer to Section 2A - Flywheel Cover Removal and Installation**.
2. Inspect for damage or debris.



a - Crankshaft position sensor
b - Bracket screw

Description	Nm	lb-in.	lb-ft
Crankshaft position sensor bracket screw	5	44	

3. Install flywheel cover.

Throttle Position Sensor (TPS) Adjustment

The TPS is not adjustable. The TPS position can be monitored with the computer diagnostic system. Voltage change should be smooth from idle to wide-open throttle. If the voltage change is erratic, the TPS is defective.

Throttle Position Sensor Specifications	
Idle	0.4–1.3 VDC
Wide-open throttle	4.0–4.7 VDC

Computer Diagnostic System (CDS)	Order through SPX

Idle Speed Adjustment (All Models)

Engine idle speed is not adjustable. The parameters affecting idle speed can be checked and monitored with the computer diagnostic system (CDS).

Computer Diagnostic System (CDS)	Order through SPX

Notes:

Fuel System

Section 3A - Fuel Pump

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3
A

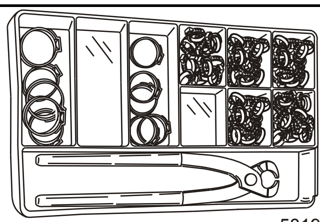
Fuel Specifications

Fuel Specifications	
Fuel	Gasoline with oil injection
Recommended gasoline	Unleaded 87 octane minimum
Recommended oil	Direct fuel injected (DFI) 2-cycle Outboard Oil or Premium Plus 2-cycle TC-W3 Outboard Oil
Gasoline/oil ratio	
At idle	300–400:1
At wide-open throttle	40:1

Fuel Lift Pump Specifications

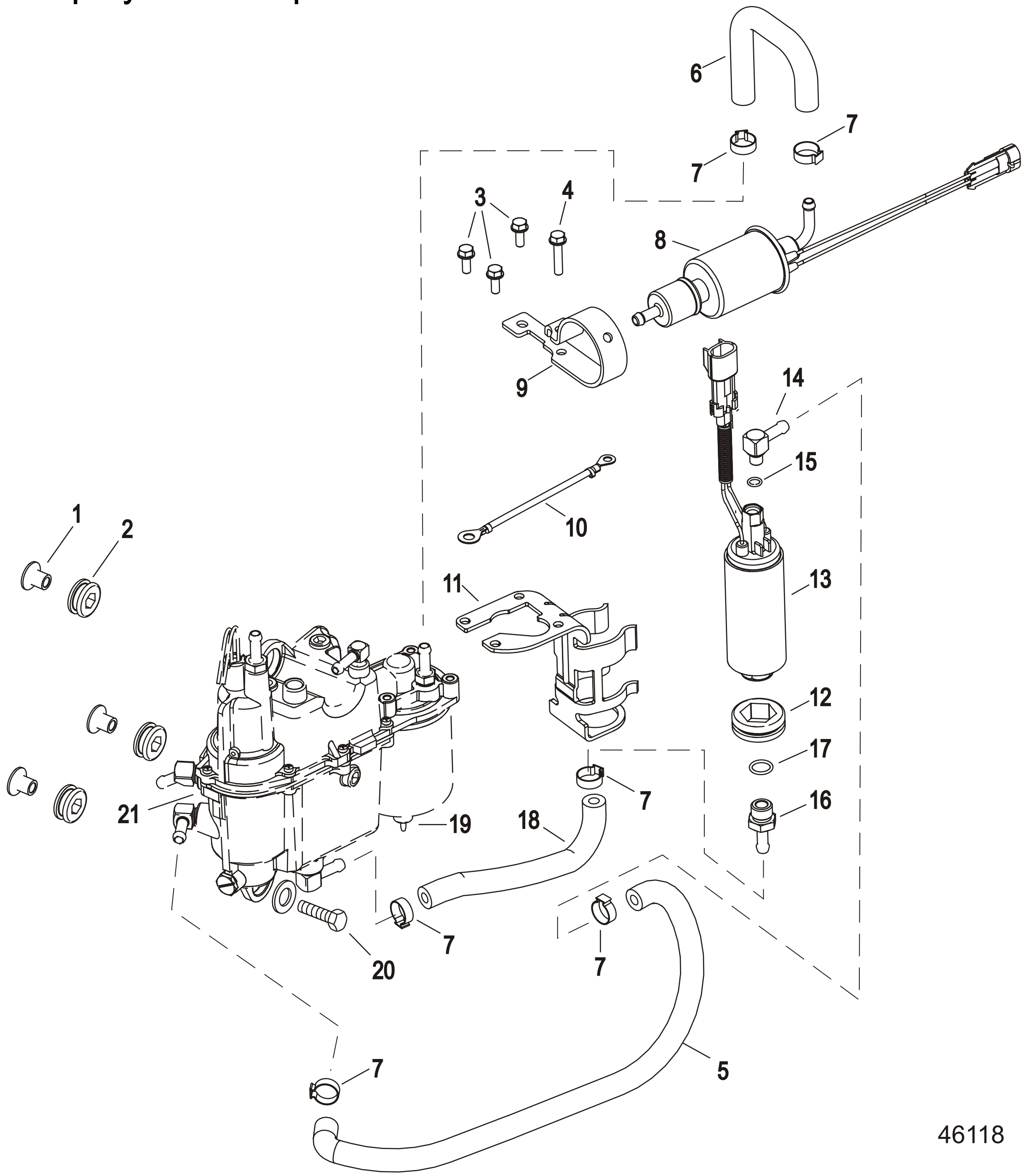
Fuel Lift Pump Specifications	
Fuel lift pump pressure at idle	
Normal	6.9–13.8 kPa (1–2 psi)
Maximum	68.9 kPa (10 psi)
Fuel lift pump amps	1–2 A

Special Tools

Hose Clamp Tool Kit	91-803146A04
 5819	Aids in the installation of high pressure (Oetiker ®) hose clamps. Clamp Tool (91-803146T)

Notes:

Fuel Pump System Components



Fuel Pump System Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	3	Bushing			
2	3	Grommet			
3	3	Screw (M6 x 16)	11.5	102	
4	1	Screw (M6 x 35)	11.5	102	
5	1	Hose			
6	1	Hose			
7	A/R	Hose clamp (18.3 mm)			
8	1	Lift pump and filter			
9	11	Bracket			
10	1	Wire assembly			
11	1	Bracket kit			
12	1	Grommet			
13	1	Low-pressure fuel pump (boost pump)			
14	1	90° elbow			
15	1	O-ring			
16	1	Fitting			
17	1	O-ring			
18	1	Hose			
19	1	Water sensor			
20	3	Screw (M8 x 35) and washer	16	142	
21	1	Vapor separator tank (VST) assembly			

Anti-Siphon Valves

While anti-siphon valves may be helpful from a safety standpoint, they clog with debris, they may be too small, or they may have too heavy a spring. The pressure drop across these valves can, and often does, create operational problems and/or powerhead damage by restricting fuel to the fuel lift pump and, subsequently, the high-pressure fuel pump. Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

- Severe fuel rail pressure fluctuation
- Loss of fuel pump pressure
- High-speed surging
- Outboard cuts out or hesitates upon acceleration
- Outboard runs rough
- Outboard quits and cannot be restarted
- Outboard will not start
- Vapor lock

Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking if such a device (or bad fuel) is a problem source, is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

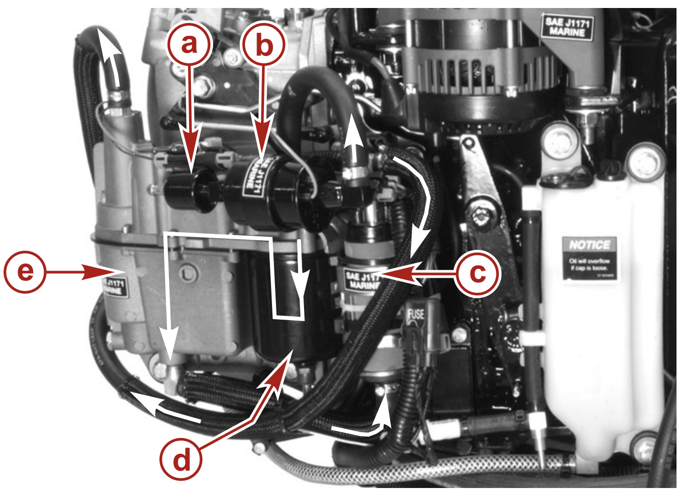
If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are two solutions to the problem; either 1) replace the anti-siphon valve with one that has a lighter spring tension, or 2) replace it with a solenoid-operated fuel shutoff valve.

NOTE: If the fuel tank is pressurized, a fuel demand valve is required. Refer to ***Section 1D - Fuel Demand Valve Requirements*** *or* ***Integrated Fuel Demand Valve Requirements****.*

Fuel Lift Pump Description/Operation

The fuel lift pump is an electric fuel pump that supplies fuel from the fuel tank to the low-pressure boost pump, the water separating filter, then to the high-pressure fuel pump inside the VST. Electrical power is supplied to the fuel lift pump from the starter solenoid positive terminal (starter side terminal).

The fuel lift pump is designed to lift the fuel (vertically) approximately 152 cm (60 in.) using a 7.9 mm (5/16 in.) minimum diameter fuel hose with no other restrictions. As filters, fitting, and valves are added, restricting fuel flow, the lift capability of the pump decreases.



45446

- **a -** Fuel filter
- **b -** Lift pump
- **c -** Low-pressure boost pump
- **d -** Water separating filter
- **e -** High-pressure fuel pump (inside the VST)

Testing the Fuel Lift Pump Vacuum

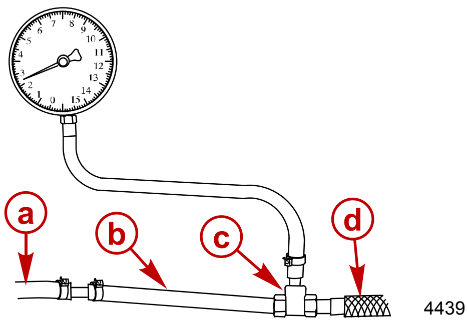
1. Separate the engine fuel line and the boat fuel line.
2. Install a T-fitting on the boat fuel line.
3. Install a clear fuel line on the opposite side of the T-fitting.
4. Connect the clear fuel line to the engine fuel line.
5. Install a fuel vacuum gauge (obtain locally) on the T-fitting.
6. Clamp all fuel line connections securely to prevent vacuum leaks.
7. Start engine.

NOTE: Before proceeding with the system vacuum test, confirm that the lift pump is capable of delivering the required vacuum. To do this:

a. Pinch off (restrict) the fuel supply hose between the vacuum gauge and the fuel tank.
b. The vacuum gauge reading should exceed 2.5 in. Hg. If the lift pump fails to reach 2.5 in. Hg, replace the lift pump assembly.
c. Release the restriction.
d. Continue with the system vacuum test.

8. Observe the clear fuel line for air bubbles.
9. The vacuum gauge reading should be within the listed specification when the pump is active.

NOTE: A vacuum reading above the listed specification is an indication of a restriction between the gauge and the fuel supply.



a - Engine fuel line
b - Clear fuel line
c - T-fitting
d - Boat fuel line

Fuel Lift Pump Vacuum	
At idle	8.4 kPa (2.5 in. Hg)

Fuel Lift Pump/System Troubleshooting

Vacuum Test

This test is normally performed at idle speed. As engine speed increases, vacuum increase slightly. The increased vacuum reading should not exceed the specification.

Vacuum Test	
Normal reading	Less than 2.5 in. Hg of vacuum
Reading greater than 2.5 in. Hg of vacuum	Restricted anti-siphon valve
	Restriction within the primer bulb
	Kinked or collapsed fuel hose
	Plugged water separating fuel filter (in the boat)
	Restriction in fuel line through-the-hull fitting
	Restriction in fuel tank switching valves
	Plugged fuel tank pickup screen

Pressure Test

Install a clear fuel hose between the fuel pump and VST. Run the engine, and inspect the fuel passing through the hose for air bubbles.

Problem: Air bubbles in the fuel line	
Low fuel in tank.	Fill tank with fuel.
Loose fuel line connection.	Check and tighten all connectors.
Fuel pump fitting loose.	Tighten fitting.
A hole or cut in fuel line.	Check condition of all fuel lines and replace.
Fuel pump anchor screw loose.	Tighten all screws evenly and securely.
Fuel pump filter cover anchor screw loose.	Tighten screws securely.

Problem: Air bubbles in the fuel line	
Fuel vaporizing.	Fuel with high reed vapor pressure (winter grade fuel) may vaporize (form bubbles) when used in hot/warm weather. Use fuel with a lower reed vapor pressure (summer grade fuel).

Problem: Lack of fuel pump pressure	
An anti-siphon valve.	Refer to **Anti-Siphon Valves**.
Air in fuel line.	Refer to **Air Bubbles in the Fuel Line**.
A dirty or clogged fuel filter.	Replace fuel filter.
The fuel pickup in fuel tank is clogged or dirty.	Clean or replace pickup.
Fuel hose internal diameter too small.	Use 5/16 I.D. fuel hose.
Excessive fuel lift required.	Fuel lift exceeds 2.5 in. of vacuum (mercury).

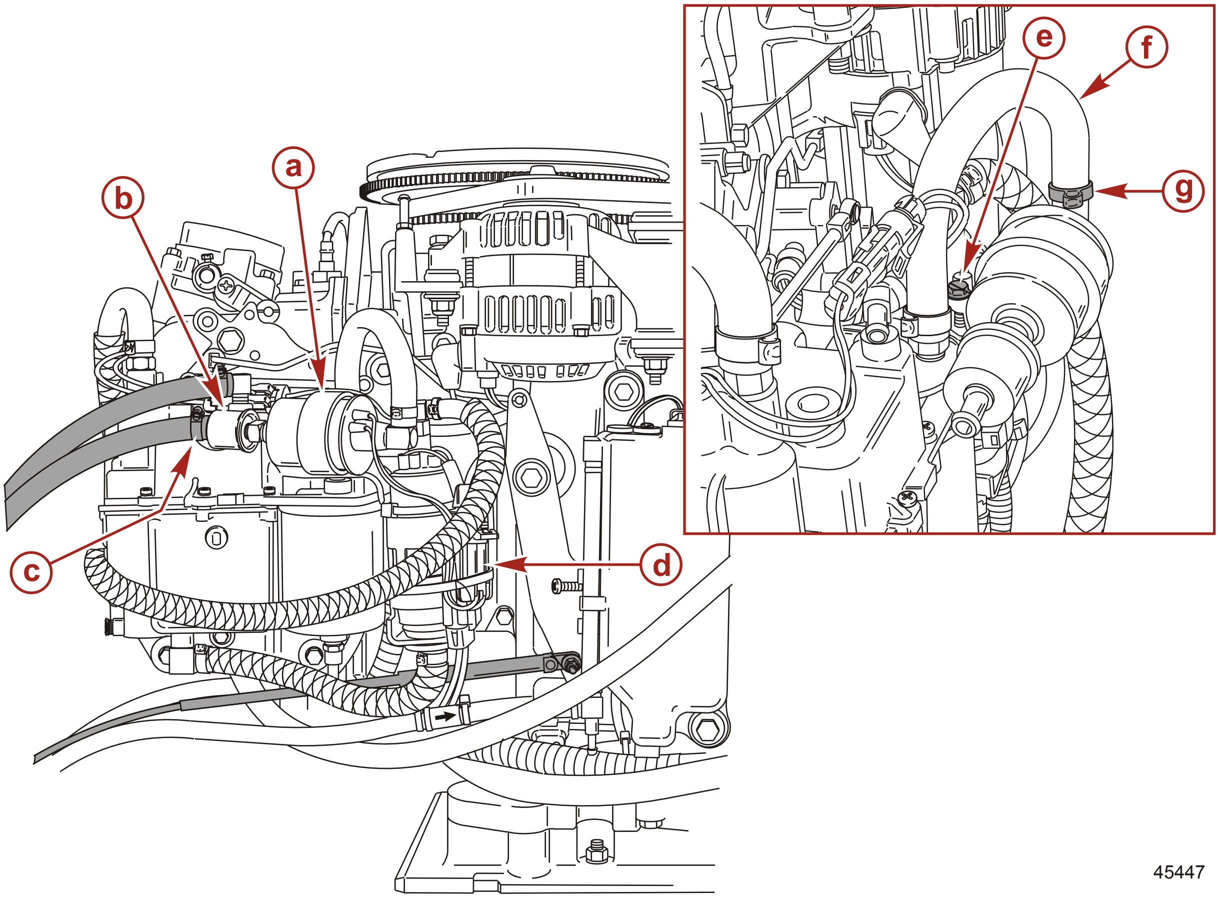
Problem: No fuel flow	
Blown fuse.	Check the 3 amp fuse.
Low or no voltage at harness connection.	Check for loose, corroded, or damaged wires or connections.
12 volts present and pump is not running.	Replace the fuel lift pump.
12 volts present and pump is running.	Inspect fuel hose connection, pinched fuel hose, or stuck anti-siphon valve.

Fuel Lift Pump Removal/Inspection/Installation

Removal

1. Disconnect the fuel pump harness connector.
2. Disconnect the fuel hose from the fuel filter.
3. Use sharp side cutter or end cutter to peel back end of the crimp hose clamp securing vapor separator hose. Remove hose from fuel pump.

4. Loosen the screw securing the pump retaining clamp and remove the pump.



a - Fuel lift pump clamp
b - Filter
c - Hose clamp
d - Harness connector
e - Screw (M6 x 35)
f - Hose to VST
g - Hose clamp (18.3 mm)

Filter Replacement

There are no serviceable parts within the electric fuel pump. However, there is a replaceable fuel filter on the pump which should be replaced every 100 hours or once a season. Use a strap wrench to remove the filter.

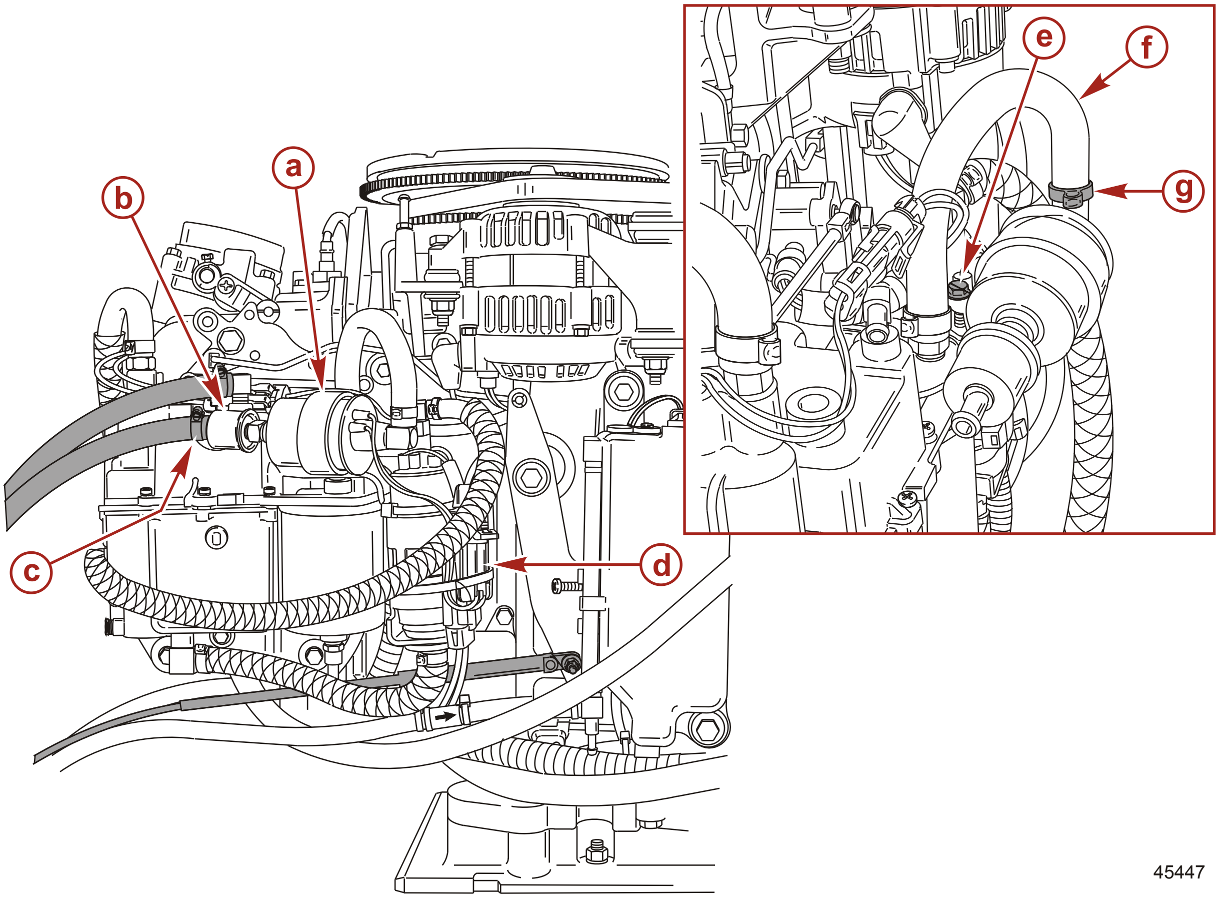
Fuel Lift Pump Installation

1. Install the fuel pump inside the retaining clamp. Secure the clamp with screw. Tighten the screw to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel lift pump retaining clamp screw (M6 x 35)	16	142	

2. Connect the harness connector.
3. Connect the fuel tank hose to the filter. Use stainless hose clamp to secure the fuel hose.

4. Connect the vapor separator fuel hose to the fuel pump. Secure the hose with an 18.3 mm hose clamp.



a - Fuel lift pump clamp
b - Filter
c - Hose clamp
d - Harness connector
e - Screw (M6 x 35)
f - Hose to VST
g - Hose clamp (18.3 mm)

Hose Clamp Tool Kit	91-803146A04

5. Run the engine and check for leaks.

Fuel System

Section 3B - Direct Fuel Injection

Table of Contents

3
B

Air Compressor Specifications

Air Compressor Specifications	
Air compressor type	Reciprocating piston Single cylinder, oil lubricated, water-cooled
Air compressor output	655 ± 14 kPa (95 ± 2 psi)
Displacement	116 cc (7.07 cid)
Cylinder bore	65.0 mm (2.559 in.)
Cylinder bore taper (maximum)	0.025 mm (0.001 in.)
Cylinder bore out of round (maximum)	0.025 mm (0.001 in.)
Cylinder bore type	Cast iron
Stroke	34.9 mm (1.374 in.)
Piston type	Aluminum
Piston diameter	64.97 ± 0.010 mm (2.5578 ± 0.0004 in.)
Ring end gap	
Top ring	0.15–0.25 mm (0.006–0.0010 in.)
Middle ring	0.15–0.25 mm (0.006–0.0010 in.)
Bottom ring	0.10–0.35 mm (0.004–0.014 in.)
Reed stand open (maximum)	0.25 mm (0.0010 in.)

Fuel System Specifications

Fuel Lift Pump Specifications	
Fuel lift pump pressure at idle	
Normal	6.9–13.8 kPa (1–2 psi)
Maximum	69 kPa (10 psi)
Fuel lift pump amps	1–2 A

Low-Pressure Boost Pump Specifications	
Low-pressure boost pump pressure at idle	41–62 kPa (6–9 psi)
Low-pressure boost pump amps	1–2 A

Fuel System Specifications	
High-pressure fuel pump pressure	751.5 ± 14 kPa (109 ± 2 psi)
Air pressure	655 ± 14 kPa (95 ± 2 psi)
Fuel/air differential	103.5 kPa (15 psi)
High-pressure fuel pump amp	10–14 A
High-pressure fuel pump ohm resistance	1.0–1.8 Ω
Fuel injector ohm resistance	1.8 ± 0.1 Ω
Direct injector ohm resistance	1.3 ± 0.3 Ω

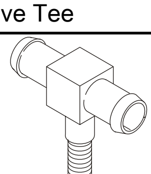
Fuel Rail Specifications

Fuel System Specifications	
Fuel pressure	751.5 ± 14 kPa (109 ± 2 psi)
Air pressure	655 ± 14 kPa (95 ± 2 psi)
Tracker valve spring pressure	103.5 kPa (15 psi)
Fuel injector ohm resistance	1.8 ± 0.1 Ω
Direct injector ohm resistance	1.3 ± 0.3 Ω
Direct injector color	Gray
Fuel rail water cooling	None

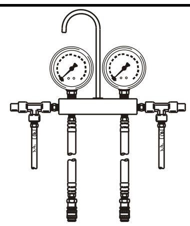
Lubricants, Sealants, Adhesives

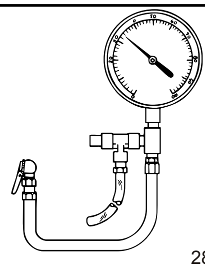
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Air compressor end cap screws	92-809819
		Air compressor end cap screw threads	
		Air compressor pulley screw threads	
14	2-cycle Premium Outboard Oil	Air pressure regulator O-rings	92-858021K01
		Air hose and fuel hose fitting O-rings	
		Air compressor cylinder bore	
		Air compressor end cap O-rings	
		O-rings on the fuel rail air compressor hose fitting	
34	Special Lubricant 101	Fuel pump body seal and fuel pump outlet seal	92-802865Q02
		Fuel pump body seal	
		Water separator fuel filter seal	
66	Loctite 242 Threadlocker	VST mounting screw threads, VST ground wire screw threads	92-809821
95	2-4-C with Teflon	Fuel injector O-rings and screw threads	92-802859A 1
		Tracker diaphragm, O-ring, and screw threads	
		Air pressure regulator screw threads	
		Fuel pressure regulator diaphragm and O-ring	
		Fuel pressure regulator screw threads	
110	4-Stroke 10W-30 Outboard Oil	Direct injector and injector washer	92-858045K01

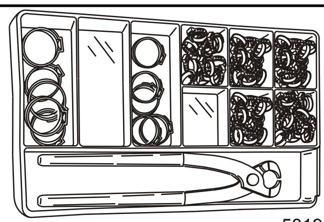
Special Tools

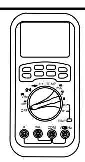
Schrader Valve Tee	22-849606
 13678	Aids in checking fuel pressure when using a fuel pressure gauge with a screw on Schrader valve connector

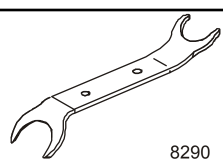
Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS)

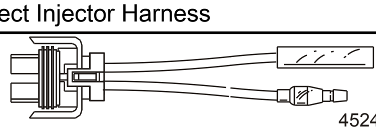
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously

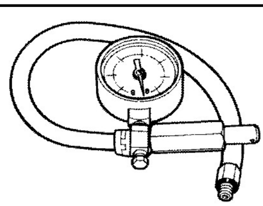
Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure

Hose Clamp Tool Kit	91-803146A04
 5819	Aids in the installation of high-pressure (Oetiker ®) hose clamps

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.

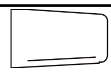
Direct Injector Removal Tool	91-883521
 8290	Aids in the removal of direct injectors from the fuel rail

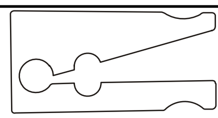
Direct Injector Harness	84-879346A49
 45245	Connects to the direct injector while the injector is in place between the cylinder head/block and fuel rail.

Leakage Tester Kit	FT8950
 29497	Checks gear housing for leakage prior to filling with gear lubricant, pressurize the oil injection system, and direct injector leakage

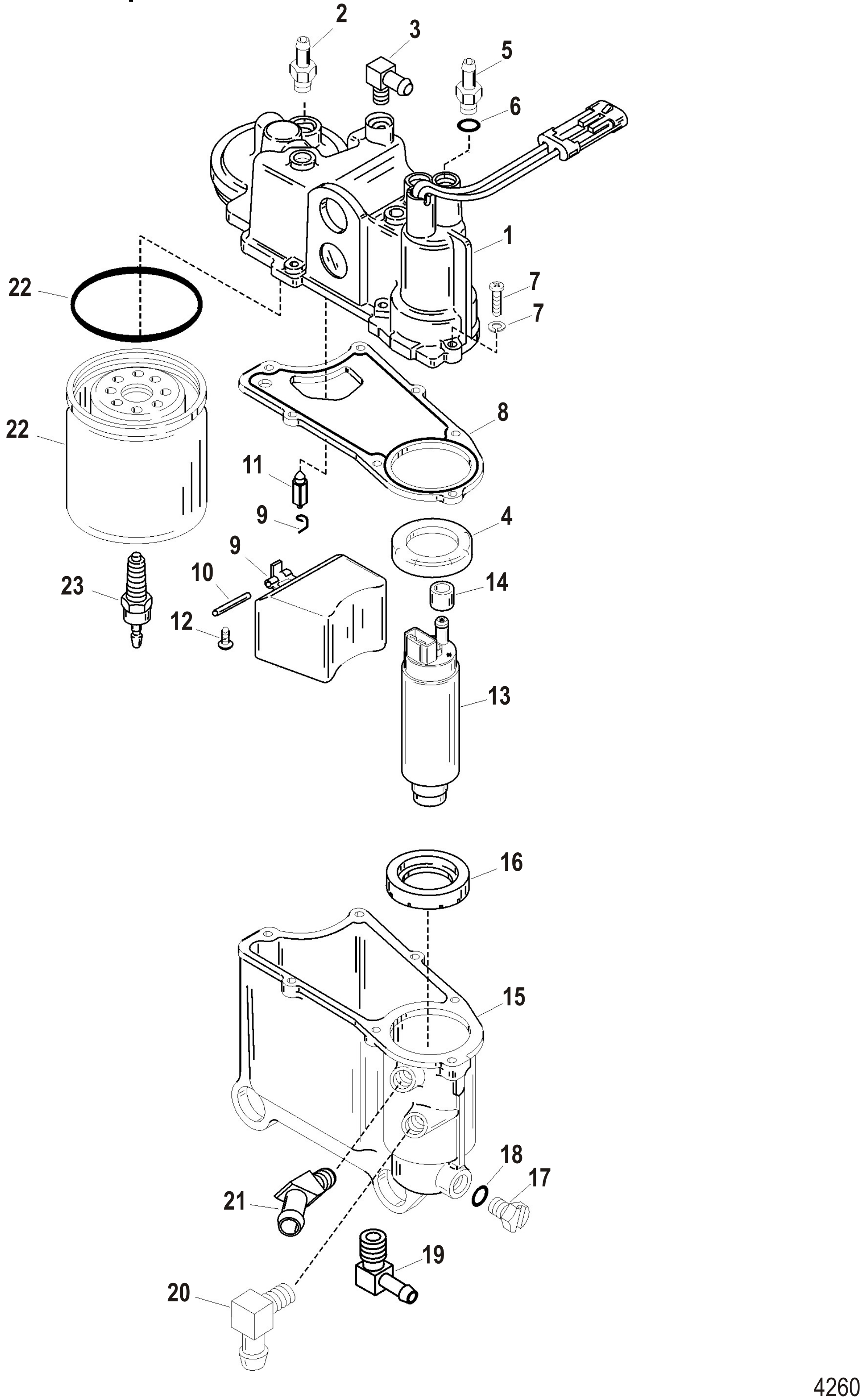
Pintle Test Fixture	91-899883A08
 35783	Used with a dial indicator to test the operating movement of a direct injector pintle.

Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

Seal/Teflon Ring Installation Tool	91-851980--3
 8285	Aids in the installation of Teflon seals on direct injectors

Seal/Teflon Ring Sizing Tool	91-851980--2
 8286	Compresses the Teflon seal on direct injectors after seal installation

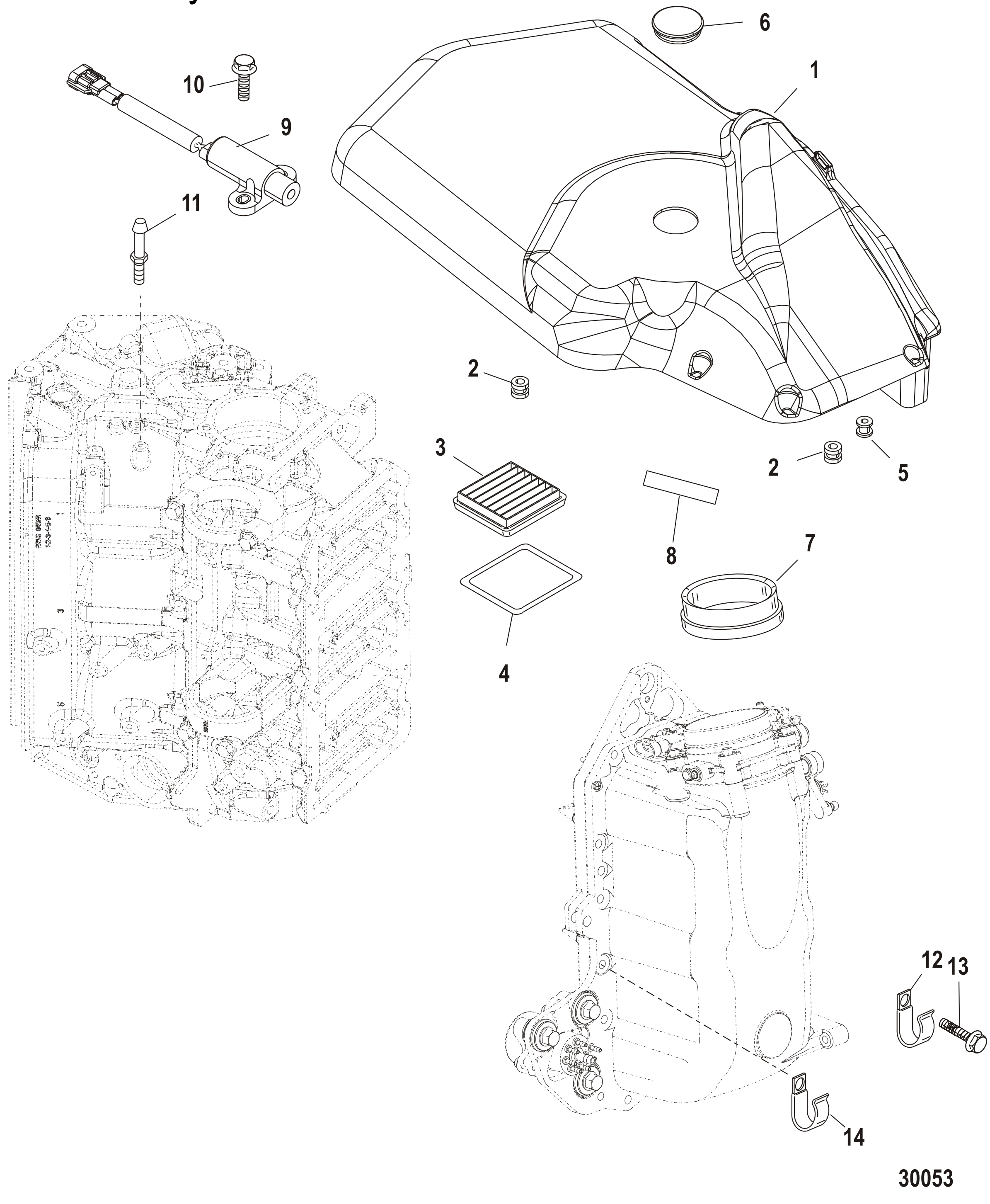
Vapor Separator Components



Vapor Separator Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cover kit			
2	1	Straight fitting			
3	1	90° elbow fitting			
4	1	Seal			
5	1	Pump outlet fitting kit			
6	1	O-ring			
7	7	Screw and washer (8-32 x 0.750 in.)	3.5	31	
8	1	Gasket			
9	1	Float kit			
10	1	Pin			
11	1	Needle valve			
12	1	Screw (8-32 x 0.187 in.)	1	9	
13	1	Pump kit			
14	1	Sleeve			
15	1	Bowl kit			
16	1	Seal			
17	1	Plug kit			
18	1	O-ring			
19	2	Elbow fitting			
20	1	Elbow fitting			
21	1	Elbow fitting			
22	1	Fuel filter kit			
23	1	Water sensing probe			

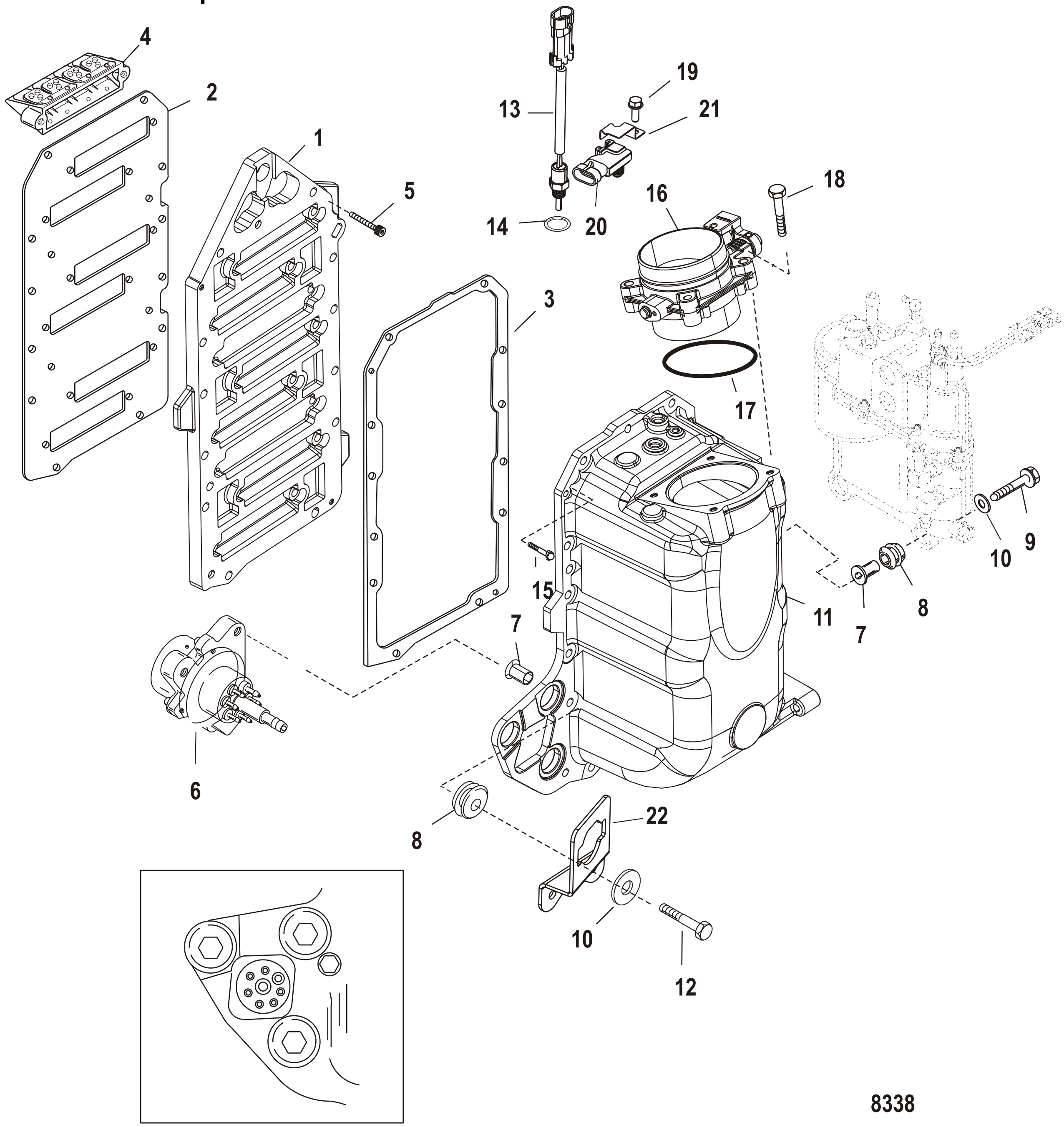
Air Handler and Flywheel Cover



Air Handler and Flywheel Cover

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Cover assembly			
2	2	Grommet			
3	1	Air filter			
4	1	Cover			
5	1	Grommet			
6	1	Plug			
7	1	Grommet			
8	1	Start in gear decal			
9	1	Crankshaft position sensor			
10	2	Screw (M5 x 16)	5.5	49	
11	1	Special pin	5.5	49	
12	2	J-clamp			
13	12	Screw (1/4-20 x 1-1/2 in.)	20	177	
14	1	J-clamp			

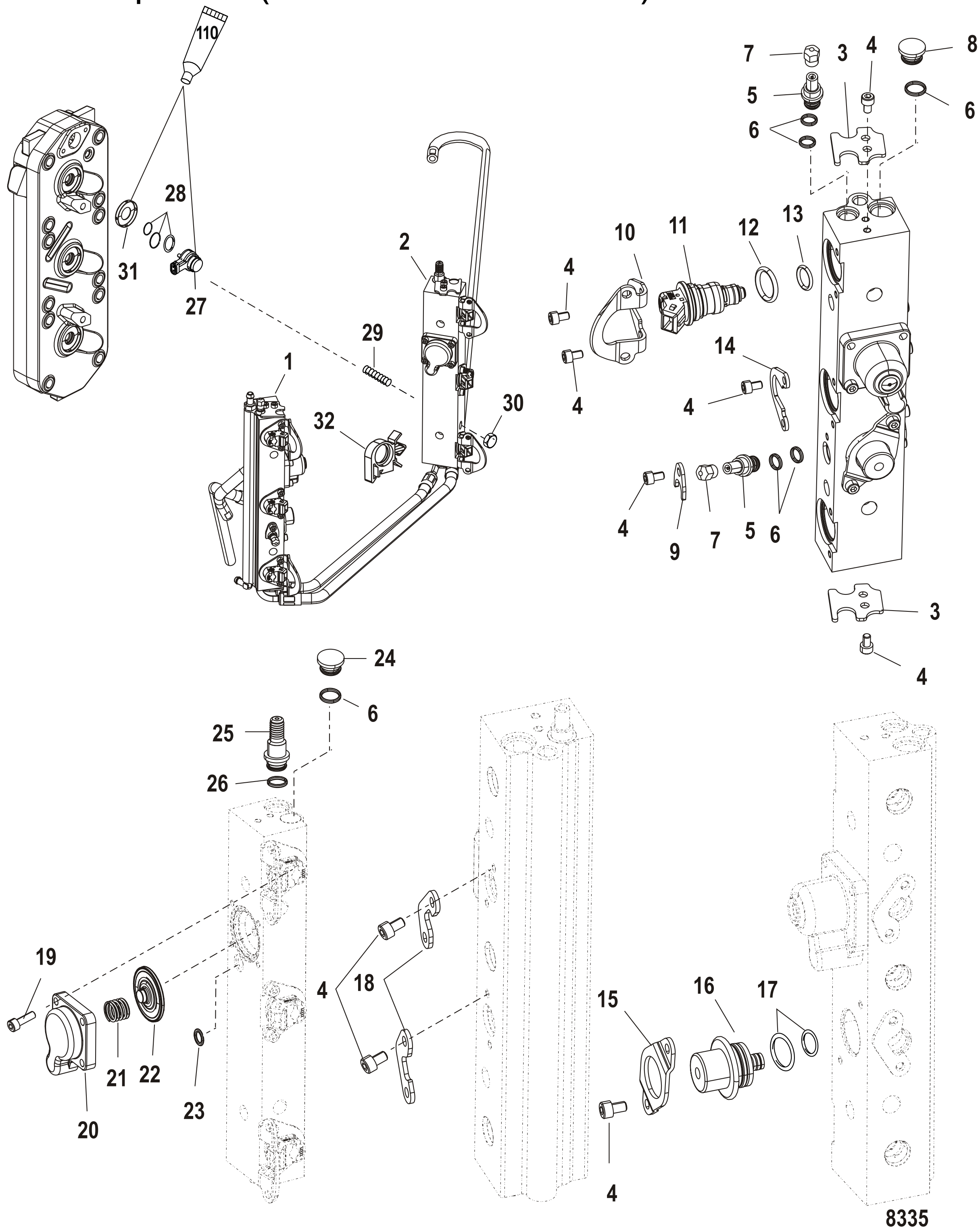
Air Handler Components



Air Handler Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Adapter plate			
2	1	Gasket			
3	1	Gasket			
4	6	Reed block assembly			
5	12	Screw (1/4-20 x 7/8 in.)	11.5	102	
6	1	Oil pump			
7	6	Bushing			
8	6	Grommet			
9	3	Screw (M8 x 35)	16	142	
10	6	Washer (0.344 x 1.00 x 0.063 in.)			
11	1	Air plenum kit			
12	3	Screw (M8 x 30)	16	142	
13	1	Manifold air temperature (MAT) sensor	16	142	
14	1	O-ring			
15	2	Screw (M4 x 16)	2.5	22	
16	1	Throttle body assembly			
17	1	O-ring			
18	4	Screw (M6 x 40)	7.5	66	
19	1	Screw (M6 x 16)	4.5	40	
20	1	Manifold absolute pressure (MAP) sensor			
21	1	MAP sensor bracket			
22	1	Bracket			

Fuel Rail Components (S/N 0T178500 and Above)

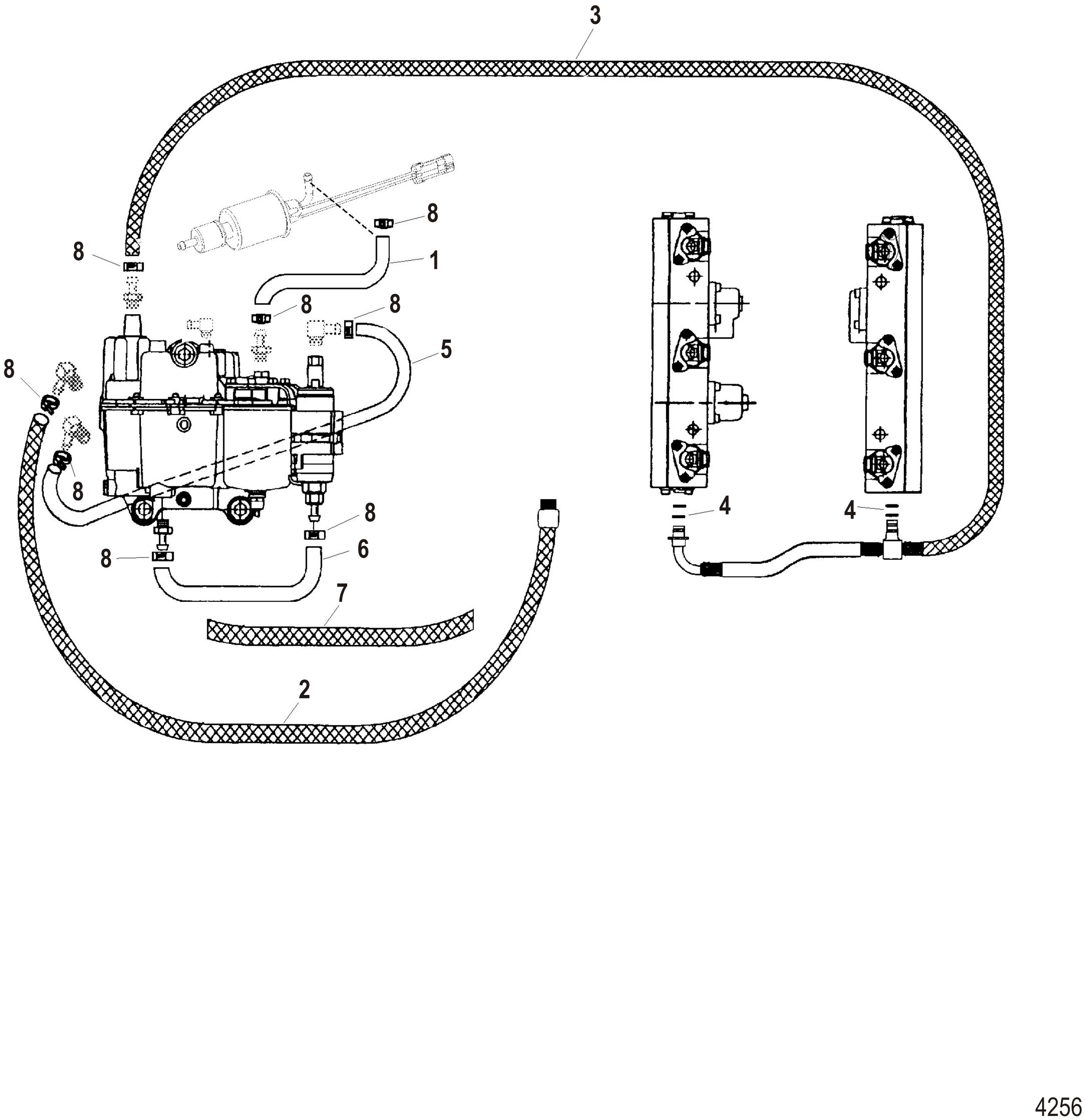


Fuel Rail Components (S/N 0T178500 and Above)

Ref. No.	Qty.	Description	Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Port fuel rail			
2	1	Starboard fuel rail			
3	4	Clamp			
4	20	Screw (M5 x 10)	8	71	
5	2	Schrader valve assembly			
6	1	O-ring kit			
7	2	Brass cap			
8	1	Port plug			
9	1	Clamp			
10	4	Clamp			
11	6	Fuel injector			
12	1	O-ring kit			
13	1	O-ring kit			
14	2	Clamp			
15	1	Clamp			
16	1	Air regulator			
17	1	O-ring kit			
18	2	Clamp			
19	4	Screw (M5 x 16)	8	71	
20	1	Cover			
21	1	Spring			
22	1	Diaphragm assembly			
23	2	O-ring			
24	1	Starboard plug			
25	1	Fitting			
26	1	O-ring kit			
27	6	Direct injector			
28	6	Seal kit			
29	4	Stud (M10 x 91)			
30	4	Nut (M10)	45		33
31	6	Injector washer			
32	4	Clip			

Tube Ref No.	Description	Where Used	Part No.
110	4-Stroke 10W-30 Outboard Oil	Direct injector and injector washer	92-858045K01

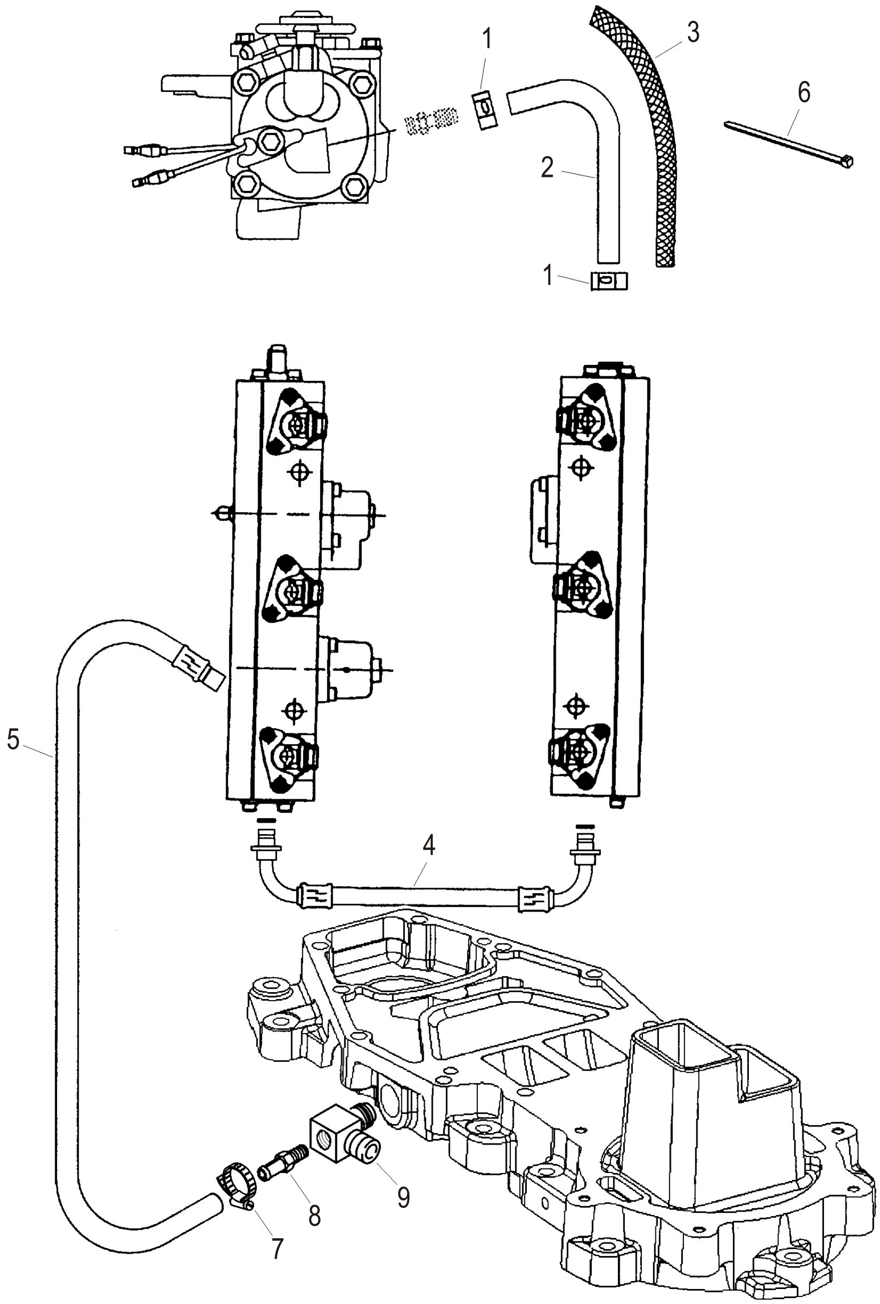
Fuel Hose Components



Fuel Hose Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Hose (21.6 cm [8.5 in.])			
2	1	Fuel return hose assembly			
3	1	Fuel supply hose assembly			
4	1	O-ring kit			
5	1	Hose			
6	1	Hose			
7	2	Sleeve			
8	8	Hose clamp (18.3 mm)			

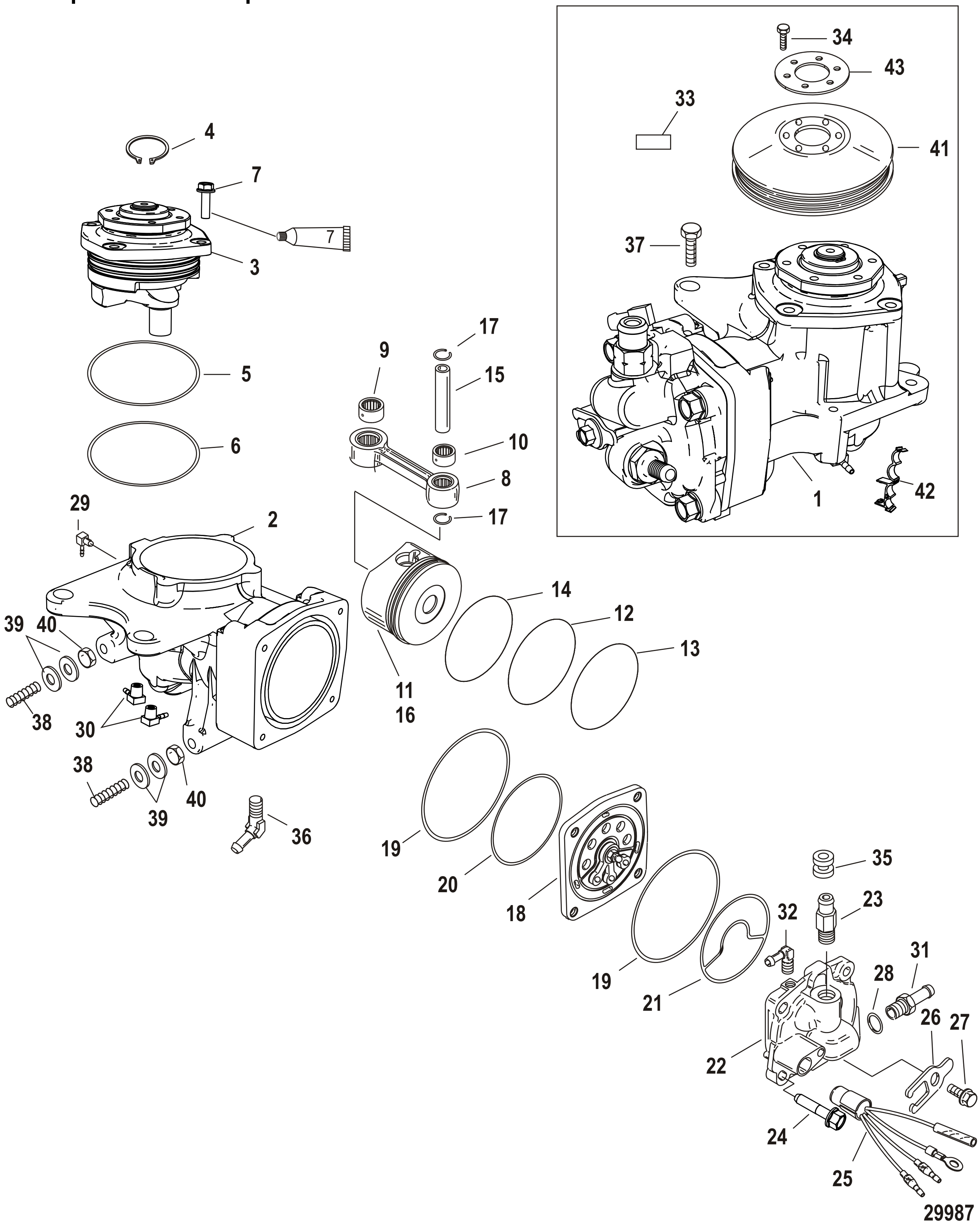
Air Hose Components



Air Hose Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Hose clamp (18.3 mm)			
2	1	Air supply hose			
3	1	Insulation sleeve			
4	1	Air balance hose assembly			
5	1	Air bypass hose assembly			
6	2	Cable tie			
7	1	Worm gear clamp			
8	1	Fitting (1/8-27)			
9	1	90° elbow fitting			

Air Compressor Components



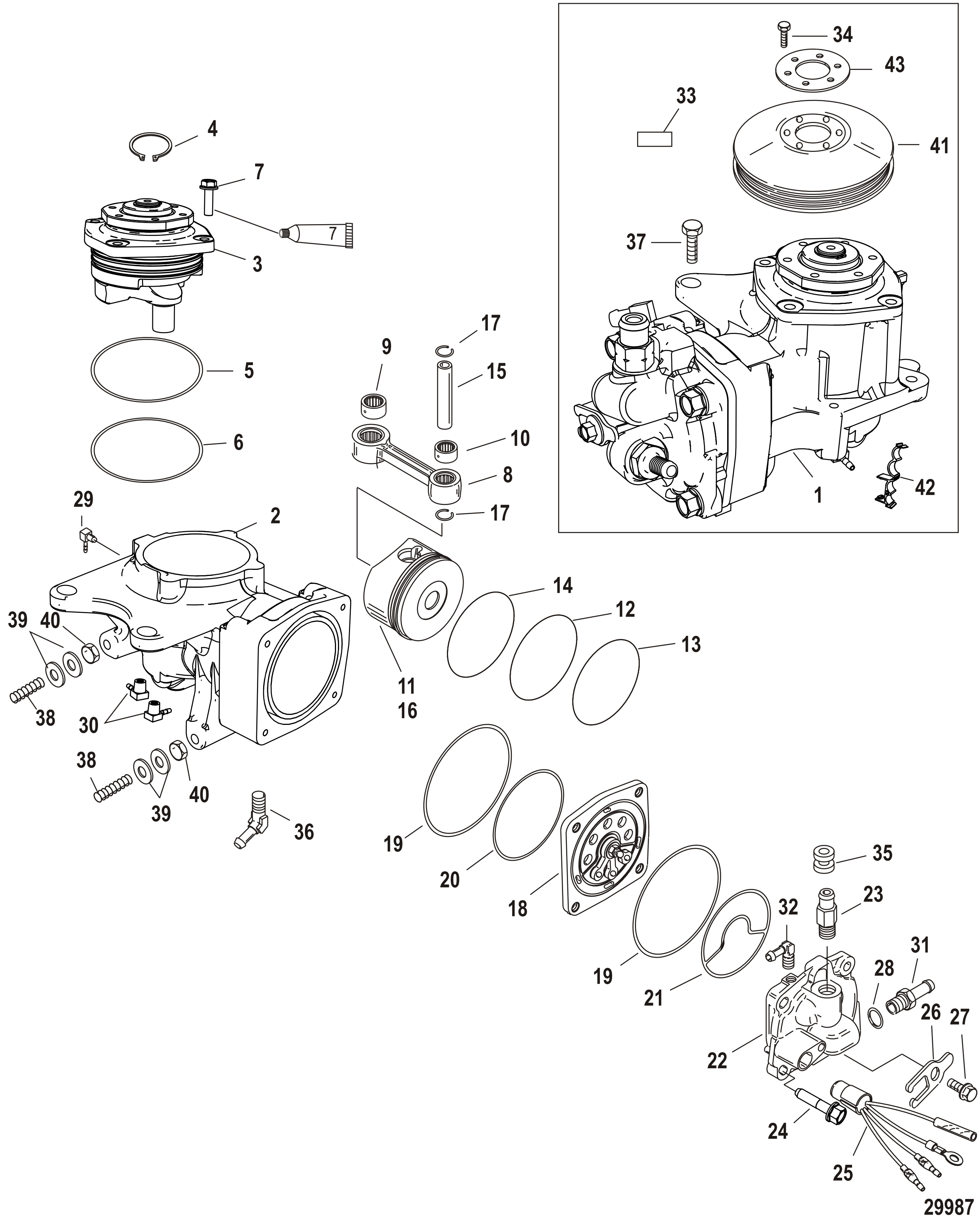
Air Compressor Components

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Air compressor kit				
2	1	Body				
3	1	End cap assembly				
4	1	Retaining ring				
5	1	O-ring				
6	1	O-ring				
7	4	Carbon steel screw (M6 x 20)		17	150	
		Stainless steel screw (M6 x 20)		11.5	102	
8	1	Connecting rod assembly				
9	1	Bearing				
10	1	Bearing				
11	1	Piston assembly				
12	1	Oil scraper ring				
13	1	Top ring				
14	1	Oil ring				
15	1	Wrist pin				
16	1	Piston with wrist pin				
17	2	Lockring				
18	1	Reed plate assembly				
19	2	O-ring				
20	1	O-ring				
21	1	Seal				
22	1	Compressor head kit				
23	1	Fitting				
24	4	Screw (M8 x 14)		27		20
25	1	Temperature sensor				
26	1	Retainer				
27	1	Screw (M8 x 14)		27		20
28	1	O-ring				
29	1	Fitting				
30	2	Check valve fitting				
31	1	Fitting				
32	1	Fitting				
33	1	Instruction decal				
34	6	Screw (M6 x 12)		19	168	
35	1	Grommet				
36	1	45° elbow fitting				
37	2	Hex flange screw (M10 x 25)	First	1.5	13	
			Final	56		41
38	2	Stud (0.312-18/0.324-24 x 4.190)				

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
39	4	Special washer			
40	2	Nut (0.312-24)	34		25
41	1	Pulley			
42	1	Clamp			
43	1	Washer			

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Air compressor end cap screws	92-809819

Air Compressor Components



DFI Operation

Air Induction

Air enters the cowl through holes in the top aft end of the cowl. The cowl liner directs the air to the bottom of the powerhead. This limits salt exposure to the engine components. Air volume entering the plenum is controlled with the throttle body shutter mounted on the plenum. The throttle body shutter is actuated by the throttle cam. When the throttle body shutter opens, the air passes through the reed valves and into the crankcase. The throttle position sensor (TPS) is mounted on a support plate and is connected to the throttle cam by a link shaft. The TPS transmits throttle angle information to the propulsion control module (PCM).

Air Compressor System

Air from inside the engine cowl is drawn into the compressor through the flywheel cover. This cover acts like a muffler to quiet compressor noise and contains a filter to prevent the ingestion of debris into the compressor. The compressor is driven by a belt from a pulley mounted on the flywheel and is automatically self-adjusted with an idler pulley. This air compressor is a single cylinder unit containing a connecting rod, piston, rings, bearings, reed valves, and a crankshaft. The compressor is water-cooled to lower the temperature of the air charge and is lubricated by oil from the engine oil pump assembly. As the compressor piston moves downward inside the cylinder, air is pulled through the filter, reed valves and into the cylinder. After the compressor piston changes direction, the intake reeds close and the exhaust reeds open allowing compressed air into the hose leading to the air/fuel rails. The air compressor is designed to deliver a charged air pressure significantly higher than what is required for the engine to operate efficiently. Inside the fuel rail, an air pressure regulator limits the charged air to a specific pressure that is lower than the pressure of the fuel. The excess air pressure is dumped into the adapter plate.

Fuel

IMPORTANT: Due to the inconsistent fuel quality in some areas, excessive fuel system and combustion chamber deposits are on the rise. These deposits cause many driveability problems that range from hesitation, rough idle, spark plug fouling, to detonation problems. This performance characteristic can be greatly reduced through regular fuel system maintenance.
To minimize fuel system and carbon deposit buildup in the engine, it is strongly recommended to add Mercury/Quicksilver Quickleen Engine Treatment (or equivalent) to your engine's fuel at each tank fill throughout the boating season. Use additive as directed on the container.

Fuel for the engine is stored in a fuel tank. An electric lift pump assembly is installed into the fuel line for priming the fuel system and supplies fuel to the low-pressure boost pump. The low-pressure boost pump mounted on the vapor separator tank, then pushes the fuel through a water separating fuel filter. This filter removes contaminants and water before the fuel reaches the vapor separator tank. Fuel vapors are vented through a hose into the air compressor inlet on the front of the flywheel cover. The electric fuel pump (inside the VST) is different than the fuel pump that is utilized on the standard EFI engine (non-DFI), and is capable of developing fuel pressures in excess of 751.5 ± 14 kPa (109 ± 2 psi). Fuel inside the rail must remain pressurized at exactly 103.5 kPa (15 psi) over the air rail pressure or the PCM (map) calibrations will be incorrect. Fuel from the vapor separator is supplied to the bottom of the starboard fuel rail. A fuel line connects the bottom of the first rail to the opposite fuel rail. Fuel is stored inside the rail until an injector opens. A fuel pressure regulator controls pressure in the fuel rails, and allows excess fuel to return into the vapor separator. The fuel regulator not only regulates fuel pressure, but also regulates it at approximately 10 psi higher than whatever the air rail pressure is. The fuel regulator diaphragm is held closed with a spring that requires 103.5 kPa (15 psi) to force the diaphragm off the diaphragm seat. The backside of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase. Example: If there is 345 kPa (50 psi) of air pressure on the air rail side of the diaphragm, 448 kPa (65 psi) of fuel pressure will be required to open the regulator. The port fuel rail is water-cooled.

To equalize the pulses developed by the pumps (both air and fuel) a tracker diaphragm is installed in the starboard rail. The tracker diaphragm is positioned between the fuel and air passages. The tracker diaphragm is a rubber diaphragm which expands and retracts depending upon which side of the diaphragm senses the pressure increase (pulse).

Oil

Oil is not mixed with fuel before entering the combustion chamber. The oil is stored inside the reservoir. Oil flows from the oil reservoir to the oil pump. The oil pump is mounted on the powerhead. The oil pump is a solenoid-driven pump, actuated by the PCM and includes seven pistons with discharge ports. The oil is discharged into the crankcase and lubricates each cylinder. The seventh passage lubricates the air compressor. Excess oil from the compressor returns into the cylinder bores.

The PCM will change the discharge rate of the oil pump depending upon engine demand. The PCM energizes the pump on initial start-up to fill the oil passages eliminating the need to bleed the oil system. The PCM provides additional oil for the break-in. The break-in time is determined by the PCM internal clock.

Electrical

The electrical system consists of the PCM, crankshaft position sensor, throttle position sensor, manifold absolute pressure sensor, engine temperature sensor, ignition coils, fuel injectors, and direct injectors. The engine requires a battery to start and will not run off of the alternator.

Operation

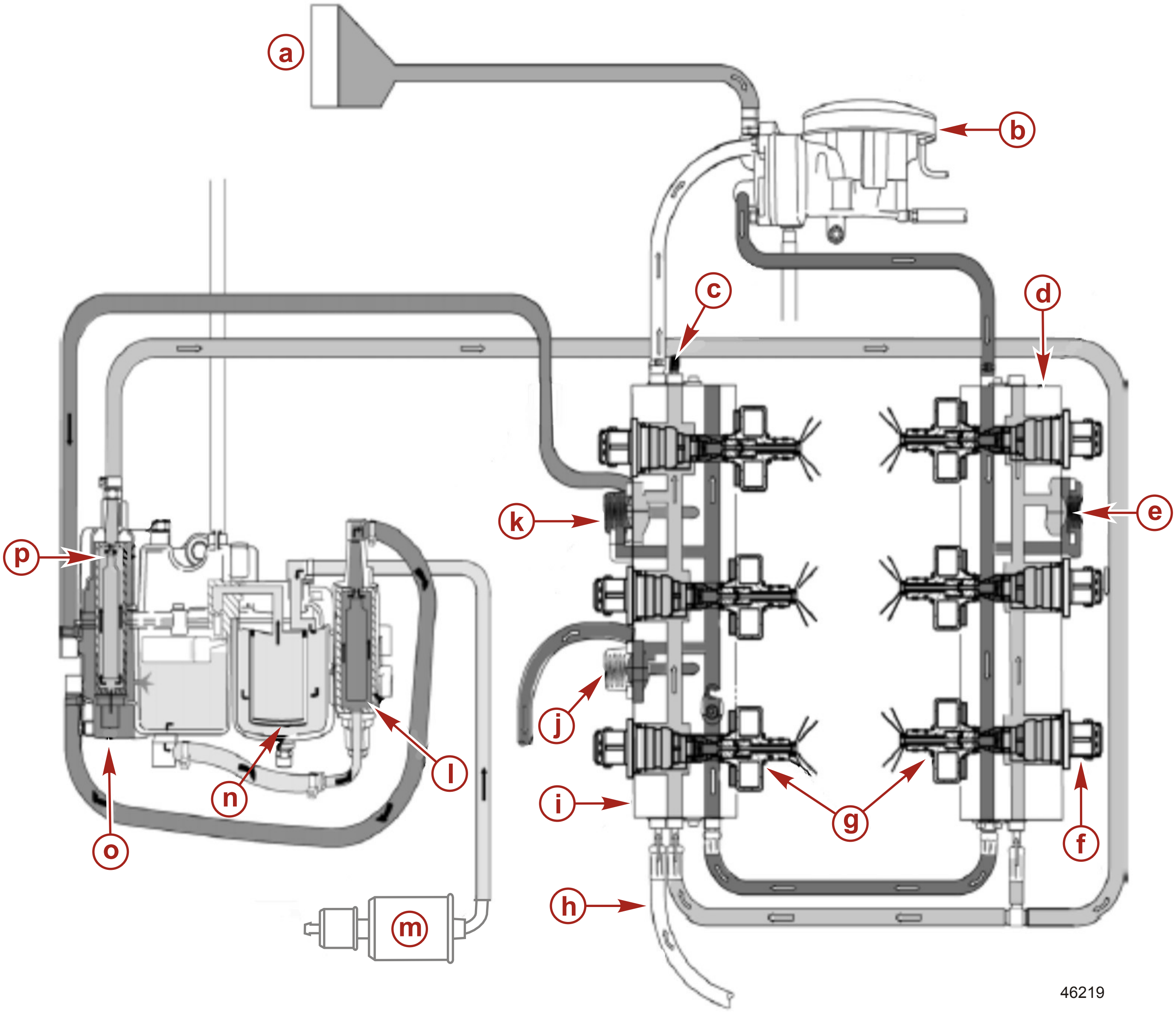
The operation of the system happens in milliseconds (ms); exact timing is critical for engine performance. As the crankshaft rotates, air is drawn into the crankcase through the throttle shutter, into the plenum, and through the reed valves. As the piston nears bottom-dead-center, air from the crankcase is forced through the transfer system into the cylinder. As the crankshaft continues to rotate the exhaust and intake ports close. With these ports closed, fuel can be injected into the cylinder. The ECM will receive a signal from the throttle position sensor (TPS), engine temperature sensor, and the crankshaft position sensor (flywheel speed and position sensor). With this information the ECM refers to the fuel calibration (maps) to determine when to activate (open and close) the injectors and fire the ignition coils. With the piston in the correct position, the ECM opens the fuel injector, high-pressure fuel is discharged into a machined cavity inside the air chamber of the air/fuel rail. This mixes the fuel with the air charge. Next the direct injector will open, discharging the air/fuel mixture into the combustion chamber. The direct injector directs the mixture at the bowl located in top of the piston. The piston's bowl directs the air/fuel mixture into the center of the combustion chamber. This air/fuel mixture is then ignited by the spark plug.

Compressor notes: On initial start-up, some direct injectors are held open by the PCM to allow the compression from inside the cylinders to pressurize the air rail faster within one or two strokes, or 60° of crankshaft rotation.

Idle notes: Idle quality is controlled by fuel volume and fuel timing. The shift switch is mounted on the exhaust adapter plate and is activated by a cam/notch in the upper shift shaft. The PCM monitors the switch and will change fueling, timing, and RPM limits according to whether the engine is in gear or in neutral.

The TPS signals the ECM to change the fuel and spark without movement of the throttle shutters. The throttle cam is manufactured to allow the TPS sensor shaft to move before opening the throttle shutter.

200 OptiMax Jet Drive Air/Fuel Schematic

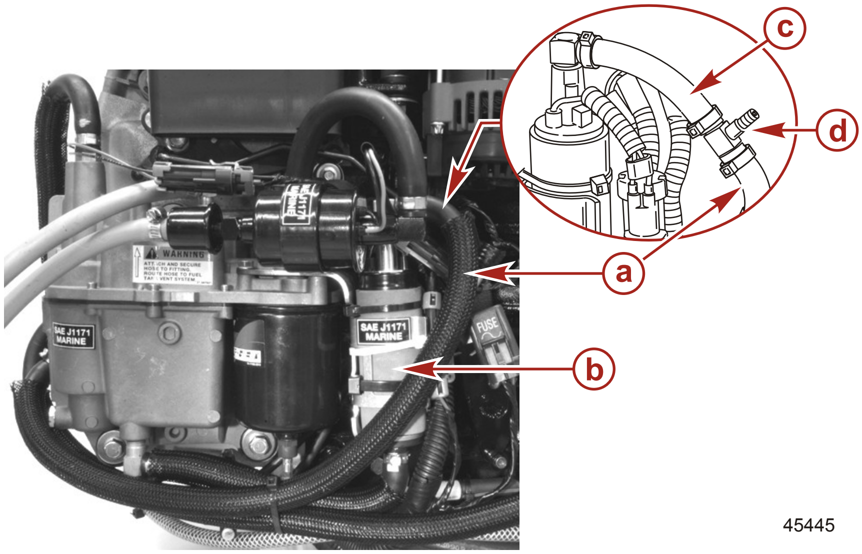


- a - Air intake
- b - Air compressor
- c - Fuel system test valve
- d - Starboard fuel rail
- e - Tracker valve
- f - Fuel injector (6)
- g - Direct injector
- h - Water into fuel rail
- i - Port fuel rail
- j - Air pressure regulator
- k - Fuel pressure regulator
- l - Low-pressure boost pump
- m - Lift pump assembly
- n - Water separating fuel filter
- o - Fuel filter
- p - High-pressure fuel pump

Electric Fuel Pump Pressure Tests

Low-Pressure Boost Pump Test

1. Remove the fuel outlet hose from the low-pressure boost pump and install a short piece of hose (obtain locally) onto the fuel pump outlet fitting.
2. Install a Schrader valve T-fitting between the hose removed from the pump and the fuel hose installed on the pump. Secure the hose connections with cable ties.
3. Connect a pressure gauge to the Schrader valve T-fitting.
4. Turn the ignition key to the "ON" position. The pressure must be within the specifications.



a - Outlet fuel hose
b - Boost pump
c - Fuel hose
d - Schrader valve

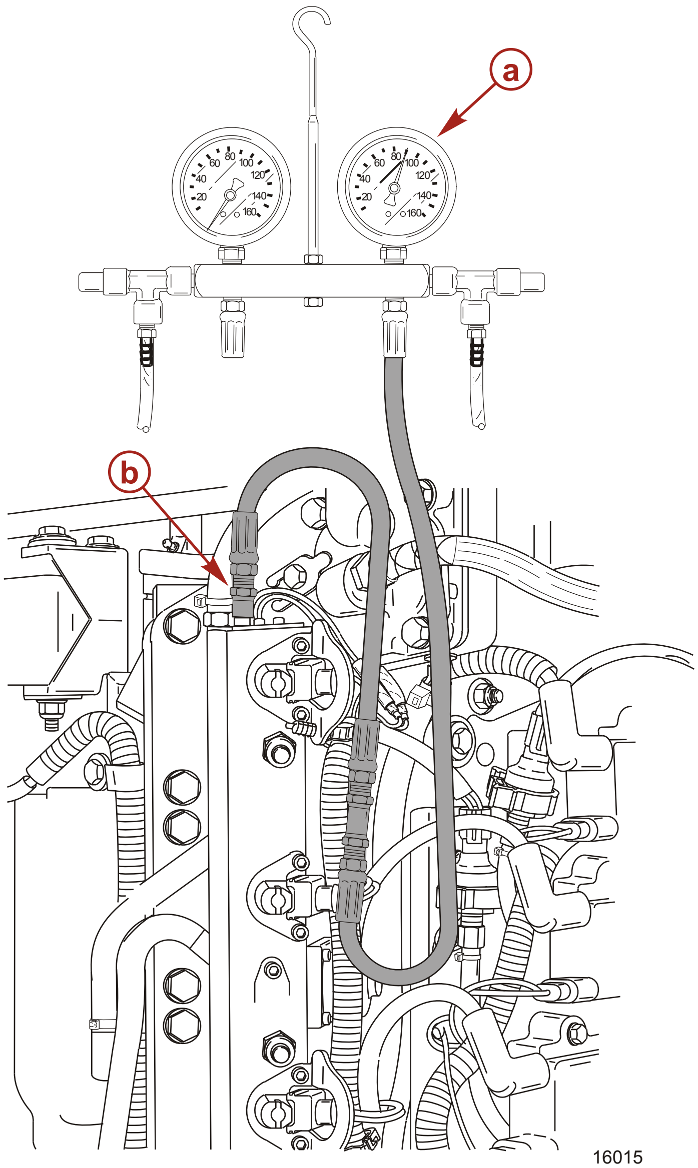
Low-Pressure Electric Fuel Pump (Boost Pump)	
Low-pressure fuel pump output	41–62 kPa (6–9 psi)

Schrader Valve Tee	22-849606
Digital Pressure Meter	91-892651A01
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Fuel Pressure Gauge Kit	91-881833A03

High-Pressure Fuel Pump

1. Install the pressure gauge assembly to the port fuel rail pressure test valve.
2. Start the engine, or crank the engine for 15 seconds with the starter motor. The fuel pressure on the gauge must be within specifications.

IMPORTANT: The air pressure within the fuel rail must reach the air pressure specification to display the high-pressure fuel accurately.



a - Fuel/air pressure gauge
b - Fuel pressure test valve

High-Pressure Fuel Specification	
Pressure	751.5 ± 14 kPa (109 ± 2 psi)

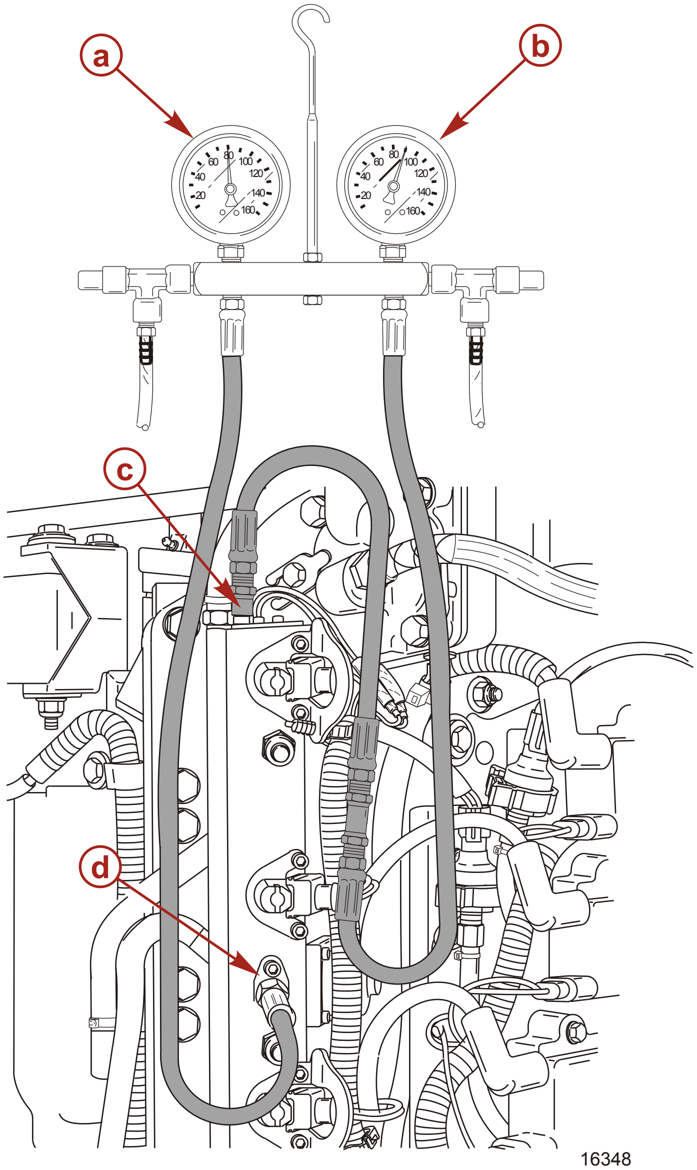
Air Pressure Specification	
Pressure	655 ± 14 kPa (95 ± 2 psi)

Digital Pressure Meter	91-892651A01
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Fuel Pressure Gauge Kit	91-881833A03

Air Compressor Pressure Test

Install the pressure gauge assembly to fuel rail pressure test valves. The fuel pressure and air pressure test valves are located on the starboard rail.

NOTE: After 15 seconds of cranking engine with starter motor, air pressure gauge should indicate 655.0 ± 14 kPa (95 ± 2 psi) and fuel pressure gauge should indicate 751.5 ± 14 kPa (109 ± 2 psi).



a - Air pressure gauge
b - Fuel pressure gauge
c - Fuel pressure test valve
d - Air pressure test valve

Fuel or Air Pressure Not to Specifications - SportJet Models

⚠ 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. If you suspect the fuel rails or a component of the fuel delivery system (electronic fuel pumps, VST, fuel lines, fuel rails, air system), connect a dual pressure, liquid-filled gauge to the port and starboard fuel rails and check both air and fuel pressure together.
2. If fuel and air pressures are out of specification, refer to the following chart for help with system diagnostics.
3. Refer to **Electric Fuel Pump Pressure Tests** and **Air Compressor Pressure Test** for procedures on checking the fuel and air system pressure.

Component or Problem	Possible Causes	Corrective Action
Fuel pressure and air pressure are *both* low	Air compressor	Provide 80 psi of shop air to the air rail test (Schrader) valve. Inspect the air compressor for leaks. Leaking air through the compressor indicated bad reeds.
		Inspect for broken reeds.
		Remove the air compressor cylinder head and inspect the cylinder wall and piston for scuffing.
		Replace components as necessary.
	Air compressor inlet	Inspect the compressor air inlet for blockage, kinks, or tears.
		Clean, correct, or replace components as necessary.
	Starboard rail air inlet hose	Inspect the air inlet hose to the starboard rail for blockage, kinks, or tears.
		Clean, correct, or replace components as necessary.
Fuel pressure and air pressure are *both* low	Starboard to port rail air transfer hose	Inspect the air transfer hose from the starboard to port rails for blockage, kinks, or tears.
		Clean, correct, or replace components as necessary.
	Tracker valve	Remove/inspect the tracker valve diaphragm for cuts, tears, or abrasions.
		Inspect the diaphragm seat and rail for damage. Replace components as necessary.
	Direct injector	Injector may be damaged or stuck open. Perform a resistance check or leak test to determine cause.
		Check O-ring for nicks or cuts.
Fuel pressure and air pressure are *both* low	Air regulator	Provide 80 psi of shop air to the air rail test (Schrader) valve.
	(This should be the last component to check/ remove)	Visually inspect the air regulator cover. If air is escaping through the small hole, the regulator is faulty. Replace the port fuel rail.
		If necessary, remove/inspect the air regulator diaphragm for cuts, tears, or abrasions.
		Inspect the diaphragm seat and rail for damage. If the air regulator is faulty, replace the port fuel rail.
	Air rail test (Schrader) valve	Damaged valve. Replace the valve with an Air Valve Kit.
Fuel pressure is low or fuel pressure drops while running Air pressure remains normal	Tracker valve	Remove/inspect the tracker valve diaphragm for cuts, tears, or abrasions.
		Inspect the diaphragm seat and rail for damage. Replace components as necessary.
		Check the air system for fuel contamination.
	Fuel hoses	Inspect the fuel hoses for blockage, kinks, or tears.
		Clean, correct, or replace components as necessary.
	Fuel regulator	Remove/inspect the fuel regulator diaphragm for cuts, tears, or abrasions.
		Inspect the diaphragm seat and rail for damage. If the fuel regulator is faulty, replace the port fuel rail.
		Check the air system for fuel contamination.

Component or Problem	Possible Causes	Corrective Action
Fuel pressure is low or fuel pressure drops while running Air pressure remains normal	Electric fuel pumps, VST, or filters	Ensure that the lanyard switch is in the correct position.
		Turn the ignition switch to the "RUN" position. Both electric pumps should operate for two seconds. If they do not run, check the 20 amp fuse and wire connections.
		Replace components as necessary.
	Electric fuel pumps, VST, or filters	If the pumps run, but have low fuel pressure, remove the drain plug from the vapor separator tank (VST) and inspect for fuel.
		If the VST does not contain fuel: Prime the system (primer bulb) and check the water separator for debris. Clean/replace as necessary. If the bulb primes the fuel system, perform a vacuum test on the pulse pump. If there is still no fuel in the VST, check all components prior to the VST for restrictions. If no restrictions are found, inspect/replace the water separating fuel filter. If there is still no fuel, inspect the VST filter and needle/seat for contamination or obstruction. Replace as necessary.
Fuel pressure is low or fuel pressure drops while running Air pressure remains normal	Electric fuel pumps, VST, or filters	**If the VST contains fuel:** Pinch the fuel return line to the high-pressure fuel pump/VST. The pressure at the fuel test valve should exceed 110 psi. If necessary, check the high-pressure pump amperage draw (in series). Normal draw is 6–9 amps. If the draw is below 2 amps, check the fuel pump filter at the base of the pump for debris. If filter is clean and the draw is below 2 amps, replace the pump. If the draw is above 9 amps, replace the pump.
	Lift pump	Check the fuel lift pump for output. Normal output is 1–2 psi at idle, 1 psi minimum.
		Service/replace if necessary.
	Anti-siphon valve	Check for restricted fuel flow.
	Fuel test (Schrader) valve	Damaged valve. Replace the valve with a Fuel Valve Kit.
Fuel pressure is high and air pressure is normal	Fuel regulator	Inspect the fuel regulator hole for blockage. Clean or correct as necessary.
		Inspect the diaphragm seat and rail for damage. If the fuel regulator is faulty or incorrectly calibrated, replace the port fuel rail.
		Inspect the diaphragm seat and the rail for damage. Replace the rail as necessary.
Fuel and air pressure are *both* high	Air vent hose	Remove the air vent hose at the rail and check air pressure at idle. If the pressures return to normal, the air vent hose is blocked or otherwise restricted.
		Inspect the air vent hose to the air plenum for blockage or kinks. Clear or correct as necessary.
	Air regulator	Check the air pressure regulator for blockage or kinks.
		Clean or correct as necessary. If the air regulator is faulty or incorrectly calibrated, replace the port rail.

Component or Problem	Possible Causes	Corrective Action
Air and fuel pressure differential out of range Normal differential is103.5 kPa (15 psi)	Tracker valve	Remove/inspect the tracker valve diaphragm for cuts, tears, or abrasions.
		Check the diaphragm seat and rail for damage. Replace components as necessary.
	Fuel regulator	Remove/inspect the fuel regulator diaphragm for cuts, tears, or abrasions.
		Inspect the fuel regulator hole for blockage. Clean or correct as necessary.
		Inspect the diaphragm seat and rail for damage. If the fuel regulator is faulty, replace the port fuel rail.
		Check the air system for fuel contamination.
	Failed fuel injector	Inspect the injector O-ring for nicks, cuts, or abrasions.
		Replace the injector as necessary.
	Injector stuck open	Perform a fuel injector leak test.
		Replace components as necessary.
	Fuel rail damaged	Check for fuel in the air system.
		Inspect the offending rail valves and regulators. If all components check out, replace the rail.

Fuel Management Assembly Removal

⚠ WARNING

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

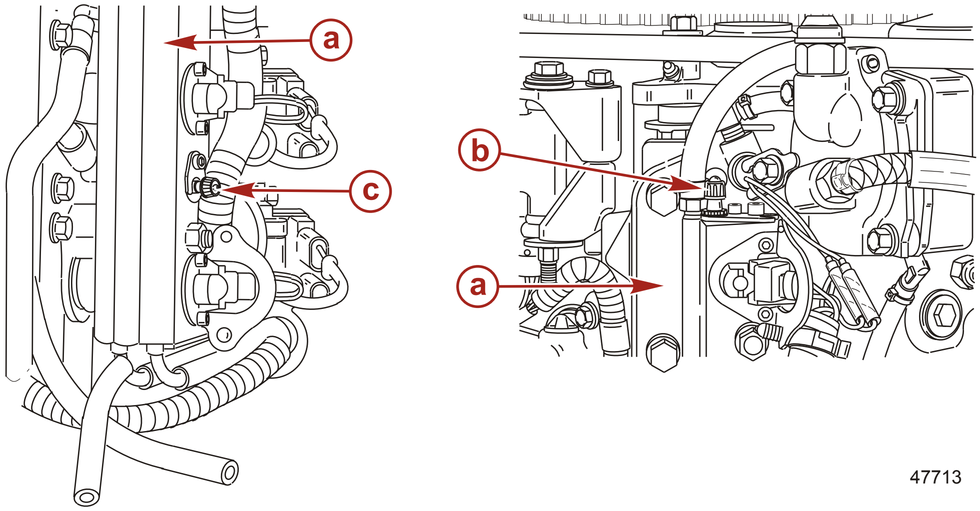
⚠ CAUTION

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

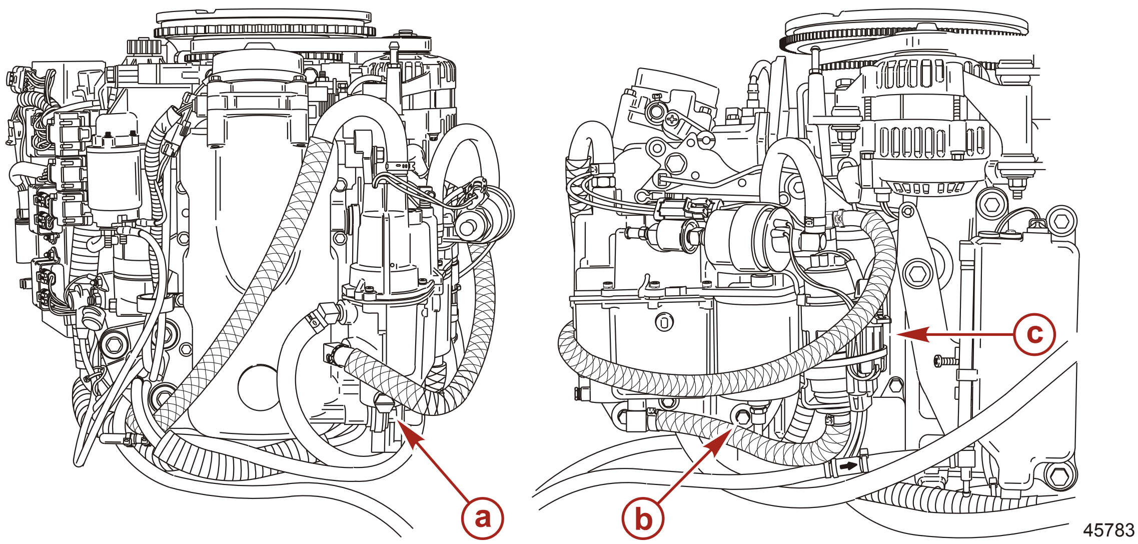
Fuel may still remain in the fuel rails and hoses after draining the vapor separator tank (VST). To avoid a possible fire or explosion, follow normal precautionary procedures while working with the fuel system. Use a suitable container when draining fuel from the VST and avoid sparks, smoking, and open flame while in the presence of liquid fuel or fuel vapors.

1. Release the pressure in the fuel system. Fuel should be captured in an appropriate container.



a - Port fuel rail
b - Fuel pressure test valve
c - Air pressure test valve

2. Place a suitable container underneath the vapor separator drain plug and remove the plug.
3. Disconnect the water separator sensor lead.
4. Disconnect the electric fuel pump harness connectors.

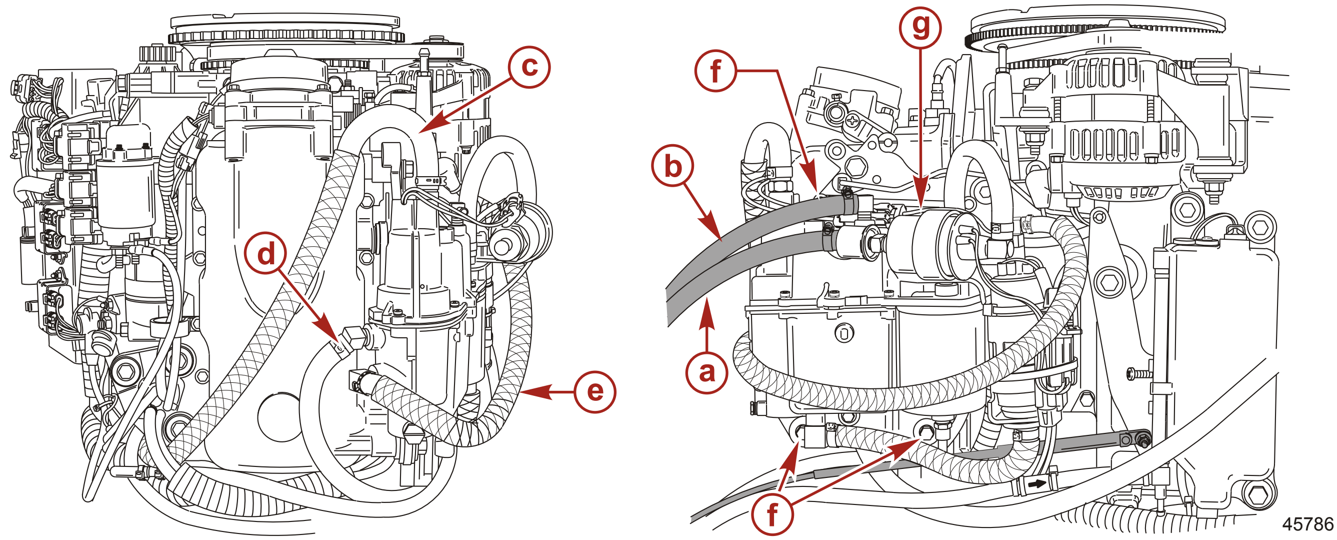


a - Drain plug
b - Sensor lead
c - Harness connectors

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Fuel Pressure Gauge Kit	91-881833A03

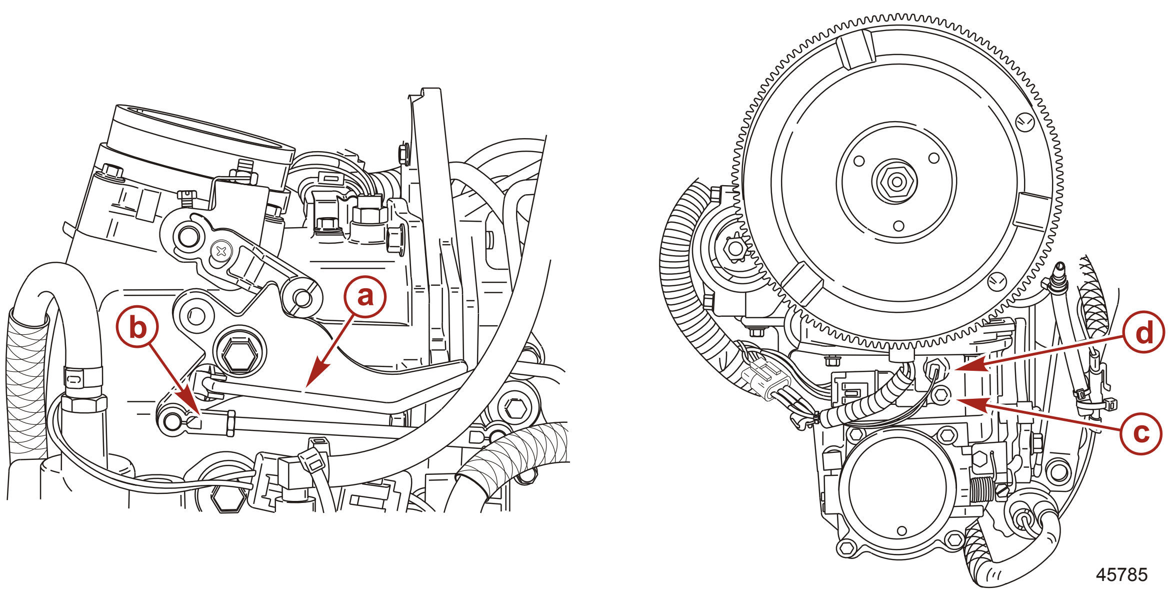
5. Remove the fuel inlet hose from the fuel lift pump.
6. Remove the vapor separator vent hose.
7. Remove the fuel outlet hose and fuel return hose from the fuel rails.
8. Remove the vapor separator ground lead.

9. Remove the three mounting bolts and remove the separator.



a - Fuel inlet hose to fuel lift pump
b - Vapor separator vent hose
c - Fuel outlet hose
d - Fuel return hose
e - Fuel inlet hose
f - Mounting bolts (3)
g - Ground lead

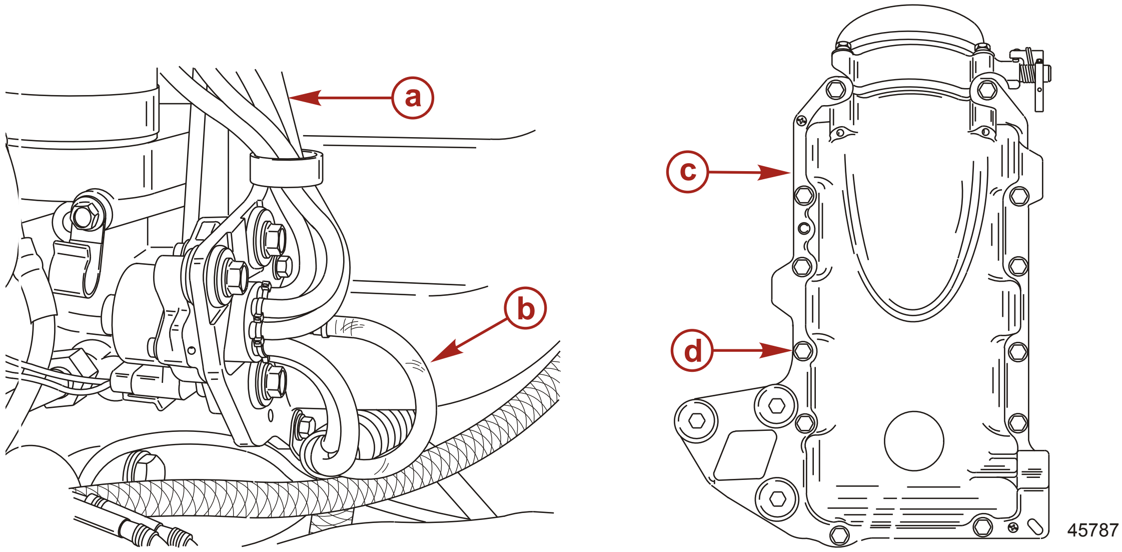
10. Disconnect the throttle cam link rod and the throttle position sensor (TPS) link rod.
11. Disconnect the manifold absolute pressure (MAP) sensor from the air management assembly.
12. Disconnect the engine harness connector from the manifold air temperature (MAT) sensor connector.



a - Throttle link rod
b - TPS link rod
c - MAP sensor
d - MAT sensor

13. Disconnect the oil hoses from the oil pump.
14. Remove and plug the oil inlet hose to the oil pump.

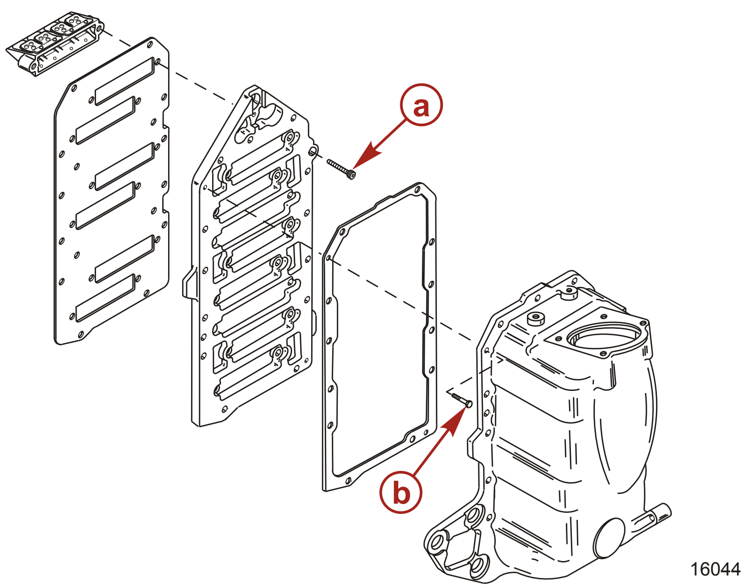
15. Remove the twelve bolts securing the air management assembly to the crankcase and remove the assembly.



a - Oil outlet hoses (6)
b - Oil inlet hose (1)
c - Air management
d - Bolts (1/4-20 x 1-1/2, flange) (12)

Reed Block Assembly Removal

1. Remove the two screws securing the air plenum to the reed plate assembly.
2. Remove the 12 screws securing the reed blocks to the reed plate assembly.

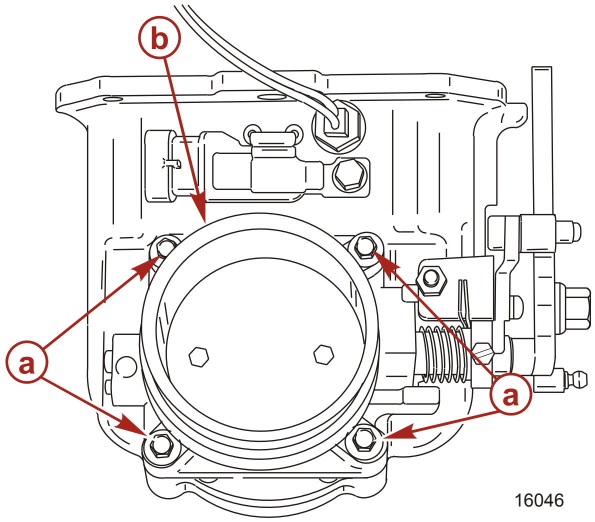


a - Screw (1/4-20 x 7/8 in.) (12)
b - Screw (M4 x 16) (2)

Throttle Body Assembly Removal

NOTE: The throttle body assembly is calibrated and preset at the factory. Other than complete assembly removal from the air plenum, no further disassembly should be made.

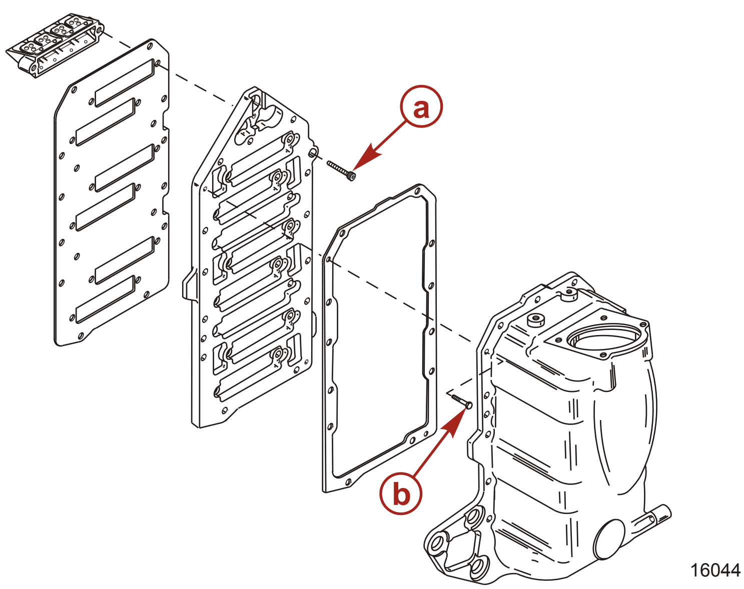
Remove the four screws securing the throttle body assembly to the air plenum. Remove the throttle body assembly.



a - Screw (4)
b - Throttle body assembly

Air Management Assembly and Installation

1. Remove the old gasket material from the mating surfaces of the reed blocks, reed block plate, and air plenum.
2. Install a new gasket onto the reed block plate. Secure each reed block to the reed block plate with two 1/4-20 x 7/8 in. screws. Tighten the screws to the specified torque.
3. Install a new gasket onto the air plenum. Secure the reed block plate to the air plenum with two M4 x 16 screws. Tighten the screws to the specified torque.

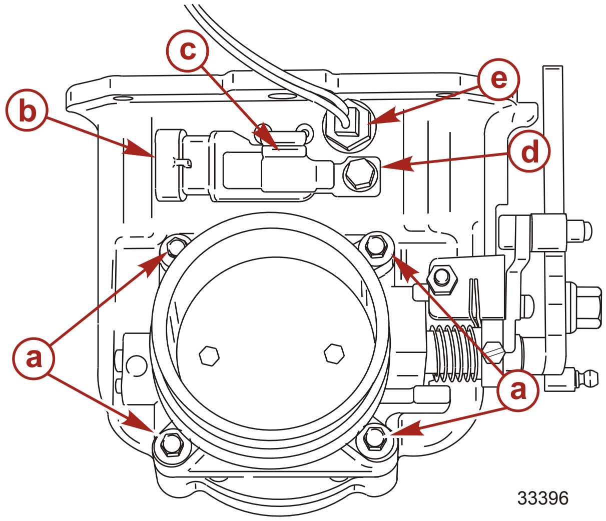


a - Screw (1/4-20 x 7/8 in.) (12)
b - Screw (M4 x 16) (2)

Description	Nm	lb-in.	lb-ft
Screw (1/4-20 x 7/8 in.)	11.5	102	
Screw (M4 x 16)	2.5	22	

4. Install a new O-ring onto the throttle body. Secure the throttle body assembly to the air plenum assembly with four M6 x 40 screws. Tighten the screws to the specified torque.
5. Install the MAP sensor and bracket onto the air plenum assembly. Secure the bracket with a M6 x 16 screw. Tighten the screw to the specified torque.
6. Install an O-ring onto the manifold air temperature (MAT) sensor.

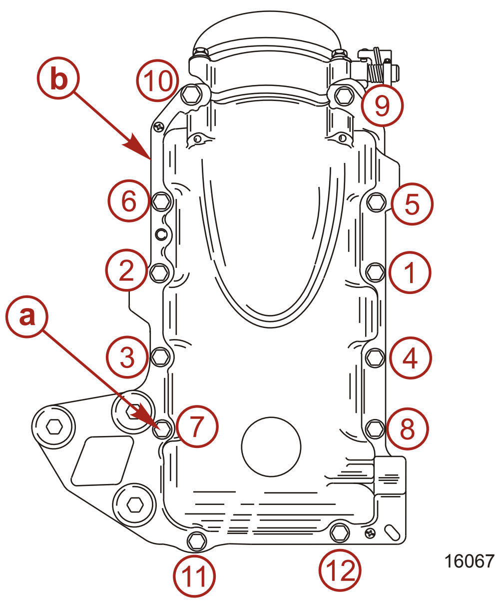
7. Install the MAT sensor onto the air plenum assembly. Tighten the MAT sensor to the specified torque.



a - Screw (M6 x 40) (4)
b - MAP sensor
c - Bracket
d - Screw (M6 x 16)
e - MAT sensor

Description	Nm	lb-in.	lb-ft
Throttle body screw (M6 x 40)	7.5	66	
MAP sensor bracket screw (M6 x 16)	4.5	40	
MAT sensor	16	142	

8. Install the air plenum assembly onto the crankcase cover. Secure the plenum with 12 (1/4-20 x 1.5 in.) screws. Tighten the screws to the specified torque in the sequence shown.

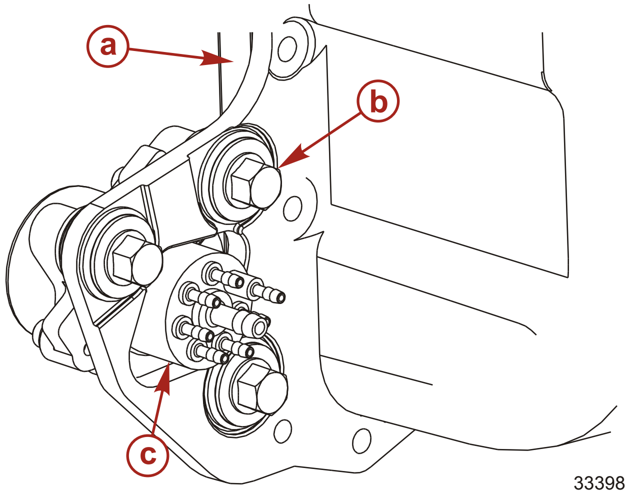


a - Screw (1/4-20 x 1.5 in.) (12)
b - Air plenum

Description	Nm	lb-in.	lb-ft
Screw (1/4-20 x 1.5 in.)	20	177	

9. Install three rubber grommets onto the air plenum assembly. Insert three bushings into the rubber grommets.

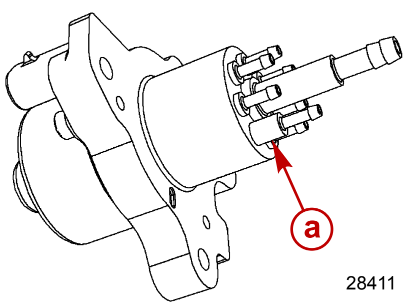
10. Install the oil pump onto the air plenum assembly. Secure the pump with three M8 x 30 screws. Tighten the screws to the specified torque.



a - Air plenum
b - Grommet, bushing, and screw (3 each)
c - Oil pump

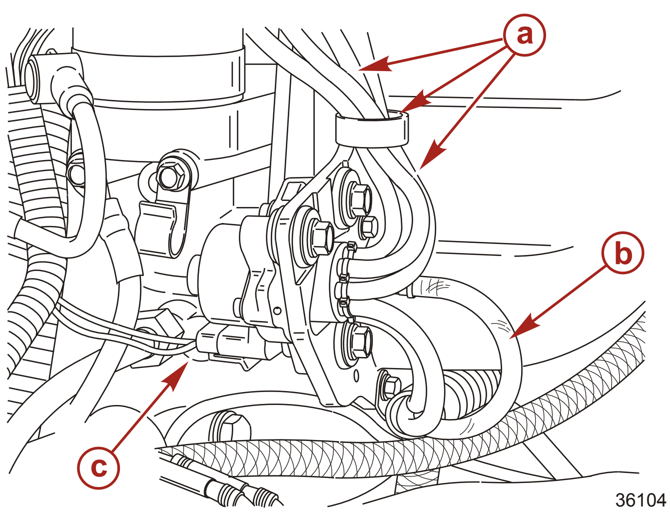
Description	Nm	lb-in.	lb-ft
Screw (M8 x 30) (3)	16	142	

11. Install the air compressor oil line hose onto the oil pump air compressor discharge port and secure with a cable tie.
IMPORTANT: Verify the oil line to the air compressor is connected to the correct oil pump discharge port. The air compressor receives less oil than the engine.



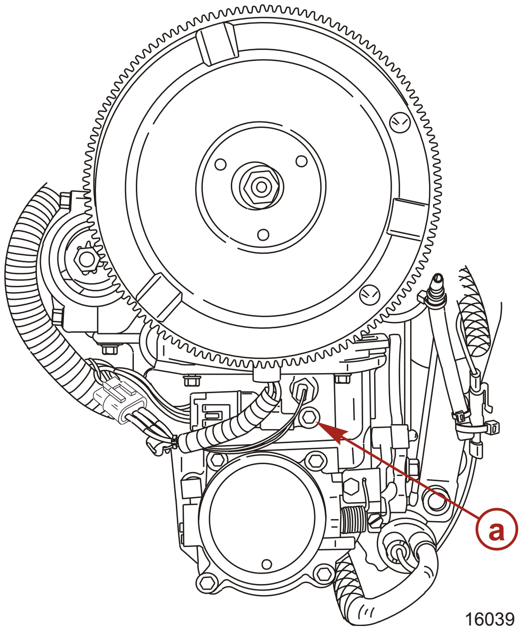
a - Oil pump discharge port for the air compressor

12. Install the oil hoses to the oil pump and secure with cable ties.
13. Connect the engine harness to the oil pump connector.
14. Install the oil inlet hose to the oil pump and secure with a cable tie.



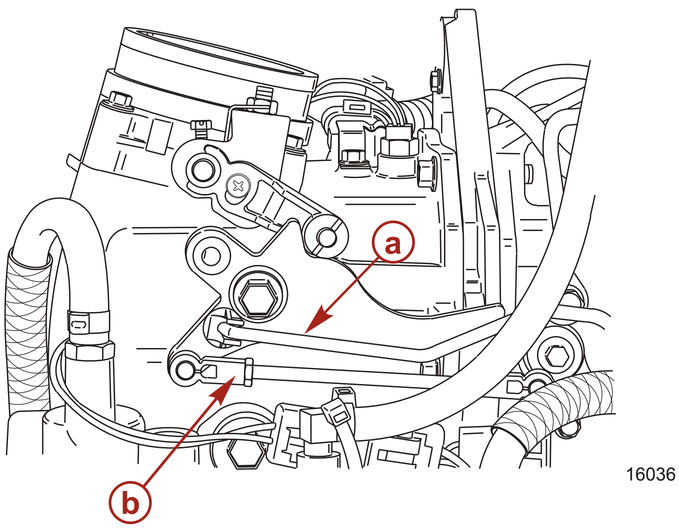
a - Oil hoses
b - Oil inlet hose
c - Oil pump connector

15. Connect the engine harness to the MAP and MAT sensor connectors.



a - MAP sensor

16. Connect the throttle cam link rod and the throttle position sensor link rod.



a - Throttle link rod

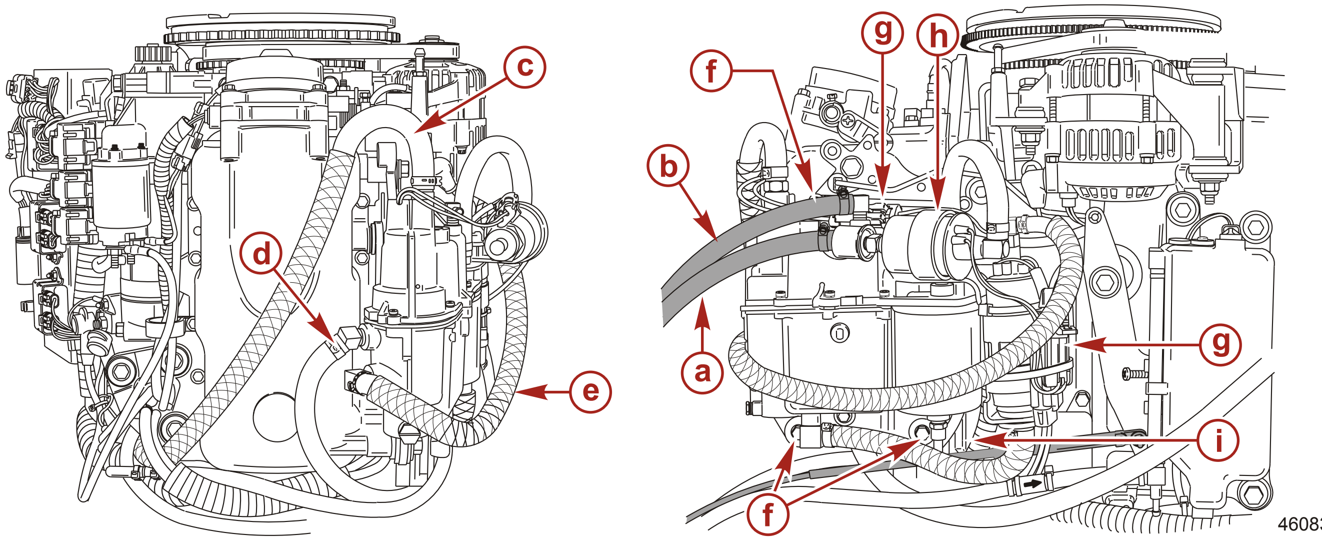
b - Throttle position sensor link rod

17. Install the vapor separator and secure with three M8 x 35 screws and washers. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Vapor separator mounting screws (M8 x 35)	16	142	

18. Install the fuel high-pressure fuel outlet hose and fuel return hose.
19. Connect the engine harness to the electric fuel pump connectors.
20. Connect the engine harness to the water sensor connector.

21. Install the fuel inlet hose to the fuel lift pump.



a - Fuel inlet hose to fuel lift pump
b - Vapor separator vent hose
c - High-pressure fuel outlet hose
d - Fuel return hose
e - Fuel inlet hose
f - Mounting bolts (3)
g - Electrical fuel pump connectors
h - Ground lead
i - Water sensor connector

Vapor Separator Tank

VST Removal

⚠ WARNING

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

⚠ CAUTION

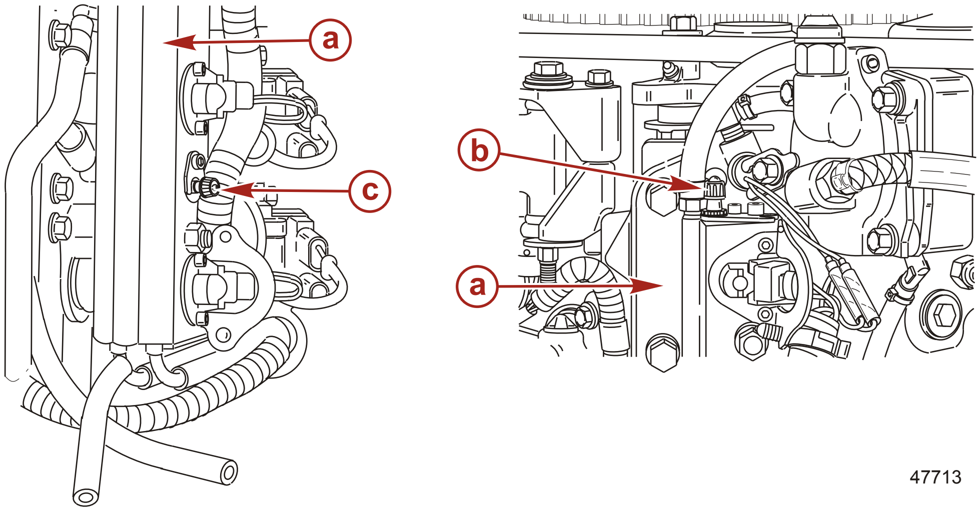
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

⚠ WARNING

Fuel may still remain in the fuel rails and hoses after draining the vapor separator tank (VST). To avoid a possible fire or explosion, follow normal precautionary procedures while working with the fuel system. Use a suitable container when draining fuel from the VST and avoid sparks, smoking, and open flame while in the presence of liquid fuel or fuel vapors.

1. Disconnect both battery cables from the battery.

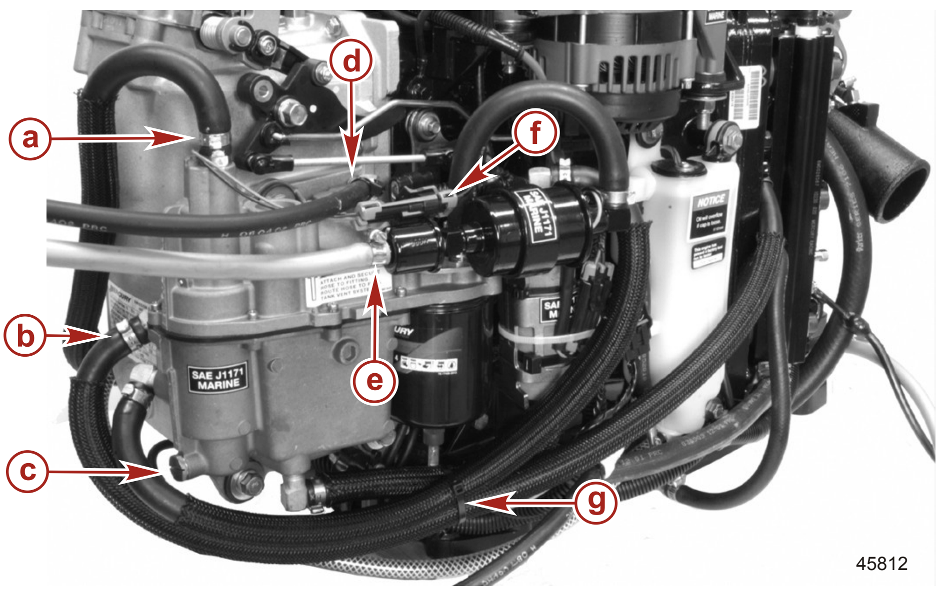
2. Install the fuel/air pressure gauge kit to the fuel pressure test valve and release the fuel pressure into an appropriate container.



- a - Port fuel rail
- b - Fuel pressure test valve
- c - Air pressure test valve

Fuel Pressure Gauge Kit	91-881833A03

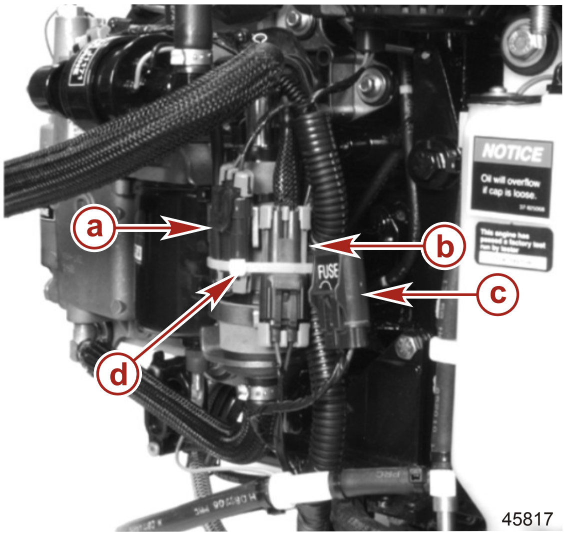
3. Disconnect the high-pressure fuel pump from the engine harness.
4. Remove the metal hose clamps securing the high-pressure fuel outlet hose and the low-pressure fuel return hose. Remove the fuel hoses from the fittings.
5. Remove the air vent hose and lift pump fuel inlet hose.
6. Remove the cable tie securing the hoses.



- a - High-pressure fuel outlet hose
- b - Fuel return hose (from fuel regulator)
- c - Drain plug
- d - Air vent hose (to fuel tank)
- e - Lift pump fuel inlet
- f - High-pressure fuel pump electrical connector
- g - Cable tie

7. Disconnect the engine harness water sensor connector from the water separator fuel filter.
8. Disconnect the low-pressure fuel pump connector from the engine harness connector.

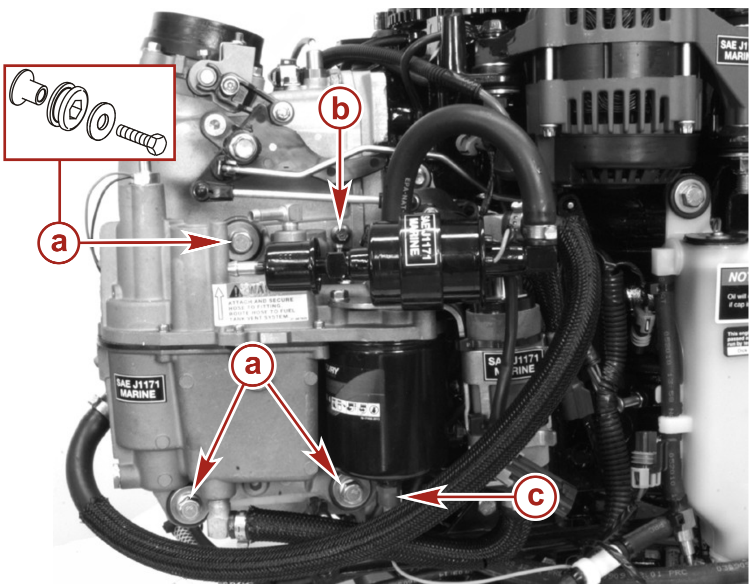
9. Cut the cable tie securing the low-pressure fuel pump harness connectors, the lift pump connectors, the high-pressure fuel pump wire harness, and the water sensor wire harness to the low-pressure fuel pump bracket.



45817

a - Lift pump connector
b - Low-pressure fuel pump connector
c - Fuse holder
d - Cable tie

10. Remove the engine harnesses from behind the low-pressure fuel pump hose.
11. Remove the screw securing the VST ground to the plenum.
12. Remove the three screws and washers securing the VST to the plenum.



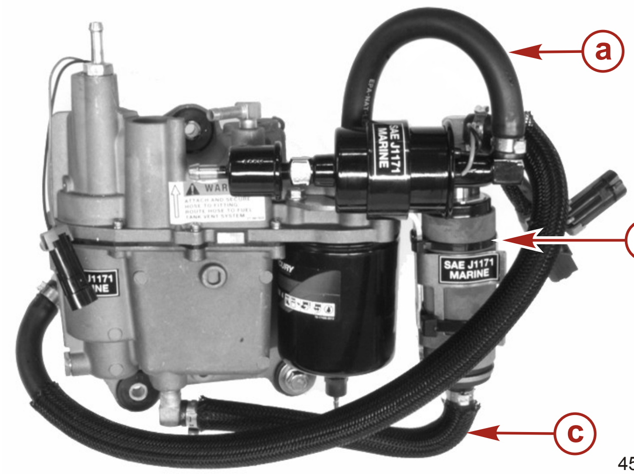
45818

a - Screw and washer
b - Ground screw
c - Water sensor connector

VST Disassembly

1. Remove the two metal hose clamps securing the lift pump to water separating filter fuel hose to the fittings. Remove the hose from the fittings.

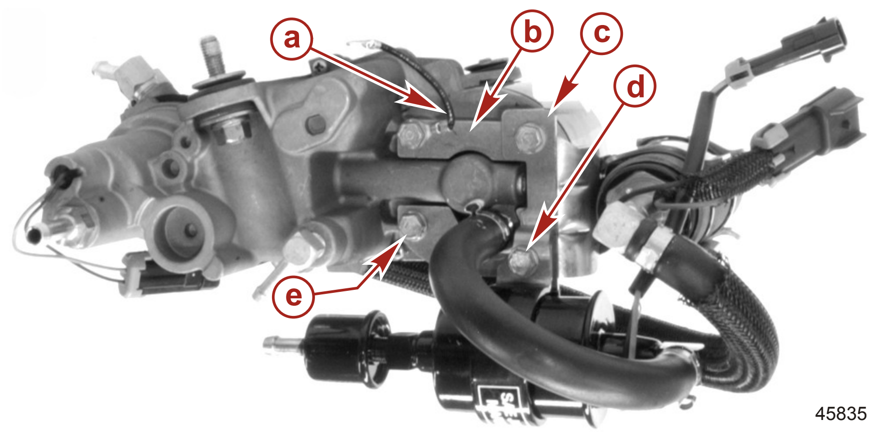
2. Remove the two metal hose clamps securing the low-pressure electric fuel pump outlet hose to the fittings. Remove the hose from the fittings.



45836

- **a -** Lift pump to water separating filter fuel hose
- **b -** Cable tie
- **c -** Low-pressure electric fuel pump outlet hose

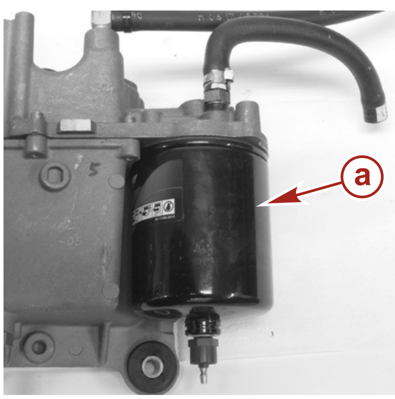
3. Remove the four screws securing the low-pressure electric fuel pump and lift pump brackets to the VST. Remove the brackets.



45835

- **a -** Ground cable
- **b -** Low-pressure electric fuel pump bracket
- **c -** Lift pump bracket
- **d -** Screw (M6 x 35) (1)
- **e -** Screw (M6 x 16) (3)

4. Remove the water separator fuel filter.

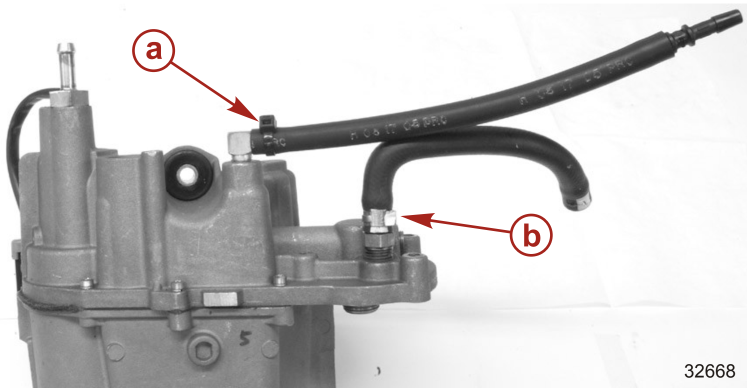


32666

- **a -** Water separator fuel filter

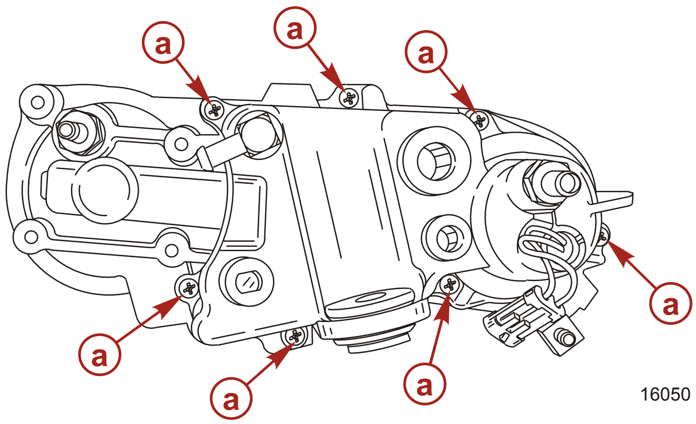
5. Cut the cable tie securing the vent hose to the fitting.

6. Remove the metal hose clamp securing the pulse pump fuel hose to the fitting.



a - Cable tie
b - Metal hose clamp

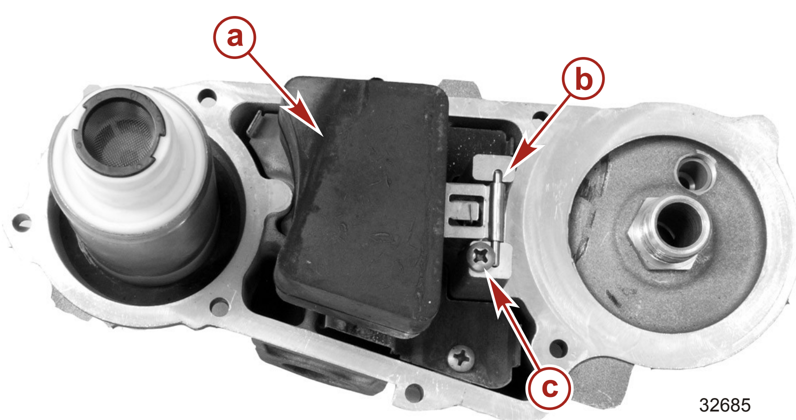
7. Remove the seven screws securing the VST cover to the VST tank. Remove the cover.



a - Screw (7)

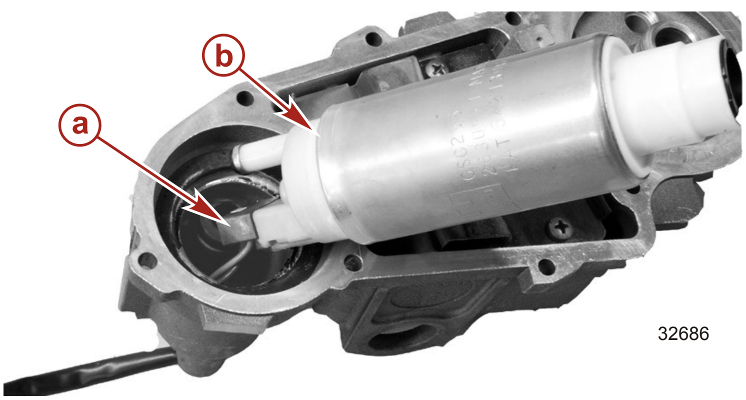
8. Loosen the screw securing the float pin. Remove the float, float pin, and needle.

NOTE: *It is not necessary to remove the screw when removing the float, float pin, and needle.*



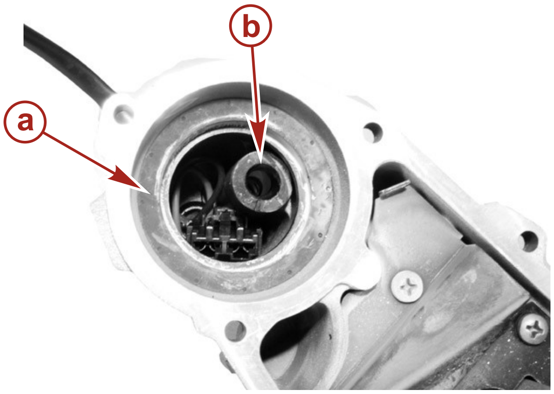
a - Float
b - Float pin
c - Screw

9. Carefully remove the fuel pump from the VST cover. Disconnect the fuel pump electrical harness.



a - Fuel pump electrical harness connector
b - Fuel pump

10. Remove and discard the fuel pump body seal and the fuel pump outlet seal.

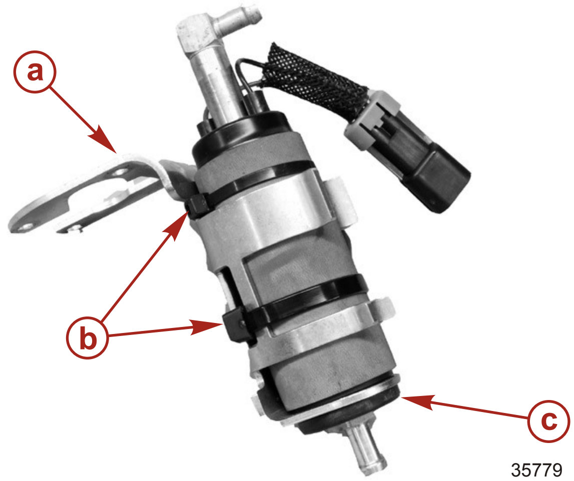


32687

a - Fuel pump body seal
b - Fuel pump outlet seal

IMPORTANT: Do not remove the electric fuel pump harness from the VST cover. If the electric fuel pump harness inside the VST cover is damaged, the VST cover must be replaced.

11. Cut the cable ties securing the low-pressure electric fuel pump to the bracket. Remove the low-pressure fuel pump.

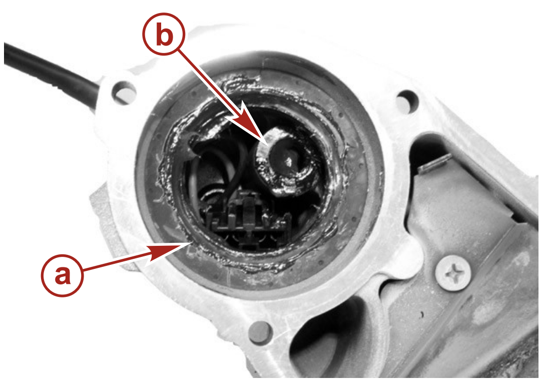


35779

a - Low-pressure electric fuel pump bracket
b - Cable ties
c - Grommet

VST Assembly

1. Install the new fuel pump body seal and the new fuel pump outlet seal into the VST cover. Lubricate the seals with Special Lubricant 101.



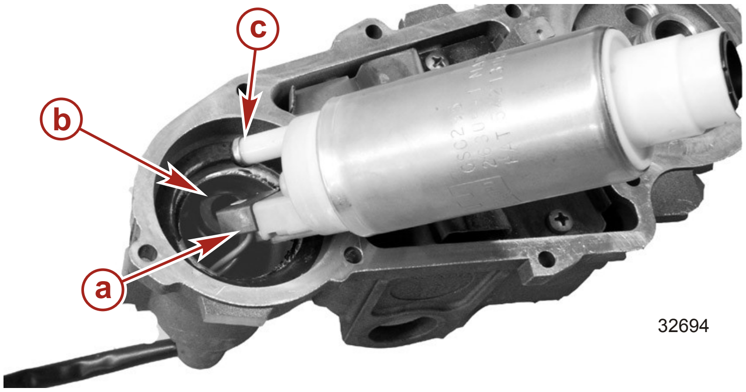
32689

a - Fuel pump body seal
b - Fuel pump outlet seal

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Fuel pump body seal and fuel pump outlet seal	92-802865Q02

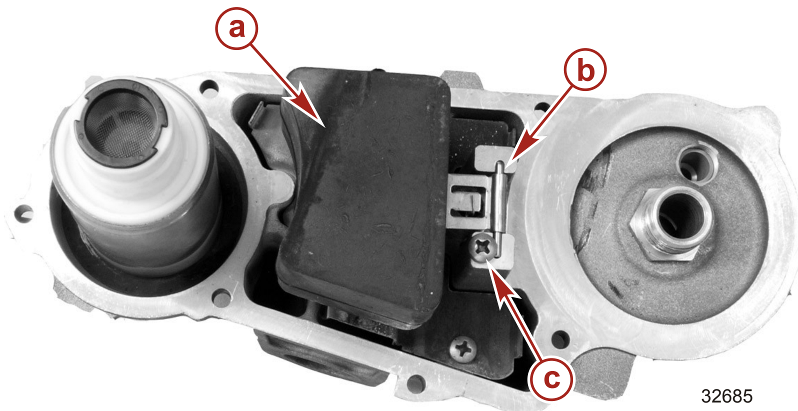
2. Connect the fuel pump electrical harness to the fuel pump.

3. Align the fuel pump outlet with the fuel pump outlet seal. Push the fuel pump into the seals.



a - Fuel pump electrical harness connector
b - Fuel pump outlet seal
c - Fuel pump outlet

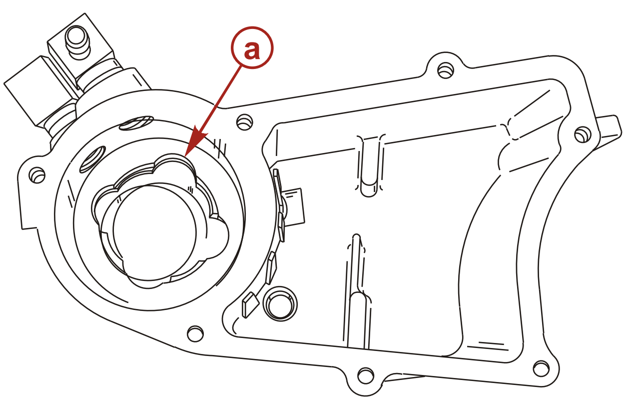
4. Install the needle onto the float.
5. Install the float with the needle onto the VST cover. Insert the pin into the float arm. Secure the float pin with the float pin screw. Tighten the float pin screw to the specified torque.



a - Float
b - Float pin
c - Screw

Description	Nm	lb-in.	lb-ft
Float pin screw	1	9	

6. Lubricate the inside diameter of the fuel pump body seal with Special Lubricant 101.

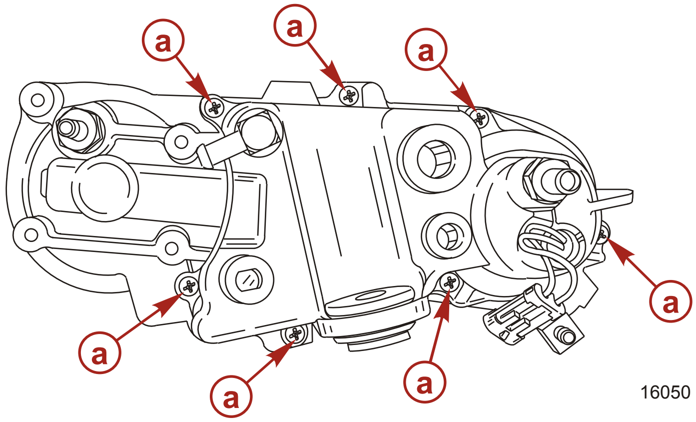


a - Fuel pump body seal

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Fuel pump body seal	92-802865Q02

7. Install the VST cover gasket onto the VST tank.

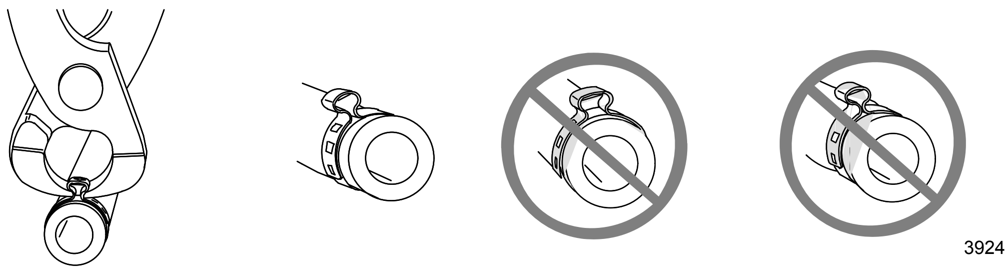
8. Install the VST cover onto the VST tank and secure with seven screws. Tighten the screws to the specified torque.

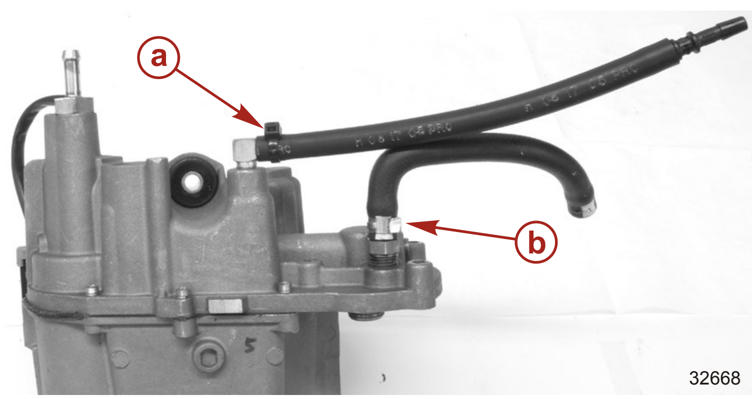


a - Screw (7)

Description	Nm	lb-in.	lb-ft
Screw (8-32 x 0.750) (7)	3.5	31	

9. Install the vent hose and secure the hose with a cable tie.
10. Install a 18.3 mm hose clamp onto the lift pump hose.
11. Install the lift pump hose onto the VST cover. Secure the hose with a 18.3 mm hose clamp using a hose clamp tool.
 IMPORTANT: Use tool 91-803146T or Snap-On equivalent YA3080 to crimp the full circle hose clamp. Using a different tool could result in a crimp that is too loose or too tight. Do not use a screw type hose clamp as it may damage the hose.

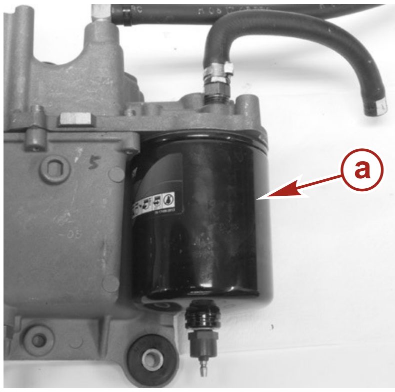




a - Cable tie
b - 18.3 mm hose clamp

Hose Clamp Tool Kit	91-803146A04

12. Lubricate the water separator fuel filter seal with Special Lubricant 101. Install the water separator fuel filter. Tighten the water separator fuel filter securely.

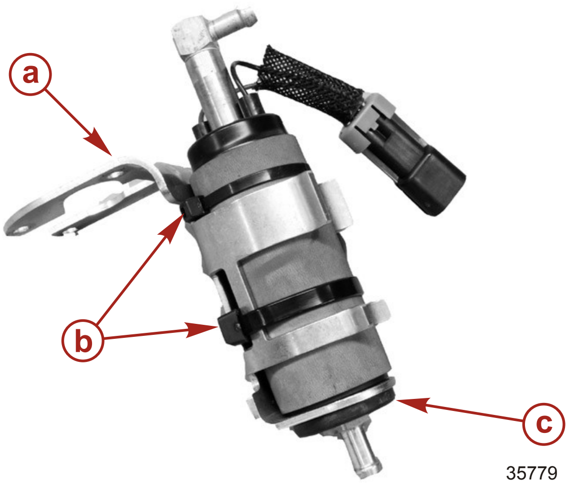


32666

a - Water separator fuel filter

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Water separator fuel filter seal	92-802865Q02

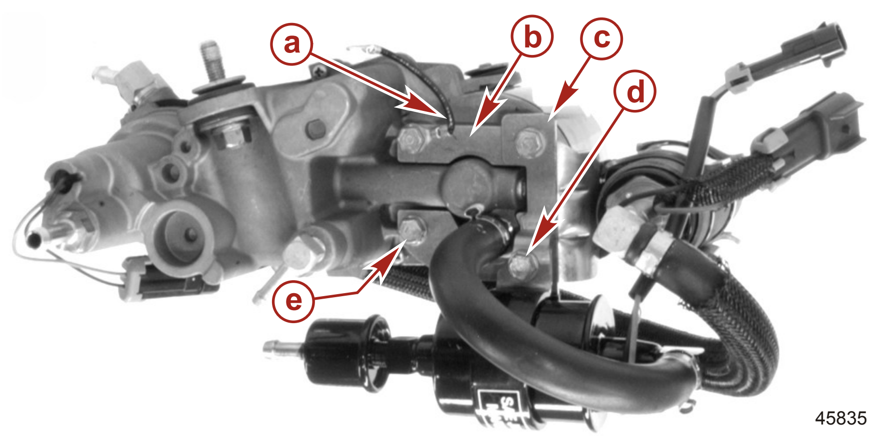
13. Install the grommet onto the fuel filter bracket.
14. Install the low-pressure electric fuel pump onto the fuel pump bracket. Secure the pump with two cable ties.
IMPORTANT: If the low-pressure electric fuel pump does not have a sleeve or grommet, refer to Service Bulletin 98-8.



35779

a - low-pressure electric fuel pump bracket
b - Cable ties
c - Grommet

15. Install the VST ground wire onto the screw, as shown.
16. Install the low-pressure electric fuel pump bracket and lift pump bracket onto the VST. Secure the brackets with four screws. Tighten the screws to the specified torque.

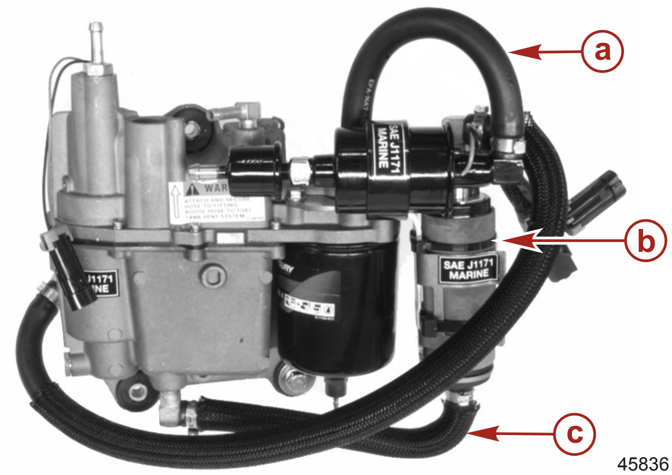


45835

a - Ground cable
b - Low-pressure electric fuel pump bracket
c - Lift pump bracket
d - Screw (M6 x 35) (1)
e - Screw (M6 x 16) (3)

Description	Nm	lb-in.	lb-ft
Screw (M6 x 16) (3), (M6 x35)	11.5	102	

17. Install two 18.3 mm hose clamps onto the low-pressure electric fuel pump outlet fuel hose.
18. Install the fuel hose onto the fittings. Crimp the 18.3 mm hose clamps with the hose clamp tool.
19. Install two 18.3 hose clamps onto the lift pump to water separating filter fuel hose.
20. Install the fuel hose onto the VST fittings. Crimp the 18.3 mm hose clamps with the hose clamp tool.



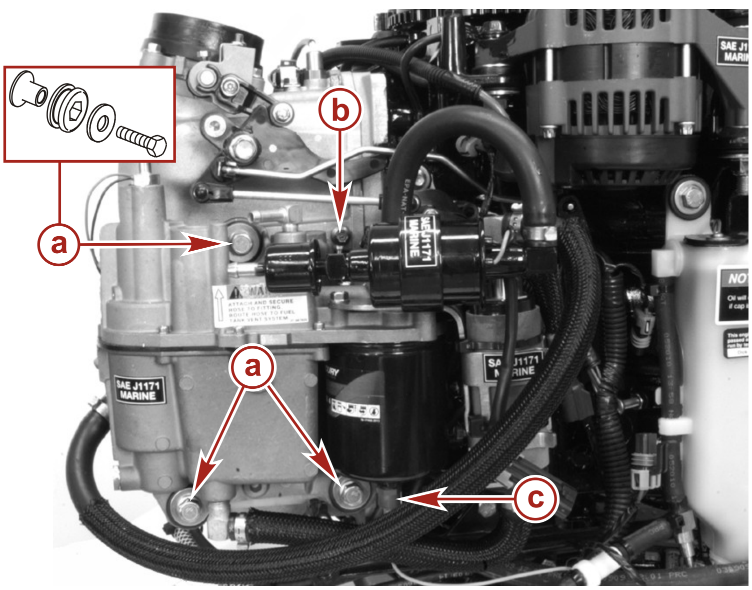
45836

a - Lift pump to water separating filter fuel hose
b - Cable tie
c - Low-pressure electric fuel pump outlet fuel hose

Hose Clamp Tool Kit	91-803146A04

VST Installation

1. Secure the VST to the plenum with three M8 x 35 screws and washers. Apply Loctite 242 Threadlocker to the threads of the VST mounting screws. Tighten the screws to the specified torque.
2. Secure the VST ground wire to the plenum with a M6 x 10 screw. Apply Loctite 242 Threadlocker to the threads of the VST ground wire screw. Tighten the screw to the specified torque.
3. Connect the engine harness water sensor connector to the water separator fuel filter.



45818

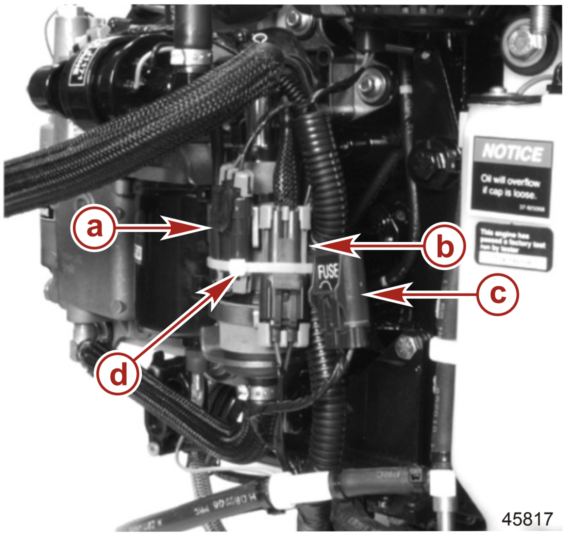
a - Screw and washer (3)
b - Ground screw
c - Water sensor connector

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	VST mounting screw threads, VST ground wire screw threads	92-809821

Description	Nm	lb-in.	lb-ft
VST mounting screws (M8 x 35) (3)	16	142	
Ground screw (M6 x 10)	3.5	31	

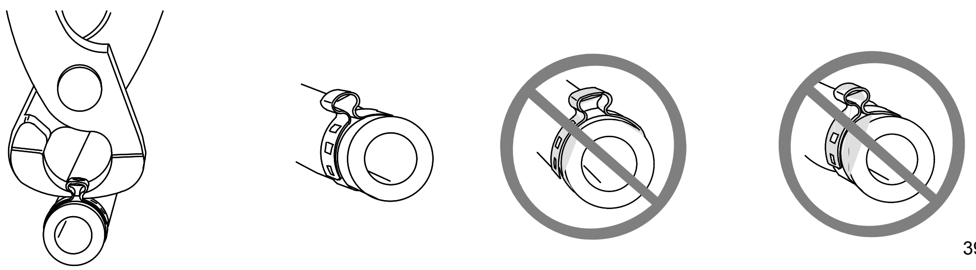
4. Connect the low-pressure fuel boost pump and the lift pump connectors to the engine harness connectors.

5. Secure the fuse holder, low-pressure fuel boost pump, and the lift pump connectors fuel pump with a cable tie.
6. Secure the low-pressure fuel pump connector and the fuse holder to the boost pump with a cable tie.

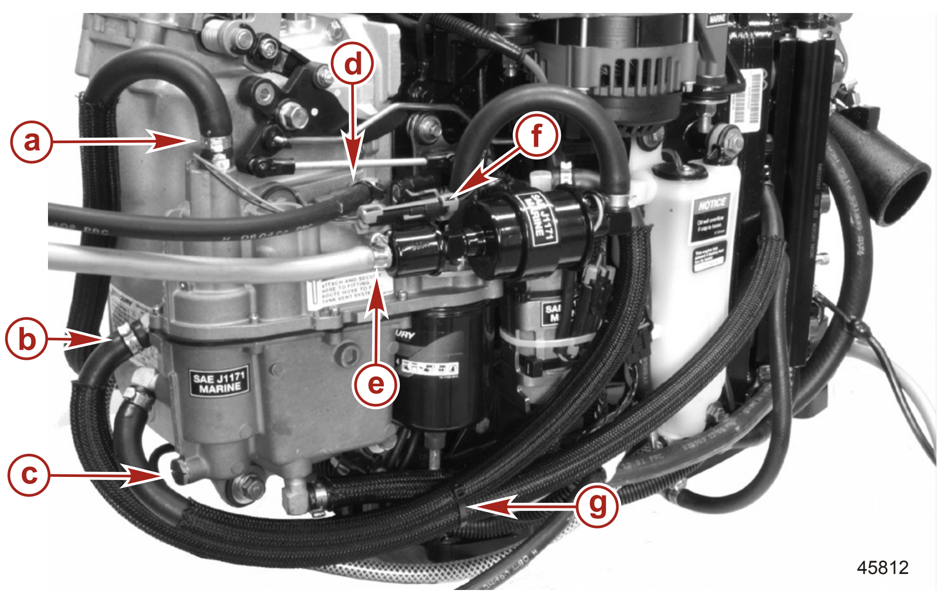


a - Lift pump connector
b - Low-pressure fuel boost pump connector
c - Fuse holder
d - Cable tie

7. Install 18.3 mm hose clamps onto the high-pressure fuel hose and low-pressure fuel return hose.
8. Install the fuel hoses and crimp the 18.3 mm hose clamps with the hose clamp tool.
   IMPORTANT: Use tool 91-803146T or Snap-On equivalent YA3080 to crimp the full circle hose clamp. Using a different tool could result in a crimp that is too loose or too tight. Do not use a screw type hose clamp as it may damage the hose.



9. Secure the high-pressure fuel hose and the low-pressure fuel return hose together with a cable tie. Do not overtighten the cable tie.
10. Install the air vent hose to the VST. Secure the hose with a cable tie.
11. Install the fuel hose to the lift pump inlet. Secure with a hose clamp.
12. Connect the high-pressure fuel pump connector to the engine harness connector. Secure the fuel pump harness connectors to the high-pressure fuel hose with a cable tie.

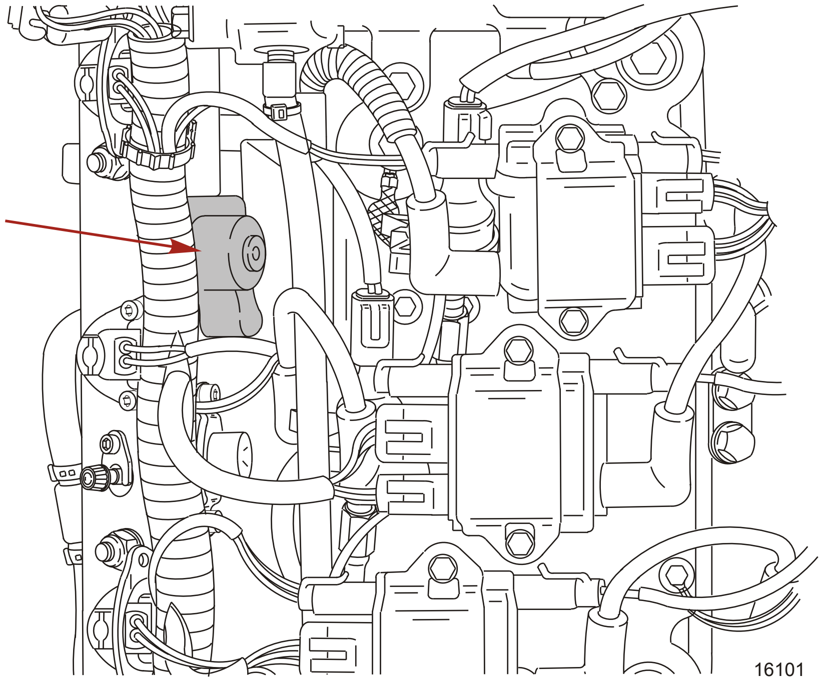


a - High-pressure fuel outlet hose (18.3 mm hose clamp)
b - Fuel return hose (from fuel regulator) (18.3 mm hose clamp)
c - Drain plug
d - Air vent hose (to fuel tank) (cable tie)
e - Lift pump fuel inlet
f - High-pressure fuel pump electrical connector
g - Cable tie

Hose Clamp Tool Kit	91-803146A04

Fuel Rail

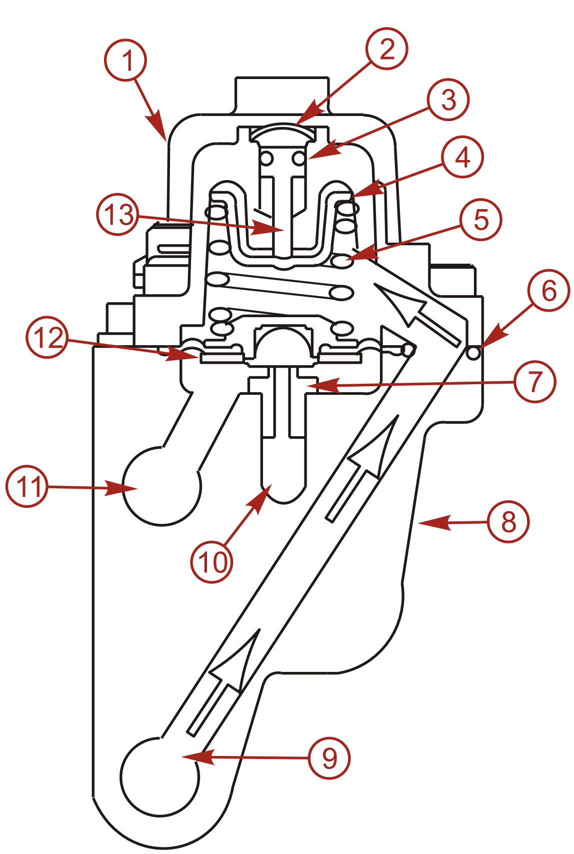
Fuel Pressure Regulator



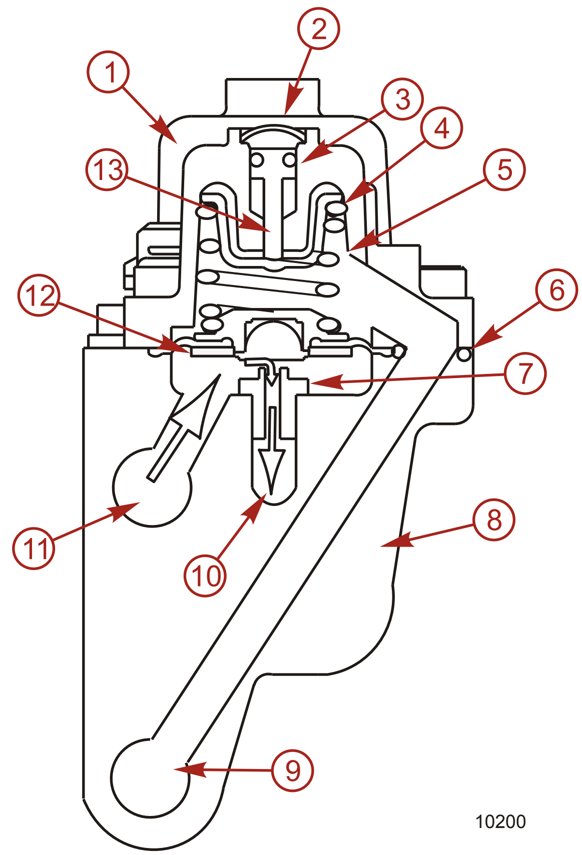
The fuel regulator is located on the port fuel rail.

The fuel pump can deliver pressure in excess of 689.5 kPa (100 psi). Fuel pressure inside the fuel rail must be at a specific higher pressure over the air pressure or the PCM calibrations will be incorrect. The fuel pressure regulator maintains the higher pressure over the air pressure in the fuel rail and allows the excess fuel to return into the vapor separator. The fuel pressure regulator diaphragm is held closed with a spring that requires a specific pressure to force the diaphragm off the diaphragm seat. The backside of the diaphragm is exposed to air rail pressure. As the air rail pressure increases, the fuel pressure needed to open the regulator will equally increase.

Fuel Pressure Regulator Cutaway



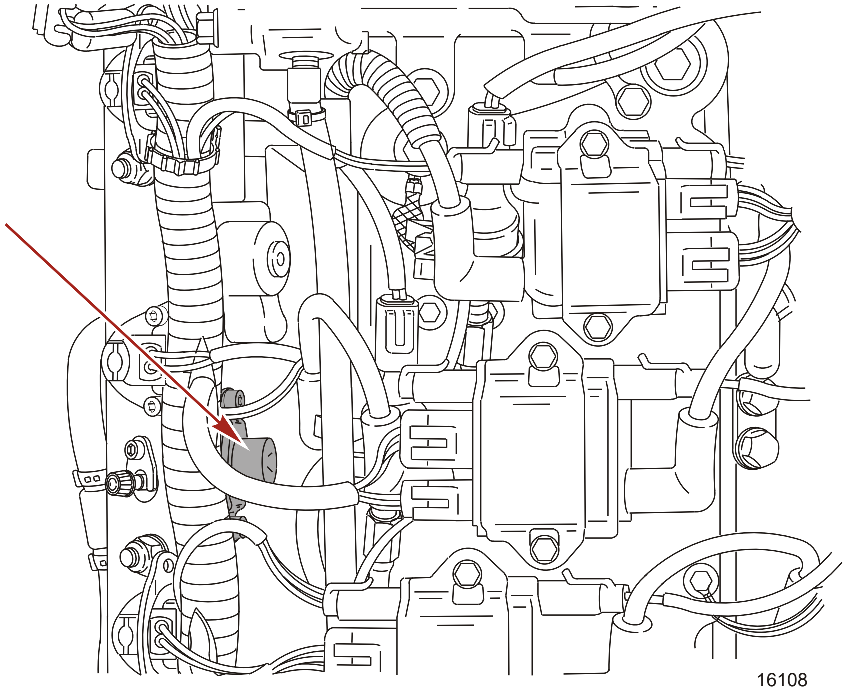
Regulator Closed



Regulator Open

1 - Top cover
2 - Expansion plug
3 - O-ring
4 - Spring retainer
5 - Spring
6 - O-ring
7 - Diaphragm seat
8 - Air rail
9 - Air passage from air compressor
10 - Fuel return passage to vapor separator
11 - Fuel inlet passage from electric fuel pump
12 - Diaphragm assembly
13 - Calibration screw (do not adjust)

Air Pressure Regulator

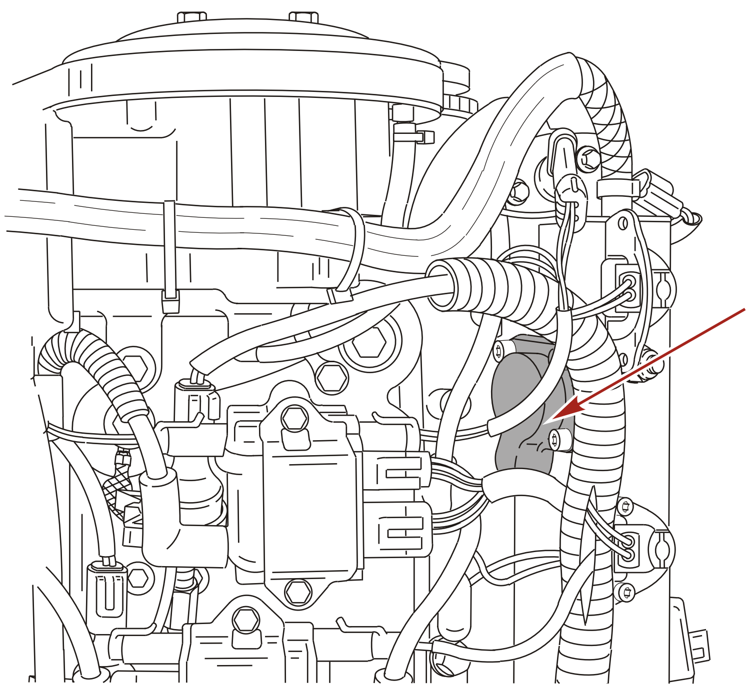


16108

The air pressure regulator is located on the port fuel rail.

The air regulator uses a spring to control the air pressure. This spring holds the diaphragm against the diaphragm seat. The air must reach a pressure that is equal to or greater than the spring pressure holding the diaphragm closed. When the air pressure exceeds the pressure of the spring, the diaphragm is lifted off the diaphragm seat, allowing the excess air pressure to dump into the discharge hose.

Tracker Valve

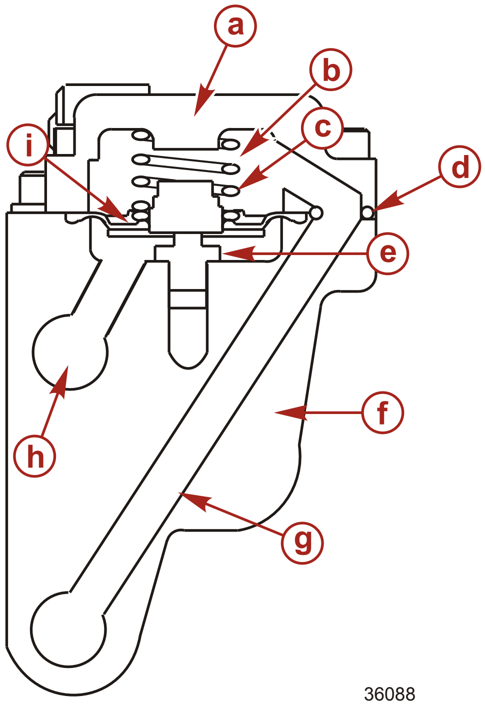


16133

The tracker valve is located on the starboard fuel/air rail assembly.

A tracker diaphragm is used to maintain a constant pressure difference between the fuel pressure and air pressure inside the fuel rails at all times. The tracker diaphragm minimizes the pressure changes caused by the air compressor pulses and fuel injectors at lower engine RPM. The tracker diaphragm is located between the fuel and air chambers on the fuel rail. The tracker diaphragm will expand into the lower pressure chamber side of the fuel rail when a pressure spike occurs.

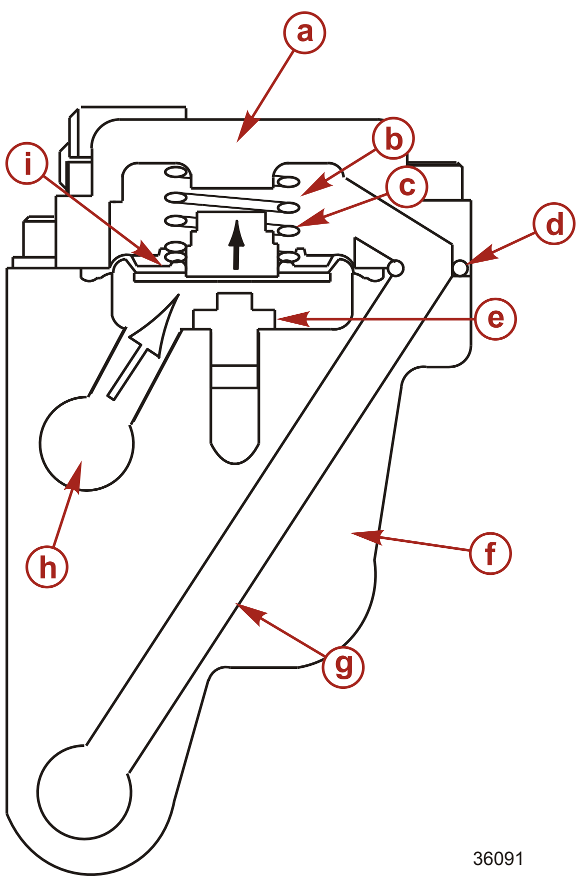
NOTE: To prevent excessive wear in the seat, the tracker is calibrated to allow the diaphragm to be slightly away from the seat during normal operation.



36088

Engine off (no pressure)

- a - Top cover
- b - Spring retainer (not shown)
- c - Spring
- d - O-ring
- e - Diaphragm seat
- f - Air rail
- g - Air passage
- h - Fuel inlet passage
- i - Diaphragm assembly



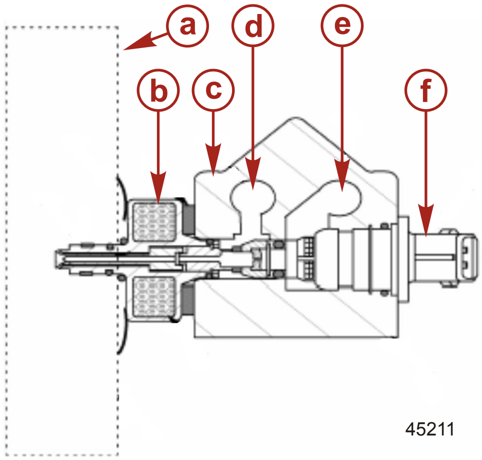
36091

Engine at operating pressures

- a - Top cover
- b - Spring retainer (not shown)
- c - Spring
- d - O-ring
- e - Diaphragm seat
- f - Air rail
- g - Air passage
- h - Fuel inlet passage
- i - Diaphragm assembly

Fuel Injectors

A fuel injector is an electromagnetic device. The precision mechanical components are controlled by a solenoid in the injector. The solenoid is energized by a driver in the PCM that controls the on time of the solenoid by providing a ground. Six fuel injectors are used to provide fuel from the fuel rail to the direct injectors. The fuel injectors are mounted in the fuel rails.



- a - Cylinder head
- b - Direct injector
- c - Fuel/air rail
- d - Air passage
- e - Fuel passage
- f - Fuel injector

Fuel Injector Resistance Test			
Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Injector pin	Injector pin	Ω	1.7–1.9 Ω

Fuel Rail Removal

⚠ WARNING

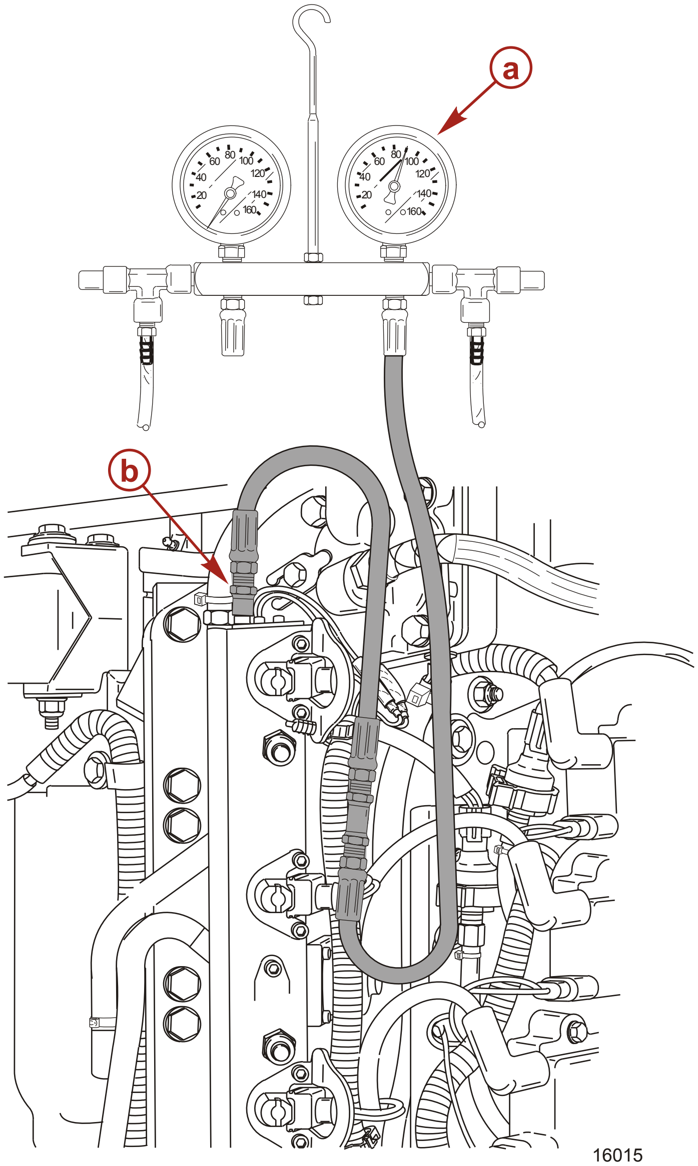
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

⚠ 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. Disconnect both battery leads from the battery.

2. Install the fuel/air pressure gauge kit. Relieve the fuel pressure into an appropriate container.



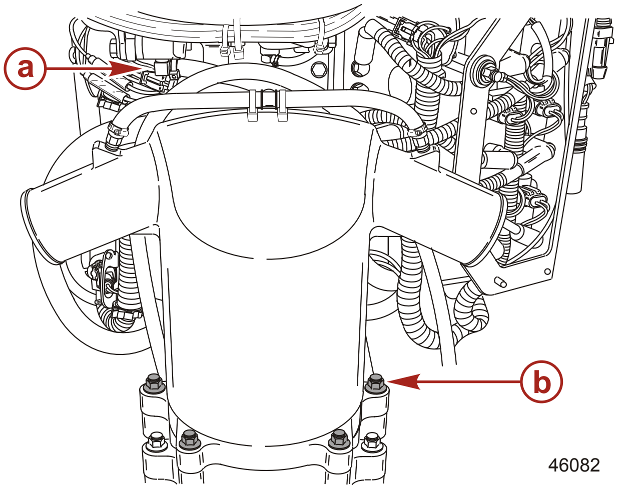
a - Fuel/air pressure gauge kit
b - Fuel pressure test valve

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1

NOTE: *It is recommended that the expansion chamber be removed to provide improved access to the fuel rails.*

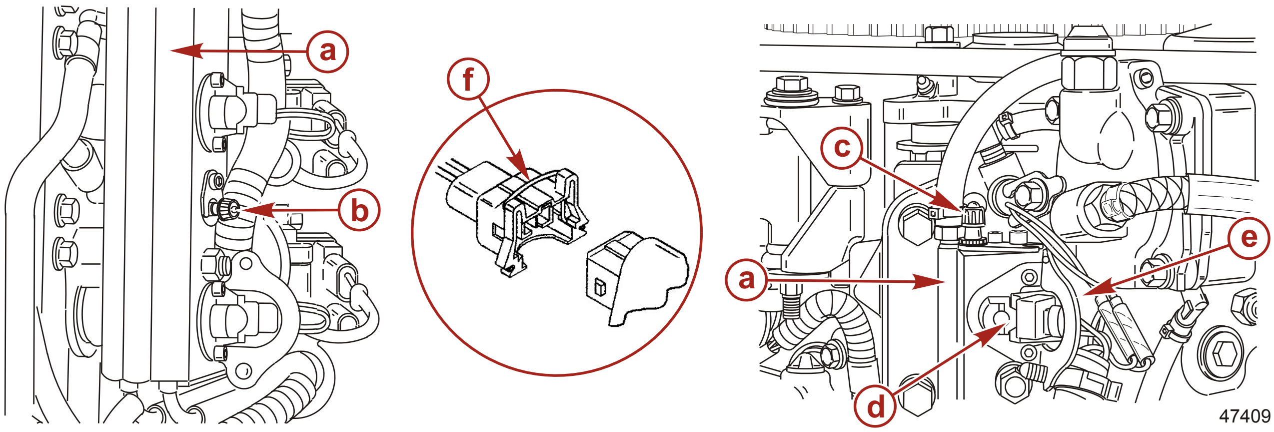
3. Remove the coolant hose between the air compressor and expansion chamber.

4. Remove the six nuts securing the expansion chamber and lay the chamber off to one side.



a - Coolant hose
b - Nut (6)

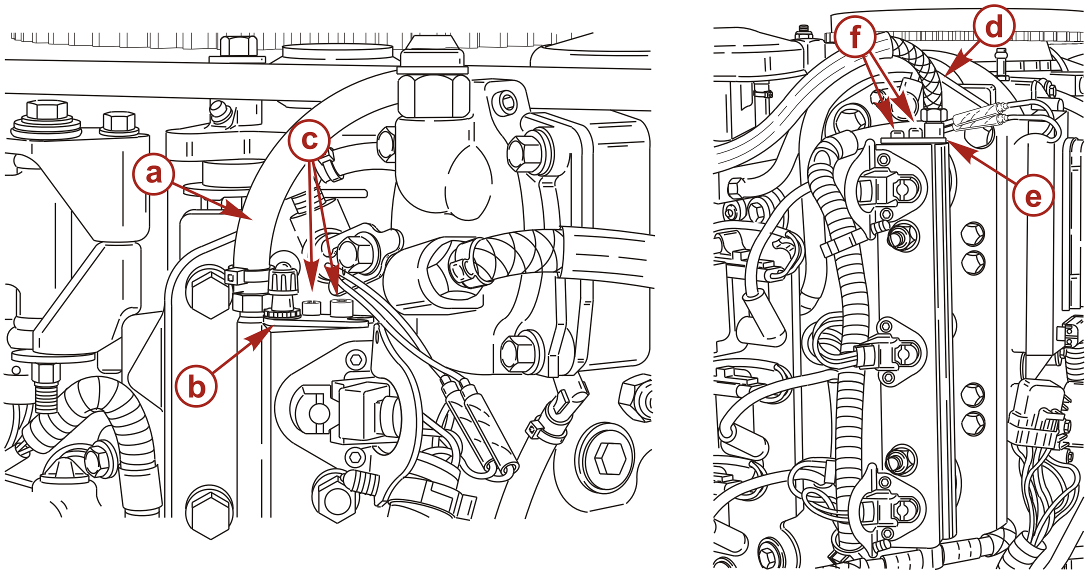
5. Remove the fuel injector harness from each fuel injector by compressing the spring clip with a flat tip screwdriver and pulling on the connector.



a - Port fuel rail
b - Air pressure test valve
c - Fuel pressure test valve
d - Fuel injector
e - Harness connector (hidden)
f - Spring clip

6. Cut the cable tie securing the compressor water inlet hose to the fuel rail. Remove the water inlet hose.

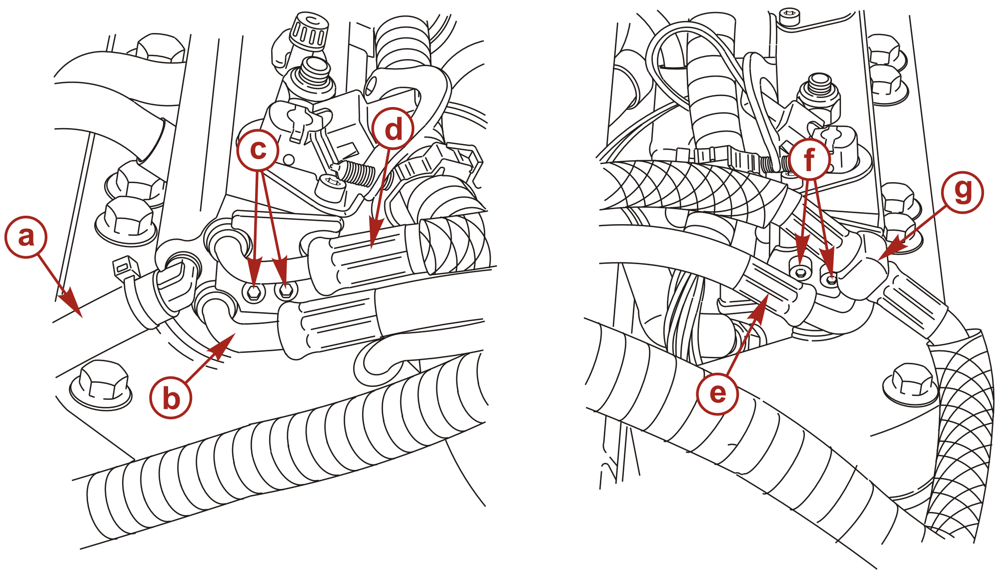
7. Remove the screws securing the retainers for the fuel hose and air hose at the top of the fuel rails.



16087

- a - Water inlet hose to compressor
- b - Fuel hose retainer
- c - Screw (2)
- d - Air hose
- e - Air hose retainer
- f - Screw (2)

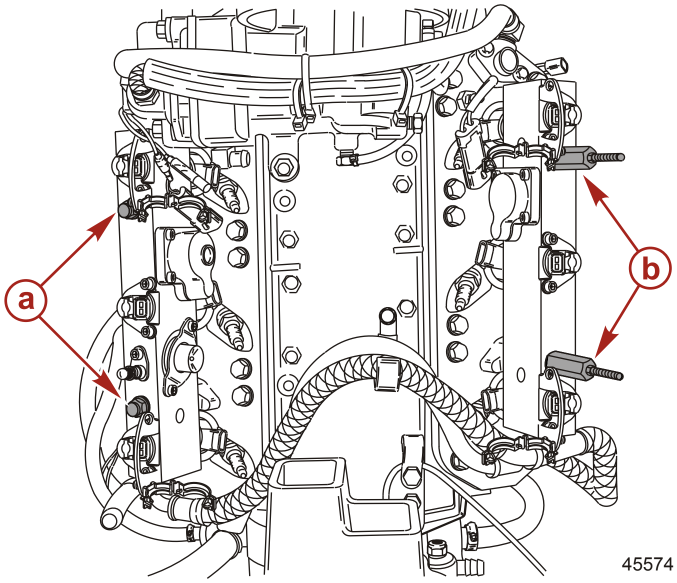
8. Remove the screws securing the retainers for the fuel hose and air hose at the bottom of the fuel rails.



16088

- a - Water inlet hose to fuel rail
- b - Air hose
- c - Fuel hose retainer screw (2)
- d - Fuel hose
- e - Air hose
- f - Air hose retainer screw (2)
- g - Fuel hose fitting

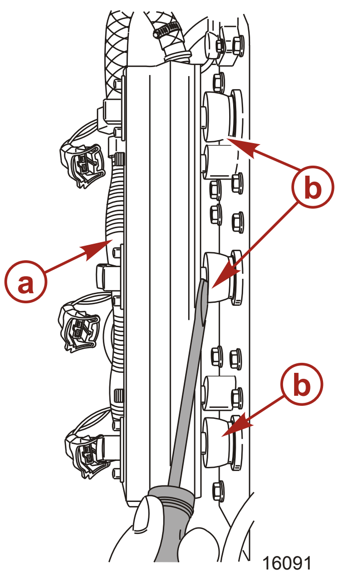
9. Remove the two nuts and two coil plate spacers securing the fuel rail to the cylinder head.



a - Nut
b - Coil plate spacer

10. As the fuel rail is removed, use a flat tip screwdriver to ensure the direct injectors remain in the cylinder head.

NOTE: The direct injectors should remain in the cylinder head. The direct injectors have a Teflon seal which may expand when the direct injector is removed from the cylinder head. This expansion may cause installation difficulty or require the replacement of the seal.



a - Fuel rail
b - Direct injectors

The starboard fuel rail contains three fuel injectors and a tracker valve.

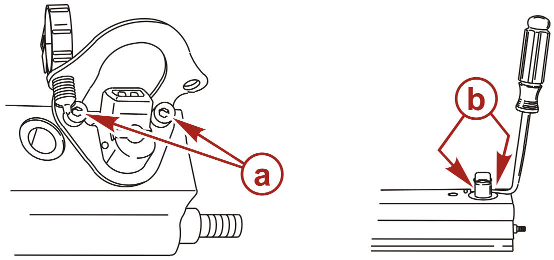
The port fuel rail contains three fuel injectors, one fuel regulator, and one air regulator.

NOTE: Each fuel/air inlet or outlet hose adapter has two O-ring seals. These O-rings should be inspected for cuts or abrasions and replaced as required when the fuel rail is disassembled for cleaning.

Fuel Injector Removal

1. Remove the two screws securing the injector to the fuel rail.

2. Use a cotter pin extractor tool to gently pry up on the fuel injector to loosen the O-ring adhesion to the fuel rail and remove the fuel injector.

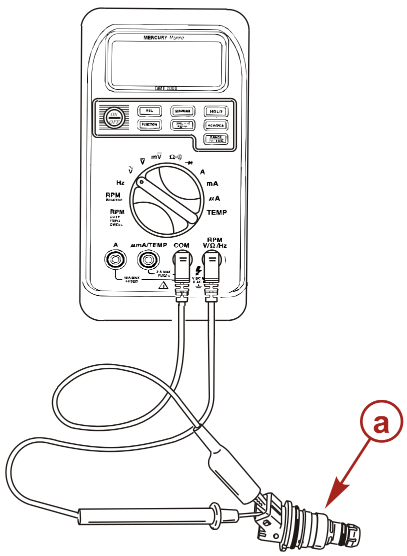


a - Screws
b - Pry holes

8355

3. Use the DMT 2004 digital multimeter to check the resistance between the fuel injector pins and the fuel injector steel body. Replace the fuel injector if it is not within the specifications.

   NOTE: The fuel injector ohm test is not polarity sensitive.



a - Fuel injector

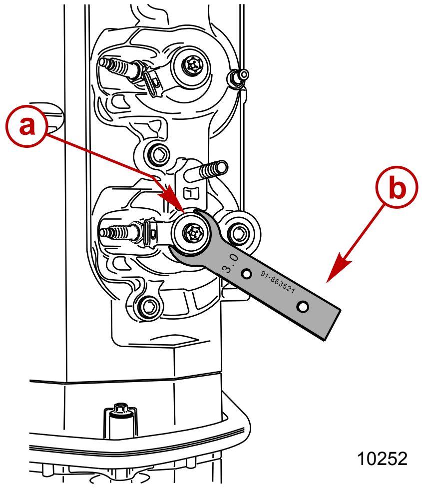
8309

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Injector pin	Injector pin	Auto	1.8 ± 0.1
Injector pin	Injector steel body	Auto	No continuity

DMT 2004 Digital Multimeter	91-892647A01

Direct Injector Removal

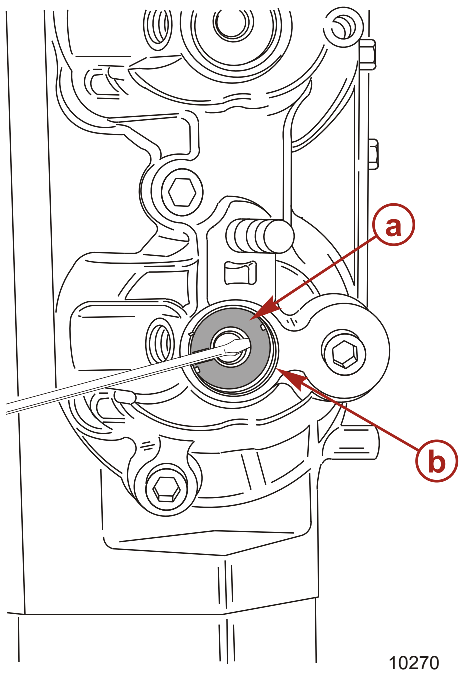
1. Remove the direct injector from the cylinder head using a direct injector removal tool.



a - Direct injector
b - Direct injector removal tool

Direct Injector Removal Tool	91-883521

2. Inspect the cupped washer on the cylinder head for damage.
3. If the cylinder head is to be replaced, ensure the new cylinder head supplies the cupped washers. If the new cylinder head does not have the cupped washers, remove the cup washers from each direct injector port by prying it out with a flat tip screwdriver. Reinstall the washers into the new cylinder head. The washers provide tension for the direct injectors between the cylinder head and fuel rails.



a - Cupped washer
b - Retainer

4. Inspect the direct injector white teflon sealing ring for signs of combustion blowby. The teflon ring will be streaked with carbon. The carbon color can range from light brown to black. If blowby is present, replace the teflon sealing ring.
5. Inspect the O-rings and teflon ring for cuts or abrasions. Replace the components as necessary.
6. Install the direct injector into the cylinder head.

Direct Injectors

Six direct injectors (one per cylinder) are used to inject a fuel/air mix into the cylinders. Injectors are mounted between the fuel rails and cylinder heads.

For best results, check the direct injector for continuity to ground when the injector is near operating temperature (engine warmed up).

***NOTE:** Checking resistance on a direct injector while still installed in the engine can be difficult. An easy and fast way to make resistance checks on direct injectors is to use service harness P/N 84-879346A49. This harness is normally used as a service replacement part for the direct injector connector if it becomes damaged, but also works well to test the injector when it is in place between the cylinder head/block and fuel rail.*

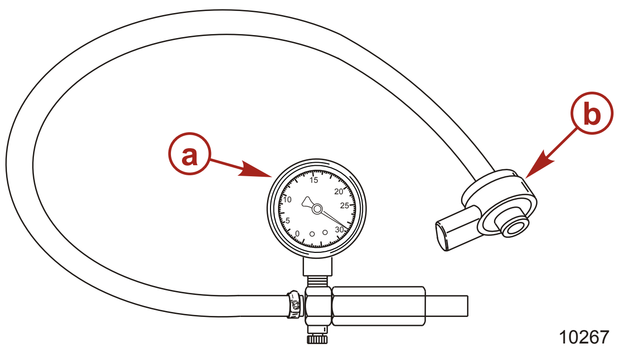
Direct Injector Resistance Test			
Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Injector pin	Injector pin	Auto	1–1.6
Each injector pin	Ground	Auto	> 1000

DMT 2004 Digital Multimeter	91-892647A01
Direct Injector Harness	84-879346A49

Direct Injector Tests

Direct Injector Leak Test

1. Attach the leakage tester kit to the discharge side of the direct injector.
2. Pump up the leakage tester to 172.4–206.8 kPa (25–30 psi).
3. The direct injector should not leak-down more than 3.5 kPa (0.5 psi) in one minute. Replace the direct injector if it does not meet the specifications.



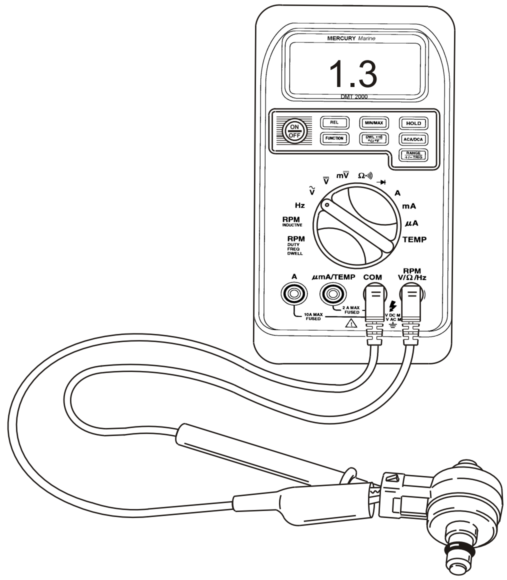
a - Leakage tester kit
b - Direct injector

Leakage Tester Kit	FT8950

Direct Injector Ohm Test

Use the DMT 2004 digital multimeter to complete the following tests.

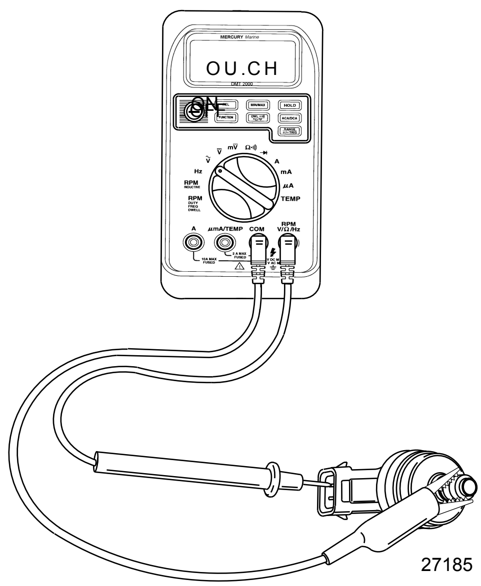
1. Connect the meter leads to the two direct injector pins. Replace the direct injector if the resistance is out of specification.



Winding resistance test

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Injector pin	Injector pin	Ω	1.3 ± 0.3

2. Connect one meter lead to either injector pin and the other meter lead to the direct injector metal case. Replace the direct injector if the resistance is out of specification.



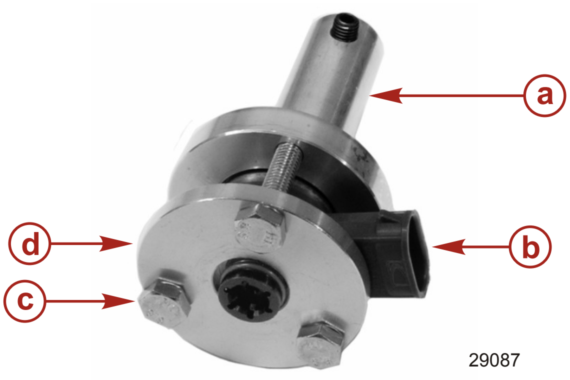
Short to metal case test

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Injector pin	Metal case	Ω	1000 Ω or greater

DMT 2004 Digital Multimeter	91-892647A01

Direct Injector Pintel Movement Test

1. Place the direct injector into the test fixture housing.
2. Install the base plate over the direct injector. Secure the base plate with three screws. Tighten the screws to the specified torque.

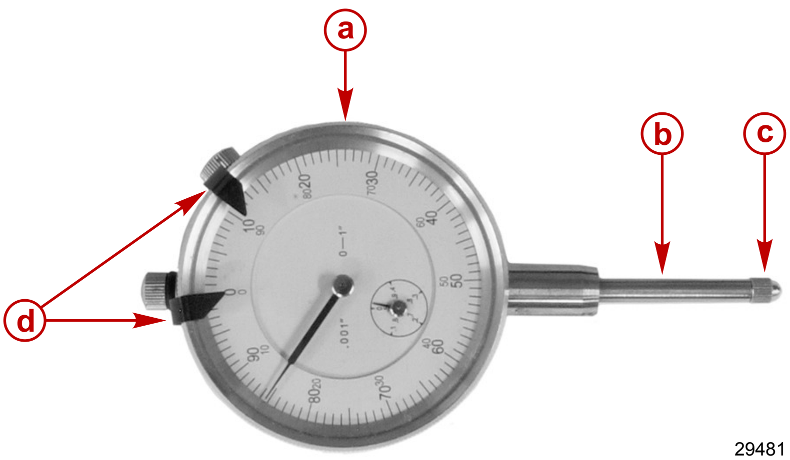


29087

a - Test fixture housing
b - Direct injector
c - Screw (M6 x 40)
d - Base plate

Description	Nm	lb-in.	lb-ft
Screw (M6 x 40)	1.7	15	

3. Install the nose piece into the end of the dial indicator plunger.

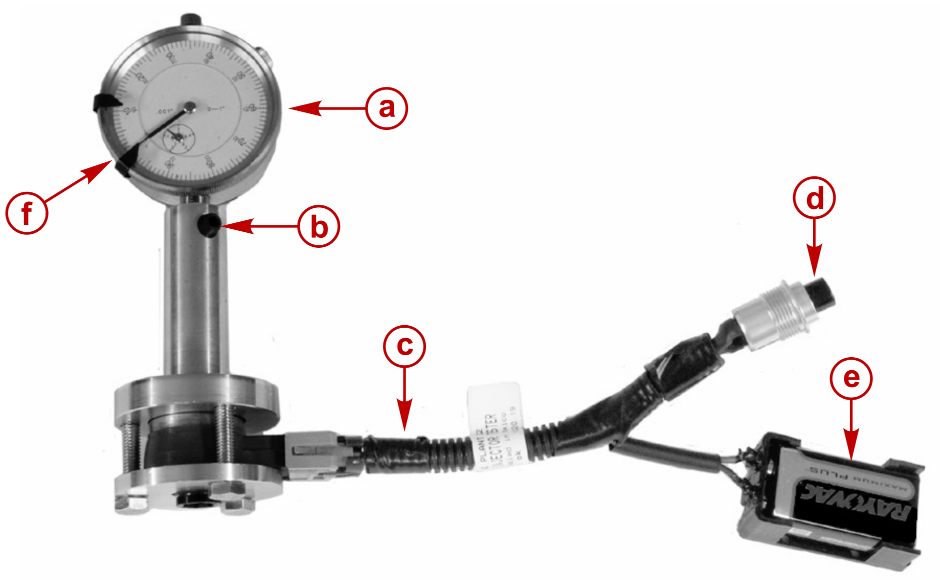


29481

a - Dial indicator
b - Plunger
c - Nose piece
d - Tolerance pointers

4. Connect the harness connector to the direct injector.
5. Install a 9 V battery into the battery holder.
6. Install the dial indicator into the test fixture housing. Tighten the screw to the specified torque.
7. Adjust the dial indicator bezel to point towards zero.
8. Press and release the button on the harness to actuate the direct injector.
9. Adjust the dial indicator bezel to zero if necessary.
10. Move the tolerance pointer, if equipped, to the specified limits.
11. Actuate the direct injector again.

12. Note the dial indicator reading when the direct injector is actuated. The dial indicator measures the direct injector tip movement. The dial indicator measurement should be within specification.



29088

- a - Dial indicator
- b - Screw
- c - Harness
- d - Button
- e - 9 V battery installed
- f - Dial indicator set at zero

Pintle Test Fixture	91-899883A08
Dial Indicator	91- 58222A 1

Description	Nm	lb-in.	lb-ft
Screw	1.7	15	

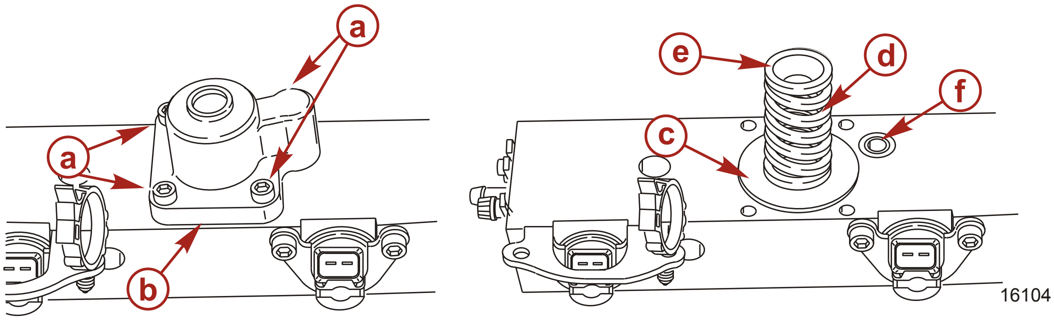
Direct Injector Specification	
Direct injector pintle movement	0.020–0.031 mm (0.008–0.012 in.)

13. If the test result is not within specification, the direct injector is defective.

Fuel Pressure Regulator Removal

1. Remove the four screws securing the fuel pressure regulator cover and 4.5 kg (10 lb) spring to the fuel rail.
2. Inspect the fuel pressure regulator diaphragm for damage.

3. Inspect the fuel pressure regulator housing O-ring for damage.

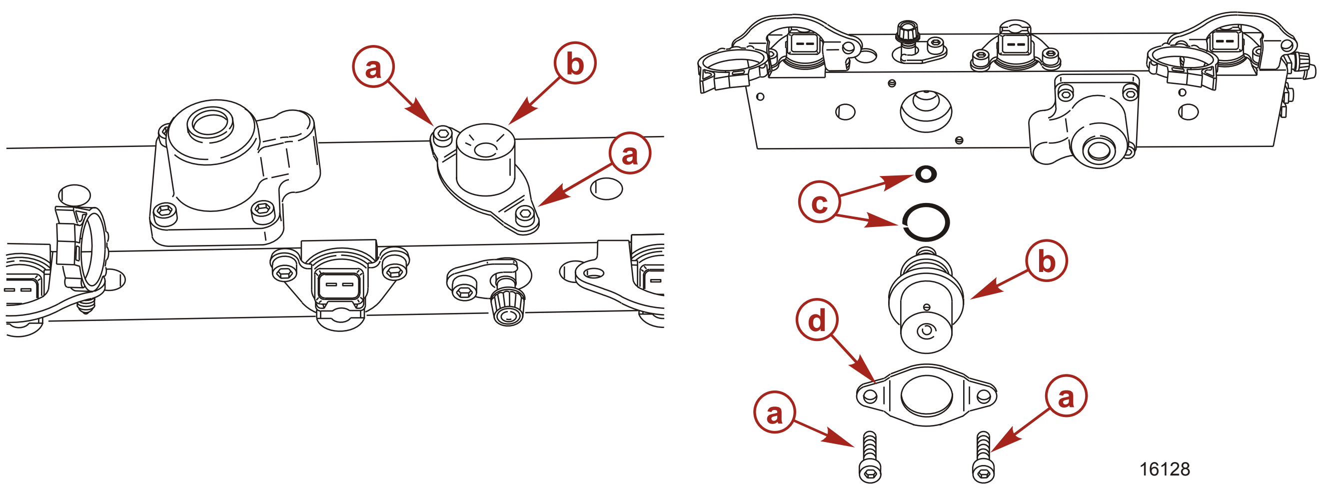


a - Screw (4)
b - Fuel regulator
c - Diaphragm
d - Spring
e - Cup
f - O-ring

Air Pressure Regulator Removal (S/N 0T178500 and Above)

1. Remove the two screws securing the air pressure regulator to the fuel rail.
2. Inspect the air pressure regulator O-rings for damage.

NOTE: The air pressure regulator is not serviceable.

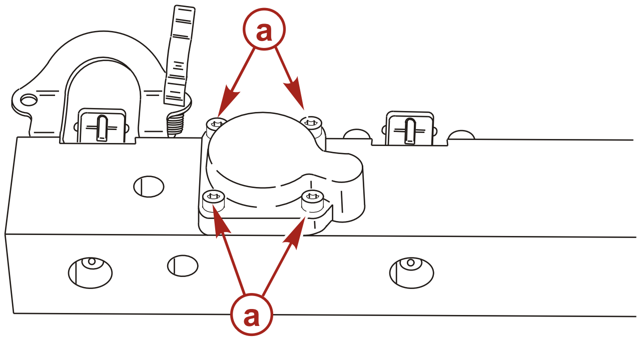


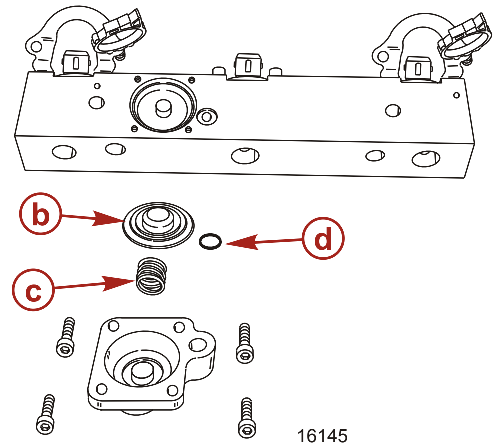
a - Screws
b - Air pressure regulator
c - O-rings
d - Retainer

Tracker Valve Removal

1. Remove the four screws securing the tracker valve to the fuel rail.
2. Inspect the tracker diaphragm for damage.

3. Inspect the tracker cover O-ring for damage.





16145

a - Screws
b - Diaphragm
c - Spring
d - O-ring

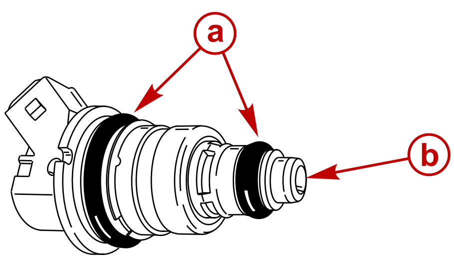
Fuel Rail Cleaning

After all components have been removed, flush the fuel rails with a solvent. Use compressed air to remove any remaining solvent.

IMPORTANT: If a mechanical failure has occurred with the air compressor or direct injector assemblies, the fuel rail must be disassembled and flushed with a solvent to remove debris.

Fuel Injector Installation

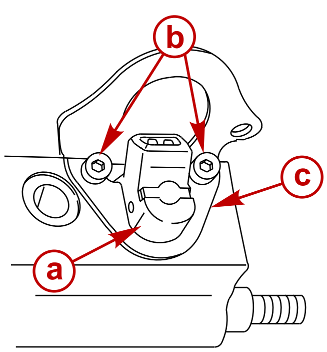
1. Inspect the fuel injector plastic body for heat damage. Replace as needed.
2. Inspect the fuel injector nozzle for debris. Replace as needed.
3. Install new O-rings onto the fuel injector.



10185

a - O-rings
b - Fuel injector nozzle

4. Lubricate the fuel injector O-rings with 2-4-C with Teflon.
5. Install the fuel injector into the fuel rail. Turn the injector back and forth slightly to seat the fuel injector O-rings into the fuel rail.
6. Lubricate the fuel injector retainer screw threads with 2-4-C with Teflon. Secure the fuel injector to the fuel rail with the retainer and two screws. Tighten the screws to the specified torque.



29608

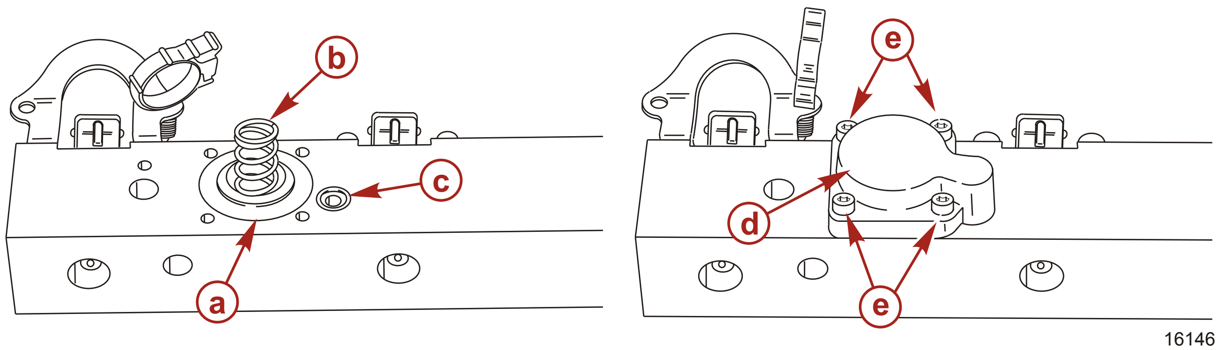
a - Injector
b - Screws
c - Retainer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Fuel injector O-rings and screw threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Screw	8	70	

Tracker Valve Installation

1. Lubricate the tracker diaphragm and O-ring with 2-4-C with Teflon.
2. Lubricate the screw threads with 2-4-C with Teflon.
3. Install the tracker diaphragm, spring, and O-ring onto the fuel rail.
4. Install the cover and secure with four screws. Tighten the screws to the specified torque.



a - Diaphragm
b - Spring
c - O-ring
d - Cover
e - Screws

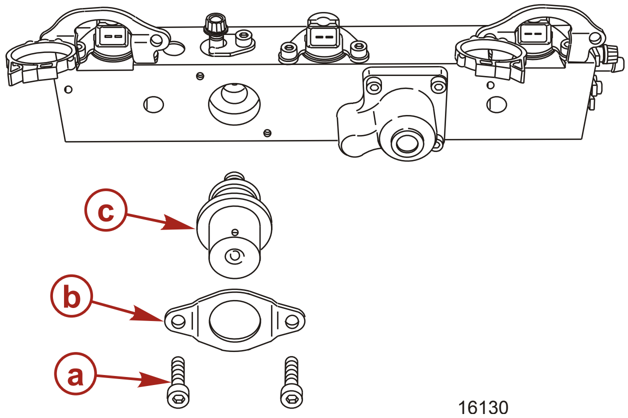
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Tracker diaphragm, O-ring, and screw threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Screw (4)	8	71	

Air Pressure Regulator Installation (S/N 0T178500 and Above)

1. Install new O-rings onto the air pressure regulator.
2. Lubricate the air pressure regulator O-rings with 2-cycle Premium Outboard Oil.
3. Lubricate the screws with 2-4-C with Teflon.

4. Install the air pressure regulator into the fuel rail and secure with the retainer and screws. Tighten the screws to the specified torque.



16130

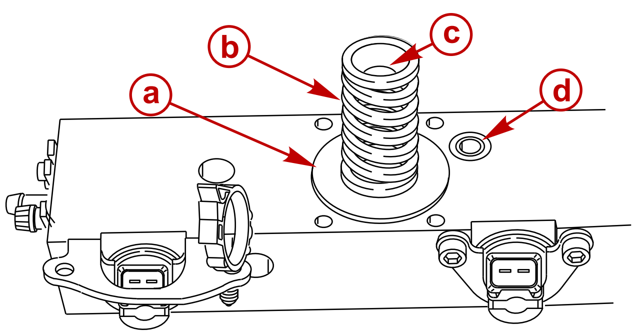
- a - Screw (2)
- b - Retainer
- c - Air pressure regulator

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Air pressure regulator O-rings	92-858021K01
95	2-4-C with Teflon	Air pressure regulator screw threads	92-802859A 1

Description	Nm	lb-in.	lb-ft
Air pressure regulator screw (2)	8	71	

Fuel Pressure Regulator Installation

1. Lubricate the fuel pressure regulator diaphragm and O-ring with 2-4-C with Teflon.
2. Install the O-ring onto the fuel rail.
3. Install the diaphragm onto the fuel rail.
4. Install the spring onto the diaphragm and the cup onto the spring.



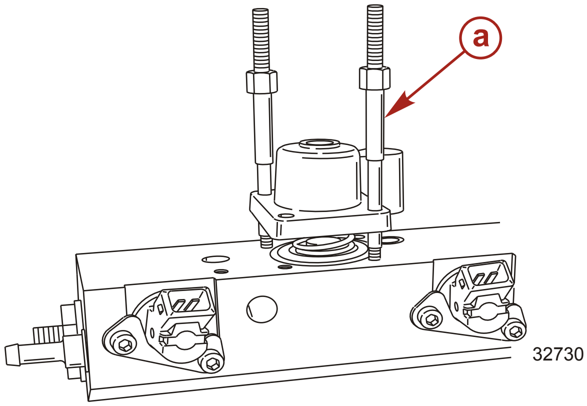
32729

- a - Fuel pressure regulator diaphragm
- b - Spring
- c - Cup
- d - O-ring

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Fuel pressure regulator diaphragm and O-ring	92-802859A 1

5. Lubricate the screw threads with 2-4-C with Teflon.
6. Install the cover onto the fuel pressure regulator spring.

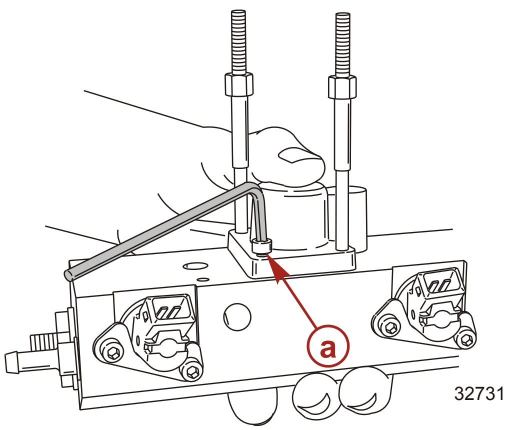
7. Use the two screws from the air regulator installation tool and thread the screw at opposite corners to align the cover.



a - Air regulator installation tool screw (2)

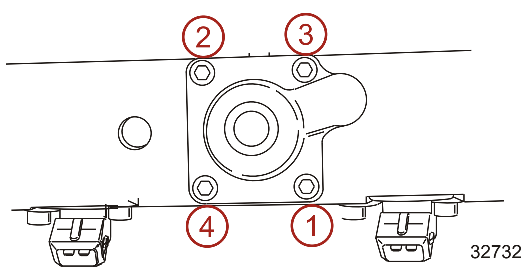
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Fuel pressure regulator screw threads	92-802859A 1

8. Push the cover against the fuel rail. While holding the cover down, install two of the cover retaining screws. Thread the two screws in until the head of the screws contact the cover. Do not torque the screws at this time.



a - Screw (2)

9. Remove the air regulator installation tool screws and install the two remaining screws. Tighten the screws in the sequence shown, in two steps, to the specified torque.

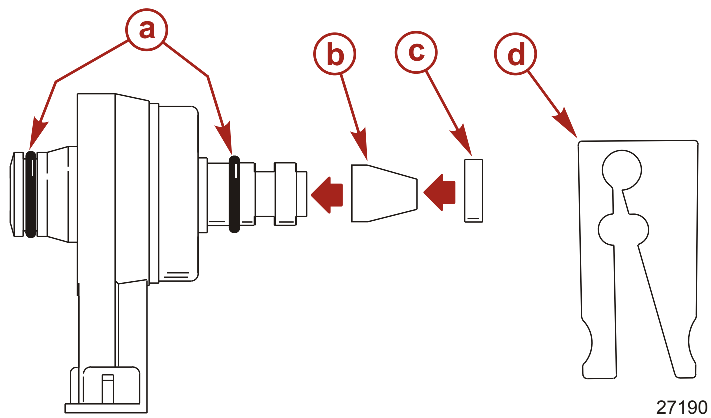


Description		Nm	lb-in.	lb-ft
Screw (4)	**First**	5.5	50	
	Final	8	71	

Fuel Rail Installation

1. Ensure there is a cupped washer on each of the cylinder head direct injector ports.
2. Inspect the direct injector O-rings and Teflon ring for cuts or abrasions. Replace the components as necessary.

3. Use the seal/Teflon ring installation tool to slide the new seal onto the injector. Use the Teflon ring sizing tool to compress the Teflon seal.



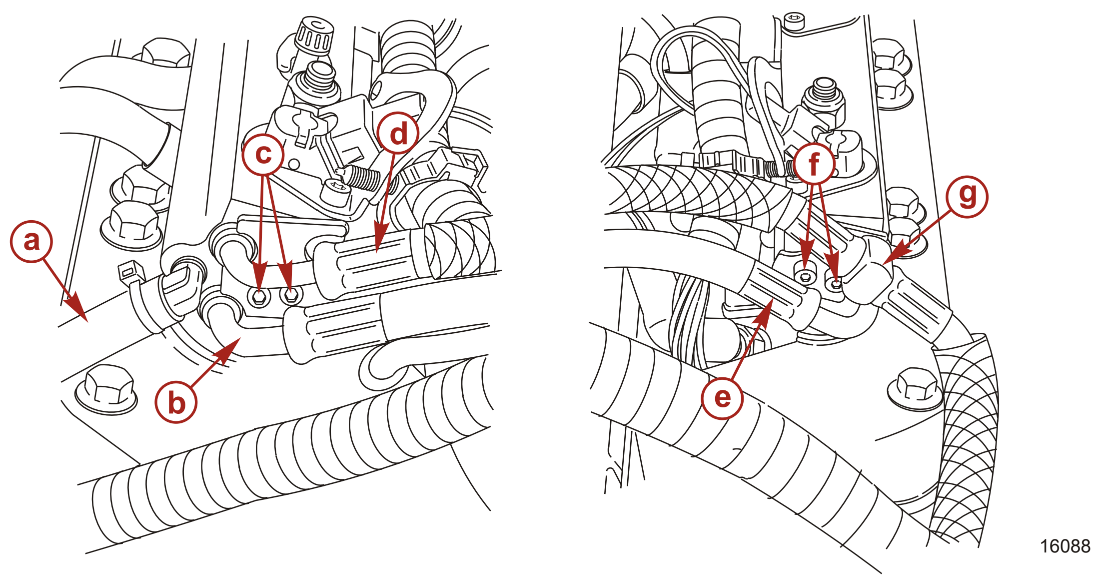
a - O-rings
b - Seal/Teflon ring installation tool
c - Teflon seal
d - Seal/Teflon ring sizing tool

Seal/Teflon Ring Installation Tool	91-851980--3
Seal/Teflon Ring Sizing Tool	91-851980--2

4. Install the direct injector into the cylinder head.
5. Slide the fuel rail onto the mounting studs and secure with two washers and M10 nuts. Tighten the nuts to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel rail mounting nuts (M10)	45		33

6. Install new O-rings onto the fuel rail air hose and fuel hose fittings.
7. Lubricate the O-rings with oil and install onto the fuel rail.
8. Secure the fittings to the fuel rail with a retainer and two screws. Tighten the screws to the specified torque.
9. Install the water hose onto the fuel rail fitting and secure with a cable tie.

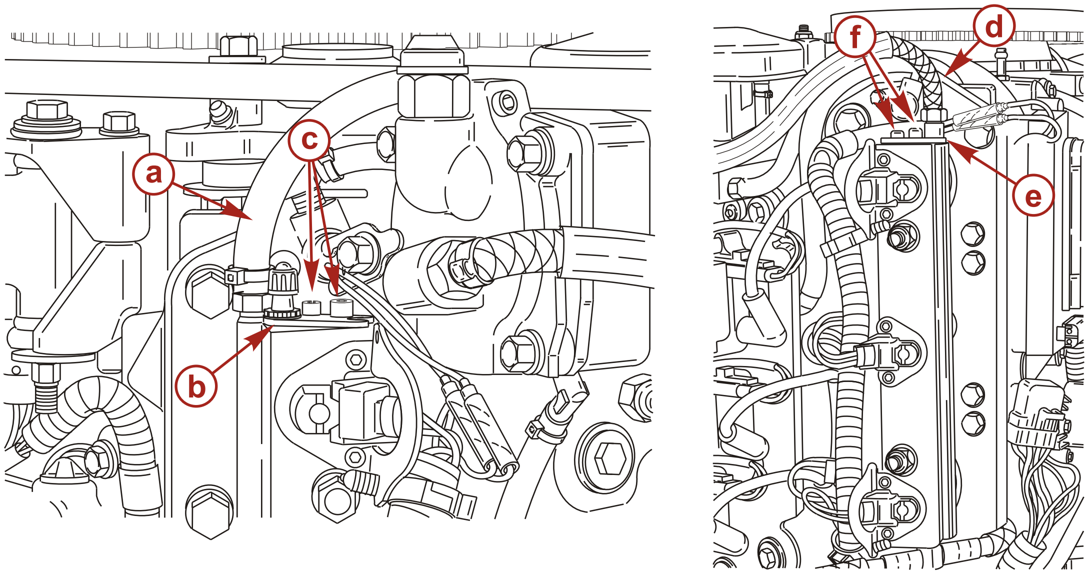


a - Water inlet hose to fuel rail
b - Air hose
c - Screw (2)
d - Fuel hose
e - Air hose
f - Screw (2)
g - Fuel hose

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Air hose and fuel hose fitting O-rings	92-858021K01

Description	Nm	lb-in.	lb-ft
Screws	8	71	

10. Install new O-rings onto the fuel rail air hose and fuel hose fittings.
11. Lubricate the O-rings with oil and install onto the fuel rail.
12. Secure the fittings to the fuel rail with a retainer and two screws. Tighten the screws to the specified torque.
13. Install the compressor water inlet hose to the fuel rail and secure with a cable tie.



16087

a - Water inlet hose to compressor
b - Fuel hose retainer
c - Screw (2)
d - Air hose
e - Air hose retainer
f - Screw (2)

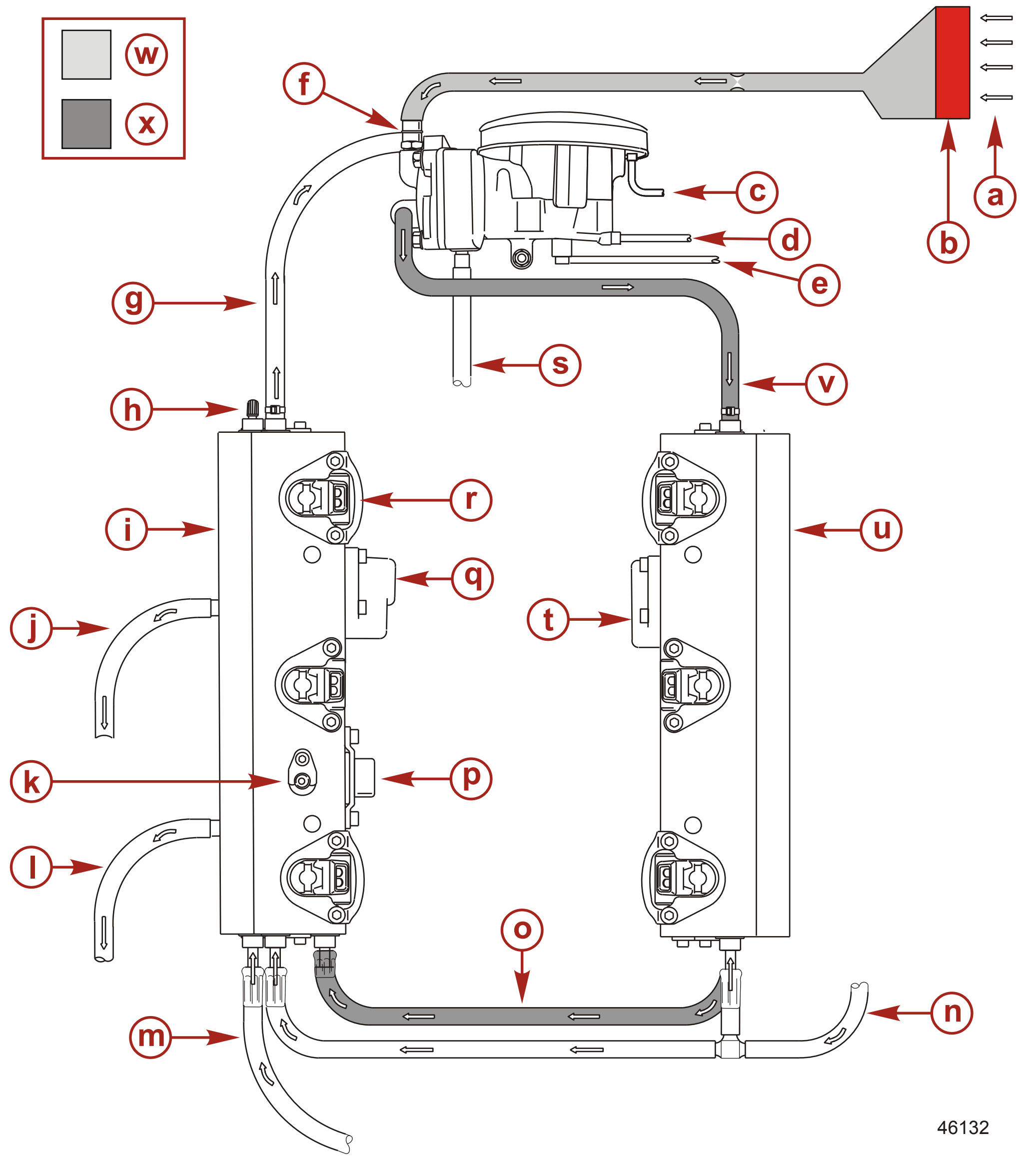
Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Air hose and fuel hose fitting O-rings	92-858021K01

Description	Nm	lb-in.	lb-ft
Screws	8	71	

14. Connect the engine harness connectors to the fuel injector and direct injector connectors.

Air Compressor

Air Compressor Flow Diagram



- a - Air inlet
- b - Air filter
- c - Compressor oil inlet
- d - Oil to upper main bearing
- e - Oil to lower crankshaft bearing
- f - Compressor inlet
- g - Compressor water inlet
- h - Fuel pressure test valve
- i - Port fuel rail
- j - Excess fuel return to VST
- k - Air pressure test valve
- l - Excess air return to exhaust adapter plate
- m - Water inlet to fuel rail
- n - High-pressure fuel hose
- o - Air hose
- p - Air regulator valve of 655 ± 14 kPa (95 ± 2 psi)
- q - Fuel regulator valve of 751.5 ± 14 kPa (109 ± 2 psi)

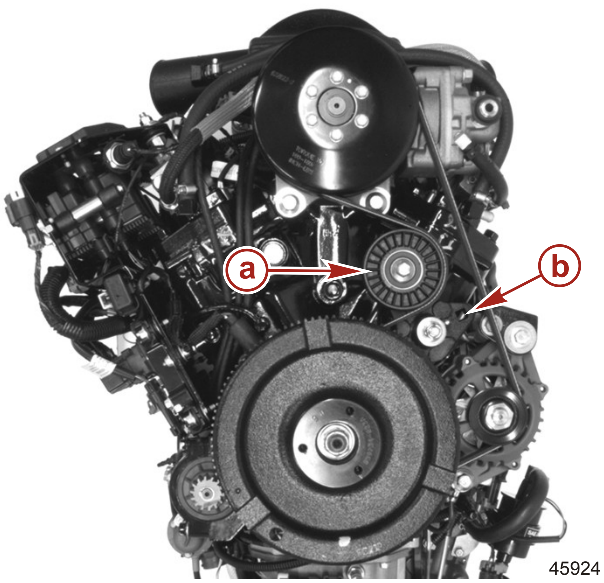
- **r -** Fuel injector (6)
- **s -** Water outlet to expansion chamber outlets
- **t -** Tracker valve
- **u -** Starboard fuel rail
- **v -** Compressor outlet of 655 ± 14 kPa (95 ± 2 psi)
- **w -** Low-pressure air
- **x -** High-pressure air

Air Compressor Removal

⚠ WARNING

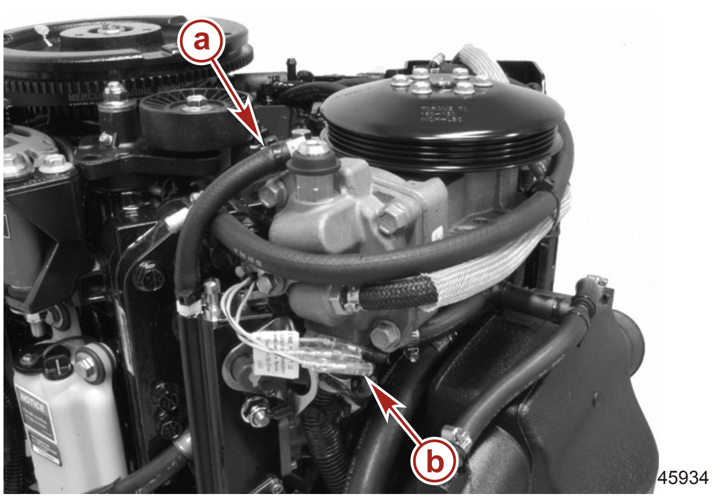
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

1. Disconnect both of the battery cables from the battery.
2. Remove the vent hose from the flywheel cover. Remove the flywheel cover.
3. Use a 3/8 in. square drive on the belt tension arm to remove the belt.



- **a -** Belt tensioner
- **b -** 3/8 in. square drive

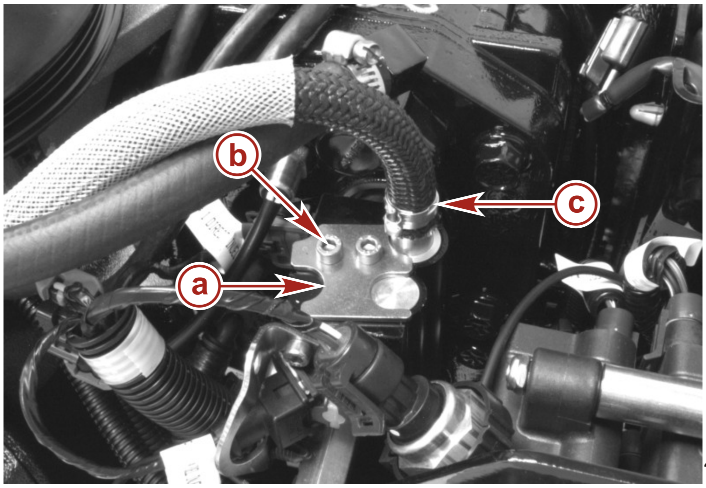
4. Disconnect the air compressor bullet connectors.
5. Cut the cable tie securing the water inlet hose to the air compressor. Remove the water inlet hose.



- **a -** Water inlet hose
- **b -** Bullet connectors

6. Remove the two screws securing the retainer to the fuel rail. Remove the air compressor hose with the fitting from the fuel rail.

NOTE: *Do not remove the air compressor hose from the fitting on the fuel rail. Removing the hose from the fitting on the fuel rail will damage the air compressor hose.*

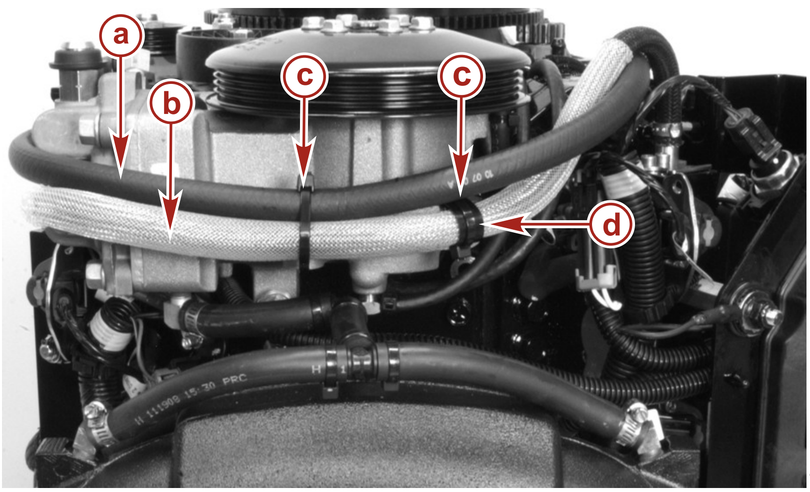


45927

a - Retainer
b - Screw (2)
c - Air compressor hose with fitting

7. Remove the cable ties securing the water hose and air hose to the compressor.
8. Remove the air compressor fitting with the hose from the air compressor.

NOTE: *Do not remove the air compressor hose from the fitting on the air compressor. Removing the hose from the fitting will damage the air compressor hose.*

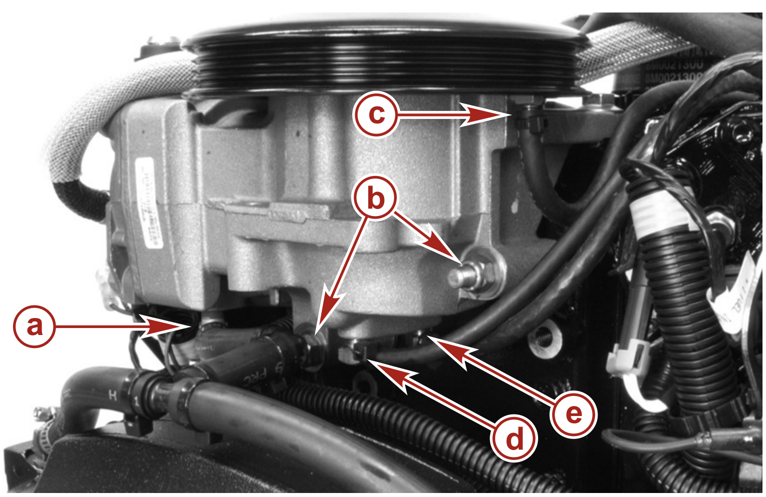


45930

a - Water hose
b - Air compressor to fuel rail hose
c - Cable tie
d - Plastic J-clamp

9. Remove the two nuts and washers securing the air compressor to the cylinder block.
10. Remove the water hose to the expansion chamber.
11. Remove the oil hoses from the air compressor.

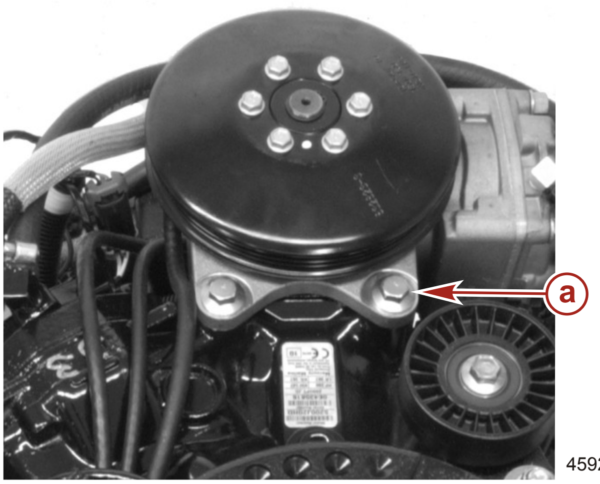
NOTE: *Mark or identify the three oil hoses when removing to aid in the installation.*



45931

a - Water hose to expansion chamber
b - Nut and washer (M8)
c - Air compressor oil inlet hose
d - Oil hose to top main bearing
e - Oil hose to #5 reed block

12. Remove the two screws securing the air compressor to the top of the cylinder block.

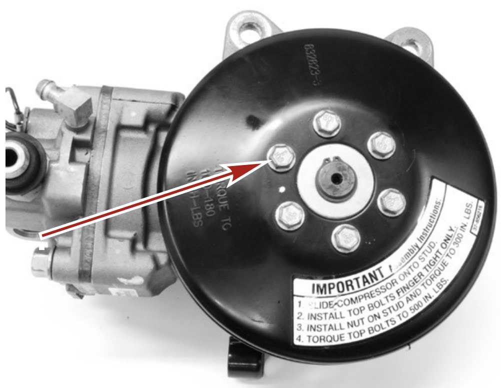


45928

a - Screw (M8 x 25, flange) (2)

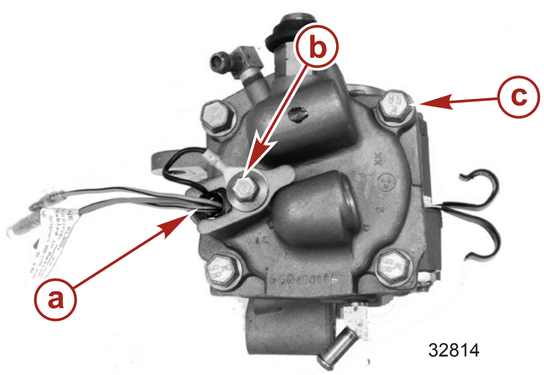
Air Compressor Disassembly

1. Use a strap wrench to hold the air compresser pulley and remove the six screws securing the pulley to the air compressor crankshaft.



26410

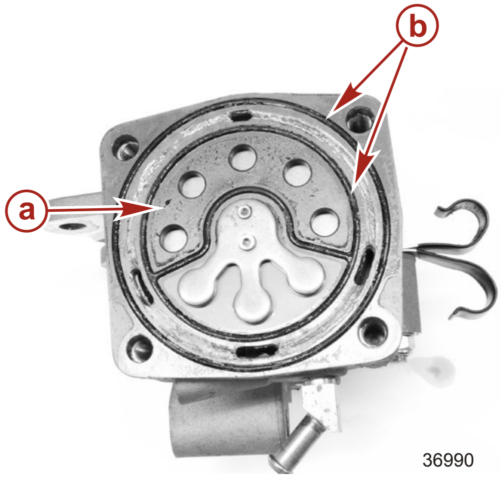
2. Remove the screw securing the air compressor temperature sensor. Remove the sensor.
3. Remove the four screws securing the air compressor cylinder head to the cylinder block. Remove the cylinder head.



32814

a - Air compressor temperature sensor
b - Screw
c - Screws securing the air compressor cylinder head

4. Remove the reed plate assembly and O-rings.



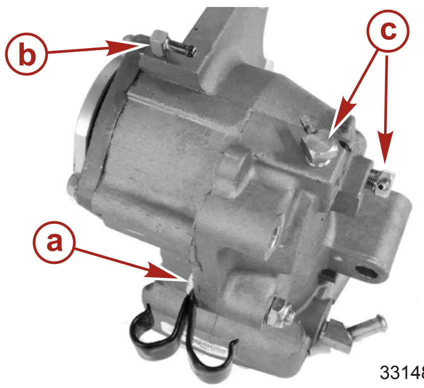
36990

a - Reed plate
b - O-rings

5. Remove the check valves and fittings.
6. Remove the bolt and nut securing the two J-clamps.

   NOTE: *Later models will not use a bolt and nut to secure the J-clamps. The J-clamps will be replaced by a plastic clip or cable ties.*

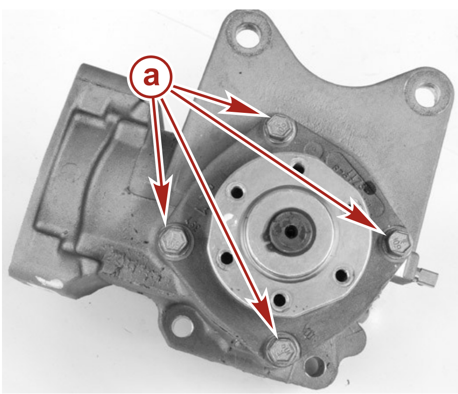
   IMPORTANT: Do not remove the air compressor oil supply fitting.



33148

a - Bolt and nut securing the two J-clamps
b - Oil supply fitting
c - Check valves (2)

7. Remove the four screws securing the air compressor end cap. Remove the end cap.



33149

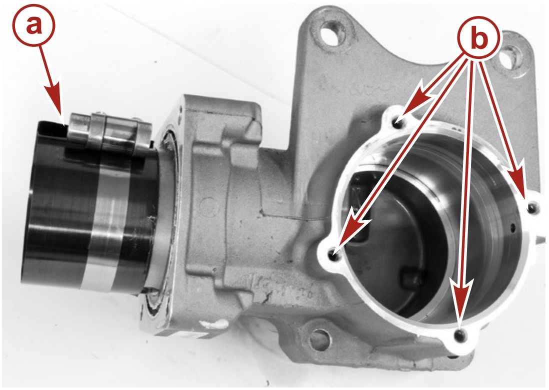
a - Screw (4)

8. Push the piston connecting rod assembly out of the air compressor.

Air Compressor Assembly

1. Clean the threaded holes on the air compressor with a M6 x 1.0 tap and solvent to remove debris and oil. Clear the threaded holes with compressed air.
2. Install the rings onto the piston. Stagger the piston rings so they do not line up with each other.
3. Lubricate the air compressor cylinder bore with 2-cycle Premium Outboard Oil.

4. Install a ring compressor onto the piston. Install the piston into the air compressor cylinder bore.

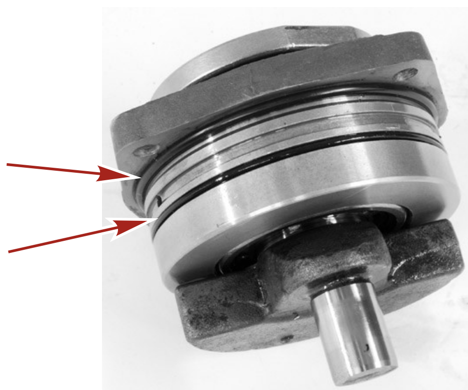


26767

a - Ring compressor
b - Threaded holes on the air compressor

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Air compressor cylinder bore	92-858021K01

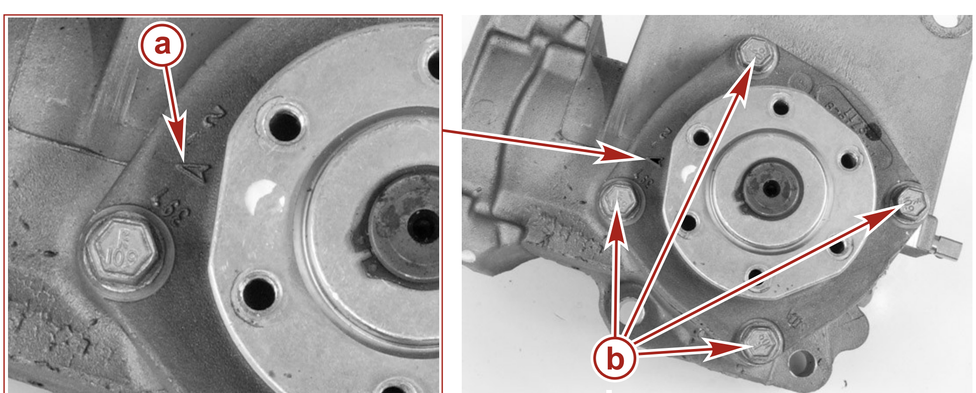
5. Ensure the connecting rod end is correctly positioned.
6. Install the O-rings onto the air compressor end cap. Lubricate the O-rings with 2-cycle Premium Outboard Oil.



30319

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Air compressor end cap O-rings	92-858021K01

7. Install the end cap onto the air compressor. Ensure the crank journal is engaged with the connecting rod by turning the drive sheave. The piston should move in the cylinder bore.
8. Ensure the arrow on the end cap points towards the cylinder head.
9. Apply Loctite 271 to the threads of the M6 x 20 end cap screws. Install the screws and tighten the screws to the specified torque.



31370

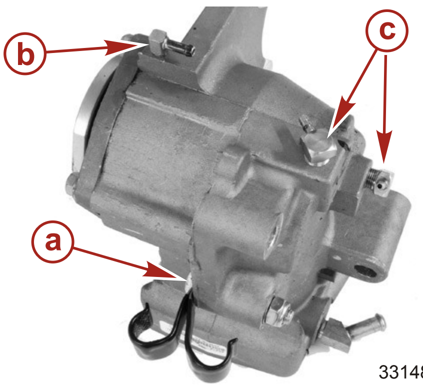
a - Arrow
b - Screws (M6 x 20) (4)

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Air compressor end cap screw threads	92-809819

Description	Nm	lb-in.	lb-ft
Screw (carbon steel) (M6 x 20)	17	150	
Screw (stainless steel) (M6 x 20)	11.5	100	

10. Install the two check valves onto the air compressor.
11. Install and secure the two J-clamps, if used, to the air compressor with a bolt and nut. Tighten the bolt and nut securely.

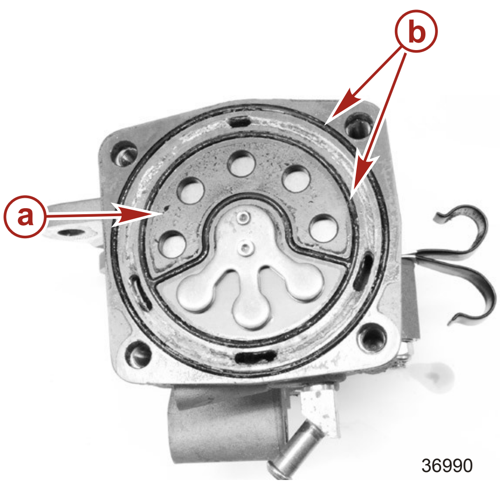
    NOTE: Later models will use either a plastic clip or cable ties in place of the two J-clamps.



33148

a - Bolt and nut securing the two J-clamps
b - Oil supply fitting
c - Check valves (2)

12. Install the O-rings onto the reed plate assembly.
13. Install the reed plate assembly with the five petal side towards the piston.

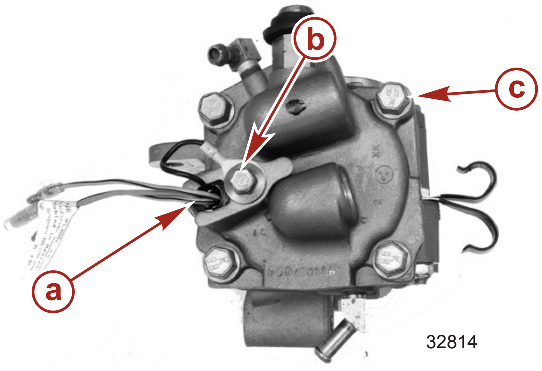


36990

a - Reed plate
b - O-rings

14. Install the air compressor cylinder head and secure with four M8 x 35 screws. Tighten the screws to the specified torque.
15. Install the air compressor temperature sensor into the cylinder head.

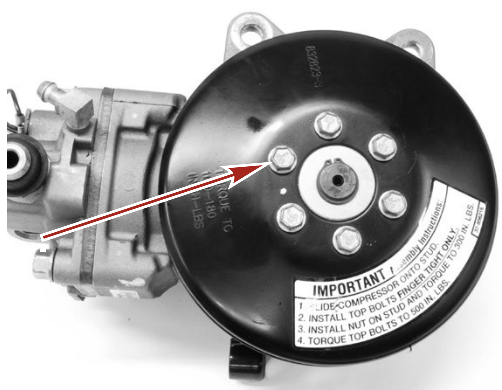
16. Install the temperature sensor ground wire onto the M8 x 14 screw. Secure the temperature sensor with a retainer and the screw.



a - Air compressor temperature sensor
b - Screw (M8 x 35)
c - Screws securing the air compressor cylinder head (4)

Description	Nm	lb-in.	lb-ft
Screws (M8 x 35)	27		20
Screw (M8 x 14)	27		20

17. Install the air compressor pulley.
18. Apply Loctite 271 Threadlocker to the six M6 x 12 screw threads and secure the compressor pulley with the screws. Tighten the screws to the specified torque.



26410

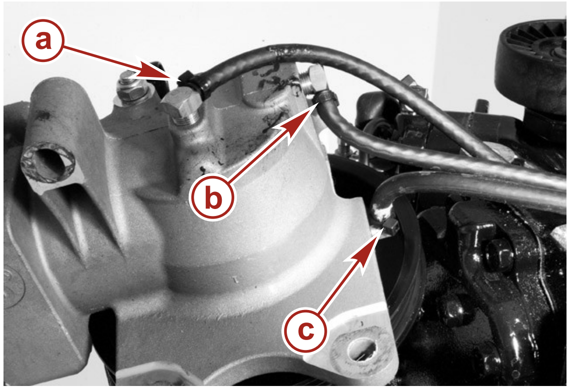
Description	Nm	lb-in.	lb-ft
Screw (M6 x 12) (6)	19	170	

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Air compressor pulley screw threads	92-809819

Air Compressor Installation

1. Install the oil line coming from the #5 reed block onto the bottom check valve and secure with a cable tie.
2. Install the oil line coming from the top main bearing onto the side check valve and secure with a cable tie.

3. Install the oil line coming from the oil pump onto the fitting under the air compressor pulley and secure with a cable tie.

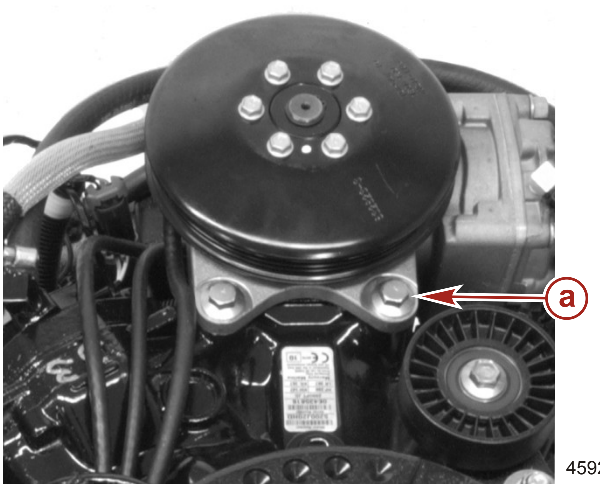


26404

a - Cable tie securing the oil line coming from #5 reed block
b - Cable tie securing the oil line coming from the top main bearing
c - Cable tie securing the oil delivery line coming from the oil pump

4. Install the air compressor onto the studs.
5. Install the two top screws (M10 x 25) finger-tight and then tighten to the first specified torque.
IMPORTANT: Do not overtighten. This is the first of a two stage torque process.

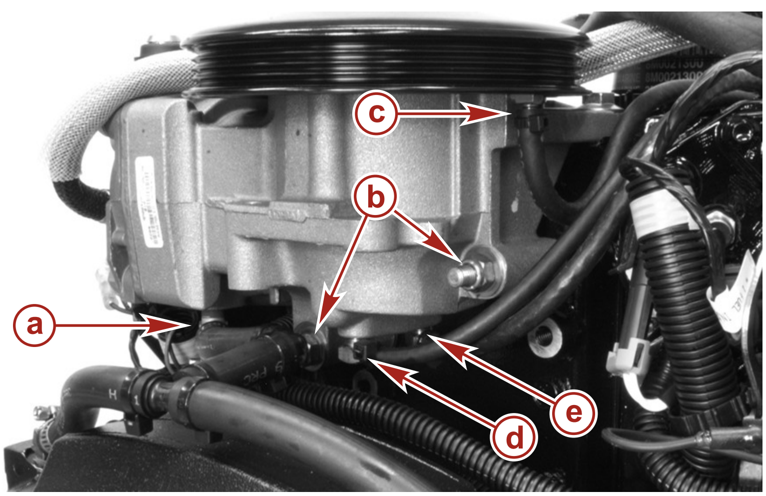
Description		Nm	lb-in.	lb-ft
Screw (M10 x 25) (2)	First	1.5	13	
	Final	56		41.3



45928

a - Screw (M10 x 25, flange) (2)

6. Install the water dump hose to the air compressor and secure with a cable tie.
7. Install a washer and nut onto each stud and tighten the nut to the specified torque.



45931

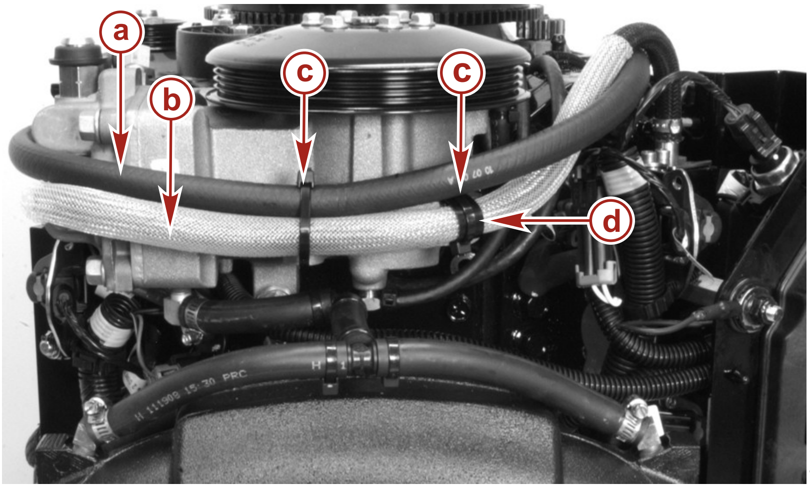
a - Water hose to expansion chamber
b - Nut and washer (M8)
c - Air compressor oil inlet hose
d - Oil hose to top main bearing
e - Oil hose to #5 reed block

Description	Nm	lb-in.	lb-ft
Nut securing air compressor	34		25

8. Tighten the two top screws (M10 x 25) securing the air compressor assembly to the cylinder block to the specified torque.

Description		Nm	lb-in.	lb-ft
Screw (M10 x 25) (2)	First	1.5	13	
	Final	56		41.3

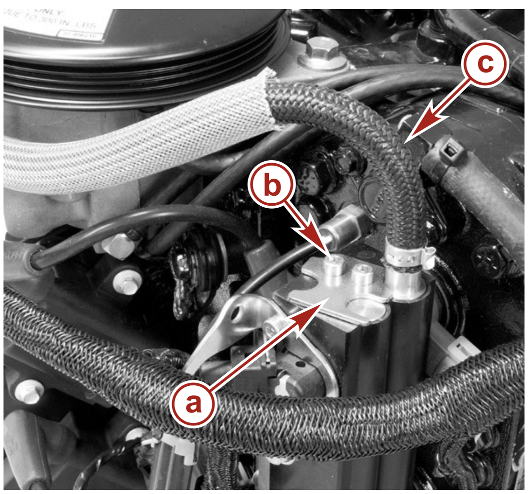
9. Secure the air compressor hose to the air compressor with a J-clamp and cable tie. Secure the water hose and air compressor hose to the air compressor with a cable tie.



45930

a - Water hose
b - Air compressor to fuel rail hose
c - Cable tie
d - Plastic J-clamp

10. Install two O-rings onto the fuel rail air compressor hose fitting. Lubricate the O-rings with 2-cycle Premium Outboard Oil.
11. Install the fitting into the fuel rail and secure with a retainer and two screws. Tighten the screws to the specified torque.



32810

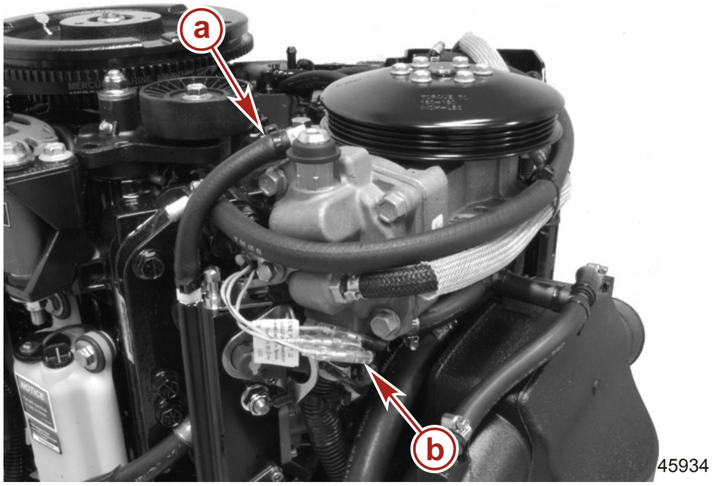
a - Retainer
b - Screw (2)
c - Air compressor hose

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	O-rings on the fuel rail air compressor hose fitting	92-858021K01

Description	Nm	lb-in.	lb-ft
Screw	8	71	

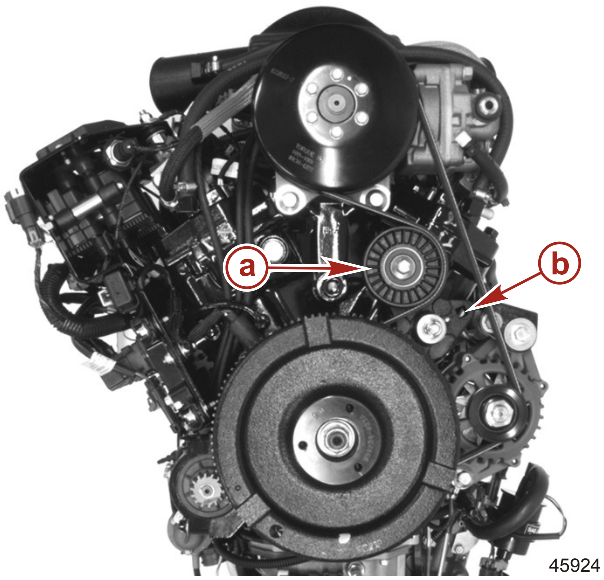
12. Secure the water inlet hose to the air compressor with a cable tie.

13. Connect the air compressor temperature sensor bullet connectors to the wire harness connector.



a - Water inlet hose
b - Bullet connectors

14. Use a 3/8 in. square drive on the belt tension arm and install the belt to the air compressor pulley.



a - Belt tensioner
b - 3/8 in. square drive

Notes:

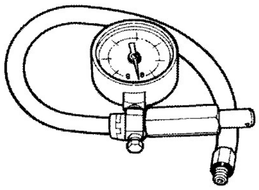
Fuel System

Section 3C - Oil Injection

Table of Contents

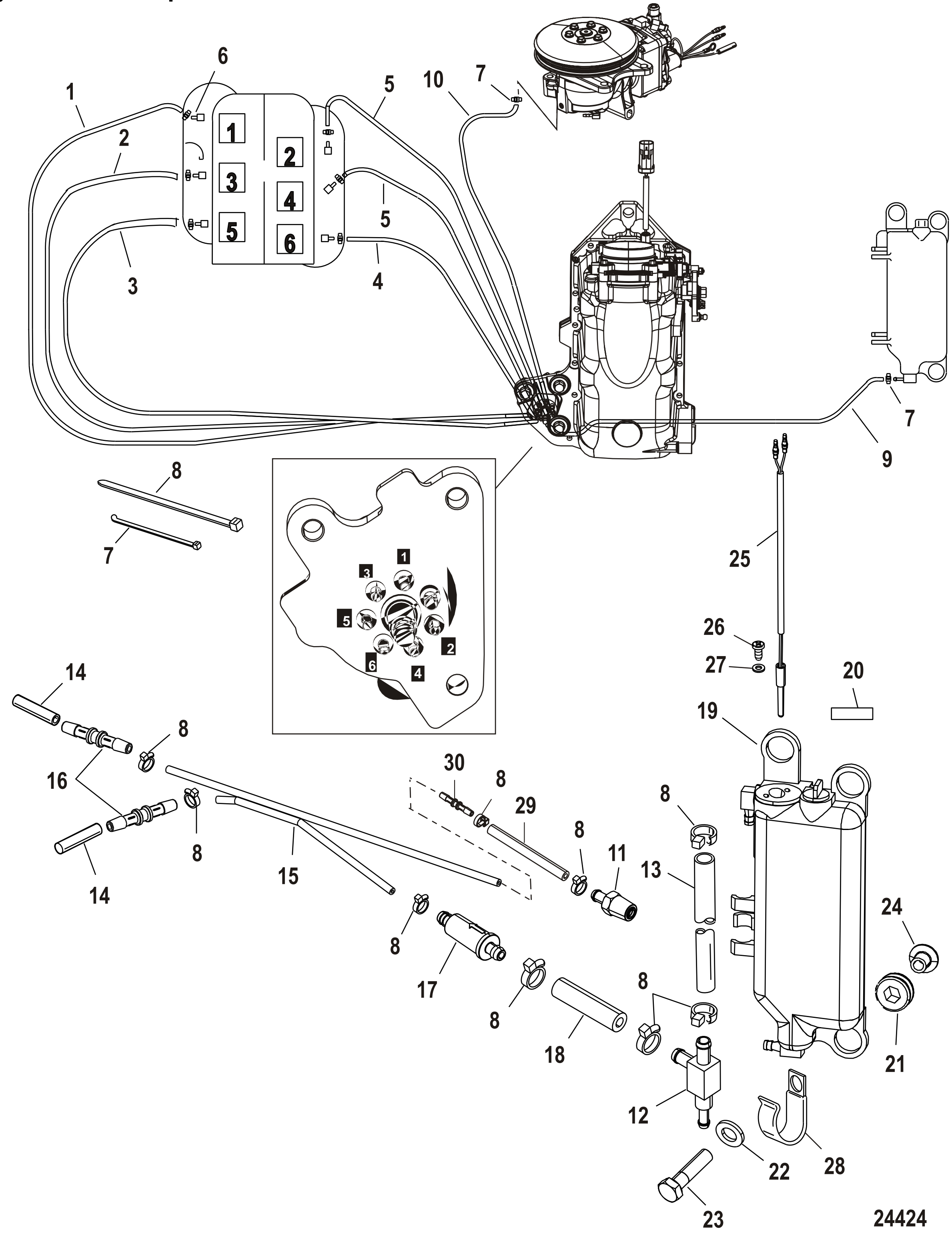
3
C

Special Tools

Leakage Tester Kit	FT8950
 29497	Used for pressure testing of closed systems (gearcase, fuel lines, cooling).

Notes:

Oil Injection Components



Oil Injection Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Tubing (61 cm [24 in.])			
2	1	Tubing (47 cm [18.5 in.])			
3	1	Tubing (42 cm [16.5 in.])			
4	1	Tubing (62.2 cm [24.5 in.])			
5	2	Tubing (68.6 cm [27 in.])			
6	6	Check valve			
7	AR	Cable tie (14 cm [5.5 in.])			
8	AR	Cable tie (20.3 cm [8 in.])			
		Cable tie (10 cm [4 in.])			
9	1	Hose (61 cm [24 in.])			
10	1	Hose (81.3 cm [32 in.])			
11	1	Check valve (to block)			
12	1	Fitting			
13	1	Hose (15.3 cm [6 in.])			
14	2	Cap			
15	1	Hose			
16	2	Connector			
17	1	In-line oil filter			
18	1	Hose (5 cm [2 in.])			
19	1	Reservoir assembly			
20	1	Reservoir decal			
21	3	Grommet			
22	3	Washer			
23	3	Screw (0.312-18 x 1.250)			
24	3	Bushing			
25	1	Switch assembly			
26	1	Screw (0.164-18 x 3/8)			
27	1	Washer			
28	1	Clamp			
29	1	Hose (12 cm [4.75 in.])			
30	1	Connector			

Oil System Operation

Oil is stored in an engine-mounted reservoir and in a remote oil tank on the boat. Crankcase pressure forces oil from the remote oil tank into the engine-mounted oil reservoir. The engine oil reservoir feeds oil to the oil pump. The oil pump is actuated by the PCM and distributes oil to the crankcase and air compressor. The oil pump has seven discharge ports with an oil delivery hose attached to each discharge port. Six of the hoses are connected to check valves near the reed assembly. The check valves are spring-loaded and require 34.5–48 kPa (5–7 psi) to unseat the check ball. The seventh oil delivery hose is connected to the air compressor for lubrication. Serial number 0T178499 and below, the air compressor has a single oil return port and is connected to the top of the intake plenum. Serial number 0T178500 and above, the air compressor has two oil return ports. These two ports return oil to the top and bottom main bearings on the engine.

The PCM is programmed to increase the oil supply to the engine during the initial engine break-in period. The oil ratio is doubled during the first 120 minutes of operation whenever the engine is under a load. At idle the oil pump is providing oil at the normal ratio. After the engine break-in period has expired, the oil ratio returns to normal.

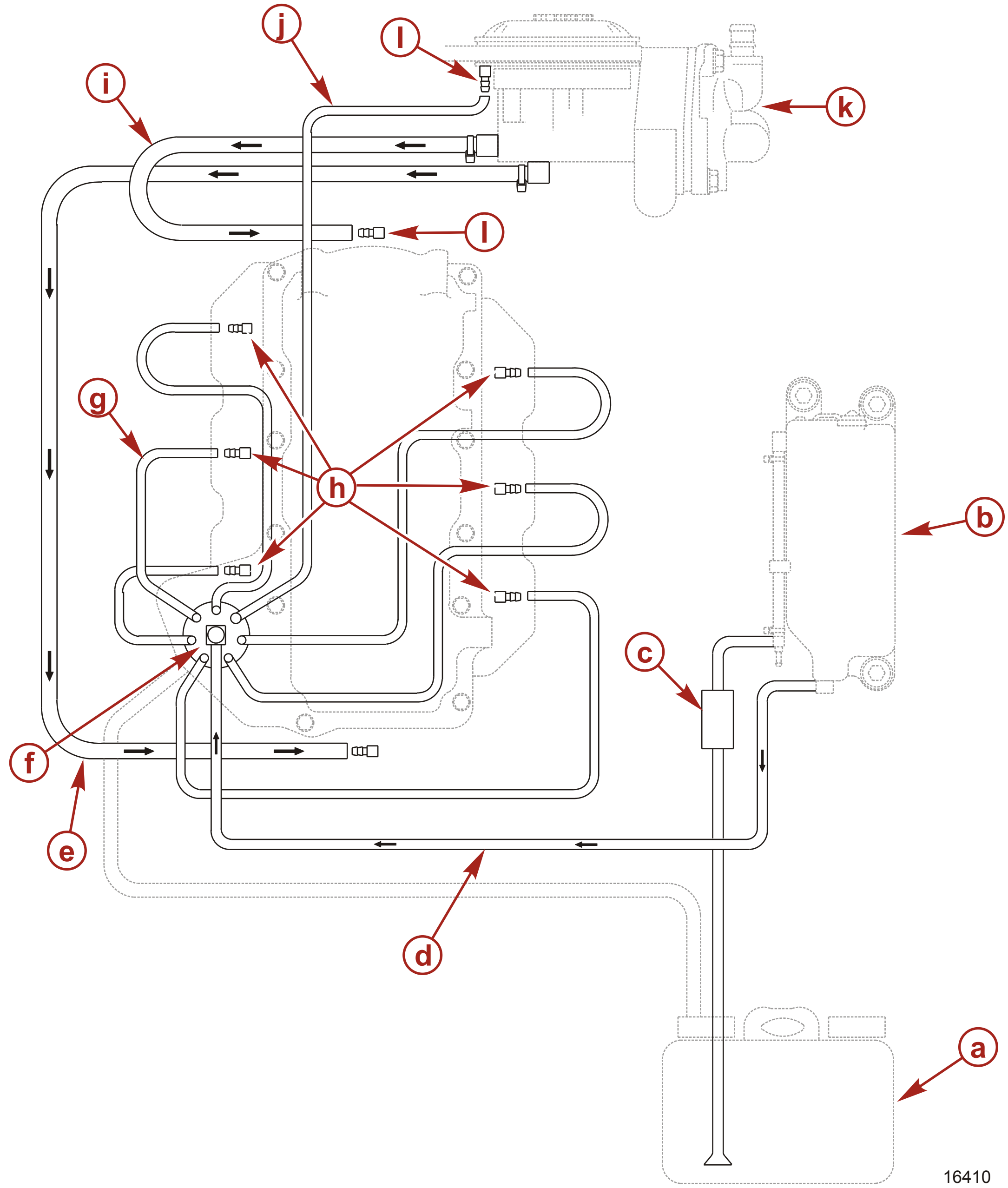
Oil Pump Output

Use the computer diagnostic system (CDS) to activate the auto prime. The oil pump should discharge approximately 100 ± 8 ml (3 ± 0.2 oz) during the auto prime.

To check the oil pump output:

- Verify the engine-mounted oil reservoir is full.
- Release the pressure from the remote oil tank in the boat by loosening the cap.
- With the engine not running, use the CDS to activate the auto prime.
- Use a ml or cc graduated container to record the amount of oil needed to fill the engine mounted oil reservoir.
- Tighten the cap on the remote oil tank in the boat.

Oil System Hose Installation (S/N 0T178500 and Above)

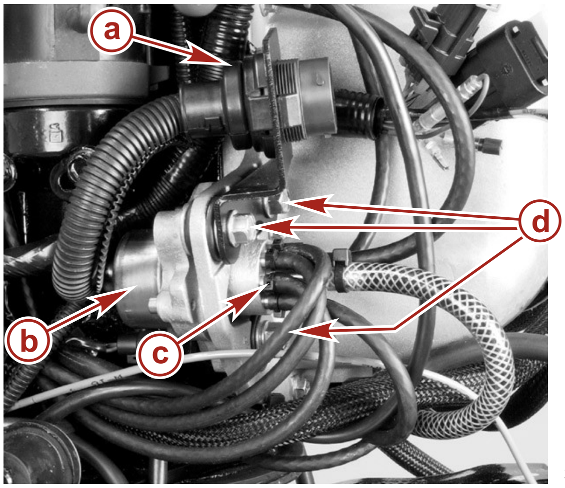


a - Remote oil tank
b - Engine-mounted oil reservoir
c - Filter
d - Oil hose to the oil pump
e - Oil hose to lower main bearing
f - Oil pump
g - Oil hoses to the cylinders
h - Check valve
i - Oil hose to upper main bearing
j - Oil hose to the air compressor
k - Air compressor
l - Fitting

Oil Pump Removal and Installation (S/N 1B490866 and Above)

Oil Pump Removal

1. Disconnect the wiring harness from the pump.
2. Cut the cable ties securing the oil hoses to the oil pump and remove the oil hoses.
3. Remove the three screws securing the oil pump to the air plenum assembly and remove the pump.

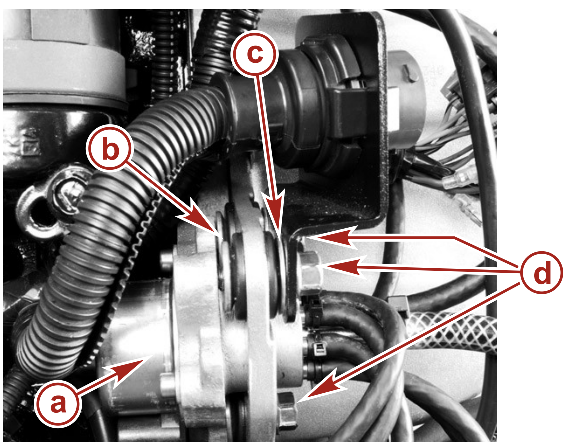


33410

- a - 14 pin connector
- b - Oil pump
- c - Cable ties securing oil hoses
- d - Screws securing the oil pump

Oil Pump Installation

1. Insert the oil pump discharge ports through the air plenum assembly oil pump opening.
2. Connect the oil hoses to the oil pump and secure with cable ties.
3. Insert two screws through the 14 pin mounting bracket and install washers on the screws.
4. Thread the three M8 x 35 screws into the oil pump and tighten the screws to the specified torque.



35101

- a - Oil pump
- b - Bushing
- c - Washer
- d - Screw (M8 x 35)

Description	Nm	lb-in.	lb-ft
Screw (M8 x 35) (3)	15.8	140	

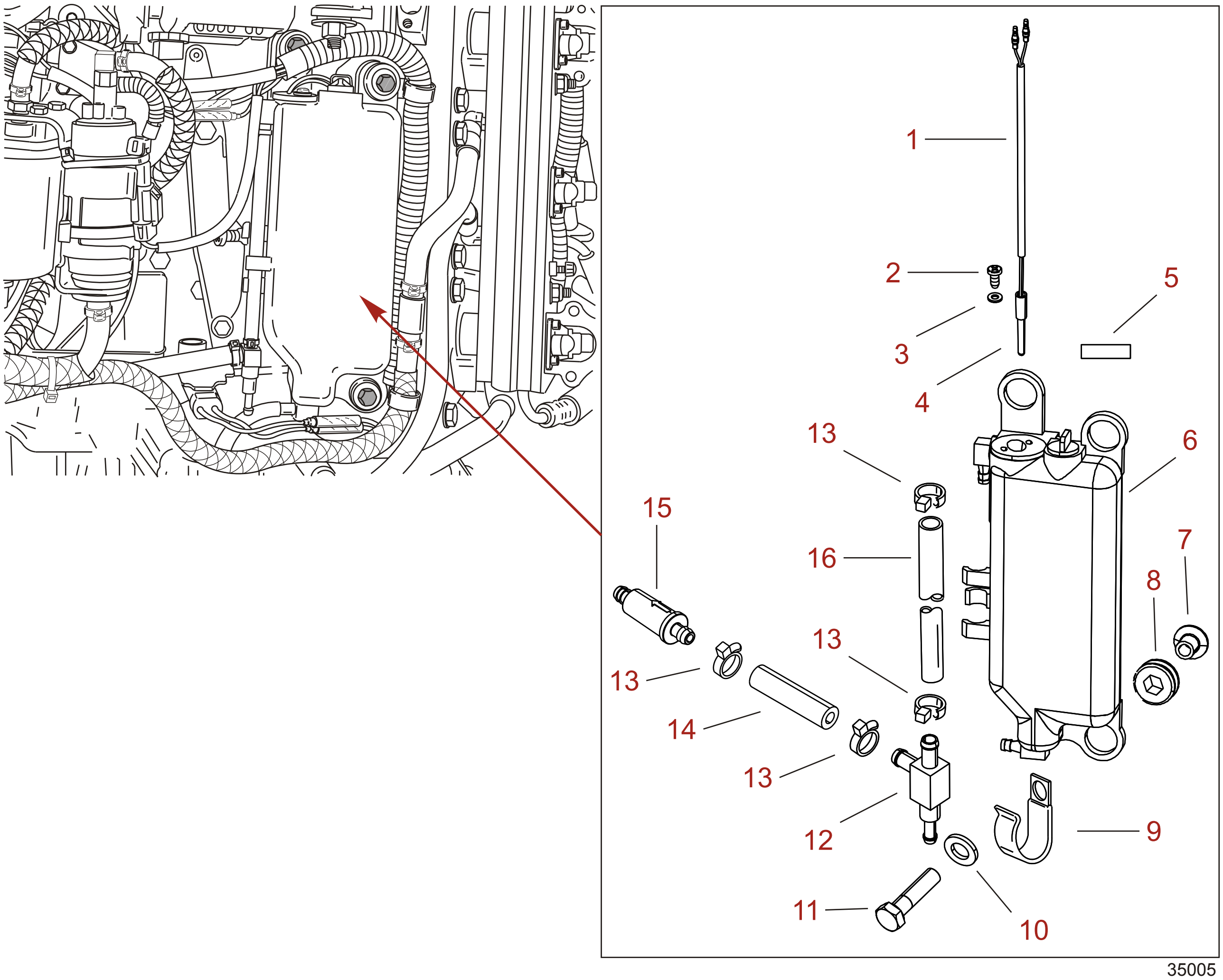
5. Fill the oil reservoirs and prime the oil injection system. Refer to **Priming the Oil Injection Pump**.

Engine Oil Reservoir Removal and Installation

Removal

1. Disconnect the oil hoses. Plug the hoses to prevent the oil from draining.
2. Disconnect the blue with black stripe oil tank low oil switch bullet connectors.

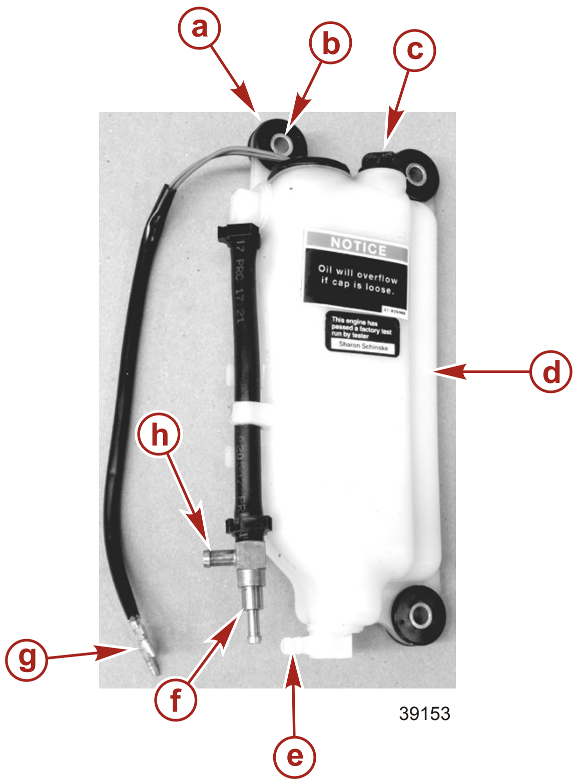
3. Remove the three screws securing the oil reservoir to the powerhead and remove the tank.



1 - Low oil switch harness
2 - Screw (0.164-18 x 0.375)
3 - Washer (0.203 x 0.562 x 0.060)
4 - Low oil switch
5 - Reservoir decal
6 - Oil reservoir
7 - Bushing (3)
8 - Grommet (3)
9 - Clamp
10 - Washer (3)
11 - Screw (0.312-18 x 1.250)
12 - Fitting
13 - Cable tie, 20.3 cm (8 in.)
14 - Hose, 5 cm (2 in.)
15 - Oil filter
16 - Hose, 15.3 cm (6 in.)

Installation

1. Install the rubber grommets and bushings onto the oil reservoir.



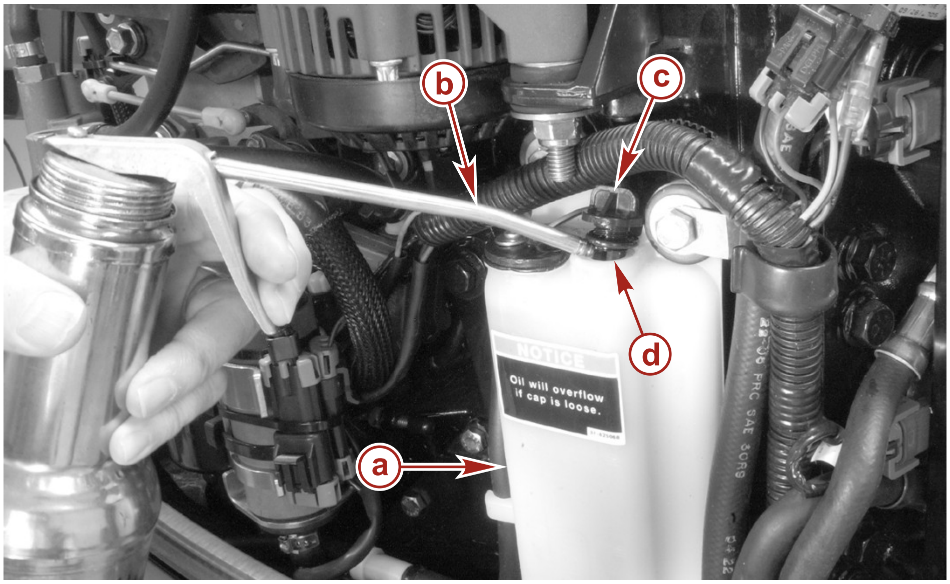
a - Grommet (3)
b - Bushing (3)
c - Vent cap
d - Oil reservoir
e - Reservoir oil outlet fitting to oil pump
f - Oil reservoir low oil vent
g - Low oil switch bullet connectors
h - Oil reservoir oil inlet fitting

2. Install the oil reservoir onto the cylinder block and secure with two 0.312-18 x 1.250 inch screws and washers. Tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Screws (0.312-18 x 1.250 in.) (2)	19.2	170	

3. Install the oil hose and secure the oil hose with a cable tie.
4. Connect the oil tank low oil switch bullet connectors to the engine harness.

IMPORTANT: If the oil reservoir contains no oil prior to installation, it is recommended that the oil vent cap not be removed to fill the oil reservoir. Removal of the vent cap may damage the threads in the oil reservoir. Damage to the threads may result in future oil leakage. Loosen the vent cap enough to allow access to the slot between the vent cap retaining fingers. Using a squirt oil can filled with the recommended oil, inject oil into the oil reservoir through the slot between the vent cap retaining finger until the reservoir contains approximately 118 ml (4 oz) of oil. Refer to Purging Air from the Engine Oil Reservoir and Remote Oil Hose, following, for the proper procedure to completely fill the engine oil reservoir.



a - Oil reservoir
b - Squirt oil can
c - Vent cap
d - Slot

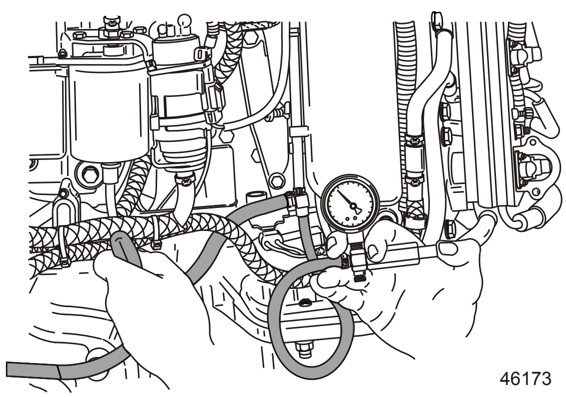
39188

5. Fill the oil reservoirs and prime the oil injection system. Refer to **Priming the Oil Injection Pump**.

Priming the Oil Injection Pump

Purging Air from the System

If a new powerhead is being installed or oil hoses/oil pump has been removed, it is recommended all air be purged from the oil pump/oil lines using gearcase leakage tester kit (FT-8950). Connect the leakage tester to the inlet T-fitting on the onboard oil reservoir. While clamping off the inlet hose, manually pressurize the reservoir to 70 kPa (10 psi). Using the computer diagnostic system, activate the oil pump prime sequence. Maintain the 70 kPa (10 psi) pressure throughout the auto prime sequence. When the auto prime is completed, remove the leakage tester and refill the onboard oil reservoir.



46173

Leakage Tester Kit	FT8950

IMPORTANT: Fill the engine fuel system with fuel before priming the oil injection pump to prevent damage to the fuel pump during the priming process.

- Priming the oil injection system does three things:
  a. Fills the oil pump, oil supply hose feeding pump, and oil hoses going to the crankcase and air compressor
  b. Activates break-in oil ratio
  c. Initiates a new 120 minute engine break-in cycle

There are two methods for priming the oil injection pump. Each method is unique to the condition that requires the priming of the oil injection system.

Conditions Requiring Priming the Oil Pump	
Condition	Priming Procedure
New engine	Use Method 1
Rebuilt powerhead	Use Method 1
New powerhead	Use Method 1
Oil system ran out of oil	Use Method 2
Oil drained from oil supply hose feeding pump	Use Method 2
Oil pump removed	Use Method 2
Oil injection hoses drained	Use Method 2

Method 1 - Computer Diagnostic System Break-in Clock Reset

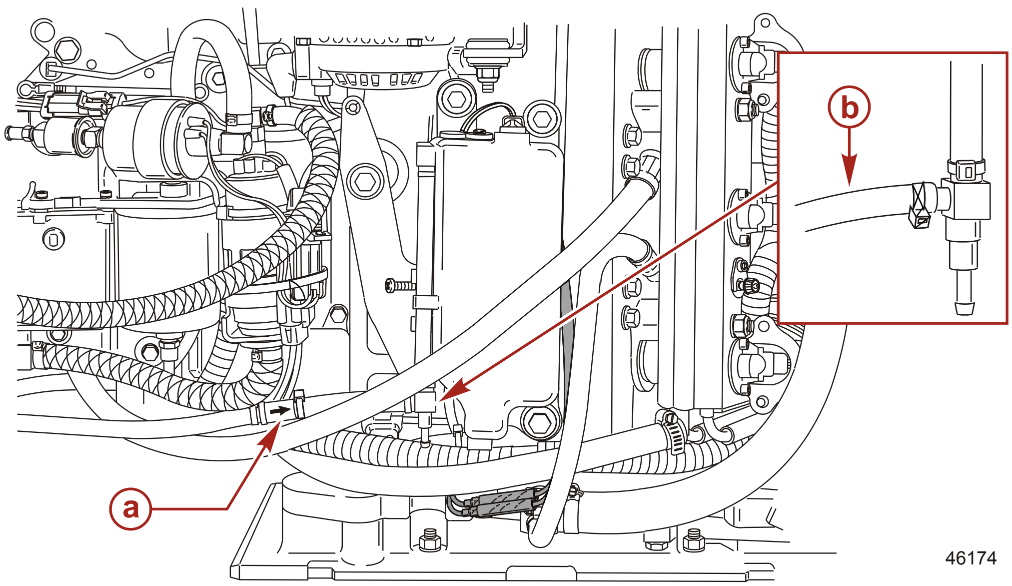
This method should be used for a new engine, a new powerhead, or a rebuilt powerhead. This method ensures the oil injection system does not have air pockets trapped in the pump or oil hoses, and resets the break-in clock. Follow the procedures in the computer diagnostic system for resetting the break-in clock.

Method 2 - Computer Diagnostic System Oil Pump Prime

This method should be used when the break-in clock does not need to be reset. Use this method if the oil injection system ran out of oil, the hose supplying the oil pump was leaking or removed, the oil pump was replaced, or if any of the oil supply hoses were leaking or removed. This method can also be used to test the output volume of the oil injection pump. Follow the procedures in the computer diagnostic system for priming the oil pump.

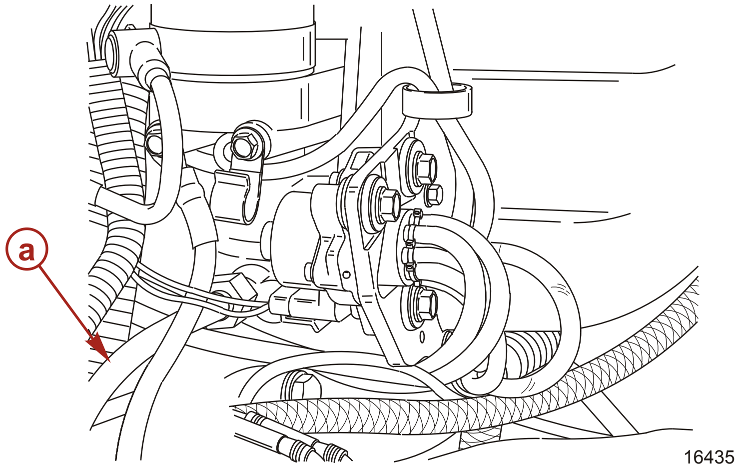
Remote Oil Tank Hose Connections

1. Verify the oil hose with the blue stripe coming from the remote oil tank has an oil filter installed. This filter is directional and is marked with an arrow. The arrow must point towards the engine-mounted oil reservoir.
2. Install the oil hose with the blue stripe and filter onto the T-fitting. Secure the oil hose with a cable tie.



a - Oil filter
b - Oil hose with blue stripe

3. Connect the remote oil tank pressure hose without the blue stripe to the crankcase fitting. Secure the hose to the fitting with a cable tie.

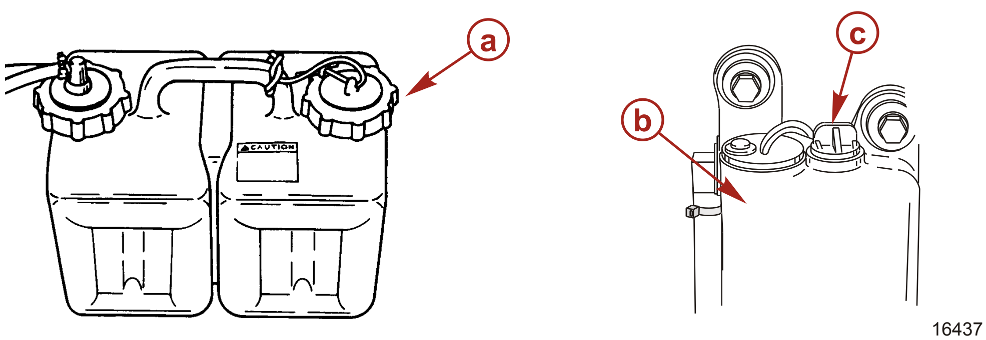


a - Oil hose without the blue stripe

Filling the Oil Tanks

1. Remove the remote oil tank cap and fill the remote oil tank with the recommended oil. Install the cap and tighten securely.
2. The engine-mounted oil reservoir may be filled by loosening the vent cap and using a squirt oil can to inject oil through the vent cap finger retainer slot or, while the engine is idling, allowing crankcase pressure to fill the reservoir with oil from the boat-mounted oil reservoir. The engine-mounted oil reservoir must contain at least 118 ml (4 oz) of oil prior to starting the engine. The engine-mounted oil reservoir must be monitored while the vent cap is loose and the engine is idling to prevent leakage from overfilling. Tighten the vent cap securely when the reservoir is full.

   IMPORTANT: The engine-mounted oil tank must be completely filled prior to the initial operation. The boat-mounted remote oil tank will not displace the air in the engine-mounted oil reservoir unless the vent cap is loosened.



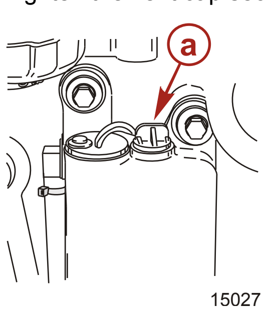
a - Remote oil tank cap
b - Engine-mounted oil tank reservoir
c - Vent cap

Purging Air from the Engine Oil Reservoir and Remote Oil Hose

***NOTE:** Before starting the engine, verify the oil pump has been primed.*

IMPORTANT: It is recommended that the engine-mounted oil reservoir vent cap not be removed to fill the oil reservoir. Removal of the vent cap may damage the threads in the reservoir. Damage to the threads may result in future oil leakage.

1. Loosen the vent cap on the engine-mounted reservoir.
2. Start and run the engine until all the air has vented out of the reservoir and oil starts to flow out of the reservoir.
3. Tighten the vent cap securely.



a - Vent cap

Warning Horn Signals

When the key switch is turned to the "ON" position, the horn will be audible for a moment as a test to show the horn is working.

The warning horn will emit either a continuous beep or intermittent short beeps. This will alert the operator and help identify the following listed situations. For visual display of the specific engine functions and additional engine data, refer to the helm-mounted SmartCraft product for more information.

Warning Horn		
Function	**Sound**	**Description**
Start up	One beep	Normal system test.
Low oil reserve	Four beeps every two minutes	Oil level is low in the engine-mounted oil reservoir. Refill the engine-mounted oil reservoir and the remote oil tank.
Water in fuel	Four beeps every two minutes	Water in the water separating fuel filter reaches the full level. Water can be removed from the filter.
Cooling system problem	Continuous	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. The Guardian System must be reset before engine will operate at higher speeds. Moving throttle lever back to idle resets the system.
Oil level is critically low	Continuous	Engine Guardian System is activated. Power will be limited. The oil level is critically low in the engine-mounted oil reservoir. Refill the engine-mounted oil reservoir and the remote oil tank.
Oil pump failure	Continuous	Engine Guardian System is activated. Power will be limited. The warning horn is activated if the oil pump stops functioning electrically. No lubricating oil is supplied to the engine.
Engine overspeed	Continuous	The warning horn is activated any time engine speed exceeds the maximum allowable RPM. The system will limit the engine speed within the allowable range. Engine overspeed indicates a condition that should be corrected.
Sensor out of range	Continuous	Engine Guardian System is activated. Power will be limited.
	Intermittent beep	

Oil System Troubleshooting

Low Oil Warning System is Activated

Component or Problem	Possible Causes	Corrective Action
Low oil level in the engine-mounted oil reservoir, but sufficient level in the vessel-mounted remote tank	Air was not purged from the engine-mounted oil reservoir	Purge air from the engine-mounted oil reservoir by operating the engine with the cap removed.
		Fill the engine-mounted oil reservoir tank with oil.
	Fill cap is leaking air on the vessel-mounted remote oil tank	Inspect the vessel-mounted remote tank cap seals.
		Ensure the cap is installed tightly.
		Replace components as necessary.
	Remote oil hose is blocked, cut, or porous	Inspect hoses for nicks, cuts, or kinks.
		Pressure check each hose for leaks.
		Replace components as necessary.
	Oil outlet filter in the vessel-mounted remote oil tank is restricted	Remove, inspect, and clean the filter. Replace if necessary.
	Oil inlet filter in the oil hose before the engine-mounted oil reservoir is restricted	Replace the oil filter.
	Air leak in the upper portion on the oil pickup tube	Replace the pickup tube.
	Pressure check valve is faulty. (Located on the engine at the end of the black hose, no stripe.)	Replace the check valve.
	Hose connections	Check all hose connections for leaks.
Low oil level in engine-mounted oil reservoir and vessel-mounted remote oil tank	Lack of proper periodic maintenance	Fill both tanks. Purge the air from the engine-mounted oil tank and oil hose.
		Refer to the **Operation Manual** for the maintenance schedule.
Oil level in both tanks is OK	Low oil switch in the engine-mounted oil reservoir is faulty	Perform a resistance test on the low oil switch. Replace components as necessary.
	Low oil switch in the engine-mounted reservoir is disconnected	Check the condition of the connection and correct as necessary.
	Bad ground	Check the sensor connection for proper ground. Correct as necessary.
Oil leaks out of exhaust or #6 cylinder	Pulse hose and oil supply hose are reversed	Correct the hose orientation.
	Vessel-mounted oil tank is mounted higher than the pulse hose fitting on the engine, and the oil tank is overfilled	Correct the oil tank installation location. Clean internal engine components.
	A deck fill kit is installed. This may cause overfilling due to improper use.	
Low oil level in engine-mounted oil reservoir when engine is not in operation	Oil reservoir check valve is leaking	Perform engine-mounted oil reservoir check valve test. Check valve should open at 27.57 ± 10.34 kPa (4 ± 1.5 psi).
	Oil reservoir leaking air when cold	Pressurize the oil system with the leakage tester. Check for leaks when the engine is cold.

Notes:

Fuel System

Section 3D - Emissions

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D

Exhaust Emission Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasoline contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx).

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO_2). CO_2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen – NOx

NOx is a slightly different by-product of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). This happens in the engine's combustion chambers when temperatures are too high. NOx itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. But, enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NOx - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

Emissions Information

Models Affected

Models Covered	Serial Number or Year
Mercury/Mariner/Force/Sport Jet 2.5–250 HP	1998 and Newer

Manufacturer's Responsibility

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility

When performing service on all 1998 and newer outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturer's prescribed changes, such as that for altitude adjustments. Also included would be factory authorized:

- Installation of performance style gear housings by Mercury Marine.
- Service replacement parts modified, changed, or superceded by Mercury Marine.

Owner Responsibility

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations

All new 1998 and newer outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the following locations:

VIA U.S. POSTAL SERVICE:
Office of Mobile Sources Engine Programs and Compliance Division Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460,

VIA EXPRESS or COURIER MAIL:
Office of Mobile Sources Engine Programs and Compliance Division Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001,

EPA INTERNET WEB SITE: http:/www.epa.gov/omswww

Service Replacement EPA Decal

IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification decal. If this decal is missing or damaged, contact Mercury Marine Warranty Registration for a replacement.

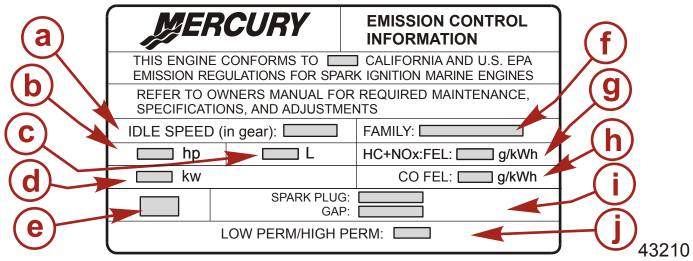
Removal

Remove all remaining pieces of the damaged or illegible decal. Do not install the new decal over a damaged old decal. Use a suitable solvent to remove any traces of the old decal adhesive from the display location.

NOTE: If the original decal surface is in good condition, it is acceptable to clean the surface and apply the new decal over the original.

Emission Certification Label

The new label will be sent with data based on the engine serial number.



- a - Idle speed
- b - Engine horsepower
- c - Piston displacement
- d - Engine power - kilowatts
- e - Date of manufacture
- f - Family number
- g - Regulated emission limit for the engine family
- h - Regulated emission limit for the engine family
- i - Recommended spark plug and gap
- j - Percent of fuel line permeation

Installation

Apply the decal on a clean surface in the original factory location.

Powerhead

Section 4A - Powerhead

Table of Contents

4
A

Powerhead Specifications

Powerhead Specifications	
Number of cylinders	6
Displacement	2.5 liter (153 in³)
Stroke	67.3 mm (2.65 in.)
Standard cylinder bore diameter	88.925 mm (3.501 in.)
Cylinder bore maximum taper (service)	0.076 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.076 mm (0.003 in.)
Oversize cylinder bore diameter - 0.038 mm (0.015 in.)	88.963 mm (3.516 in.)
Cylinder liner type	Cast iron
Compression	620–758 kPa (90–110 psi)[1]
Crankshaft	
Maximum runout	0.152 mm (0.006 in.)
Piston type	Aluminum
Piston skirt standard diameter	88.6968–88.7222 mm (3.492–3.493 in.)
Piston skirt oversize diameter - 0.038 mm (0.015 in.)	88.0778–89.1032 mm (3.507–3.508 in.)
Reed stand open (maximum)	0.51 mm (0.020 in.)
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
At 5500 RPM (boat on plane)	69–103 kPa (10–15 psi)

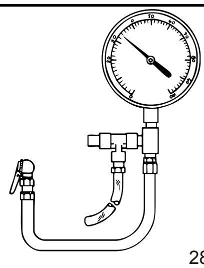
Lubricants, Sealants, Adhesives

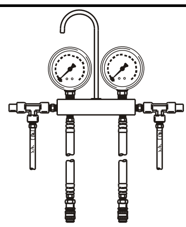
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Divider plate screw threads	92-809819
		Lower end cap oil seals	
12	Loctite Master Gasket Kit	Crankcase cover and cylinder block mating surface	92-12564 2
		Crankcase cover and cylinder block mating surface	
14	2-cycle Premium Outboard Oil	Upper end cap bearing and end cap O-ring surface	92-858021K01
		Cylinder head screw threads and face	
		Connecting rod screws, lower ball bearing, piston rings	
		Cylinder bores after honing	
		Main bearings	
		Center main crankshaft roller bearings and races	
		O-ring seal surface of end cap	
		Roller bearing	
		Crankshaft sealing rings	
		Crankshaft sealing rings and lower crankshaft end oil seal	
		Piston and cylinder wall	
		Cylinder bores and pistons	
		Threads and face of connecting rod screws	
		Center main screw and perimeter screw threads and face	
		O-rings on the fuel rail air compressor hose fitting	
33	Loctite 680 Retaining Compound	Cylinder block stud threads	92-809833
34	Special Lubricant 101	Driveshaft splines	92-802865Q02

1. When performing cylinder compression test, place lanyard switch in the "OFF" position to prevent operation of direct injectors or remove fuse controlling fuel and direct injectors.

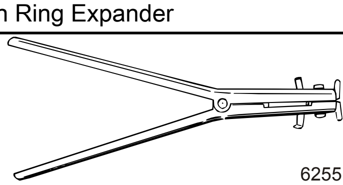
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Upper and lower end cap seal lips and O-rings	92-802859A 1
		Thrust washers, piston pin needle bearings, connecting rod caged bearings, center main bearings, and lower crankshaft seal lips	
		Oil seal lips	
		Oil seal and O-ring surfaces as shown	
		Needle bearings	
		Bearing surfaces of connecting rod and rod cap	
117	Loctite 7649 Primer N	Crankcase cover and cylinder block mating surface	92-809824
		Divider plate screw threads	

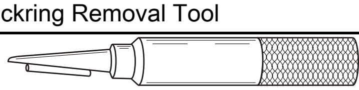
Special Tools

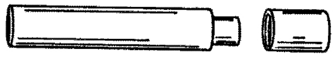
Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

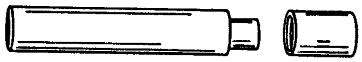
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously

Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS).

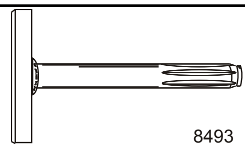
Piston Ring Expander	91-24697
 6255	Expands piston rings for removal and installation

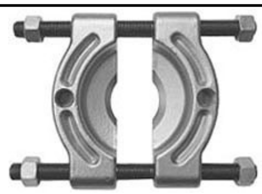
Lockring Removal Tool	91-52952T 1
 8500	Removes the lockrings securing the piston wrist pin

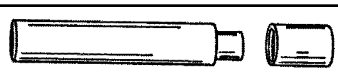
Piston Pin Tool	91-76159A1
 20637	Aids in the removal and installation of the piston pins

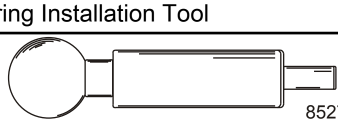
Piston Pin Tool	91- 92973A 1
 11564	Aids in the removal and installation of the piston pins.

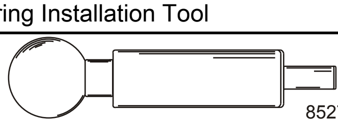
Torch Lamp	91- 63209
 8776	Heats surfaces to aid in the removal and installation of interference fit engine components

Powerhead Stand	91- 30591T 1
 8493	Crankshaft/Powerhead vise stand (8 spline)

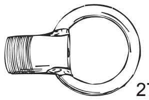
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft

Piston Pin Tool	91- 74607A 3
 20637	Aids in the removal and installation of the piston wrist pin

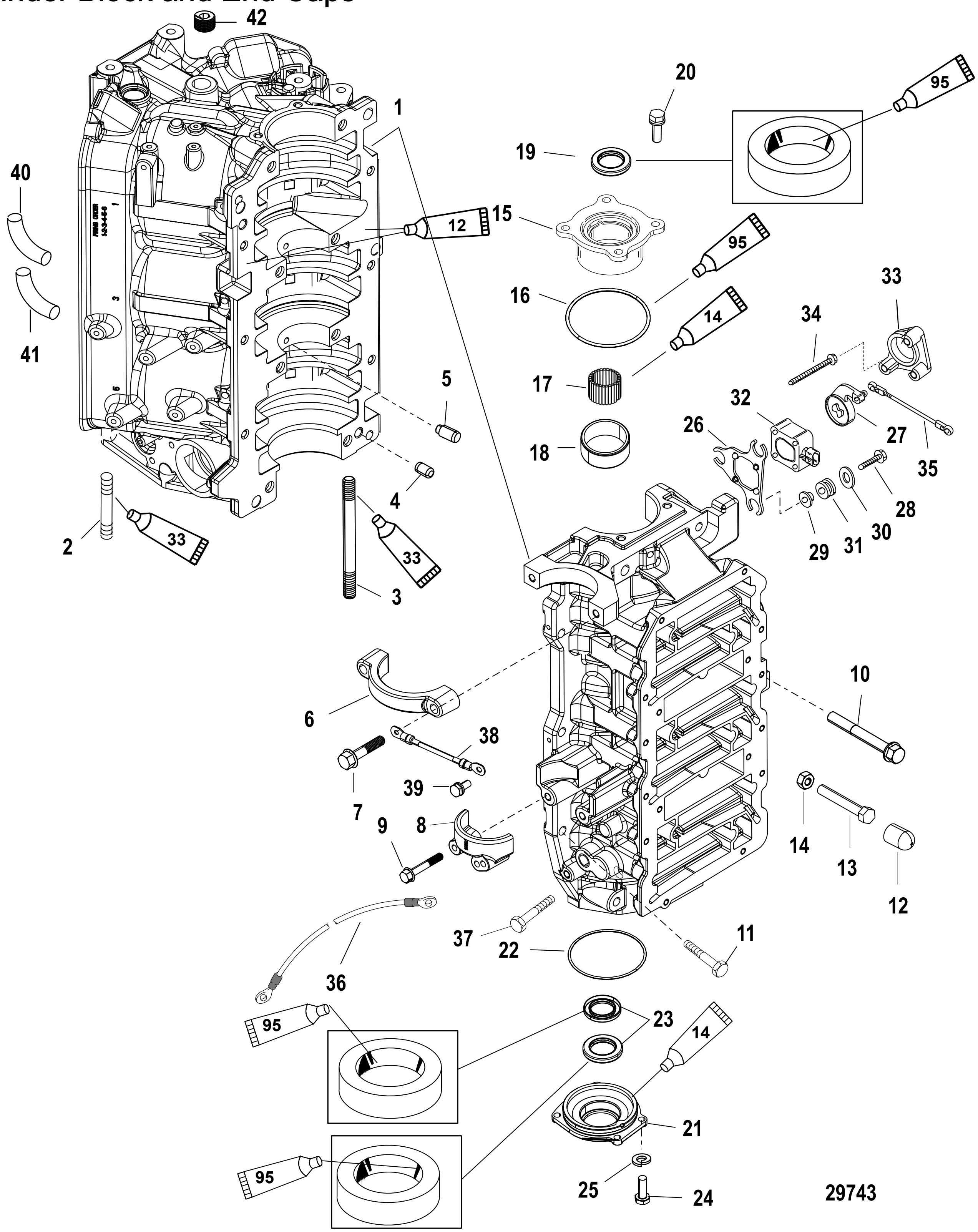
Lockring Installation Tool	91-77109A3
 8527	Installs the lockrings to secure the piston wrist pin in the piston

Lockring Installation Tool	91-93004A 2
 8527	Installs the lockrings to secure the piston wrist pin in the piston

Piston Ring Compressor	91-818773T
 4739	Compresses piston rings into piston ring grooves to ease piston rod assembly into cylinder block

Lifting Eye	91- 90455 1
	Threads into the flywheel to remove the powerhead assembly from the driveshaft housing, or to lift entire engine for removal/installation.

Cylinder Block and End Caps



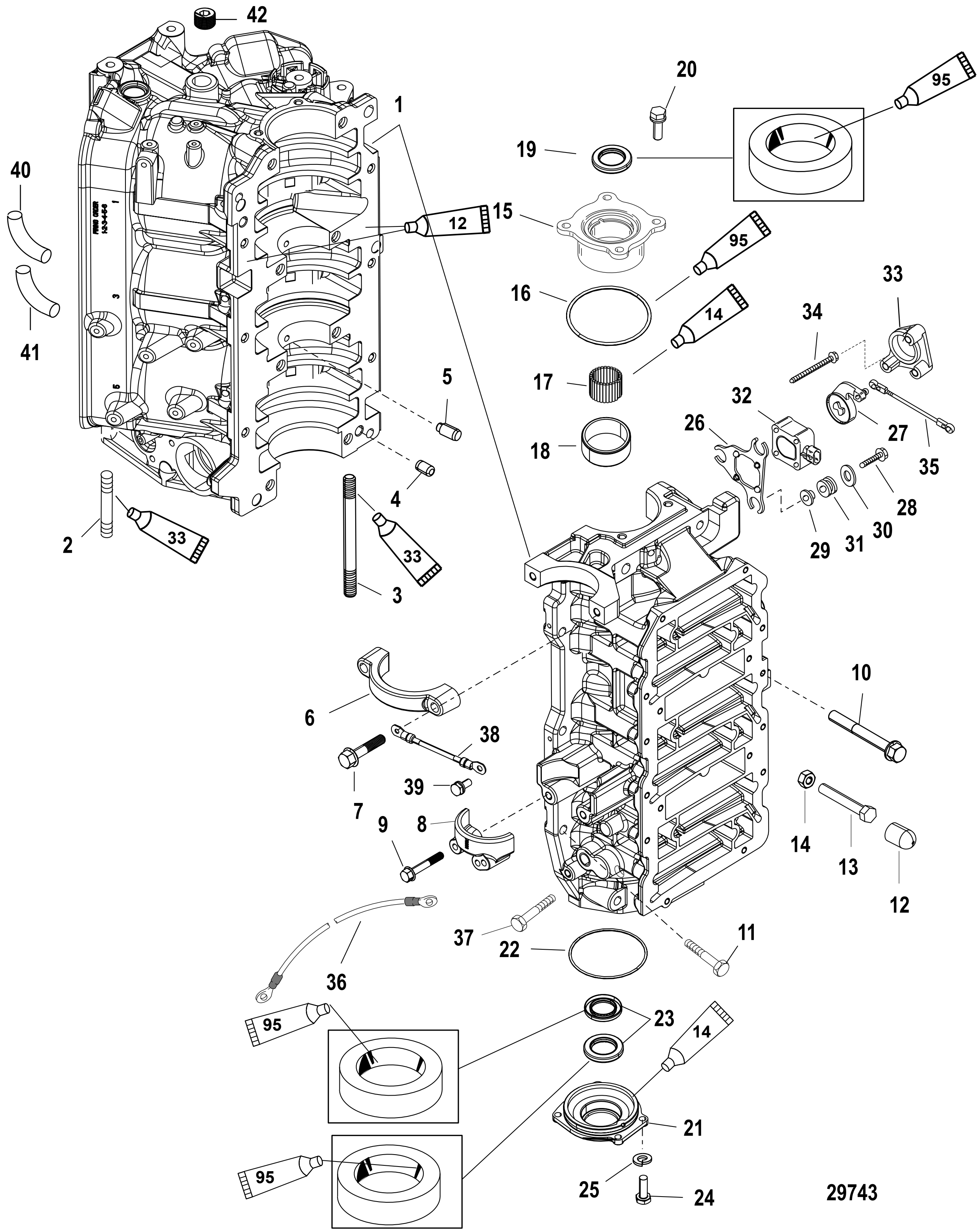
Cylinder Block and End Caps

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft.
1	1	Cylinder block assembly			
2	6	Stud (1.75 in.)			
3	2	Stud (0.375-16/0.375-24 x 5.62 in.)			
	2	Stud (0.375-16/0.375-24 x 6.87 in.)			
4	2	Dowel pin (without hole) (0.375 x 0.62 in.)			
5	2	Bearing race pin			
6	1	Starter motor top cover			
7	2	Screw (0.312-18 x 1.50 in.)	23		17
8	1	Starter motor bottom cover			
9	2	Screw (0.312-18 x 2.0 in.)	23		17
10	8	Screw (0.375-16 x 3.25 in.)	50		37
11	6	Screw (0.375-18 x 1.25 in.)	28		21
12	1	Nylon cap			
13	1	Screw (0.25-20 x 1.75 in.)			
14	1	Nut (0.25-20 in.)			
15	1	End cap assembly			
16	1	O-ring (2.80 x 0.103 in.)			
17	1	Bearing kit			
18	1	Bearing race			
19	1	Seal			
20	4	Screw (0.312-18 x 1.0 in.)	23		17
21	1	End cap assembly			
22	1	O-ring (3.237 x 0.103 in.)			
23	2	Seal			
24	4	Screw (0.25-20 x 0.75 in.)	9	80	
25	4	Lockwasher (0.25 in.)			
26	1	Throttle position indicator bracket			
27	1	Throttle position indicator lever			
28	3	Screw (M6 x 25)	11.5	102	
29	3	Bushing			
30	3	Washer (0.265 x 0.75 x 0.048 in.)			
31	3	Grommet			
32	1	Throttle position indicator			
33	1	Throttle position indicator cover			
34	3	Screw (10-32 x 2.0 in.)	4	35	
35	1	Link assembly			
36	1	Positive battery cable			
	1	Negative battery cable			
37	1	Screw (M8 x 14)	24		18
38	1	Cable assembly			

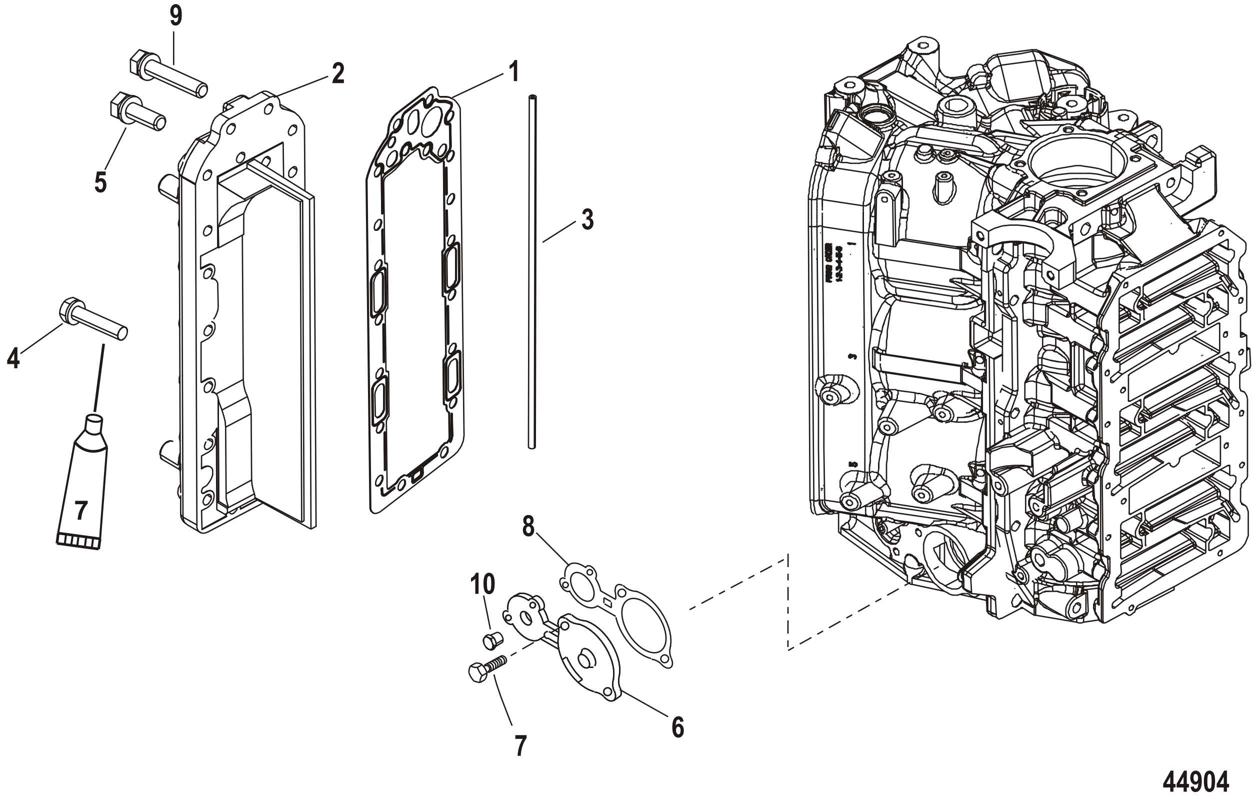
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft.
39	1	Screw and lockwasher (0.25-20 x 0.625 in.)			
40	1	Hose (1-1/4 in.)			
41	1	Hose (1-1/2 in.)			
42	1	Plug (0.50-14 in.)			

Tube Ref No.	Description	Where Used	Part No.
12	Loctite Master Gasket Kit	Crankcase cover and cylinder block mating surface	92-12564 2
14	2-cycle Premium Outboard Oil	Upper end cap bearing and end cap O-ring surface	92-858021K01
33	Loctite 680 Retaining Compound	Cylinder block stud threads	92-809833
95	2-4-C with Teflon	Upper and lower end cap seal lips and O-rings	92-802859A 1

Cylinder Block and End Caps



Exhaust Manifold and Exhaust Plate

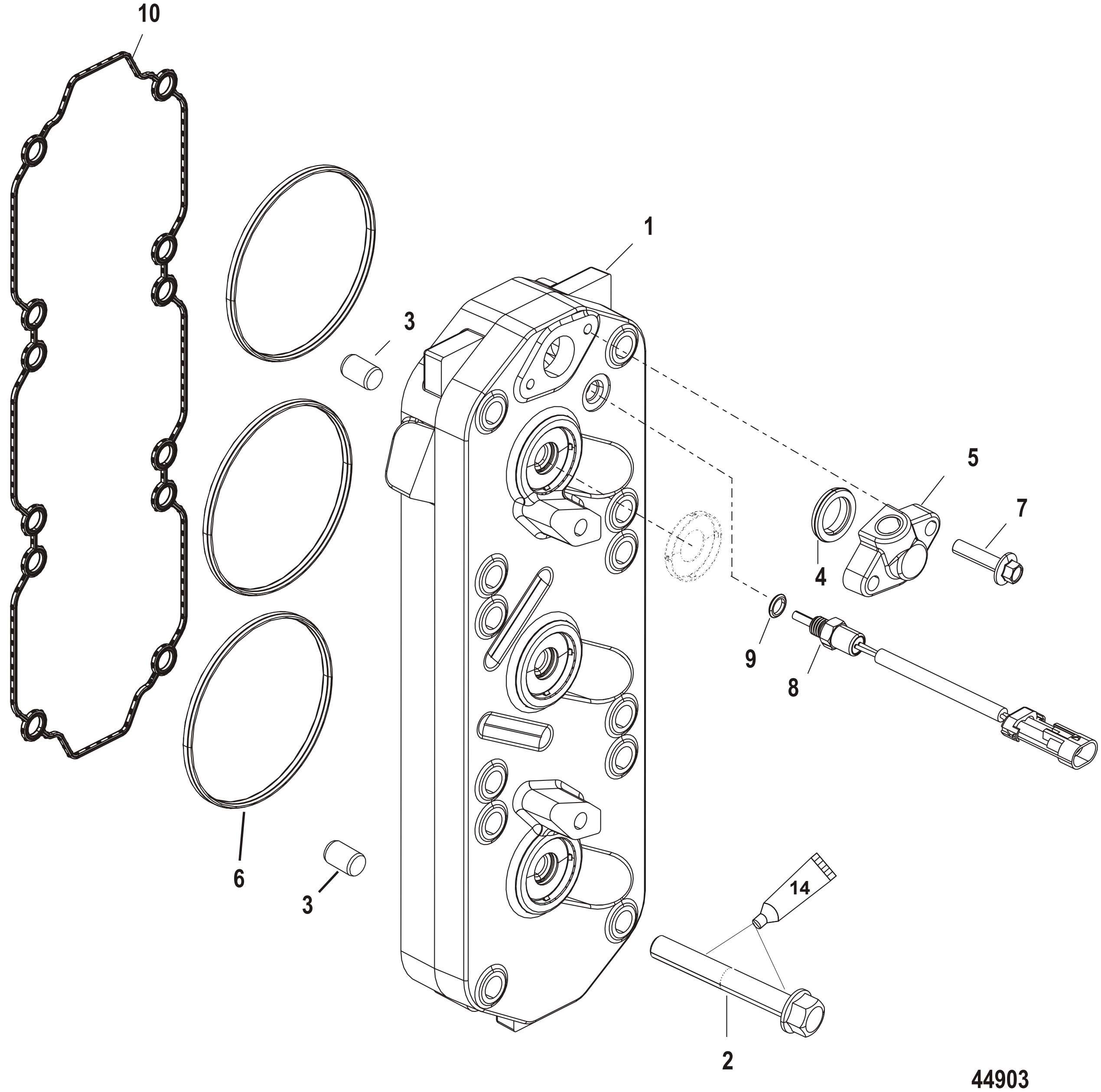


Exhaust Manifold and Exhaust Plate

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gasket			
2	1	Exhaust divider plate assembly			
3	1	Seal (12.5 in.)			
4	16	Screw and washer (0.312-18 x 1.50 in.)	18	160	13
5	2	Screw (0.312-18 x 1.00 in.)	18	160	13
6	1	Relief valve cover			
7	4	Screw (0.312-18 x 1.375 in.)	15	133	
8	1	Gasket			
9	1	Screw (0.312-18 x 1.75 in.)			
10	1	Plug (0.50-14 in.)			

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Divider plate screw threads	92-809819

Cylinder Head

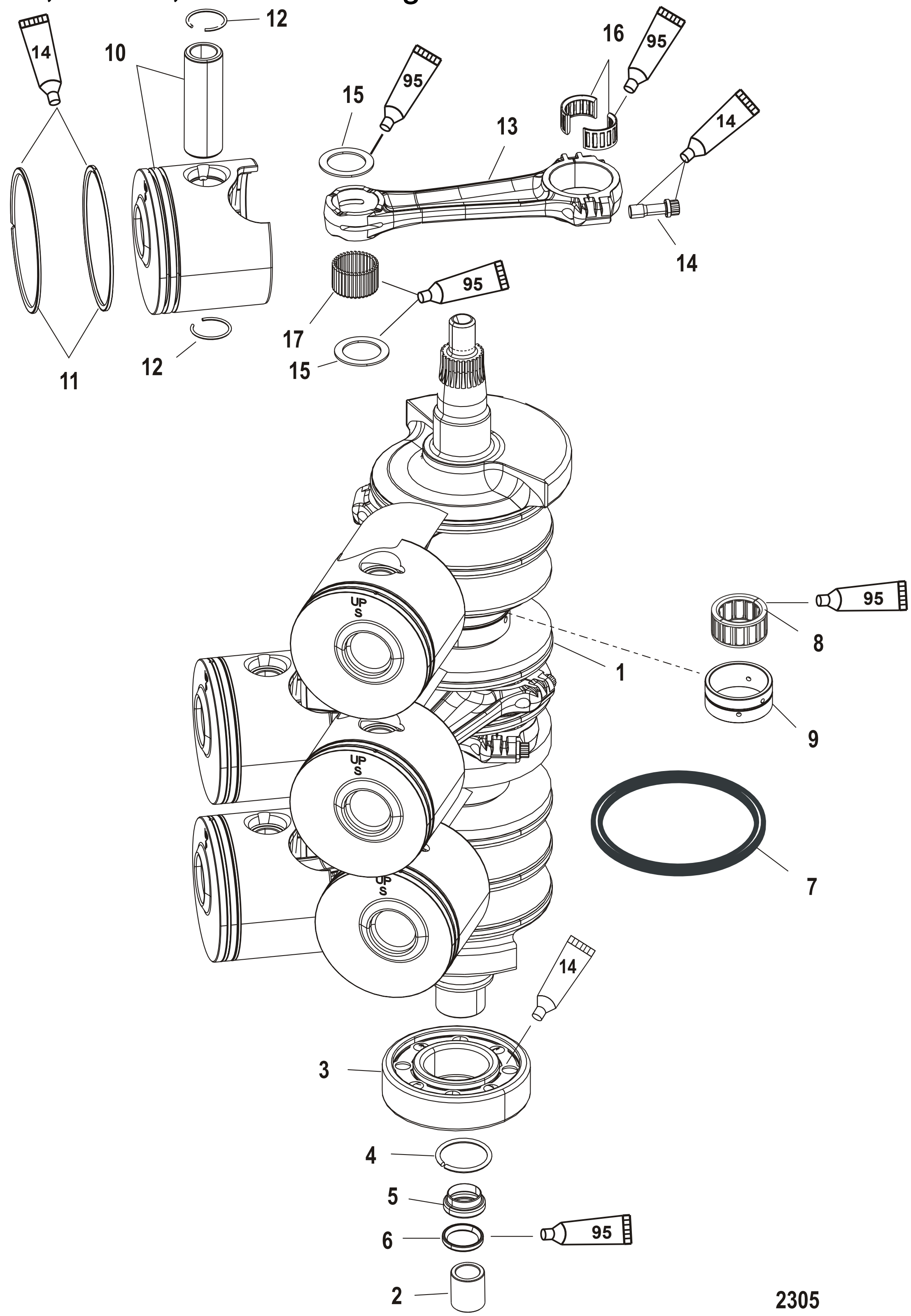


Cylinder Head

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Cylinder head assembly (port)				
	1	Cylinder head assembly (starboard)				
2	24	Screw (0.375-16 x 2.75 in.)	First	40.5		30
			Final	Turn an additional 90°		
3	4	Dowel pin (0.25 x 0.625 in.)				
4	2	Gasket				
5	2	Cover				
6	6	Seal				
7	4	Screw (M6 x 25 mm)		13.5	120	10
8	2	Temperature sensor assembly		17	150	12
9	2	O-ring (1.78 mm x 0.08 mm)				
10	2	Seal				

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Cylinder head screw threads and face	92-858021K01

Crankshaft, Pistons, and Connecting Rods

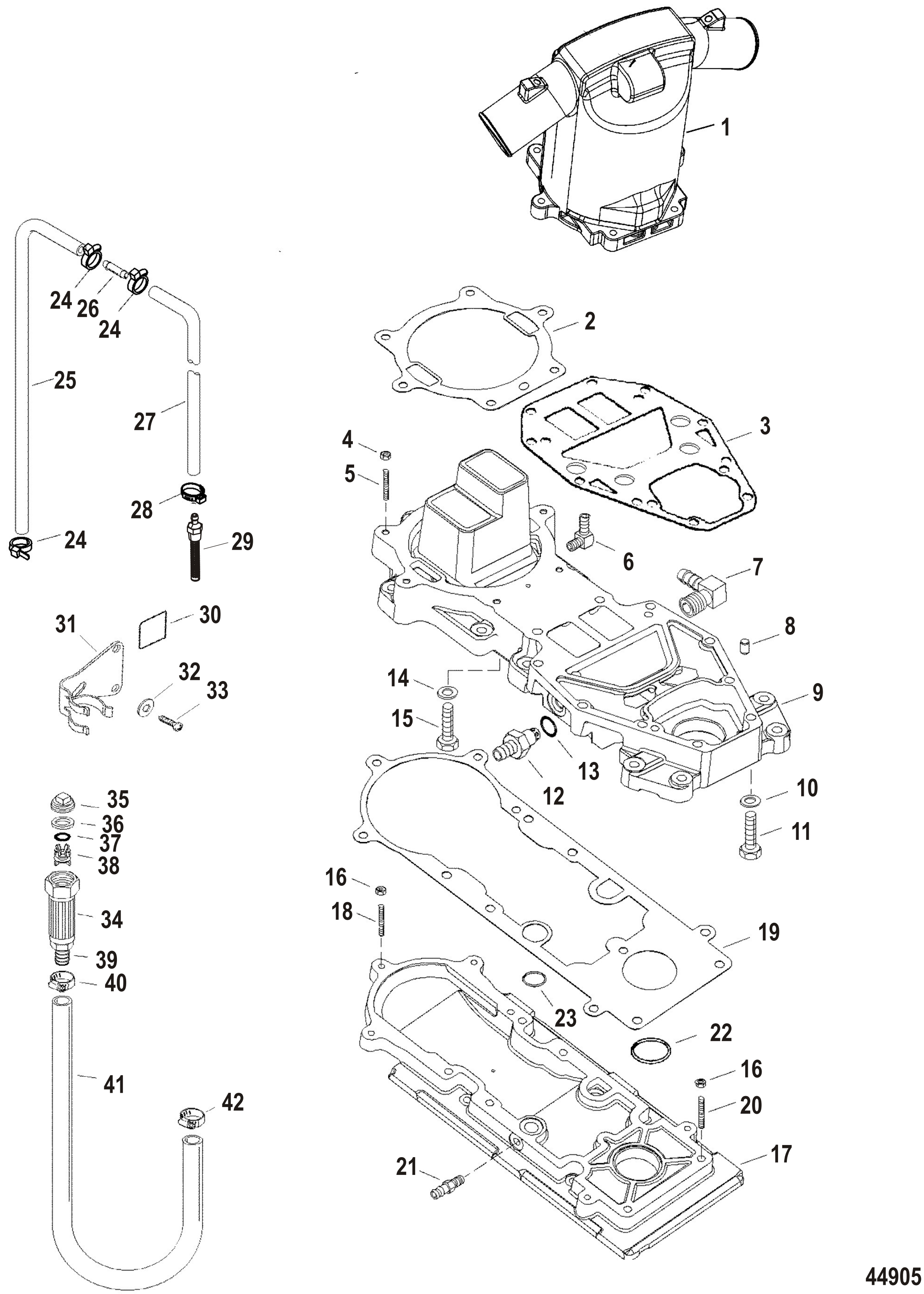


Crankshaft, Pistons, and Connecting Rods

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Crankshaft assembly				
2	1	Wear sleeve				
3	1	Lower ball bearing				
4	1	Ring				
5	1	Carrier assembly				
6	1	Seal				
7	9	Sealing ring				
8	2	Main bearing				
9	2	Bearing race				
10	3	Starboard piston assembly (standard)				
	3	Port piston assembly (standard)				
	AR	Starboard piston assembly (0.015 in. oversize)				
	AR	Port piston assembly (0.015 in. oversize)				
11	1	Ring set (standard)				
	AR	Ring set (0.015 in. oversize)				
12	12	Lockring				
13	6	Connecting rod assembly				
14	12	Screw (0.312-24 x 0.875 in.)	**First**	4.0	35	
			Second	27		20
			Final	Turn screw an additional 90° after the second torque		
15	12	Thrust washer				
16	6	Bearing kit				
17	204	Needle bearing				

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Connecting rod screws, lower ball bearing, piston rings	92-858021K01
95	2-4-C with Teflon	Thrust washers, piston pin needle bearings, connecting rod caged bearings, center main bearings, and lower crankshaft seal lips	92-802859A 1

Expansion Chamber and Adapter Plate Components

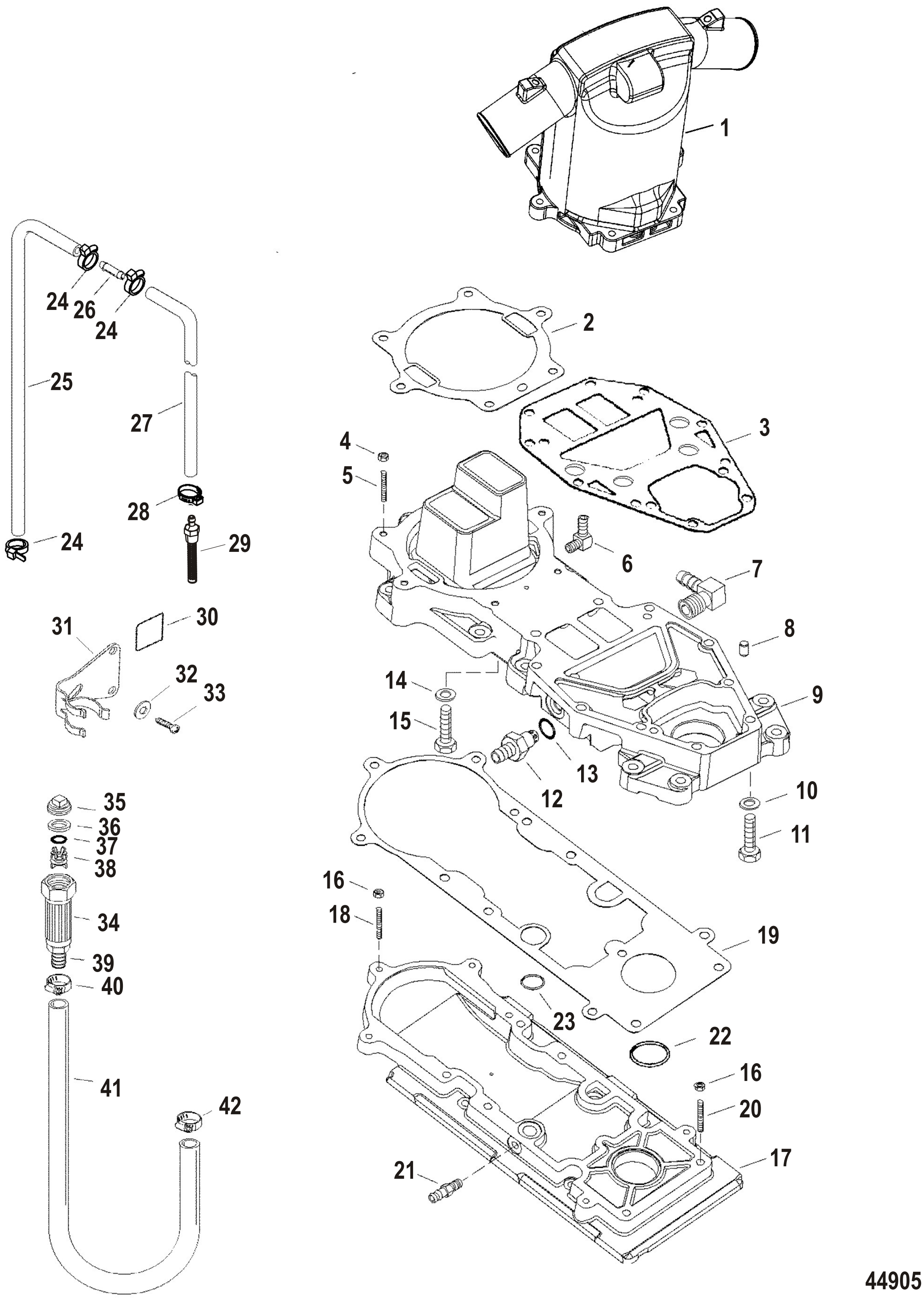


Expansion Chamber and Adapter Plate Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Expansion chamber kit			
2	1	Gasket (expansion chamber to adapter plate)			
3	1	Gasket (block to exhaust expansion chamber)			
4	6	Nut (M8)	27		20
5	6	Stud (M8 x 50)			
6	1	90° elbow fitting			
7	1	90° elbow fitting			
8	2	Dowel pin without hole			
9	1	Engine adapter			
10	8	Washer			
11	8	Screw (3/8-16 x 2-1/4)	47		35
12	1	Strainer fitting			
13	1	O-ring			
14	2	Washer			
15	2	Screw (3/8-16 x 3-3/4)	47		35
16	11	Nut (M10)	47		35
17	1	Cover assembly			
18	5	Stud (M10 x 53)	40		30
19	1	Gasket (engine adapter)			
20	6	Stud (M10 x 101)	40		30
21	1	Barbed connector			
22	1	O-ring			
23	1	O-ring			
24	3	Cable tie			
25	1	Siphon hose (106.7 cm [42 in.])			
26	1	Siphon break			
27	1	Siphon hose (45.7 cm [18 in.])			
28	1	Cable tie			
29	1	Siphon hose strainer			
30	1	Flushing adapter decal			
31	1	Flushing assembler holder clip			
32	3	Washer			
33	3	Screw (#12-24 x 0.620)			
34	1	Flushing adapter assembly			
35	1	Top plug			
36	1	Washer			
37	1	O-ring			
38	1	Check valve			
39	1	Connector			
40	1	Worm gear clamp			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	1	Hose			
42	1	Worm gear clamp			

Expansion Chamber and Adapter Plate Components

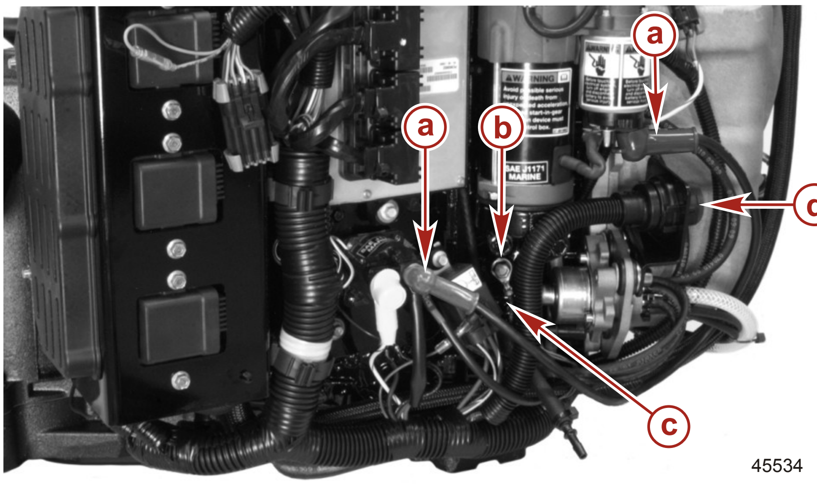


Powerhead Removal from the Pump Unit

⚠ WARNING

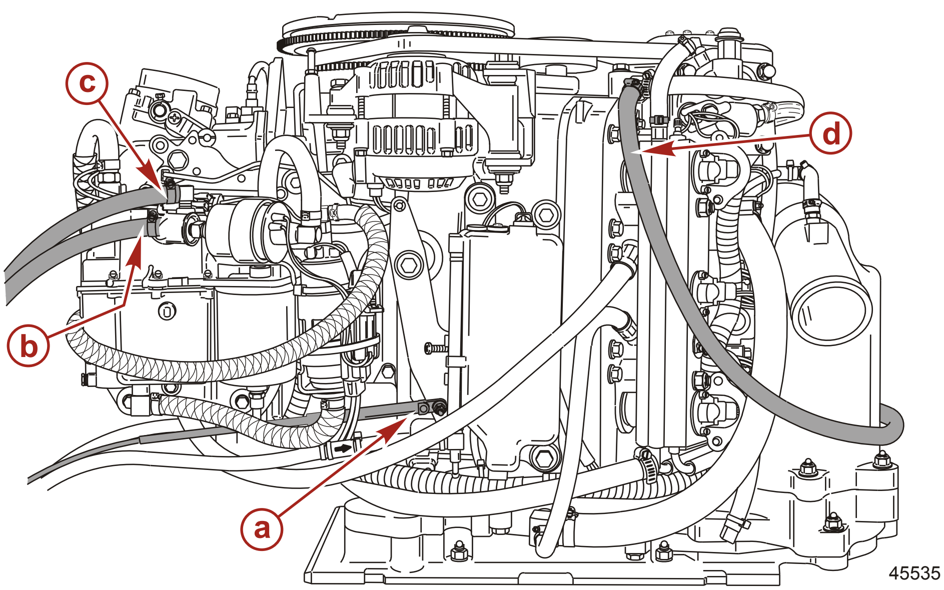
Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing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

1. Disconnect the battery cables from the battery terminals.
2. Remove the positive battery cable from the starter solenoid. Remove the negative battery cable from the lower front starter mounting bolt.
3. Disconnect the remote oil tank hose.
4. Disconnect the remote control harness from the powerhead harness connector.



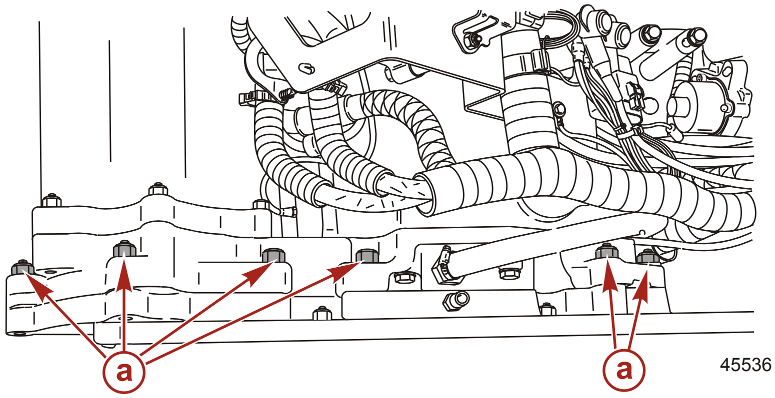
a - Positive battery cable
b - Negative battery cable
c - Remote oil tank hose (hidden)
d - Remote control harness connection

5. Remove the throttle cable.
6. Remove the fuel inlet line.
7. Disconnect the water bypass hose.
8. Disconnect the vapor separator vent hose between the vapor separator and boat hull.



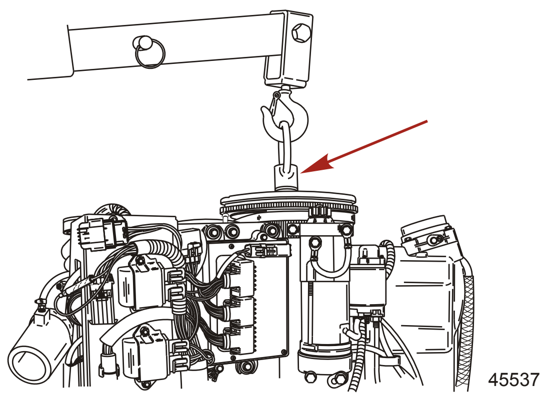
a - Throttle cable
b - Fuel inlet
c - Vent hose
d - Water bypass hose

9. Remove eleven nuts (five nuts on opposite side) securing the powerhead to the housing cover.

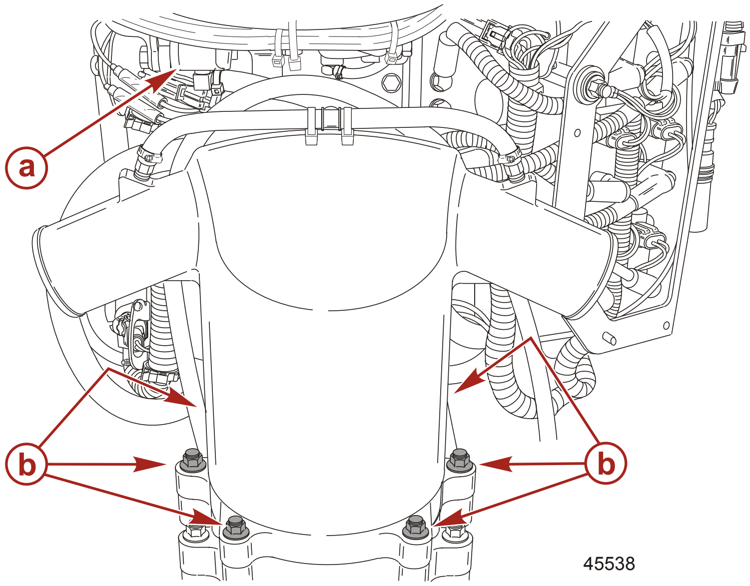


a - M10 nuts (11)

10. Remove the plastic cap from the center of the flywheel and install the lifting eye into the flywheel at least five full turns. Lift the powerhead assembly from the pump unit.



11. Remove the exhaust outlet coolant hose from the air compressor.
12. Remove six nuts securing the expansion chamber and remove the expansion chamber.



a - Coolant hose
b - Nuts (6)

Removing Powerhead Components

Individual Components

NOTE: Engine components can be removed individually or in some cases as an assembly.

1. Refer to **Section 2A - Ignition** to remove the following components:
   - Flywheel cover

- Electronic control module
- Ignition coils

2. Refer to **Section 2B - Charging and Starting System** to remove the following components:
   - Flywheel
   - Alternator
   - Starter motor
   - Starter solenoid
3. Refer to **Section 3A - Fuel Pump** to remove the following components:
   - Fuel lift pump
4. Refer to **Section 3B - Direct Fuel Injection** to remove the following components:
   - Air plenum
   - Oil pump

Vapor Separator Tank Removal

⚠ WARNING

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

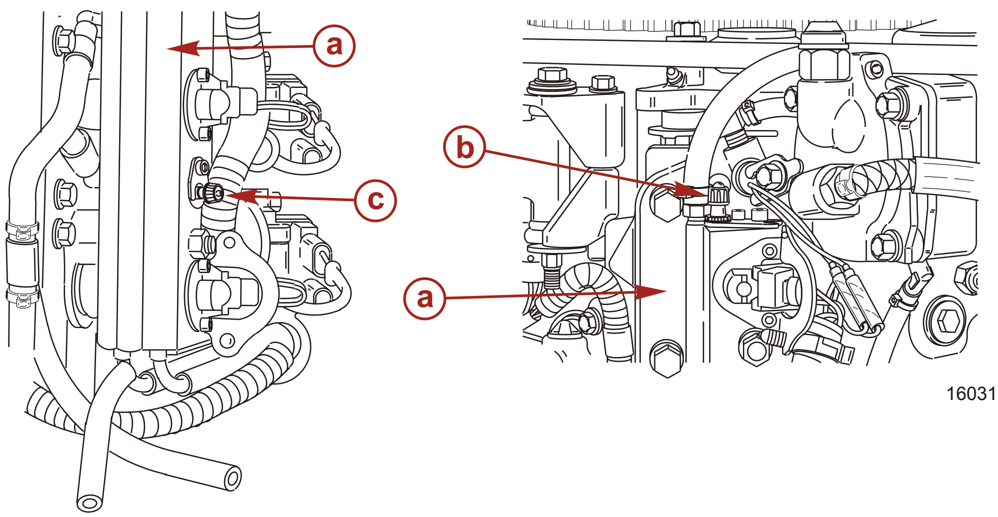
⚠ CAUTION

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 may still remain in the fuel rails and hoses after draining the vapor separator tank (VST). To avoid a possible fire or explosion, follow normal precautionary procedures while working with the fuel system. Use a suitable container when draining fuel from the VST and avoid sparks, smoking, and open flame while in the presence of liquid fuel or fuel vapors.

1. Disconnect both battery cables from the battery.
2. Install the fuel/air pressure gauge kit to the fuel pressure test port and release the fuel pressure into an appropriate container.

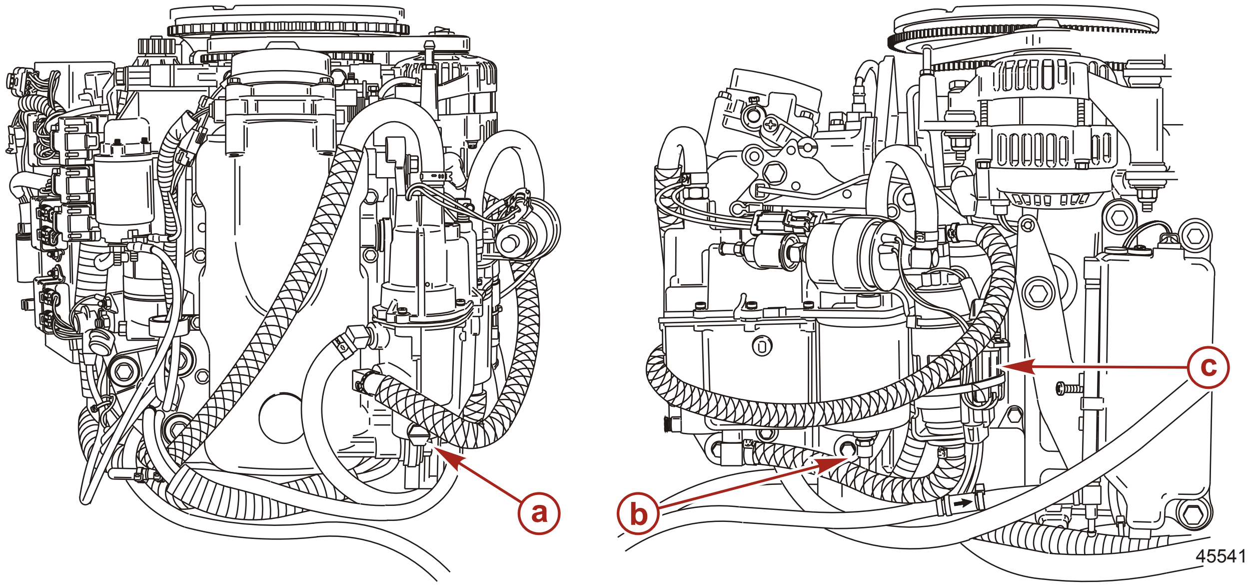


a - Port fuel rail
b - Fuel pressure test port
c - Air pressure test port

Fuel Pressure Gauge Kit	91-881833A03

3. Place a suitable container underneath the vapor separator drain plug and remove the plug.
4. Disconnect the water separator sensor lead.

5. Disconnect the lift pump harness connectors.

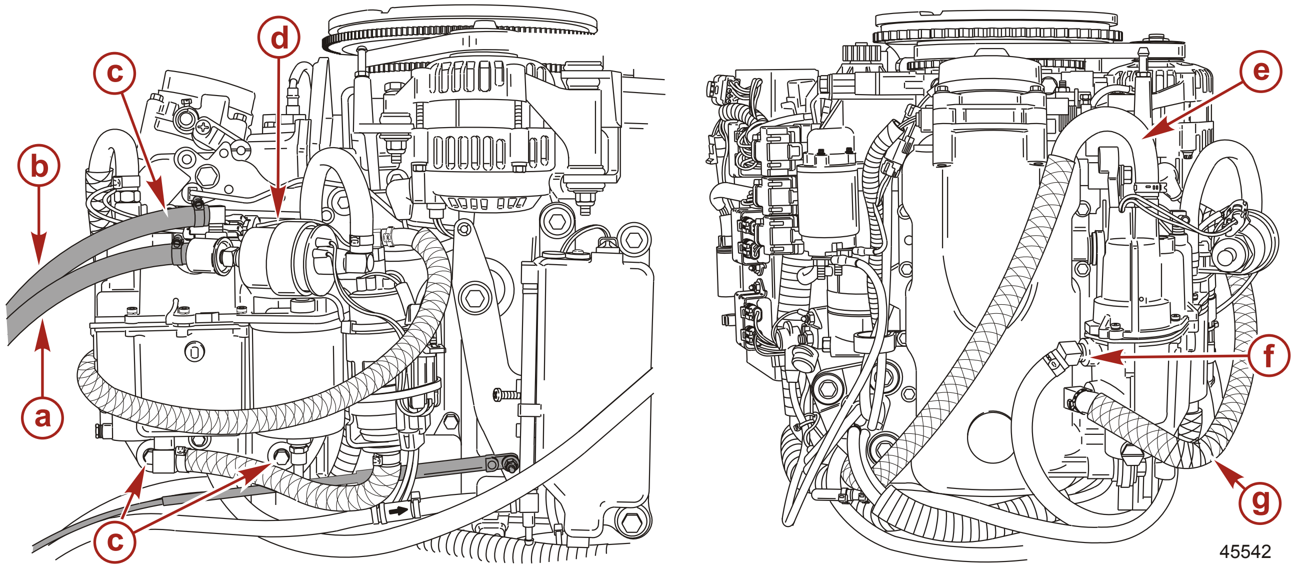


a - Drain plug
b - Sensor lead
c - Lift pump harness connector

NOTE: The upper fuel hose is excess fuel return from the fuel rails; the lower fuel hose is the fuel inlet from the electric circulating pump beside the fuel/water separator.

6. Remove the fuel inlet hose from the fuel lift pump.
7. Remove the vapor separator vent hose.
8. Remove the high-pressure fuel outlet hose and the low-pressure fuel return hose from the fuel rails.
9. Remove the vapor separator ground lead.

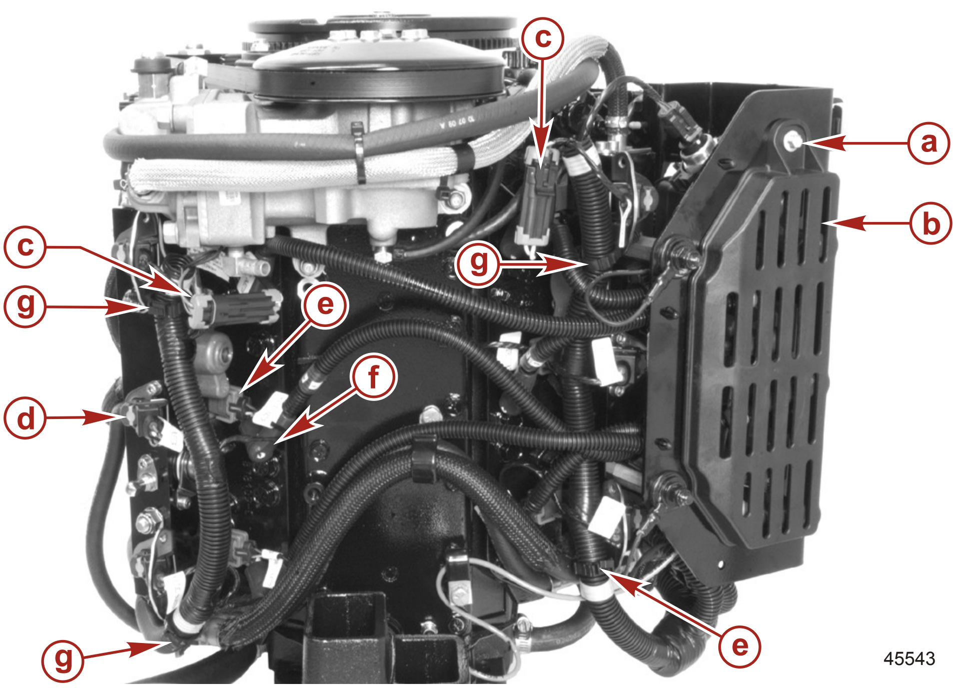
10. Remove three mounting bolts and remove the separator.



- a - Fuel lift pump inlet hose
- b - VST vent hose
- c - Mounting bolts (M8 x 35) (3) (hidden)
- d - Ground lead
- e - High-pressure fuel outlet hose
- f - Low-pressure fuel return hose
- g - VST fuel inlet hose

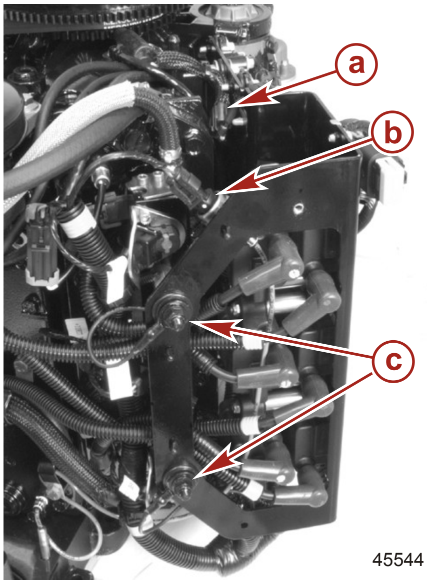
Electrical Plate and Harness Removal

1. Remove the electrical plate cover.
2. Disconnect the temperature sensor connectors.
3. Remove the spark plug boots from the spark plugs.
4. Disconnect the fuel injector connectors.
5. Disconnect the direct injector connectors on the starboard fuel rail.
6. Disconnect the wiring harness retainers.



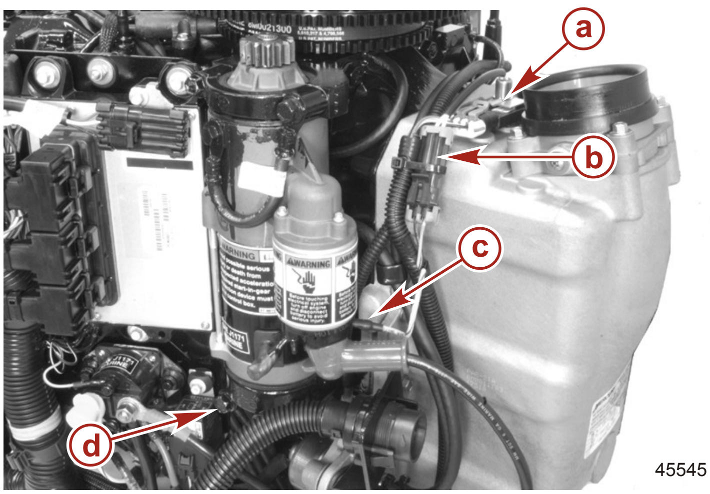
- a - Screw and bushing
- b - Electrical plate cover
- c - Temperature sensor connectors (2)
- d - Direct injector connectors (6)
- e - Fuel injector connectors (6)
- f - Spark plug boots (6)
- g - Wiring harness retainers (4)

7. Remove two nuts securing the aft portion of the electrical plate.
8. Disconnect the water pressure sensor harness and sensor retainer.
9. Disconnect the crankshaft position sensor connector.



a - Crankshaft position sensor connector
b - Water pressure sensor
c - Nut (M8)

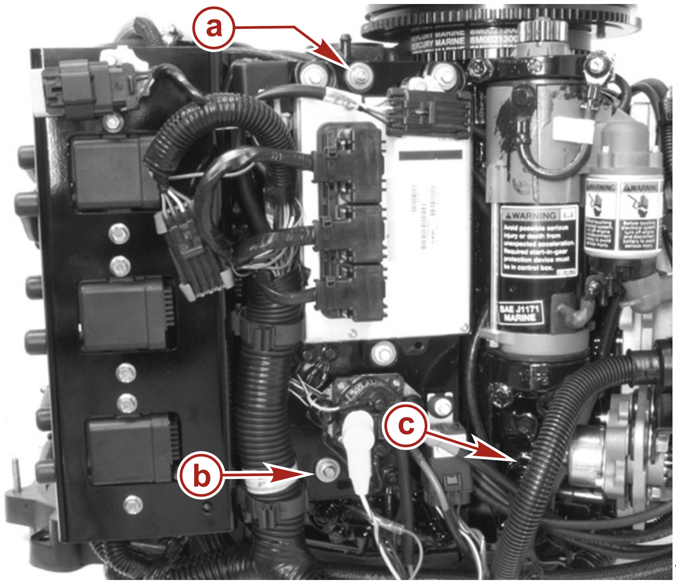
10. Disconnect the air temperature sensor connector.
11. Disconnect the MAP sensor connector.
12. Disconnect the yellow/red lead from the starter solenoid.
13. Disconnect the harness ground lead below the starter motor.



a - MAP sensor connector
b - Air temperature sensor connector
c - Yellow/red wire
d - Harness ground lead

14. Disconnect the oil pump connector.

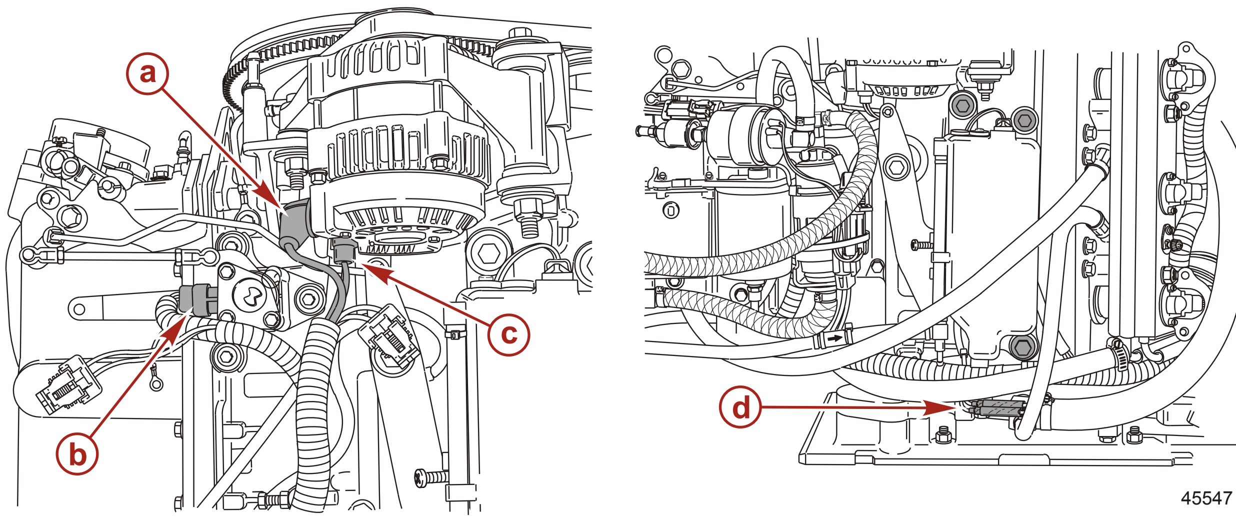
15. Remove the nut and screw securing the electrical plate.



45918

- a - Nut and washer
- b - Screw
- c - Oil pump connector

16. Remove the output lead from the alternator.
17. Disconnect the TPS harness connection.
18. Remove the sense lead from the alternator.
19. Disconnect the low oil sensor bullet connectors.



45547

- a - Alternator output lead
- b - TPS harness connection
- c - Alternator sense lead
- d - Low oil sensor bullet connectors

20. Remove the electrical harness assembly from the engine.

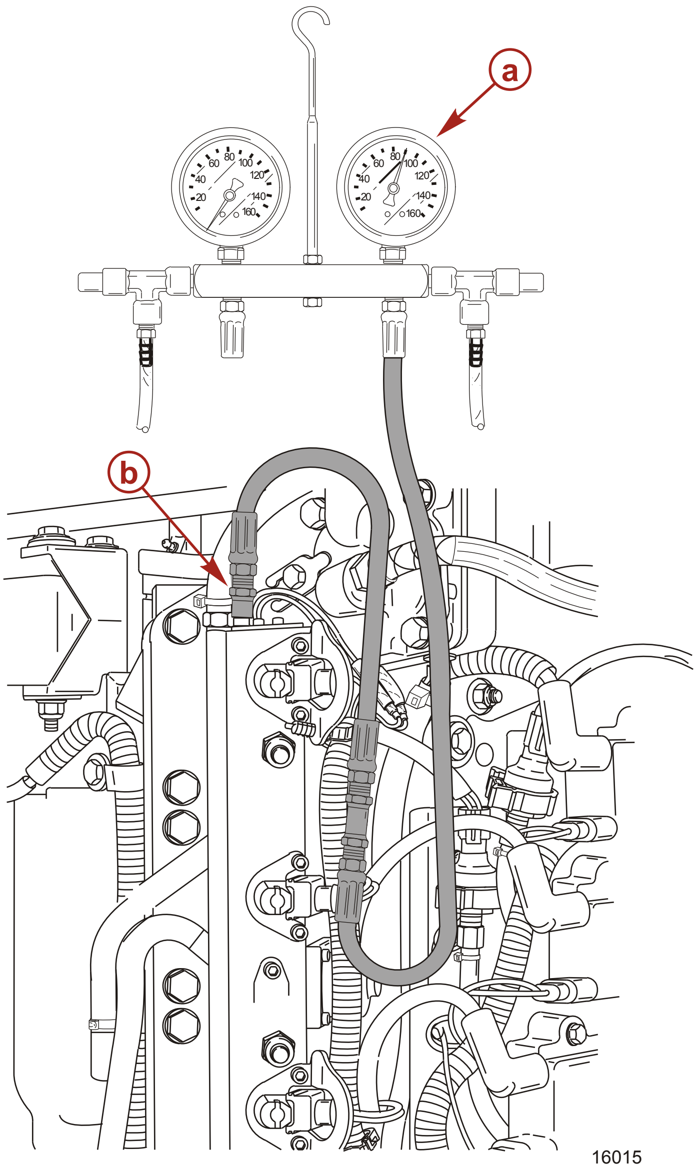
Fuel Rail Removal

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

⚠ 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. Disconnect both battery leads from the battery.
2. Install the fuel/air pressure gauge kit. Relieve the fuel pressure into an appropriate container.

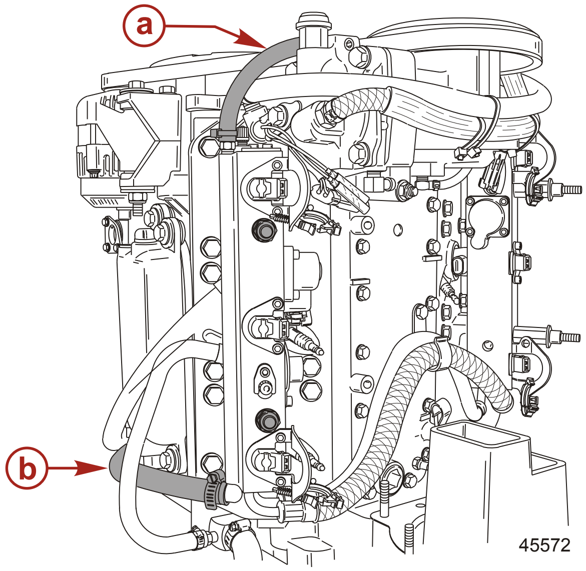


a - Fuel/air pressure gauge kit
b - Fuel pressure test valve

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

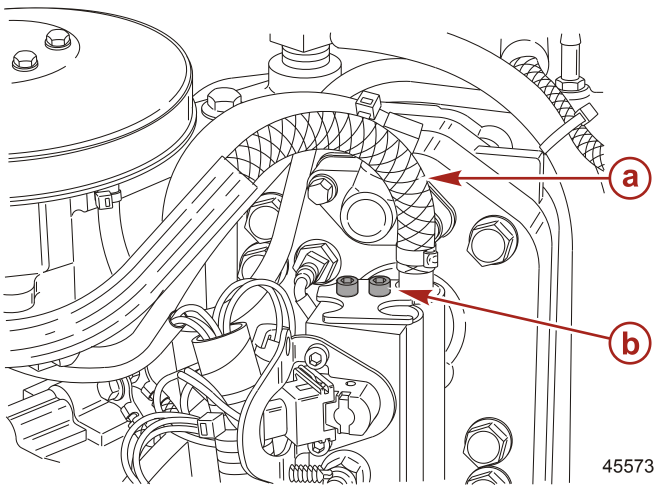
3. Remove the coolant hose between the port fuel rail and air compressor.

4. Remove the incoming coolant hose from the port fuel rail.



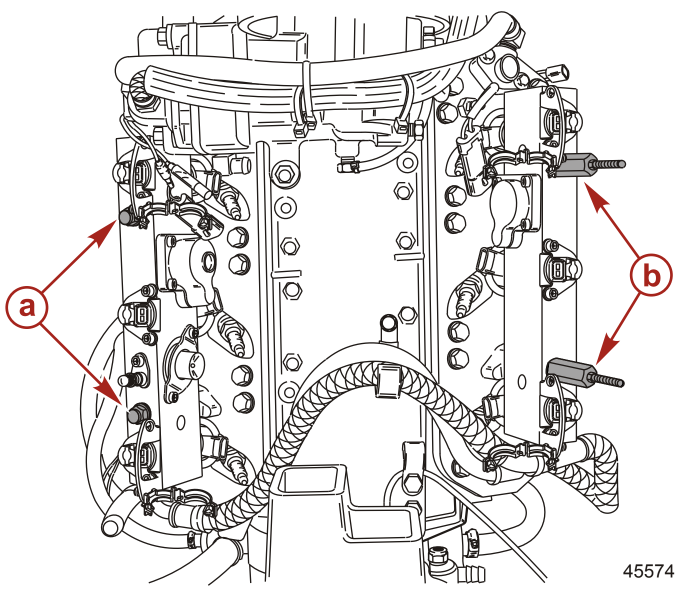
a - Air compressor coolant hose
b - Incoming coolant hose

5. Remove two screws securing the compressor air hose and remove the hose from the starboard fuel rail.



a - Air hose
b - Screw (2)

6. Remove two nuts and coil plate spacers securing the fuel rails.
7. Remove both fuel rails as an assembly.



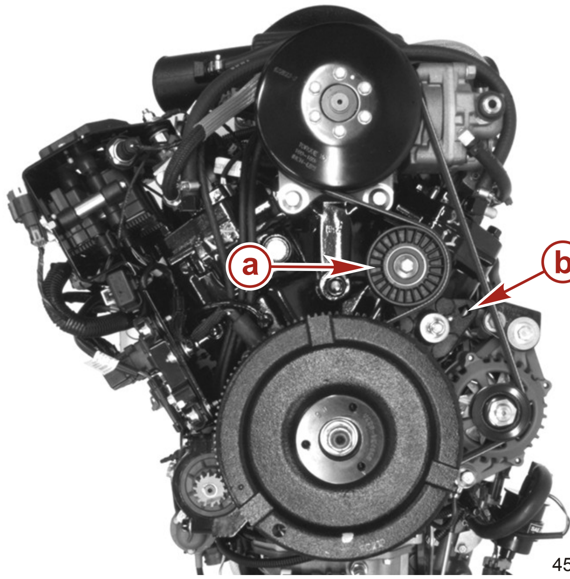
a - Nuts
b - Coil plate spacers

Air Compressor 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.

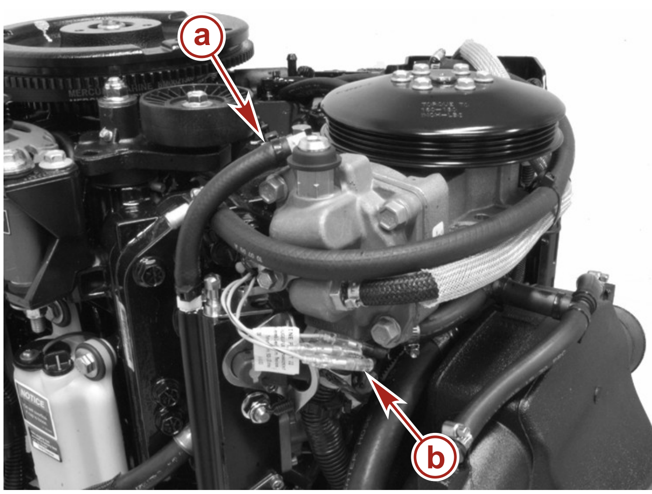
1. Disconnect both of the battery cables from the battery.
2. Remove the vent hose from the flywheel cover. Remove the flywheel cover.
3. Use a 3/8 in. square drive on the belt tension arm to remove the belt.



45924

a - Belt tensioner
b - 3/8 in. square drive

4. Disconnect the air compressor bullet connectors.
5. Cut the cable tie securing the water inlet hose to the air compressor. Remove the water inlet hose.

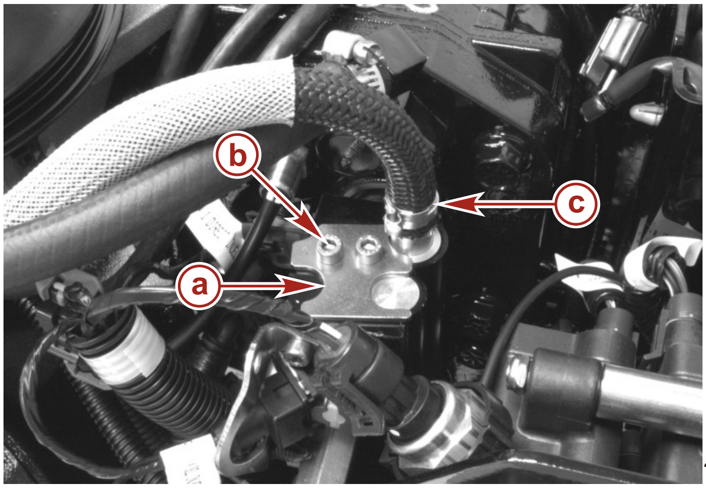


45934

a - Water inlet hose
b - Bullet connectors

6. Remove the two screws securing the retainer to the fuel rail. Remove the air compressor hose with the fitting from the fuel rail.

NOTE: Do not remove the air compressor hose from the fitting on the fuel rail. Removing the hose from the fitting on the fuel rail will damage the air compressor hose.

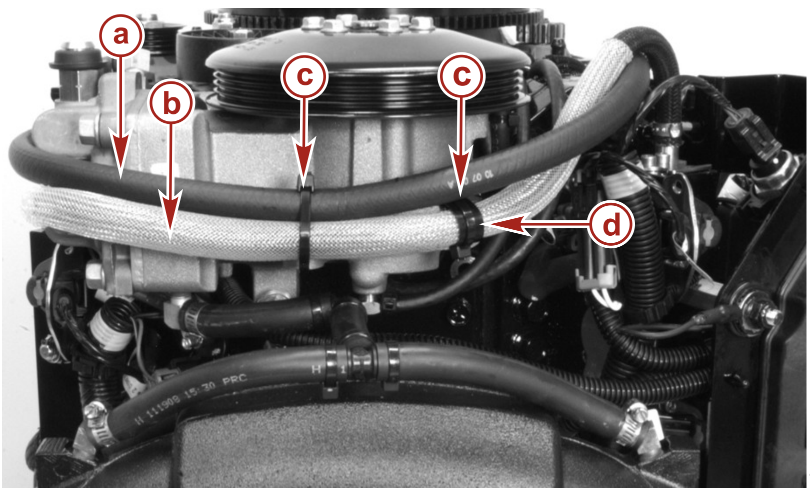


45927

a - Retainer
b - Screw (2)
c - Air compressor hose with fitting

7. Remove the cable ties securing the water hose and air hose to the compressor.
8. Remove the air compressor fitting with the hose from the air compressor.

NOTE: Do not remove the air compressor hose from the fitting on the air compressor. Removing the hose from the fitting will damage the air compressor hose.

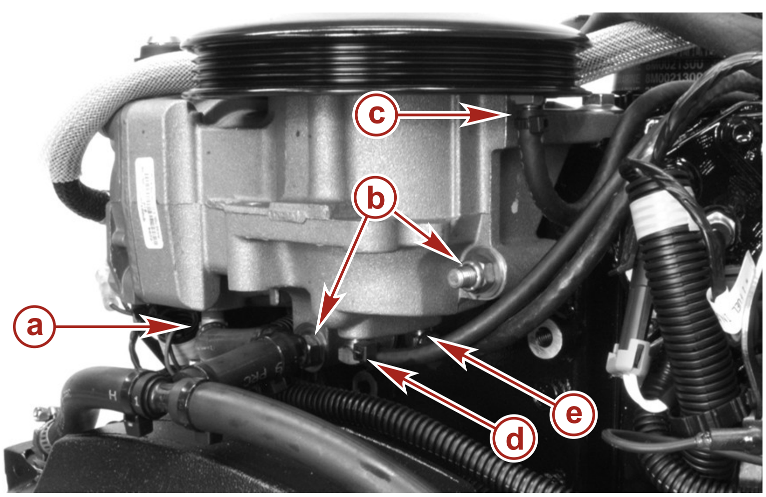


45930

a - Water hose
b - Air compressor to fuel rail hose
c - Cable tie
d - Plastic J-clamp

9. Remove the two nuts and washers securing the air compressor to the cylinder block.
10. Remove the water hose to the expansion chamber.
11. Remove the oil hoses from the air compressor.

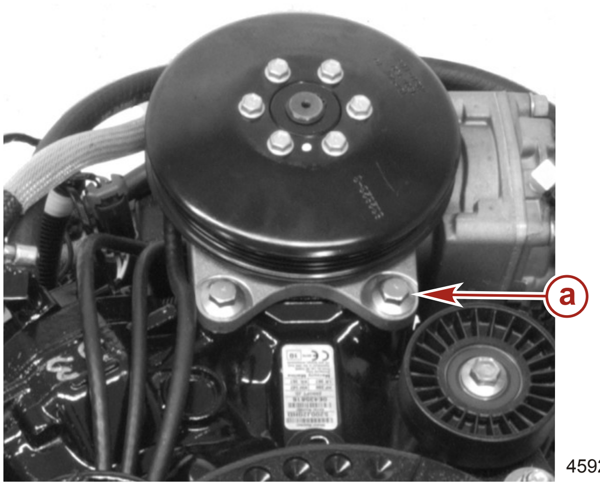
NOTE: Mark or identify the three oil hoses when removing to aid in the installation.



45931

a - Water hose to expansion chamber
b - Nut and washer (M8)
c - Air compressor oil inlet hose
d - Oil hose to top main bearing
e - Oil hose to #5 reed block

12. Remove the two screws securing the air compressor to the top of the cylinder block.

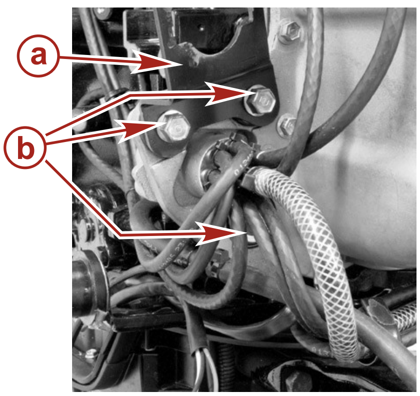


45928

a - Screw (M8 x 25, flange) (2)

Oil Hoses and Reservoir Removal

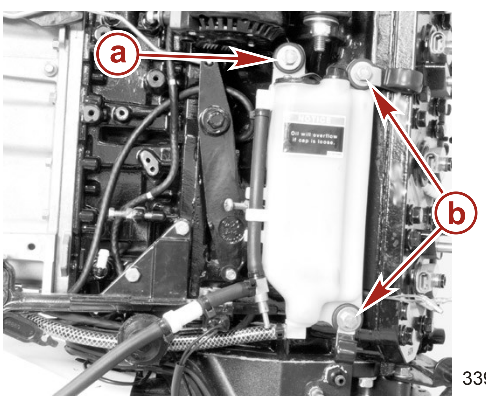
1. Remove the three screws securing the 14 pin connector mounting bracket and the oil pump to the plenum.
2. Cut the cable ties securing the oil hoses to the oil pump and remove the oil hoses. Use an appropriate container to capture the oil that may drip from the oil hoses.



33668

a - 14 pin connector mounting bracket (newer models only)
b - Screws

3. Remove the three screws and washers securing the oil reservoir to the cylinder block.

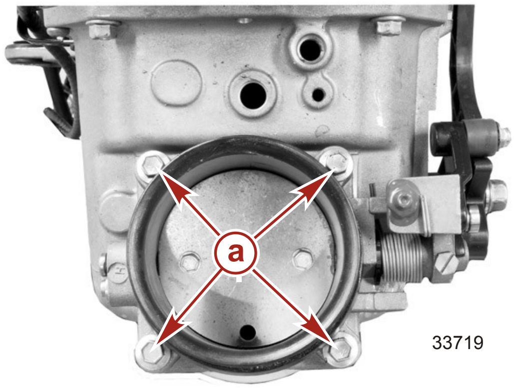


33954

a - Screw and washer securing oil reservoir
b - Screw and washer securing a clamp and the oil reservoir (2)

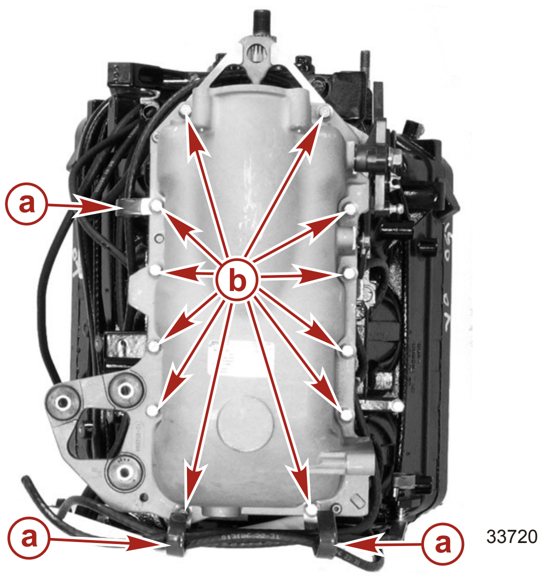
Throttle Body and Air Plenum Removal

1. Remove the four screws securing the throttle body to the plenum.



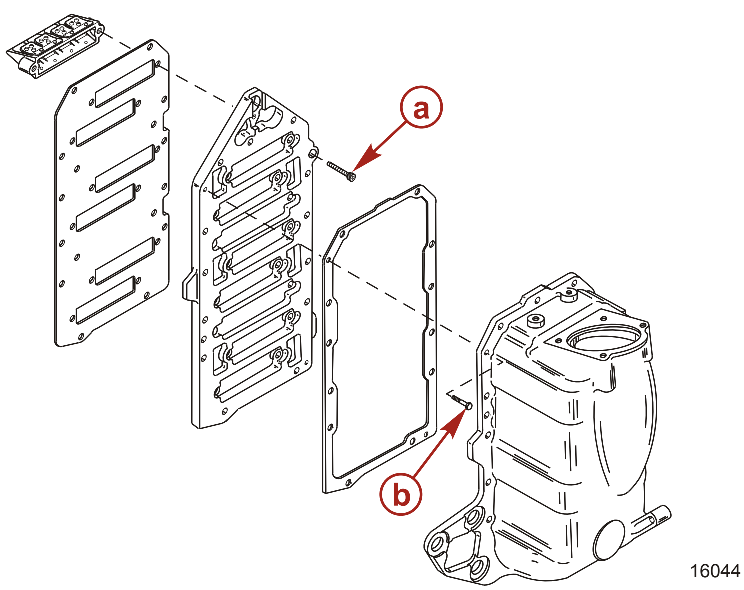
a - Screw (4)

2. Remove the 12 screws securing the air plenum to the cylinder block assembly.



a - Clamp (3)
b - Screw (12)

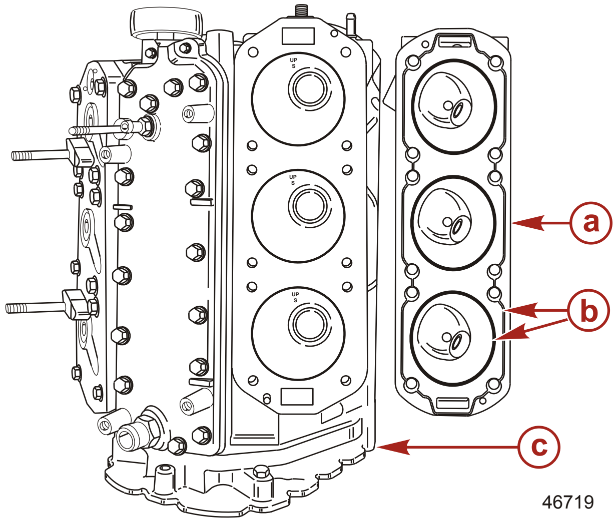
3. Remove the two screws securing the air plenum to the reed plate assembly.
4. Remove the 12 screws securing the reed blocks to the reed plate assembly.



a - Screw (0.250-20 x 0.88 in.) (12)
b - Screw (M4 x 16) (2)

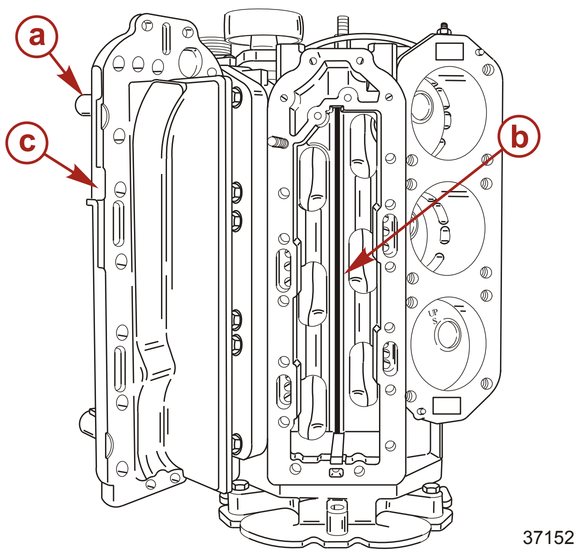
Powerhead Disassembly

1. Place the powerhead in a repair stand or on a bench.
2. Remove the screws securing the cylinder heads. Remove the cylinder heads.



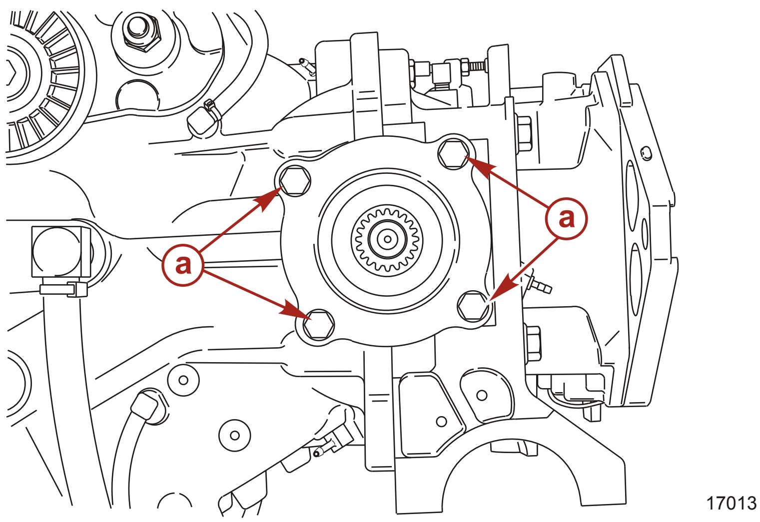
a - Cylinder head
b - O-rings
c - Engine block

3. Remove the screws securing the exhaust manifold. Remove the exhaust manifold.



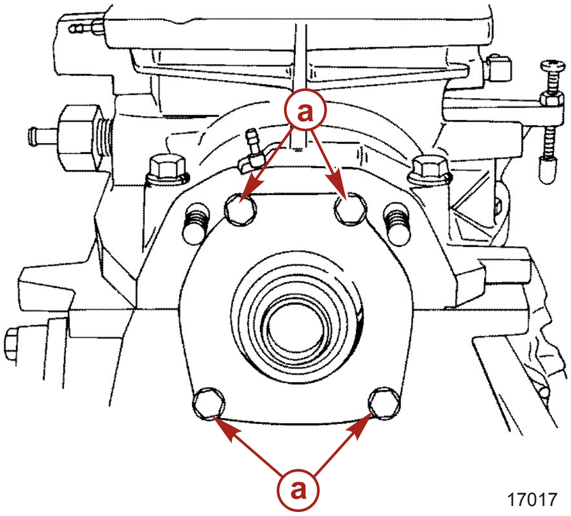
a - Exhaust manifold
b - Seal
c - Gasket

4. Remove the four screws securing the upper end cap. Do not remove the end cap at this time.



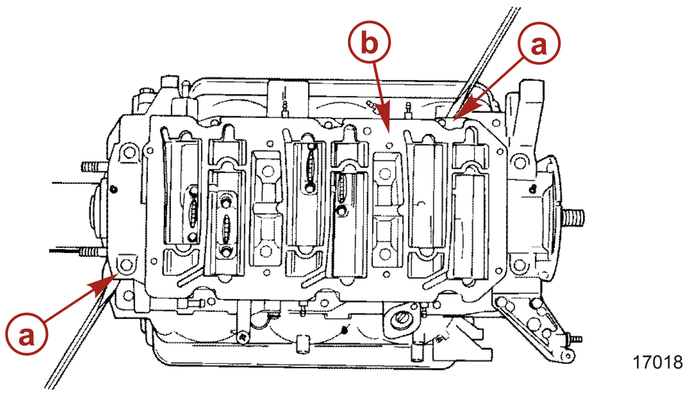
a - Screws (4)

5. Remove the four screws securing the lower end cap. Do not remove the end cap at this time.



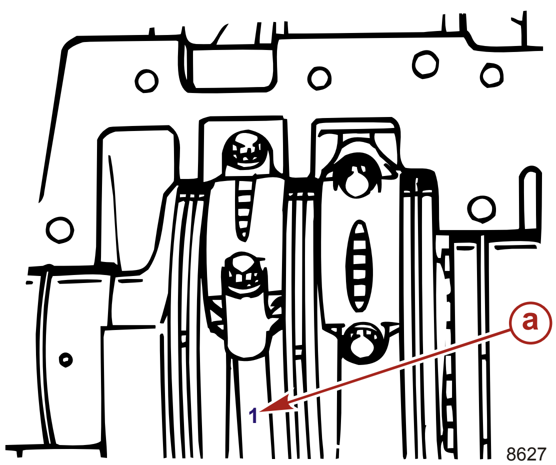
a - Screws (4)

6. Remove the screws that secure the crankcase cover to the cylinder block.
7. Pry the crankcase cover off the cylinder block with pry bars at the locations shown.



a - Pry locations
b - Crankcase cover

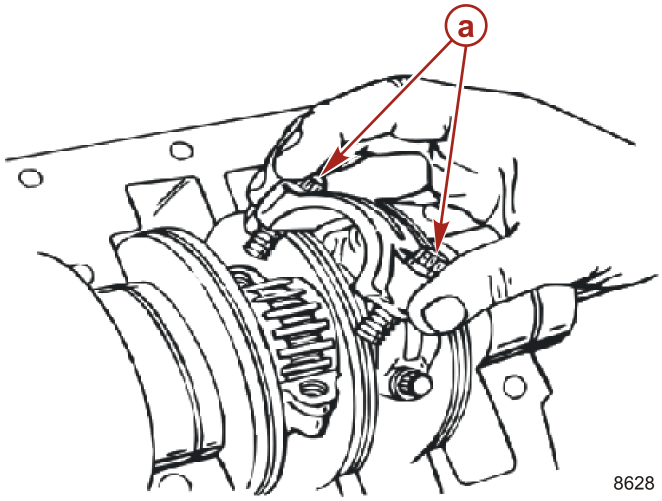
8. Use paint or indelible ink to identify each connecting rod location.



a - Cylinder number

9. Remove the connecting rod cap screws and the connecting rod cap.

10. Remove the roller bearings and bearing cage from the connecting rod.

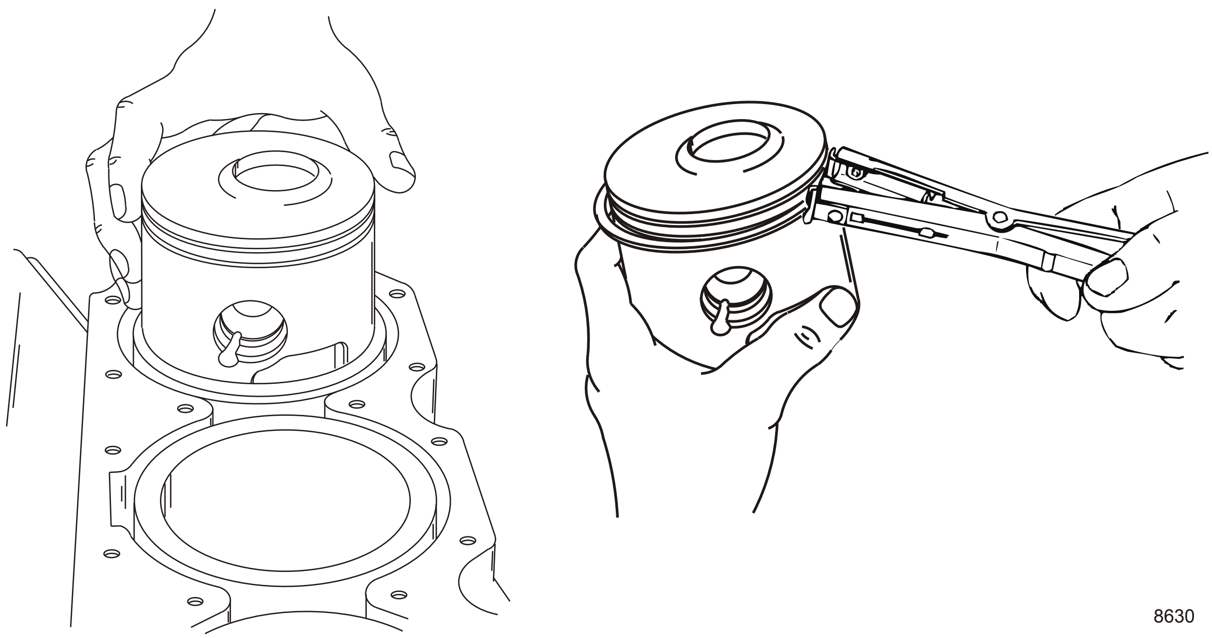


a - Connecting rod cap screws

11. Push the piston out of the cylinder block and reassemble the connecting rod.

NOTICE
Connecting rods and end caps are matched sets. Mismatching the original pairs will result in catastrophic engine damage. Install all connecting rods with their matched end caps.

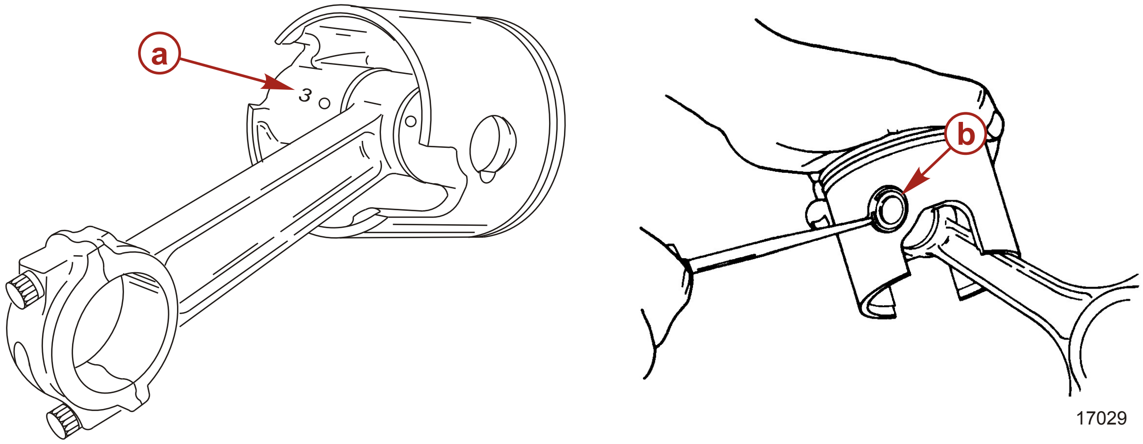
12. Use a piston ring expander to remove the piston rings.



Piston Ring Expander	91-24697

13. On the inside of the piston, use paint or indelible ink to identify the location.

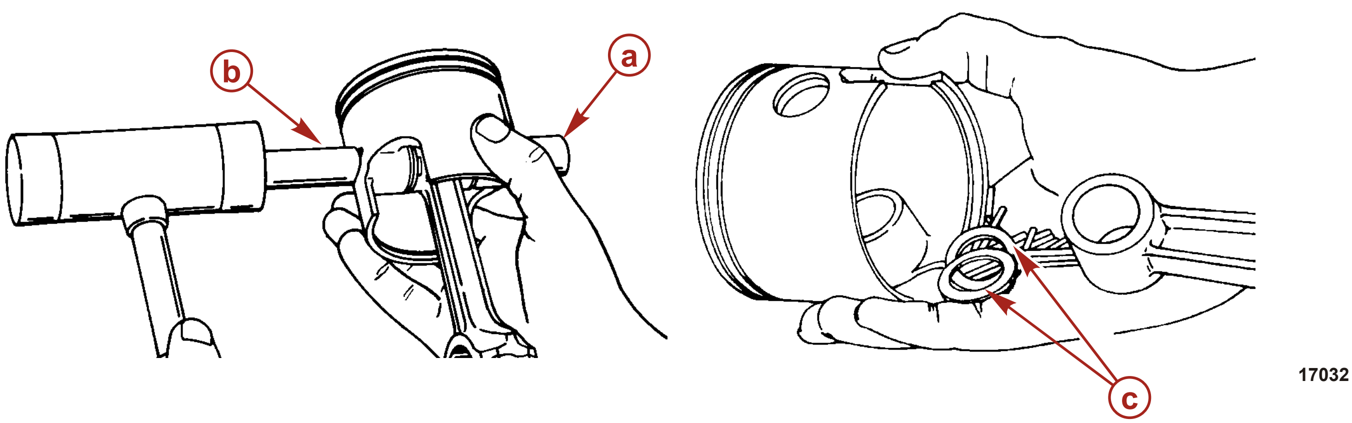
14. Use the lockring removal tool to remove the piston lockring.



a - Location of the identification number
b - Lockring

Lockring Removal Tool	91-52952T 1

15. Use a heat gun or torch lamp to heat the piston to remove the piston pin.
16. Support the piston and remove the piston pin using service tool 91-76159A1 for serial number 0T178499 and below, or service tool 91-92973A1 for serial number 0T178500 and above.

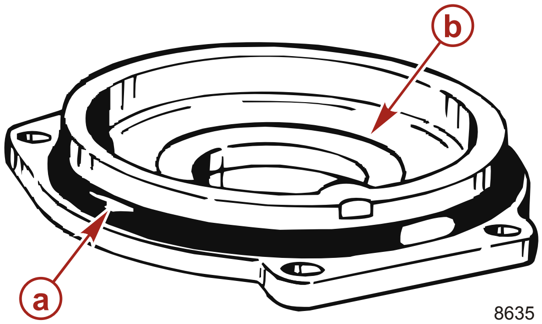


a - Piston pin
b - Piston pin tool
c - Needle bearings and locating washers

Piston Pin Tool	91-76159A1
Piston Pin Tool	91- 92973A 1
Torch Lamp	91- 63209

17. Remove the upper and lower end caps from the crankshaft.
18. Remove and discard the O-rings from each end cap.

19. Remove the oil seals from the end caps with a hammer and an appropriate tool.

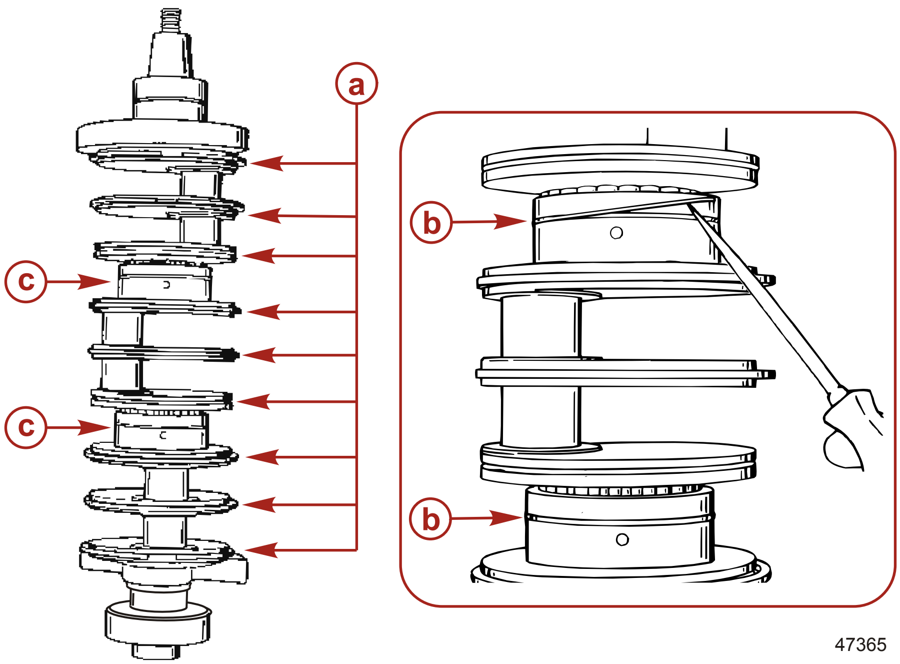


a - O-ring
b - Seal

20. Install the crankshaft onto a powerhead stand and inspect the sealing rings.
IMPORTANT: Do not remove the crankshaft sealing rings unless the sealing ring is broken.

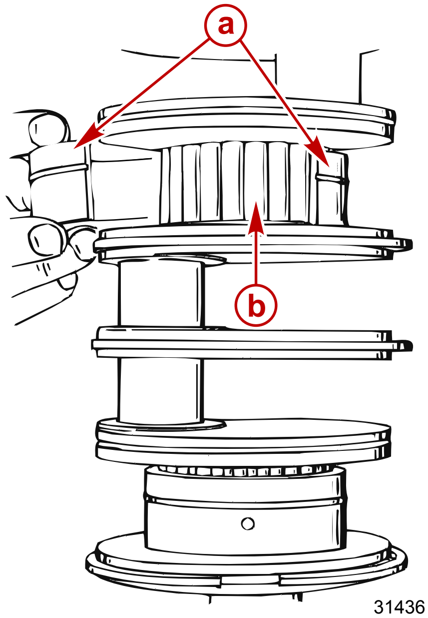
Powerhead Stand	91- 30591T 1

21. Remove the retainer ring holding the main bearing races together.



a - Sealing rings (9)
b - Retainer ring (2)
c - Main bearing (2)

22. Remove the bearing race and the roller bearings.

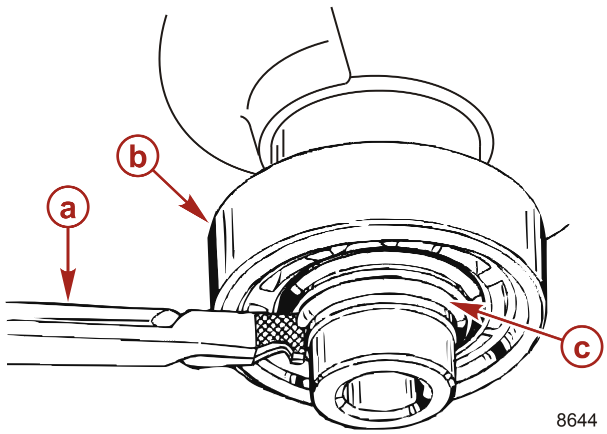


a - Bearing race
b - Roller bearings

23. Inspect the lower crankshaft ball bearing for damage.
IMPORTANT: Do not remove the lower crankshaft ball bearing unless replacement is required.

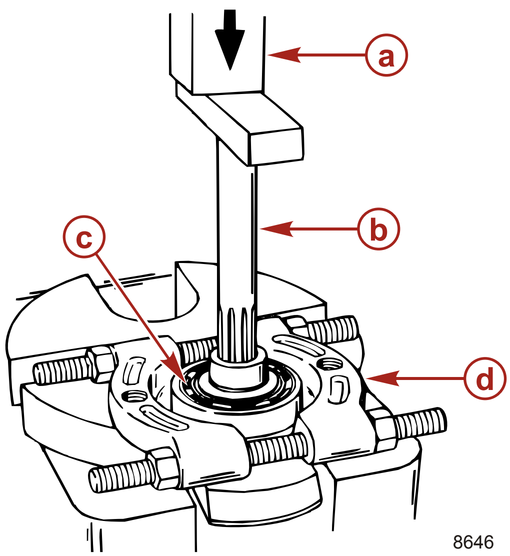
Lower Crankshaft Ball Bearing Removal

1. Remove the crankshaft ball bearing retaining ring with a snap ring pliers.



a - Pliers
b - Crankshaft ball bearing
c - Retaining ring

2. Install the universal puller plate onto the crankshaft. Press the crankshaft ball bearing off with the powerhead stand.



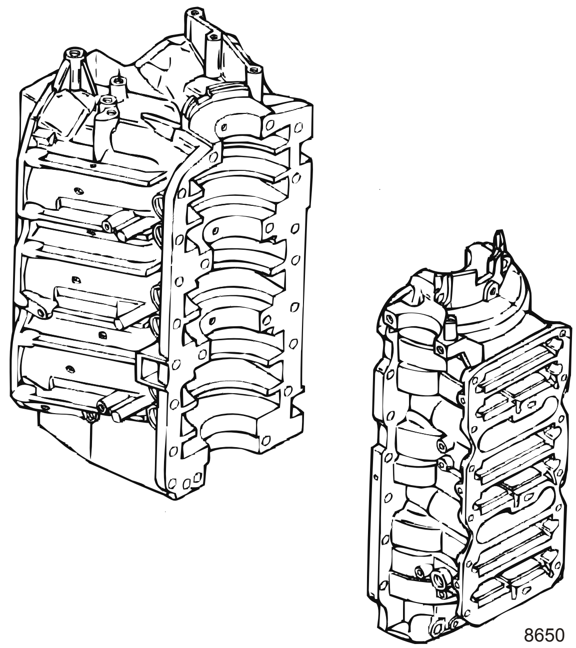
a - Press
b - Powerhead stand
c - Crankshaft ball bearing
d - Universal puller plate

Universal Puller Plate	91-37241
Powerhead Stand	91- 30591T 1

Cleaning and Inspection

Cylinder Block and Crankcase Cover

IMPORTANT: The crankcase cover and cylinder block are a matched, line-bored assembly and must never mate with a different crankcase cover or cylinder block.



8650

IMPORTANT: To prevent damage to components, remove all hoses, check valves, and other oil system components before submerging the cylinder block in cleaning solution.

1. Thoroughly clean the cylinder block and crankcase cover. Ensure that all sealant and old gaskets are removed from matching surfaces. Ensure that carbon deposits are removed from exhaust ports.
2. Inspect the cylinder block and crankcase cover for cracks or fractures.
3. Check the gasket surfaces for nicks, deep grooves, cracks, or distortion that could cause compression leakage.
4. Check all water and oil passages in the cylinder block and crankcase cover to ensure that they are not obstructed and that the plugs are in place and tight.

Special Service Information

Grooves in the Cylinder Block Caused by Crankshaft Sealing Rings

Grooves in the cylinder block caused by crankshaft sealing rings are not a problem, unless installing a new crankshaft, and the new sealing rings do not line up with the existing grooves in the cylinder block. If installing a new crankshaft, refer to **Crankshaft Installation** to determine if the powerhead can be used.

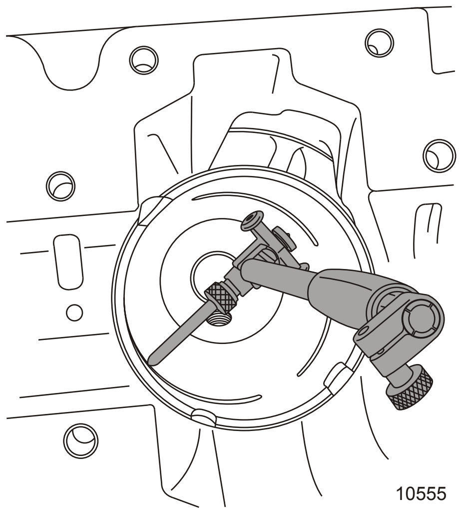
Cylinder Bores

Inspect cylinder bores for scoring, scuffing, or aluminum transfer. Minor scoring or scuffing can be removed by honing. If aluminum transfer has occurred, muriatic acid can be applied where the transfer of aluminum has occurred. Flush the cylinder bore with water to remove any remaining acid.

Honing Procedure

1. Follow the hone manufacturer's recommendations for use of the hone and lubrication during the honing process.
2. A continuous flow of honing oil should be pumped into the work area.
   IMPORTANT: Incorrect or excessive honing may damage the cylinder bores, leading to engine failure. Follow the hone manufacturer's instructions. Measure the cylinder diameter often.
3. Start stroking at the smallest diameter. Maintain firm stone pressure against the cylinder wall to assure fast stock removal and accurate results.

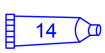
4. Localize the stroking in the smallest diameter until the drill speed is constant throughout the length of the bore. Expand the stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce the best cross-hatch pattern. Use honing oil generously.
5. Clean cylinder bores with hot water and detergent. Scrub with a stiff bristle brush and rinse with hot water. If the abrasive material is not washed from the cylinder bore, rapid wear of the new piston rings and cylinder bores will occur. After cleaning, the bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean dry cloth. The cylinders should not be cleaned with kerosene or gasoline.
6. Measure the cylinder bore diameter with a snap gauge micrometer or bore gauge in each of the cylinders. Check for tapered, out-of-round (egg-shaped), and oversize bore.



Cylinder block finish hone	
Standard	88.925 mm (3.501 in.)
Oversize 0.38 mm (0.015 in.)	89.306 mm (3.516 in.)
Maximum taper or out-of-round	0.076 mm (0.003 in.)

7. If a cylinder bore is tapered or out-of-round more than 0.076 mm (0.003 in.) from the finished hone diameter, it will be necessary to bore the cylinder oversize.

   NOTE: The weight of an oversize piston is approximately the same as a standard size piston. It is not necessary to bore all the cylinders oversize.
8. After measuring the cylinder bores, apply 2-Cycle Premium Outboard Oil to the cylinder bores to prevent corrosion.

Tube Ref No.	Description	Where Used	Part No.
 14	2-Cycle Premium Outboard Oil	Cylinder bores after honing	92-858021K01

Pistons and Piston Rings

IMPORTANT: If the engine was submerged while engine was running, the piston pin and/or connecting rod may be bent. If the piston pin is bent, the piston must be replaced and the connecting rod must be checked to verify it is straight.

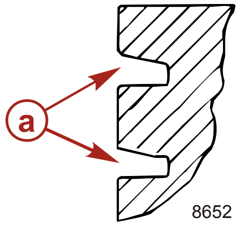
1. Inspect the pistons for scoring and excessive piston skirt wear.
2. Check the tightness of the piston ring locating pins. The locating pins must be tight.
3. Thoroughly clean the pistons. Carefully remove the carbon deposits from the pistons with a soft wire brush or carbon removal solution. Do not burr or round off the machined edges on the piston.
4. Inspect the piston ring grooves for wear and carbon accumulation. If necessary, scrape the carbon from the piston ring grooves. Be careful not to scratch the sides of the grooves.

Cleaning Piston Ring Grooves

Keystone (tapered) ring grooves:

1. Use a bristle brush and carbon removal solution to remove carbon from the piston surfaces.

2. A tool can be made for cleaning the inner diameter of the tapered ring grooves. The tool can be made from a broken tapered piston ring with the side taper removed to enable the inside edge of the ring to reach the inner diameter of the groove. Carefully scrape carbon from the inner diameter of the ring grooves. Care must be taken not to damage the grooves by scratching the side surfaces of the grooves.

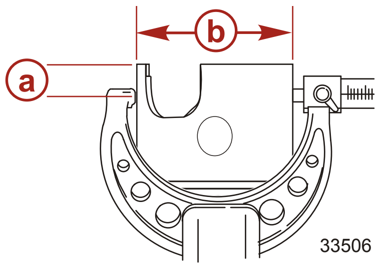


a - Ring grooves

Measuring Piston

The piston has a barrel profile shape and is not a true diameter.

Measure the piston at a point 24 mm (0.945 in.) from the bottom of the piston skirt, 90° to the wrist pin opening.



a - 24 mm (0.945 in.)
b - Piston diameter

Piston diameter	
Standard	88.7095 ± 0.0127 mm (3.4925 ± 0.0005 in.)
Oversize	89.0905 ± 0.0127 mm (3.5075 ± 0.0005 in.)

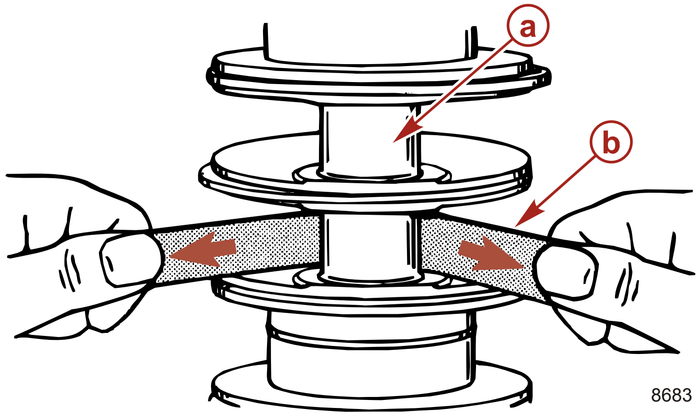
Cylinder Heads and Exhaust Divider Plate

1. Inspect the internal surface of the cylinder heads for possible damage as a result of piston or foreign material striking the cylinder heads.
   IMPORTANT: Cylinder head warpage must not exceed 0.025 mm (0.001 in.) over the entire length of the cylinder head. If the warpage exceeds 0.025 mm (0.001 in.) in the narrow portion of the cylinder head, the cylinder head must be replaced. The cylinder head must not be resurfaced, as the O-ring groove depth in the head will be reduced, which will result in cylinder leakage.
2. Replace the cylinder head as necessary.
3. Thoroughly clean the gasket surfaces of the exhaust divider plate.
4. Inspect the exhaust divider plate for deep grooves, cracks, or distortion that may cause leakage. Replace the part as necessary.

Crankshaft

1. Inspect the splines on the crankshaft end of the driveshaft for wear. Replace the crankshaft if necessary.
2. Check the crankshaft for runout. Maximum runout is 0.152 mm (0.006 in.). Replace the crankshaft if necessary.
3. Inspect the crankshaft oil seal surfaces. The sealing surfaces must not be grooved, pitted, or scratched. Replace the crankshaft if necessary.
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear, or overheating.

5. Clean the crankshaft surfaces with crocus cloth.



8683

a - Crankshaft journals
b - Crocus cloth

6. Thoroughly clean the crankshaft with a mild solvent and dry with compressed air. Replace the crankshaft if the bearing surfaces are damaged and cannot be properly cleaned up. Lubricate the surfaces of the crankshaft with light oil to prevent rust. Do not lubricate the crankshaft ball bearing at this time.

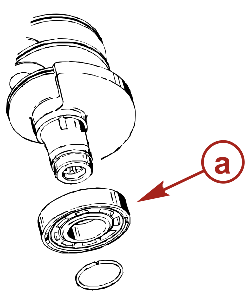
⚠ WARNING

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.

Crankshaft and End Cap Bearings

IMPORTANT: When overhauling the powerhead assembly, replace all crankshaft bearings; upper/lower, center main, connecting rod, and wrist pin bearings. This ensures optimum powerhead performance and longevity.

1. After cleaning the crankshaft, grasp the outer race of the crankshaft ball bearing installed on the lower end of the crankshaft and work the race back and forth. There should not be excessive play.
2. Lubricate the ball bearing with light oil. Rotate the outer bearing race. The bearing should have smooth action and no rust stains. If the ball bearing sounds or feels rough, or has catches, remove and discard the bearing.



8684

a - Lower crankshaft ball bearing

3. Thoroughly clean and dry the crankshaft center main roller bearings. Lubricate the bearings with 2-Cycle Premium Outboard Oil.

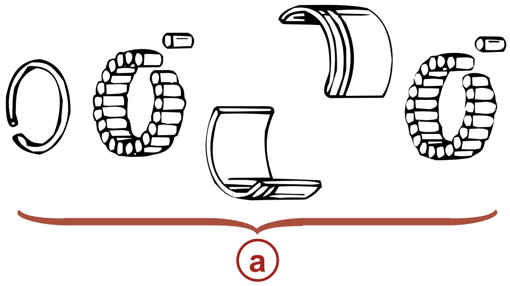
Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Main bearings	92-858021K01

⚠ 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.

IMPORTANT: The crankshaft bearings are matched sets. Mismatching the bearings can result in engine damage. Replace and install the bearings in matched pairs.

4. Thoroughly inspect the center main roller bearing. Replace the bearings if they are rusted, fractured, worn, galled, or badly discolored.



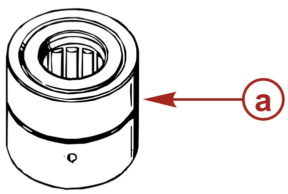
8685

a - Center main roller bearing

5. Clean and dry the crankshaft roller bearing that is installed in the upper end cap. Lubricate the bearing with 2-Cycle Premium Outboard Oil.

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Main bearings	92-858021K01

6. Thoroughly inspect the upper crankshaft roller bearing. If the roller bearing is rusted, fractured, worn, galled, badly discolored, or loose inside of the end cap, replace the end cap and roller bearing as an assembly.

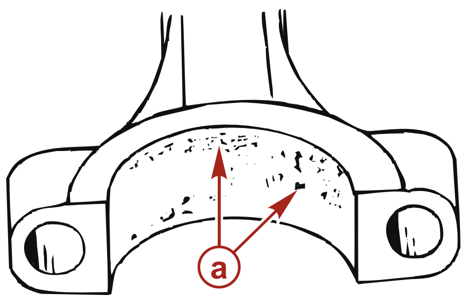


8686

a - Upper roller bearing

Connecting Rods

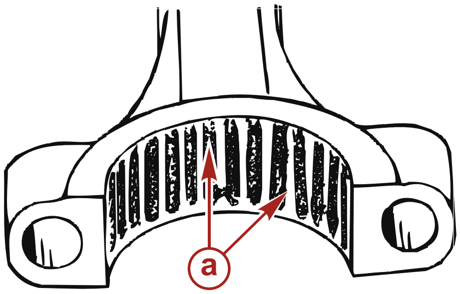
1. Check the connecting rods for alignment by placing the rods on a surface plate. If light can be seen under any portion of the machined surfaces, if the rod has a slight wobble on the plate, or if a 0.051 mm (0.002 in.) feeler gauge can be inserted between any machined surface and surface plate, replace the rod.
2. Check for overheating. Overheating is visible as a bluish bearing surface color caused by inadequate lubrication or excessive RPM.
3. Check for rust. Rust formation on bearing surfaces causes uneven pitting of surfaces.



8688

a - Pitting

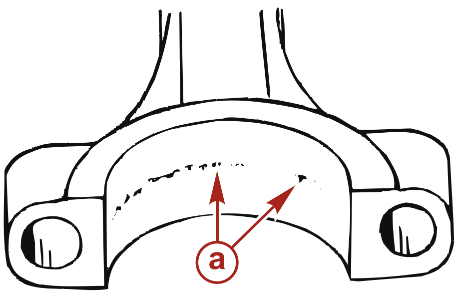
4. Check for water marks. When bearing surfaces are subjected to water contamination, a bearing surface etching occurs. This etching resembles the size of the bearing.



a - Water marks

8690

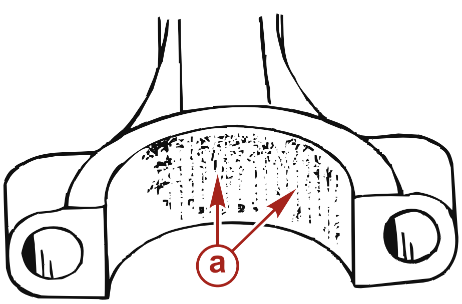
5. Check for spalling. Spalling is the loss of bearing surface, resembling flaking or chipping. Spalling is most evident on the thrust portion of the connecting rod in line with the "I" beam. General bearing surface deterioration could be caused or accelerated by improper lubrication.



a - Spalling

8691

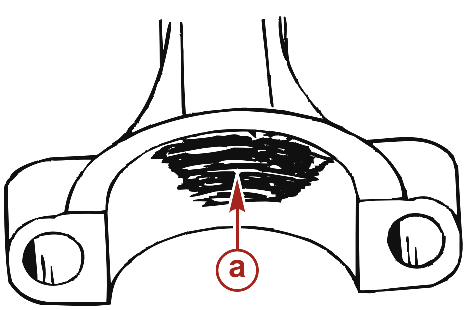
6. Check for chatter marks. Chatter marks are the result of a combination of low speed - low load - cold water temperature operation, aggravated by inadequate lubrication or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surface which resembles a tiny washboard. In some instances, the connecting rod crankpin bore becomes highly polished. During operation, the engine will emit a whir or chirp sound when it is accelerated rapidly from idle speed to approximately 1500 RPM, then quickly returned to idle. If the preceding conditions are found, replace both the crankshaft and connecting rods.



a - Chatter marks

8692

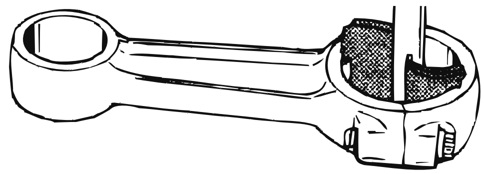
7. Check for uneven wear. Uneven wear could be caused by a bent connecting rod.



a - Uneven wear

8694

8. If necessary, clean the connecting rod bearing surfaces, as follows:
   a. Ensure that etched marks on the connecting rod (crankshaft end) are perfectly aligned with etched marks on the connecting rod cap. Tighten the connecting rod cap attaching bolts securely.
   b. Clean the crankshaft end of the connecting rod by using crocus cloth placed in a slotted, 9.5 mm (3/8 in.) diameter shaft, as shown. Secure the shaft in a drill press and operate the press at high speed, keeping the connecting rod at a 90° angle to the slotted shaft.
   IMPORTANT: Use only crocus cloth to clean the bearing surface at the crankshaft end of the connecting rod. Do not use other types of abrasive materials to clean the bearing surface.
   c. Clean the connecting rod just enough to clean up the bearing surfaces. Do not continue to clean after marks are removed from the bearing surfaces.



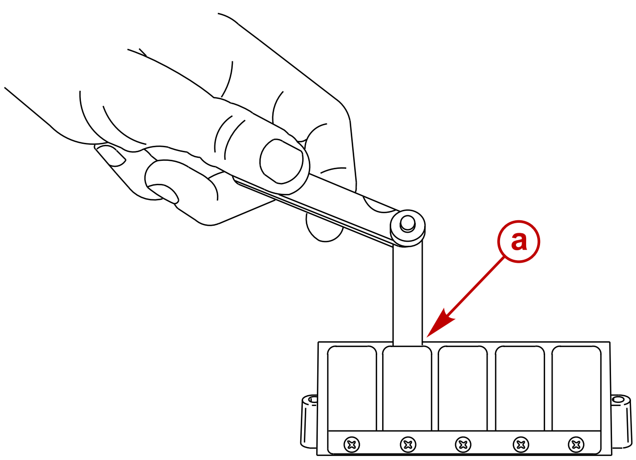
8695

   d. Using a 320 grit carborundum cloth (instead of crocus cloth), clean the wrist pin end of the connecting rod using the same method as in step "b."
   e. Thoroughly wash the connecting rods to remove abrasive grit. Recheck the bearing surfaces. Replace any connecting rod that cannot be properly cleaned up. Lubricate the bearing surfaces of the connecting rods being reused with light oil to prevent rust.

Reed Block Assembly

IMPORTANT: Do not remove the reeds from reed blocks unless replacement is necessary. Do not turn used reeds over for reuse. Replace reeds in sets.

1. Thoroughly clean the gasket surfaces of the reed blocks and reed block housing. Check for deep grooves, cracks, or distortion that could cause leakage. Replace parts as necessary.
2. Inspect the reed block neoprene surface for wear, cuts, or abrasions. Replace the reed blocks as necessary.
3. Check for chipped and broken reeds.



8687

a - 0.51 mm (0.020 in.) opening

NOTE: Allowable reed opening is 0.51 mm (0.020 in.) or less. Replace reeds if either reed is standing open more than 0.51 mm (0.20 in.).

End Bearing Bleed System

1. Check the rubber bleed hoses. Replace any cracked, cut, or deteriorating hoses.
2. Check operation of the lower end cap check valve. If the valve is working properly, air can be drawn through the check valve one way only. If air can pass through a check valve both ways, replace the valve.

Powerhead Assembly

Powerhead Preassembly Cleaning Recommendations

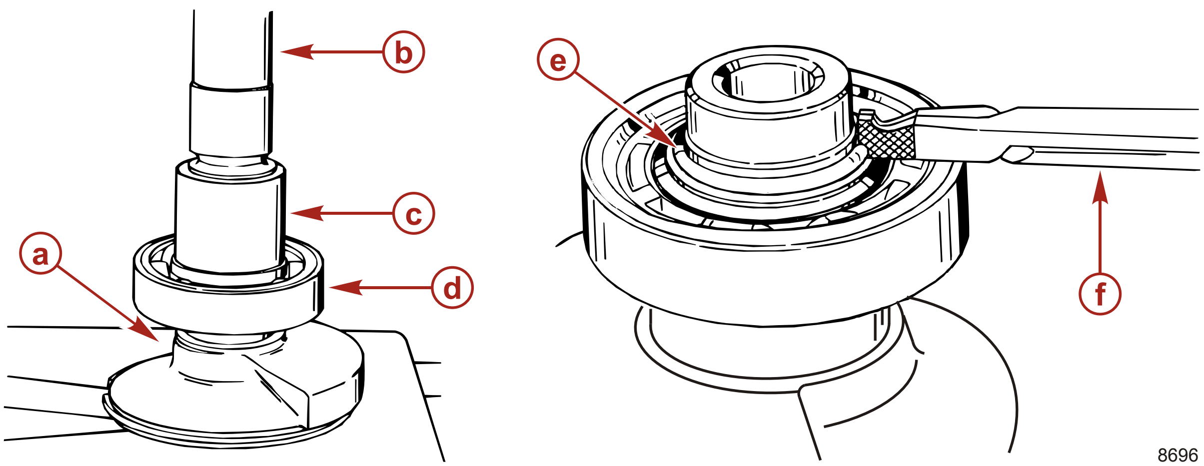
IMPORTANT: Any threaded hole or bolt with threadlocking compound that is contaminated with oil, must be thoroughly cleaned with a solvent to remove all traces of oil contamination. Failure to remove oil contamination will result in poor threadlocking compound adhesion.

Prior to assembling the powerhead, all threaded holes on the crankcase cover and cylinder block must be cleared of threadlocking compound dust. Use compressed air to clear threadlocking compound dust.

Wash the cylinder block and crankcase cover with hot soapy water to remove debris and honing compound. Dry the cylinder block with compressed air. Failure to thoroughly clean the cylinder block of honing compound and debris will result in premature engine failure.

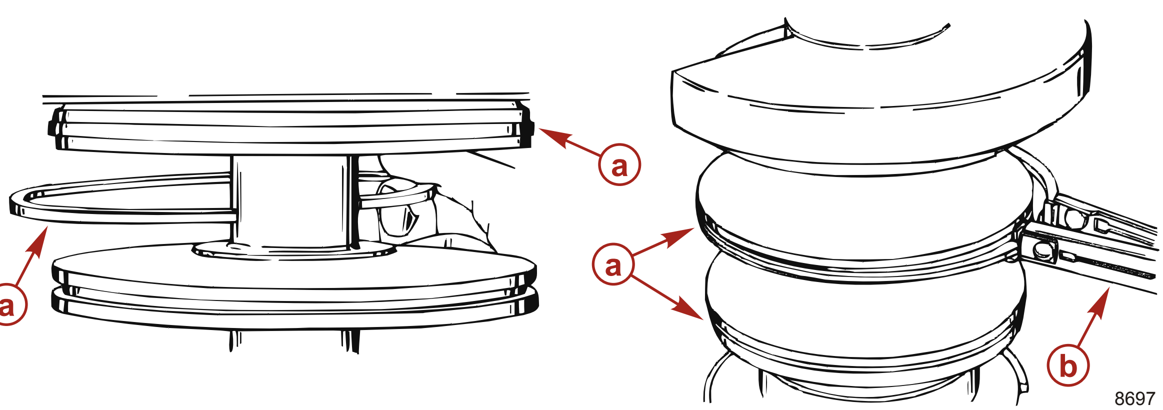
Crankshaft Bearings Installation

1. If the lower crankshaft ball bearing has been removed, press it onto the crankshaft as shown. Ensure that the bearing is pressed firmly against the shoulder.
2. Reinstall the retaining ring using a suitable pair of snap ring pliers.



a - Crankshaft
b - Press
c - Suitable mandrel
d - Crankshaft ball bearing
e - Retaining ring
f - Snap ring pliers

3. If the crankshaft sealing rings have been removed, spread the new rings just enough to slide them over the crankshaft journal.
4. Use the piston ring expander tool to install the crankshaft sealing rings into the grooves.



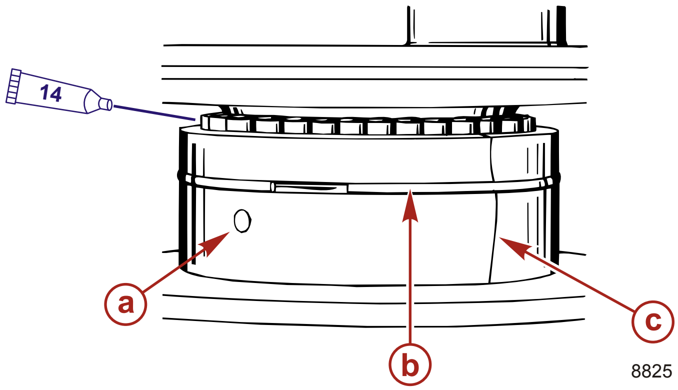
a - Crankshaft sealing rings
b - Piston ring expander tool

Piston Ring Expander	91-24697

5. Lubricate the center main crankshaft roller bearings and races with 2-Cycle Premium Outboard Oil.

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Center main crankshaft roller bearings and races	92-858021K01

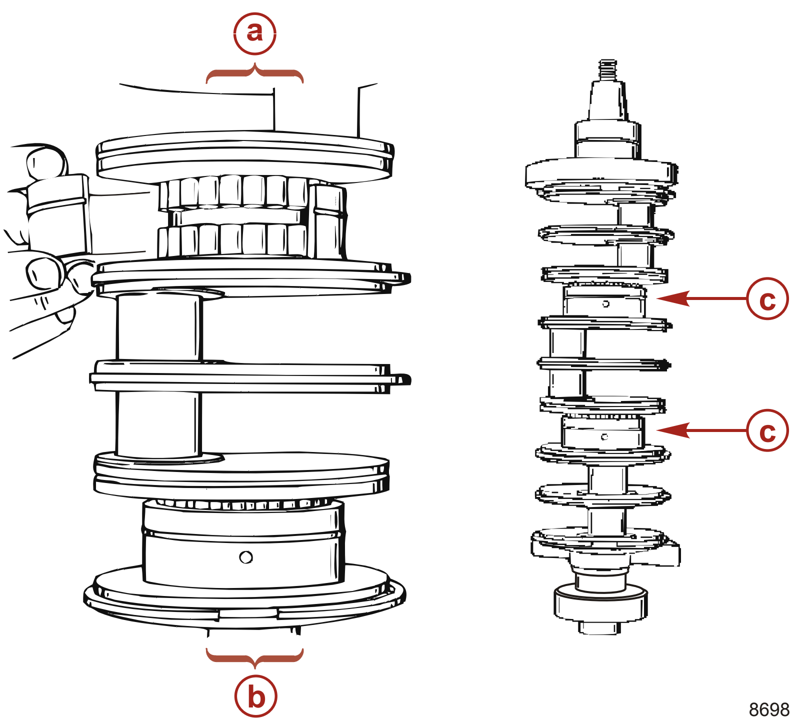
6. Install the center main crankshaft roller bearing so that the hole is toward the driveshaft end of the crankshaft.
7. Verify that the retaining ring bridges the separating lines of the bearing race.



a - Hole is toward driveshaft end
b - Retaining ring
c - Separating line

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Center main crankshaft roller bearings and races	92-858021K01

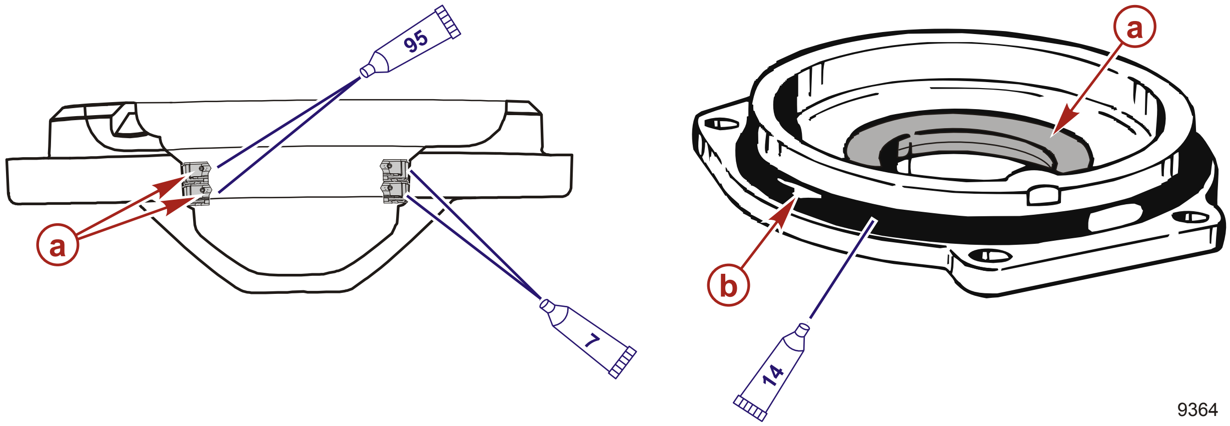
8. Place the center main crankshaft roller bearings on the upper and lower main bearing journals as shown.
9. Install the center main bearing races as shown.
10. Secure the center main bearing races together with the retaining rings. Make sure the retaining ring bridges the separating lines of the bearing race.



a - Flywheel end
b - Driveshaft end
c - Center main bearing races

11. Install the new oil seals into the lower end cap as follows:
    a. Apply a thin bead of Loctite 271 Threadlocker to the outer diameter on the two lower end cap oil seals.

b. Use a suitable mandrel to press one oil seal (lip facing down) into the lower end cap until firmly seated. Remove any excess Loctite.
c. Press the second oil seal (lip facing down) until firmly seated on the first oil seal. Remove any excess Loctite.
d. Lubricate the oil seal lips with 2-4-C with Teflon.
e. Lubricate the O-ring seal surface on the end cap with 2-Cycle Premium Outboard Oil.
f. Install the O-ring over the lower end cap.

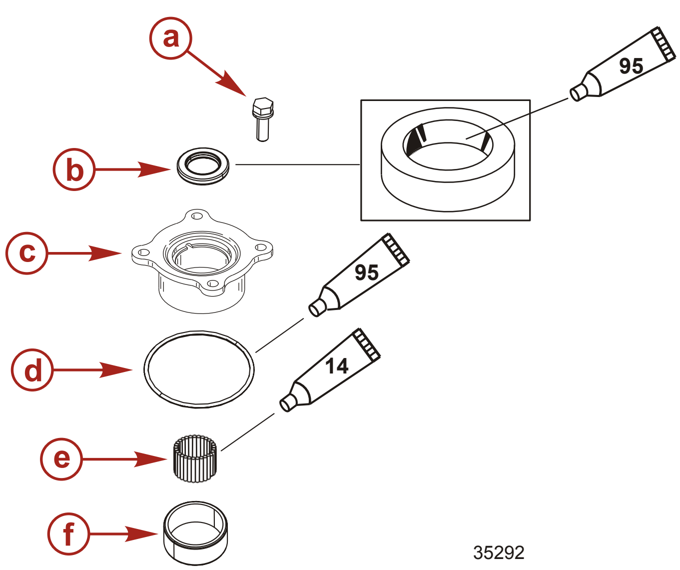


9364

a - Oil seal
b - O-ring

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Lower end cap oil seals	92-809819
14	2-cycle Premium Outboard Oil	O-ring seal surface of end cap	92-858021K01
95	2-4-C with Teflon	Oil seal lips	92-802859A 1

12. Install the oil seal into the upper end cap bearing carrier as follows:
    a. Apply a light film of 2-4-C with Teflon to the outer diameter of the upper end cap oil seal. This eases the seal into the carrier.
    b. Lubricate the oil seal lip with 2-4-C with Teflon.
    c. Using a suitable mandrel, press the oil seal into the bearing carrier (lip facing down) until bottomed out on the shoulder of the carrier.
    d. Lubricate the O-ring seal surface on the end cap with 2-4-C with Teflon and install on the carrier.
    e. Lubricate the roller bearing with 2-Cycle Premium Outboard Oil.



35292

a - Screw (0.312-18 x 1.00 in.)
b - Seal (lip faces down)
c - End cap
d - O-ring
e - Roller bearing
f - Race

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Oil seal and O-ring surfaces as shown	92-802859A 1
14	2-cycle Premium Outboard Oil	Roller bearing	92-858021K01

Crankshaft Installation

Before Installing a New Crankshaft

1. Check the crankshaft sealing ring mating surfaces in the cylinder block and crankcase cover for wear grooves caused by the crankshaft sealing rings from the previous crankshaft.

   NOTE: If wear grooves are present, the sealing rings on the new crankshaft will have to fit into the grooves without binding the crankshaft.
2. Before installing the crankshaft, remove any burrs that may exist on the groove edges.
3. Lubricate the sealing rings with 2-Cycle Premium Outboard Oil and install the new crankshaft as instructed.

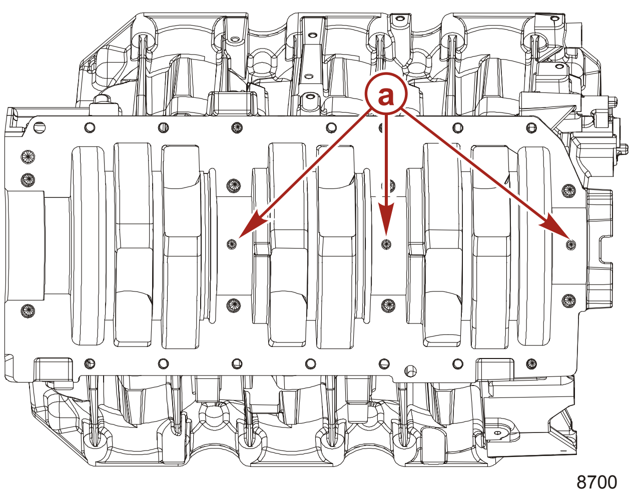
Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Crankshaft sealing rings	92-858021K01

4. Install the upper and lower end caps and inspect the fit between the sealing rings and grooves.
5. Temporarily install the crankcase cover and rotate the crankshaft several times to check if the sealing rings are binding against the crankshaft.

   NOTE: You will feel a drag on the crankshaft.
6. If the sealing rings are binding, recheck the grooves for burrs. If this does not correct the problem, replace the cylinder block.

Installing the New Crankshaft

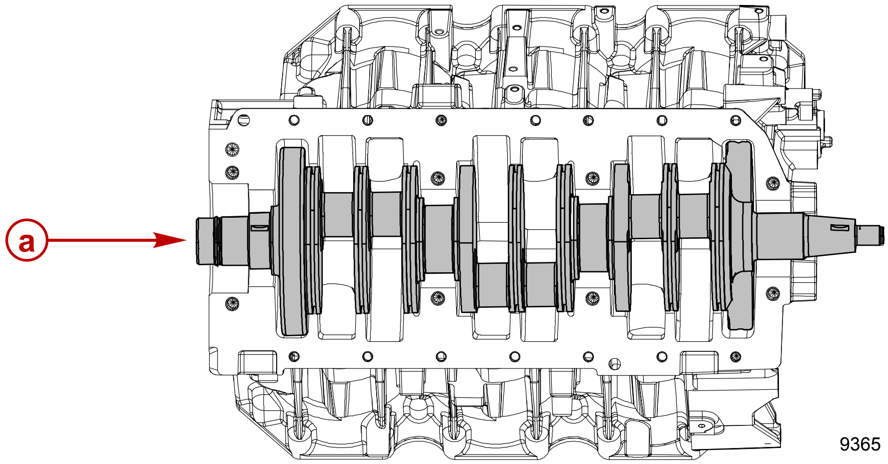
1. Lubricate the crankshaft sealing rings with 2-Cycle Premium Outboard Oil.
2. Check the cylinder block to ensure that the center pins are in place.



a - Center pins

3. Position all crankshaft seal ring gaps straight up.
4. Align the hole in each center main bearing race with a center pin.

5. Gently push the crankshaft down into position and verify that the center pins are lined up with the holes in the center main bearings and that the crankshaft seal rings are in place.

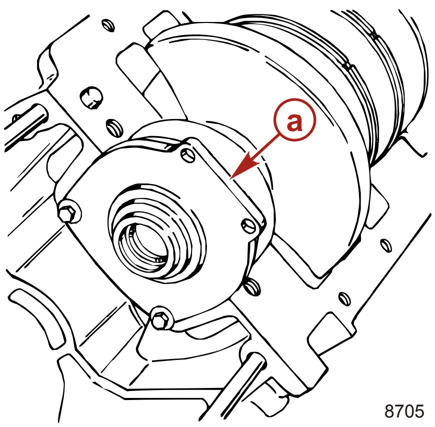


a - Crankshaft

6. Lubricate the lower crankshaft end (oil seal area) with 2-Cycle Premium Outboard Oil, then install the lower end cap.

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Crankshaft sealing rings and lower crankshaft end oil seal	92-858021K01

7. Secure the end cap to the cylinder block with attaching bolts. Do not tighten the end cap bolts at this time.



a - Lower end cap (installed but not tightened)

Piston and Connecting Rod Assembly

1. Place the needle bearings on a clean piece of paper and lubricate them with 2-4-C with Teflon.

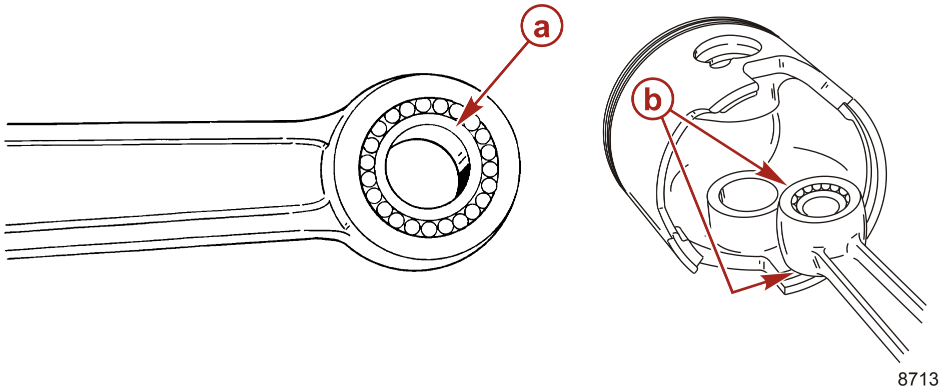
   NOTE: There are 29 needle bearings per piston for the 175 Pro XS and for S/N 0T178499 and below. S/N 0T178500 and above have 34 needle bearings per piston.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Needle bearings	92-802859A 1

2. Place the sleeve from piston pin tool 91-74607A3 for S/N 0T178499 and below, or 91-92973A1 for S/N 0T178500 and above, into the connecting rod journal and install the needle bearings around the sleeve.
3. Place the locating washers on the connecting rod.

   IMPORTANT: Position the connecting rod part number so it is facing towards the flywheel.

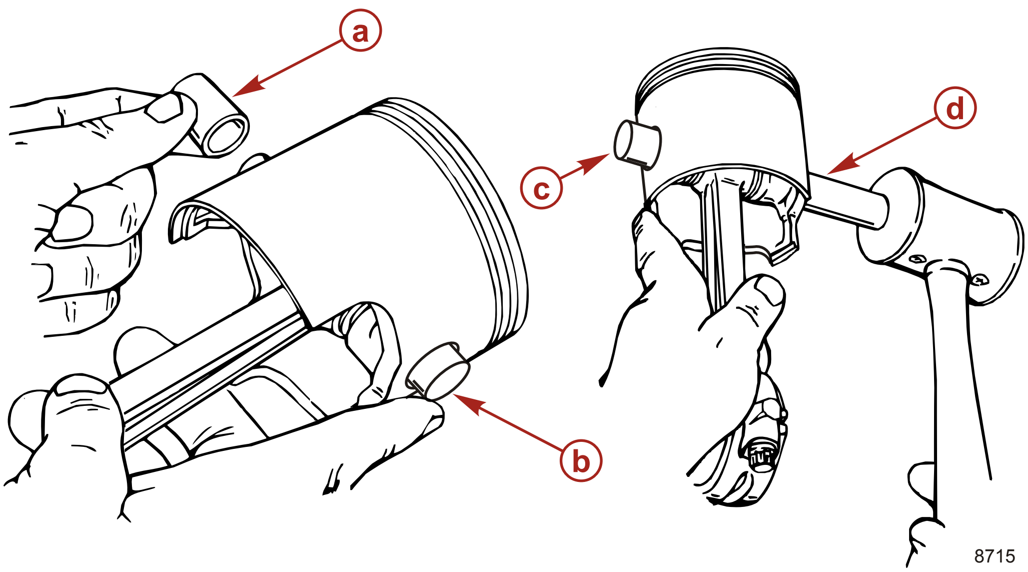
4. Carefully position the piston over the end of the rod. Ensure the locating washers are in place.



a - Sleeve
b - Locating washers

Piston Pin Tool	91- 74607A 3
Piston Pin Tool	91- 92973A 1

5. Insert piston pin tool 91-74607A3 for S/N 0T178499 and below, and 91-92973A1 for S/N 0T178500 and above, and push the sleeve out of the piston. Ensure the piston pin tool remains in the piston assembly.
6. Install the piston pin and tap the piston pin into the piston with a mallet.

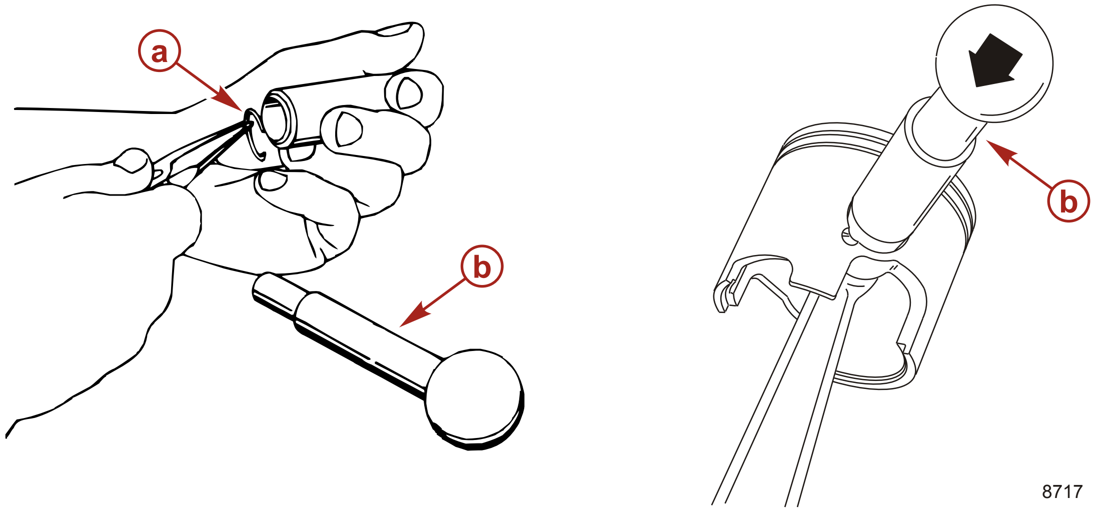


a - Sleeve
b - Piston pin tool
c - Piston pin tool
d - Piston pin

Piston Pin Tool	91- 74607A 3
Piston Pin Tool	91- 92973A 1

7. Install two new piston pin lockrings using lockring installation tool 91-77109A3 for S/N 0T178499 and below, and 91-93004A2 for S/N 0T178500 and above.

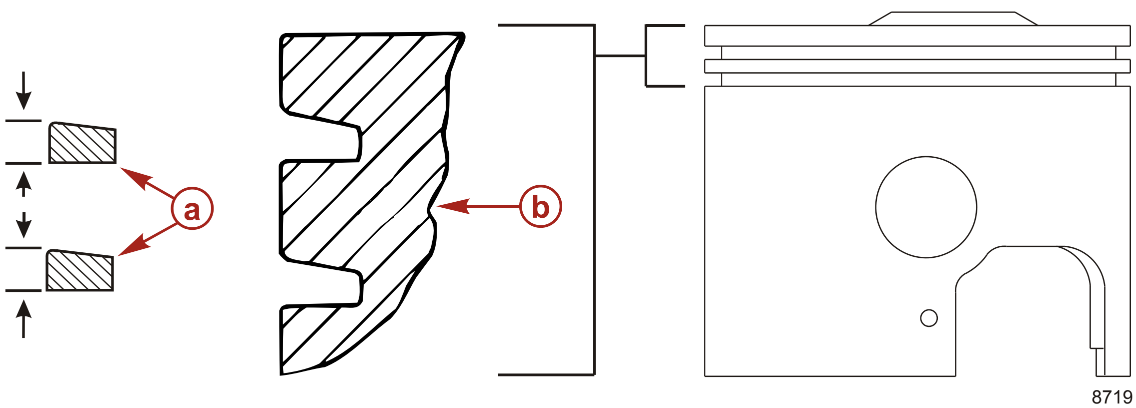
8. Verify the lockrings are properly seated in the piston grooves.



a - Lockring
b - Lockring installation tool

Lockring Installation Tool	91-77109A3
Lockring Installation Tool	91-93004A 2

Piston and Piston Ring Combinations

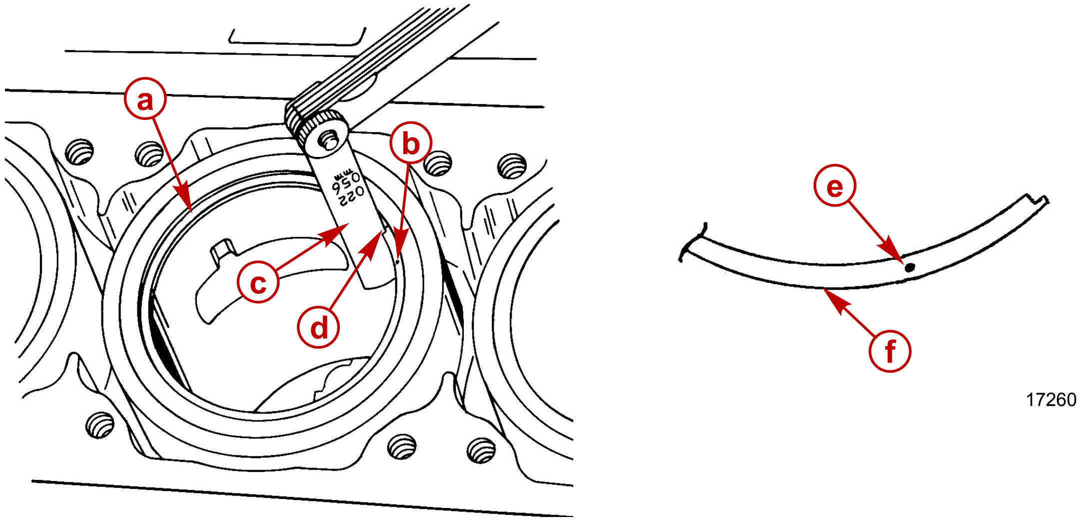


a - Half keystone piston ring (1.4 mm [0.056 in.])
b - Enlarged view of piston ring grooves

Piston Installation

1. Before installing the new piston rings, check the ring gap by placing each ring in its respective cylinder and pushing the ring 12.7 mm (1/2 in.) into the cylinder using the piston.
2. Check the end gap of each piston ring with a feeler gauge. The end gap must be within specification. If the end gap is greater than the specifications, check other piston rings until rings within the tolerance are found.

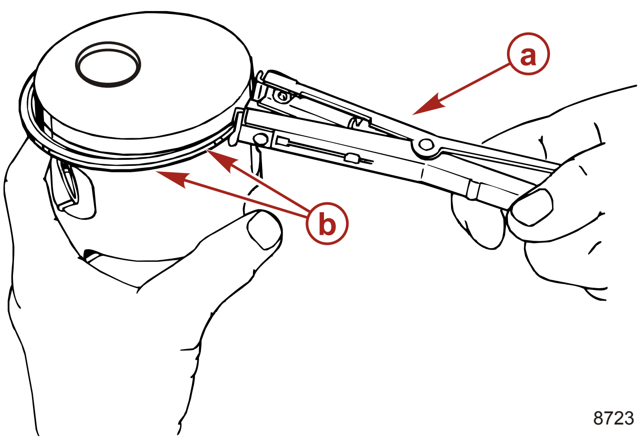
IMPORTANT: The piston ring side with a dot or letter must be facing up.



a - Piston ring
b - Dots
c - Feeler gauge
d - Ring end gap
e - Dot or letter
f - Piston ring

Piston ring end gap	
Standard bore	0.25 mm–0.45 mm (0.010 in.–0.018 in.)
Oversize bore	

3. Use a piston ring expander and install the piston rings with the dot side up onto the piston.
4. Verify the piston rings rotate in the ring groove.
5. Lubricate the piston and rings with 2-Cycle Premium Outboard Oil.



a - Piston ring expander
b - Dot side up on piston ring

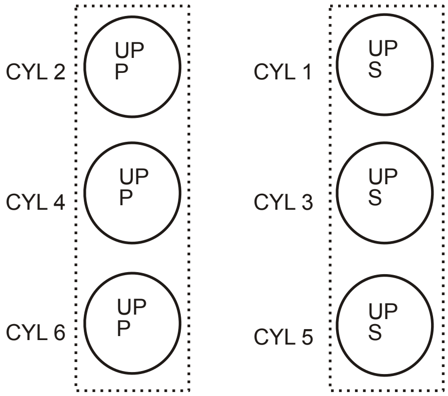
Piston Ring Expander	91-24697

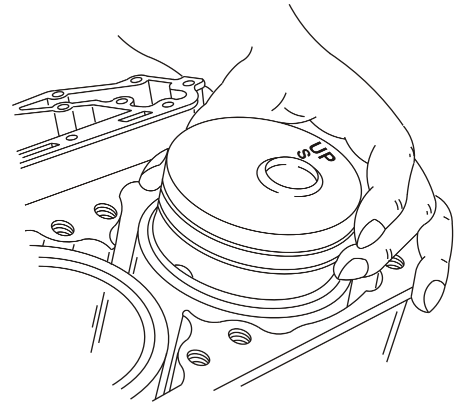
Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Piston and cylinder wall	92-858021K01

6. Align the piston ring end gap with the locating pin.
7. Install the piston ring compressor.

Piston Ring Compressor	91-818773T

8. Remove the screws and connecting rod cap from the piston rod assembly.
9. Install the pistons with the letter "P" into the port side of engine with the word "UP" facing toward the flywheel.
10. Install the pistons with the letter "S" into the starboard side of engine with the word "UP" facing toward the flywheel.
11. Apply 2-Cycle Premium Outboard Oil to the cylinder bores. Install the piston assembly into the cylinder it was removed from. Push the piston into the cylinder bore.





17263

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Cylinder bores and pistons	92-858021K01

12. Apply 2-4-C with Teflon to the bearing surface of the connecting rod and rod cap. Install the connecting rod bearing.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Bearing surfaces of connecting rod and rod cap	92-802859A 1

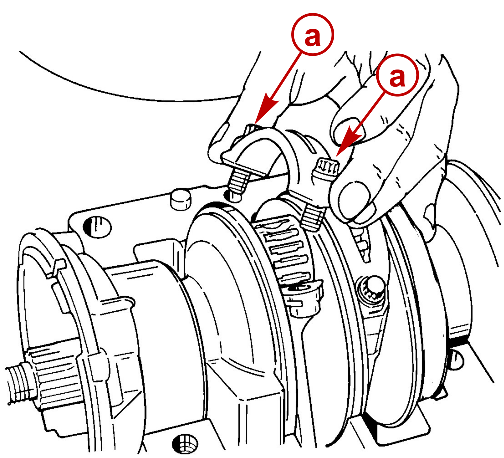
13. Install the connecting rod cap. Lubricate the threads and face of the connecting rod screws with 2-Cycle Premium Outboard Oil. Thread the screws into the connecting rod finger-tight while checking the alignment of the rod cap.

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Threads and face of connecting rod screws	92-858021K01

IMPORTANT: The connecting rod and rod cap are a matched set. Do not torque the screws before completing the following procedure.

- Run a pencil lightly over the ground area.
- If the pencil stops at a fracture point, loosen bolts, retighten, and check again.

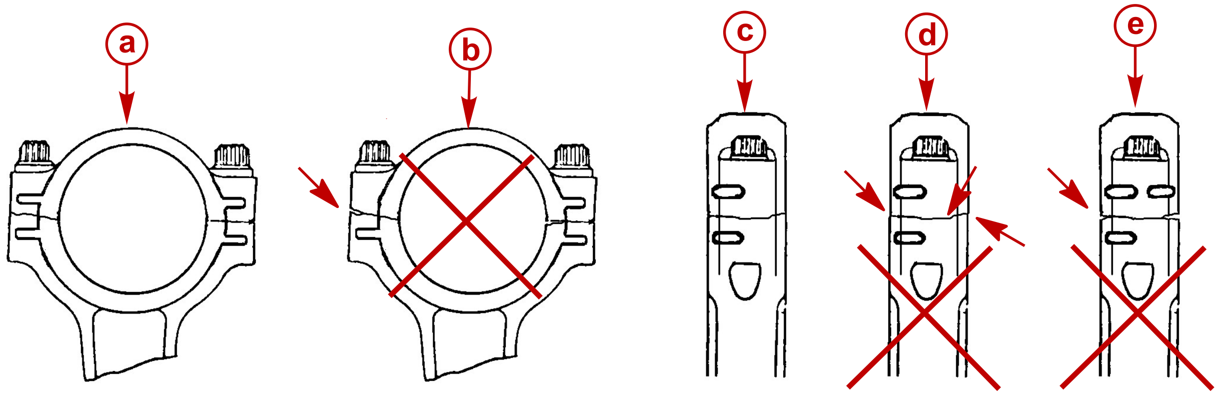
NOTE: If you still feel the fracture point, discard the rod.



17268

a - Connecting rod cap screws

14. Check each connecting rod cap for correct alignment. If it is not aligned, a ridge can be seen or felt at the separating line as shown below. Correct any misalignment.



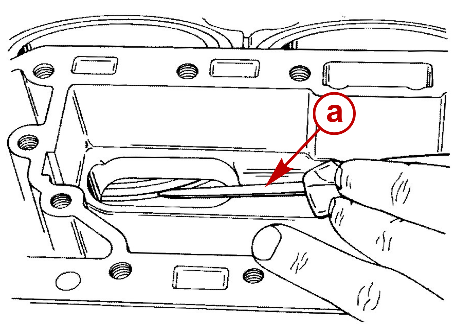
37568

a - Side view correct
b - Side view incorrect - cap on backwards
c - End view correct
d - End view incorrect - not aligned
e - End view incorrect - cap on backwards

15. Tighten the connecting rod cap screws in three steps to the specified torque.

Description		Nm	lb-in.	lb-ft
Connecting rod cap screw	**First**	1.5	15	
	Second	27		20
	Final	Turn additional 90°		

16. Rotate the crankshaft several revolutions to verify there is no binding or catching.
17. Verify if the piston rings were broken during installation by pressing in on each piston ring through the exhaust port with a screwdriver. If the ring fails to return to spring back position, it is likely the ring is broken and must be replaced.



17275

a - Screwdriver

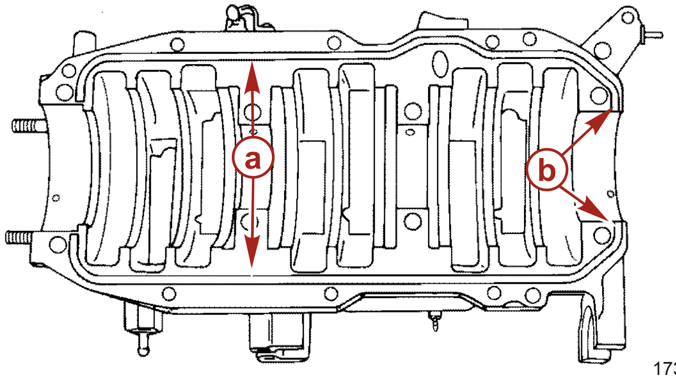
Crankcase Cover Installation

1. Ensure the mating surfaces of the crankcase cover and cylinder block are clean.
2. Apply Loctite 7649 Primer N to both of the mating surfaces.

Tube Ref No.	Description	Where Used	Part No.
117	Loctite 7649 Primer N	Crankcase cover and cylinder block mating surface	92-809824

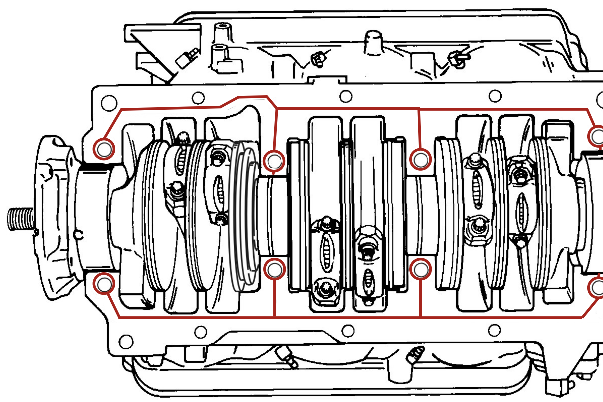
3. Install gasket strips into the grooves in the crankcase cover on S/N 0T178499 and below. Trim the end of each gasket strip flush with the edge of the cover.

NOTE: S/N 0T178500 and above do not use gasket strips on the crankcase cover.



a - Gasket strips
b - Edge of cover

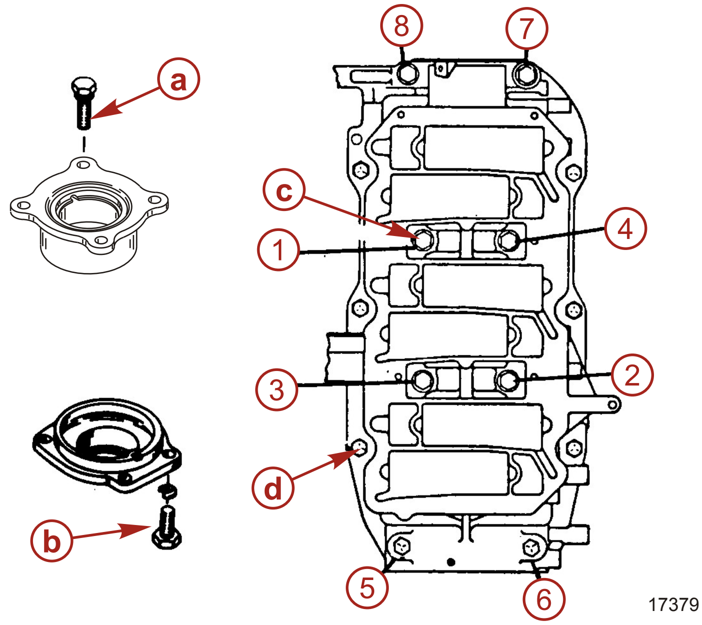
4. Apply Loctite Master Gasket onto the mating surface of the cylinder block.



Tube Ref No.	Description	Where Used	Part No.
12	Loctite Master Gasket Kit	Crankcase cover and cylinder block mating surface	92-12564 2

5. Install the crankcase cover onto the cylinder block.
6. Apply 2-Cycle Premium Outboard Oil to the eight center main screw threads and face. Install the eight center main screws and tighten the screws progressively and in the sequence shown until the crankshaft cover contacts the cylinder block.
7. Apply 2-Cycle Premium Outboard Oil to the perimeter screw threads and face. Install the crankcase cover perimeter screws.
8. Install the end cap screws and tighten the screws in sequence to the specified torque.
9. Tighten the center main screws to the specified torque.

10. Tighten the perimeter screws to the specified torque.



a - Upper end cap screws (4)
b - Lower end cap screw (4)
c - Center main screw (8)
d - Perimeter screw (6)

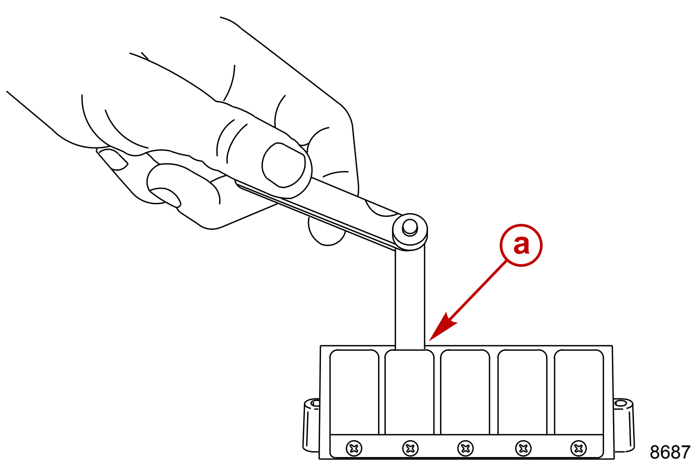
Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	Center main screw and perimeter screw threads and face	92-858021K01

Description	Nm	lb-in.	lb-ft
Upper end cap screws	17	150	
Lower end cap screws	9	80	
Center main screws	51		37
Perimeter screws	20	180	15

Reed Block Assembly

IMPORTANT: Do not remove the reeds from reed blocks unless replacement is necessary. Do not turn used reeds over for reuse. Replace reeds in sets.

1. Thoroughly clean the gasket surfaces of the reed blocks and reed block housing. Check for deep grooves, cracks, or distortion that could cause leakage. Replace parts as necessary.
2. Inspect the reed block neoprene surface for wear, cuts, or abrasions. Replace the reed blocks as necessary.
3. Check for chipped and broken reeds.

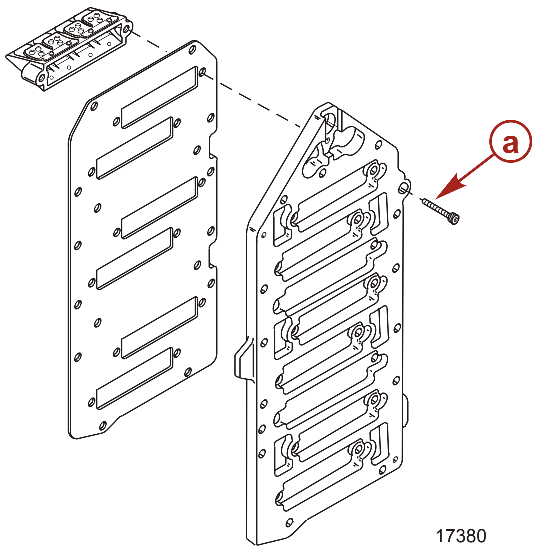


a - 0.51 mm (0.020 in.) opening

NOTE: Allowable reed opening is 0.51 mm (0.020 in.) or less. Replace reeds if either reed is standing open more than 0.51 mm (0.20 in.).

Reed Block Adapter Plate Assembly

1. Install a gasket onto the reed block adapter plate.
2. Secure the reed block to the reed block adapter plate with two screws. Tighten the screws to the specified torque.



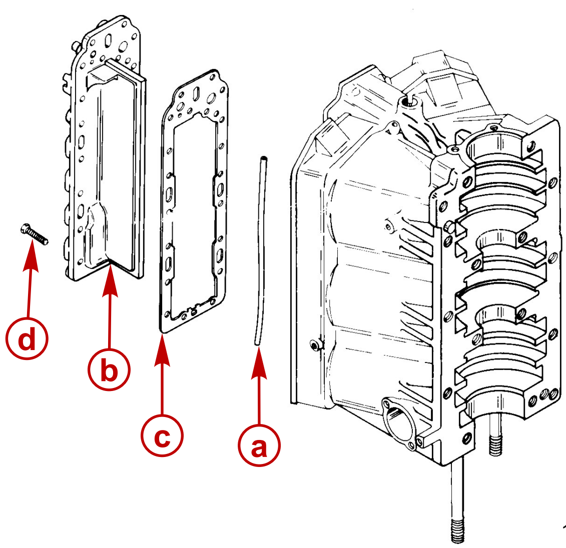
17380

a - Screw (0.250-20 x 0.880 in.) (2 each reed block)

Description	Nm	lb-in.	lb-ft
Screw (0.250-20 x 0.880 in.) (12)	11.5	100	

Exhaust Divider Assembly

1. Install the exhaust divider seal into the slot in the cylinder block.
2. Install the exhaust divider gasket onto the cylinder bock and install the exhaust divider.
3. Clean the screw threads with Loctite 7649 Primer N.
4. Apply Loctite 271 Threadlocker to the screw threads.
5. Secure the exhaust divider with the screws.

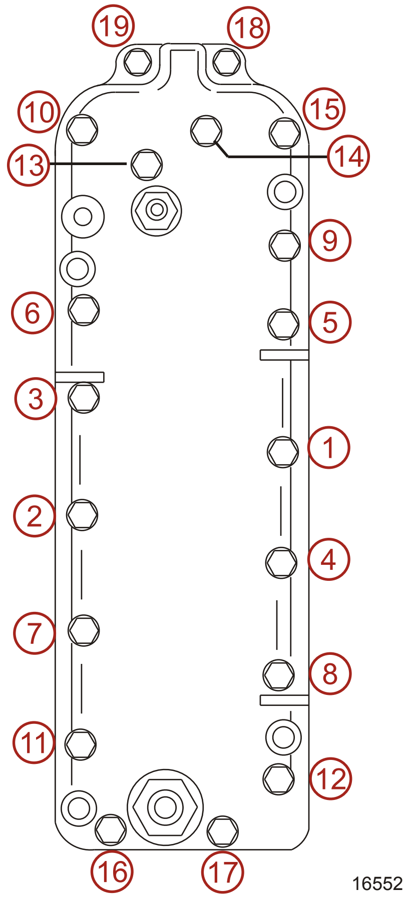


17390

a - Divider seal
b - Exhaust divider
c - Divider gasket
d - Screw (19)

Tube Ref No.	Description	Where Used	Part No.
117	Loctite 7649 Primer N	Divider plate screw threads	92-809824
7	Loctite 271 Threadlocker	Divider plate screw threads	92-809819

6. Tighten the screws in sequence to the specified torque.

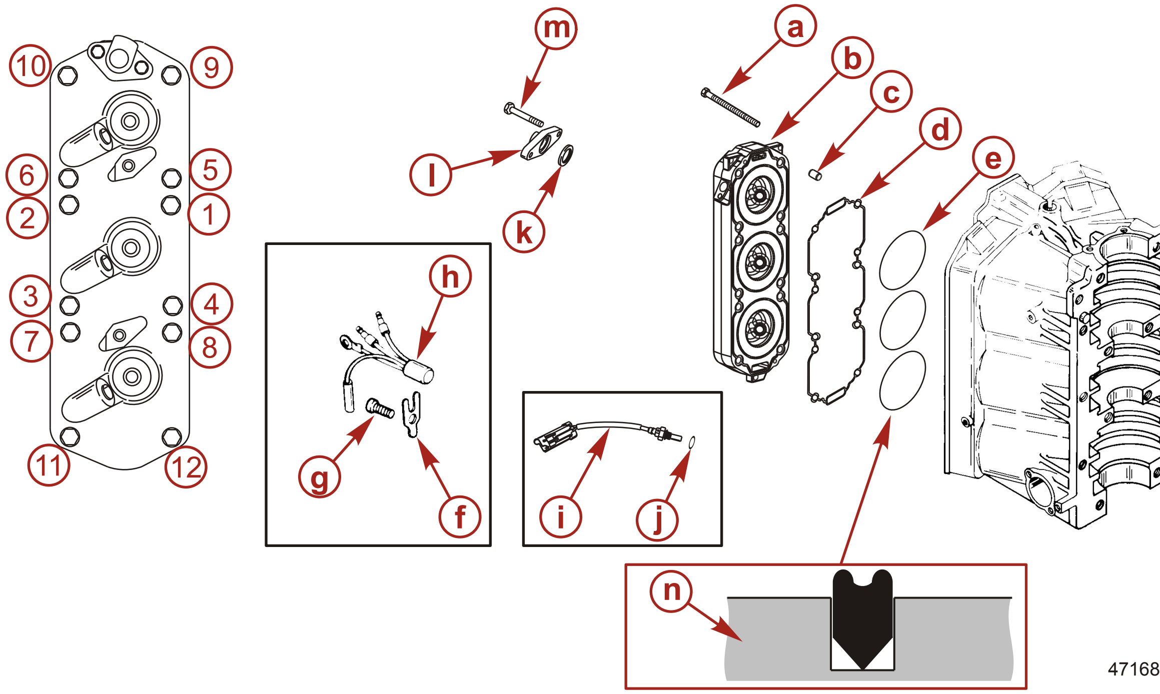


Description	Nm	lb-in.	lb-ft
Screws (19)	18	160	13

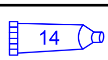
Cylinder Head Installation

1. Install the cylinder head combustion chamber seal with the grooved side towards the cylinder block.
2. Install the cylinder head seal.
3. Install the cylinder head with the thermostat towards the flywheel.
4. Apply 2-Cycle Premium Outboard Oil to the new cylinder head screw threads and face.
5. Install the thermostat cover and gasket onto the cylinder head. Secure the thermostat cover and two M6 x 25 screws.

6. Install the cylinder heads onto the cylinder block. Tighten the cylinder head screws in two stages, in sequence, to the specified torque.

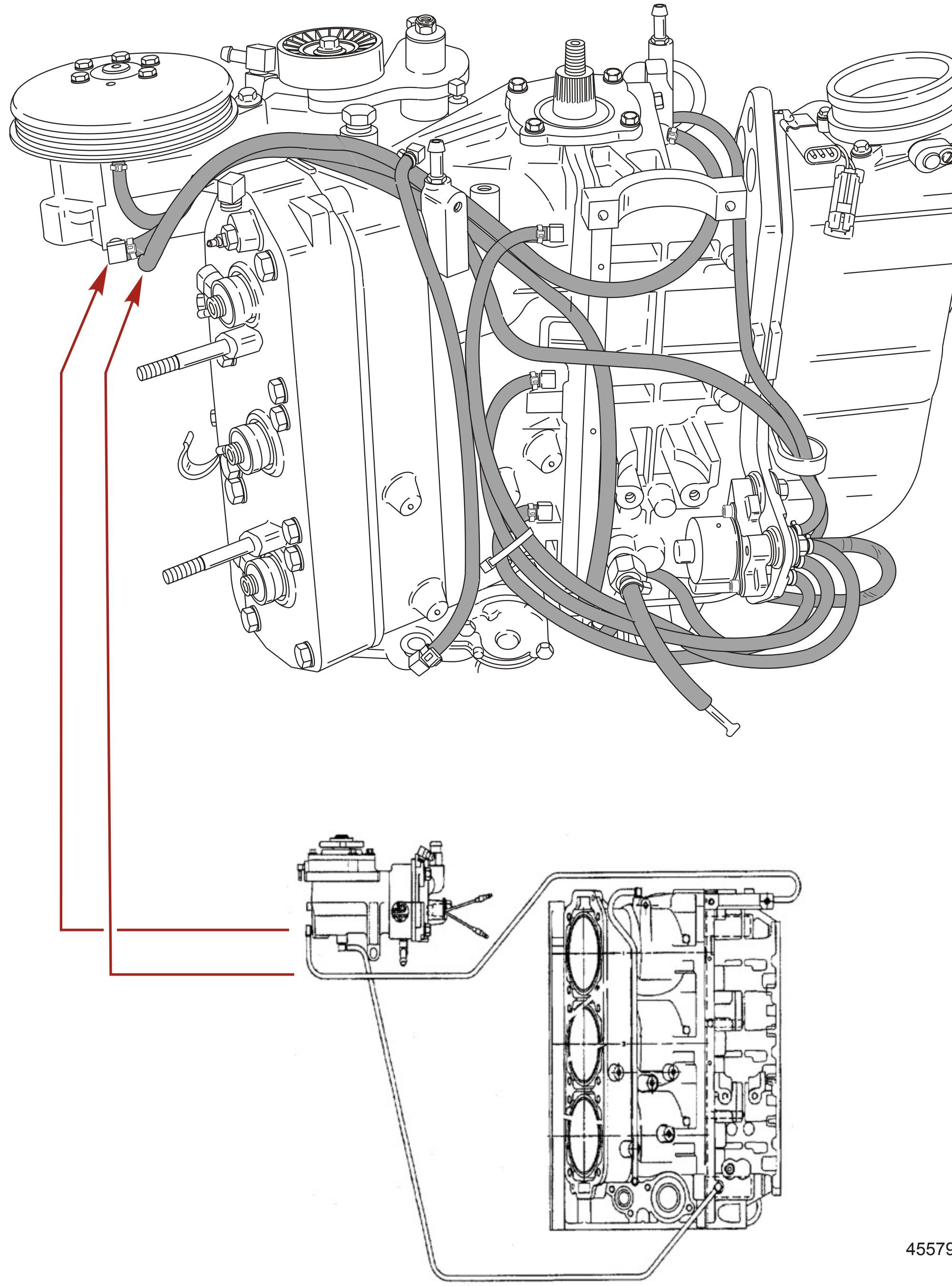


- **a -** Cylinder head screw (12)
- **b -** Cylinder head
- **c -** Dowel pin
- **d -** Seal
- **e -** Seal
- **f -** Retainer
- **g -** Screw (M8 x 12)
- **h -** Temperature sensor (S/N 0T178499 and below)
- **i -** Temperature sensor (S/N 0T178500 and above)
- **j -** O-ring
- **k -** Gasket
- **l -** Cover
- **m -** Screw (M6 x 25) (2)
- **n -** Cylinder head seal direction

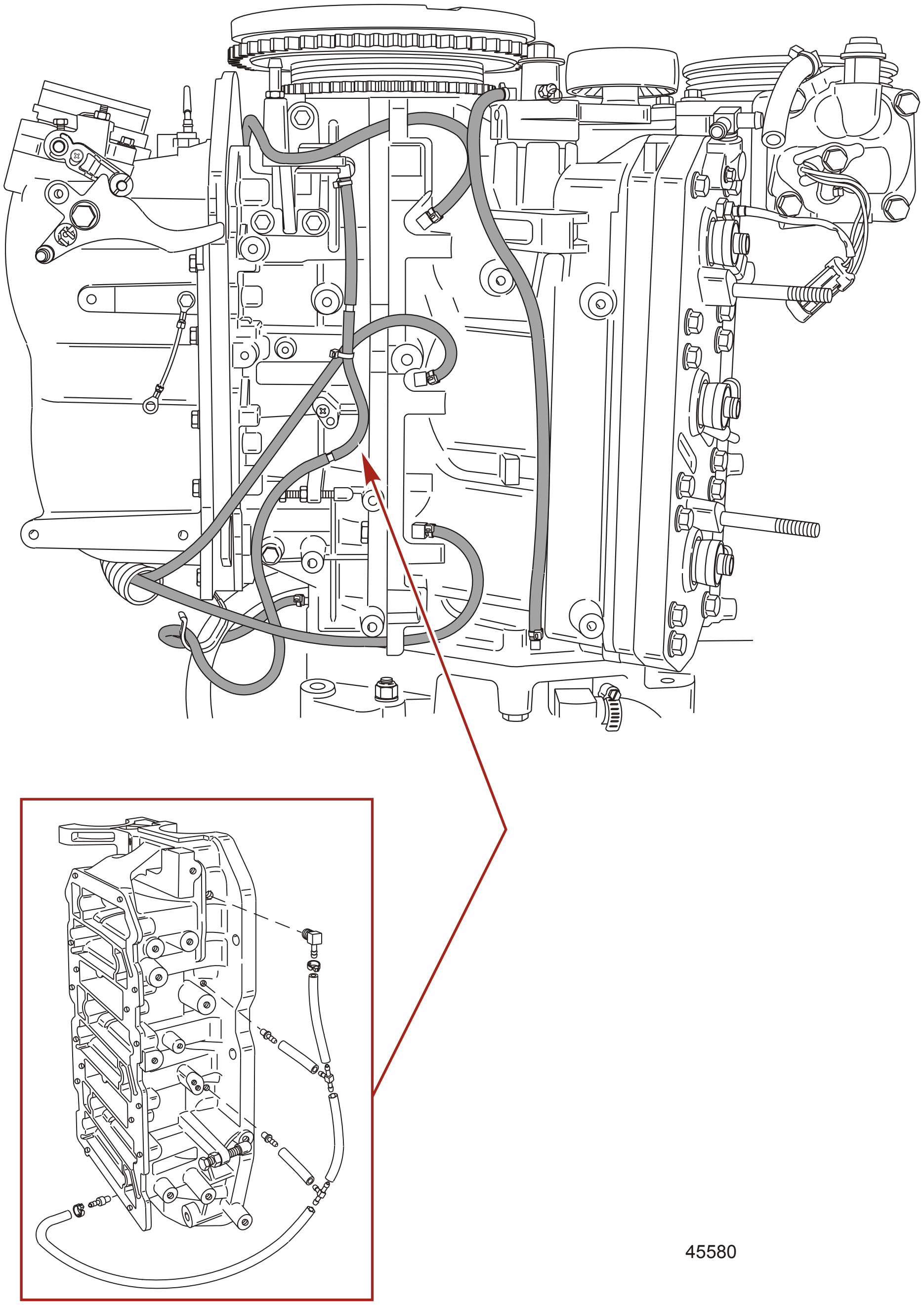
Tube Ref No.	Description	Where Used	Part No.
	2-cycle Premium Outboard Oil	Cylinder head screw threads and face	92-858021K01

Description		Nm	lb-in.	lb-ft
Cylinder head screw	**First**	40.5		30
	Final	Turn additional 90°		
Screw (M8 x 12)		23	203	17
Screw (6M x 25)		23	203	17
Temperature sensor		17	150	12

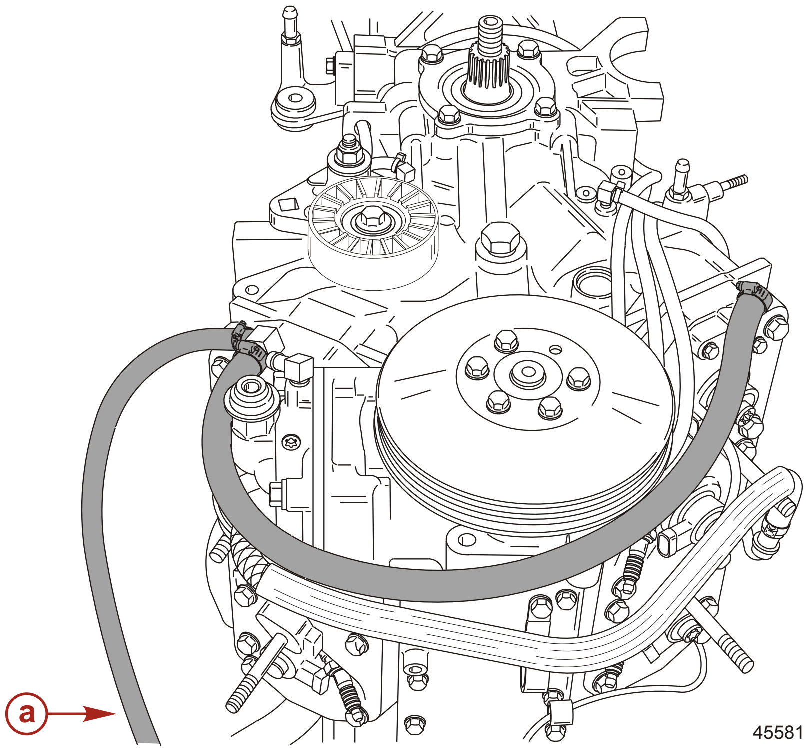
Starboard Side Oil Hose Routing



Port Side Oil Hose Routing



Water Bypass Hose Routing



a - Water bypass hose to through-the-hull fitting

Installing Powerhead Components

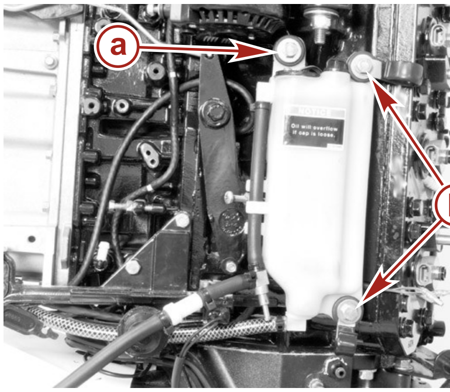
Installing Individual Engine Components

NOTE: Engine components can be installed individually or in some cases as an assembly. If installing components individually, refer to the following sections.

1. Refer to **Section 2A - Ignition** to install the following components:
   - Flywheel cover
   - Electronic control module
   - Ignition coils
2. Refer to **Section 2B - Charging and Starting System** to install the following components:
   - Flywheel
   - Alternator
   - Starter motor
   - Starter solenoid
3. Refer to **Section 3A - Fuel Pump** to install the following components:
   - Fuel lift pump
4. Refer to **Section 3B - Direct Fuel Injection** to install the following components:
   - Air plenum
   - Oil pump
   - Fuel rails

Oil Hoses and Reservoir Installation

1. Install the oil reservoir onto the cylinder block. Secure the reservoir with three 0.312-18 x 1.25 in. screws, washers, and two clamps. Tighten the screws to the specified torque.



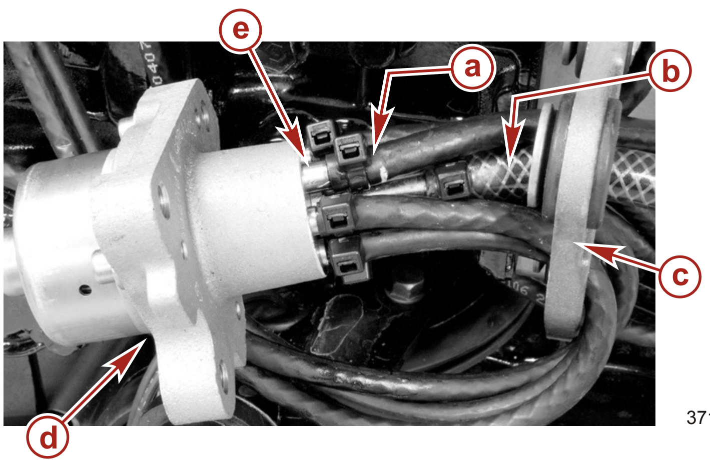
33954

- **a -** Screw and washer securing oil reservoir
- **b -** Screw and washer securing clamp and oil reservoir

Description	Nm	lb-in.	lb-ft
Screw (0.312-18 x 1.25 in.) (3)	20	177	15

NOTE: Attach the air compressor oil hose to the extended fitting on the oil pump.

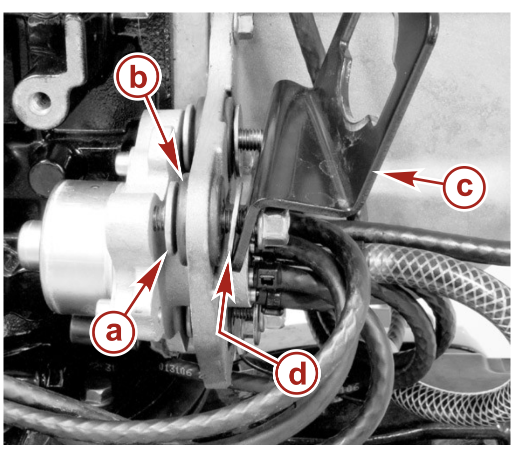
2. Install the oil hoses onto the oil pump and secure with cable ties.



37189

- **a -** Oil hose for the air compressor
- **b -** Oil delivery hose
- **c -** Plenum
- **d -** Oil pump
- **e -** Extended fitting

3. Install the oil pump onto the plenum. Secure the oil pump with three M8 x 30 screws, washers, and the 14 pin connector mounting bracket. Tighten the screws to the specified torque.



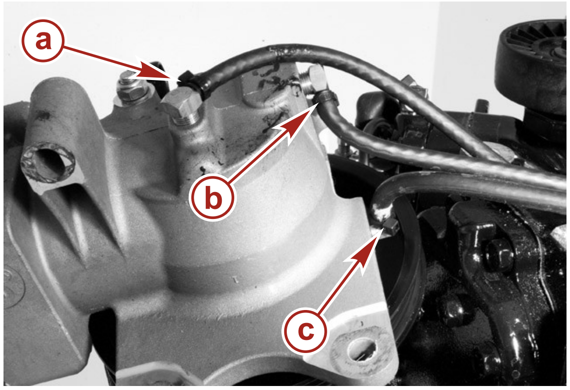
33780

- **a -** Bushing
- **b -** Grommet
- **c -** Bracket
- **d -** Washer

Description	Nm	lb-in.	lb-ft
Screw (M8 x 30)	17	150	

Air Compressor Installation

1. Install the oil line coming from the #5 reed block onto the bottom check valve and secure with a cable tie.
2. Install the oil line coming from the top main bearing onto the side check valve and secure with a cable tie.
3. Install the oil line coming from the oil pump onto the fitting under the air compressor pulley and secure with a cable tie.

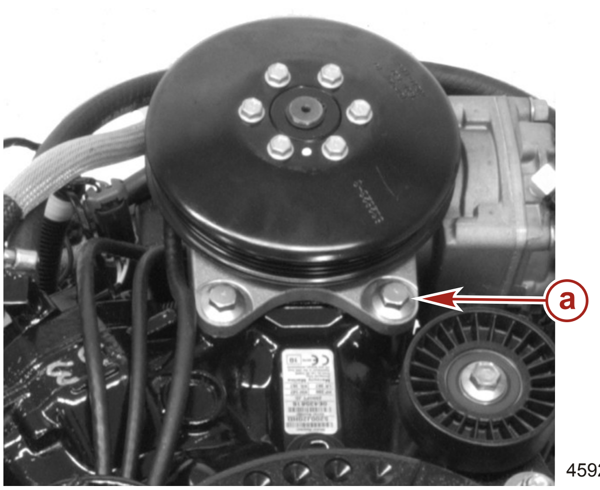


26404

a - Cable tie securing the oil line coming from #5 reed block
b - Cable tie securing the oil line coming from the top main bearing
c - Cable tie securing the oil delivery line coming from the oil pump

4. Install the air compressor onto the studs.
5. Install the two top screws (M10 x 25) finger-tight and then tighten to the first specified torque.
   IMPORTANT: Do not overtighten. This is the first of a two stage torque process.

Description		Nm	lb-in.	lb-ft
Screw (M10 x 25) (2)	First	1.5	13	
	Final	56		41.3

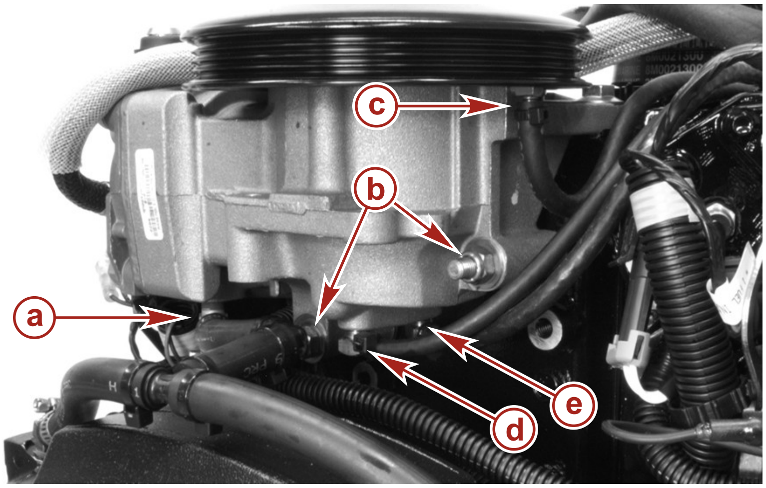


45928

a - Screw (M10 x 25, flange) (2)

6. Install the water dump hose to the air compressor and secure with a cable tie.

7. Install a washer and nut onto each stud and tighten the nut to the specified torque.



45931

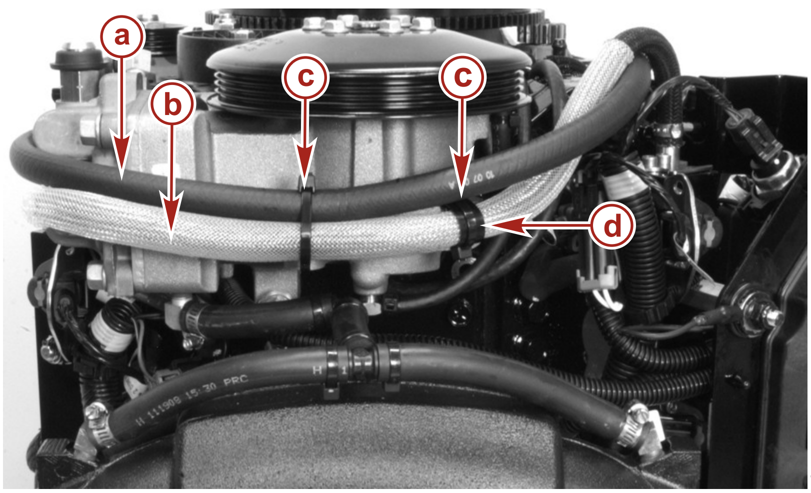
a - Water hose to expansion chamber
b - Nut and washer (M8)
c - Air compressor oil inlet hose
d - Oil hose to top main bearing
e - Oil hose to #5 reed block

Description	Nm	lb-in.	lb-ft
Nut securing air compressor	34		25

8. Tighten the two top screws (M10 x 25) securing the air compressor assembly to the cylinder block to the specified torque.

Description		Nm	lb-in.	lb-ft
Screw (M10 x 25) (2)	First	1.5	13	
	Final	56		41.3

9. Secure the air compressor hose to the air compressor with a J-clamp and cable tie. Secure the water hose and air compressor hose to the air compressor with a cable tie.

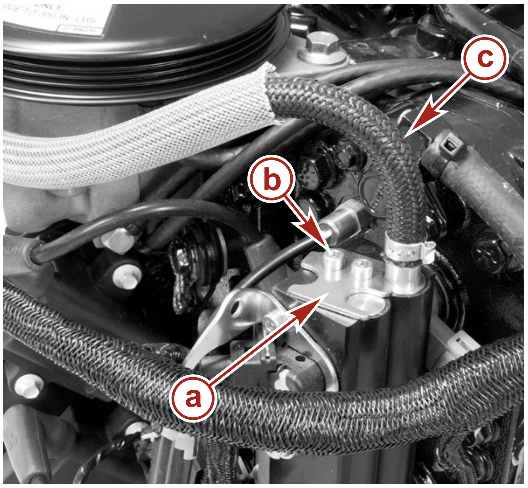


45930

a - Water hose
b - Air compressor to fuel rail hose
c - Cable tie
d - Plastic J-clamp

10. Install two O-rings onto the fuel rail air compressor hose fitting. Lubricate the O-rings with 2-cycle Premium Outboard Oil.

11. Install the fitting into the fuel rail and secure with a retainer and two screws. Tighten the screws to the specified torque.



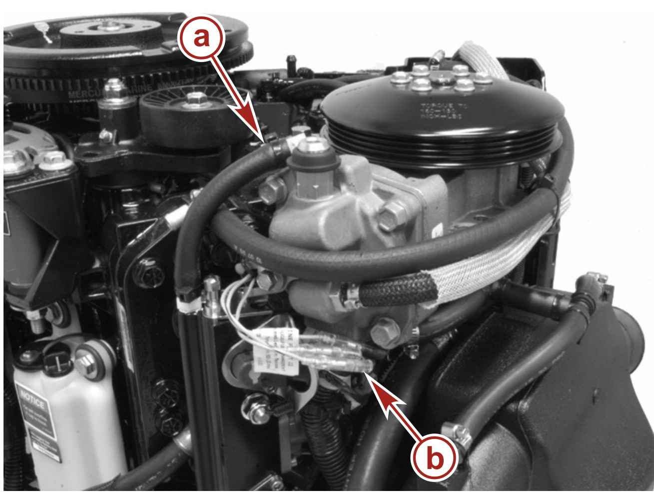
32810

a - Retainer
b - Screw (2)
c - Air compressor hose

Tube Ref No.	Description	Where Used	Part No.
14	2-cycle Premium Outboard Oil	O-rings on the fuel rail air compressor hose fitting	92-858021K01

Description	Nm	lb-in.	lb-ft
Screw	8	71	

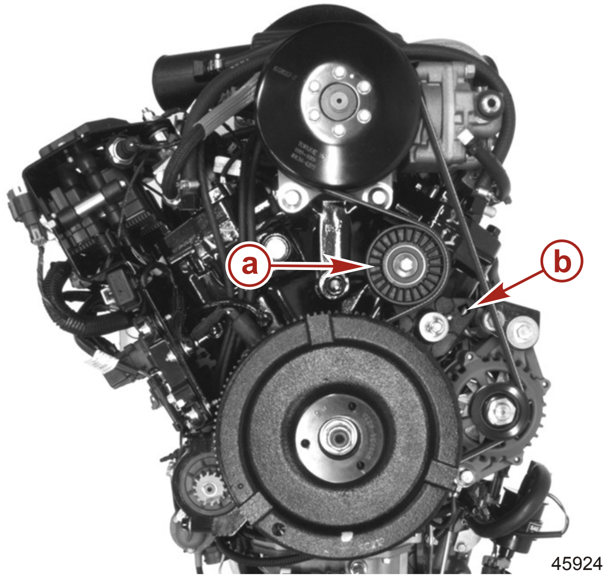
12. Secure the water inlet hose to the air compressor with a cable tie.
13. Connect the air compressor temperature sensor bullet connectors to the wire harness connector.



45934

a - Water inlet hose
b - Bullet connectors

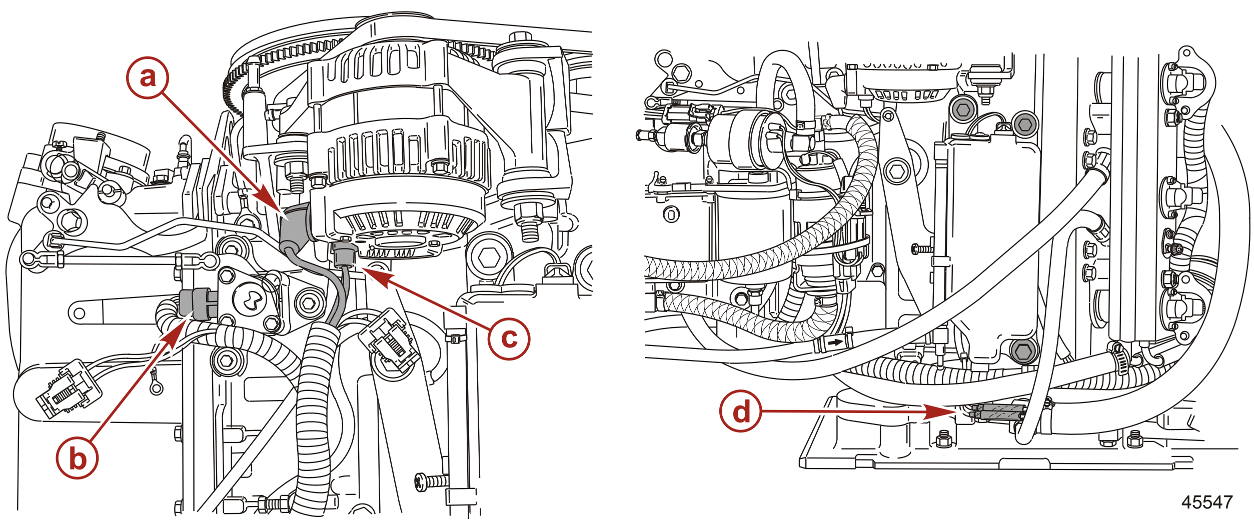
14. Use a 3/8 in. square drive on the belt tension arm and install the belt to the air compressor pulley.



a - Belt tensioner
b - 3/8 in. square drive

Electrical Plate and Harness Installation

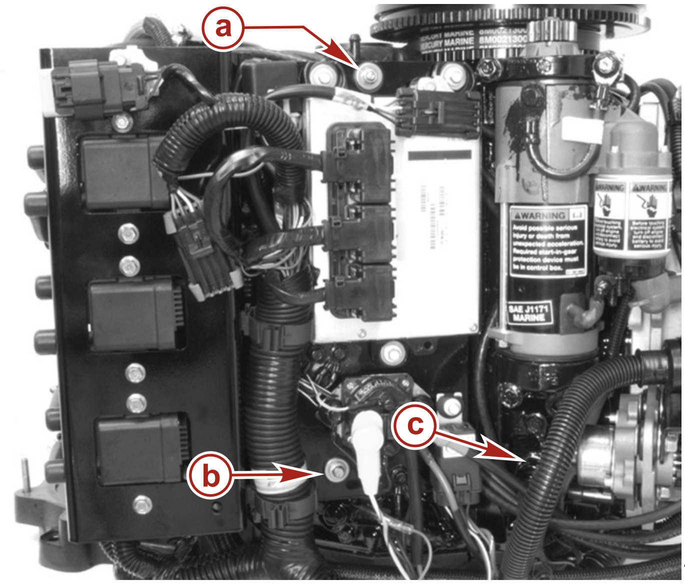
1. Install the electrical harness assembly onto the engine.
2. Connect the low oil sensor bullet connectors.
3. Install the sense lead onto the alternator.
4. Connect the TPS harness connection.
5. Install the output lead onto the alternator.



a - Alternator output lead
b - TPS harness connection
c - Alternator sense lead
d - Low oil sensor bullet connectors

6. Install the nut and screw securing the electrical plate.

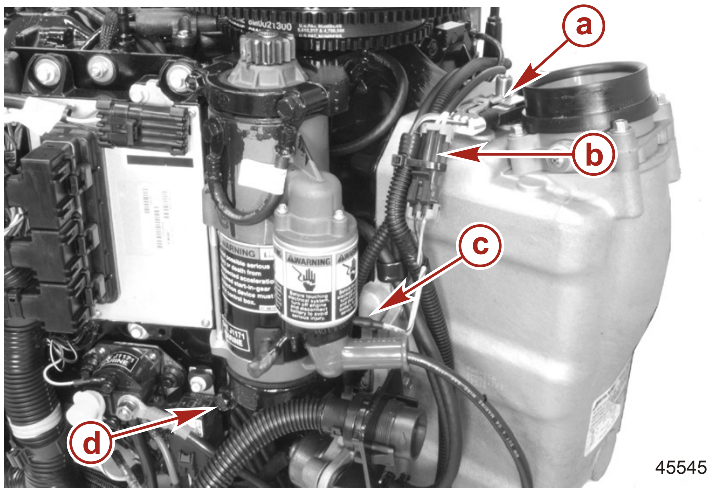
7. Connect the oil pump connector.



45918

a - Nut and washer
b - Screw
c - Oil pump connector

8. Connect the harness ground lead below the starter motor.
9. Connect the red and yellow/red leads to the starter solenoid.
10. Connect the MAP sensor connector.
11. Connect the air temperature sensor connector.

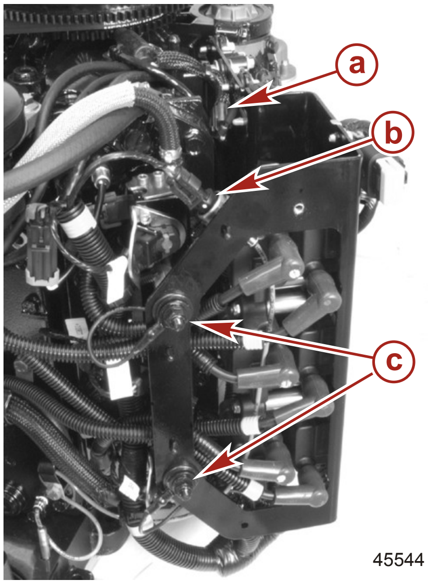


45545

a - MAP sensor connector
b - Air temperature sensor connector
c - Yellow/red wire
d - Harness ground lead

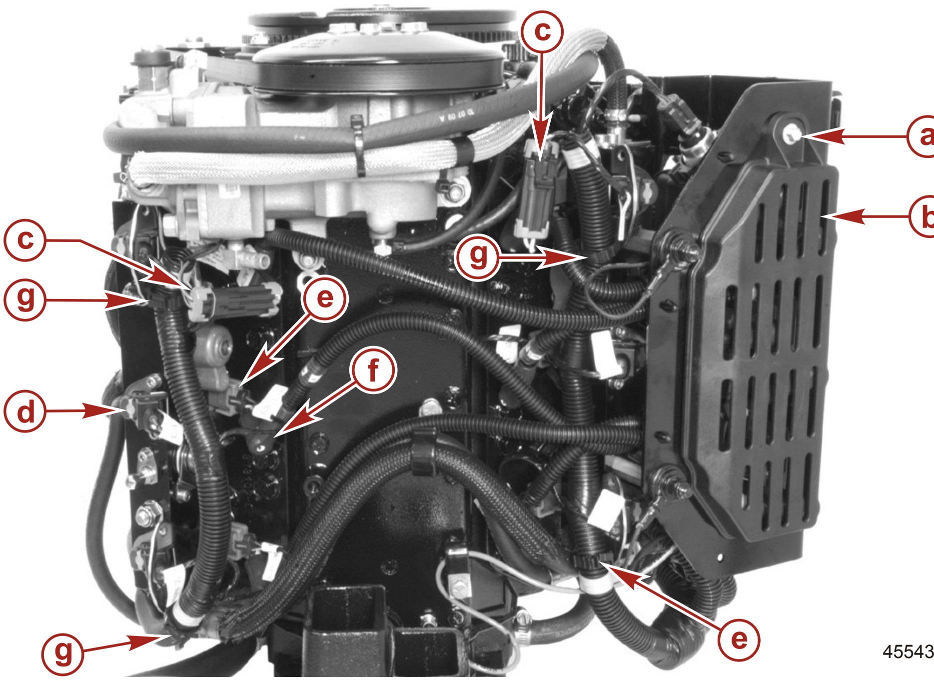
12. Connect the crankshaft position sensor connector.
13. Connect the water pressure sensor harness and sensor retainer.
14. Install two nuts securing the aft portion of the electrical plate.

15. Install the screw securing the electrical plate cover.



a - Crankshaft position sensor connector
b - Water pressure sensor
c - Nut (M8)

16. Connect the wiring harness retainers.
17. Connect the direct injector connectors on the starboard fuel rail.
18. Connect the fuel injector connectors.
19. Install the spark plug boots onto the spark plugs.
20. Connect the temperature sensor connectors.

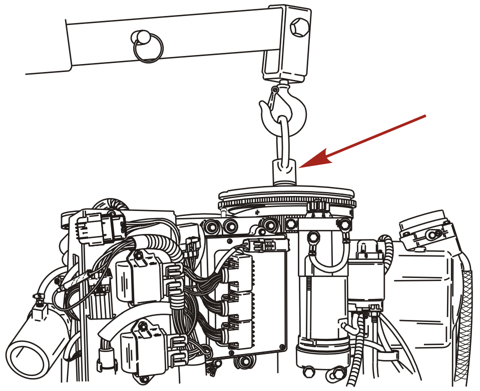


a - Screw and bushing
b - Electrical plate cover
c - Temperature sensor connectors (2)
d - Direct injector connectors (6)
e - Fuel injector connectors (6)
f - Spark plug boots (6)
g - Wiring harness retainers (4)

Powerhead Installation on the Pump Unit

1. Install the lifting eye into the flywheel.
2. Lift powerhead high enough to allow removal of the powerhead from the stand. Remove the powerhead from the stand, being careful not to damage gasket surface of adapter plate.
   IMPORTANT: DO NOT apply lubricant to top of driveshaft as this will prevent driveshaft from fully engaging into crankshaft.
3. Apply a small amount of Special Lubricant 101 onto the driveshaft splines.

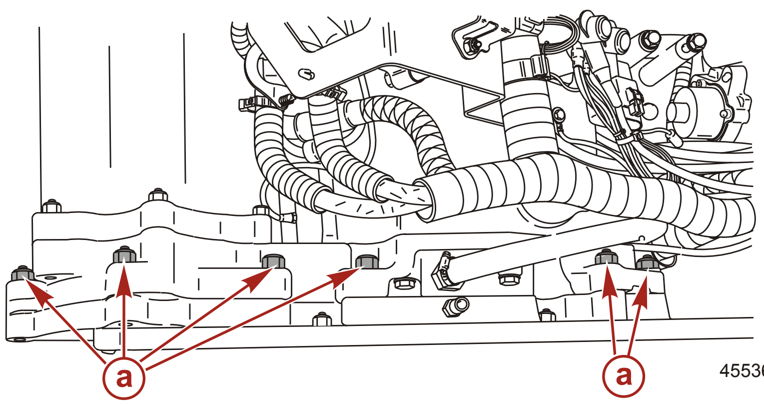
4. Lower powerhead onto pump unit. It may be necessary to turn flywheel (aligning crankshaft splines with driveshaft splines) so that powerhead will be fully installed.



Lifting Eye	91- 90455 1

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

5. Install eleven nuts which secure powerhead to exhaust extension plate/driveshaft housing. Tighten the nuts in three progressive steps until the final torque specification is reached.

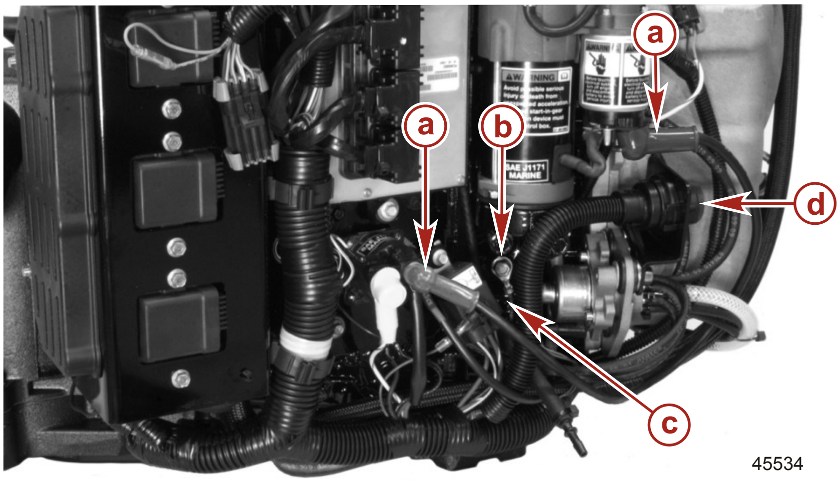


a - M10 nuts (11)

Description		Nm	lb-in.	lb-ft
M10 nuts (11)	Final	47		35

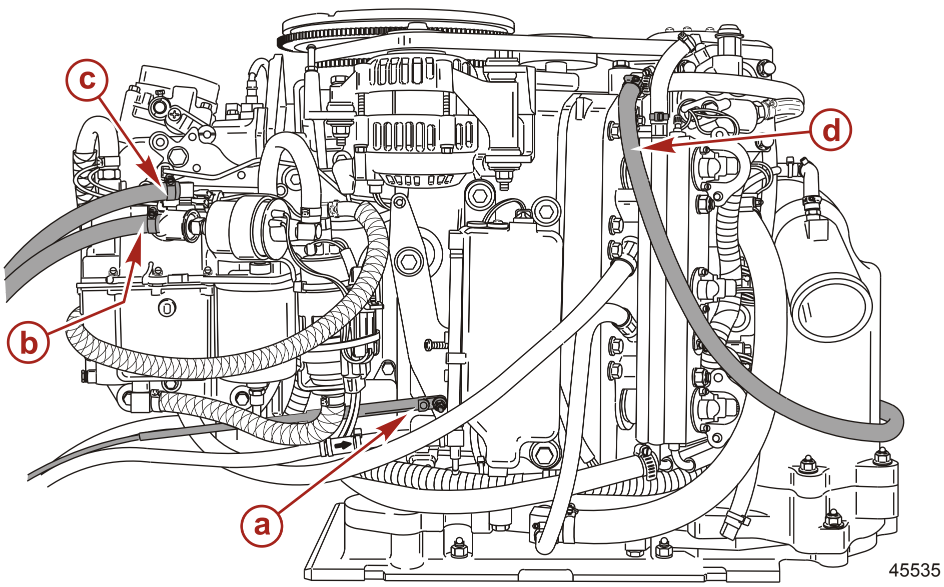
6. Disconnect the hoist from lifting eye and remove the lifting eye from flywheel.
7. Install the plastic cap into the center of the flywheel cover.
8. Connect the positive battery cable to the starter solenoid.
9. Connect the negative battery cable to the lower front starter mounting bolt.
10. Connect the remote oil tank pressure hose.

11. Connect the remote control harness to the powerhead harness connector.



a - Positive battery cable
b - Negative battery cable
c - Remote oil tank hose (hidden)
d - Remote control harness connection

12. Install the throttle cable. Secure with a washer and locknut. Tighten the locknut and then back off 1/4 turn.
13. Install the fuel inlet line. Secure the hose with a stainless hose clamp.
14. Install the vapor separator vent hose. Secure the hose with a stainless hose clamp.
IMPORTANT: The high-pressure pump connector must be routed on the outside of the VST vent fitting.
15. Install the water bypass hose. Secure the hose with a stainless hose clamp.



a - Throttle cable
b - Fuel inlet
c - Vent hose
d - Water bypass hose

NOTE: Refer to ***Section 2C - Timing, Synchronizing, and Adjusting*** *for engine set-up procedures.*

16. Connect the battery cables to the battery.

Engine Break-in Procedure After Powerhead Assembly

IMPORTANT: The service technician must complete the following break-in procedure before delivery to the owner. Do not use premixed gas and oil in this engine. Use straight gasoline during break-in and after engine break-in.

The recommended engine break-in procedure for the sport jet engine is important to ensure proper performance and maximum life from the engine. The break-in procedure allows the pistons to ease into conformance with the cylinder bore.

The engine automatically receives extra oil during the first hours of operation. This extra oil mode will complete in about ten hours.

Engine Break-in Procedure	
Step 1: First 40 minutes - Keep the boat on the trailer. Place the boat and trailer in water that is deep enough to submerge the water intake grate. Keep the bow attached and tight to the trailer, but remove or loosen the rear straps to allow the boat to float at the rear. Run the engine at the listed run time and at the RPM speed.	
Run Time	**Engine RPM Speed**
First 10 minutes	2500 RPM
Next 10 minutes	3000 RPM
Next 5 minutes	3500 RPM
Next 5 minutes	4000 RPM
Next 5 minutes	4500 RPM
Next 5 minutes	5000 RPM
Step 2: Next 14 minutes - Remove the boat from the trailer and run on the water. The run times for the first four wide-open throttle encounters is very critical. Keep the run time within the given range. Run the engine at the listed run time and RPM speed.	
Run Time	**Engine RPM Speed**
First 10 seconds ± 3 seconds	Wide-open throttle 5600 RPM
Next 20 seconds	3500 RPM
Next 20 seconds ± 3 seconds	Wide–open throttle 5600 RPM
Next 40 seconds	3500–4000 RPM
Next 30 seconds ± 3 seconds	Wide–open throttle 5600 RPM
Next 1½ minutes	3500–4000 RPM
Next 45 seconds ± 3 seconds	Wide-open throttle 5600 RPM
Next 1½ minutes	3500–4000 RPM
Next 4¼ minutes	Wide-open throttle 5600 RPM

NOTE: After this break-in procedure is completed, the owner should follow the ***Recommended Break-in Procedure****.*

Recommended Break-in Procedure

IMPORTANT: Failure to follow the engine break-in procedures can result in poor performance throughout the life of the engine and can cause engine damage. Always follow break-in procedures.

Fuel Requirements

Do not use premixed gas and oil in this engine. Use straight gasoline during engine break-in and after engine break-in. The PCM is programmed to signal the oil pump to provide additional oil during the first 120 minutes of operation. The PCM monitors this period through its own internal clock. At the end of this period, the PCM signals the oil pump to go to a standard ratio of 300–400:1 at idle and 60:1 at WOT.

Initiating Engine Break-in Sequence (Priming Oil Pump)

Refer to **Section 3C - Oil Injection** for proper procedures.

Engine Break-in Procedure (All Models)

First Hour:

- Allow engine to warm up for 30–60 seconds.
- Avoid continuous operation at idle speed for more than 10 minutes.
- Operate engine for the majority of time between 3000–5000 RPM; approximately 3/4 throttle.
- Vary engine speed; change engine speed approximately every two minutes.
- Avoid trimming outboard up/out beyond a vertical trim position during operation.
- Short bursts of full throttle for periods up to 10 seconds are acceptable.

Next Three Hours:

- Change engine speed every 10 minutes.

Notes:

Powerhead

Section 4B - Cooling

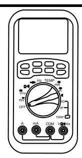
Table of Contents

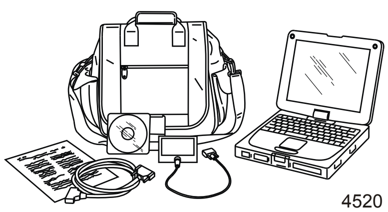
4
B

Cooling System Specifications

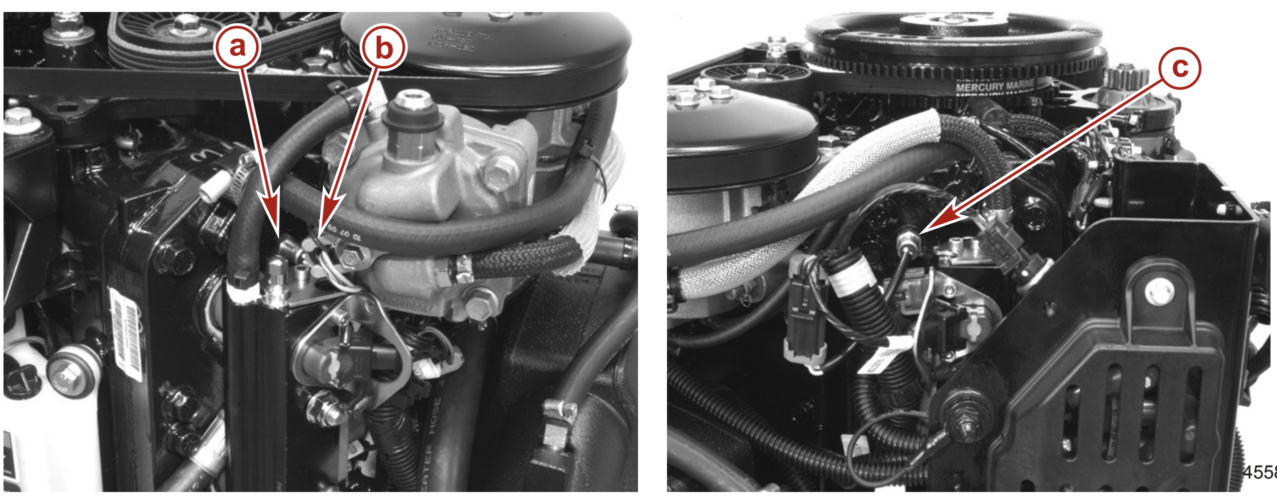
Cooling System Specifications	
Water pressure	
At 900–1000 RPM	1.4–41 kPa (0.2–0.6 psi)
Temperature sensor	
Between black and each tan/black wire	Refer to **Temperature Sensors**
Between each lead and ground	Refer to **Temperature Sensors**

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

Temperature Sensor Location and Function



45586

Port Starboard

- **a -** Port cylinder head temperature sensor - Activates at 105 °C (221 °F) - Horn activation and speed reduction
- **b -** Air compressor temperature sensor - Activates at 105 °C (221 °F) - Horn activation and analog temperature gauge
- **c -** Starboard cylinder head temperature sensor - Activates at 105 °C (221 °F) - Horn activation and speed reduction

Temperature Sensors

NOTE: The computer diagnostic system (CDS) can be used to monitor temperature readings from both temperature sensors.

Three temperature sensors are used to provide temperature information to the PCM. One sensor is mounted in each cylinder head (2 pin connector) and one sensor is mounted in the air compressor cylinder head (4 wire sensor). The cylinder head sensors are threaded into the cylinder head. The air compressor sensor is secured by a retainer and bolt.

The PCM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an overheat condition.

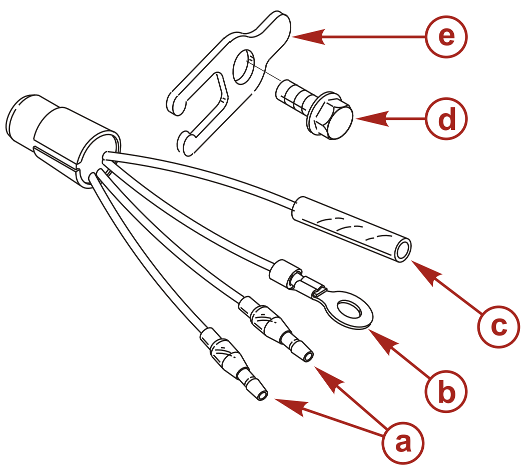
A resistance test of the temperature sensor would be as follows:

Disconnect the temperature sensor harness and check continuity with digital or analog ohmmeter test leads between both connector pins. Readings should be within 10% of specified. There should be no continuity between each connector pin and ground.

DMT 2004 Digital Multimeter	91-892647A01
Computer Diagnostic System (CDS)	Order through SPX

4 and 2 Wire Temperature Sensor

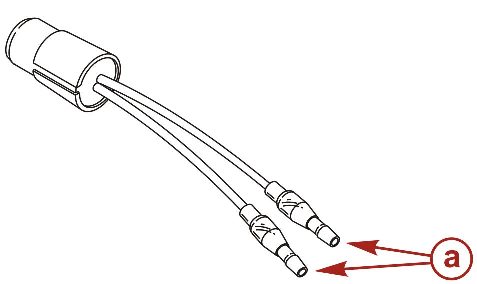
1. 4 wire sensor:
   a. Analog gauge sender - tan/blue and black leads
   b. Temperature sensor - tan/black leads
   c. One sensor installed in the air compressor head



40460

4 wire sensor
- a - Tan/black wires - temperature sensor
- b - Black wire - analog gauge
- c - Tan/blue wire - analog gauge
- d - Bolt
- e - Retainer

2. 2 wire sensor:
   a. Temperature sensor only - tan/black leads
   b. One sensor installed in each cylinder head



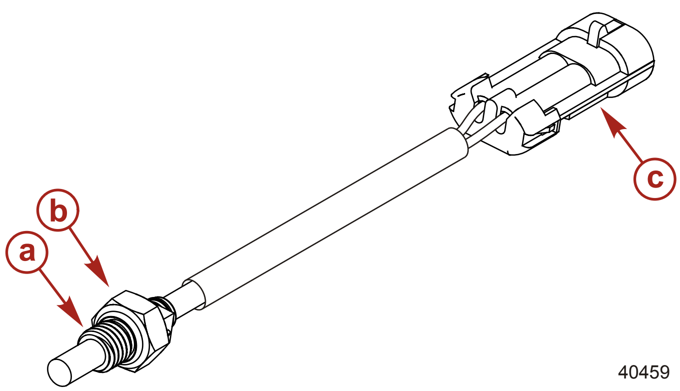
40461

2 wire sensor
- a - Tan/black wires - temperature sensor

Analog Gauge Sender		
°C	°F	Ohms ± 10%
85	185	83
80	176	97
75	167	115
70	158	136
65	149	161
60	140	193
55	131	231
50	122	279
45	113	338
40	104	412
35	95	505
30	86	623
25	77	774
20	68	968
15	59	1218
10	50	1544
5	41	1974
0	32	2544
-5	23	3319
-10	14	4362
-15	5	5778

2 Pin Connector Cylinder Head Temperature Sensor

S/N 0T801000 and above (model year 2004 and newer) - Threaded brass housing.



a - M10-1.5 thread
b - Brass housing
c - 2 pin connector

Brass Housing Sender		
°C	°F	Ohms ± 10%
85	185	1070
80	176	1256
75	167	1480
70	158	1751
65	149	2082
60	140	2487
55	131	2985
50	122	3601
45	113	4367
40	104	5325
35	95	6530
30	86	8056
25	77	10000
20	68	12493
15	59	15713
10	50	19902
5	41	25391
0	32	32640
-5	23	42292
-10	14	55253
-15	5	72809

Water Pressure Check

Water pressure may be checked by using a computer diagnostic system (CDS) or if the boat is so equipped, with SmartCraft gauges.

Water pressure	
900–1000 RPM	1.4–4 kPa (0.2–0.6 psi)
5500 and boat on plane	69–103 kPa (10–15 psi)

Problem Diagnosis

Condition	Recommended Range	Possible Cause
Pressure below specification at idle	1.4–4 kPa (0.2–0.6 psi)	• Severe internal leak • Inlet restriction
Pressure above 34 kPa (5 psi) at idle	1.4–4 kPa (0.2–0.6 psi)	• Plugged tell-tale
Pressure is below minimum specification at WOT, 5500 RPM with boat on plane	69 kPa (10 psi)	• Inlet restriction • Severe internal leak
Pressure higher than normal at WOT, but engine still indicates overheat condition, 5500 RPM with boat on plane	Maximum pressure - 103 kPa (15 psi)	• Outlet water passages restricted • Steam pocket has formed at top of powerhead due to lack of cooling water • Kinked hose - expansion chamber to adapter plate
Pressure below specification at idle or WOT		• Pinched/kinked/leaky hose from exhaust cover to water pressure sensor • Plugged fitting on exhaust cover • Wire harness connection at water pressure sensor • Weeds or debris on impeller shaft
Exhaust hose burned - expansion chamber to muffler		• Kinked hose - strainer to starboard fuel rail • Plugged strainer - adapter plate • Kinked hose - compressor to expansion chamber

Model 200 Water Flow

Description

Water is pumped up through the adapter plate (9) and into the powerhead by the jet pump impeller which is constantly turning whenever the engine is running. Water flows through the center of the block, around the cylinder sleeves and through the cylinder heads (1).

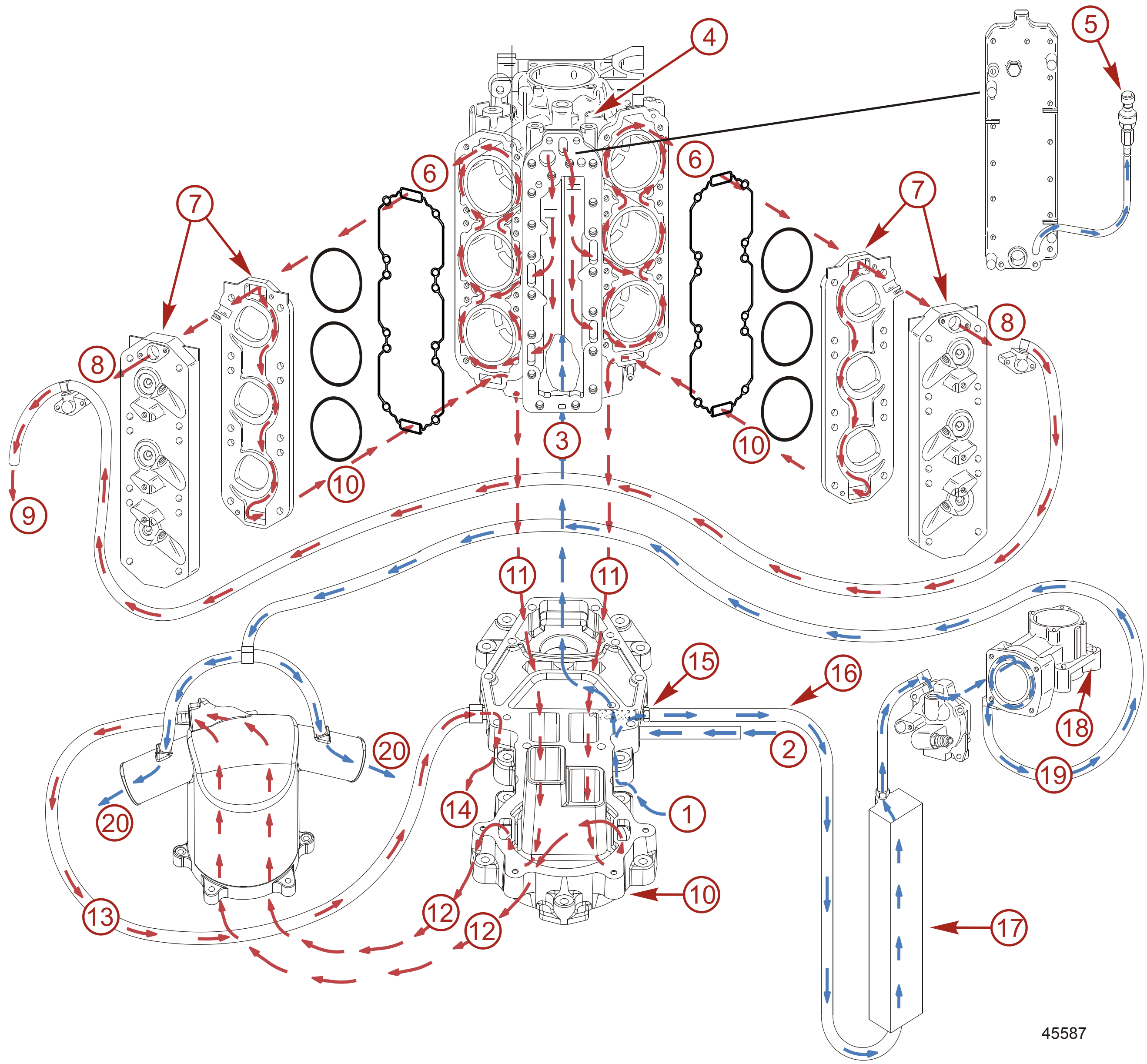
Water exits from the bottom of the block and into the adapter plate (9) flowing past the exhaust runners and into the expansion chamber. The water fills the expansion chamber and exits out the top of the chamber via a hose and back into the adapter plate where it drains into the pump.

Water is also pumped from the starboard side of the adapter plate to the fuel cooler (13) and then to the air compressor (12). The water exits the air compressor via a hose to a T-fitting over the expansion chamber. The water is then sprayed into each exhaust pipe for cooling purposes.

To allow complete passage filling and to prevent steam pockets, all cooling passages are interconnected. Small passages are incorporated to allow the cooling system to drain.

Notes:

Water Flow Diagram



Powerhead and Exhaust Cooling Circuit

1 - Inlet cooling water from jet pump
2 - Water inlet from flushing connection
3 - Water flow from adapter to powerhead
4 - Water fills center of powerhead, flows over exhaust runners, then to cylinder jackets
5 - Water pressure sensor
6 - Cooling water fills cylinder jackets, then flows to cylinder head
7 - Majority of water flows down cylinder head. Cylinder head cover has been removed from head for illustration. It is normally part of head casting.
8 - Small amount of water flows out top of head to water bypass. The thermostats are removed on the jet drive powerhead.
9 - Water bypass - discharged outside of boat
10 - Water flows from bottom of cylinder head through passage in cylinder block to adapter plate
11 - Water flows from block through adapter plate, cooling exhaust passages in adapter
12 - Water flows from adapter to expansion chamber water jacket
13 - Cooling water from expansion chamber is emptied back into adapter plate
14 - Cooling water from adapter plate is exhausted through the jet tunnel

Compressor and Fuel Cooling Circuit

15 - Fitting with strainer
16 - Incoming cooling water is directed to fuel rail
17 - Water flows through fuel rail (port) to air compressor
18 - Air compressor
19 - Water flows from air compressor to expansion chamber exhaust pipes
20 - Cooling water for exhaust tubes is discharged with exhaust

Notes:

Pump Unit

Section 5A - Pump Unit

Table of Contents

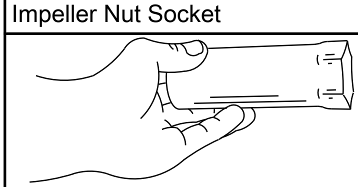
Wear Ring/Impeller Specifications

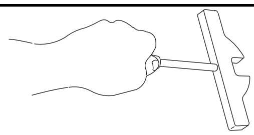
Wear Ring/Impeller Specifications	
Wear ring bore diameter	184.73–184.98 mm (7.273–7.283 in.)
Impeller outside diameter	183.52–183.77 mm (7.225–7.235 in.)
Clearance between wear ring and impeller	0.96–1.47 mm (0.038–0.058 in.)

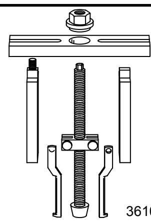
Lubricants, Sealants, Adhesives

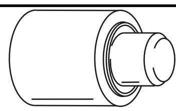
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Impeller shaft nut	92-809819
		Nozzle assembly bolts, pivot bolts, stator assembly bolts, anode bolts	
		Jet drive housing studs, special pivot screws	
		Reverse gate and rudder pivot pin threads	
		Stator/wear ring mounting screws	
		Nozzle assembly and anode screws	
		Pinion shaft housing screw threads (M8 x 25)	
		Impeller shaft threads	
		Pinion shaft housing screws (M8 x 25)	
		Nozzle/reverse gate assembly and anode bolt threads	
9	Loctite 567 PST Pipe Sealant	Stator fill plugs	92-809822
		Stator fill/drain and vent plugs	
34	Special Lubricant 101	Pinion shaft seals and impeller shaft splines	92-802865Q02
		Wear ring O-ring	
		Impeller shaft splines and wear ring O-rings	
		Between shaft seals	
		Impeller shaft splines and seal protector	
66	Loctite 242 Threadlocker	Ride plate screws, inlet screen screws and rock grate screws	92-809821
		Inlet screen screws and bolts	
		Trim plate screws	
		Ride plate bolt threads (M6 x 20) (16)	
87	High Performance Gear Lubricant	Stator housing fill	92-858064K01
		Jet drive housing	
		Stator	
		Drive housing	
		Stator and drive housing	
95	2-4-C with Teflon	Pinion shaft housing O-ring and impeller shaft cover O-ring	92-802859A 1
		Pinion shaft housing O-ring	
		Impeller shaft bore and O-ring	
142	Loctite 598 RTV Sealant	Ride plate and inlet grate screws	Obtain Locally
		Ride plate	

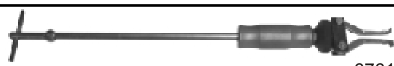
Special Tools

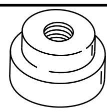
Impeller Nut Socket	91-850297
 25463	Aids in the removal, installation, and torquing of the impeller nut.

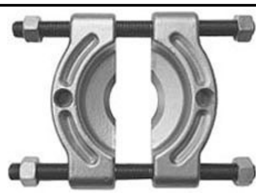
Impeller Shaft Wrench	91-832093A 1
 25462	Secures the impeller shaft when removing or installing the impeller nut.

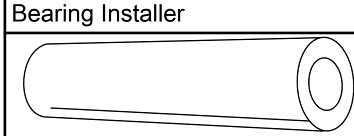
Bearing Puller Assembly	91- 83165T
 3610	Removes bearings, races and bearing carriers

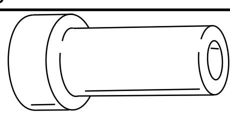
Oil Seal Installation Tool	91-850830
 46803	Installs the stator seal.

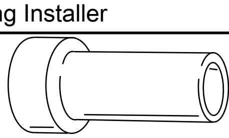
Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components. Use with puller jaws.

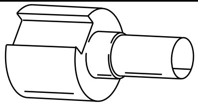
Bearing Cup Installer	91-832018
 25450	Installs the bearing cup into the pinion shaft housing and drive housing cover.

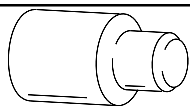
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft.

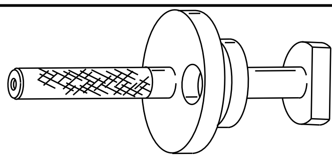
Bearing Installer	91-827983T
 25453	Installs the taper roller bearing onto the pinion shaft.

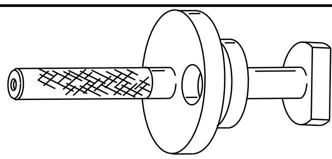
Bearing Installer	91-832016T
 25442	Installs the bearings and seals into the pinion shaft housing.

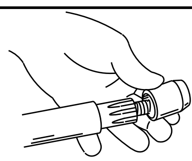
Bearing Installer	91-820552 1
 25445	Installs a ball bearing onto a large outside diameter shaft.

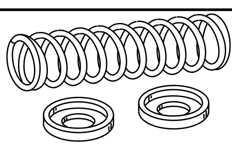
Bearing Installer	91-832017
 25446	Installs a ball bearing into the drive housing.

Seal Installer	91-832019T
 25449	Installs the pinion shaft seals into the drive housing.

Pinion Gear Height Location Tool	91-831897
 25440	Aids in determining the exact pinion gear height location for the 1.25:1 gear ratio jet drive. (175–240 hp)

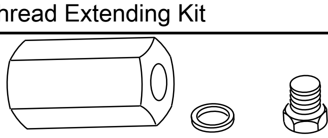
Pinion Gear Height Location Tool	91-882758
 25440	Aids in determining the exact pinion gear height location for the 1.15:1 gear ratio jet drive. (250 hp)

Seal Protector	91-850233
 25456	Protects the impeller shaft seal during installation.

Impeller Shaft Preload Kit	91-824871A 1
 25417	Applies a preload to the impeller shaft when checking gear lash.

Backlash Indicator Rod	91- 53459
 10452	Aids in checking gear backlash.

Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

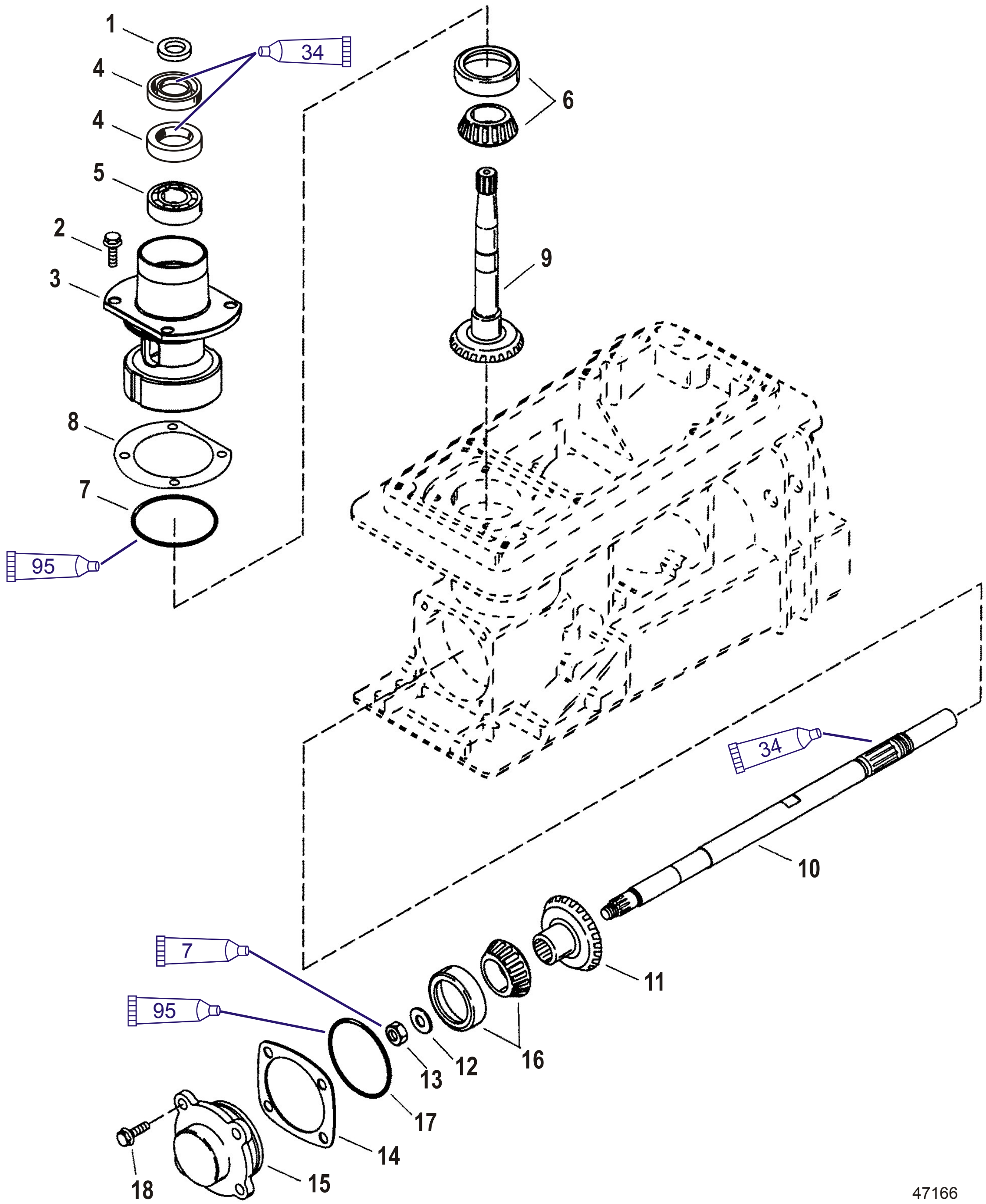
Thread Extending Kit	91-824869A 1
 25439	Extends the reach for the dial indicator kit when checking gear lash.

XR2 Sport Jet Special Tool Kit 91-809957A1

Components Contained in Kit

Description	Part Number
Impeller shaft preload kit	91-824871A2
Pinion gear height location tool	91-831897
Pinion shaft bearing installer	91-832016T
Impeller shaft bearing installer	91-832017
Bearing cup installer	91-832018
Impeller shaft seal installer	91-832019T
Impeller shaft wrench	91-832093A1
Seal protector	91-850233
Impeller nut socket	91-850297
Oil seal installer	91-850830
Stator bushing and seal installer	91-850831

Pinion and Impeller Shaft Components

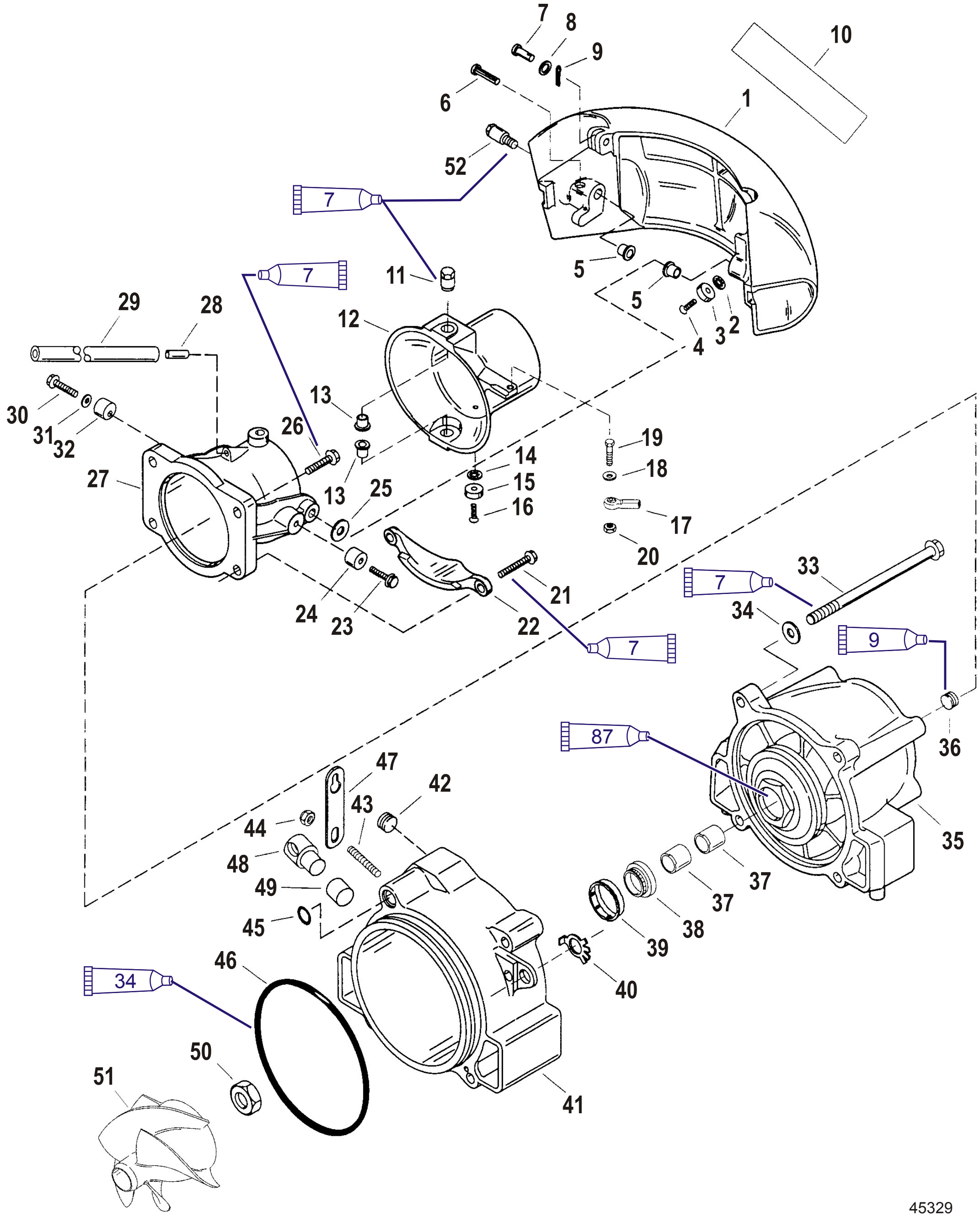


Pinion and Impeller Shaft Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Rubber ring			
2	4	Screw (M8 x 20)	20.5	181	
3	3	Pinion shaft housing assembly			
4	2	Seal			
5	1	Ball bearing			
6	1	Bearing set			
7	1	O-ring			
8	AR	Shim (0.002–0.010 in.)			
9	1	Pinion shaft assembly			
10	1	Impeller shaft			
11	1	Gear			
12	1	Washer			
13	1	Nut	122		90
14	AR	Shim (0.002–0.010 in.)			
15	1	Cover			
16	1	Bearing set			
17	1	O-ring			
18	4	Screw (M8 x 25)	20.5	181	

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Impeller shaft nut	92-809819
34	Special Lubricant 101	Pinion shaft seals and impeller shaft splines	92-802865Q02
95	2-4-C with Teflon	Pinion shaft housing O-ring and impeller shaft cover O-ring	92-802859A 1

Nozzle and Rudder Components



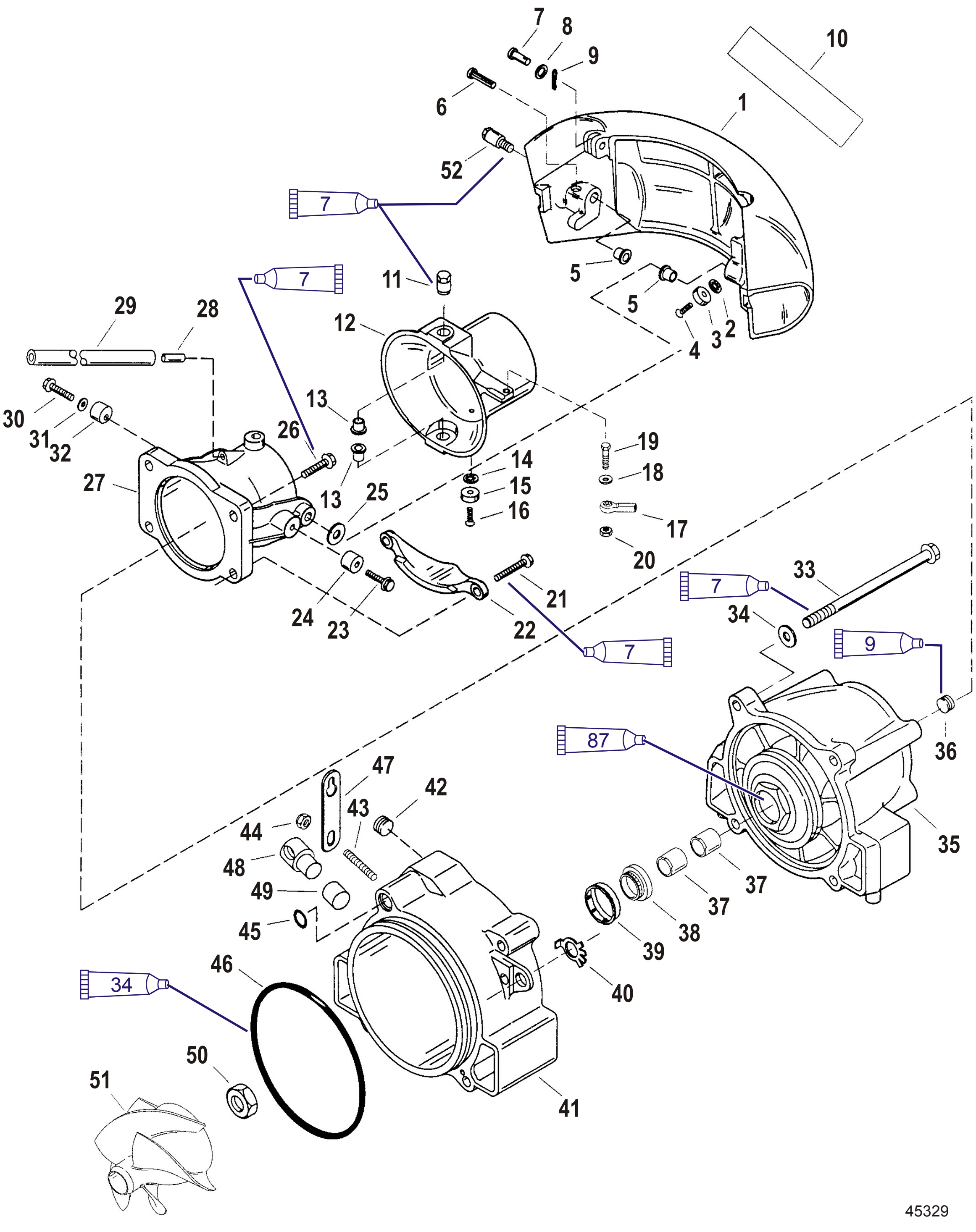
Nozzle and Rudder Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gate kit			
2	1	Lockwasher			
3	1	Anode			
4	1	Screw (M6 x 20)	8	71	
5	2	Pivot bushing			
6	2	Trilobe pin			
7	1	Clevis pin			
8	1	Washer			
9	1	Cotter pin			
10	1	Reverse gate decal (Power by Mercury)			
11	2	Special pivot bolt	68		50
12	1	Rudder kit			
13	2	Pivot bushing			
14	1	Lockwasher			
15	1	Anode			
16	1	Screw (M6 x 20)	8	71	
17	1	Swivel end kit			
18	1	Washer			
19	1	Screw and nut kit			
20	1	Nut (1/4-20)			
21	2	Flange screw (M10 x 45)	47		35
22	1	Anode with bushing in casting			
23	1	Screw (M8 x 25)			
24	1	Stop			
25	2	Special washer			
26	2	Flange screw (M10 x 35)	47		35
27	1	Nozzle assembly with pivot bushing			
28	1	Fitting			
29	1	Siphon hose			
30	1	Screw (M8 x 30)	13.5	120	
31	1	Washer			
32	1	Reverse gate stop			
33	4	Screw (M10 x 150)	47		35
34	4	Washer			
35	1	Stator assembly			
36	2	Plug (1/4-18)			
37	2	Bushing			
38	1	Seal			
39	1	Seal protector			
40	1	Tab washer			

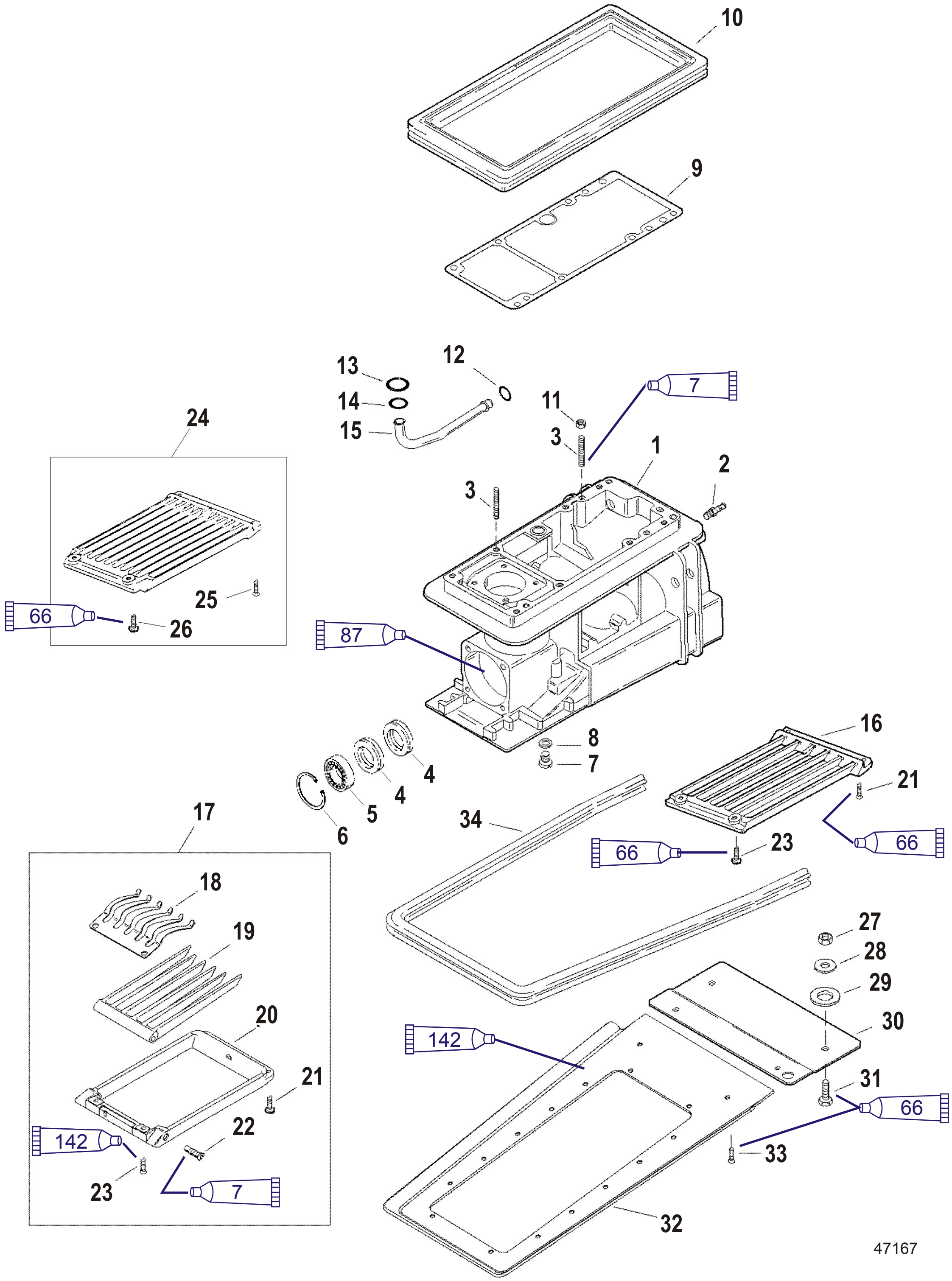
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	1	Wear ring kit			
42	1	Brass fitting (3/4-14)			
43	2	Stud (M6 x 36)			
44	2	Nut (M6)			
45	1	O-ring			
46	1	O-ring			
47	1	Shift cable retainer latch			
48	1	Retainer			
49	1	Barrel retainer cup			
50	1	Impeller shaft nut (1-1/4-12)	203		150
51	1	Four blade impeller			
52	2	Special pivot bolt	68		50

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Nozzle assembly bolts, pivot bolts, stator assembly bolts, anode bolts	92-809819
9	Loctite 567 PST Pipe Sealant	Stator fill plugs	92-809822
34	Special Lubricant 101	Wear ring O-ring	92-802865Q02
87	High Performance Gear Lubricant	Stator housing fill	92-858064K01

Nozzle and Rudder Components



Jet Drive Housing Components



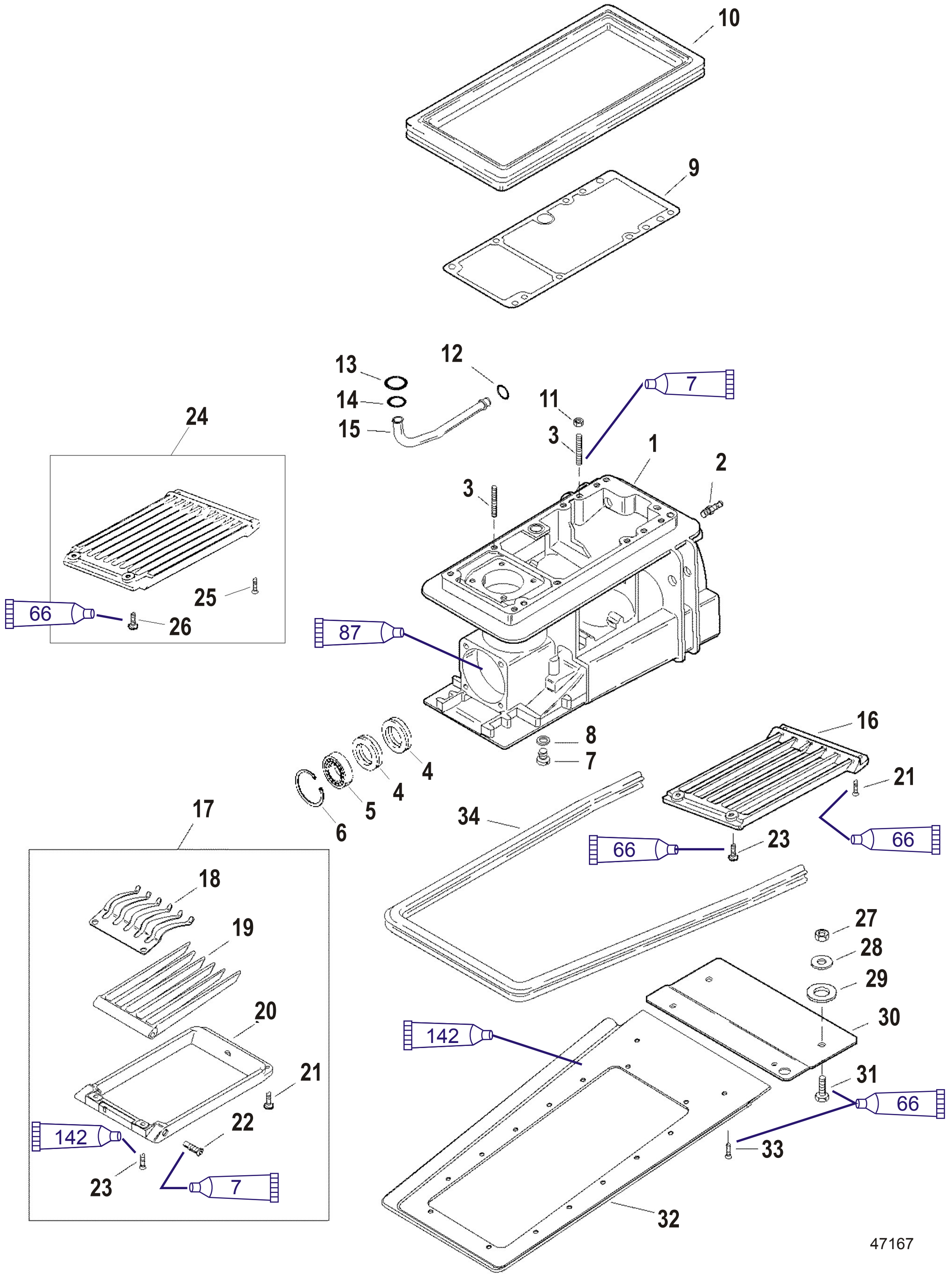
Jet Drive Housing Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Housing			
2	1	Siphon drain fitting (1/8-27)			
3	4	Stud (M10 x 55)			
4	2	Oil seal			
5	1	Ball bearing			
6	1	Snap ring			
7	2	Drain screw (3/8-16 x 1/4)	5.6	50	
8	2	Sealing washer			
9	1	Gasket (jet drive housing to top cover)			
10	1	Pump mount grommet			
11	4	Brass nut (M10)	47.5		35
12	1	O-ring (0.489 x 0.070)			
13	1	O-ring (0.796 x 0.139)			
14	1	O-ring (0.412 x 0.210)			
15	1	Water tube			
16	1	Inlet screen (6 tines)			
17	Option	Inlet grate kit			
18	1	Spring			
19	1	Tines			
20	1	Frame			
21	2	Screw with nylon patch (M6 x 20)	8.5	75	
22	2	Special pivot screw	8.5	75	
23	2	Screw (M8 x 25)	23		17
24	Option	Rock grate kit (12 tines)			
25	2	Screw with nylon patch (M6 x 20)			
26	2	Screw (M8 x 25)			
27	2	Nut (M8)	18	159	
28	2	Washer			
29	2	Washer			
30	1	Trim plate			
31	2	Screw (M8 x 35)			
32	1	Ride plate kit			
33	16	Screw with nylon patch (M6 x 20)	8.5	75	
34	1	Ride plate seal kit			

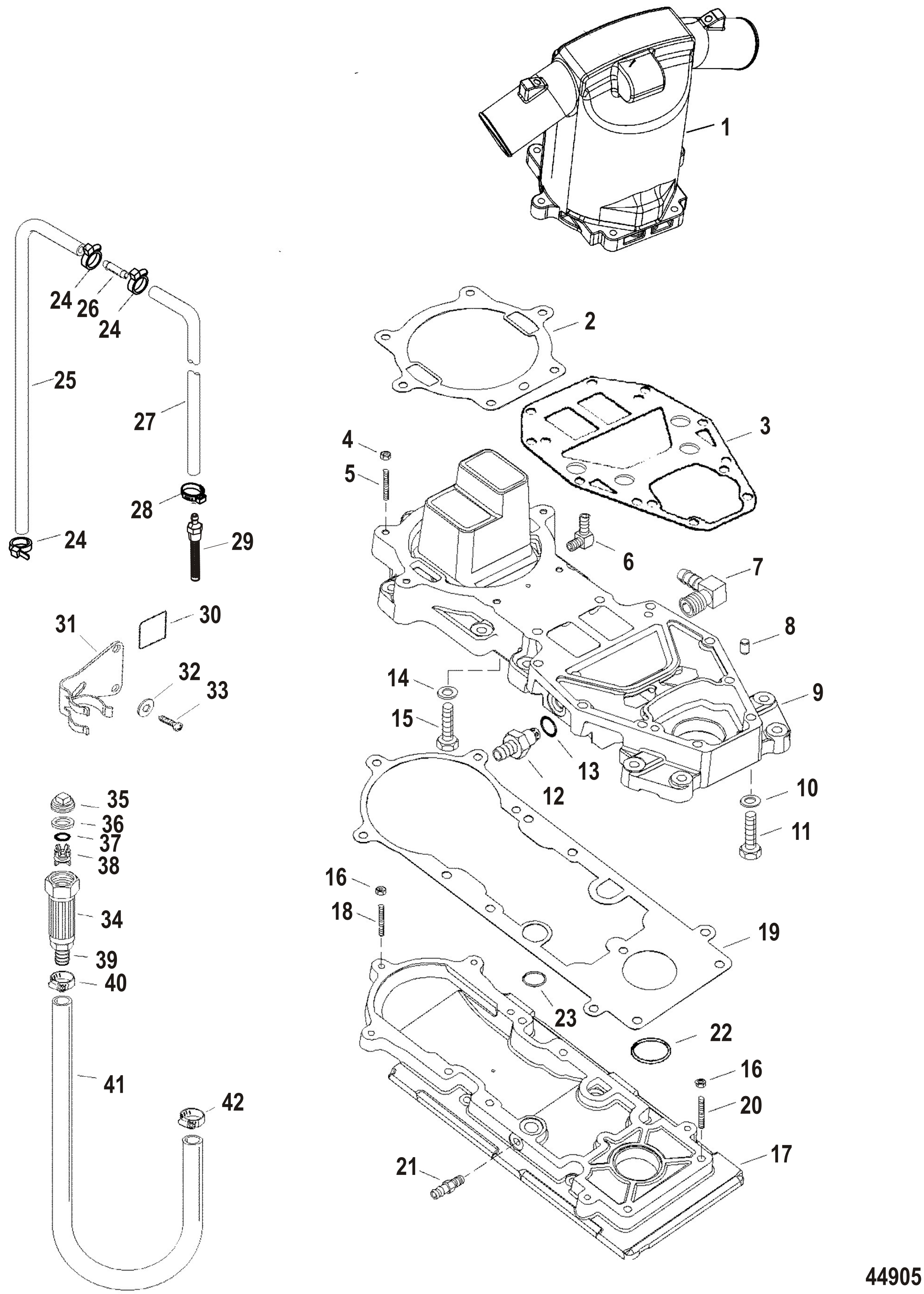
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Jet drive housing studs, special pivot screws	92-809819
66	Loctite 242 Threadlocker	Ride plate screws, inlet screen screws and rock grate screws	92-809821
87	High Performance Gear Lubricant	Jet drive housing	92-858064K01

Tube Ref No.	Description	Where Used	Part No.
142	Loctite 598 RTV Sealant	Ride plate and inlet grate screws	Obtain Locally

Jet Drive Housing Components



Expansion Chamber and Adapter Plate Components

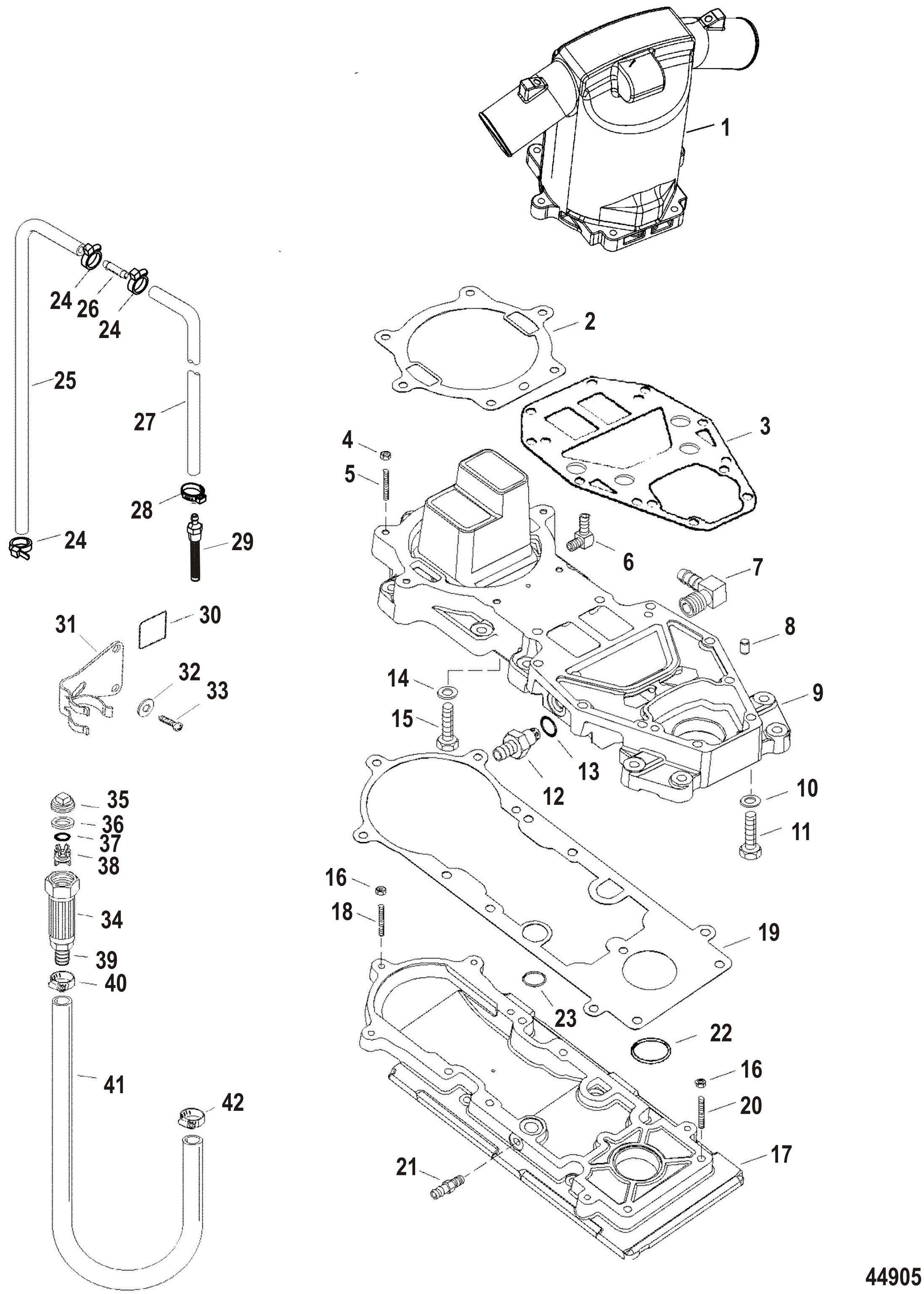


Expansion Chamber and Adapter Plate Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Expansion chamber kit			
2	1	Gasket (expansion chamber to adapter plate)			
3	1	Gasket (block to exhaust expansion chamber)			
4	6	Nut (M8)	27		20
5	6	Stud (M8 x 50)			
6	1	90° elbow fitting			
7	1	90° elbow fitting			
8	2	Dowel pin without hole			
9	1	Engine adapter			
10	8	Washer			
11	8	Screw (3/8-16 x 2-1/4)	47		35
12	1	Strainer fitting			
13	1	O-ring			
14	2	Washer			
15	2	Screw (3/8-16 x 3-3/4)	47		35
16	11	Nut (M10)	47		35
17	1	Cover assembly			
18	5	Stud (M10 x 53)	40		30
19	1	Gasket (engine adapter)			
20	6	Stud (M10 x 101)	40		30
21	1	Barbed connector			
22	1	O-ring			
23	1	O-ring			
24	3	Cable tie			
25	1	Siphon hose (106.7 cm [42 in.])			
26	1	Siphon break			
27	1	Siphon hose (45.7 cm [18 in.])			
28	1	Cable tie			
29	1	Siphon hose strainer			
30	1	Flushing adapter decal			
31	1	Flushing assembler holder clip			
32	3	Washer			
33	3	Screw (#12-24 x 0.620)			
34	1	Flushing adapter assembly			
35	1	Top plug			
36	1	Washer			
37	1	O-ring			
38	1	Check valve			
39	1	Connector			
40	1	Worm gear clamp			

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
41	1	Hose			
42	1	Worm gear clamp			

Expansion Chamber and Adapter Plate Components



General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part. It is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

Disassembly of a subassembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** to find the correct page number.

Threaded parts are right-hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel that will contact only the bearing race when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in the air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean the bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin the bearing with compressed air, as this may cause the bearing to score from lack of lubrication. After cleaning, lubricate the bearings with High Performance Gear Lubricant. Do not lubricate the tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work the inner bearing race in and out, while holding the outer race, to check for side wear.

When inspecting the tapered bearings, determine the condition of the rollers and the inner bearing race by inspecting the bearing cup for pits, scoring, grooves, uneven wear, imbedded particles, and/or discoloration from overheating. Always replace the tapered bearing and race as a set.

Inspect the gear housing for bearing races that have spun in their respective bores. If the race has spun, the gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check the shaft surface for pits, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced if the conditions described are found.

Shims

Keep a record of all shim amounts and their location during disassembly to aid in reassembly. Be sure to follow the shimming instructions during reassembly, as gears must be installed to the correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

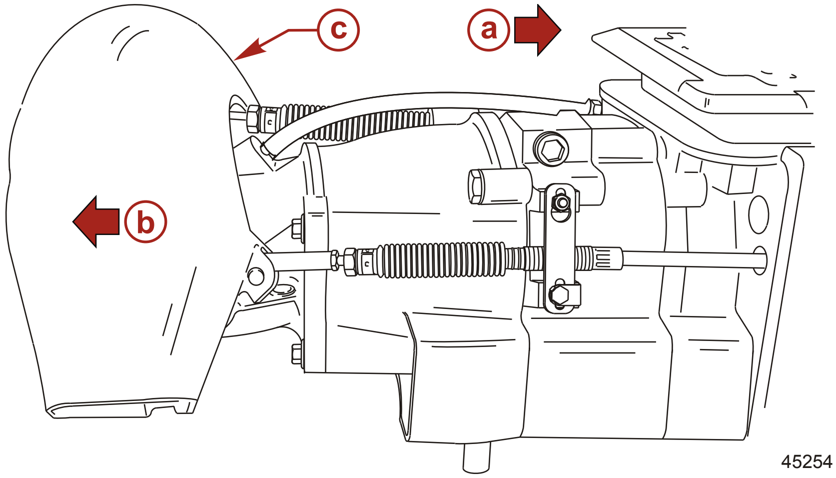
Seals

As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 Threadlocker to the outer diameter of all metal case oil seals. When using Loctite on seals or threads, the surfaces must be clean and dry. To ease installation, apply 2-4-C with Teflon on all O-rings. To prevent wear, apply 2-4-C with Teflon on the I.D. of oil seals.

Principles of Operation

NOTE: Due to running changes, some illustrations may not be exactly the same as your drive unit. Service procedures remain the same unless otherwise noted.

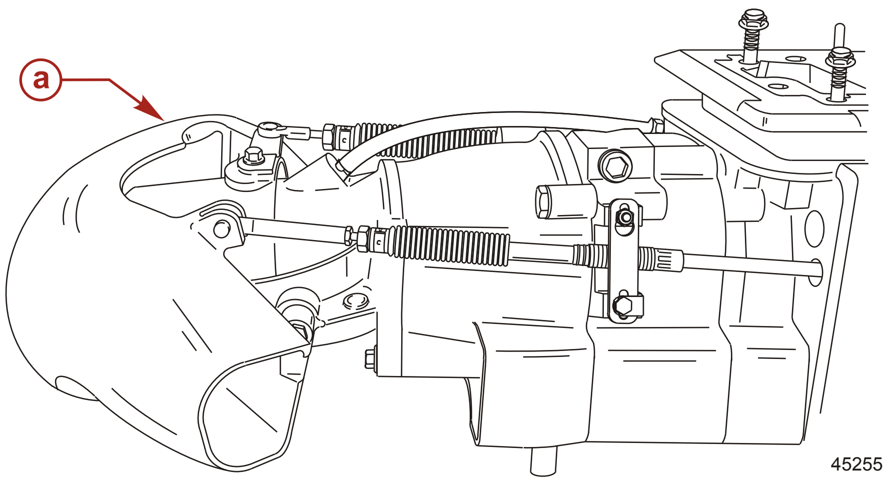
The jet pump operates by drawing water into a housing forward of the impeller. The water is pressurized within the specially designed housing and then directed to the rear to provide thrust and motion.



a - Forward motion
b - Water thrust
c - Reverse gate - forward position

The jet pump is equipped with a steerable nozzle (rudder) at the aft end of the pump housing that directs the thrust of water. The jet of water can be directed right or left when the operator turns the steering wheel in the respective direction. When the operator turns the steering wheel to the right, for example, the nozzle turns to the right and the jet force from the nozzle pushes the stern of the boat to the left causing the bow of the boat to turn right. Forward, reverse drive, and the neutral position are achieved by the position of a reverse gate located just aft of the nozzle.

Forward drive has the reverse gate clearing the nozzle to allow all the water to be directed straight back. Reverse drive has the reverse gate covering the entire opening enough to divert the water forward. Neutral position has the reverse gate covering 75 percent of the nozzle to direct the water stream forward and downward, as well as backward. The shift position is controlled at the control box in the boat.



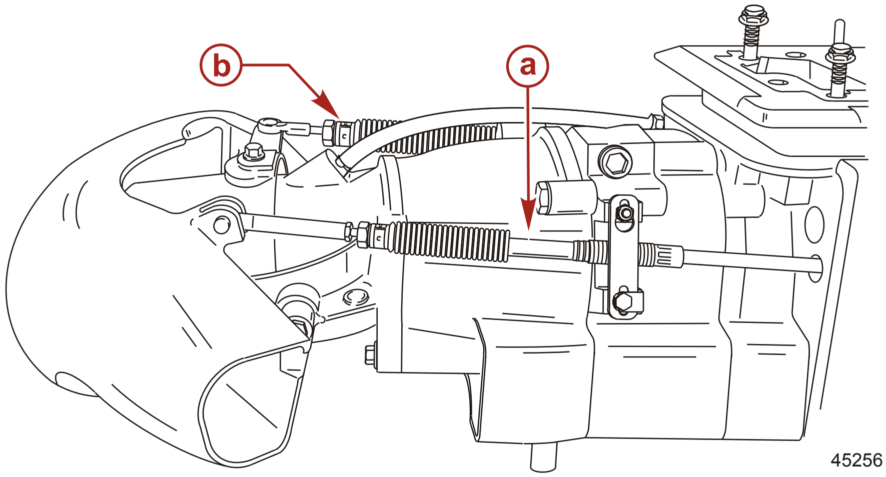
a - Reverse gate - reverse position

Servicing the Stator, Impeller, and Wear Ring

Disassembly

1. Disconnect spark plug leads from spark plugs.

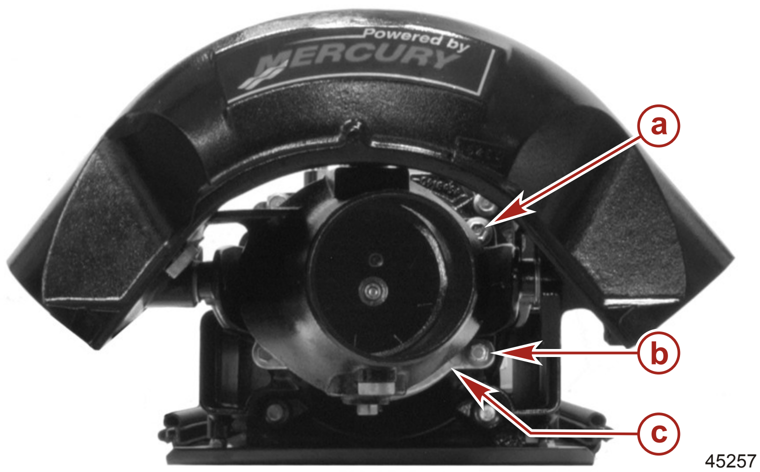
2. Disconnect shift and steering cables at reverse gate and rudder.



a - Shift cable
b - Steering cable

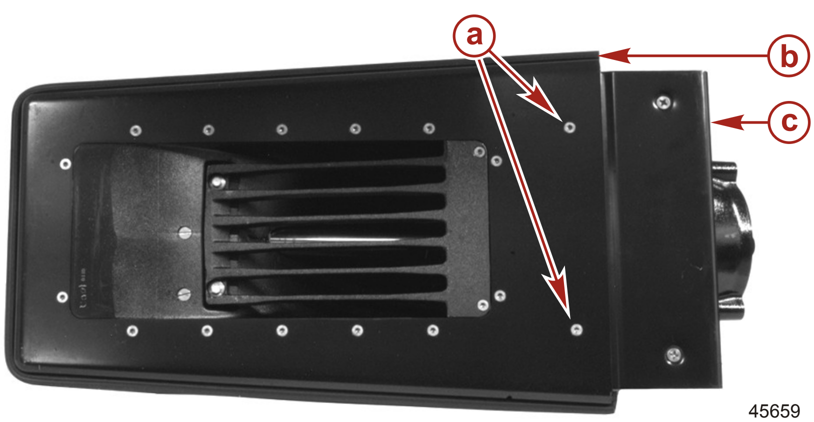
IMPORTANT: This procedure lists the disassembly of external pump components. If servicing a specific component, follow the procedure in that section.

3. Remove four screws securing nozzle to stator. Remove the reverse gate/rudder/nozzle assembly.



a - Screw (M10 x 35, flange) (2)
b - Screw (M10 x 45, flange) (2)
c - Anode

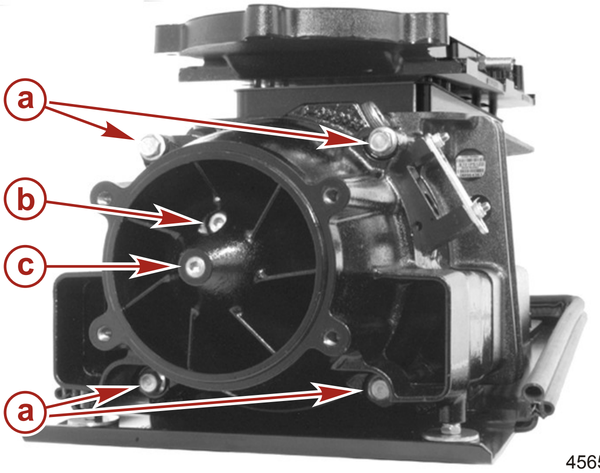
4. Remove two screws securing the trim plate to the ride plate and wear ring.



a - Screws (M6 x 20) (2) (30 Torx)
b - Ride plate
c - Trim plate

5. Remove the fill/drain plug and allow the lubricant to drain into a suitable container. Install the fill/drain plug.
6. Remove four screws securing the stator assembly to the drive housing.

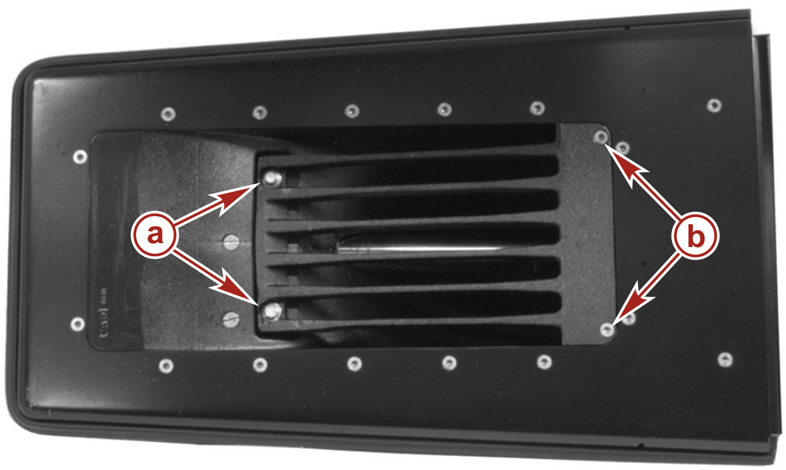
7. Remove the stator assembly.



45658

a - Screw (M10 x 150)
b - Vent plug
c - Fill/drain plug

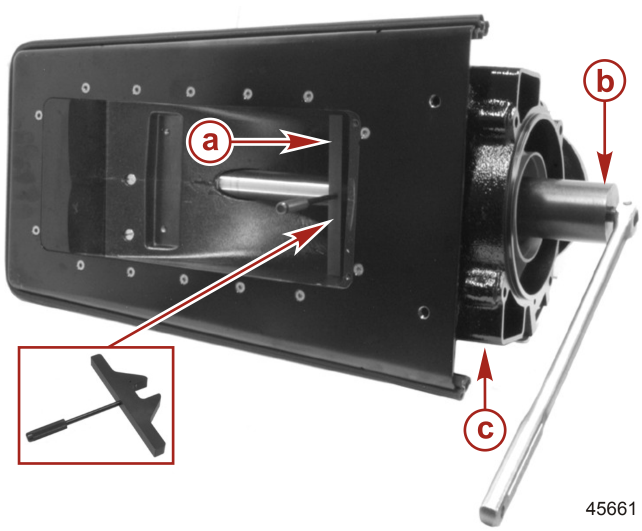
8. Drain the stator by tilting stator forward and allowing the oil to drain over the impeller shaft seals. Complete oil draining by removing stator fill/drain plug and pour the remaining oil out the drain plug hole.
9. If removed, install the wear ring to support the impeller and shaft during impeller removal.
10. Remove the inlet screen on the bottom of the drive housing to allow access to machined flats on the impeller shaft.



45660

a - Screw (M8 x 25)
b - Screw (M6 x 20)

11. While holding the impeller shaft, remove the impeller nut using special tool 91-850297. Impeller nut is a standard right-hand thread.
12. Remove the impeller and wear ring.



45661

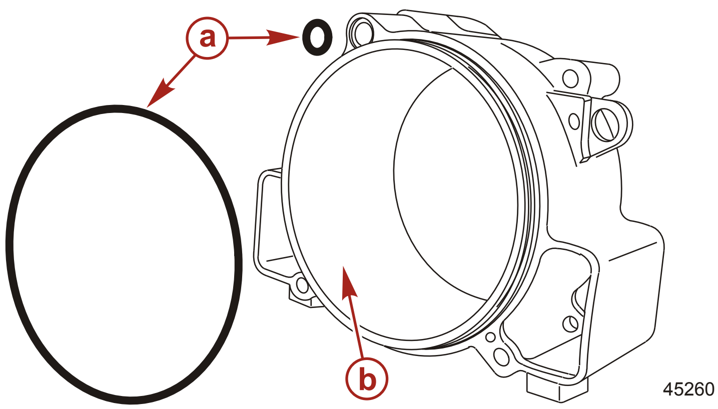
a - Special tool 91-850297
b - Special tool 91-832093A1
c - Wear ring

Impeller Nut Socket	91-850297
Impeller Shaft Wrench	91-832093A 1

Inspecting the Wear Ring and Impeller

Wear Ring

1. Inspect the wear ring for excessive scoring and/or grooves. Replace the wear ring if deep grooves are present or if severe scoring has taken place.
2. Ensure that the O-ring is in the counterbore before installing the wear ring to the drive housing.



a - O-ring
b - Wear ring surface

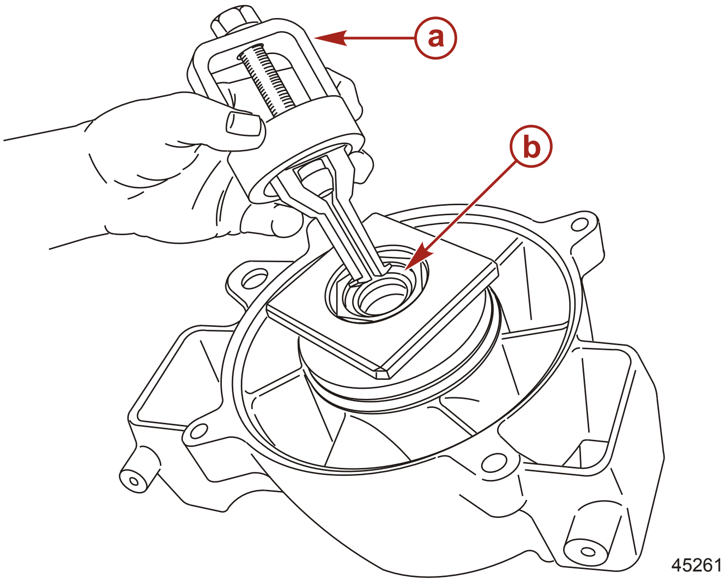
3. Refer to **Nozzle and Rudder Components** for the following:
   a. Inspect the seal in the stator for wear/damage.
   b. Inspect the bellows on cables for wear.
   c. Inspect the anodes, replace as necessary.
   d. Inspect the pivot pins and bushings, replace as necessary. Tighten the reverse gate pivot pins and rudder pivot pins to the specified torque. Use Loctite 271 Threadlocker on the threads.

Description	Nm	lb-in.	lb-ft
Reverse gate pivot pins	68		50
Rudder pivot pins	68		50

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Reverse gate and rudder pivot pin threads	92-809819

   e. Inspect the impeller for cracks and damaged blades.
   f. Inspect the stator vanes for cracks and/or damage.

g. Replace the stator seal if required. Use the bearing puller tool to remove the seal. Use the oil seal installation tool to install the new stator seal.



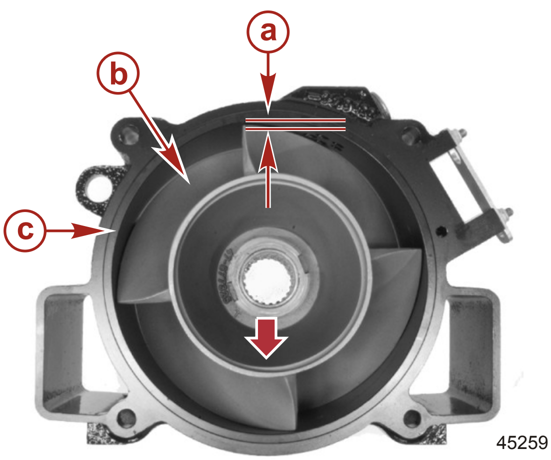
a - Puller 91-83165M
b - Stator seal

Bearing Puller Assembly	91- 83165T
Oil Seal Installation Tool	91-850830

Impeller

1. Place the impeller in the wear ring bore and push to one side.
2. Measure the clearance between impeller blades and wear ring with a feeler gauge. If clearance is over 2.54 mm (0.100 in.), replace impeller and wear ring.

   NOTE: Impeller wear usually accounts for 75% of the wear. Reducing the clearance can improve both top speed and acceleration performance.



a - Clearance
b - Impeller
c - Wear ring

Impeller Component Dimensions	
Wear ring bore diameter	184.73–184.98 mm) (7.273–7.283 in.)
Impeller outside diameter	183.52–183.77 mm (7.225–7.235 in.)
Clearance between wear ring and impeller	0.96–1.47 mm (0.038–0.058 in.)

3. Inspect the leading edges of the impeller for nicks and damage. The leading edges should be sharpened to 0.51 mm (0.020 in.) on the outer half of the leading edge for optimum performance. Dull leading edges can increase cavitation during initial acceleration.

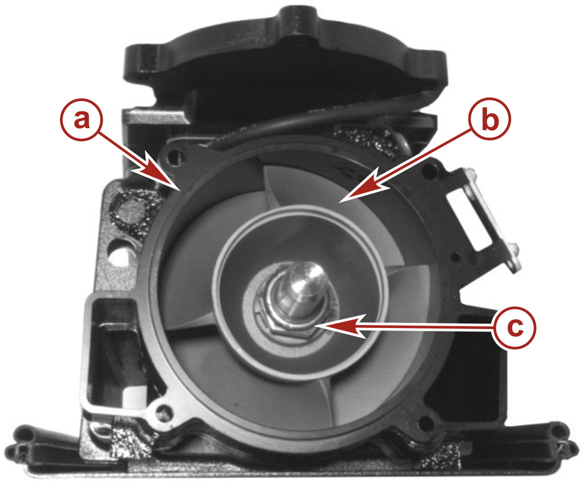
Impeller and Stator Installation

1. Lubricate the splines of the impeller shaft with Special Lubricant 101.

2. Lubricate the wear ring O-rings with Special Lubricant 101. Install the O-ring into the counterbore. Install the O-ring onto the wear ring.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Impeller shaft splines and wear ring O-rings	92-802865Q02

3. Install the wear ring onto the jet drive housing.
4. Install the impeller and nut onto the impeller shaft. Tighten the impeller nut to the specified torque.



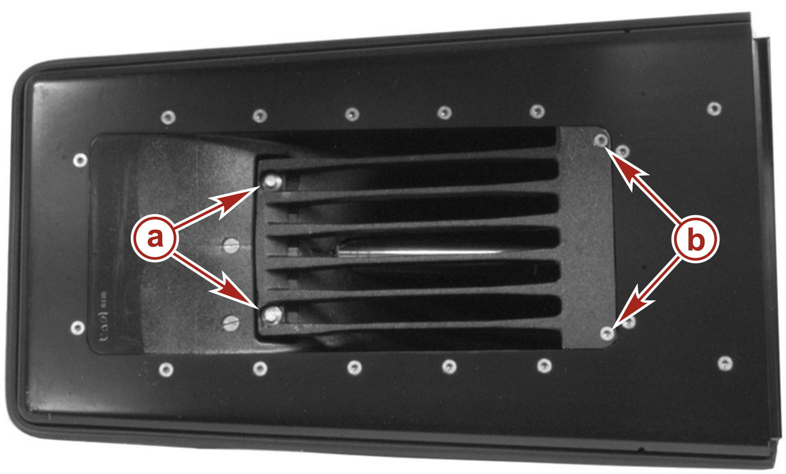
45258

a - Wear ring
b - Impeller
c - Nut (1¼-12)

Impeller Nut Socket	91-850297
Impeller Shaft Wrench	91-832093A 1

Description	Nm	lb-in.	lb-ft
Impeller nut (1¼-12)	203		150

5. Install the inlet screen. Apply Loctite 242 Threadlocker to threads of screws. Tighten the screws and bolts to the specified torque.



45660

a - Screw (M8 x 25) (2)
b - Screw (M6 x 20) (2) (30 Torx)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Inlet screen screws and bolts	92-809821

Description	Nm	lb-in.	lb-ft
Inlet screen screws (M6 x 20) (2) (30 Torx)	8.5	75	
Inlet screen screws (M8 x 25) (2)	22.5		16.6

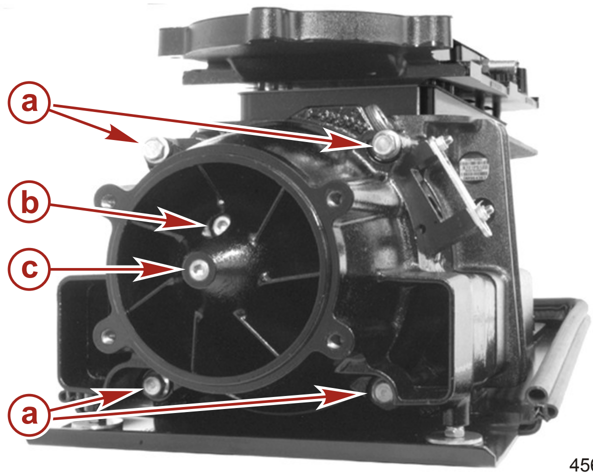
6. Install the stator. Apply Loctite 271 Threadlocker to threads of four screws. Tighten the screws to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Stator/wear ring mounting screws	92-809819

Description	Nm	lb-in.	lb-ft
Stator/wear ring mounting screws (M10 x 150) (4)	47		35

7. Remove the stator fill/drain and vent plugs. Apply Loctite 567 PST Pipe Sealant to the plug threads.
8. Fill the stator with High Performance Gear Lubricant until oil flows out the vent hole. Install the vent plug and fill plug.

NOTE: The stator oil should be checked periodically for contamination and fluid level. To check stator oil, shift the reverse gate to the forward position. Using an allen socket and extension, remove the stator vent plug. Use a small screwdriver to dip into the oil to check it for contamination, discoloration, and level. If oil is low, add oil. If oil is contaminated or discolored, shaft, seals, and bushings must be inspected and/or replaced before refilling stator with new oil. After filling the stator with oil, apply Loctite 567 PST Pipe Sealant to the plug threads and install the plug.



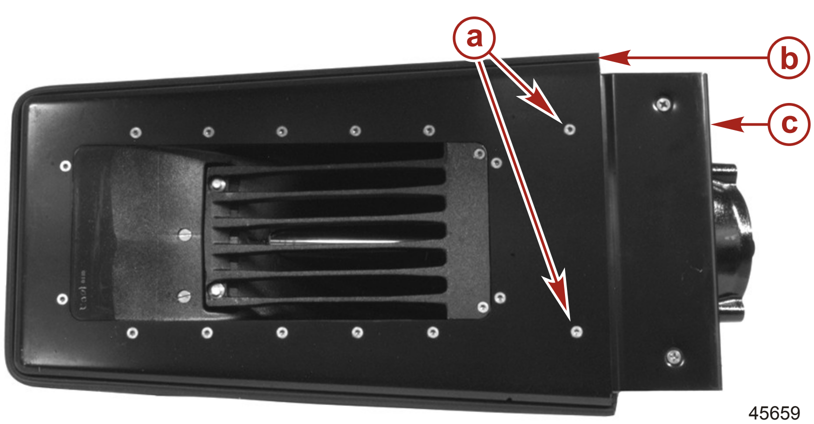
45658

a - Screw (M10 x 150)
b - Vent plug
c - Fill/drain plug

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Stator	92-858064K01
9	Loctite 567 PST Pipe Sealant	Stator fill/drain and vent plugs	92-809822

Stator	
Fluid capacity	550 ml (19 fl oz)

9. Apply Loctite 242 Threadlocker to the screws securing the trim plate to the ride plate. Tighten the screws to the specified torque.



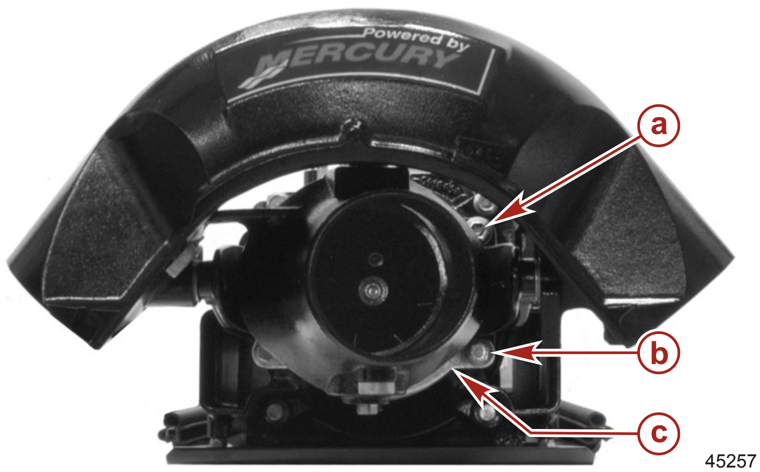
45659

a - Screws (M6 x 20) (2) (30 Torx)
b - Ride plate
c - Trim plate

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Trim plate screws	92-809821

Description	Nm	lb-in.	lb-ft
Trim plate screws	8.5	75	

10. Install the nozzle assembly and anode. Apply Loctite 271 Threadlocker to the threads of the screws. Tighten the screws to the specified torque.



a - Screw (M10 x 35) (2)
b - Screw (M10 x 45) (2)
c - Anode

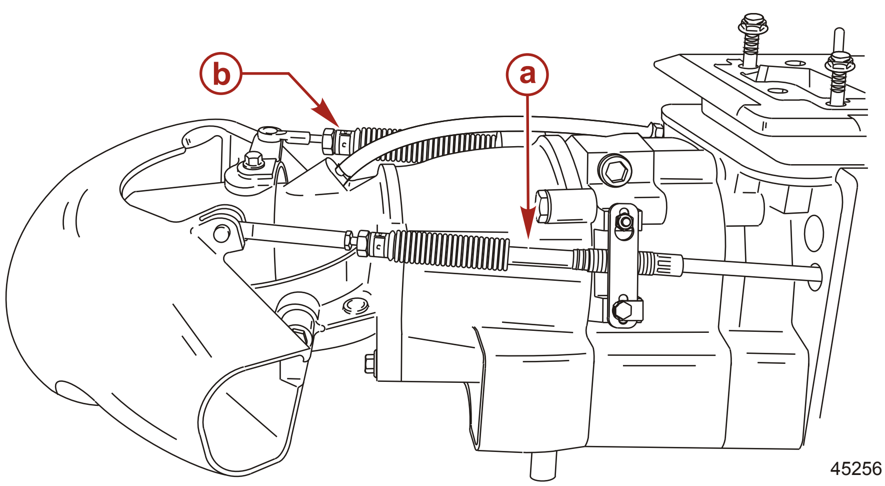
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Nozzle assembly and anode screws	92-809819

Description	Nm	lb-in.	lb-ft
Nozzle assembly and anode screws	47		35

11. Attach the shift and steering cables. Refer to **Section 1D**.

Removing Jet Drive from Boat

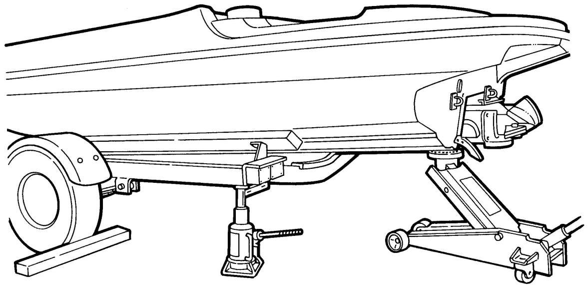
1. Remove the powerhead. Refer to **Section 4A - Powerhead Removal from the Pump Unit**.
2. Disconnect the shift and steering cables from the reverse gate and rudder. Remove the cable adapters and bellows assemblies. Loosen the shift and steering cables at the wear ring.



a - Shift cable
b - Steering cable

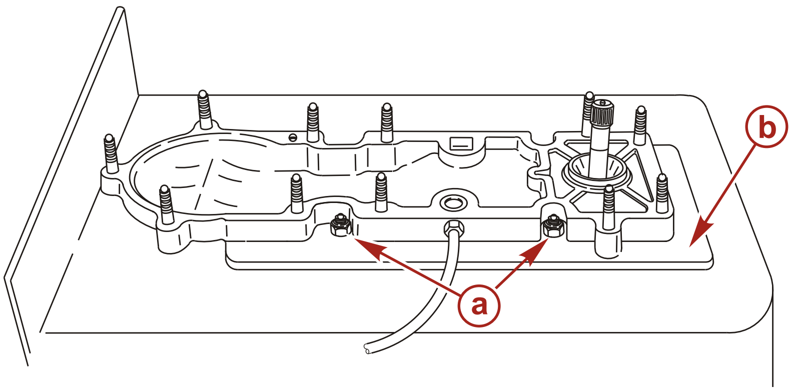
3. Loosen the shift and steering cable through-the-hull fittings.
IMPORTANT: The pump unit must be supported to prevent it from dropping through the opening when the remaining fasteners are removed.

4. Support the pump.



45263

5. Remove the remaining four nuts from the drive housing cover. Remove the drive housing cover and gasket.



45264

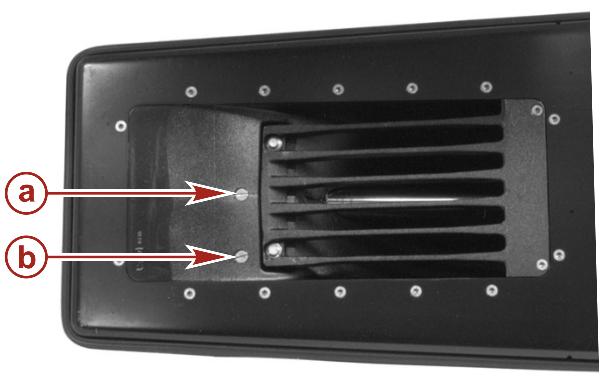
a - Nut (4)
b - Gasket

6. Lower the drive housing while sliding the cables out. Place on a bench or suitable workstand for disassembly/repair.

Drive Housing Disassembly and Assembly

Draining and Inspecting Drive Housing Lubricant

1. Position a clean drain pan under the gear housing. Remove the vent screw and the fill/drain screw with gaskets from the gear housing.
2. Inspect the fill and vent sealing washers for cuts or abrasions. Replace the washers if necessary.



45672

Bottom view
a - Fill/drain screw
b - Vent screws

3. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles resembling powder indicates normal wear. Presence of larger particles or a large quantity of fine particles, indicates need for gear housing disassembly and inspection.
4. Note the color of the gear lubricant. White or cream color indicates the presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings, and gear housing components.

   NOTE: *The drive housing should be pressure tested prior to disassembly. Using Leakage Tester FT8950, the gear housing should hold 69–83 kPa (10–12 psi) of pressure for five minutes without leakage. Failure to hold specified pressure indicates worn or damaged sealing surfaces or improperly assembled gear housing. The cause of leakage must be corrected before returning the gear housing assembly into service.*

Gear Housing Pressure	
Without gear lubricant for five minutes without leakage	69–83 kPa (10–12 psi)

NOTE: When draining the gearcase for the first time, the lubricant may appear cream colored due to the mixing of assembly lubricant and gear lubricant. This is not an indication of water intrusion. If, during the subsequent draining of the gearcase, the lubricant appears cream colored or milky, water may be present. Gearcase should be disassembled and all gaskets, seals, and O-rings replaced. Inspect all components for water damage.

NOTE: Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.

Filling the Drive Housing

IMPORTANT: The drive housing must be level and upright to obtain the correct fluid level.

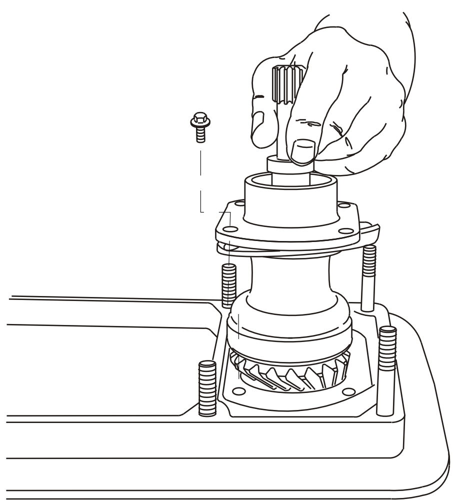
1. Remove the fill/drain plugs.
2. Slowly fill the drive housing through the fill hole with High Performance Gear Lubricant until lubricant flows out of the vent hole and no air bubbles are visible.
3. Install the vent screw into the vent hole.
   IMPORTANT: Do not lose more than 30 cc (1 fl oz) of gear lubricant while installing the fill screw.
4. Remove the fill hose and fitting from the fill hole and quickly install the fill screw into the fill hole. Tighten the fill and vent screws to the specified torque.

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

Description	Nm	lb-in.	lb-ft
Fill and vent screws	7	62	

Pinion Shaft Removal

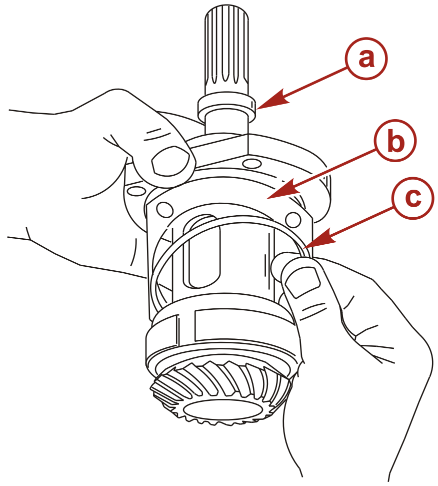
1. Remove the four screws securing the pinion shaft housing to the drive housing. Remove the pinion shaft assembly.



45265

NOTE: Take care not to damage or misplace the shims.

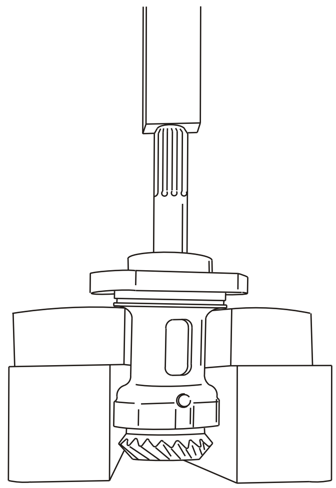
2. Remove the rubber ring, O-ring, and shims.



45266

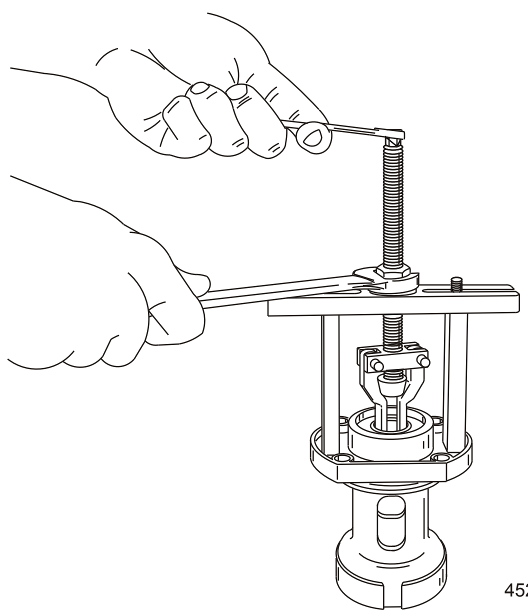
a - Rubber ring
b - Shims
c - O-ring

3. Press the pinion shaft out of the pinion shaft housing.



45267

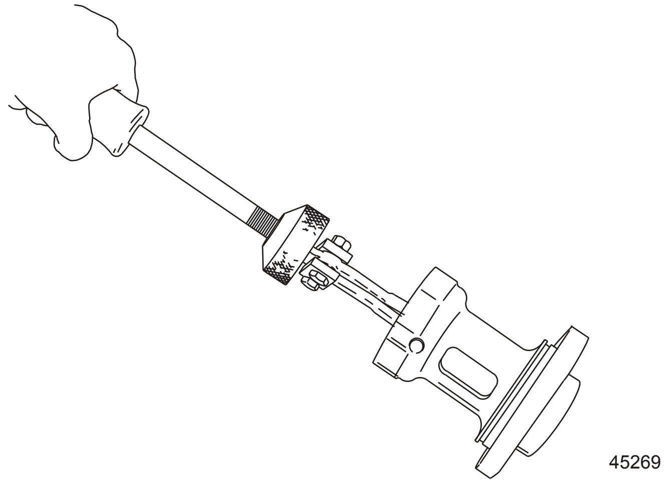
4. Remove the pinion shaft ball bearing and two seals using the bearing puller assembly.



45268

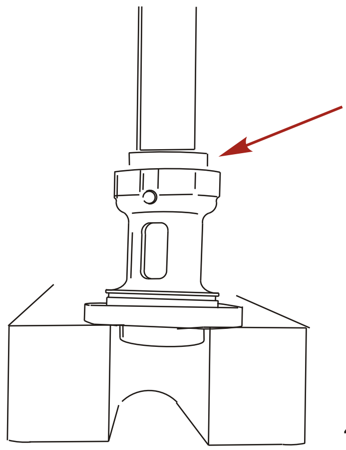
Bearing Puller Assembly	91- 83165T

5. Remove the pinion shaft outer race from the pinion shaft housing using a slide hammer.



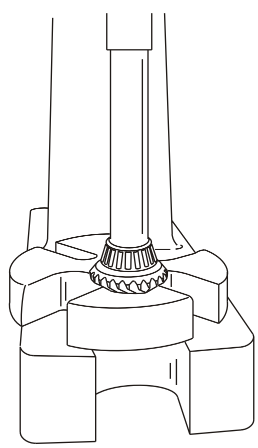
Slide Hammer	91-34569A 1

6. Press a new outer race into the pinion shaft housing using the mandrel.



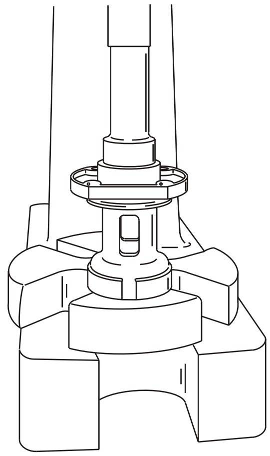
Bearing Cup Installer	91-832018

7. Remove the tapered roller bearing from the pinion shaft using the universal puller plate.
8. Press a new tapered roller bearing onto the pinion shaft using the pinion shaft taper roller bearing installer.



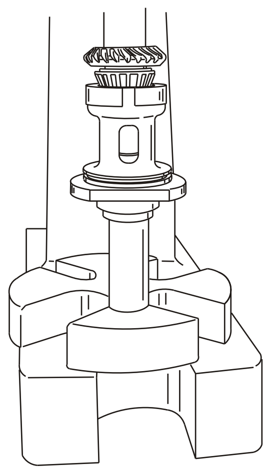
Universal Puller Plate	91-37241
Bearing Installer	91-827983T

9. Press a new ball bearing into the pinion shaft housing using the bearing installer.

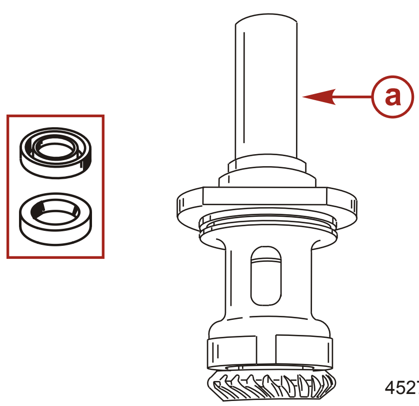


Bearing Installer	91-832016T

10. Press the pinion shaft into the pinion housing.



11. Press new seals into the pinion shaft housing, one at a time, using the seal installer. Inner seal faces in, outer seal faces out. Fill between the seals with Special Lubricant 101.



a - Seal installer 91-820552 1

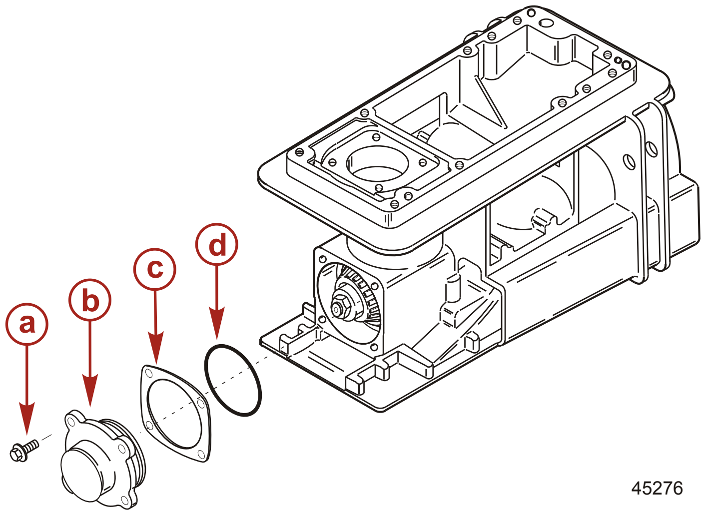
Bearing Installer	91-820552 1

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Between shaft seals	92-802865Q02

Impeller Shaft Removal

1. Remove the stator, wear ring, and impeller. Refer to **Servicing the Stator, Impeller, and Wear Ring**.

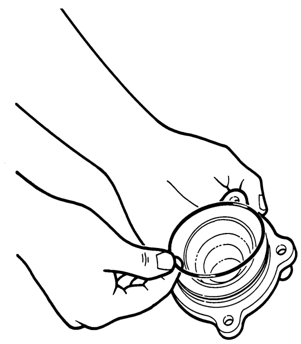
2. Remove the stator fill screw; drain oil into a suitable container.
3. Remove the ride plate.
4. Remove the four screws securing the impeller shaft cover to the drive housing. Remove the cover.



- a - Screw
- b - Cover
- c - Shim
- d - O-ring

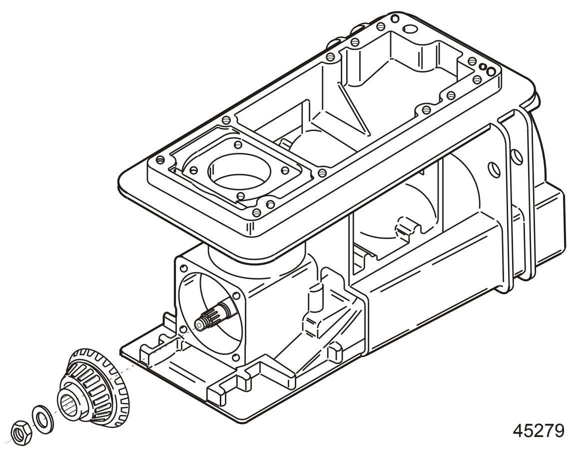
45276

NOTE: *Take care not to damage or misplace the shims.*



45277

5. Remove the nut and washer from the end of the impeller shaft. Remove the impeller shaft gear.



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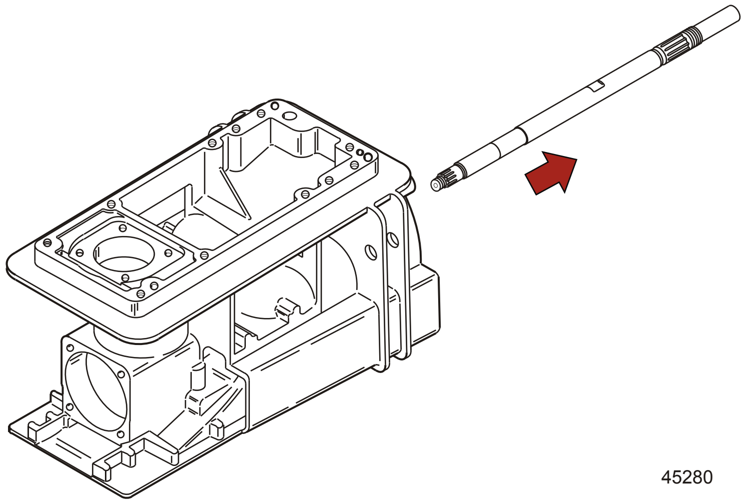
6. Pull the impeller shaft from the drive housing.



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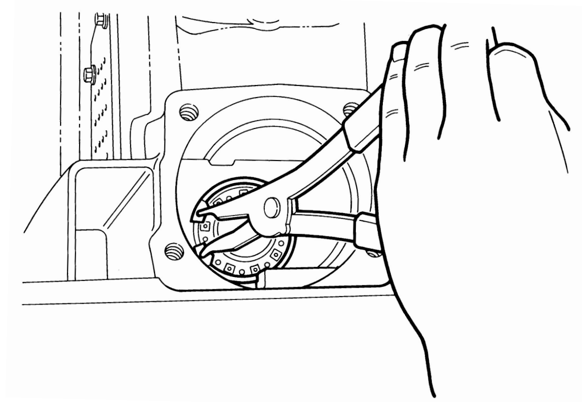
7. Remove the bearing retaining ring from the drive housing.



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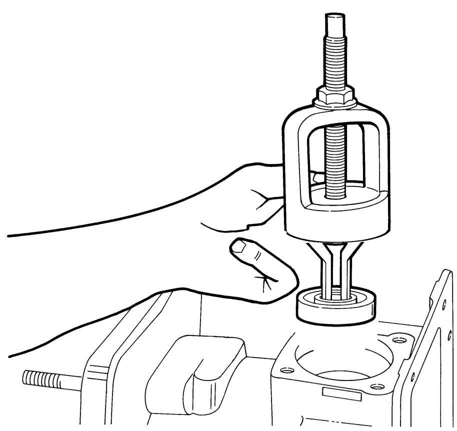
8. Remove the bearing using the bearing puller.



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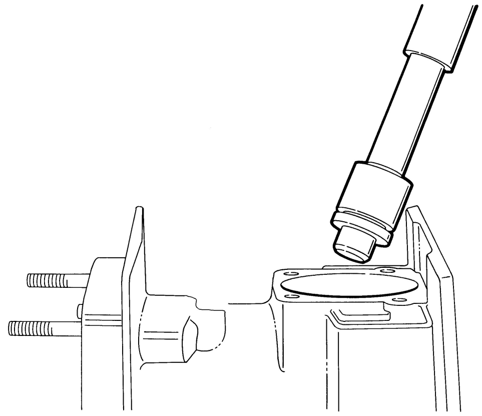
Bearing Puller Assembly	91- 83165T

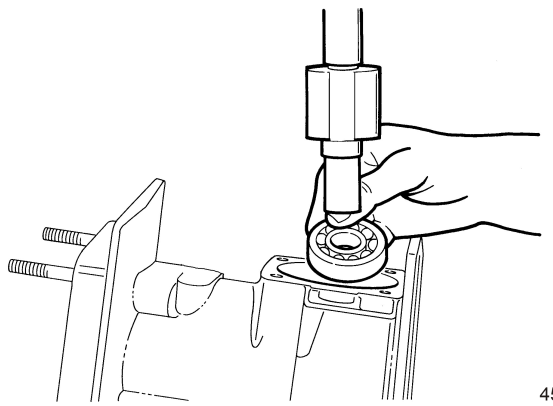
9. Remove the impeller shaft seals using the slide hammer and puller jaws.

Slide Hammer	91-34569A 1

10. Install new seals using the seal installer tool.

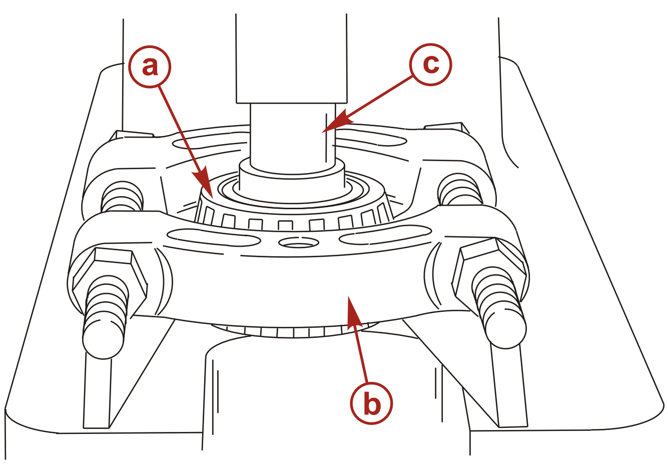


11. Install a new bearing using the bearing installer tool.



Bearing Installer	91-832017
Seal Installer	91-832019T

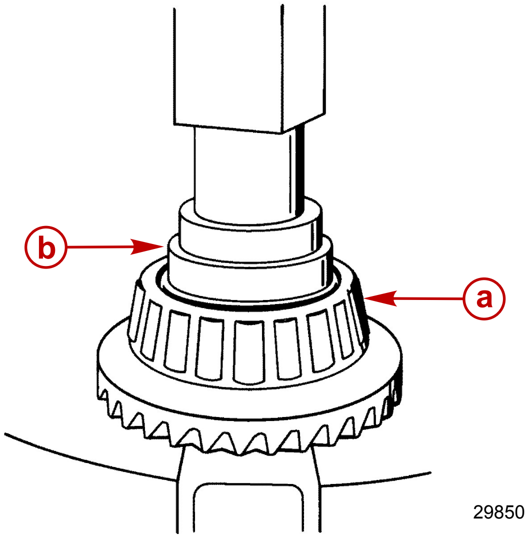
12. Install the retaining ring in the drive housing after the bearing is installed.
13. If replacing the impeller shaft gear bearing, remove using the universal puller plate.



a - Bearing
b - Plate
c - Mandrel

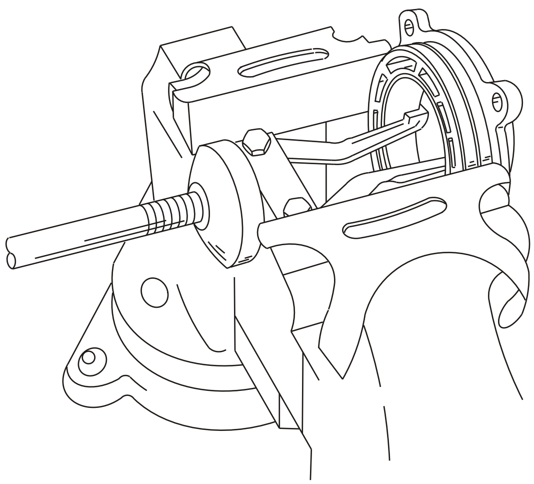
Universal Puller Plate	91-37241

14. Press a new bearing onto the gear using an appropriate size mandrel.



a - Bearing
b - Mandrel

15. If replacing the bearing, remove the outer race from the front cover using a slide hammer and puller jaws. Press the new outer race into the cover using a suitable mandrel.



Slide Hammer	91-34569A 1

Shimming Procedures and Assembly

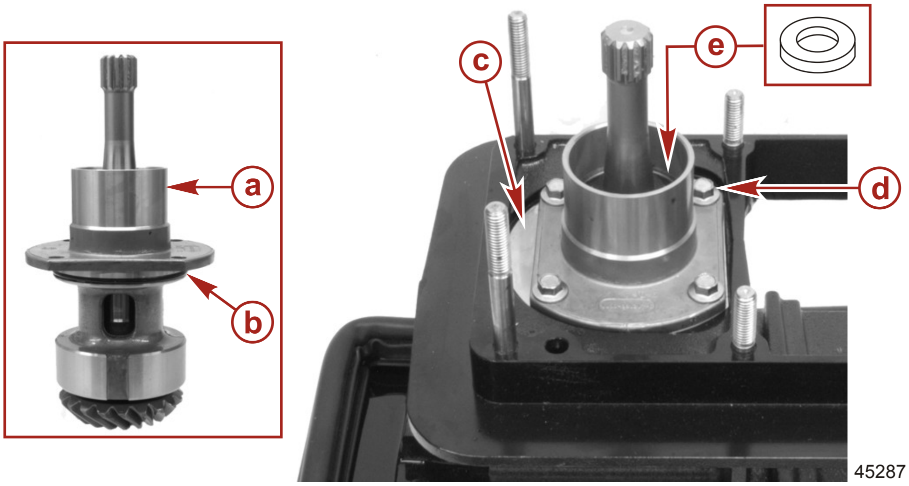
Pinion Shaft Shimming Procedure

NOTE: Pinion gear shimming and backlash procedures must be performed when any of the following components have been replaced:

- *Jet drive housing*
- *Pinion gear*
- *Pinion gear bearing assembly*
- *Pinion shaft housing*
- *Impeller gear*
- *Impeller gear bearing assembly*
- *Impeller shaft front cover*

1. Install the original shims onto the pinion shaft housing. Install the O-ring on the pinion shaft housing.
   NOTE: If the original shims are not available, start with 0.76 mm (0.030 in.) shims.
2. Lubricate the pinion shaft housing O-ring with 2-4-C with Teflon. Install the O-ring on the housing.
3. Install the pinion shaft assembly into the drive housing bore.
4. Apply Loctite 271 Threadlocker to the screw threads. Tighten the screws to the specified torque.

5. Install the rubber ring onto the pinion shaft until it lightly touches the shaft seal.



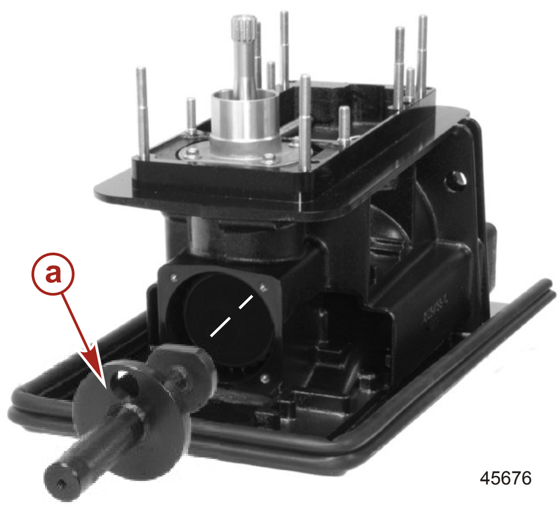
a - Pinion assembly
b - O-ring
c - Shims
d - Screw (M8 x 25) (4)
e - Rubber ring

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Pinion shaft housing O-ring	92-802859A 1
7	Loctite 271 Threadlocker	Pinion shaft housing screw threads (M8 x 25)	92-809819

Description	Nm	lb-in.	lb-ft
Pinion shaft housing screws (M8 x 25)	20.5	181	

6. Rotate the pinion shaft ten revolutions to properly seat the roller bearings.
7. Insert the pinion location tool into the drive housing.

   NOTE: *Carefully inspect the location tool to ensure it is seated in the drive housing bearing.*



a - Pinion location tool

Pinion gear	
Backlash specification	0.64 mm (0.025 in.)

Pinion Gear Height Location Tool	91-831897

NOTE: *250 hp models, 1.15 gear ratio, use pinion height location tool 91-882758.*

Pinion Gear Height Location Tool	91-882758

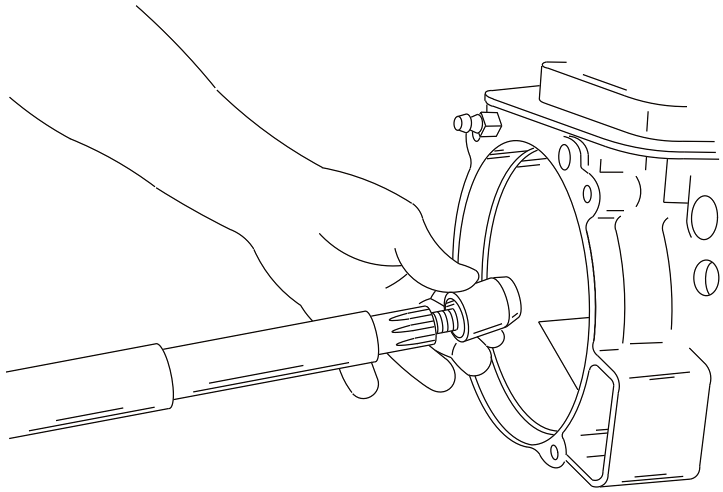
8. Insert the feeler gauge through the hole in the pinion location tool between the gauging surface of the tool and flats on the bottom of the pinion gear teeth.
9. Use the 0.64 mm (0.025 in.) feeler gauge as a starting thickness. Adjust the thickness of the feeler gauge until a slight drag is felt as the gauge is drawn out between the gauging surface of the tool and the pinion gear.

NOTE: Once the thickness is determined, the difference between the feeler gauge thickness and 0.64 mm (0.025 in.) (the required clearance) must be either added or subtracted from the total thickness of shims between the pinion shaft housing and drive housing.

- *Remove the screws securing the pinion shaft housing assembly to the drive housing.*
- *Lift the assembly out of the drive housing. Adjust shim thickness as required.*

Impeller Shaft Installation

1. Lubricate the impeller shaft splines and seal protector with Special Lubricant 101.
2. Install the seal protector onto the impeller shaft. Install the impeller shaft in the drive housing, then remove the seal protector.



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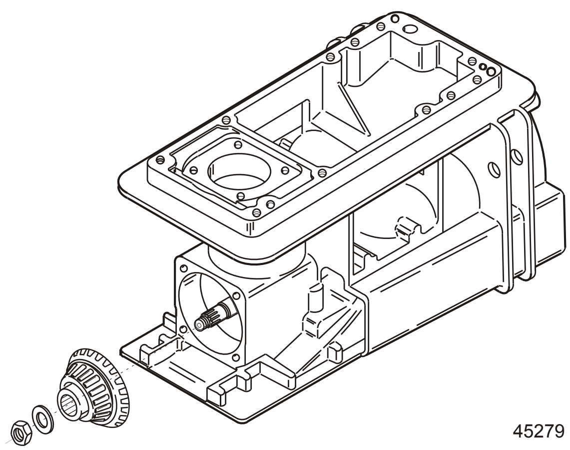
Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Impeller shaft splines and seal protector	92-802865Q02

Seal Protector	91-850233

3. Install the gear/bearing assembly and washer onto the impeller shaft. Apply Loctite 271 Threadlocker to the threads of the impeller shaft. Hold the impeller shaft with the impeller shaft wrench. Install the nut and tighten to the specified torque.



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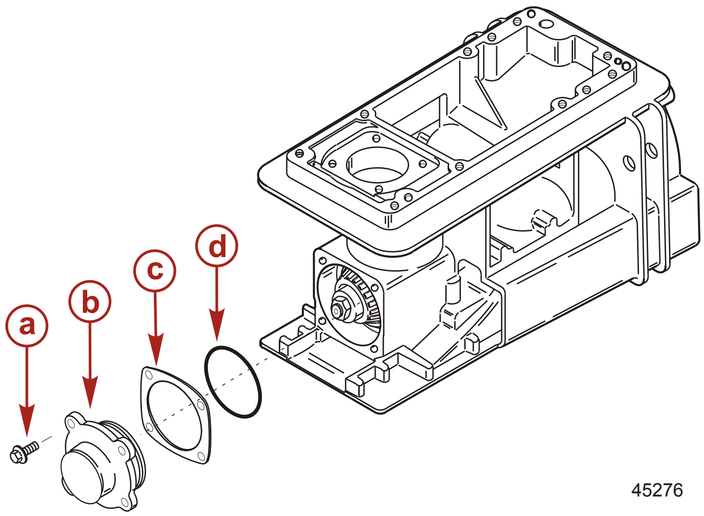
Impeller Shaft Wrench	91-832093A 1

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Impeller shaft threads	92-809819

Description	Nm	lb-in.	lb-ft
Impeller shaft nut	122		90

4. Install the original shims onto the impeller shaft cover. Install the O-ring on the impeller shaft cover.
   NOTE: If the original shims are not available, start with 0.76 mm (0.030 in.) shims.
- *Lubricate the O-ring and bore with 2-4-C with Teflon.*
- *Lubricate the cone bearing with gearcase lubricant.*
5. Install the impeller shaft cover.
6. Apply Loctite 271 Threadlocker to the screw threads. Tighten the screws to the specified torque.

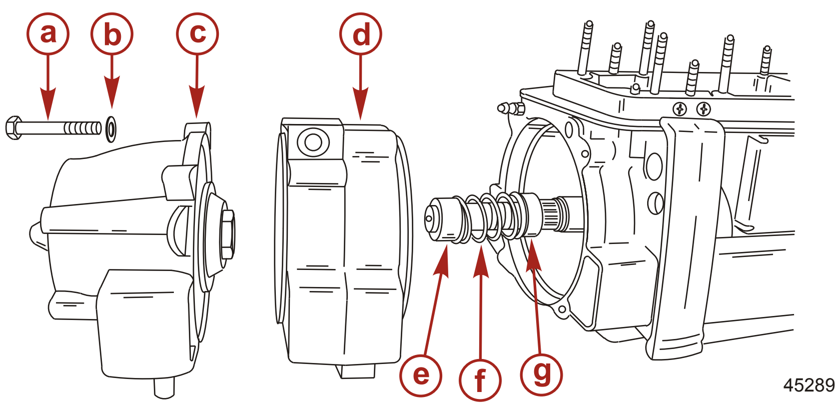


a - Screw
b - Cover
c - Shim
d - O-ring

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Impeller shaft bore and O-ring	92-802859A 1
7	Loctite 271 Threadlocker	Pinion shaft housing screws (M8 x 25)	92-809819

Description	Nm	lb-in.	lb-ft
Impeller shaft cover screws (M8 x 25) (4)	20.5	181	

7. Install the impeller shaft preload tool.
8. Install the wear ring and stator onto the impeller shaft. Secure the assembly with two bolts (opposite corners). Tighten the bolts to the specified torque.



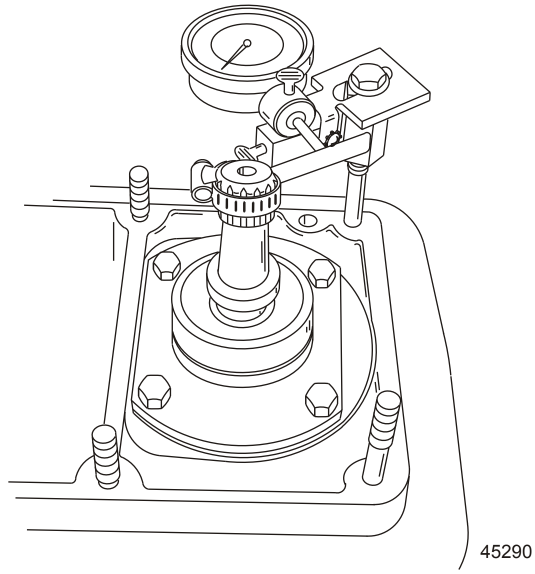
a - Bolt (M10 x 150)
b - Washer
c - Stator
d - Wear ring
e - Rear spring seat
f - Spring
g - Forward spring seat

Impeller Shaft Preload Kit	91-824871A 1

Description	Nm	lb-in.	lb-ft
Wear ring/stator bolts (M10 x 150)	47		35

9. Rotate the impeller shaft ten revolutions to properly seat the roller bearings.
10. Install the backlash indicator rod onto the pinion shaft.
11. Install the dial indicator kit, adapter kit, and thread extending kit.

- Position the rod from the dial indicator on the center mark "II" of the backlash indicator rod.



Backlash Indicator Rod	91- 53459
Dial Indicator	91- 58222A 1
Thread Extending Kit	91-824869A 1

12. Rotate the pinion shaft back and forth lightly to contact the gear teeth in each direction.–

    NOTE: Average total amount of reading of indicator backlash specification is 0.18–0.23 mm (0.007–0.009 in.).

Pinion Shaft Gear	
Backlash	0.18–0.23 mm (0.007–0.009 in.)

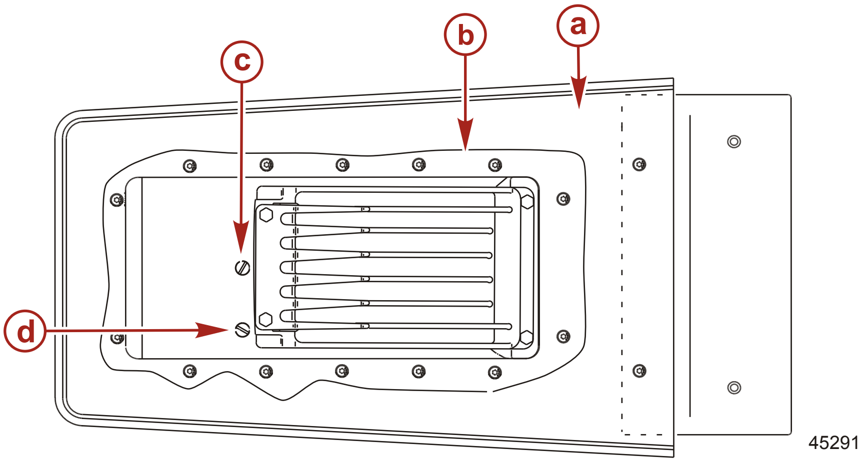
- If the reading is less than minimum, add shims between the impeller cover and drive housing.
- If the reading is more than maximum, remove shims between the impeller cover and drive housing.
- Ratio of backlash reading to shims is 1:1.

13. Remove the backlash indicator rod from the pinion shaft.
14. Remove the dial indicator kit, adapter kit, and thread extending kit.
15. Remove the stator and remove the impeller shaft preload tool.

Final Assembly

1. Install the impeller, wear ring, and stator. Fill the stator housing with High Performance Gear Lubricant. Refer to **Impeller and Stator Installation**.
2. Apply Loctite 598 RTV Sealant on the ride plate. Install the ride plate. Apply Loctite 242 Threadlocker to threads of bolts. Tighten the bolts to the specified torque.
3. Install the nozzle/reverse gate assembly and anode. Apply Loctite 271 Threadlocker to threads of the bolts. Tighten the bolts to the specified torque.
4. Remove the fill and vent screws from the bottom of the drive housing. Fill the housing with High Performance Gear Lubricant. Refer to **Filling the Drive Housing**.

IMPORTANT: The pump housing must be level and upright to obtain the correct fluid level.



Bottom view

a - Ride plate

b - Loctite 598 RTV Sealant

c - Vent screw

d - Drain/fill screw

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Nozzle/reverse gate assembly and anode bolt threads	92-809819
66	Loctite 242 Threadlocker	Ride plate bolt threads (M6 x 20) (16)	92-809821
87	High Performance Gear Lubricant	Stator and drive housing	92-858064K01
142	Loctite 598 RTV Sealant	Ride plate	Obtain Locally

Description	Nm	lb-in.	lb-ft
Ride plate bolts (M6 x 20) (16)	8.5	75	
Nozzle bolts (M10 x 35) (2)	47		35
Anode bolts (M10 x 45) (2)	47		35

5. Install the drive housing, shift, and steering cables. Refer to **Section 1D - Mercury Jet Installation**.