







Cooling System

Section 6A - Closed-Cooling System

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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Fleetguard Compleat with DCA4, Fleetguard Part Number: CC2825, Container size: 3-3/4 liters, 1 U.S. gallon	Closed cooling system	
	Marine Caulking	Seawater inlet mounting surfaces Closed cooling system	Obtain Locally
	Loctite 271 Threadlocker	Seawater inlet nut	92-809819
	Loctite Master Gasket Kit	Backside of seawater pump cam and screw threads Coolant temperature adaptor (if equipped) and sensor threads	92-12564 2
	SAE Engine Oil 30W	Seawater pump shaft	Obtain Locally
	Marine Engine Coolant	Closed cooling system (This coolant only available in Europe.) Closed cooling system	92-813054A2

Precautions

⚠ CAUTION

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

NOTICE

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

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

NOTICE

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

NOTICE

Water trapped in the passages of the heat exchanger can cause corrosion or freeze damage. Drain all sections of the heat exchanger immediately after operation or before any length of storage in cold weather.

IMPORTANT: The closed cooling section must be kept full year-round with the specified coolant.

IMPORTANT: Do not use Propylene Glycol anti-freeze in the closed cooling system of the engine.

NOTICE
For instructions on flushing the seawater cooling system or finding the interval for changing the coolant, see Section 1B—Maintenance.

Closed Cooling System Specifications

Capacity

Closed Cooling System	
Capacity	7.50 liter (8.00 qt.)

Thermostat

Thermostat		
Operating temperature	Start opening	80° C (176° F)
	End opening	95° C (203° F)

Pressure Cap



Pressure Cap	
Operating pressure	100 kPa (14.5 psi)

Coolant (Antifreeze)

IMPORTANT: The coolant (antifreeze) used must be a solution of low silicate ethylene glycol containing special additives and deionized, purified water. Using other types of engine coolant may cause fouling of the heat exchangers and overheating of the engine. Do not combine different types of coolants without knowing that they are compatible. Refer to the coolant manufacturer's instructions.

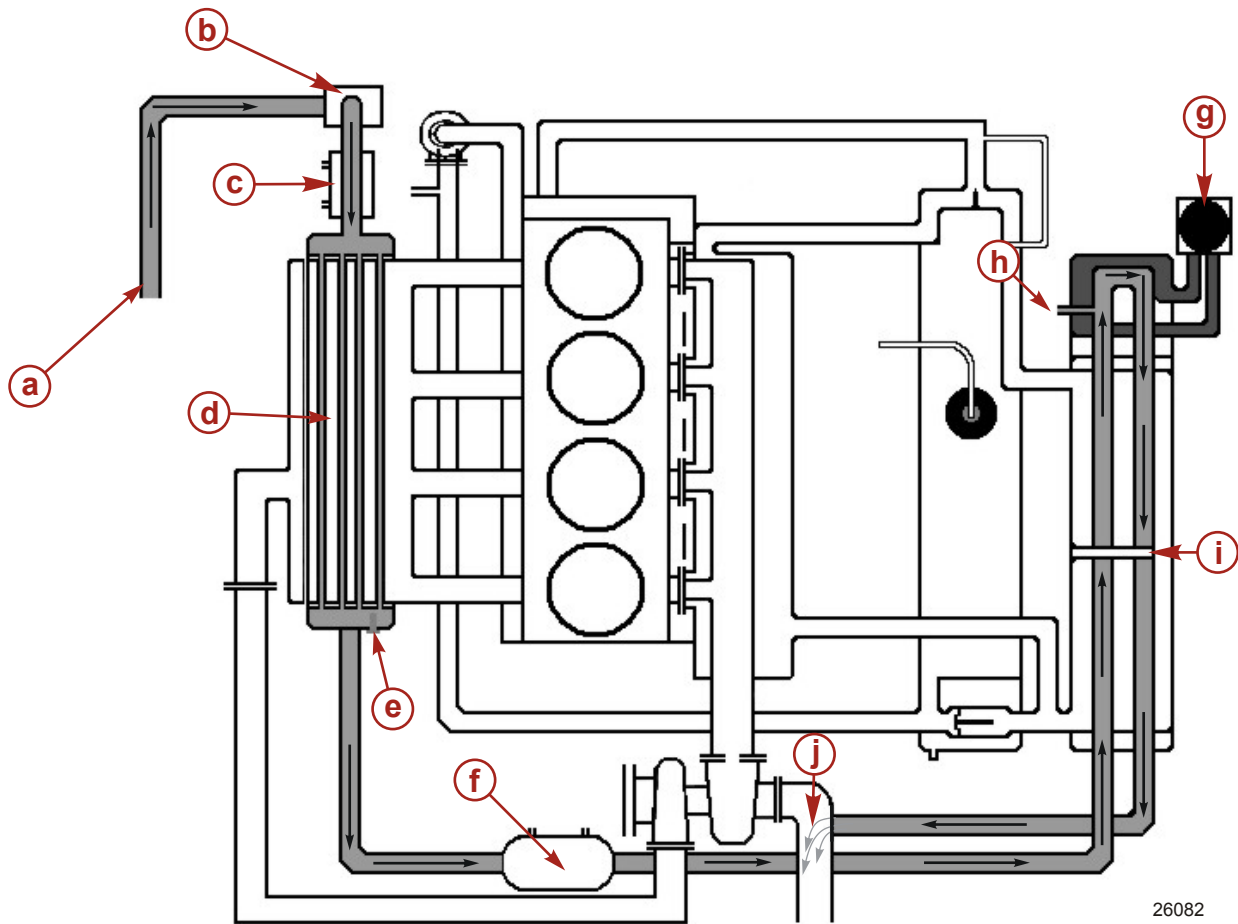
NOTE: We recommend using a 50/50 solution of coolant (antifreeze) and deionized, purified water. When operating where seawater temperatures are greater than 32 °C (90 °F), you can use a 25/75 solution of coolant (antifreeze) and deionized, purified water for improved cooling performance.

These specified, premixed formulas require no mixing with water or other additives. They prevents silicate gelling which can restrict engine cooling passages and provide freeze protection to –38° C (–33° F).

Tube Ref No.	Description	Where Used	Part No.
 123	Marine Engine Coolant	Closed cooling system (This coolant only available in Europe.)	92-813054A2
	Fleetguard Compleat with DCA4, Fleetguard Part Number: CC2825, Container size: 3-3/4 liters, 1 U.S. gallon	Closed cooling system	

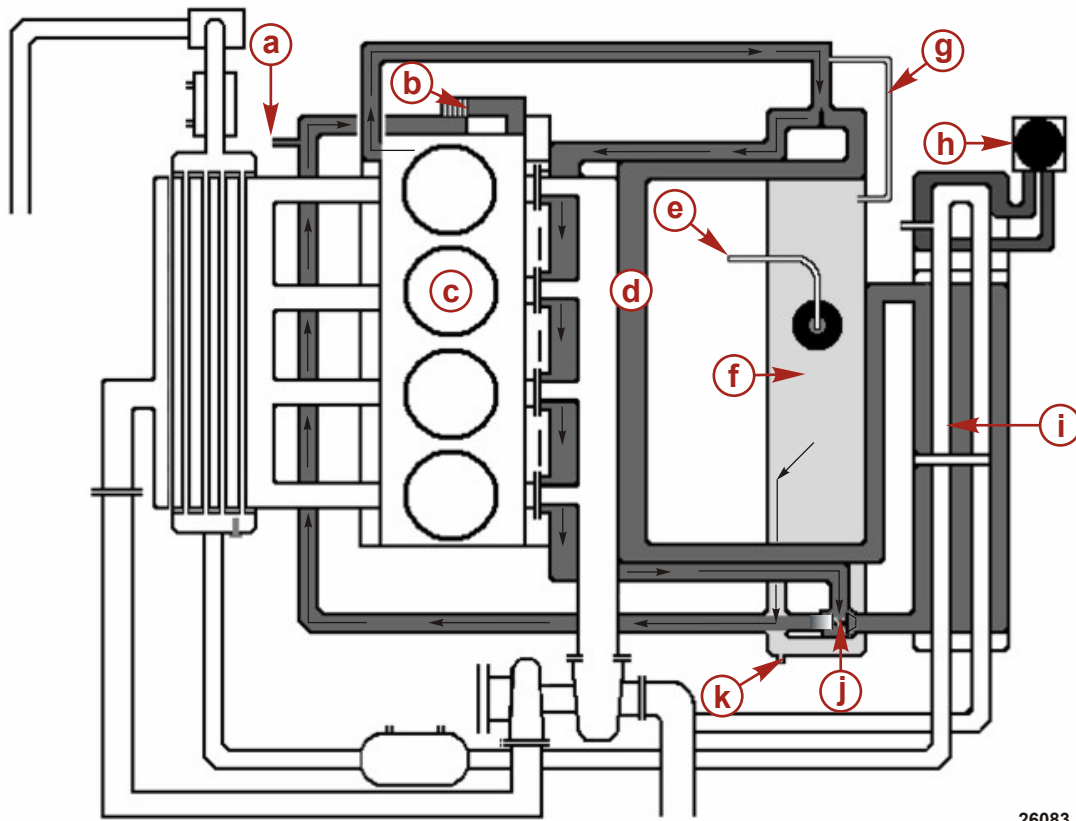
Cooling System Flow Diagrams

Early Production Models



Seawater Flow

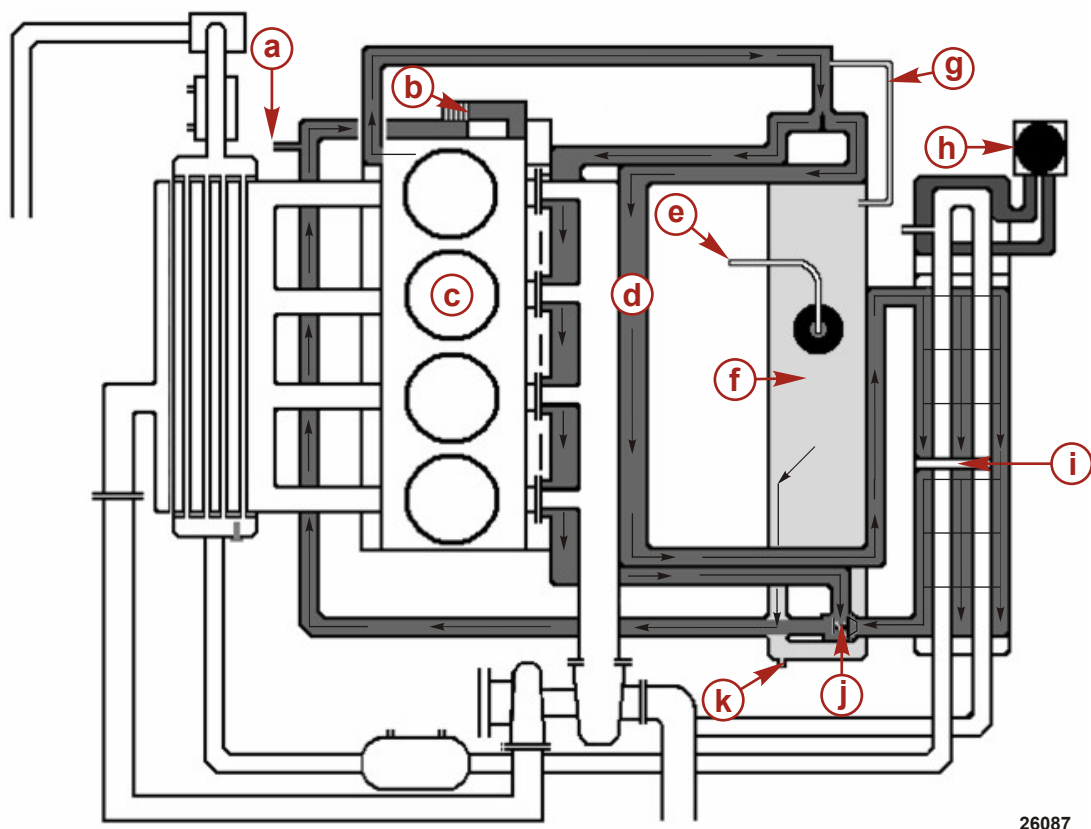
- | | |
|--------------------------------------|---|
| a - Seawater inlet | f - Power assisted steering fluid cooler |
| b - Seawater pump | g - Oil cooler |
| c - Fuel cooler (if equipped) | h - Heat exchanger drain-valve |
| d - Aftercooler | i - Heat exchanger |
| e - Zinc anode | j - Exhaust riser |



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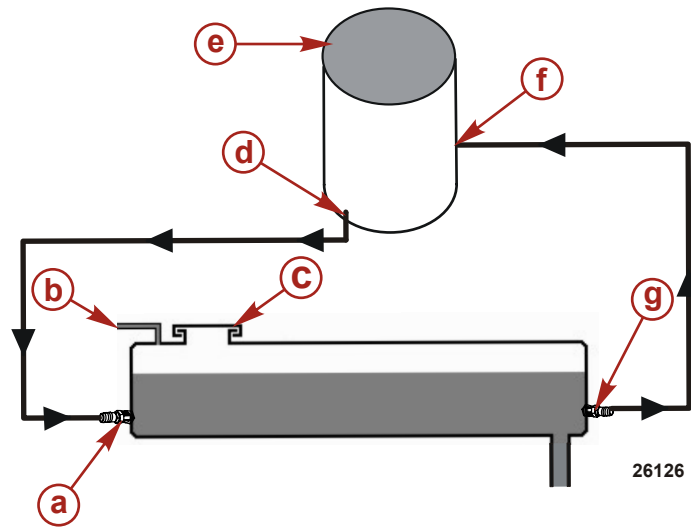
Coolant Flow with thermostat closed

- | | |
|--|--|
| a - Closed cooling system drain-valve | g - Closed cooling system line vent |
| b - Engine water circulating pump | h - Oil cooler |
| c - Engine block and heads | i - Heat exchanger |
| d - Exhaust manifold | j - Thermostat (closed) |
| e - Expansion tank vent | k - Expansion tank drain-valve |
| f - Expansion tank | |



Coolant Flow with thermostat open

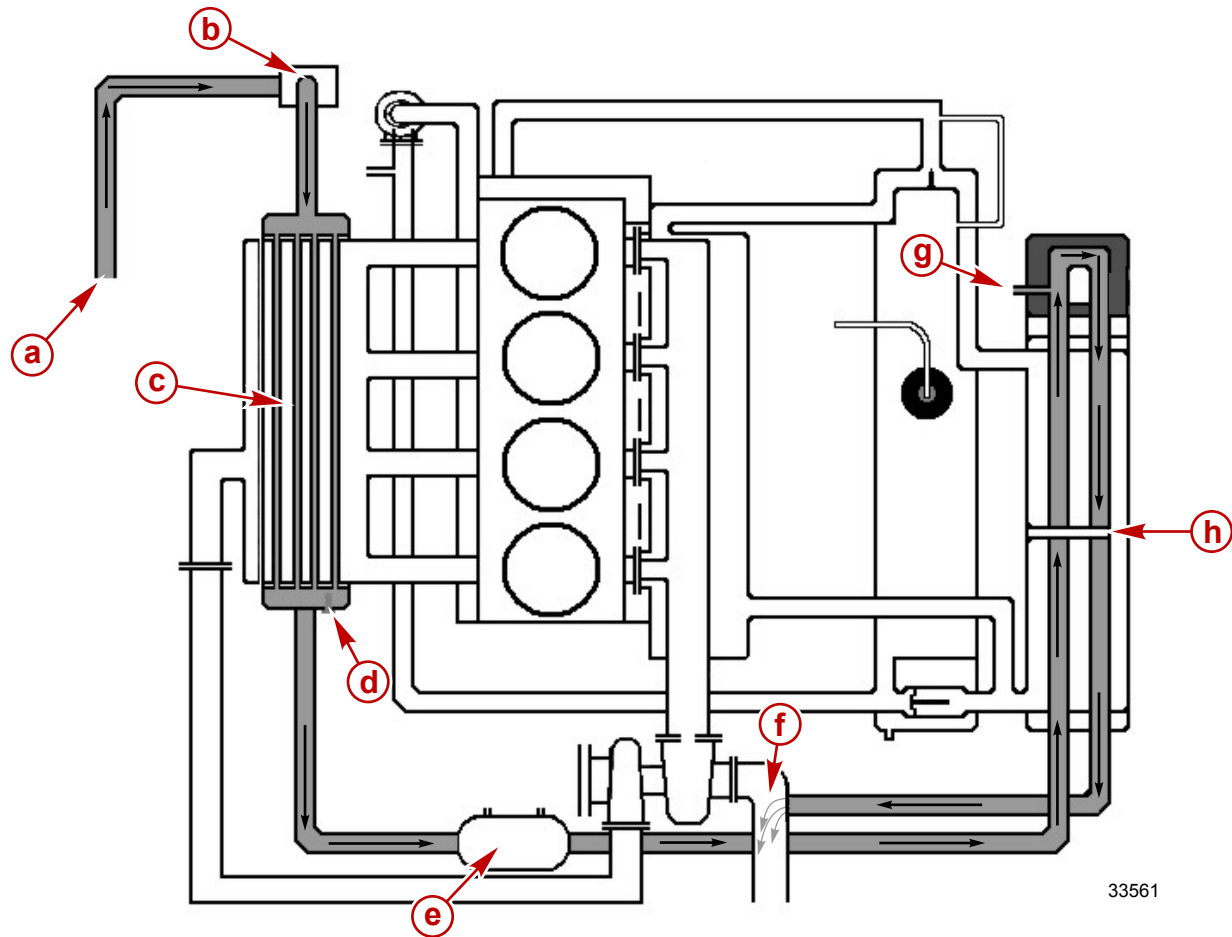
- | | |
|--|--|
| a - Closed cooling system drain-valve | g - Closed cooling system line vent |
| b - Engine water circulating pump | h - Oil cooler |
| c - Engine block and heads | i - Heat exchanger |
| d - Exhaust manifold | j - Thermostat (open) |
| e - Expansion tank vent | k - Expansion tank drain-valve |
| f - Expansion tank | |



Coolant flow for hot water heater

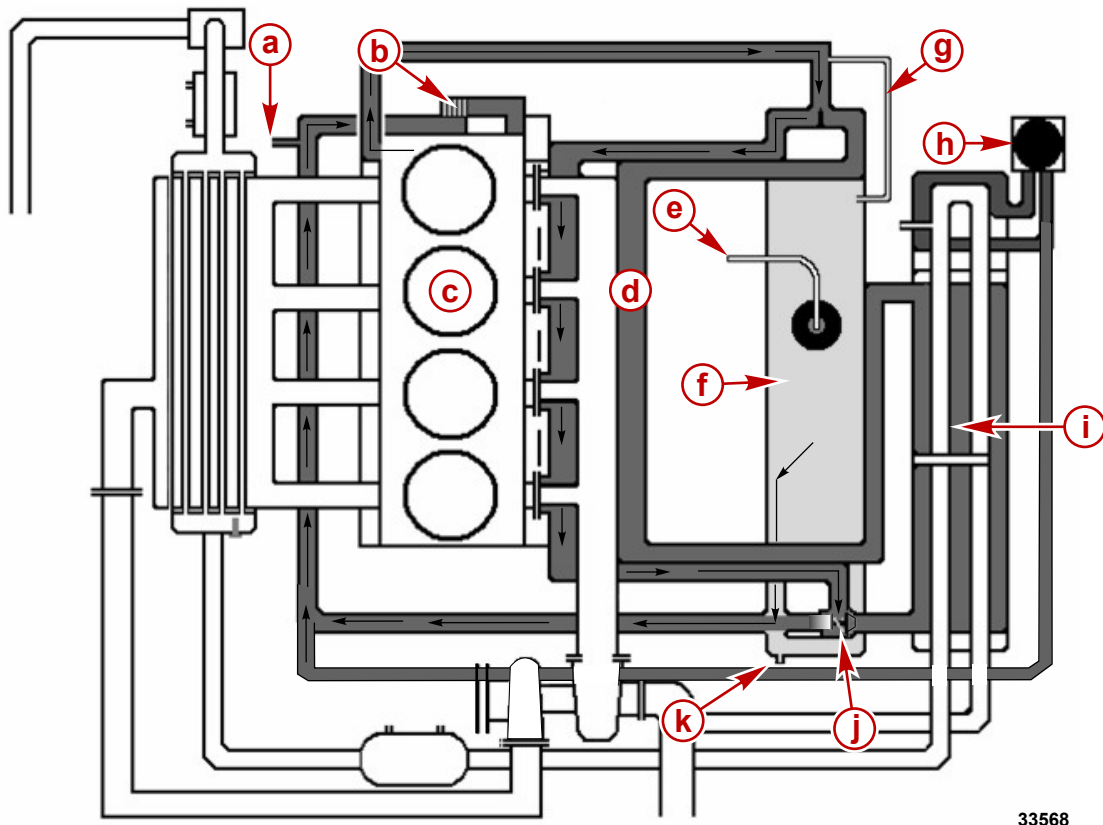
- | | |
|------------------------------------|-----------------------------------|
| a - Coolant return inlet | e - Hot water heater tank |
| b - Coolant overflow tube | f - Hot water heater inlet |
| c - Coolant fill neck | g - Coolant outlet |
| d - Hot water heater outlet | |

Full Production Models



Seawater flow with coolant cooled oil cooler

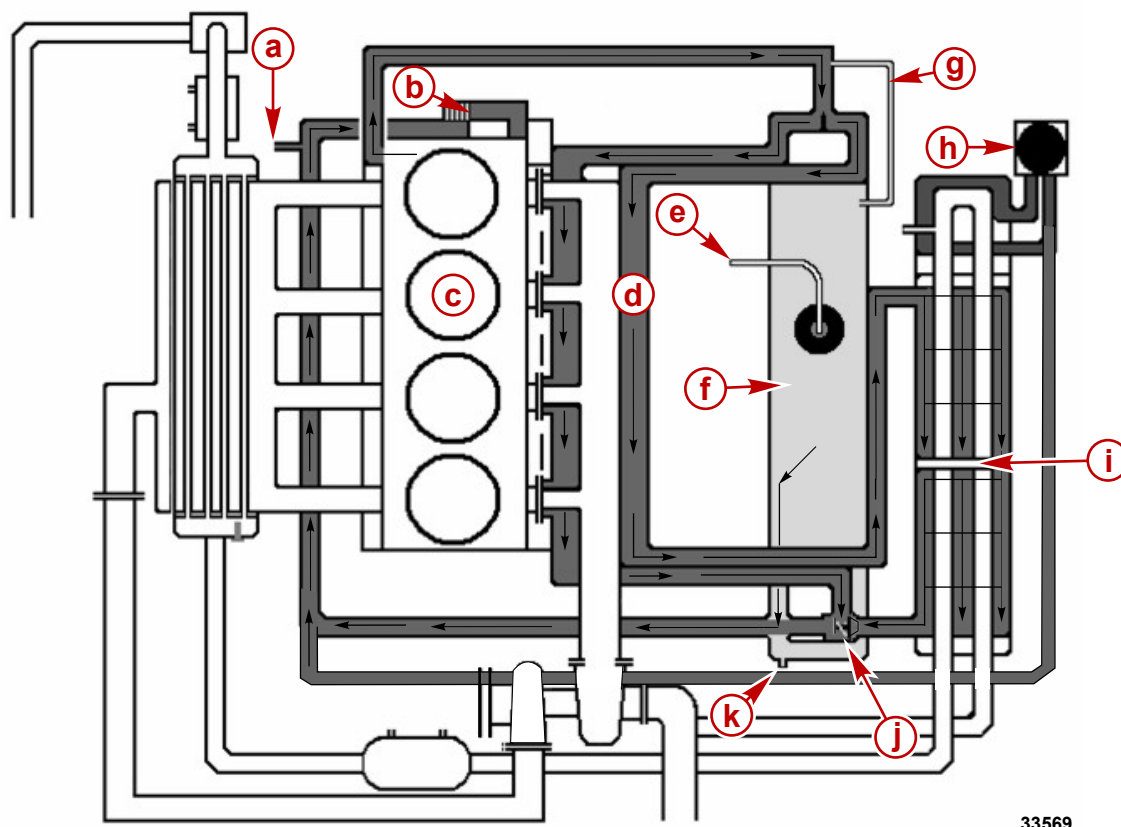
- | | |
|---------------------------|---|
| a - Seawater inlet | e - Power assisted steering fluid cooler |
| b - Seawater pump | f - Exhaust riser |
| c - Aftercooler | g - Heat exchanger drain-valve |
| d - Zinc anode | h - Heat exchanger |



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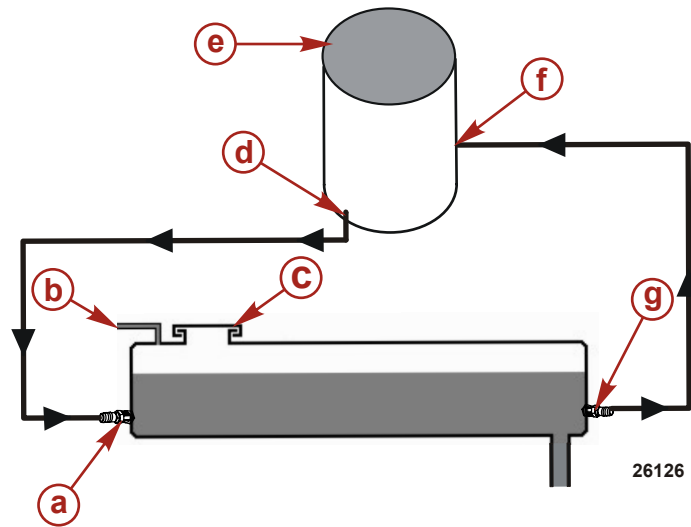
Coolant Flow with thermostat closed with coolant cooled oil cooler

- | | |
|--|--|
| a - Closed cooling system drain-valve | g - Closed cooling system line vent |
| b - Engine water circulating pump | h - Oil cooler |
| c - Engine block and heads | i - Heat exchanger |
| d - Exhaust manifold | j - Thermostat (closed) |
| e - Expansion tank vent | k - Expansion tank drain-valve |
| f - Expansion tank | |



Coolant Flow with thermostat open with coolant cooled oil cooler

- | | |
|--|--|
| a - Closed cooling system drain-valve | g - Closed cooling system line vent |
| b - Engine water circulating pump | h - Oil cooler |
| c - Engine block and heads | i - Heat exchanger |
| d - Exhaust manifold | j - Thermostat (open) |
| e - Expansion tank vent | k - Expansion tank drain-valve |
| f - Expansion tank | |

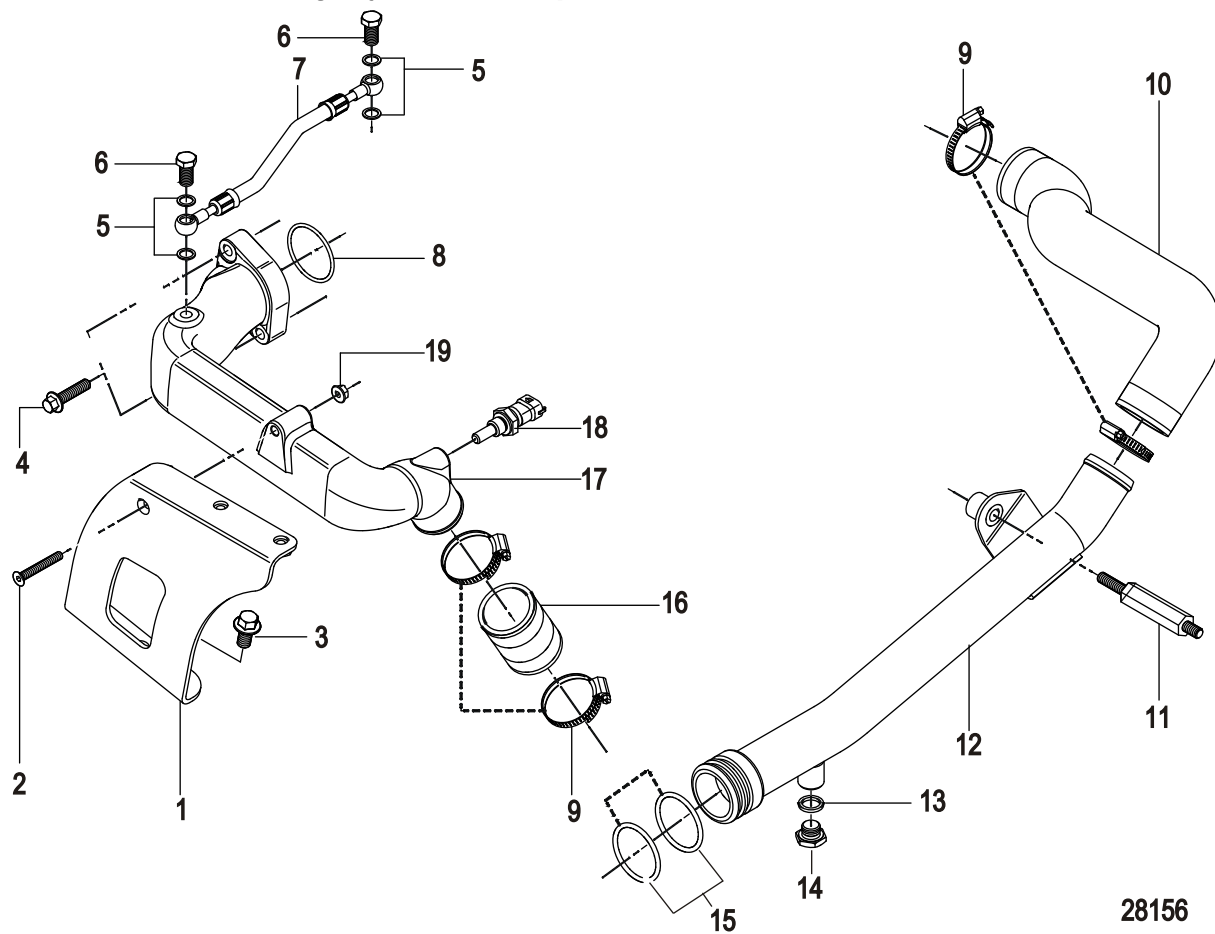


Coolant flow for hot water heater

- | | |
|------------------------------------|-----------------------------------|
| a - Coolant return inlet | e - Hot water heater tank |
| b - Coolant overflow tube | f - Hot water heater inlet |
| c - Coolant fill neck | g - Coolant outlet |
| d - Hot water heater outlet | |

Exploded Views

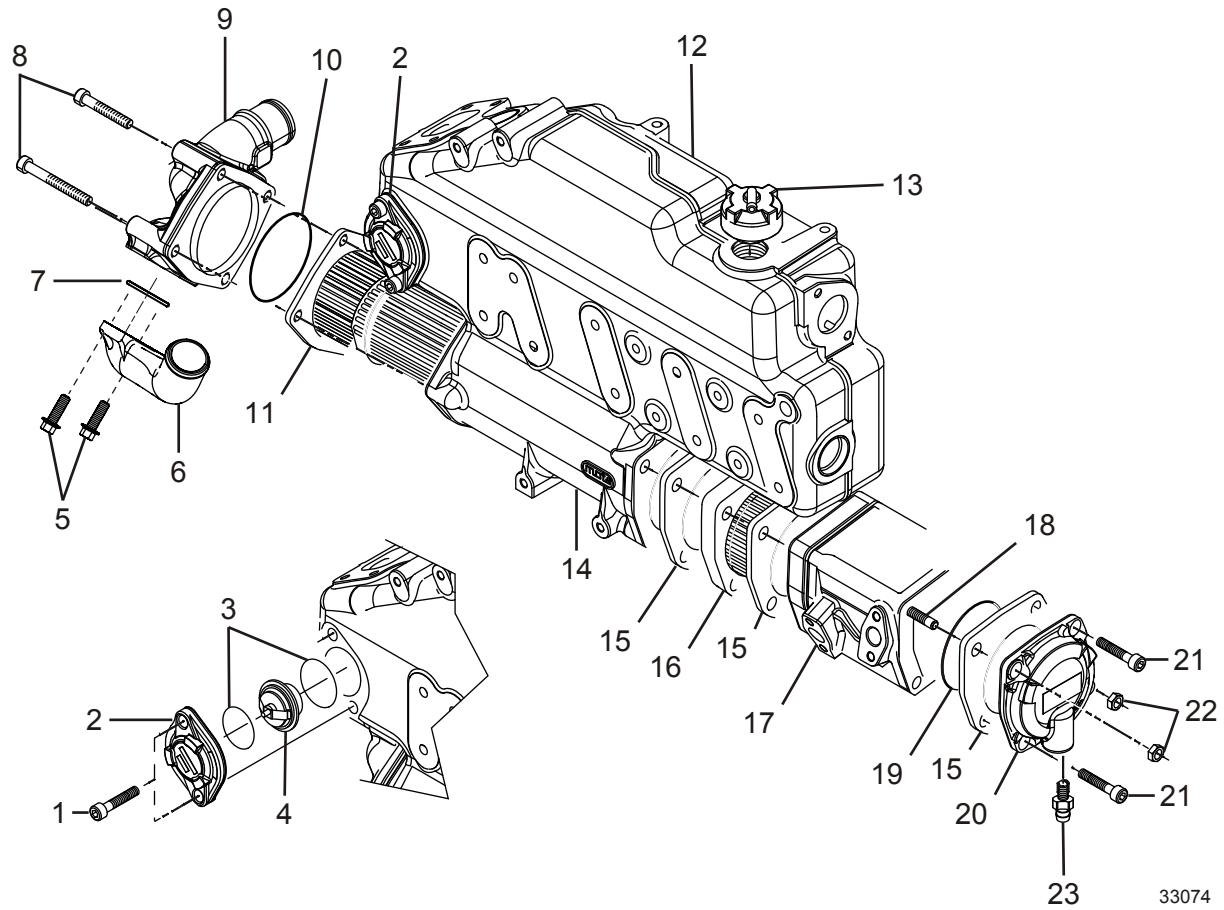
Exploded View—Cooling System Components



Exploded View—Cooling System Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb–In.	lb–ft
1	1	Bracket			
2	1	Allen headed screw			
3	1	Screw	33	–	24
4	2	Screw	27	–	20
5	4	Sealing washer			
6	2	Hollow bolt fitting	27	–	20
7	1	Coolant hose			
8	1	O-ring			
9	4	Hose clamp	5.6	50	–
10	1	Coolant hose			
11	1	Spacer	27	–	20
12	1	Coolant pipe			
13	1	Sealing washer			
14	1	Plug	32.4	–	24
15	2	O-ring			
16	1	Hose			
17	1	Coolant manifold			
18	1	Engine coolant temperature sensor	20.5	181	–
19	1	Nut	10.8	96	–

Exploded View—Heat Exchanger and Related Components with Oil Cooler

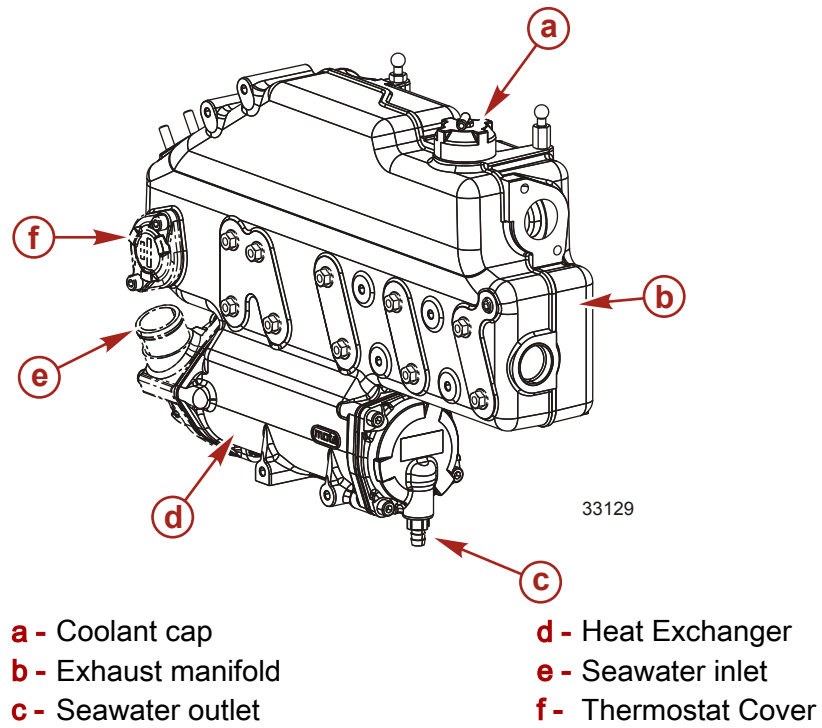


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Exploded View—Heat Exchanger and Related Components with Oil Cooler

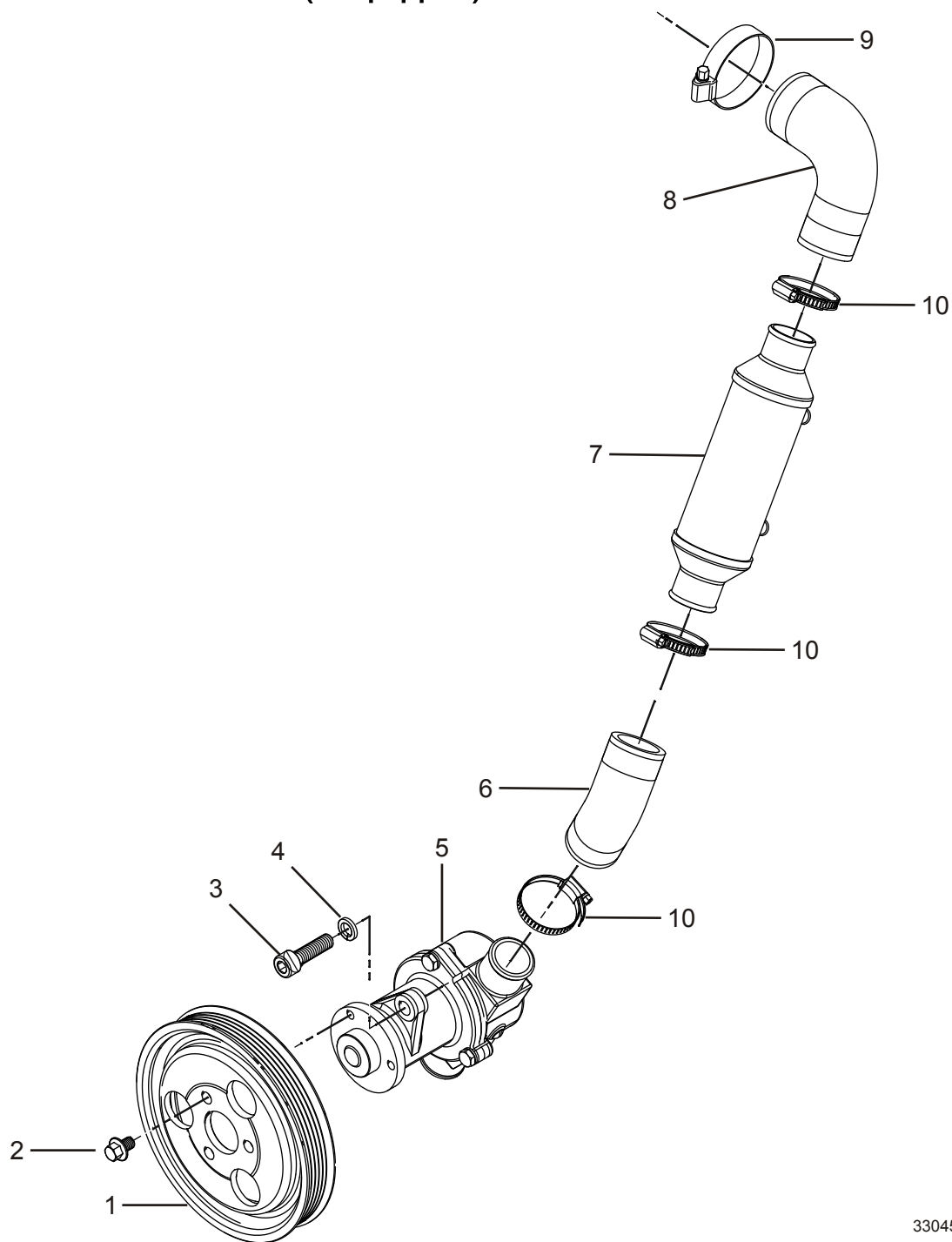
Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Screw	24.5	–	18
2	1	Thermostat cover			
3	2	O-ring			
4	1	Thermostat			
5	2	Screw	24.5	–	18
6	1	Water outlet elbow			
7	1	O-ring			
8	2	Screw	24.5	–	18
9	1	Cover			
10	1	O-ring			
11	1	Heat exchanger core			
12	1	Coolant expansion tank			
13	1	Coolant pressure cap			
14	1	Exhaust manifold and heat exchanger assembly			
15	3	Spacer			
16	1	Oil cooler core, if equipped			
17	1	Oil cooler housing, if equipped			
18	2	Stud	24.5	–	18
19	1	O-ring			
20	1	Heat exchanger cover			
21	2	Screw	24.5	–	18
22	2	Nut	24.5	–	18
23	1	Bayonet valve			

Heat Exchanger without Oil Cooler



Notes:

Exploded View—Fuel Cooler (if equipped)

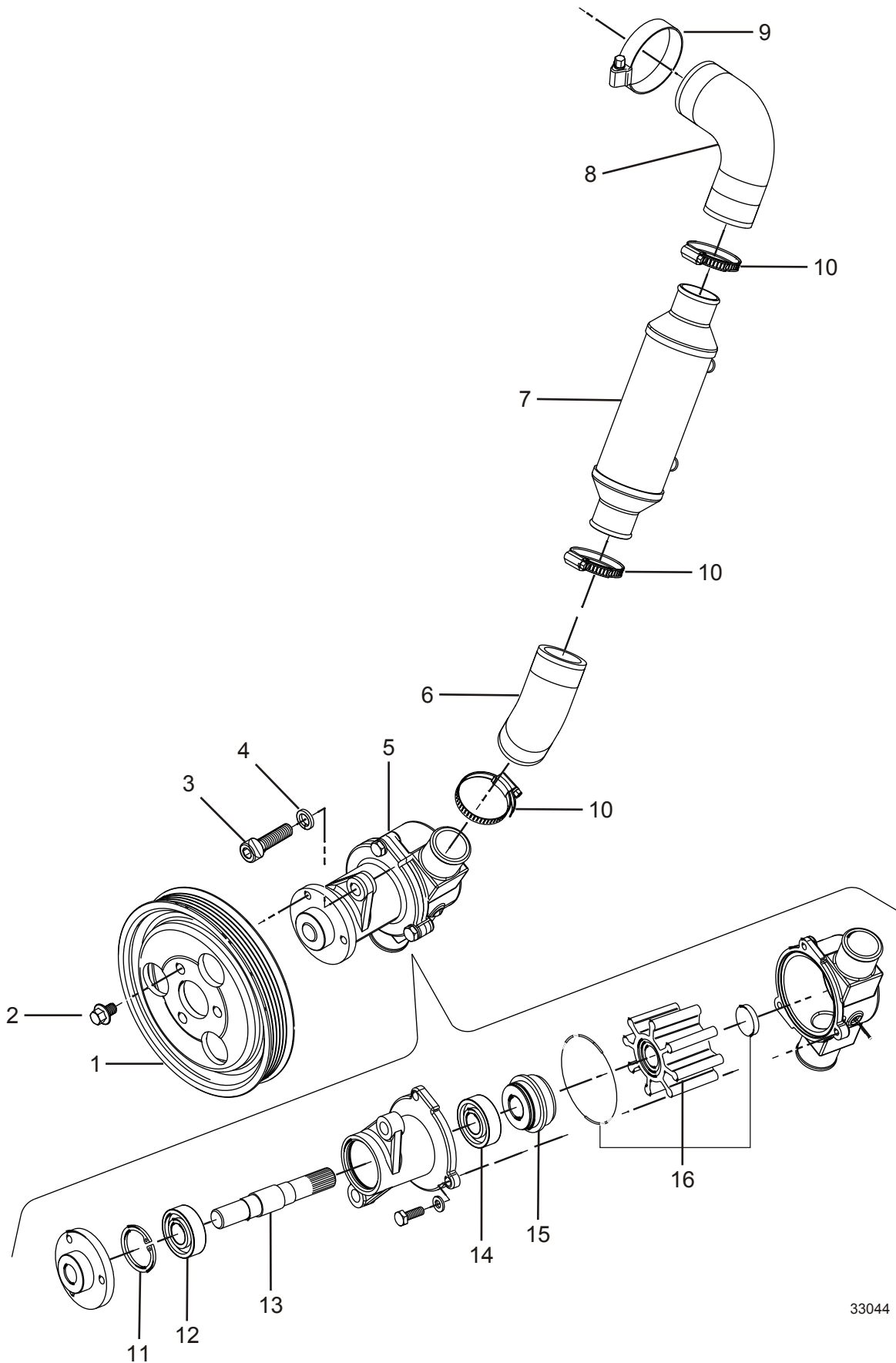


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Exploded View—Fuel Cooler (if equipped)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Pulley			
2	3	Pulley screw	24.5	–	18
3	2	Seawater pump mounting screw	47.1	–	34
4	2	Lockwasher			
5	1	Seawater pump assembly			
6	1	Hose			
7	1	Fuel cooler (early models)			
8	1	Hose elbow			
9	1	Hose clamp	5.6	50	–
10	3	Hose clamp	5.6	50	–

Exploded View—Jabsco Seawater Pump

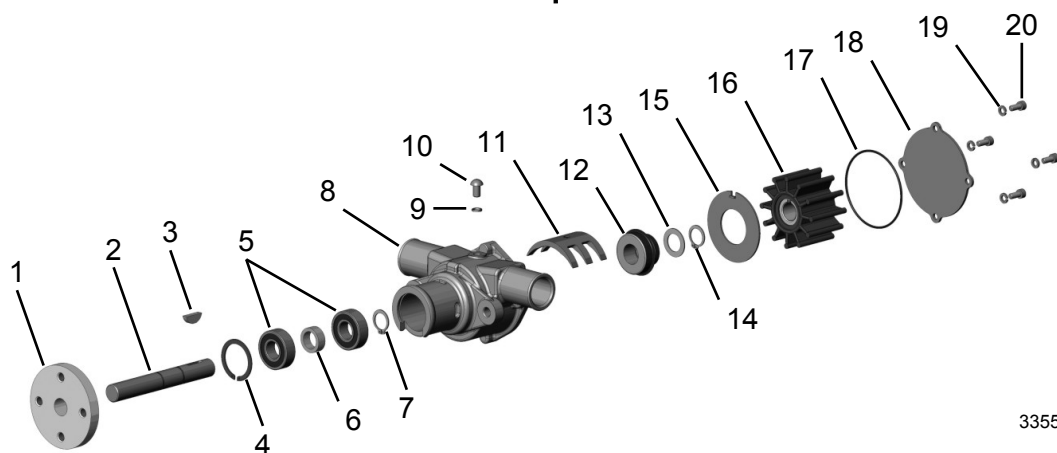


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Exploded View—Jabsco Seawater Pump

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Pulley			
2	3	Screw	24.5	–	18
3	2	Screw	47	–	34
4	2	Lockwasher			
5	1	Seawater pump assembly			
6	1	Hose			
7	1	Fuel cooler (if equipped)			
8	1	Elbow			
9	1	Hose clamp	5.6	50	–
10	3	Hose clamp	5.6	50	–
11	1	Internal snap ring			
12	1	Sealed bearing			
13	1	Shaft			
14	1	Sealed bearing			
15	1	Seal			
16	1	Impeller housing seal			

Exploded View—Sherwood Seawater Pump



Exploded View—Sherwood Seawater Pump

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Pulley hub			
2	1	Shaft			
3	1	Key			
4	1	Internal snap ring			
5	2	Sealed bearing			
6	1	Spacer			
7	1	Snap ring			
8	1	Seawater pump housing			
9	1	Sealing washer			
10	1	Cam screw			
11	1	Cam			
12	1	Water seal assembly			
13	1	Washer			
14	1	Snap ring			
15	1	Wear plate			
16	1	Impeller			
17	1	O-ring seal			
18	1	Cover			
19	4	Lockwasher			
20	4	Screw	4	36	–

Seawater Section Components

Specifications

IMPORTANT: The Alpha sterndrive's internal seawater pump will not provide an adequate supply of seawater to the QSD 2.0L engine cooling system. The seawater supply hose from the Alpha sterndrive's internal pump is cut off at the transom; a block-off plate installed by the factory and a through-hull or through-transom seawater pickup must be used to supply the engine with cooling water. The Alpha sterndrive's internal seawater pump is used for cooling the sterndrive's lower unit. The QSD 2.0L engine is equipped with an engine mounted seawater pump that must be connected to a through-hull or through-transom seawater pickup system. The seawater pickup system must include a seacock and seawater strainer. Locate the seawater pickup as close to the seawater pickup pump inlet as possible. Install in a location where an uninterrupted, solid stream of seawater will flow past the seawater pickup when the boat is underway.

IMPORTANT: All seawater supply solutions must be tested to ensure that minimum seawater flow specifications are met.

Description		QSD 2.0 L with Jabsco Seawater Pump
Seawater pickup: through-hull or through-transom mounted	Minimum	143 liters/min. (38 U.S. gal/min)
Seacock size (internal cross-sectional area)	Minimum	31.75 mm (1-1/4 in.)
Seawater inlet hose inner diameter (adapter provided for hose)	Minimum	31.75 mm (1-1/4 in.)
Seawater strainer flow rate	Minimum	143 liters/min. (38 U.S. gal/min)
Seawater inlet restriction	Maximum	125 mm Hg (5 in Hg)

Description		QSD 2.0 L with Sherwood Seawater Pump
Seawater pickup: through-hull or through-transom mounted	Minimum	150 liters/min (38 U.S. gal/min)
Seacock size (internal cross-sectional area)	Minimum	31.75 mm (1-1/4 in.)
Seawater inlet hose inner diameter (adapter provided for hose)	Minimum	31.75mm (1-1/4in.)
Seawater strainer flow rate	Minimum	150 liters/min (38 U.S. gal/min)
Seawater inlet restriction	Maximum	125 mm Hg (5 in Hg)

Models	Seawater Pickup Requirement
2.0 with Alpha sterndrive	Through-hull or through vessel-transom
2.0 with Bravo sterndrive	Through-hull, through vessel-transom, or through-drive

NOTE: Before installation, check all engine fluid and electrical connection points to ensure that they are not obstructed by shipping plugs, covers, or any foreign material.

IMPORTANT: Do not install a through-hull or transom-mounted 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. Refer to the Cummins MerCruiser Diesel Applications Manual (90-866350050) for additional information.

Seawater Pickup Connection

Water pickup connections must be large enough to permit sufficient water flow to the engine seawater pump for adequate engine cooling.

The water pickup must supply a positive head of seawater while underway. The water pickup should be located as close to the seawater pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when the boat is underway.

Use only wire-reinforced seawater hose with adequate wall thickness to prevent collapse during maximum levels of seawater pump suction. Secure the hose connections with double hose clamps. Follow manufacturer instructions for installing the seawater pickup and seawater strainer.

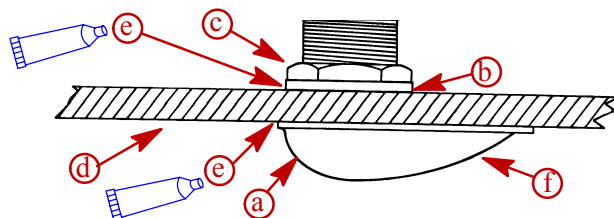
INSTALLATION

NOTE: If using a seawater pickup other than the QuickSilver model referenced below, follow the installation instructions supplied by the manufacturer.

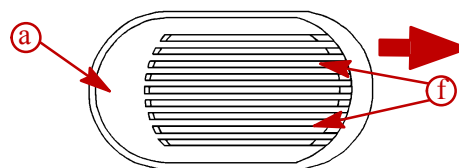
1. Install the QuickSilver through-hull seawater pickup:
 - a. Drill a 50 mm (2 in.) hole through the hull in an appropriate location. See **Installation Requirements**.
 - b. Apply marine caulking (sealer) to mounting surface on the seawater pickup where hull contact will occur when the pickup is installed.

Description	Where Used	Part Number
Marine Caulking	Seawater inlet mounting surfaces	Obtain locally

- c. Ensure that the slots in the water pickup are facing forward (toward the bow of the boat), and install the water pickup through the hull.
- d. Apply marine caulking as needed inside the boat.
- e. Position the washer on the fitting and install the large nut.
- f. Apply sealant to the threads of the nut and install on the pickup on the inside of the boat. Torque the nut.



- a** - Seawater pickup (through-hull fitting)
b - Washer
c - Large nut



21914

- d** - Hull of boat
e - Marine caulking
f - Slots facing forward

Tube Ref No.	Description	Where Used	Part No.
	Marine Caulking	Seawater inlet mounting surfaces	Obtain Locally

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Seawater inlet nut	92-809819

Description	Nm	lb. in.	lb. ft.
Seawater inlet nut	42		35

NOTE: If the pickup being installed does not have mounting screws on the underside where mounted to the hull, ensure that the slots are still facing forward after the nut is torqued.

Seacock

REQUIREMENTS

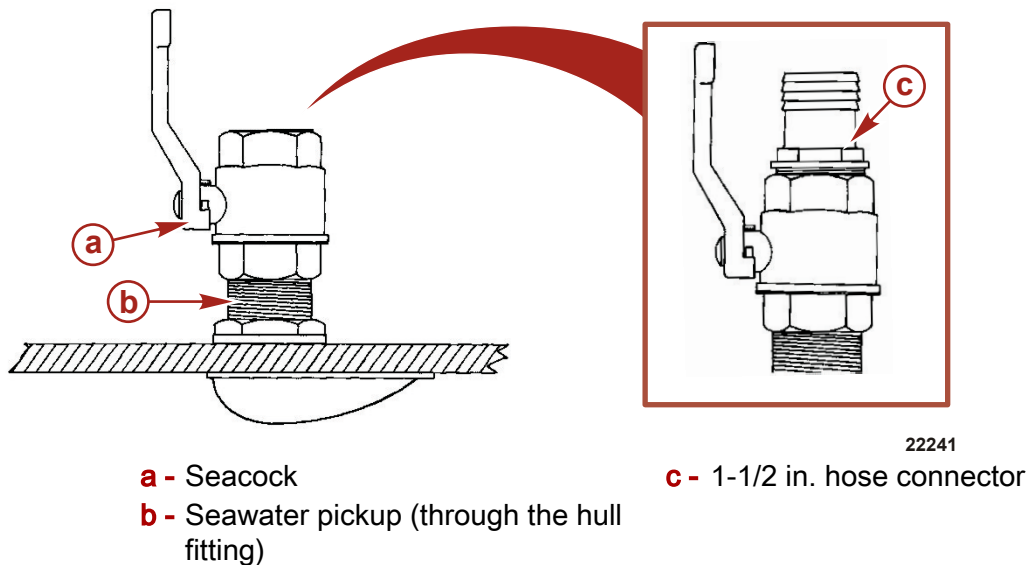
The seacock (water inlet valve) used must have an internal cross-sectional area equal to or greater than the seawater inlet hose to prevent restricting the water flow.

Install the seacock in an area where it will be easily accessible and supported adequately to prevent hose fatigue. A brass ball or gate valve is required.

INSTALLATION

If using other than the Quicksilver seacock shown following, refer to the manufacturer's instructions provided with the seacock.

1. Install the Quicksilver seacock:
 - a. Install the seacock on the seawater pickup. Tighten securely.
 - b. Install the approximately 38 mm (1-1/2 in.) hose connector on the seacock. Tighten securely.



Draining the Seawater System

⚠ CAUTION

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

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

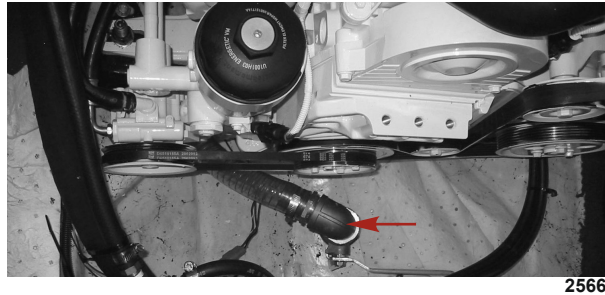
Drain the seawater system of the power package before flushing or prior to cold weather (freezing temperature), seasonal storage, or extended storage.

IMPORTANT: The boat must not be operating during this procedure.

⚠ CAUTION

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

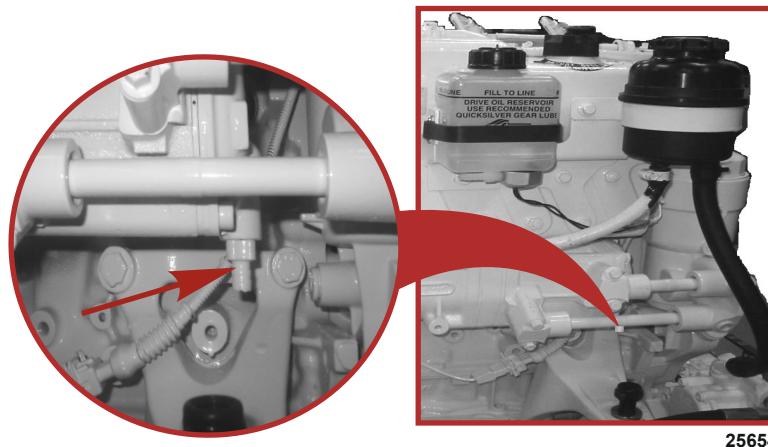
1. Remove the boat from the water if possible.
2. **If the boat is to remain in the water**, turn on the bilge pump, close the seacock (if equipped), or disconnect and plug the seawater inlet hose.



Typical seacock installation

a - Seacock

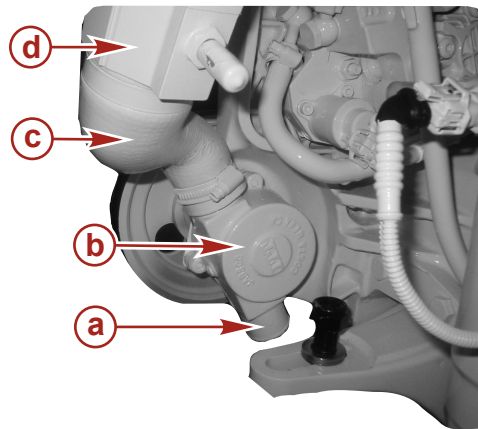
3. Make the engine as level as possible to ensure complete draining of the seawater system.
4. Attach a temporary drain hose to the barbed fitting of the seawater drain valve.



a - Seawater drain valve

5. Open the seawater drain valve.
6. A small diameter wire bore brush or stiff piece of ware can be used to clear the seawater drain of any debris.

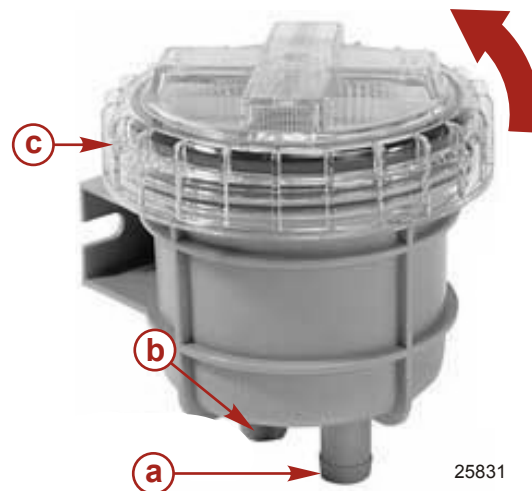
7. Disconnect the seawater inlet hose from the connector on the seawater pump.



a - Seawater pump inlet
b - Seawater pump

c - Seawater pump outlet
d - Fuel cooler

8. **On models equipped with a seawater strainer**, remove the hoses at the seawater strainer and drain them completely. Drain and empty the seawater strainer. Reconnect the hoses and tighten the hose clamps securely.



Typical

a - Seawater inlet
b - Seawater outlet

c - Seawater strainer cover

9. After the seawater has completely drained, remove the temporary drain hose and close the heat exchanger seawater drain valve.
10. Reconnect all seawater hoses. Tighten the hose clamps securely.

Cleaning the Seawater Strainer

NOTE: The seawater strainer can be visually inspected through its clear cover without requiring any seawater system disassembly.

NOTICE

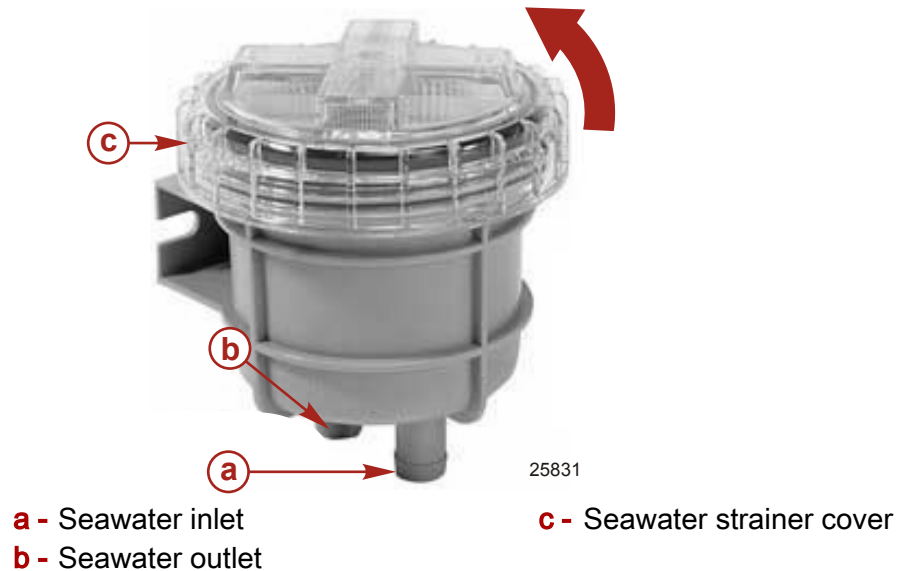
An open seawater strainer or seacock during some service or maintenance procedures can introduce water into the boat, causing damage or sinking the boat. Always close the water supply from the seawater pump, water inlet, or seacock when performing service or maintenance on the cooling system.

NOTICE

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

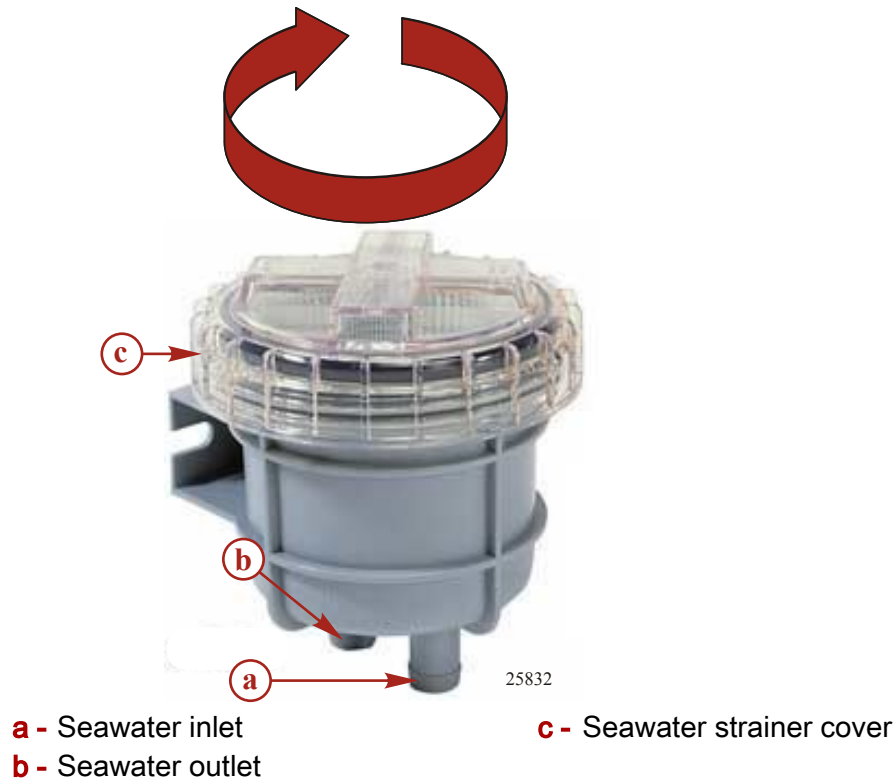
If the boat is in the water, ensure that the engine is off, close the seacock, if equipped, or remove and plug the seawater inlet hose.

2. Remove the the seawater strainer cover by turning it counterclockwise by hand.



3. Remove the strainer from the strainer housing and clean out any debris. Flush the strainer with clean water.
4. Clean out any debris from the strainer housing and flush with clean water.
5. Place the strainer back into strainer housing. Ensure that it is fully and evenly seated into the bottom of the strainer housing.
6. Inspect the strainer cover's O-ring seal and replace if damaged or leaking.

7. Install the strainer cover by turning it clockwise by hand. Ensure that the strainer cover O-ring is properly located and moderately compressed when the cover is installed. Do not overtighten.



8. If the boat is out of the water, tag the boats keys, record the service in the maintenance log, or otherwise make note that a proper operational inspection of the seawater system must be performed before returning the boat to use on the water.
9. Boat out of the water. Perform an operational inspection of the seawater cooling system after cleaning the seawater strainer.
 - a. Cooling water must be supplied to both the engine and the sterndrive. See **Flushing the Seawater System** regarding cooling water supply when this service is performed with the boat out of the water.
 - b. Start the engine and allow the seawater system to fill and the engine to reach normal operating temperature.
 - c. Run the engine at a fast idle between 600 to 1400 RPM. Monitor engine temperature to confirm proper operation of the cooling system.
 - d. Inspect the seawater system for leaks maintaining a fast idle engine speed between 600 to 1400 RPM.
10. If the boat is in the water, perform an operational inspection of the seawater cooling system.
 - a. Open the seacock, if equipped, or remove the plug and reconnect the seawater inlet hose.
 - b. Start the engine and allow the seawater system to be filled and the engine to reach normal operating temperature.
 - c. Check the seawater cooling system for leaks within an RPM range of 600 to 1400 RPM.

- d. Carefully monitor the engine's operating temperature to ensure that it remains in normal operational range and that the seawater cooling system is functioning properly.

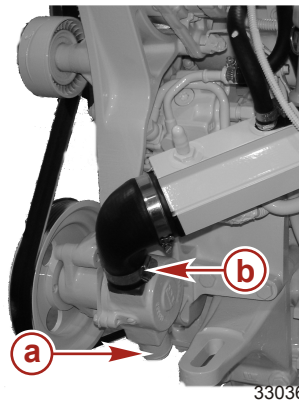
Jabsco Seawater Pump

Removal

NOTICE

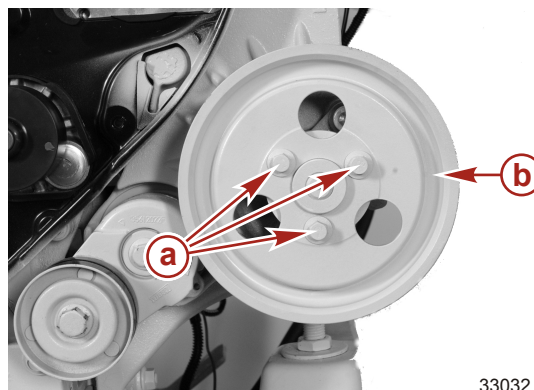
If the boat is at rest in the water with the engine off, an open seacock or water inlet hose could introduce water into the engine's cooling system or the boat. Keep the seacock or water inlet hose plugged until ready to start the engine. Attach a tag to the ignition switch or steering wheel to inform others of the water inlet connection.

1. Close the seacock if equipped, or disconnect and plug the seawater inlet hose if the boat is to remain in the water.
2. Drain the seawater from the cooling system. Refer to **Section 1B—Seawater System**.
3. Remove the serpentine belt. Refer to **Section 1B—Serpentine Belt**.
4. Remove the seawater pump inlet and outlet hose. Drain the seawater into a suitable container.



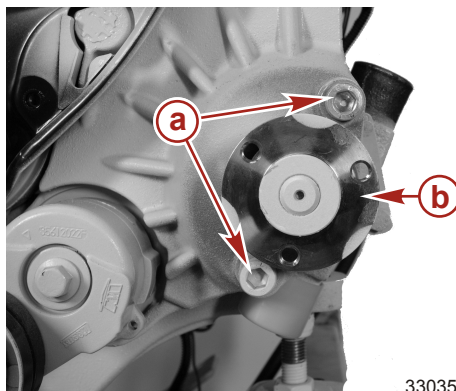
- a** - Seawater inlet
b - Seawater outlet

5. Remove the seawater pump pulley.



- a** - Pulley screws
b - Seawater pump pulley

6. Remove the two seawater pump mounting screws.

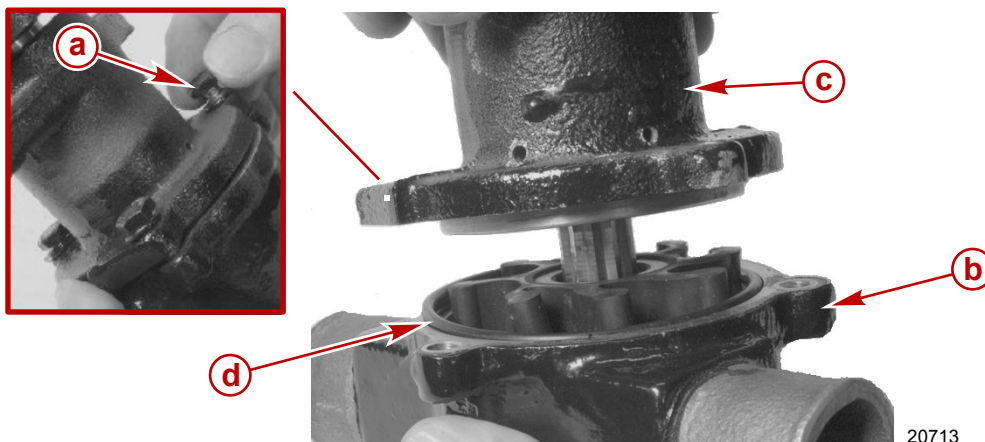


- a** - Mounting screws
- b** - Pulley hub

7. Remove the seawater pump.

Disassembly

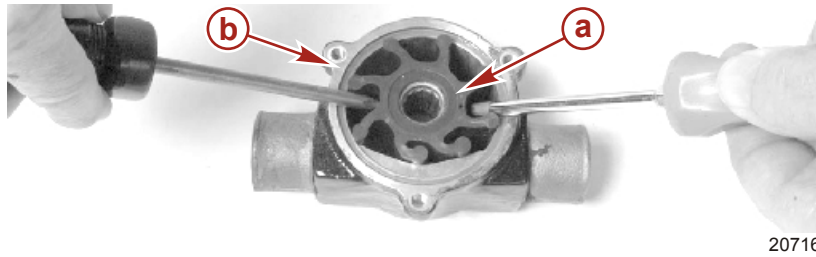
1. Clamp the seawater pump in a soft-jawed vise.
2. Remove the three impeller housing screws.
3. Slide the impeller housing off of the bearing housing and shaft assembly.
4. Remove and discard the O-ring from the groove in the impeller housing.



- a** - Screw
- b** - Impeller housing
- c** - Bearing housing and shaft assembly
- d** - O-ring

IMPORTANT: Be careful not to damage the impeller or impeller housing during removal.

5. Note the direction of the impeller vane rotation for installation later and suitably mark the outer surface of the impeller. Then, remove the impeller from the impeller housing using a pair of pliers to grasp the hub of the impeller (preferred method) or two screwdrivers to pry the impeller out of the impeller housing. Ensure that the impeller or impeller housing is not damaged.

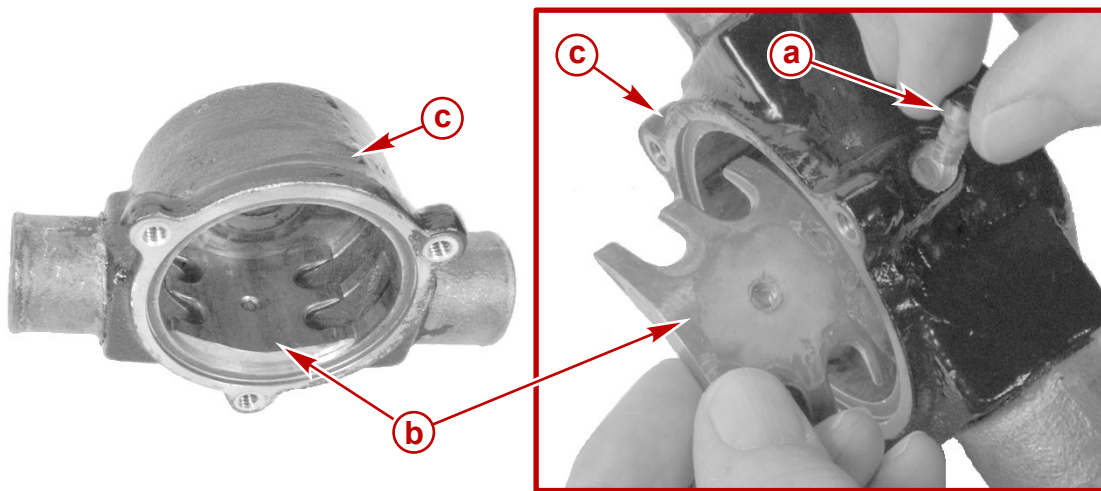


20716

Impeller removal using two screwdrivers

- a** - Impeller
b - Impeller housing

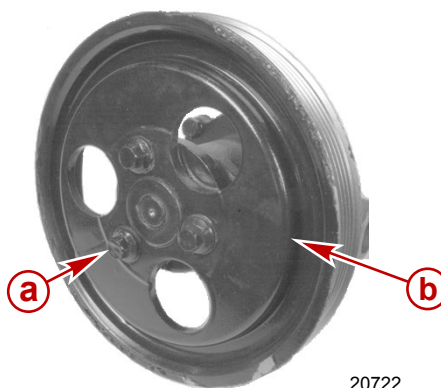
6. Remove the cam screw and remove the cam from the impeller housing.



20720

- a** - Cam screw
b - Cam
c - Impeller housing

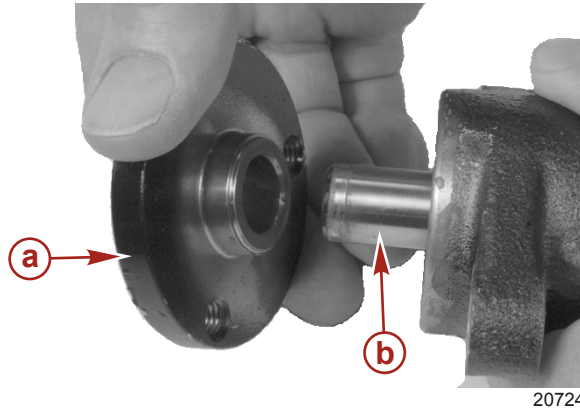
7. Loosen the three seawater pump pulley screws and remove the pulley.



20722

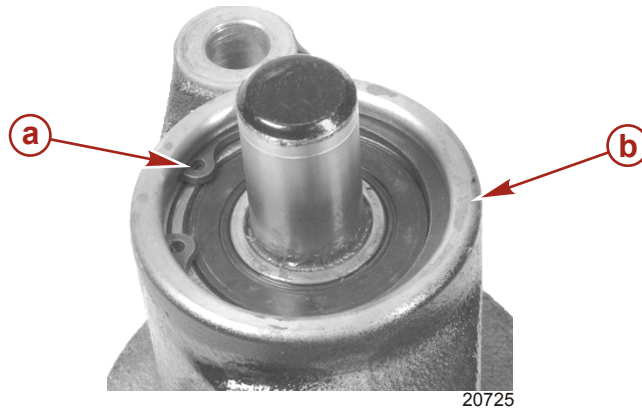
- a** - Pulley screws
b - Pulley

8. Using an arbor press and suitable hardware, press the seawater pump pulley flange off of the pump shaft.



a - Pulley flange
b - Pump shaft

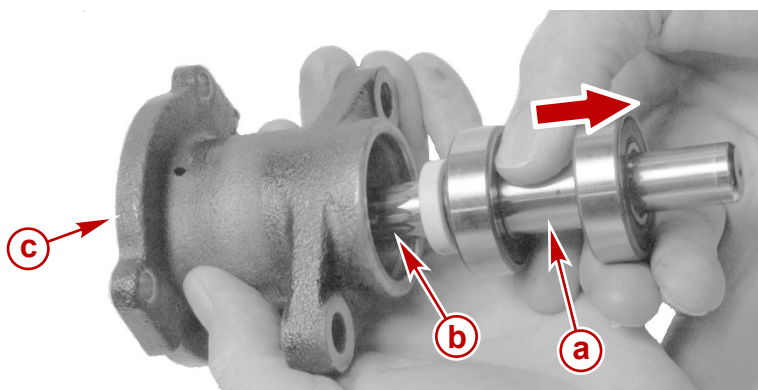
9. Remove the internal snap ring from the bearing housing.



a - Internal snap ring
b - Bearing housing

IMPORTANT: To avoid interference with the ball bearings during disassembly, do not damage the spline end of the pump shaft.

10. Press—or lightly tap using a plastic or brass hammer—the spline end of the pump shaft in the direction indicated by the arrow to remove the pump shaft from the bearing housing.

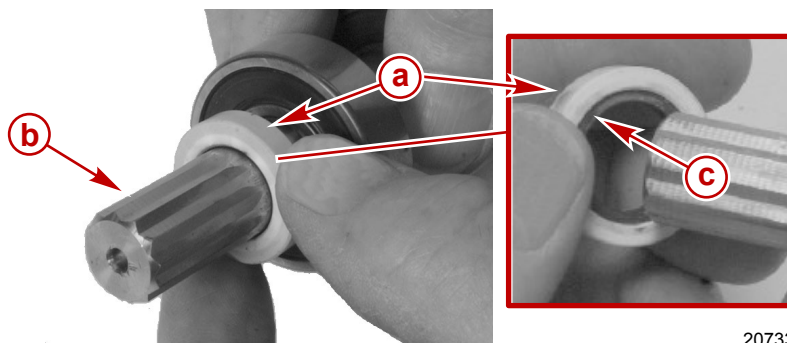


20729

- a** - Pump shaft
- b** - Spline end
- c** - Bearing housing

NOTE: The seal between the impeller and the bearings has two parts. Normally the white ceramic part of the seal will remain on the shaft and the brass and carbon part of the seal will remain pressed into the bearing housing.

11. Slide the white ceramic part of the seal off of the spline end of the shaft. Ensure that the rubber seal stays with the ceramic part.

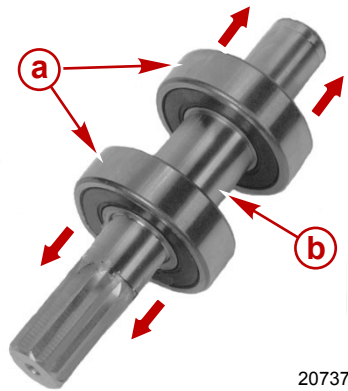


20733

- a** - Ceramic part of seal
- b** - Spline end of shaft
- c** - Rubber seal

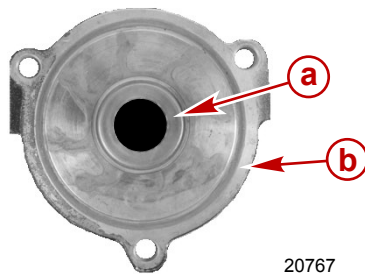
IMPORTANT: Take note of the factory markings on the bearings, or suitably mark each bearing to ensure installation in their original position if reused.

12. Using an arbor press and suitable hardware, remove one bearing at a time from the pump shaft. The bearings press off of the shaft in opposite directions. Press only on the inner race of the bearings.



- a** - Bearing
b - Pump shaft

13. Using a suitable device and hardware, press the brass and carbon component of the pump shaft seal from the bearing housing.



- a** - Brass and carbon component
b - Bearing housing

Cleaning

1. Put on safety glasses.
2. Clean the metal parts in solvent and dry the parts with compressed air.
3. After cleaning, apply engine oil to the shaft and bearings to prevent rusting.

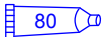
Inspection

1. Inspect the bearing housing. Examine the surfaces where the bearings contact housing for evidence of bearing outer races turning in the housing.
2. Inspect the bearings for a worn or defective condition. Examine sealed bearings for evidence of loss of factory grease or evidence of internal contamination.
3. Inspect the two-part seal from the bearing housing.
4. Inspect the seawater pump shaft for grooves in the surface where the seals contact the shaft.
5. Inspect where the bearings contact the shaft for evidence of the inner races turning on the shaft.
6. Inspect the impeller housing.
7. Inspect the cam for scratches or gouging.
8. Inspect the impeller splines and shaft splines.

9. Inspect the seawater pump impeller for wear on the sides and the tips of the blades.
10. Inspect the blades for cracks in the area where the blades must flex.
11. Replace the impeller if the blades remain in a curved position.

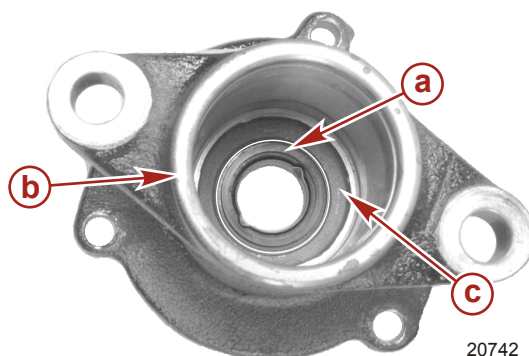
Assembly

1. Lightly lubricate the seawater pump shaft.

Tube Ref No.	Description	Where Used	Part No.
 80	SAE Engine Oil 30W	Seawater pump shaft	Obtain Locally

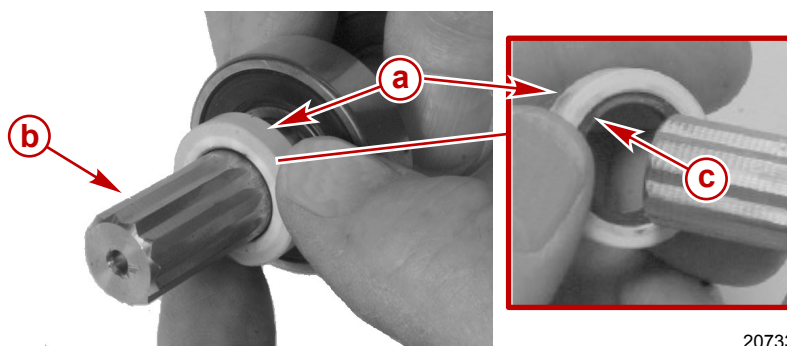
IMPORTANT: If the bearings are reused, ensure they are installed in their original positions.

2. Press the bearings on the pump shaft using an arbor press and suitable hardware. Press only on the inner race of the bearings.
3. Using a suitable device and hardware, press the brass and carbon component of the seal into the bearing housing. The brass side of the seal will face toward the impeller. Press on the seal until the carbon side of the seal is flush with the bottom (inside) of the bearing housing.



- a** - Brass and carbon component—carbon side
- b** - Bearing housing
- c** - Bottom (inside)

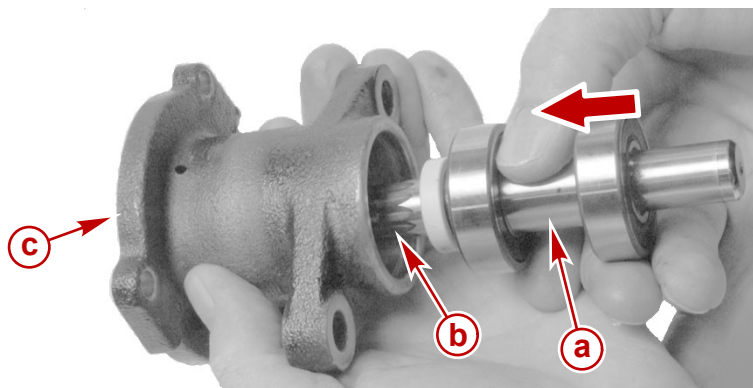
4. Slide the white ceramic part of the seal on the spline end of the shaft. Ensure the smooth side of the seal faces the spline end of the shaft and the side with the quad-ring rubber seal faces the bearing.



- a** - White ceramic part of the seal—smooth side
- b** - Spline end
- c** - Quad-ring rubber seal

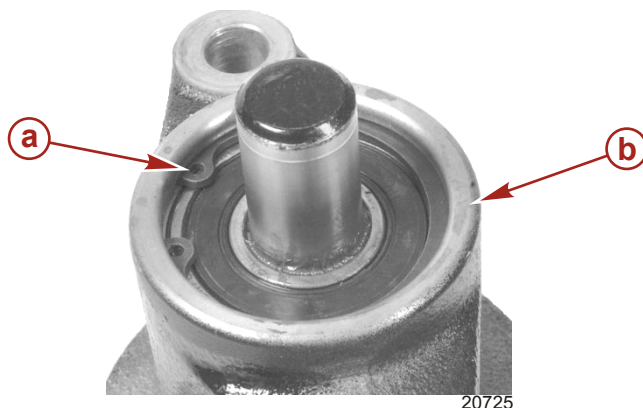
IMPORTANT: To avoid interference with the pulley assembly, do not damage the end of the pump shaft during bearing installation. Do not damage either part of the seal.

5. Insert the spline end into the bearing housing. Lightly tap, using a plastic or brass hammer, or press the pulley end of the pump shaft into the bearing housing until the bearings seat in the housing.



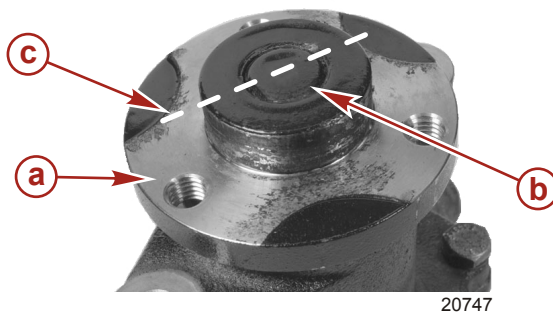
- a** - Pump shaft
- b** - Spline end
- c** - Bearing housing

6. Install the internal snap ring into the bearing housing.



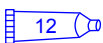
- a** - Internal snap ring
- b** - Bearing housing

7. Using an arbor press and suitable hardware, press the seawater pump pulley flange onto the pump shaft. The outer edge of the pulley flange will be parallel to the end of the pump shaft when correctly installed.

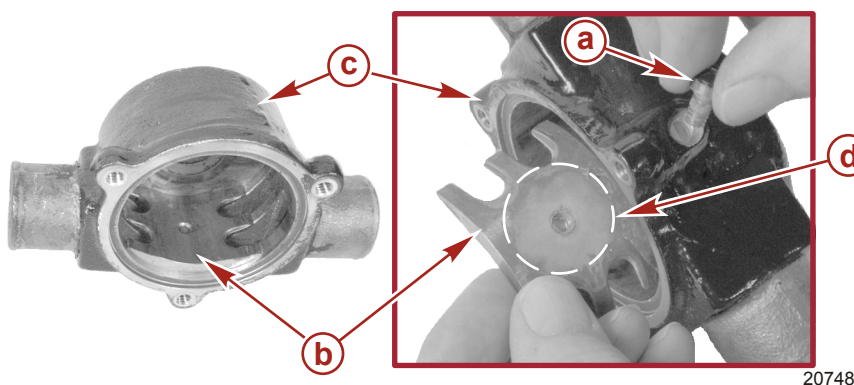


- a** - Pulley flange
b - Pump shaft
c - Parallel

8. Apply sealant to the seawater pump cam screw and to the area on the backside of the cam as indicated.

Tube Ref No.	Description	Where Used	Part No.
 12	Loctite Master Gasket Kit	Backside of seawater pump cam and screw threads	92-12564 2

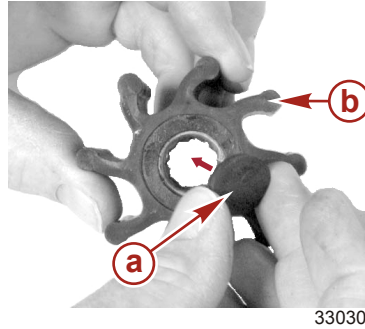
9. Install the cam into the impeller housing.
10. Install and securely tighten the cam screw.



- a** - Cam screw
b - Cam
c - Impeller housing
d - Sealant area

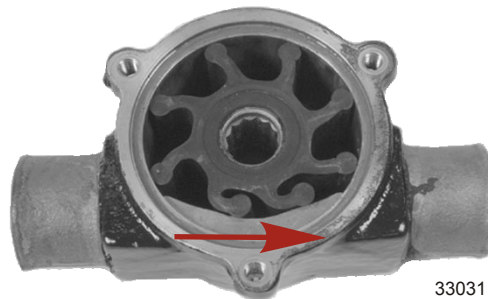
IMPORTANT: If the outer surface of the impeller was not marked during removal and the original direction of rotation cannot be determined, replace the impeller.

11. Push the rubber seal into the end of the impeller that will enter the impeller housing first during installation.



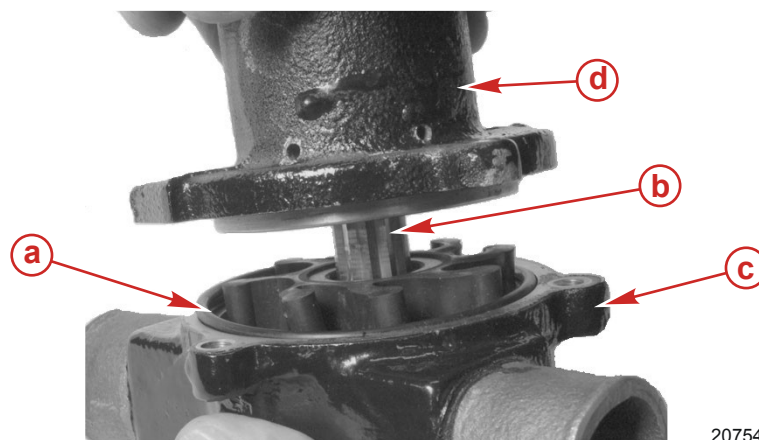
- a** - Rubber seal
b - Impeller

12. Install the impeller and rubber seal into the impeller housing by turning the impeller clockwise while simultaneously pushing inward. After installation, the blades should be flexed in the direction shown.



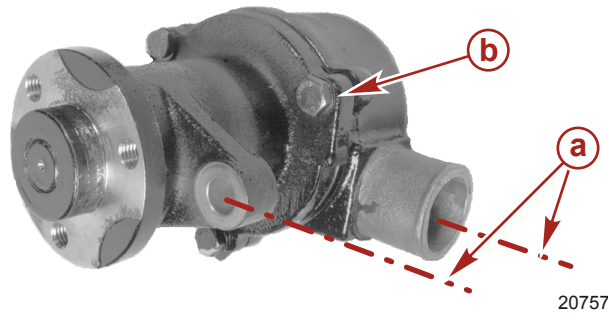
Direction of blade flex

13. Install the O-ring into the groove of the impeller housing.
14. Insert the spline end of the pump shaft into the impeller. Slide the bearing housing assembly over the impeller and onto the impeller housing using a twisting motion, if necessary, in the direction of engine rotation.



- a** - O-ring
b - Pump shaft spline end
c - Impeller housing
d - Bearing housing assembly

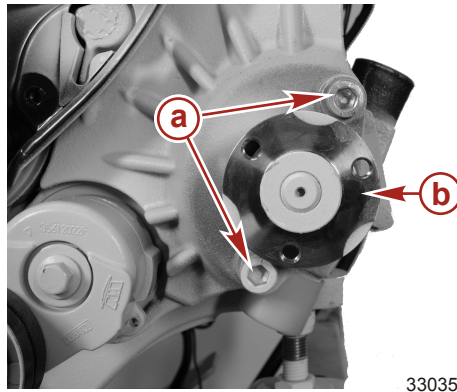
15. Turn the assembly to align the mounting flanges in-line with the pump outlet and inlet fittings as shown.
16. Install and securely tighten the three screws with lockwashers.



- a** - Alignment reference marks
b - Screw and lockwasher

Installation

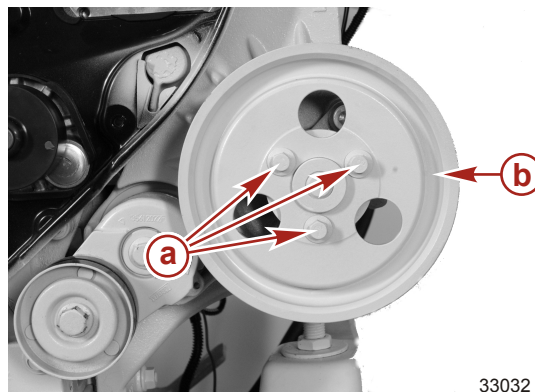
1. Position the seawater pump on the engine front bracket.
2. Install and torque the two seawater pump mounting screws.



- a** - Mounting screws
b - Pulley hub

Description	Nm	lb-in.	lb-ft
Seawater pump mounting screw	47.1	–	34

3. Install the seawater pump pulley.

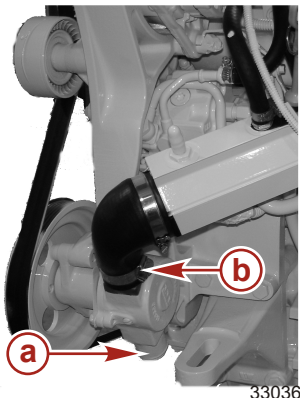


- a** - Pulley screws
b - Seawater pump pulley

4. Torque the seawater pump pulley screws.

Description	Nm	lb-in.	lb-ft
Seawater pump pulley screws	24.5	–	18

5. Install the serpentine drive belt. Ensure that the seawater pump pulley is properly aligned with the serpentine belt. Refer to **Section 1B—Serpentine Belt**.
6. Install the seawater pump inlet and outlet hose.



- a** - Seawater inlet
b - Seawater outlet

7. Torque the seawater hose clamps.

Description	Nm	lb-in.	lb-ft
Seawater hose clamps	5.6	–	50

8. Open the seacock if equipped, or unplug and connect the seawater inlet hose.
9. Check for leaks when you first start the engine.

Sherwood Seawater Pump

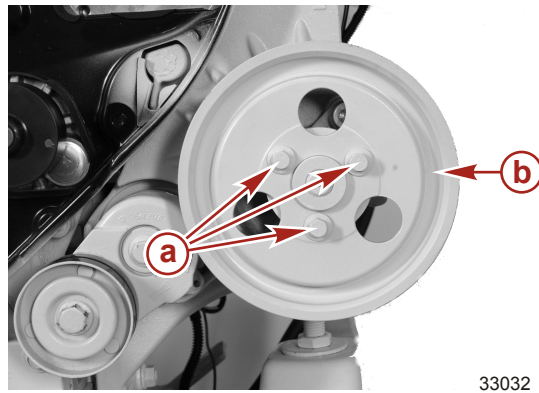
Removal

NOTICE

If the boat is at rest in the water with the engine off, an open seacock or water inlet hose could introduce water into the engine's cooling system or the boat. Keep the seacock or water inlet hose plugged until ready to start the engine. Attach a tag to the ignition switch or steering wheel to inform others of the water inlet connection.

1. Close the seacock if equipped, or disconnect and plug the seawater inlet hose if the boat is to remain in the water.
2. Drain the seawater from the cooling system. Refer to **Section 1B—Seawater System**.
3. Remove the serpentine belt. Refer to **Section 1B—Serpentine Belt**.
4. Remove the seawater pump inlet and outlet hose. Drain the seawater into a suitable container.

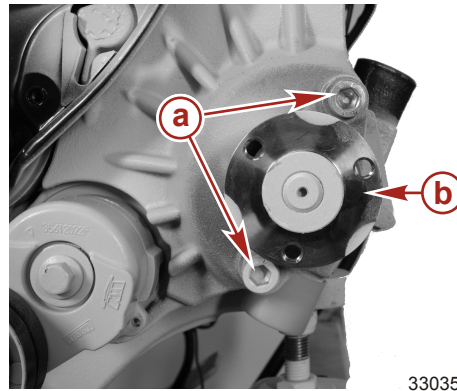
5. Remove the seawater pump pulley.



Typical

- a** - Pulley screws
- b** - Seawater pump pulley

6. Remove the two seawater pump mounting screws.



Typical

- a** - Mounting screws
- b** - Pulley hub

7. Remove the seawater pump.

Disassembly

1. See **Section 6A—Exploded Views** for a graphical reference.
2. Remove the screws and lock washers that hold the cover to the housing.
3. Remove the O-ring from the housing.
4. Remove the impeller from the housing. Remove the key from the shaft.
5. Remove the cam screw and washer from the cam and pull the cam out of the housing. The wear plate can now be removed from the housing.
6. Remove the retaining ring that holds the seal seat in place. Slide the seal seat and washer off the shaft.
7. Support the pump shaft and drive off the pulley hub.
8. Remove the large internal retaining ring from the housing at the end of the bearing.
9. Support the housing and press the shaft, bearings, spacer, slinger, and retaining ring out through the pulley end or hub end of the housing.

10. Remove the water seal assembly by pushing an appropriately sized tool (punch or socket) through the bearing end of the pump body against the back side of the seal pushing it out.

Cleaning

1. Put on safety glasses.
2. Clean the metal parts in solvent and dry the parts with compressed air.
3. After cleaning, apply engine oil to the shaft and bearings to prevent rusting.

Inspection

1. Inspect the bearing housing. Examine the surfaces where the bearings contact housing for evidence of bearing outer races turning in the housing.
2. Inspect the bearings for a worn or defective condition. Examine sealed bearings for evidence of loss of factory grease or evidence of internal contamination.
3. Inspect the two-part seal from the bearing housing.
4. Inspect the seawater pump shaft for grooves in the surface where the seals contact the shaft.
5. Inspect where the bearings contact the shaft for evidence of the inner races turning on the shaft.
6. Inspect the impeller housing.
7. Inspect the cam for scratches or gouging.
8. Inspect the impeller splines and shaft splines.
9. Inspect the seawater pump impeller for wear on the sides and the tips of the blades.
10. Inspect the blades for cracks in the area where the blades must flex.
11. Replace the impeller if the blades remain in a curved position.

Assembly

1. See **Section 6A—Exploded Views** for a graphical reference.
2. Press the water seal assembly into the body from the impeller end. Position the carbon face toward the impeller and ensure the seal is pressed in square and the carbon face is not scratched during assembly.
3. Push the bearing and shaft assembly into the housing using care not to damage the bearing. Apply equal pressure around the bearing outer race when installing. Lock the bearing in place with the large internal retaining ring.
4. Assemble the ceramic seat assembly, washer, and retaining ring over the shaft from the impeller end. Locate the white ceramic surface against the carbon face of the seal.

IMPORTANT: Do not damage the white ceramic surface of the seat or the carbon face of the seal – minor scratches can cause the seat assembly to leak. Lubricate the rubber part of the seat with a non-petroleum fluid for ease of assembly.

5. Support the shaft at the impeller end without contacting the mechanical seal. Press the hub onto the shaft flush to the ball bearings. Failure to support the shaft or placing pressure against the mechanical seal during this step will cause seal and/or bearing damage.
6. Place the wear plate in the housing.

NOTE: Do not use petroleum-based fluid to lubricate the impeller.

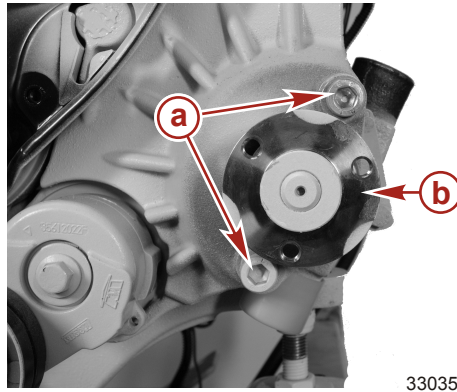
7. Assemble the O-rings and cover on the housing. Replace the lock-washers and screws on the cover and tighten the screws to specification.

Description	Nm	lb. in.	lb. ft.
Screws	4.5	38	–

8. After installation inspect the pump seal, housing, cam area, and cover for leaks.

Installation

1. Position the seawater pump on the engine front bracket.
2. Install and torque the two seawater pump mounting screws.

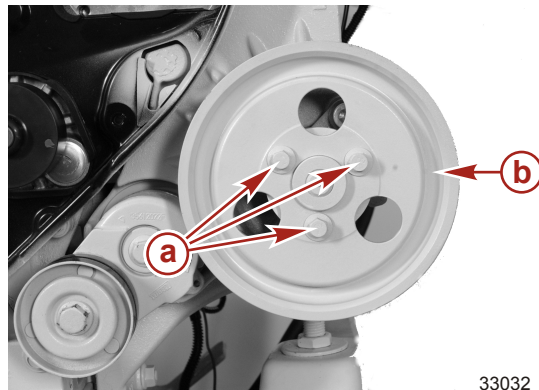


Typical

- a** - Mounting screws
- b** - Pulley hub

Description	Nm	lb-in.	lb-ft
Seawater pump mounting screw	47.1	–	34

3. Install the seawater pump pulley.



Typical

- a** - Pulley screws
- b** - Seawater pump pulley

4. Torque the seawater pump pulley screws.

Description	Nm	lb-in.	lb-ft
Seawater pump pulley screws	24.5	–	18

5. Install the serpentine drive belt. Ensure that the seawater pump pulley is properly aligned with the serpentine belt. Refer to **Section 1B—Serpentine Belt**.
6. Install the seawater pump inlet and outlet hose.
7. Torque the seawater hose clamps.

Description	Nm	lb-in.	lb-ft
Seawater hose clamps	5.6	–	50

8. Open the seacock if equipped, or unplug and connect the seawater inlet hose.
9. Check for leaks when you first start the engine.

Testing the Closed-Cooling System

Testing the Closed Cooling System

CAUTION

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

Testing for Alkalinity

The coolant in the closed cooling (fresh water) section of the cooling system should be changed at specified intervals. See the **Maintenance Schedules**. Checked for alkalinity at least once between change intervals.

To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier.
2. Allow the engine to cool.
3. Remove the pressure cap from the coolant reservoir and insert one end of the litmus paper into the coolant.
4. **If pink litmus paper turns blue**, the coolant is alkaline and need not be replaced.
5. If pink litmus paper remains pink, coolant is not alkaline and must be replaced. See Changing The Coolant.

Pressure Testing

If the closed cooled system is suspected of leaking or not holding sufficient pressure and no visible signs of leakage can be found, perform the following test:

1. Allow the engine to cool.
2. Remove the pressure cap from the expansion tank and coolant reservoir.
3. Clean and inspect the pressure cap to ensure that the pressure cap is maintaining proper pressure in system. See **Testing The Pressure Cap**.
4. Clean the inside of the filler neck to remove any deposits or debris.
5. Examine the expansion tank and coolant reservoir sealing surface for nicks or other damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the pressure cap.
6. Adjust the coolant level in closed cooling (fresh water) section to 25 mm (1 in.) below filler neck.
7. Attach an automotive-type cooling system pressure tester to filler neck. Pressurize the closed cooling system to amount specified in the following chart, based on pressure cap rating for your engine.

Pressure Cap	
Operating pressure	1 bar (14.5 PSI)

8. Observe the pressure tester gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
9. While maintaining the specified pressure on the closed cooling system, visually inspect the external portion of the cooling system (hoses, gaskets, drain plugs, core plugs, circulating pump seal, and so on) for leakage. Also listen closely for bubbling or hissing, as they indicate a leak.
10. See **Testing The Heat Exchanger** in this section and test as outlined.
11. If no leakage could be found in the above steps, the engine is leaking internally, probably due to one or more of the following:
 - Loose cylinder head bolts or damaged gasket
 - Loose turbocharger bolts or damaged gasket
 - Loose exhaust elbow or damaged gasket
 - Cracked or porous cylinder head or block
 - Cracked or porous exhaust manifold
12. Proceed as follows until the location of the internal leak is found:
 - a. Start the engine. Pressurize the closed cooling system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, compression or combustion is leaking into the closed cooled section from a leak in a combustion chamber. Stop the engine.
 - b. Remove the plugs in the glow plug holes (one at a time) from the cylinders and examine for the presence of coolant. A plug that is perfectly clean or milky appearing indicates a leak.
 - c. Drain the oil from the engine and examine for the presence of coolant. Oil usually will be milky or discolored, if coolant is present.
 - d. If coolant is present, remove the engine from the boat and remove the oil pan. With the engine in the upright position, pressurize the closed cooled section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.
 - e. If no leaks can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Cylinder Head Gasket Leak Testing

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure checks normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak.

An effective test follows.

IMPORTANT: Operate the boat in open water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. **During idle and warm-up:** some coolant or air or both will leave the expansion tank and reservoir.
2. **During cruising speed (2800 – 3200 RPM):** coolant or air, or both, leaving the expansion tank and coolant reservoir should stop after approximately five minutes of operation at a steady RPM. A leaking head gasket will produce air bubbling. The frequency and size of the bubbles will depend on the size of the leak.

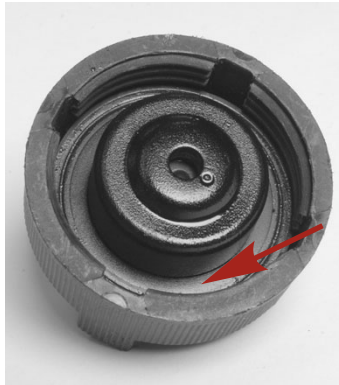
3. **At higher speeds (3200 – 3600 RPM):** Normal operation is the same as described in step 2 above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately five minutes at a steady RPM. A head gasket leak will not stop because a failed head gasket allows the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the expansion tank or reservoir. If coolant continues to flow but not in violent, intermittent bursts from the expansion tank or reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Pressure Cap Testing

The pressure cap is designed to maintain closed cooling system pressure once the engine has reached operating temperature. Refer to **Section 6A—Closed Cooling System Specifications**. The pressure cap should be cleaned, inspected, and pressure-tested at regular intervals or whenever the pressure cap is suspected of not maintaining proper pressure.

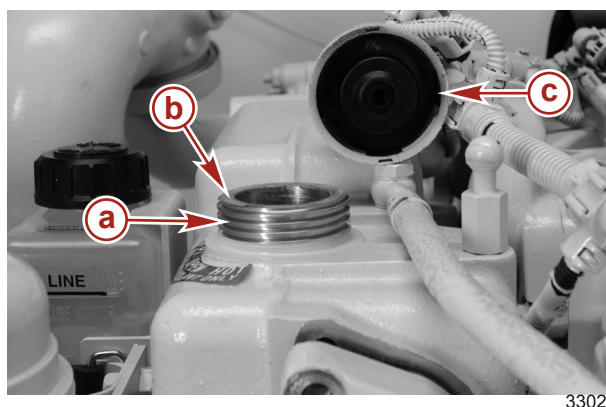
1. Allow the engine to cool.
2. Carefully remove the coolant pressure cap from the expansion tank and coolant reservoir.
3. Wash the cap with clean water to remove any deposits or debris from sealing surfaces.
4. Inspect the gasket on the coolant pressure cap for tears, cuts, cracks, or other signs of deterioration.



Coolant pressure cap gasket

5. Replace the coolant pressure cap if the gasket is damaged.

6. Examine the sealing surface of the expansion tank and coolant reservoir filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the threads of the filler neck to ensure that they are not damaged.



- a** - Expansion tank and coolant reservoir filler neck
- b** - Sealing surface
- c** - Coolant pressure cap

7. Using a suitable cooling system pressure tester, test the pressure cap to ensure that it releases at the specified pressure and does not leak. Refer to the pressure tester instructions for the correct test procedure.

Pressure Cap	
Operating pressure	1.0 ± 0.1 bar (14.5 ± 1.4 psi)

8. Replace the pressure cap if it does not meet specification.

Draining the Closed Cooling System

IMPORTANT: Due to the complex nature of this service Cummins MerCruiser Diesel strongly recommends that this service be performed by a Cummins MerCruiser Diesel Authorized Repair Facility.

NOTICE

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

NOTE: For instructions on draining the seawater section, see **Draining the Seawater System** in this section.

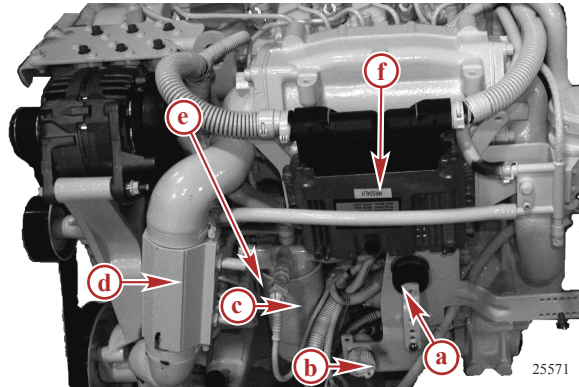
IMPORTANT: Observe the following points.

- Ensure that the engine is as level as possible to promote complete draining of the cooling system.
- The closed cooling section must be filled year-round with the required coolant. If the engine will be exposed to freezing temperatures, ensure that the closed cooling section is filled with a solution of low silicate ethylene glycol antifreeze and deionized, purified water properly mixed to protect the engine to the lowest temperature to which it will be exposed.
- Do not use propylene glycol antifreeze in the closed cooling section of the engine.

⚠ CAUTION

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

1. Allow the engine to cool.
2. Remove the pressure cap from the expansion tank and coolant reservoir.
3. Remove the fuel filter for access to the engine coolant drain plug. See **Water-Separating Fuel Filter**.
4. Move the fuel lines so they do not obstruct access to the engine coolant drain plug.



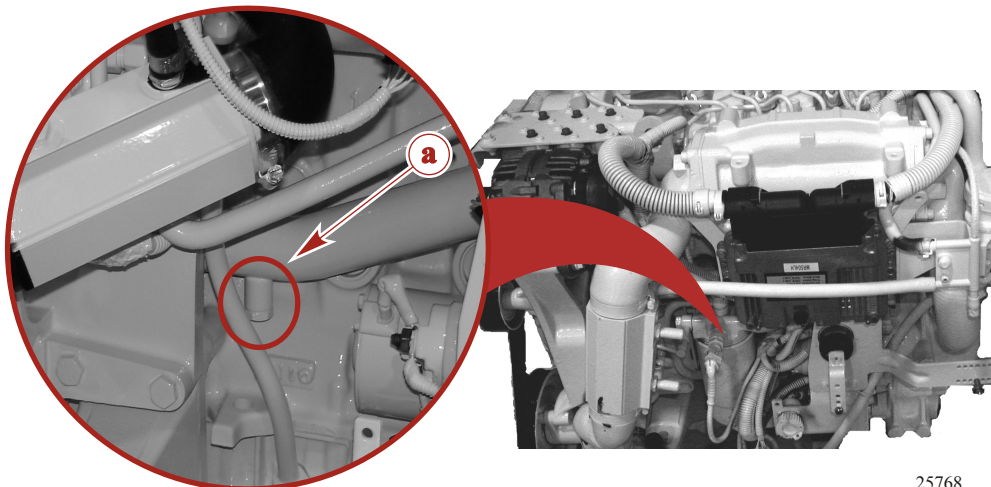
Port side of engine

- | | |
|---|--|
| a - Throttle cable bracket | d - Fuel cooler with fuel lines moved to provide access |
| b - 14-pin electrical connector | e - General location of engine coolant drain plug |
| c - Water-separating fuel filter | f - Engine control module |

5. Remove the engine coolant drain plug and drain the coolant into a suitable container.

NOTE: Allow the engine coolant system to drain completely.

NOTE: Dispose of old coolant properly.



Port side of block with water-separating fuel filter removed for access

- a** - Engine coolant drain plug

6. Ensure that the coolant has drained completely.

7. If required, clean the closed cooling system. See your local Cummins MerCruiser Diesel Authorized Repair Facility.
8. Install and tighten the engine coolant drain plug.
9. Reinstall the water-separating fuel filter. See **Water-Separating Fuel Filter, Replacing**.
10. Fill the system with the specified coolant. See **Filling the Closed Cooling System**.

Cleaning the Closed Cooling System

The closed cooling section of the cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

Use a high-grade automotive cooling system cleaner to remove closed cooling system deposits. Follow the manufacturer's instructions.

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

Coolant Expansion Tank and Reservoir

Removal and Installation

The coolant expansion tank and reservoir are components of the exhaust manifold and heat exchanger assembly. For removal and installation instructions see **Section 7B—Exhaust Manifold**.

Cleaning And Inspection

1. Clean the coolant expansion tank in soap and water to remove any deposits and debris.
2. Inspect the coolant expansion tank for cracks, corrosion, or other damage. Replace as necessary.
3. Clean the exterior surfaces as required. On models equipped with a cast aluminum expansion tank, paint the exterior surfaces to prevent corrosion.

Coolant Manifold Assembly

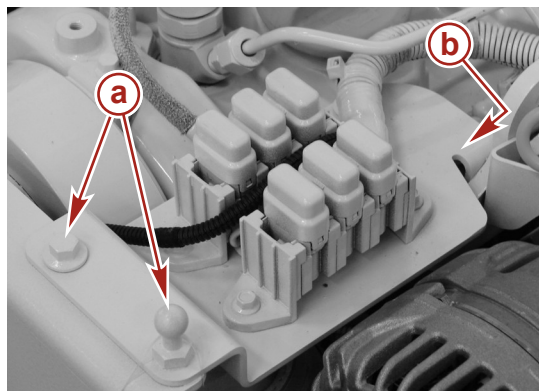
Removal

NOTICE

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

1. Drain the engine coolant. Refer to **Section 6A—Draining the closed cooling system**.

2. Remove bolts attaching the the engine fuse panel to the front engine bracket.

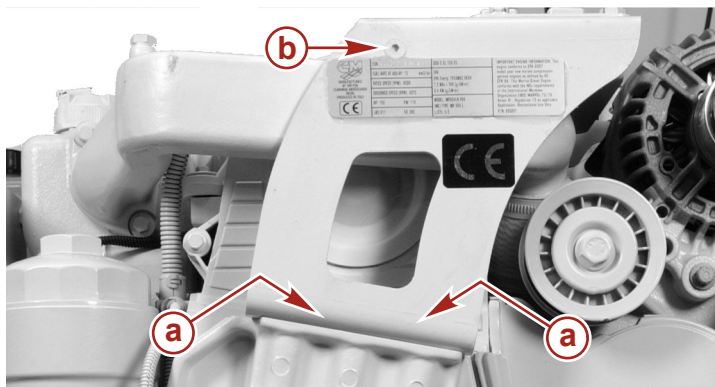


33119

- a** - Screws
- b** - Nut and bolt

NOTE: The coolant manifold to turbo charger coolant line can remain attached to the turbocharger if it does not require replacement.

3. Disconnect the coolant temperature sender electrical connector.
4. Remove the two screws attaching the front engine bracket to the front engine cover plate.

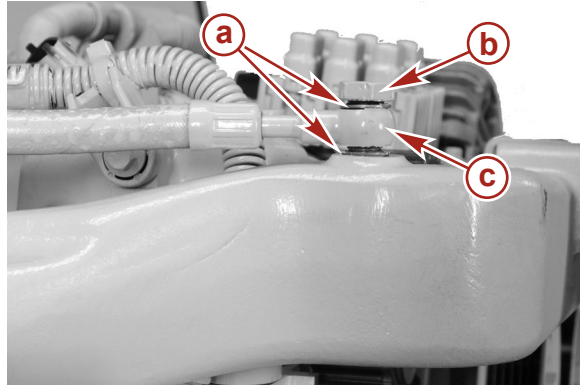


33117

- a** - Front engine bracket screws
- b** - Nut (on backside)

5. Remove the nut attaching the engine coolant manifold to the front engine bracket.
6. Remove the front engine bracket.

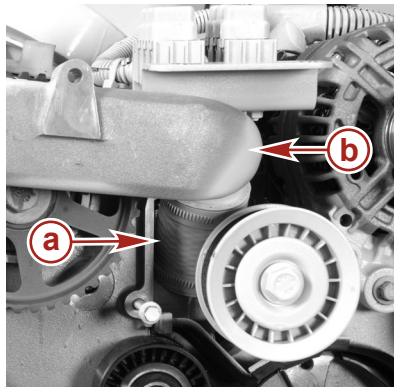
7. Remove the hollow bolt and sealing washers and the coolant manifold to turbocharger coolant line.



33122

- a** - Sealing washers
- b** - Hollow bolt fitting
- c** - Coolant line

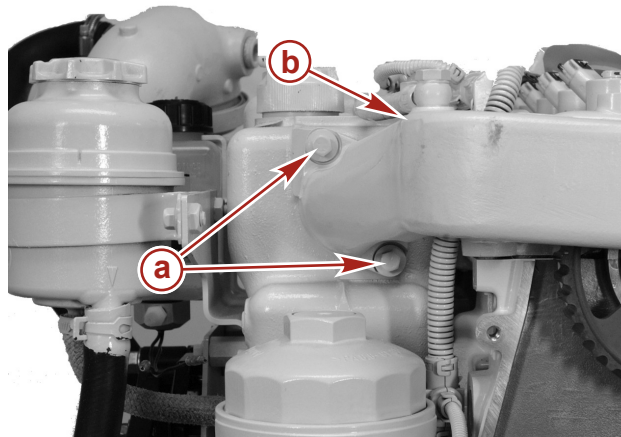
8. Remove the coolant manifold to intake manifold hose.



33123

- a** - Hose
- b** - Coolant manifold

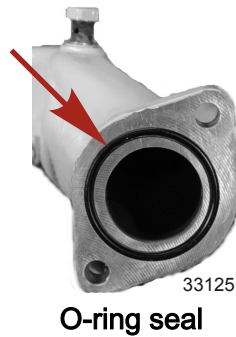
9. Remove the bolts attaching the coolant manifold to the Exhaust manifold heat exchanger assembly.



33124

- a** - Bolts
- b** - Coolant manifold

10. Discard the O-ring seal.



Cleaning

IMPORTANT: Do not drop anything into the cylinder head openings.

1. Discard the existing hollow bolt sealing washers.
2. Clean the gasket material from cylinder heads, coolant manifold flanges and end cover.
3. Clean the coolant manifold assembly components with cleaning solvent.
4. Put on safety glasses and dry the components with compressed air.
5. Remove all traces of oil and debris from the threaded mounting holes in the cylinder heads for the coolant manifold assembly.

Inspection

1. Inspect the sealing surfaces for deep nicks and scratches.
2. Inspect the castings for cracks or corrosion that might prevent a proper seal.
3. Inspect the vent pipe, vent hose, and water hose for signs of damage.
4. Replace or repair components as needed.

Installation

1. Use a new gasket and install the end cover on the coolant manifold using the four screws and washers. Finger-tighten the screws.

IMPORTANT: The end cover and the coolant manifold gasket flanges must align for proper sealing on the cylinder heads. Align the flanges using a machinist straight edge as shown.

2. If removed, align the coolant manifold end cover and the coolant manifold using a machinist straightedge and torque the coolant manifold end cover screws evenly in a diagonal pattern.

Description	Nm	lb-in.	lb-ft
Coolant manifold end cover screw	10.8	95	–

3. Place new gaskets in position on the cylinder heads.

NOTE: A small amount of sealant can be used to hold a gasket in place during installation.

4. Install the coolant manifold assembly while simultaneously positioning the water hose onto the rear of the manifold. Finger-tighten the eight coolant manifold screws.
5. Torque the coolant manifold screws in a diagonal pattern from the center to the outer ends.

Description	Nm	lb-in.	lb-ft
Coolant manifold screw	11.8	104	–


6. Install the turbocharger vent pipe onto the coolant manifold using the hollow bolt and new sealing washers. Torque the coolant manifold vent pipe hollow bolt while simultaneously positioning the vent pipe.

Description	Nm	lb-In.	lb-ft
Coolant manifold vent pipe hollow bolt	27.5	–	20

7. Connect the vent hose to the coolant reservoir. Tighten the hose clamps.

NOTE: Dual helm applications may have an adaptor and dual station coolant temperature sensor installed.

8. Install the coolant temperature sender adaptor (if equipped). Install the coolant temperature sensor. Apply sealant to all threads.

Tube Ref No.	Description	Where Used	Part No.
 12	Loctite Master Gasket Kit	Coolant temperature adaptor (if equipped) and sensor threads	92-12564 2

9. Torque the coolant temperature sensor adaptor (if equipped) and the coolant temperature sensor.

Description	Nm	lb-In.	lb-ft
Coolant temperature sensor adaptor (if equipped)	39.2	–	29
Coolant temperature sensor	19.6	173	–

10. Connect the wire terminal to the coolant temperature sender.

NOTE: Coolant manifold assembly shown with aftercooler removed for visual clarity only.

11. Tighten the hose clamp on the coolant hose at the rear of the coolant manifold.

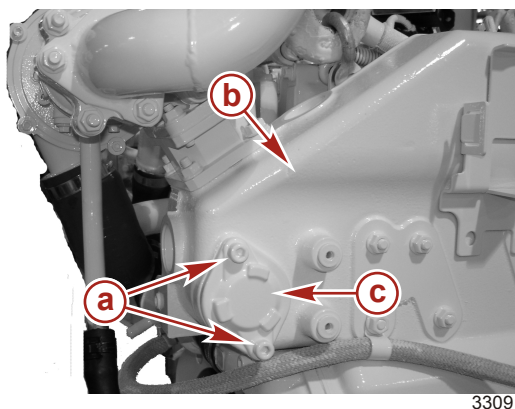
12. See **Section 6** for appropriate procedures on filling the closed cooling system and test the engine operation.

13. Check for leaks upon first starting the engine.

Thermostat

Removal

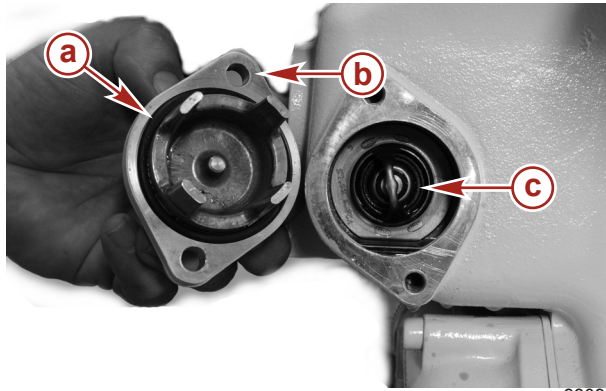
1. Allow the engine to cool.
2. Drain the seawater system. See **Section 6A—Draining the Seawater System**.
3. Drain the closed cooling system. Dispose of the coolant properly. See **Section 6A—Draining the Closed Cooling System**.
4. Remove the two thermostat cover screws.



- a** - Thermostat cover screw
- b** - Exhaust manifold and heat exchange assembly
- c** - Thermostat cover

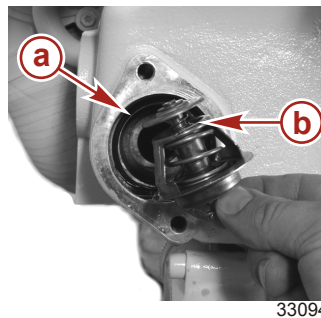
5. Remove the thermostat housing cover.

6. Remove and discard the old O-ring.



- a** - O-ring
- b** - Thermostat housing cover
- c** - Thermostat

7. Remove the thermostat and thermostat O-ring.



- a** - O-ring
- b** - Thermostat

Cleaning

1. Remove and discard the old thermostat seal.
2. Clean the thermostat in soap and water to remove any deposits or debris.

Inspection

1. Inspect the thermostat for corrosion or other visible damage.
2. Check the thermostat for leaks by holding it up to a lighted background. Light visible around the thermostat valve indicates that the thermostat is not closing completely and should be replaced.

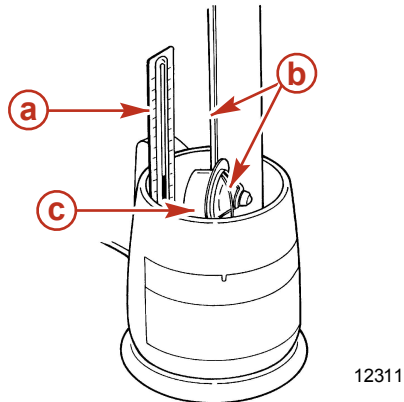
NOTE: A few visible light leaks at one or two points around the thermostat valve perimeter are acceptable.

3. Replace the thermostat if damaged or leaking.

Testing

1. Remove the thermostat.

- Following the usage recommendations of the manufacturer of a Thermostat Tester, check the opening and closing temperature of the thermostat. The thermostat opens when it drops off of the nylon string. The thermostat must open at the specified temperature stamped on the thermostat.



Typical Thermometer Tester in use

a - Thermometer

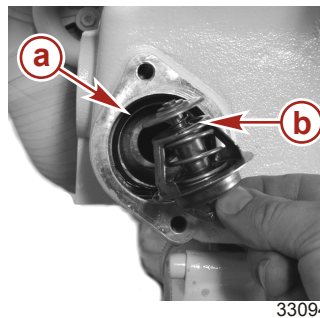
b - Nylon string

c - Thermostat

- Continue to heat the water until a temperature 14° C (25° F) above opening temperature is reached. The thermostat valve must be completely open at this temperature.
- Unplug the Thermostat Tester and allow the water to cool to a temperature 5° C (10° F) below the specified thermostat opening temperature. The thermostat must be completely closed at this temperature.
- Replace the thermostat if it fails to meet specifications.

Installation

- Install the seal around the thermostat.
- Install the thermostat and the seal.

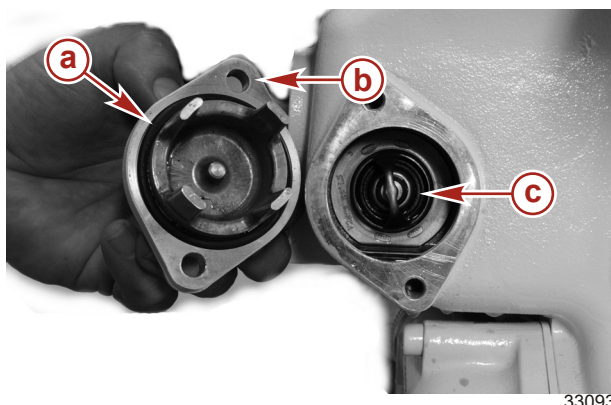


a - O-ring

b - Thermostat

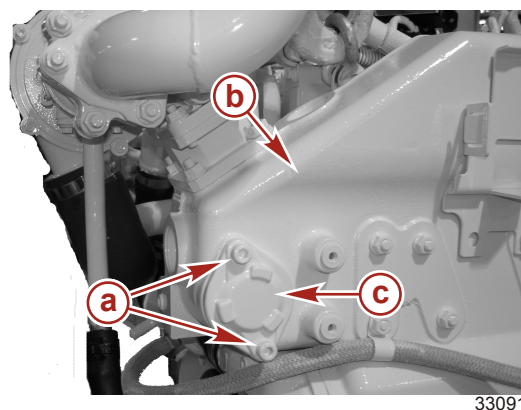
NOTE: Always use a new thermostat housing cover O-ring.

3. Install a new thermostat housing cover O-ring.



- a** - O-ring
- b** - Thermostat housing cover
- c** - Thermostat

4. Install the thermostat housing cover using the two screws.



- a** - Thermostat cover screw
- b** - Exhaust manifold and heat exchange assembly
- c** - Thermostat cover

5. Torque the thermostat housing cover screws.

Description	Nm	lb-in.	lb-ft
Thermostat housing cover screw	24.5	–	18

6. Fill the closed cooling system. See **Section 6A—Filling the Closed Cooling System**.
7. Open the seacock if equipped, or unplug and reconnect the seawater inlet hose.
IMPORTANT: An adequate supply of seawater must be supplied to both the engine and sterndrive seawater systems any time the engine is in operation.
8. Ensure that the engine and sterndrive seawater pickups are supplied cooling water.
9. Connect the battery cables and start the engine.
10. Test the engine operation. Ensure that the engine operating temperature is normal.
Check for leaks.
11. Stop the engine.
12. Check the engine coolant level. Fill to the proper level.

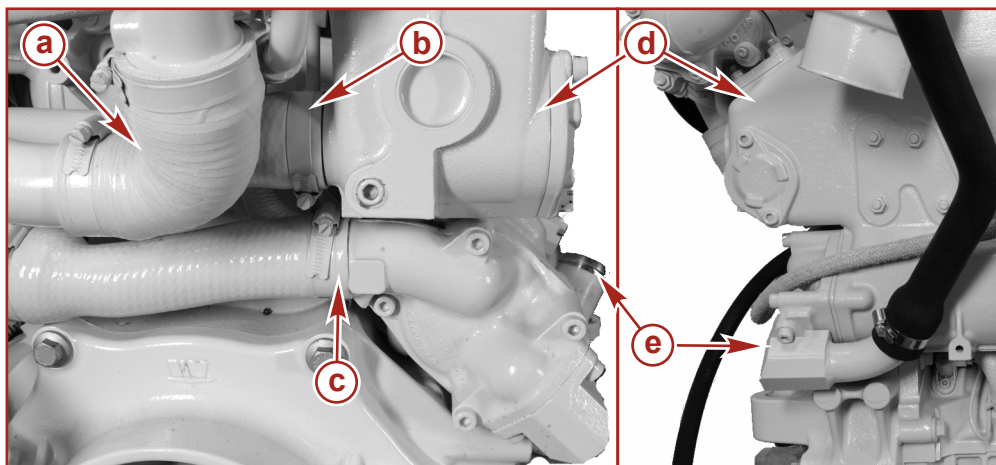
Heat Exchanger and Fluid Cooler Assembly

Removal

NOTICE

If the boat is at rest in the water with the engine off, an open seacock or water inlet hose could introduce water into the engine's cooling system or the boat. Keep the seacock or water inlet hose plugged until ready to start the engine. Attach a tag to the ignition switch or steering wheel to inform others of the water inlet connection.

1. Close the seacock, if equipped, or disconnect and plug the seawater inlet hose if the boat is to remain in the water.
2. Drain the seawater system. See **Section 6A—Draining the Seawater System**.
3. Drain the closed cooling system. Dispose of the coolant properly. See **Section 6A—Draining the Closed Cooling System**.
4. Disconnect and remove the gear lube monitor bottle.
5. Disconnect and remove the power assisted steering reservoir. Refer to **Section 9A—Power-Assisted Steering Pump and Related Components**.
6. For Sterndrive models, remove the engine mounted shift lever. See **Section 2—Removal and Installation**.
7. Disconnect the cabin water heater fitting, if equipped.
8. Remove the coolant manifold assembly. See **Section 6A—Coolant Manifold Assembly**.
9. Disconnect the turbocharger to intake manifold air tube elbow. See **Section 7B—Intake Manifold, Exhaust Manifold, Riser, and Elbow**.

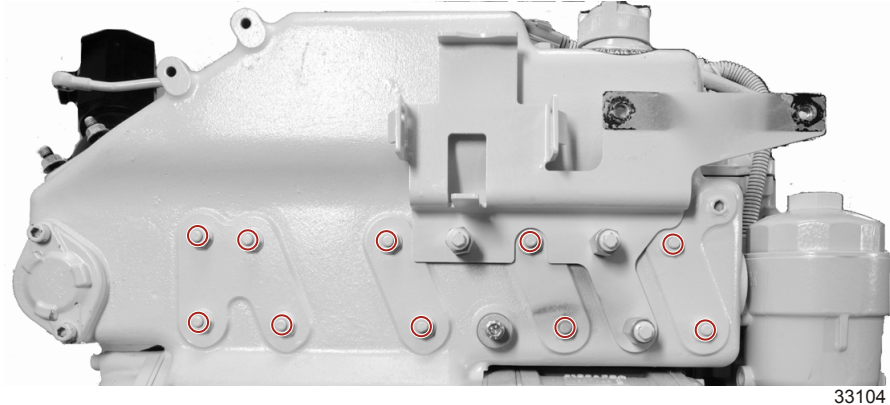


33095

- a** - Air tube elbow
- b** - Coolant hose
- c** - Seawater inlet hose
- d** - Heat exchanger and fluid cooler assembly
- e** - Seawater outlet hose

10. Disconnect the heat exchanger fluid cooler assembly coolant hoses.
11. Disconnect the heat exchanger fluid cooler assembly seawater hoses.
12. For early production models, remove the oil cooler tubes from the heat exchanger fluid cooler assembly. See **Section 3A—Oil Filter and Oil Cooler Assembly**.

13. Completely detach the turbocharger oil drain line and position so that it will not interfere with heat exchanger fluid cooler assembly removal. See **Section 7C—Turbocharger**.
14. Completely detach the turbocharger oil supply line and position so that it will not interfere with heat exchanger fluid cooler assembly removal. See **Section 7C—Turbocharger**.
15. Remove the turbocharger if required for the service or repair being performed. See **Section 7C—Turbocharger**.
16. Remove the 10 heat exchanger fluid cooler assembly attaching nuts from their studs.



Attaching nuts

17. Dismount the exhaust manifold and heat exchanger assembly from the cylinder head by sliding straight off of the studs.
18. Discard the exhaust manifold and heat exchanger assembly to cylinder head gasket.

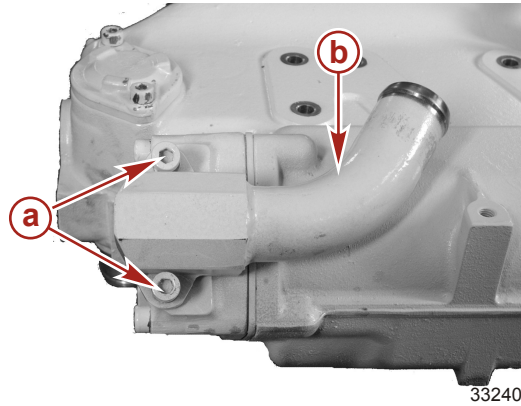
Disassembly

NOTICE

Engine coolant leaking into the seawater circuit could result in engine damage. Replace all O-ring seals whenever disassembling the heat exchanger or removing the radiator insert (core).

1. For early production models, remove the oil cooler tubes. See **Section 3A—Oil Filter and Oil Cooler Assembly**.

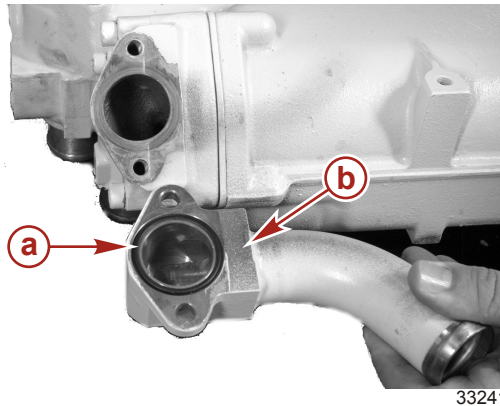
2. For early production models, remove the seawater outlet elbow from the heat exchanger end cover.



Early models

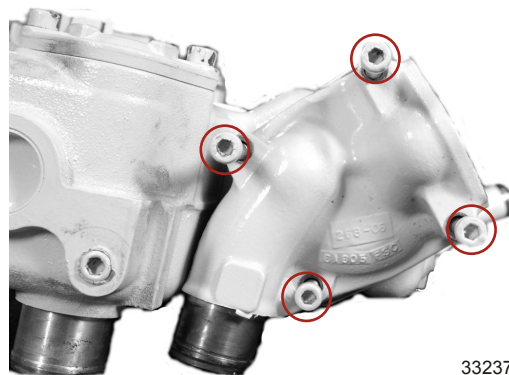
- a** - Screw
- b** - Seawater outlet elbow

3. Remove and discard the seawater outlet elbow O-ring.



- a** - O-ring
- b** - Seawater outlet elbow

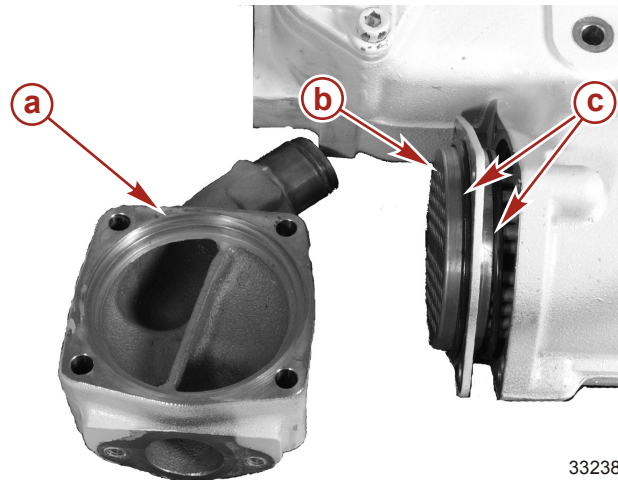
4. Remove the four flange nuts on the heat exchanger end cover.



Heat exchanger end cover screws (Typical)

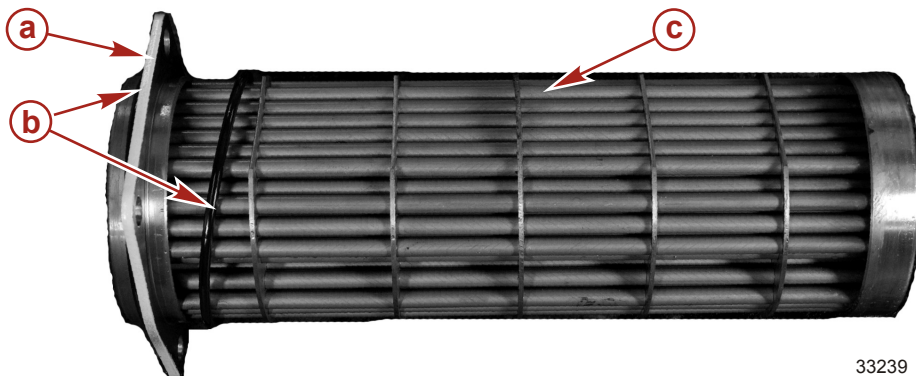
5. Remove the heat exchanger end cover.

NOTE: Note the position of the O-rings during disassembly. Use new O-rings during assembly.



- a** - End cover
- b** - Radiator insert (core)
- c** - O-ring

6. Remove the radiator insert (core) from the heat exchanger housing.



- a** - Mounting flange
- b** - O-ring
- c** - Radiator insert (core)

7. Discard all used O-rings.

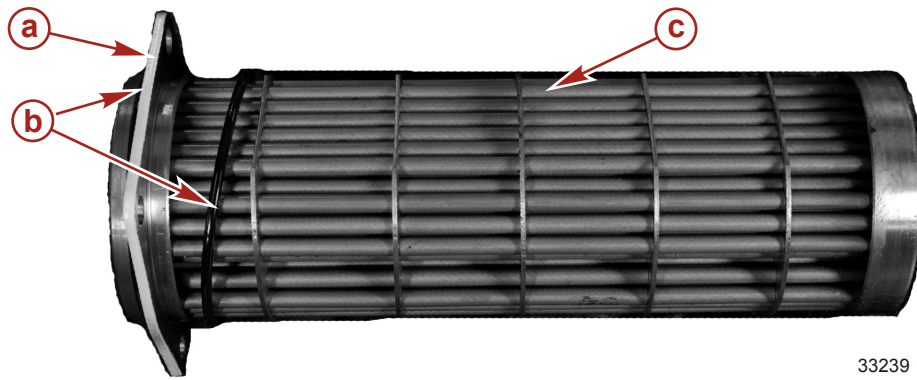
Cleaning and Inspection

1. Remove the old O-rings and clean the sealing flanges.
2. Use a suitable long rod or brush to clean out the radiator insert tubes.
3. Inspect each part for cracks, corrosion, or other damage. Replace as necessary.
4. Clean and paint the exterior surfaces as required to prevent corrosion.

Assembly

IMPORTANT: Do not roll or twist O-rings during installation.

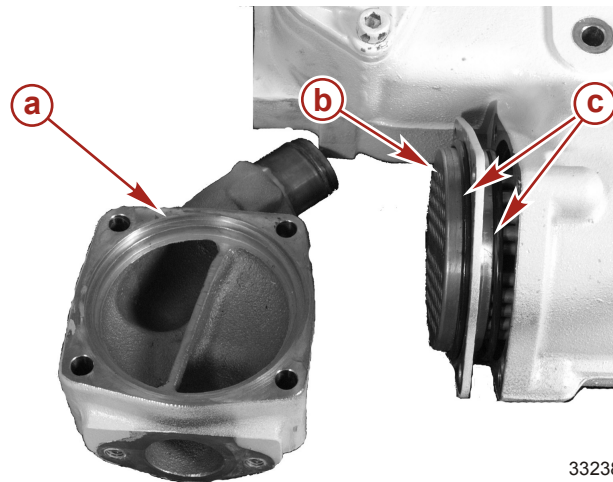
1. Place the O-rings around the heat exchanger radiator insert.



33239

- a** - Mounting flange
- b** - O-ring
- c** - Radiator insert (core)

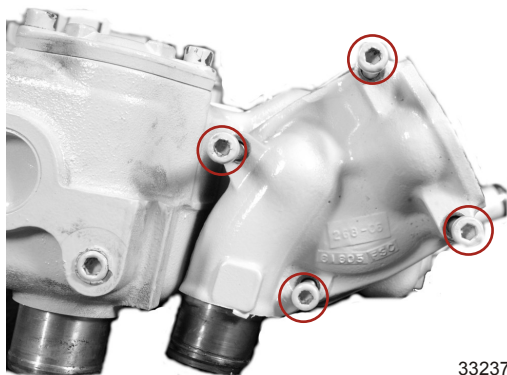
2. Press the O-rings flush against both sides of the mounting flange. Do not allow the O-rings to twist or roll.
3. Insert the heat exchanger radiator insert (core) into the rear of the heat exchanger housing.



33238

- a** - End cover
- b** - Radiator insert (core)
- c** - O-ring

4. Install the heat exchanger end cover and the four flange nuts. Tighten the fluid cooler end cover flange nuts evenly, in a diagonal pattern.

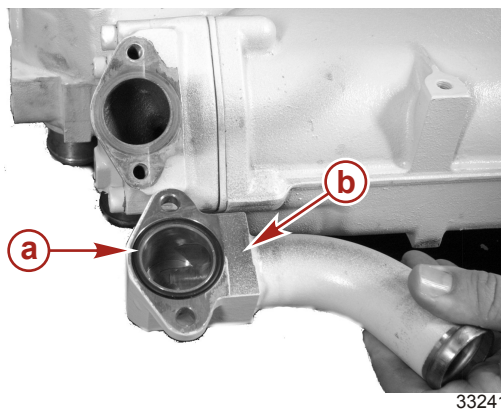


Heat exchanger end cover screws (Typical)

5. Torque to specification.

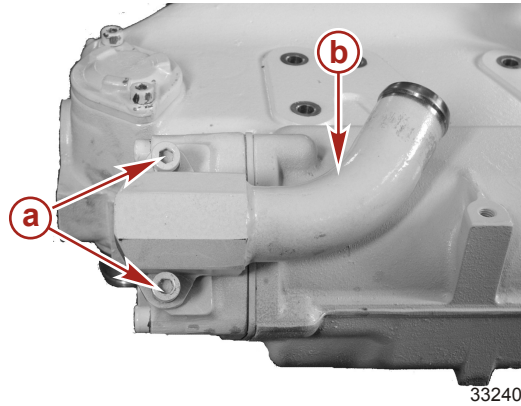
Description	Nm	lb-in.	lb-ft
Fluid cooler end cover flange nuts	24.5	–	18

6. Install a new seawater outlet elbow O-ring.



- a** - O-ring
b - Seawater outlet elbow

7. For early production models, install the seawater outlet elbow from the heat exchanger end cover.



Early models

- a** - Screw
- b** - Seawater outlet elbow

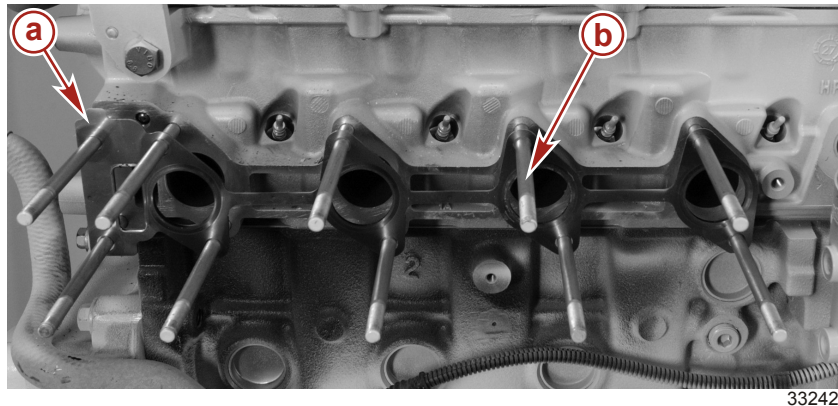
8. Torque the seawater outlet elbow screws.
9. Torque to specification.

Description	Nm	lb-in.	lb-ft
Seawater outlet elbow screws	24.5	–	18

10. For early production models, install the oil cooler. See **Section 3A—Oil Filter and Oil Cooler Assembly**.

Installation

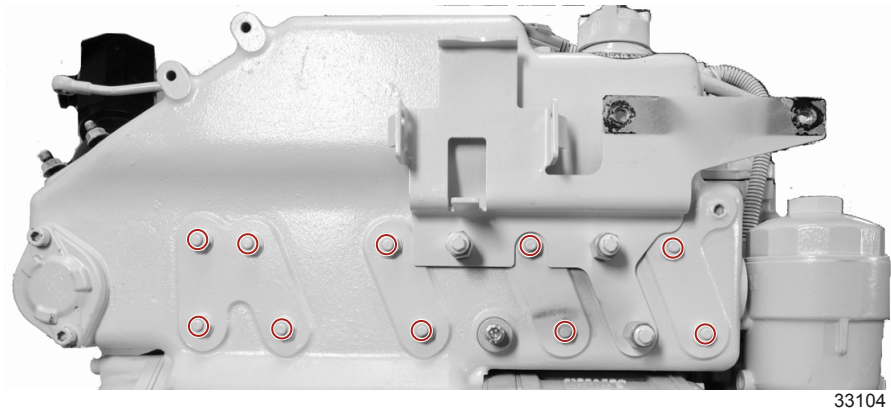
1. Position a new exhaust manifold and heat exchanger assembly to cylinder head gasket on the heat exchanger fluid cooler assembly studs.



- a** - Gasket
- b** - Stud

2. Mount the exhaust manifold and heat exchanger assembly on the cylinder head by sliding straight on to the studs.

3. Install and tighten the 10 exhaust manifold and heat exchanger assembly attaching nuts in a alternating pattern starting in the middle and working outward.



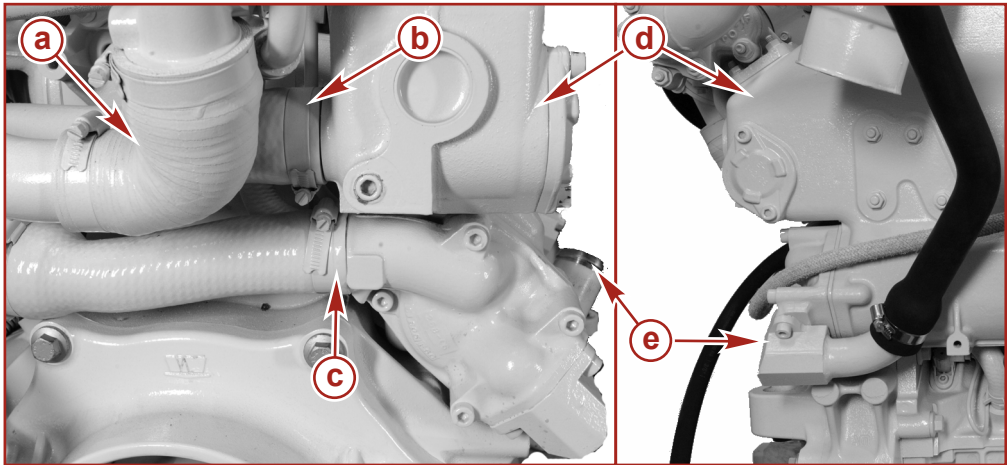
33104

Attaching nuts

4. Tighten the exhaust manifold and heat exchanger assembly attaching nuts in a alternating pattern starting in the middle and working outward. Tighten the nuts to specification.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and heat exchanger assembly attaching nuts	27.5	–	20

5. For early production models, install the oil cooler tubes from the heat exchanger fluid cooler assembly. See **Section 3A—Oil Filter and Oil Cooler Assembly**.
6. Install the turbocharger. See **Section 7C—Turbocharger**.
7. Install the turbocharger oil supply and drain lines. See **Section 7C—Turbocharger**.
8. Connect the heat exchanger fluid cooler assembly seawater hoses.



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- a** - Air tube elbow
- b** - Coolant hose
- c** - Seawater inlet hose
- d** - Heat exchanger and fluid cooler assembly
- e** - Seawater outlet hose

Description	Nm	lb-in.	lb-ft
Hose clamps	5.7	50	–

9. Connect the heat exchanger fluid cooler assembly coolant hose.

10. Connect the turbocharger to intake manifold air tube elbow. See **Section 7B—Intake Manifold, Exhaust Manifold, Riser, and Elbow**.
11. Install the coolant manifold assembly. See **Section 6A—Coolant Manifold Assembly**.
12. Connect the cabin water heater fitting, if equipped.
13. For Sterndrive models, install the engine mounted shift lever. See **Section 2—Removal and Installation**.
14. Install and connect the power assisted steering reservoir. See **Section 9A—Power-Assisted Steering Pump and Related Components**.
15. Install and connect the gear lube monitor bottle.
16. Fill the closed cooling system. See **Section 6A—Draining the Closed Cooling System**.
17. Open the seacock, if equipped, or connect the seawater inlet hose.

Fuel Cooler (if equipped)

Inspection Before Removal

CAUTION

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

1. Drain the seawater system.
2. Remove the hose clamp from the inlet end of the cooler. See **Seawater Flow Diagram**.
3. Inspect the passages. Clean if needed.
4. Install the hose. Securely tighten the hose clamp.

Cleaning Without Removal

CAUTION

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

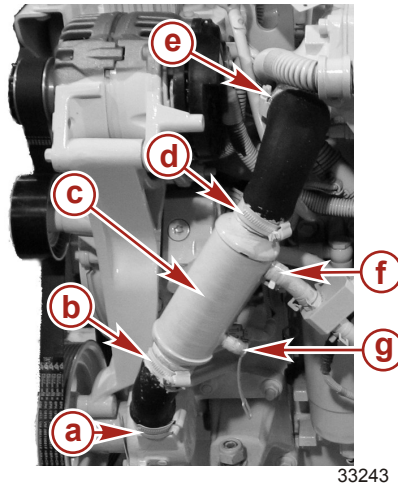
1. Drain the seawater system.
2. Remove the hoses from both ends of cooler.
3. Temporarily attach a suitable hose to the inlet end of cooler and place the end of the hose in a suitable container to collect the water in the following.
4. Attach a suitable adapter to the outlet end of cooler to which a tap water hose may be connected.
5. Open tap water faucet and back-flush cooler until the discharge water is clean.
6. Remove the temporary hose and the adapter.
7. Install the hoses. Securely tighten the hose clamps.

Removal

⚠ CAUTION

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

1. Close the seacock or plug the seawater inlet hose.
2. Drain the seawater system.
3. Disconnect the fuel cooler seawater inlet and outlet hoses.



- | | |
|--|---|
| a - Seawater pump outlet | e - Intake manifold seawater inlet |
| b - Fuel cooler seawater inlet | f - Fuel cooler fuel inlet |
| c - Fuel cooler | g - Fuel cooler fuel outlet (to fuel tank) |
| d - Fuel cooler seawater outlet | |

4. Mark the fuel hoses to aid in assembly.

NOTE: Cap all disconnected fuel lines.

5. Disconnect the fuel inlet and return hoses. Plug the hoses quickly to prevent a fuel spill.
6. Remove the fuel cooler.

Inspection and Cleaning

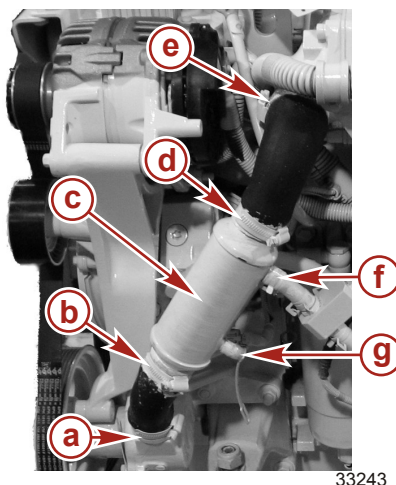
IMPORTANT: CMD does not recommend the immersion of fluid coolers in cleaning solutions. If back-flushing and wire brushing the cooler passages does not satisfactorily clear the passages, replacement of the cooler is recommended.

1. Inspect for any blockage in the seawater circuit. If the passages are obstructed, clean the tubes with a suitable wire brush of the proper size through each tube.
2. Rinse out the seawater circuit of the cooler and cooler tubes with tap water to remove loosened particles.
3. Inspect the tubes close inside the fuel fittings. Because the complete fuel circuit of the cooler cannot be inspected, the fuel cooler should be replaced if fuel circuit blockage is suspected.
4. Replace the unit if it cannot be satisfactorily cleaned.

Installation

1. Position the fuel cooler.

2. Connect the fuel cooler seawater inlet and outlet hoses.



- | | |
|--|---|
| a - Seawater pump outlet | e - Intake manifold seawater inlet |
| b - Fuel cooler seawater inlet | f - Fuel cooler fuel inlet |
| c - Fuel cooler | g - Fuel cooler fuel outlet (to fuel tank) |
| d - Fuel cooler seawater outlet | |

3. Connect the fuel inlet and return hoses. Plug the hoses quickly to prevent a fuel spill.
4. Torque all hose clamps.

Description	Nm	lb. in.	lb. ft.
Fuel cooler seawater hose clamp	4.6	40	–
Fuel hose clamp	4.6	40	–

5. Open the seacock or unplug the seawater inlet hose.

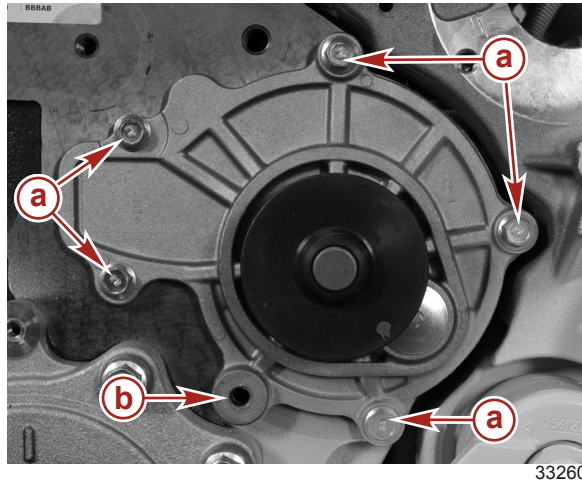
Engine Coolant Circulating Pump

Removal

1. Allow the engine to cool.
 2. Drain the seawater system. See **Section 6A—Draining the Seawater System**.
 3. Drain the closed cooling system. Dispose of the coolant properly. See **Section 6A—Draining the Closed Cooling System**.
 4. For sterndrive models, remove the power assisted steering belt. See **Section 1B—Power Assisted Steering Pump Belt—Sterndrive Only**.
 5. Remove the serpentine drive belt. See **Section 1B—Serpentine Belt**.
 6. Remove the crankshaft pulley. See **Section 3A—Engine Front Bracket and Timing Gear Cover**.
 7. Remove the engine front bracket and timing gear cover components. See **Section 3A—Engine Front Bracket and Timing Gear Cover**.
 8. Remove the engine timing belt and timing belt tensioner. See **Section 3A—Engine Timing Belt and Components**.
- NOTE:** Note the location of the long engine timing belt rear cover screw.
9. Remove the high pressure fuel pump timing belt sprocket. See **Section 5E—High Pressure Fuel Pump**.
 10. Remove the timing belt rear cover. See **Section 3A—Engine Timing Belt and Components**.

NOTE: One of the lower engine coolant circulating pump bolts is removed with the timing belt rear cover .

11. Remove the engine coolant circulating pump.



a - Screw

b - Screw removed with backing plate

12. Remove and discard the engine coolant circulating pump gasket.

Cleaning

IMPORTANT: Debris, such as old gasket material, might foul the cooling system passages. Do not allow debris inside the engine block during cleaning.

1. Remove all traces of old gasket material from the water circulating pump body.
2. Remove all traces of old gasket material from the engine block.

Inspection

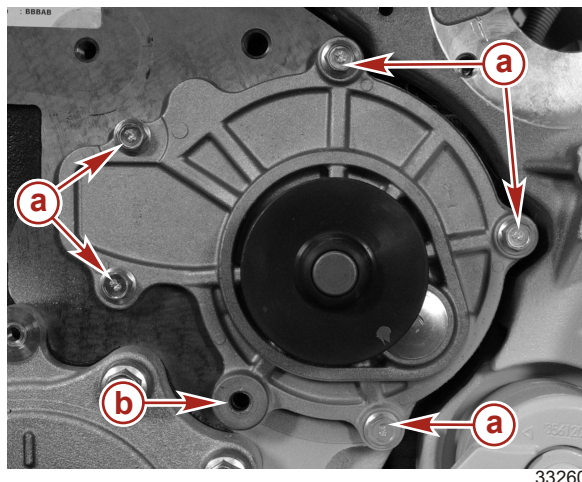
1. Inspect the water circulating pump body for blockage, cracks, sand holes, corrosion, or other damage.
2. Inspect the impeller for cracks, corrosion, or damage.
3. Inspect the impeller shaft and bearings for excessive side play, abnormal noise when turning, or wear.
4. Inspect the pulley for bends, cracks, corrosion, improper runout, or other damage.
5. Replace the complete water circulating pump for failure to pass any of these inspections.

Installation

1. Install the new new engine coolant circulating pump gasket on the engine block.
2. Install the water circulating pump.

NOTE: One of the lower engine coolant circulating pump bolts is installed with the timing belt rear cover .

3. Tighten the indicated flange screws of the engine coolant circulating pump evenly in a diagonal pattern.



- a** - Screw
b - Installed with backing plate

4. Torque the engine coolant circulating pump screws to specification.

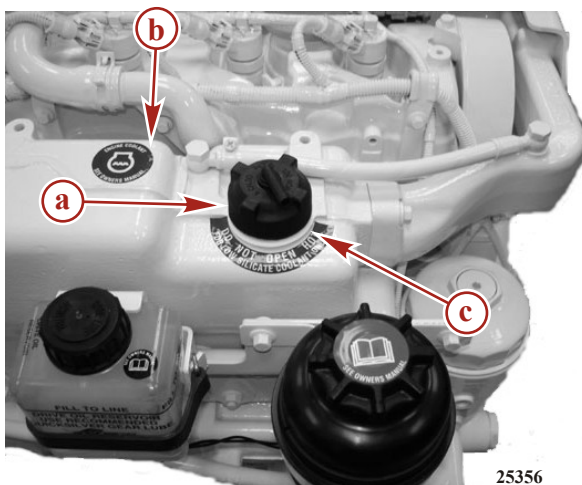
Description	Nm	lb-in.	lb-ft
Coolant circulating pump flange screw	52	–	38

NOTE: Note the location of the long engine timing belt rear cover screw.

5. Install the timing belt rear cover . See **Section 3A—Engine Timing Belt and Components**.
6. Install the high pressure fuel pump timing belt sprocket. See **Section 5E—High Pressure Fuel Pump**.
7. Install the engine timing belt and timing belt tensioner. See **Section 3A—Engine Timing Belt and Components**.
8. Install the engine front bracket and timing gear cover components. See **Section 3A—Engine Front Bracket and Timing Gear Cover**.
9. Install the crankshaft pulley. See **Section 3A—Engine Front Bracket and Timing Gear Cover**.
10. Install the serpentine drive belt. See **Section 1B—Serpentine Belt**.
11. For sterndrive models, install the power assisted steering belt. See **Section 1B—Power Assisted Steering Pump Belt—Sterndrive Only**.
12. Check the engine coolant level. Fill to the proper level.

Filling the Closed Cooling System

1. Remove the pressure cap.



QSD 2.0L (engine cover removed)

a - Pressure cap



c - Coolant fill neck

b - Coolant expansion tank

IMPORTANT: Use only the specified coolant.

2. If the coolant is being replaced or the level is low, slowly add the specified coolant to the level indicated in the table.

Coolant level in expansion tank	
QSD 2.0L	Within 25 mm (1 in.) of the top of the filler neck

Tube Ref No.	Description	Where Used	Part No.
 123	Marine Engine Coolant (Only available in Europe)	Closed cooling system	92-813054A2
	Fleetguard Compleat with DCA4, Fleetguard Part Number CC2825	Closed cooling system	Obtain Locally

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.

3. If the boat is out of the water, both the engine and sterndrive must be supplied with cooling water. See the **Flushing the Seawater System** section of this manual.
4. Do not install the pressure cap. Start and operate the engine at fast idle speed between 600 and 1400 RPM. Add coolant as necessary to maintain the coolant at the level specified previously.

IMPORTANT: When installing the pressure cap, be sure to tighten it securely to avoid coolant loss.

5. Install the pressure cap after the engine has reached normal operating temperature (with the thermostat fully open) and the coolant level remains constant.

6. Test the engine operation. Observe the temperature gauge and check the engine for coolant leaks. If the temperature gauge indicates the presence of excessive temperature or coolant is leaking, stop the engine immediately and inspect for the cause.
7. After the first operation, allow the engine to cool.
8. Remove the pressure cap and add the specified coolant to the level indicated in the table.

Coolant level in expansion tank	
2.0	Within 25 mm (1 in.) of the top of the filler neck

9. Install and securely tighten the pressure cap.

Notes: