

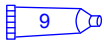
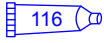
Cooling System

Section 7A - Cooling System

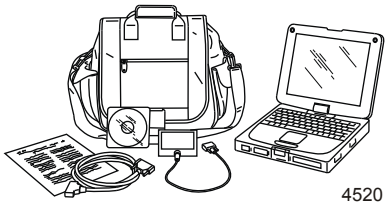
Table of Contents

MotoViewer Service Tool.....	7A-2	Seawater Supply Test.....	7A-9
General Information.....	7A-3	Seawater Inlet Restriction Test.....	7A-9
Seawater Supply System	7A-3	Seawater Pressure Test for MPI Models	
Specifications.....	7A-3	7A-9
Seawater Inlet Hose.....	7A-4	Seawater Aeration Test.....	7A-10
Through-Hull Seawater Pickup System		Closed Cooling.....	7A-11
.....	7A-5	Description.....	7A-11
Seawater Pickup.....	7A-6	Antifreeze Recommendations.....	7A-11
Seacock.....	7A-7	Water Heaters.....	7A-13
Sea Strainer.....	7A-8	Water Heater Hose Connection Points...	7A-14

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
 116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Special Tools

Computer Diagnostic System (CDS)	Order through SPX
	<p>Monitors all electrical systems for proper function, diagnostics, and calibration purposes. For additional information, pricing, or to order the Computer Diagnostic System contact:</p> <p>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</p>

MotoViewer Service Tool

At this time, the Computer Diagnostic System (CDS) software does not communicate with products using the PCM 09 controller through the RS-485 connection. However, all engine and vessel set up, information, and fault codes are available using a new software package from MotoTron called MotoViewer. All communications to MotoViewer travel over the existing RS-485 connection using the CDS laptop and SmartComms. You must install a special SmartComms software update (CDS 8.2x) to the CDS laptop to use MotoTron software. Contact your Product Integration Engineer (PIE) or Technical Account Manager (TAM) for assistance.

To connect MotoViewer to an engine using PCM 09, obtain the following:

Description	Part Number
SmartComms Interface Box	<p>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</p>
Diagnostic Tester Harness Assembly for PCM 555 models	84-822560A13

NOTE: If the Diagnostic Tester Harness Assembly (84-822560A13) is unavailable, you can order harness 84-822560T12 and adapter 84-822560A5.

General Information

Mercury MerCruiser engines have either a seawater cooling system or a closed cooling system. Seawater cooling systems are sometimes called raw water cooling or standard cooling, while closed cooling systems are sometimes called fresh water cooling. On engines with seawater cooling, the engine is cooled entirely by the seawater in which the boat is being operated. Closed cooling systems use a combination of fresh water (antifreeze and water) and seawater for cooling. Both types of systems are designed to keep the engine operating temperature at approximately 71 degrees C (160 degrees F) for optimum performance, fuel economy and durability. (Refer to cooling system flow diagrams at end of section.)

To monitor the cooling system, a temperature switch is incorporated into the audio warning system, which alerts the operator of an abnormal condition if the temperature exceeds approximately 93 degrees C (200 degrees F). A temperature sender is also employed to operate a temperature gauge at the dash. On dual helm applications, this sender must be replaced with a dual station sender to obtain the proper temperature reading at both stations. Refer to the **Instrumentation and Controls** section for more information.

The cooling system must receive a sufficient amount of seawater under all operating conditions to operate properly. The design and installation of the seawater supply system is the boat manufacturer's responsibility. Cooling system components must be constructed, sized, and installed in accordance with the following guidelines.

NOTICE

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

Seawater Supply System

Specifications

SEAWATER SUPPLY HOSE

Seawater Supply Hose Specifications	
Seawater inlet hose	32 mm (1-1/4 in.) I.D. (wire reinforced)
Seawater pickup	Low restriction with 32 mm (1-1/4 in.) connections
Seacock (optional)	
Sea strainer (optional)	

SEAWATER INLET

Seawater Inlet Specifications	
See Seawater Inlet Restriction Test; Collect data at the seawater pump inlet (vacuum).	
Maximum water inlet restriction	17 kPa (2.5 psi)

SEAWATER FLOW

Seawater Flow Specifications					
See Seawater Supply Test; Collect data within 152 mm (6 in.) of the seawater pump outlet.					
Inboard Models	Cooling	Seawater Pickup	RPM	Minimum Flow liter (gallon) per minute	Minimum kPa (psi)
5.7 MPI	Closed Cooling System	Through-Hull	4000	106 liter (28 GPM)	138 kPa (20 psi)
Horizon 5.7					
6.2 MPI					
Horizon 6.2				76 liter (20 GPM)	75 kPa (11 psi)
8.1 H.O.					
Horizon 8.1					

Seawater Flow Specifications					
See Seawater Supply Test; Collect data within 152 mm (6 in.) of the seawater pump outlet.					
Tow Sports Models	Cooling	Seawater Pickup	RPM	Minimum Flow liter (gallon) per minute	Minimum kPa (psi)
Tow Sports 5.7 TKS	Closed Cooling System	Through-Hull	4000	65 liter (17 GPM)	42 kPa (6 psi)
Tow Sports 5.7 MPI					
Scorpion 350					
Scorpion 377					

COLLECTING SEAWATER PRESSURE DATA

IMPORTANT: For models equipped with a seawater pressure transducer, collect the seawater pressure data using a Computer Diagnostic System (CDS).

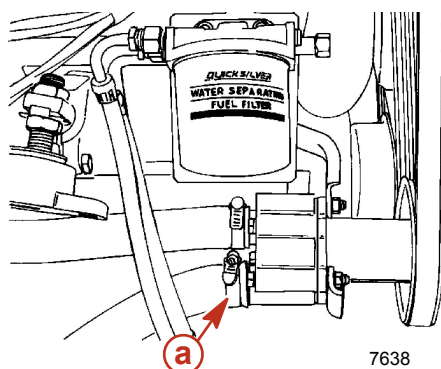
Computer Diagnostic System (CDS)	Order through SPX
----------------------------------	-------------------

IMPORTANT: On inboard models, the seawater pressure data is to be collected within 152 mm (6 in.) of the seawater pump outlet.

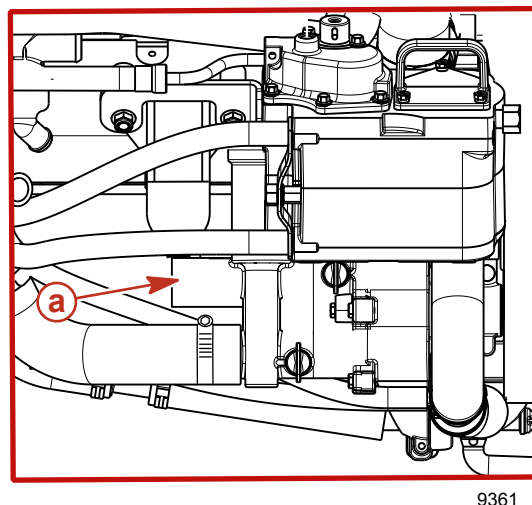
Seawater Inlet Hose

- A reinforced hose capable of supporting 10 in. Hg vacuum must be used to prevent the seawater inlet hose from collapsing from pump suction.
- The hose should be oil and seawater resistant.
- Use the shortest hose length possible with the least number of bends to minimize restriction.
- All connections must be secured with a hose clamp.

- Fasten hose as appropriate to maintain proper routing and to prevent chafing or contact with other moving parts.



Typical composite seawater pickup pump

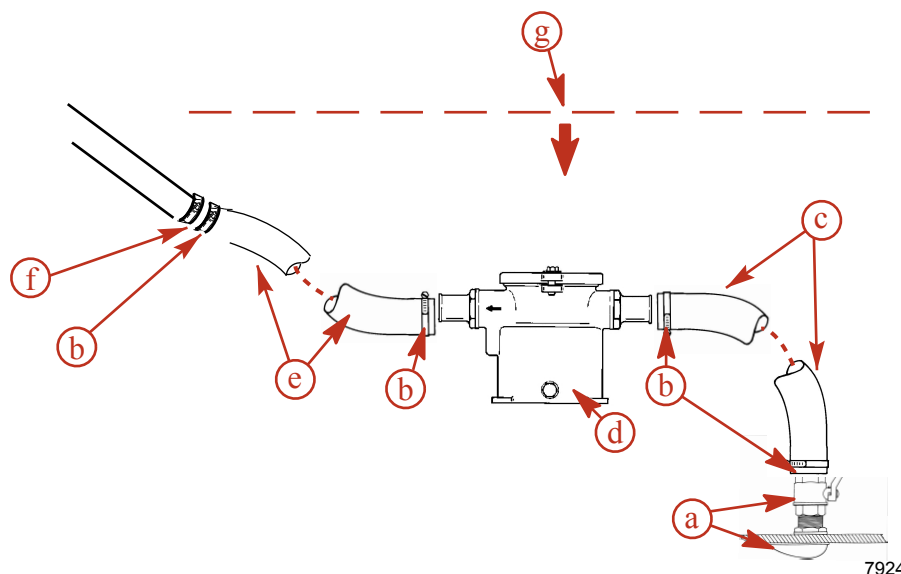


Typical brass seawater pickup pump

a - Seawater inlet hose connection

Through-Hull Seawater Pickup System

IMPORTANT: Seawater hose used must be wire reinforced to avoid collapsing hose when suction is created by seawater pump impeller.



Typical installation shown with a through the hull seawater pickup

- a** - Quicksilver seawater pickup and seacock
- b** - Hose clamp
- c** - Seawater hose to seawater strainer
- d** - Quicksilver seawater strainer
- e** - Seawater hose to engine
- f** - Seawater pump hose connector (if equipped)
- g** - Below seawater pump level

IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as the pickup may create turbulence and allow air to flow into the propeller slipstream. This will cause propeller ventilation and will adversely affect boat performance.

IMPORTANT: Make gradual bends in the seawater hoses to avoid kinks. Hoses must not come in contact with steering system components, engine coupler, or drive shaft.

- The seawater pickup must be large enough to permit sufficient seawater flow to engine seawater pickup pump for adequate engine cooling.
- The seawater pickup also must supply a positive head while underway.
- The seawater pickup should be located as close to the seawater pump inlet as possible and in an area where an uninterrupted, solid stream of seawater will flow past when the boat is underway.

Seawater Pickup

Either a through-transom or through-hull seawater pickup can be used. Select pickup location to minimize seawater inlet hose length while providing an optimum location for seawater pickup. The location should be in an area that will provide a solid, air-free flow of seawater under all operating conditions. Avoid areas with a disturbed seawater flow, such as those behind or in close proximity to the propeller. Locations that are too far forward or outboard should also be avoided as these are prone to aeration problems at high boat trim angles and in turns. Check for aeration as outlined under **Seawater Supply Test**.

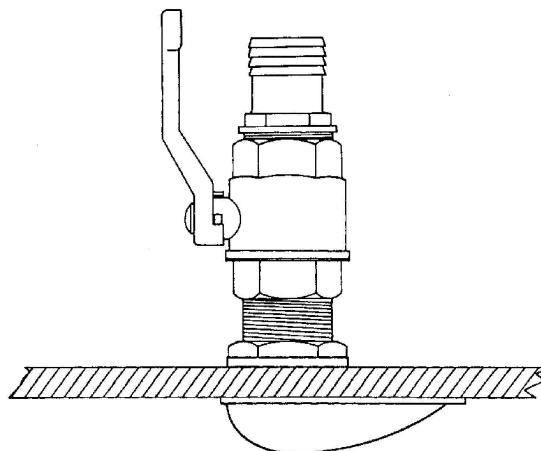
IMPORTANT: Do not install the seawater pickup directly in line with the propeller, as pickup may create turbulence and allow air to flow into the propeller slip-stream. This will cause propeller ventilation and will adversely affect boat performance.

Openings in seawater pickup should be approximately 3 mm (1/8 in.) maximum to prevent larger debris from entering and clogging the cooling system.

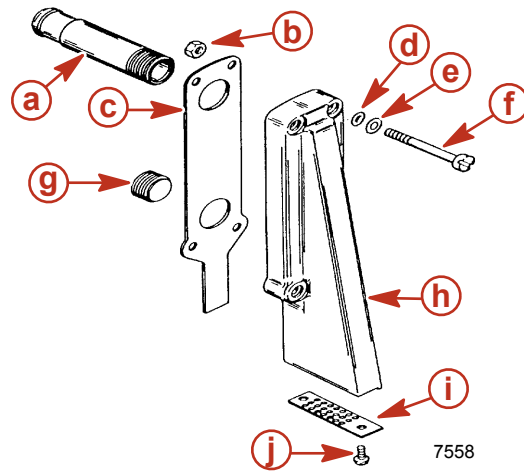
IMPORTANT: Use a seawater strainer if the seawater pickup openings exceed 3 mm (1/8 in.).

Provisions should be made to minimize galvanic corrosion, given the hull material being used and the composition of the surrounding components. Some industry standards and regulations also require that the pickup be connected into the boat's bonding system to minimize stray current corrosion. Refer to applicable standards and regulations for more details.

IMPORTANT: External seawater pickup must have an integral seacock.

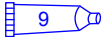



Typical seacock



Typical transom pickup

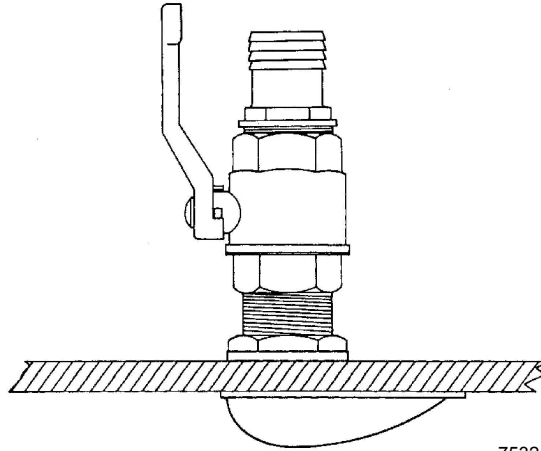
- | | |
|-------------------------|-------------------------|
| a - Hose fitting | f - Screw (4) |
| b - Nut (4) | g - Plastic plug |
| c - Gasket | h - Pickup |
| d - O-ring (4) | i - Screen |
| e - Washer (4) | j - Screw (2) |

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Hose fitting threads and plastic plug threads	92-809822
Tube Ref No.	Description	Where Used	Part No.
 116	RTV 587 Ultra Blue Silicone Sealer	Sealing surfaces and screw shaft	92-809825

Seacock

The ABYC and other industry standards and regulations require the use of a seacock on certain types of applications to stop the entry of seawater in the event of a leak in the cooling system. Refer to applicable standards and regulations for specific requirements. The seacock also allows the seawater to be shut off when servicing the engine.

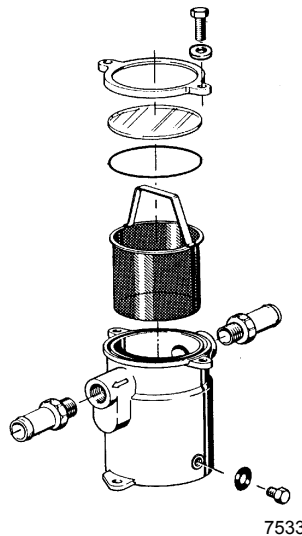
The seacock must provide minimum restriction to seawater flow (see **Specifications**). A ball valve or gate valve is recommended. The ball valve is most common and is typically equipped with a lever type handle that operates in a 90 degree arc. This design gives a clear indication of whether the valve is open or shut. Industry standards and requirements typically require that the seacock be rigidly attached to the hull at the seawater pickup. Seacock location should be readily accessible for quick, easy operation.



Typical seacock

Sea Strainer

A sea strainer is recommended if the boat is to be operated in an area with a high debris content. The strainer must be sized to minimize restriction (See **Specifications**) and to provide a reasonable service interval. Locate the strainer in an area that will be easily accessible for servicing. If the boat is not equipped with a seacock, the strainer should be located above the seawater-line to prevent seawater entry into boat when servicing. The strainer must have provision to allow draining in freezing temperature periods.



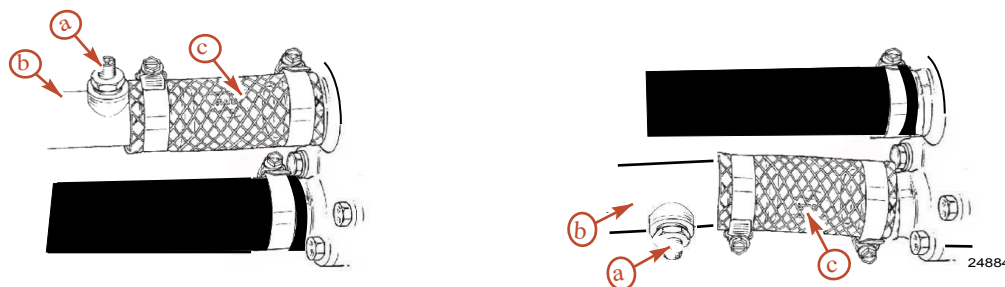
Typical Sea Strainer

Seawater Supply Test

Seawater Inlet Restriction Test

Maximum seawater inlet restriction must not exceed 17 kPa (2.5 psi) when measured at the inlet side of the seawater pump. Pressure can be tested using pressure gauge and hardware. Gauge must be capable of accurately reading a vacuum (below atmospheric pressure).

1. Install an adapter into the seawater inlet hose at the seawater pump to allow the connection of a pressure gauge.



Brass seawater pump

- a** - Connection for the pressure gauge
- b** - Adapter

Composite seawater pump

- c** - Seawater pump inlet connection

2. Zero the pressure gauge.
3. Connect the pressure gauge to the connection on the adapter.
4. With boat in the seawater and while underway, operate engine at 1000, 2000, 3000, 4000, and WOT while observing gauge.
5. Pressure should be steady and not exceed 17 kPa (2.5 psi). Check the following if abnormal readings are obtained.

FLUCTUATING READINGS

- Pickup located too far forward or outboard on the boat, allowing air to enter system.
- Pickup located too close to propeller or some other object and picking up disturbed seawater flow.
- Loose connection in the system allowing air to enter.
- Seawater inlet hose collapsing; wire reinforced hose not used.

EXCESSIVE PRESSURE READING

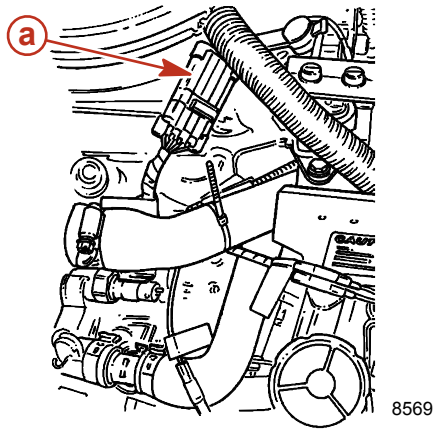
- Seawater supply components improperly sized.
- Seawater pickup not located on hull in an area with a solid, air-free flow of seawater.
- Excessive bends in seawater inlet hose.
- Seawater inlet hose collapsing; wire reinforced hose not used.

Seawater Pressure Test for MPI Models

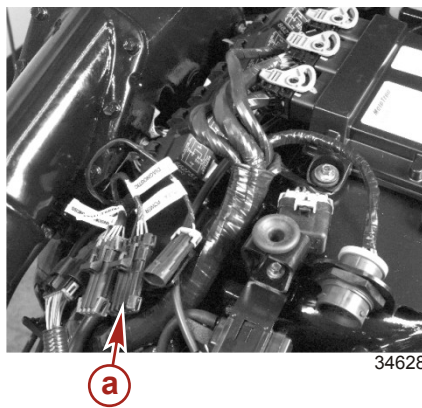
IMPORTANT: MPI models must use the flow values as listed in Specifications, see Seawater Supply Test Specifications.

IMPORTANT: The boat must be in the seawater for this test.

1. Connect an appropriate scan tool to the diagnostic connector.



a - Diagnostic connector



a - Diagnostic connector

2. Operate the boat and advance the the throttle to 4000 RPM.
3. Measure the seawater pressure. If seawater pressure does not meet specification, seawater inlet plumbing changes are required.

Seawater Aeration Test

The engine cooling system must receive a solid, air-free stream of seawater in order to operate effectively.

1. Install a piece of clear plastic wire-reinforced tubing in seawater inlet hose of seawater pickup pump.
2. Operate engine from idle to WOT, while putting the boat through normal operating maneuvers. Simultaneously, watch the seawater flow through the clear plastic tubing.
3. Seawater flow should be solid with only tiny bubbles being acceptable (due to pseudo-cavitation). If it is not:
 - Pickup located too far forward or outboard on the boat, allowing air to enter system.
 - Pickup located too close to the propeller or some other object and picking up disturbed seawater flow.
 - Loose connection in the system allowing air to enter.

Closed Cooling

Description

Closed cooling is a standard feature on some models and is available as an accessory or a factory installed option on others. When closed cooling is used, a mixture of antifreeze and water is circulated through the water jackets in the engine block, cylinder heads, and —on some applications—the exhaust manifolds to dissipate the heat. Refer to Water Flow Diagrams. This coolant is then passed through a heat exchanger. Here the coolant rejects heat to seawater (water in which the boat is being operated), which is simultaneously being passed through the exchanger. The heat is then carried away by the seawater and discharged overboard via the exhaust elbows. The design of the heat exchanger allows for the transfer of heat, while ensuring that the two coolants are separated. In this manner, the expensive engine components are never exposed to seawater, which can be corrosive in salty, polluted, or mineral laden water areas.

Mercury MerCruiser's closed cooling systems are developed by the same people who design our engines to ensure compatibility and the same high quality standards. Our systems employ several exclusive features to provide unsurpassed cooling efficiency and durability. An exclusive double-acting thermostat is used on V6 and V8 models, which provides increased coolant velocity through the engine and heat exchanger to prevent hot spots and improve performance. Mercury MerCruiser's heat exchangers also incorporate several state-of-the-art designs to enhance the heat transfer between the coolants for an additional margin of cooling capacity. Features like these allow our systems to continually operate at WOT in water temperatures up to 38 °C (100 °F), where most after-market systems fall short of this mark. This additional cooling capacity translates into longer cooling system life with fewer problems regardless of where the boat is operated. Contact your sales representative to order your closed cooling systems factory installed or refer to the Mercury Precision Parts and Accessories Guide to obtain the part numbers for the accessory kits.

The term full closed cooling, also known as full fresh water cooled or full FWC refers to the use of an ethylene glycol mixture in the engine and the exhaust water jackets. The ethylene glycol coolant mixture is circulated through the exhaust cooling passages as well as the engine cooling passages.

Antifreeze Recommendations

NOTICE

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

Factory-installed closed-cooling systems are filled with extended life coolant. Extended life coolant allows for a service interval of 5 years or 1000 hours, while the service interval for normal coolant is 2 years or 400 hours. If you are installing closed cooling kits, we encourage you to use extended life coolant as a method of reducing maintenance costs for your customers.

Do not mix normal coolant with extended life coolant. Any mixture of normal coolant requires a service interval of 2 years or 400 hours. All coolant must be mixed with an equal amount of water. Pre-mixed, extended-life coolant is available from QuickSilver. Extended-life coolants can be identified by their orange color (vs. green for regular coolant) and by an orange cap on the coolant container. Texaco offers extended-life coolant under the name Havoline Extended Life Dex Cool. Prestone offers extended-life coolant under the name Extended Life 5/100. Any coolant that you use must be Dex Cool compatible. If you are installing closed cooling kits, observe the special filling procedure in the installation instructions.

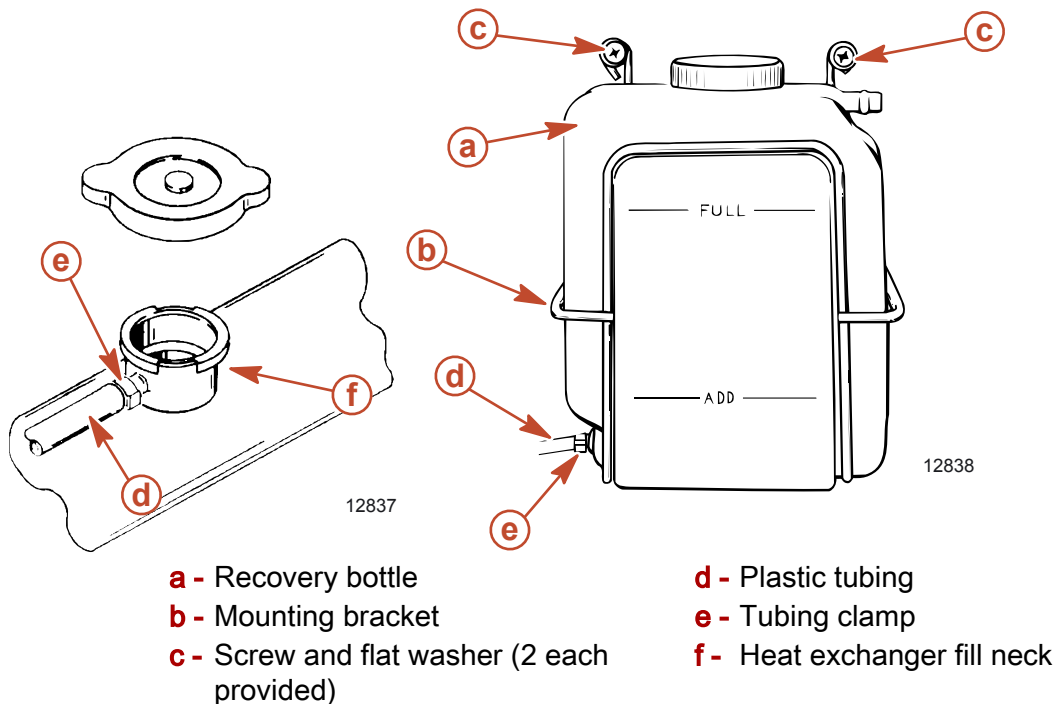
Closed Cooling System Capacity	
8.1 H.O. and Horizon 8.1 Models	18 liters (19 quarts)
All Other Models	19 liters (20 quarts)

COOLANT RECOVERY SYSTEM EXCEPT 8.1 H.O. AND HORIZON 8.1

All Mercury Mercruiser closed cooling systems (except 8.1 H.O. and Horizon 8.1) are equipped with a coolant recovery system that must be installed by the boat manufacturer. Mount the coolant recovery bottle according to the following specifications:

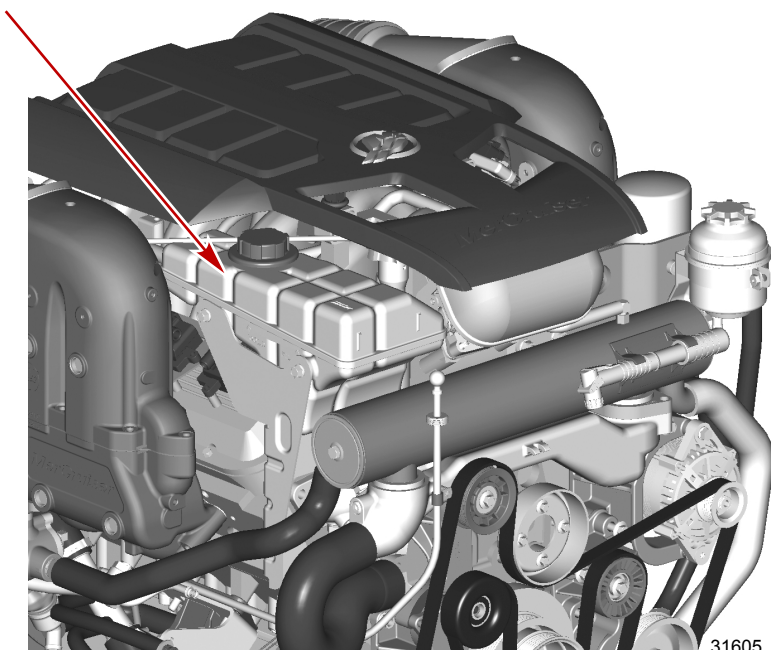
NOTE: This differs from the previous recommendation to ensure that air does not enter the cooling system upon cool down.

- Within approximately 122 cm (4 ft) of heat exchanger filler neck for connection with the provided tubing.
- Even with, or slightly above, heat exchanger filler neck.
- Clearly observable and easily accessible.



PRESSURIZED COOLANT RESERVOIR FOR 8.1 H.O. AND HORIZON 8.1

All Mercury MerCruiser systems with closed cooling are equipped with a pressurized coolant reservoir. Ensure that the coolant reservoir is accessible for observing the level and servicing the coolant.



Pressurized coolant reservoir

Water Heaters

NOTICE

Prevent engine damage from overheating. In models equipped with closed cooling, low coolant levels may allow an air pocket to form when the hot water heater or cabin heater is mounted higher than the fill cap on the heat exchanger. Mount the heater lower than the fill cap of the heat exchanger and maintain the recommended coolant level.

If you are installing a water heater, ensure that it meets the following specifications:

Description	Specification
Engine operating temperature range	71–79° C (160–175° F)
Maximum pressure at the heater connections	172 kPa (25 psi)

IMPORTANT: Engine may not maintain proper temperature if heater supply and return hoses are too large.

- Mount the heater element below the engine connections on engine to avoid air locking, which can cause overheating.
- Maximum ID of heater supply and return hose: 16 mm (5/8 in.).
- Heater connections should be made only at the specified locations.
- Do not reposition the temperature senders or switches. Senders and switches may not operate properly if repositioned.
- Hoses should be kept as short as possible with a minimum number of bends.
- The system should be arranged so that the heater hoses slope progressively upward (toward the engine) to minimize the need for air venting. Avoid U-bends in the hoses.

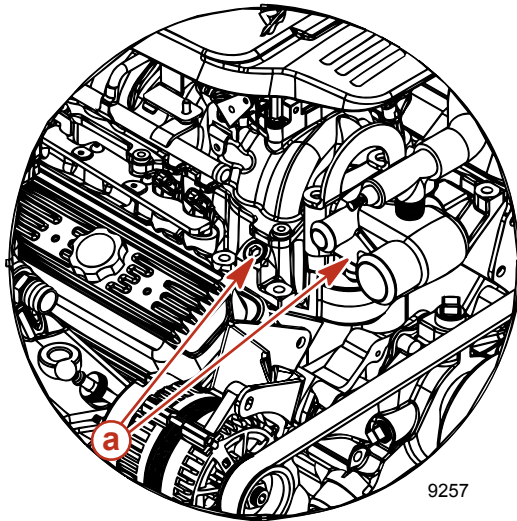
- Hoses should be properly supported to prevent chafing and interference with moving parts on engine.
- Drain plugs should be located at the lowest point in the system.
- On models with closed cooling systems, additional coolant must be added to the fresh water system to fill the heater. See **Antifreeze Recommendation**. Operate the engine while filling and recheck the level several times to ensure that all air has been purged from the system.

IMPORTANT: Closed cooling system capacity will be different than shown in the Operation, Maintenance, and Warranty manual. Be sure to advise the owner of the proper capacity for your application.

- Refer to heater manufacturer's instructions for specific installation details.

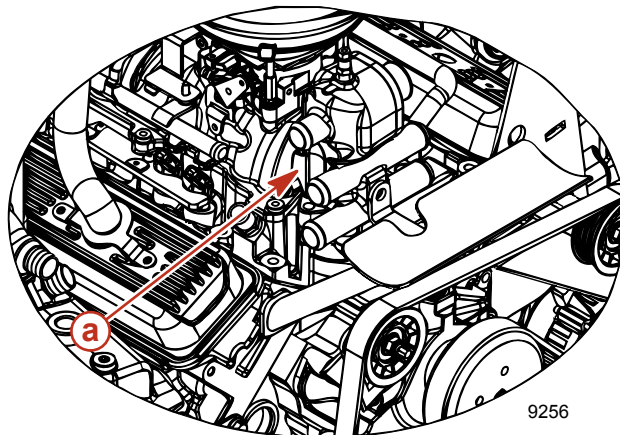
Water Heater Hose Connection Points

WATER HEATER CONNECTIONS: MPI MODELS



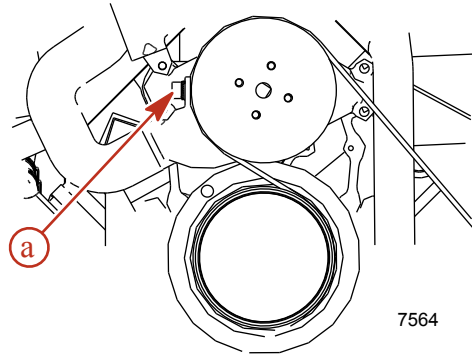
Seawater cooled models

a - Location for hot water supply connection



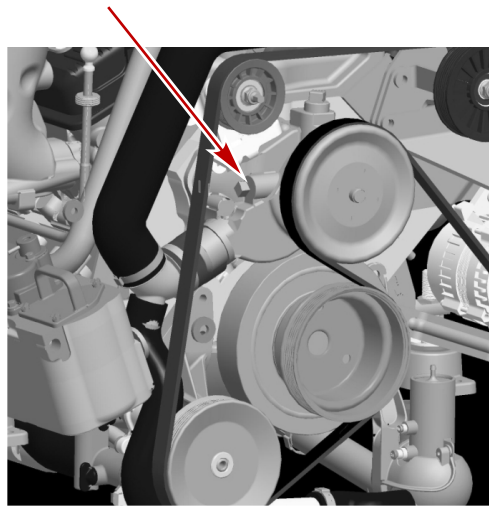
Models with closed cooling

a - Location for hot water supply connection



Water circulating pump housing

a - Location for return hose connection

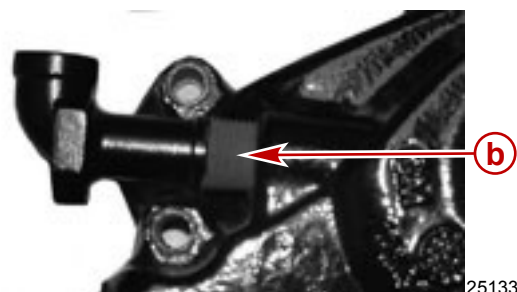


Water circulating pump fitting

IMPORTANT: If the water pump housing prevents you from tightening the standard hose barb fitting, use special fitting 22-865526.



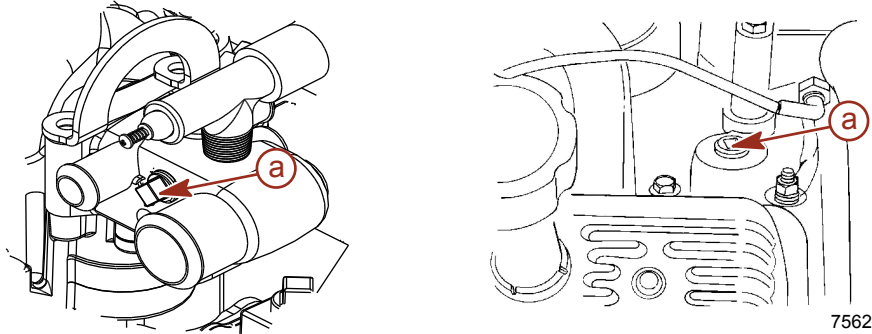
a - Standard fitting



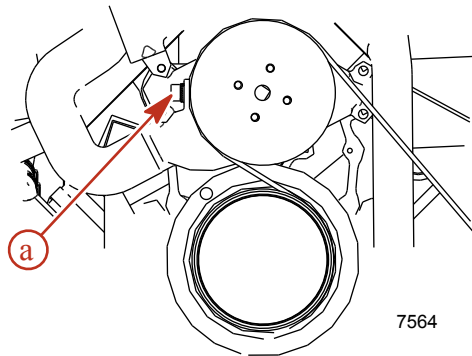
b - Special fitting

25133

WATER HEATER CONNECTIONS: CARBURETED MODELS



a - Location for hot water supply connection



Water circulating pump housing

a - Location for return hose connection

WATER HEATER CONNECTIONS: SCORPION MODELS

If you are installing a cabin heater or water heater, ensure that it meets the following specifications.

- Supply and return hoses must have a maximum inner diameter of 16 mm (5/8 in.) inside diameter (ID).
- Heater connections should be made only at the specified locations.
- Do not reposition the engine temperature switch.

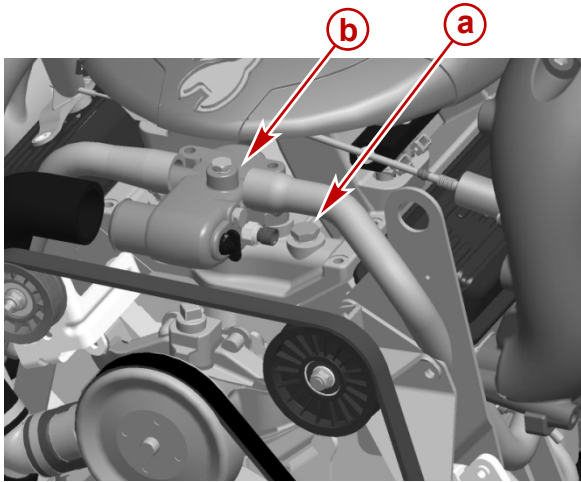
IMPORTANT: :

NOTICE

Blocking the coolant flow at the heater can cause reduced engine performance or overheating. Check for continuous coolant flow from the engine intake manifold to the water circulating pump.

SUPPLY HOSE CONNECTION

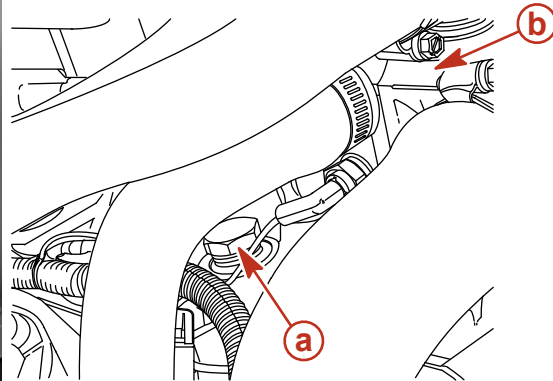
NOTE: Some models may be equipped with additional fittings.



33423

Port side intake manifold plug

a - Supply hose connection

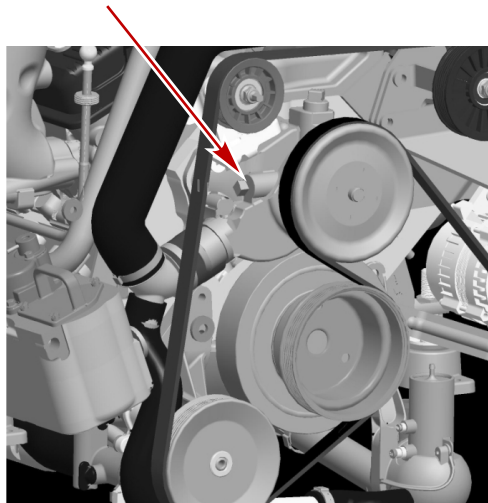


11479

Starboard side intake manifold plug

b - Thermostat housing

RETURN HOSE CONNECTION



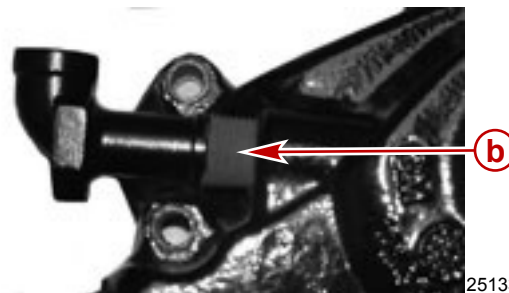
33425

Water circulating pump fitting

IMPORTANT: If the water pump housing prevents you from tightening the standard hose barb fitting, use special fitting 22-865526.



a - Standard fitting



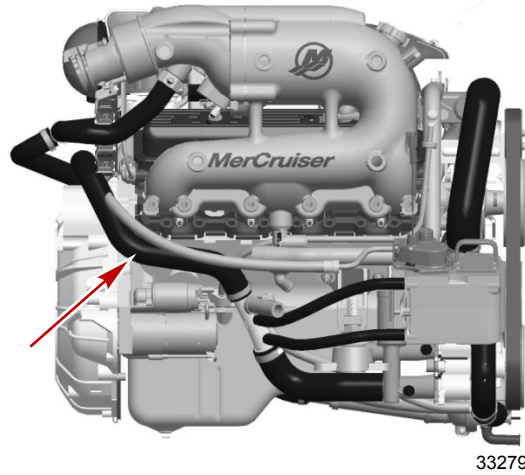
25133

b - Special fitting

COLD WATER SHOWER INSTALLATION

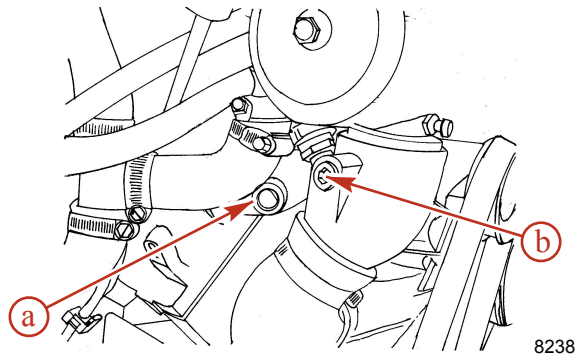
IMPORTANT: When connecting a cabin shower:

- The supply hose must have a maximum inner diameter of 16 mm (5/8 in.) .
 - Make shower connections.
 - Do not reposition the shaft log seal.
1. Trim the hose between the transmission cooler and the seawater pump.
 2. Install the shower according to manufacturer's instructions.



Hose

WATER HEATER CONNECTIONS: 8.1 H.O. AND HORIZON 8.1 MODELS



- a** - Location for hot water supply connection
- b** - Location for return hose connection