Cooling System

Section 6C - Models with Closed Cooling

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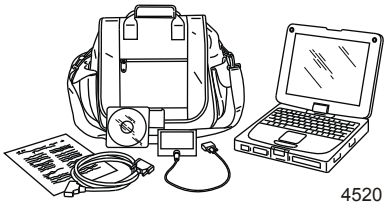
Special Tools

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

Specifications

Seawater Inlet Recommendations

Description	Specification
Minimum flow	106 L/min (28 gal/min) at 4000 RPM
Minimum pressure at full flow (If restrictions are present, the reading could be inaccurate.)	138 kPa (20 psi) at 4000 RPM

Closed-Cooling System Capacity

Description	Specification
Coolant volume in engine, heat exchanger, and exhaust manifolds	19.5 L (20.5 US qt)
Seawater volume in conduits and tube side of heat exchanger	4.3 L (4.5 US qt)

Coolant Specification

Description	Part Number
Extended Life Coolant 5/100 (orange color)	92-877770K1

Thermostat

Description	Specification
Thermostat operating temperature	77° C (170° F)

Pressure Cap

Description	Specification
Pressure cap rating	110 kPa (16 psi)

General Information

Description

The cooling system is composed of two separate subsystems: the seawater system and the closed-cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed-cooling system as it passes through the heat exchanger. The closed-cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into the recovery bottle is approximately 230 ml (7.8 fl oz) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. While there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

Within the heat exchanger, the coolant (antifreeze) flows around the outside of the cooling tubes, while seawater flows through the inside of the cooling tubes.

Full Loop Closed Cooling Systems

Full loop closed cooling systems use an ethylene glycol mixture to cool the engine and exhaust manifolds. The hot glycol mixture is circulated through the heat exchanger tubes, engine block, and exhaust manifold water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

All current production MerCruiser engines equipped with closed cooling kits use full loop systems.

Half Loop Closed Cooling Systems

Half loop closed cooling systems use an ethylene glycol mixture to cool the engine block. The hot glycol mixture is circulated through the heat exchanger tubes and engine block water jackets. Heat transfer occurs when cool raw water from the sea pump flows through the heat exchanger and is discharged into the exhaust stream at the exhaust elbows.

NOTE: *Refer to* ***Section 6D - Water Flow Diagrams*** *for full loop and half loop cooling system flow diagrams.*

Sterndrive Models with Closed Cooling

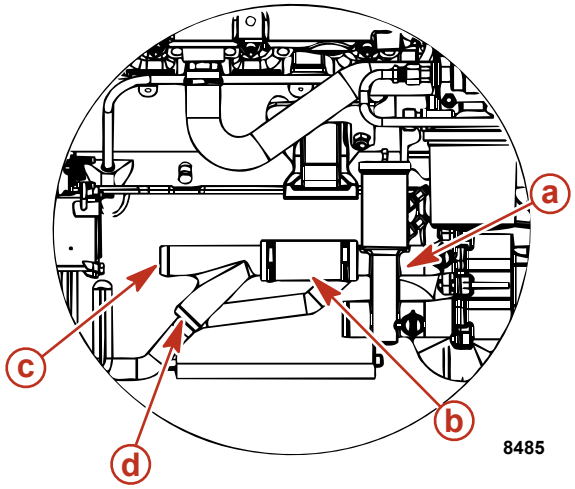
Alpha Models with Closed Cooling

Alpha sterndrive models with closed cooling are equipped with a seawater pump on the engine. However, a through-the-hull or through-the-transom seawater pickup is also required in order to meet the minimum flow specifications.

Bravo Models with Closed Cooling

NOTE: *Bravo models with closed cooling require a through-the-hull or through-the-transom pickup in addition to the sterndrive water inlets in order to meet the minimum flow specifications.*

When additional water inlets are used, a Y-fitting is installed into the engine seawater pump.



Dual seawater pickup for Bravo models with closed cooling

- **a -** Engine seawater pump
- **b -** 10 cm (4 in.) hose, from seawater pump inlet to Y-fitting port
- **c -** Y-fitting port to water inlet at transom
- **d -** Y-fitting port to through-the-hull or through-the-transom seawater pickup

Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere do not require the dual seawater pickup with a Bravo sterndrive on closed cooling models.

Remove the Y-fitting at the seawater pump inlet. Install a seawater supply hose that meets MerCruiser specifications. Cut the hose to fit from the transom inlet fitting to the seawater pump inlet.

SeaCore Models

Some SeaCore models do not require a through-the-hull or through-the-transom seawater pickup to meet the minimum flow specifications. Refer to **Seawater Pickups for SeaCore Sterndrive Engine Models**.

SeaCore Bravo One and Bravo Three Models

The SeaCore Bravo One and Bravo Three engine packages do not require a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive water pickups if:

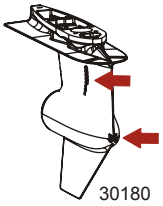
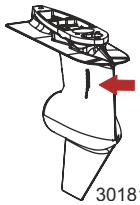
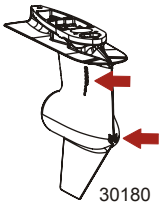
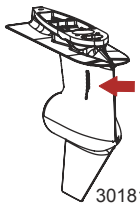
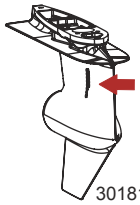
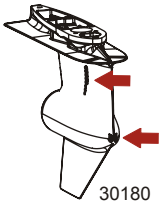
- The sterndrive gearcase has dual water pickups.
- The boat is capable of 64 km/h (40 mph) with the boat fully loaded and operated within the specified operating range.

NOTE: *If a through-the-hull or through-the-transom seawater pickup is not to be installed, refer to* ***Installing the Seawater Supply Hose****.*

SeaCore Bravo Two Models

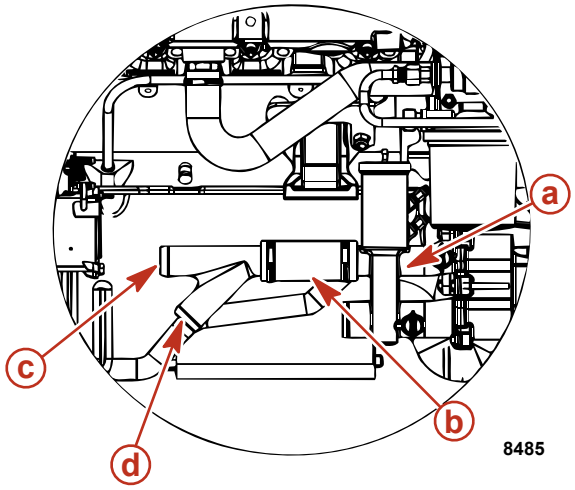
The SeaCore Bravo Two engine packages must have a through-the-hull or through-the-transom seawater pickup in addition to the sterndrive side water pickups. Install the Y-fitting at the engine's seawater pump inlet. Refer to **Installing the Y-Fitting**.

Seawater Pickups for SeaCore Sterndrive Engine Models

Boat speed with the boat fully loaded and operated within the specified operating range	SeaCore Bravo has side water pickup	SeaCore Bravo has dual water pickup	Through-the-hull or through-the-transom seawater pickup
64 km/h (40 mph) or greater			Not required. Refer to **Installing the Seawater Supply Hose**
Less than 64 km/h (40 mph)			Required. Refer to **Installing the Y-Fitting**
64 km/h (40 mph) or greater			Required. Refer to **Installing the Y-Fitting**
Any speed - Models operated above the 50th parallel of the Northern Hemisphere or below the 50th parallel of the Southern Hemisphere.			Not required. Refer to **Installing the Seawater Supply Hose**

Installing the Y-Fitting

Engine models that require a through-the-hull or through-the-transom seawater pickup require a Y-fitting at the engine seawater pump inlet port. The Y-fitting directs the seawater from the sterndrive and through-the-hull or through-the-transom seawater pickup to the engine's seawater pump to meet the minimum flow specifications.



Typical Y-fitting installation

- **a -** Engine seawater pump
- **b -** 10 cm (4 in.) Hose, from seawater pump inlet to Y-fitting port
- **c -** Y-fitting port to water inlet at transom
- **d -** Y-fitting port to through-the-hull or through-the-transom seawater pickup

NOTE: *For models not factory equipped with a Y-fitting, refer to* ***Mercury Parts Catalog, Closed-Cooling Systems (Bravo)*** *to order the specified Y-fitting, seawater supply bulk hose, and hose clamps that meet MerCruiser specifications.*

1. Cut a 10 cm (4 in.) piece of the supply hose and connect it to the seawater pump inlet and the Y-fitting port.
2. Install a seawater supply hose onto the Y-fitting port and the sterndrive's water inlet at the transom. Cut off any excess hose.
3. Install a seawater supply hose onto the Y-fitting port and the through-the-hull or through-the-transom seawater pickup. Cut off any excess hose.
4. Properly secure all hoses to all fittings to prevent water leaking into the boat.

Installing the Seawater Supply Hose

For engine models not using a through-the-hull or through-the-transom seawater pickup:

1. If applicable, remove the Y-fitting at the seawater pump inlet.
2. Install a seawater supply hose that meets MerCruiser specifications to the engine's seawater pump inlet.
3. Route the seawater supply hose directly to the seawater inlet fitting on the transom. Cut off any excess hose.
4. Properly secure the hose at both ends to prevent water leaking into the boat.

NOTE: *For models not factory equipped with a seawater supply hose, refer to the* ***Mercury Parts Catalog, Standard-Cooling Systems (Bravo)*** *to order the specified bulk hose, hose clamps, and quick-connect fittings that meet MerCruiser specifications.*

NOTE: *For models with quick-connection fittings, refer to* ***Bravo Seawater Inlet Fitting Connection*** *in* ***Section 2B****.*

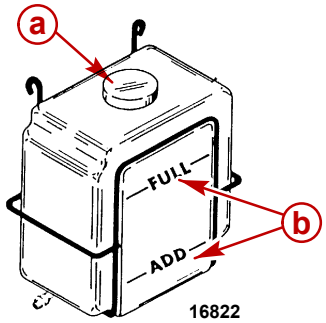
Coolant

Coolant Recommendations

IMPORTANT: Alcohol-based or Methanol-based antifreeze or plain water are not recommended for use in the closed-cooling section of the cooling system at any time.

NOTE: *All factory installed closed-cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any top-off fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.*
In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



Coolant recovery bottle
a - Cap
b - "ADD" and "FULL" marks

1. Before starting the engine, ensure that coolant is visible in the coolant recovery bottle.
2. If coolant is not visible:
   a. Check the closed-cooling system (including the coolant recovery system) for leaks.
   b. Make any necessary repairs.
   c. Refill the system with the recommended coolant solution.
3. If coolant is visible:
   a. Start the engine and operate it until it reaches its normal operating temperature.
   b. Check the coolant level in the coolant recovery bottle. The coolant level must be between the "ADD" and "FULL" marks on the front of the bottle.
   c. If the coolant level is low, remove the fill cap from the coolant recovery bottle and add the required amount of coolant solution. Refer to **Coolant Recommendations**.

⚠ 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.

4. Occasionally, ensure that the coolant recovery system is functioning properly by removing the pressure cap from the heat exchanger and checking the level. The coolant level should be up to the bottom of the heat exchanger filler neck. If it is low, examine the entire closed-cooling section (especially the coolant recovery system) for leaks, and make any necessary repairs.
   IMPORTANT: When reinstalling the pressure cap, tighten it until it contacts the stops on the filler neck.

Pressure Cap Maintenance and Testing

IMPORTANT: Replace the pressure cap if the engine overheats.

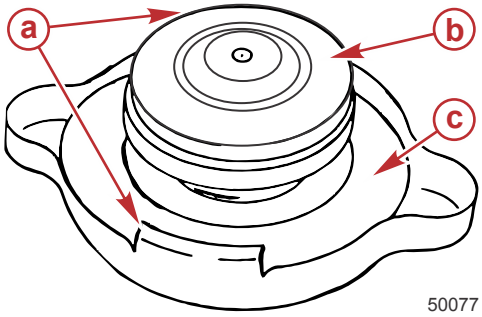
The pressure cap is designed to maintain a pressure of approximately its rated capacity once the engine has attained operating temperature. The cap should be cleaned, inspected, and pressure-tested at regular intervals or whenever the cap is suspected of not maintaining the proper pressure.

⚠ 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.

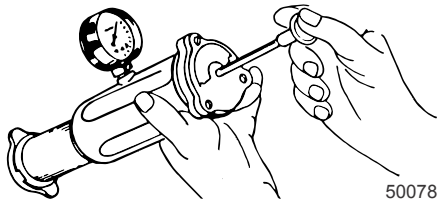
1. Carefully remove the pressure cap from the reservoir or the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the gasket (if equipped) and the rubber seal on the cap for tears, cuts, cracks, or other signs of deterioration. Replace the gasket, if damaged.
4. Replace the cap if the rubber seal is damaged.

5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.

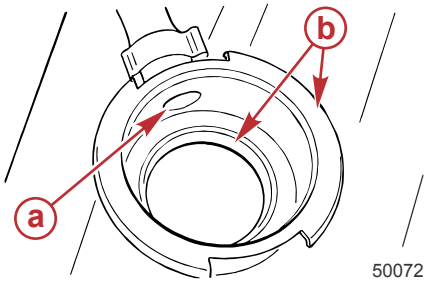


a - Locking tabs (one not shown)
b - Rubber seal
c - Gasket

6. Using a cooling system pressure tester, test the cap to ensure that it releases at the proper pressure and does not leak. Refer to the tester instructions. The cap must relieve pressure at 110 kPa (16 psi) and must hold the rated pressure for 30 seconds without going below 75.8 kPa (11 psi). Replace the cap if it fails to fall within these limits.



IMPORTANT: Before installing the cap, examine the lower inside sealing surface in the filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the cam lock flanges on the sides of the filler neck to ensure that they are not bent.



a - Coolant recovery passage
b - Sealing surfaces

7. Install the cap on the reservoir or the heat exchanger.

Testing the Closed-Cooling System

Testing Coolant for Alkalinity

⚠ CAUTION

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

The coolant should be changed per the maintenance schedule (refer to **Section 1C - Maintenance**) and should be checked for alkalinity at least once between change intervals. To check the coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local source.
2. Allow the engine to cool, remove the pressure cap from the heat exchanger, and insert one end of the litmus paper into the coolant.
3. If the pink litmus paper turns blue, the coolant is alkaline and does not need to be replaced.
4. If the pink litmus paper remains pink, the coolant is not alkaline and must be replaced. Refer to **Changing Coolant**.

Pressure Testing the 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.

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

1. Remove the pressure cap from the heat exchanger or the reservoir.
2. Clean, inspect, and pressure test the pressure cap.
3. Clean the inside of the filler neck to remove any deposits or debris.
4. Examine the lower inside sealing surface for damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the cap.
5. Ensure that the locking cams on the sides of the filler neck are not bent or damaged.
6. Adjust the coolant level to 25 mm (1 in.) below the filler neck.
7. Attach an automotive-type cooling system pressure tester to the filler neck and pressurize the closed-cooling section to amount specified.

Pressure Cap Rating	Amount of Pressure Applied to Closed-Cooling System
110 kPa (16 psi)	138 kPa (20 psi)

8. Observe the gauge reading for approximately two minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until leakage is found.
9. While maintaining the specified pressure on the closed-cooling section, inspect the external portion of the cooling system (for example, hoses, gaskets, drain plugs, petcocks, core plugs, and circulating pump seal) for leakage. Also listen closely for bubbling or hissing.
10. Test the heat exchanger.

Seawater Pressure Test

IMPORTANT: This test applies only to models with closed cooling.
IMPORTANT: The boat must be in the water for this test.

1. Connect the computer diagnostic system (CDS).

Computer Diagnostic System (CDS)	Bosch Automotive Service Solutions

2. Start the engine. When the engine is at normal operating temperature, shift into forward gear.
3. Advance the throttle to 4000 RPM.
4. Check the seawater pressure with CDS. If the seawater pressure does not meet specification, further testing is required.

Description	Specification
Minimum pressure (models with closed cooling)	138 kPa (20 psi) at 4000 RPM

5. If no leakage could be found in the above steps, the engine is leaking internally. Leaking may be caused by one or more of the following:
   - Loose cylinder head bolts or damaged gasket
   - Loose intake manifold bolts or damaged gasket
   - Loose exhaust elbow or distribution block retaining nuts or damaged gasket
   - Cracked or porous cylinder head or block
   - Cracked or porous exhaust manifold
6. Proceed as follows until the location of the internal leak is found.
   a. Start the engine.
   b. Pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, the compression or the combustion is leaking into the closed-cooling section from a leak in the combustion chamber.
   c. Stop the engine.
   d. Remove the spark plugs, examining each for the presence of coolant. A spark plug that is perfectly clean or has a milky appearance is an indication of an internal leak.
   e. Drain the oil from the engine and examine it for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove the engine from the boat and remove the oil pan. With the engine in the upright position, repressurize the closed-cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.
   f. If no leakage can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Testing for a Cylinder Head Gasket Leak

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 check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

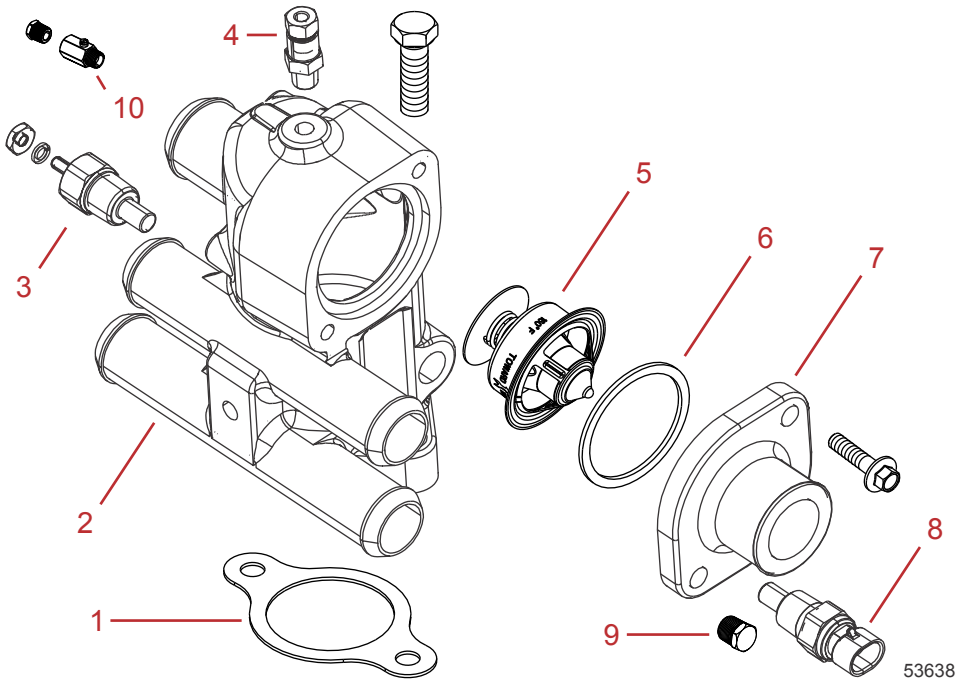
IMPORTANT: Operate the boat in the water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and the coolant recovery bottle. Use a 91 cm (3 ft) long hose for this test.
2. Route this hose so that a "U" is formed.
3. Put enough coolant into the hose to fill the center 127 mm (5 in.) of the U-shape.
4. Observe the U-shape while the engine is operating.
   - **During idle and warm-up:** Some coolant and air will leave the reservoir.
   - **At cruising speed (2500-3500 RPM):** Coolant and air leaving the reservoir should stop after approximately five minutes operating at a given RPM. A leaking head gasket will produce air bubbling through the U-shape, going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
   - **At higher speeds (4000+ RPM):** Normal operation is the same as described above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given RPM. A head gasket leak will not stop; the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Thermostat

Thermostat Housing—Exploded View



1 - Gasket
2 - Thermostat housing
3 - Temperature sender
4 - Air vent
5 - Thermostat
6 - Thermostat seal
7 - Thermostat housing cover
8 - Temperature sensor
9 - Plug
10 - Valve for water heater (TKS models)

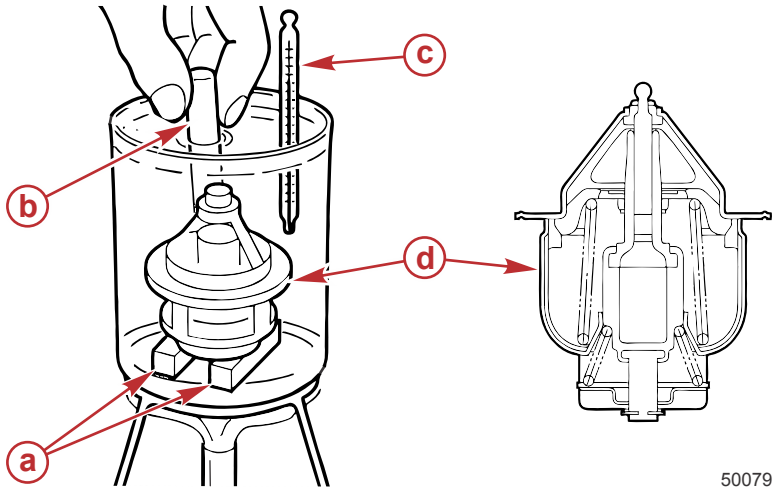
Thermostat Removal

Refer to the exploded view.

1. Drain the coolant from the engine.
2. Disconnect the hose from the thermostat housing cover.
3. Remove the thermostat housing cover bolts, the cover, and the seal.
4. Remove the thermostat from the thermostat housing.

Thermostat Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Add water to the container until it covers the thermostat.
4. Heat the water.
5. Stir the water constantly to avoid applying direct heat to the thermostat.



a - Wooden blocks
b - Stirring rod
c - Thermometer
d - Thermostat

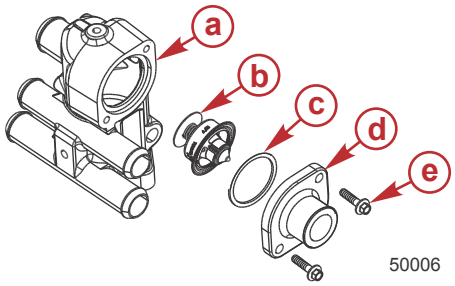
6. Observe the thermostat and check the temperature when the thermostat fully opens. If the temperature is not within specifications, then replace the thermostat.

Thermostat Installation

1. Remove the thermostat housing and the gaskets. Discard the gaskets.
2. Clean the gasket surfaces on the thermostat cover, the thermostat housing, and the intake manifold.
3. Position the gasket on the intake manifold. Place the thermostat housing on the gasket.
4. Tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake screw	33		24

5. Install the seal onto the thermostat flange.
6. Install the thermostat into the thermostat housing.
7. Install the thermostat cover. Tighten the screws to specification.



a - Thermostat housing
b - Thermostat
c - Thermostat housing seal
d - Thermostat housing cover
e - Thermostat housing cover screw (2)

Description	Nm	lb-in.	lb-ft
Thermostat cover screw	30		22

8. Connect the hoses. Tighten the hose clamps securely.
9. Supply cooling water, start the engine, and inspect for leaks.

Changing Coolant

Closed-Cooling Section

The engine and exhaust sections of a closed-cooling system should remain filled year-round with the recommended coolant solution. Do not drain the closed-cooling section for storage, as this will promote rusting of internal surfaces. If the engine will be exposed to freezing temperatures, fill the closed-cooling section with Extended Life Coolant or an ethylene glycol antifreeze and water solution. Follow the manufacturer's recommended proportions to protect the engine to the lowest temperature to which it will be exposed. If necessary, change the coolant using the coolant specified in **Coolant Recommendations**.

Change Intervals

If the closed-cooling system is factory installed, drain and flush the coolant from the closed-cooling system at least every five years or 1000 hours of operation, whichever comes first. Change the coolant whenever exhaust gases have entered the system. If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

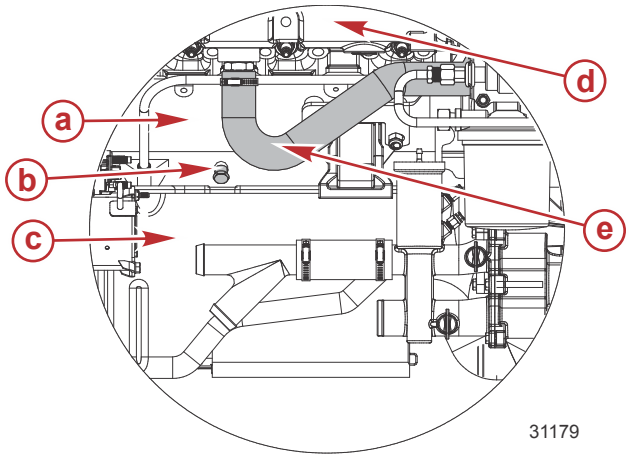
Draining

⚠ CAUTION

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

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with a two-piece petcock, removal of the petcock may be required so that wire can be inserted completely into the drain hole.
IMPORTANT: The engine must be as level as possible to ensure the complete draining of the cooling system.
IMPORTANT: The closed-cooling section must be kept filled year-round with recommended coolant. If the engine will be exposed to freezing temperatures, ensure that the closed-cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

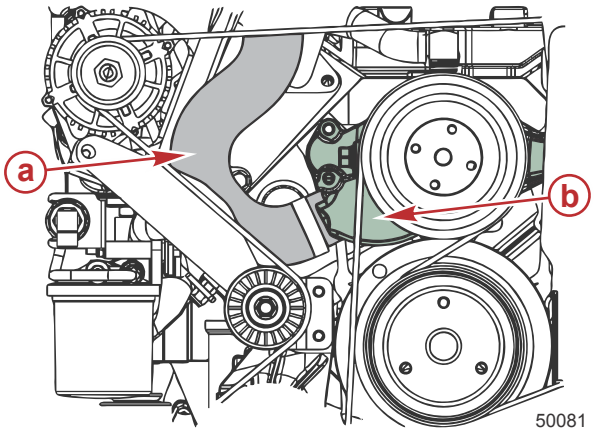
1. Remove the pressure cap from the coolant tank.
2. On the port and starboard sides of the engine block, remove the block pipe plugs. Drain the coolant into a proper container.
3. On the port and starboard sides of the engine block, remove the coolant hoses from the bottom of the exhaust manifolds. Drain the coolant into a proper container.



Port and starboard side similar

- **a -** Engine block
- **b -** Engine block drain plug
- **c -** Oil pan
- **d -** Exhaust manifold
- **e -** Exhaust manifold coolant hose

4. Remove the hose from the heat exchanger to the water circulating pump at the pump connection. Drain the coolant into a proper container.



a - Hose from heat exchanger to water circulating pump
b - Water circulating pump

5. After the coolant has drained completely, reinstall the block pipe plug and hoses. Securely tighten the clamps.
6. Remove the coolant recovery bottle from the mounting bracket and drain the coolant into a proper container.

Cleaning the Cooling System

Closed-Cooling Section

Clean the closed-cooling section at least once every five years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale, or other foreign material. Always follow the manufacturer's instructions for the cleaner.

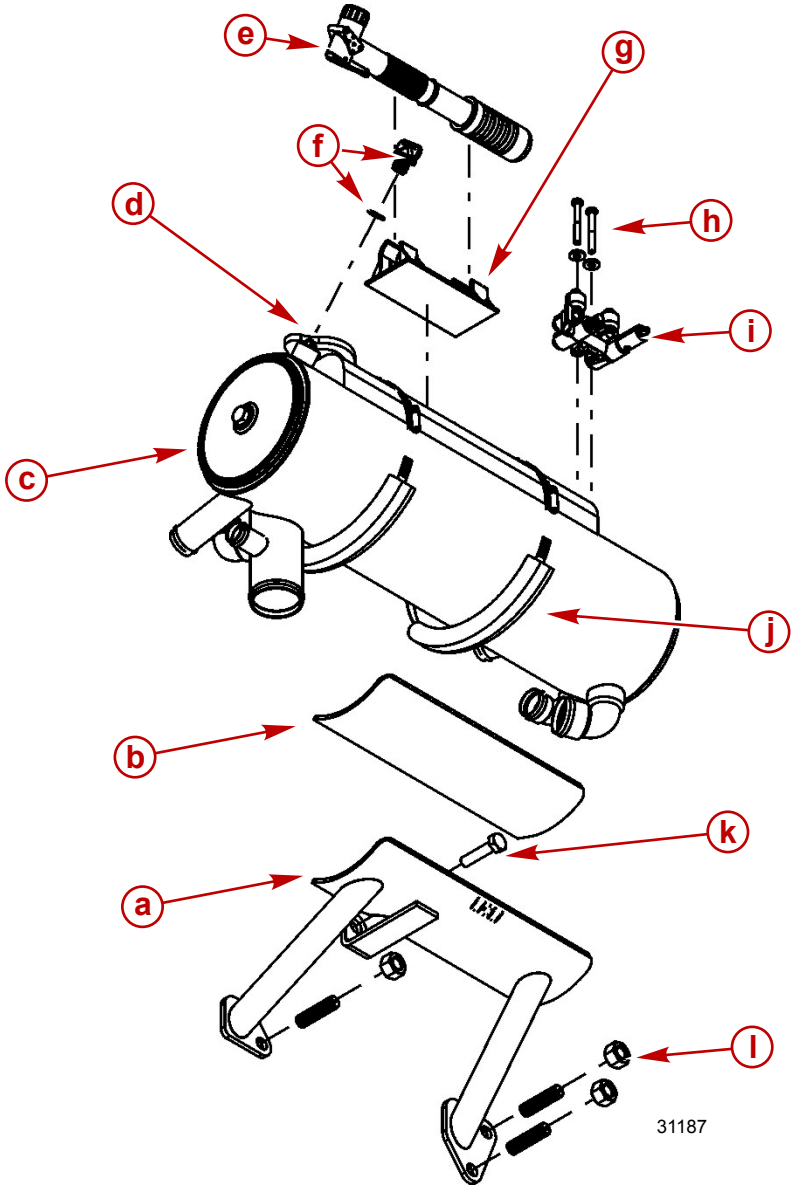
If the closed-cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in the opposite direction of the normal coolant flow to allow water to get behind deposits and force them out. Refer to the instructions that accompany the flushing device for the proper hookup and flushing procedure.

Seawater Section

The cooling efficiency of an engine with closed cooling is dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, or lime) collect on the inside of the tubes, reducing heat transfer and reducing the efficiency of the heat exchanger. It is recommended that the seawater section of the heat exchanger be cleaned as specified or whenever decreased cooling efficiency is suspected. Refer to **Heat Exchanger Assembly**.

Heat Exchanger Assembly

Heat Exchanger Assembly—Exploded View



- **a -** Heat exchanger bracket
- **b -** Heat exchanger bracket pad
- **c -** Heat exchanger
- **d -** Heat exchanger cap
- **e -** Air pump
- **f -** Air vent plug and O-ring
- **g -** Air pump bracket (later style)
- **h -** Air manifold screws and washers (2)
- **i -** Air manifold
- **j -** Heat exchanger to heat exchanger bracket clamp assembly (2)
- **k -** Heat exchanger bracket bolt
- **l -** Heat exchanger bracket locknuts (3)

Testing—Internal Leaks

An internal leak will allow coolant to enter into the seawater circuit when the closed-cooling circuit is pressurized.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed-cooling circuit to 110-138 kPa (16-20 psi) with a radiator tester.
3. If seawater begins to flow from the seawater hose fitting of the heat exchanger, there is a leak.

Blockage

IMPORTANT: Seawater flows through the tubes in the exchanger. Coolant/antifreeze flows around the tubes.

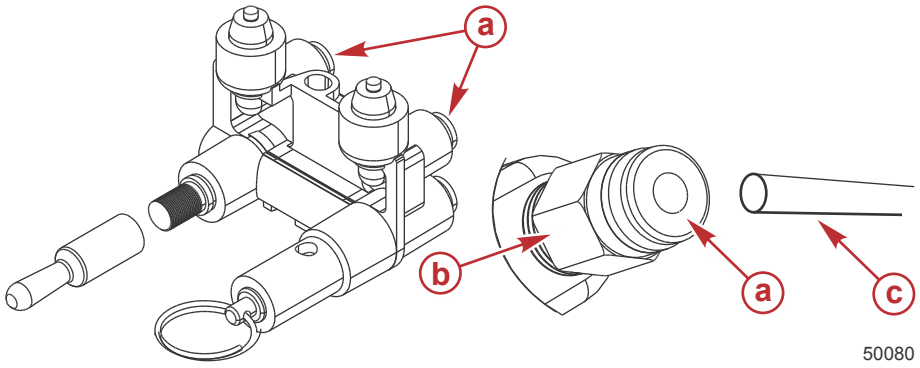
1. Remove the end caps and inspect for any blockage in the seawater circuit, such as broken impeller blades or weeds.
2. Remove the closed-cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Removal

NOTE: *The heat exchanger does not have to be removed for cleaning.*

1. Allow the engine to cool.

2. Drain the seawater from the engine.
3. Drain the coolant from the engine.
4. If applicable, remove each air line from the air manifold by pressing on the fitting and pulling the line out.



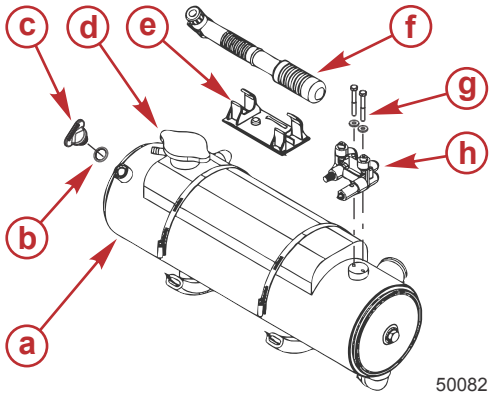
a - Release location
b - Air line fitting
c - Air line

5. Remove the hoses from the heat exchanger.
6. Remove the two large hose clamps fastening the heat exchanger to the engine.
7. Remove the heat exchanger.

Disassembly

IMPORTANT: Do not remove the air pump and air pump bracket if they are mounted to the engine compartment.

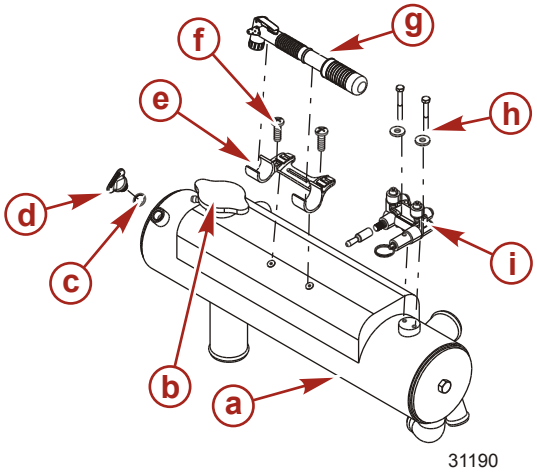
1. Remove the air pump from the air pump bracket.
2. If the air pump bracket is secured with adhesive, do not remove the bracket.



Mounted on top of heat exchanger and secured with adhesive

a - Heat exchanger
b - O-ring
c - Air vent plug
d - Heat exchanger cap
e - Air pump bracket (later style)
f - Air pump
g - Air manifold screws and washers
h - Air manifold

3. If the air pump bracket is secured by screws, remove the air pump bracket.

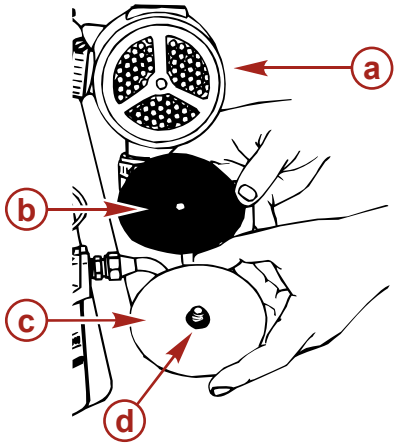


Mounted on front edge of heat exchanger and secured with screws

a - Heat exchanger
b - Heat exchanger cap
c - O-ring
d - Air vent plug
e - Air pump bracket (early style)
f - Air pump bracket screws
g - Air pump
h - Air manifold screws and washers
i - Air manifold

4. Remove the air manifold.

5. Remove the screws attaching the end cap to the heat exchanger.
6. Remove the end caps and gaskets.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - Sealing washer

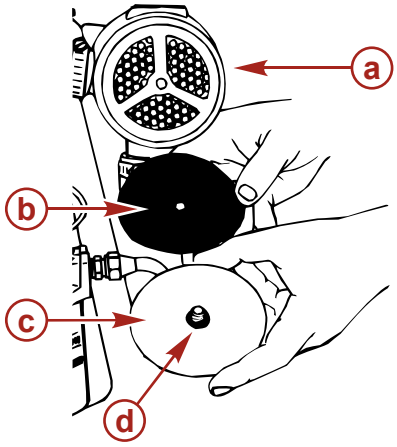
Cleaning and Inspection

1. Clean the old gasket material and sealant from the surfaces. Do not nick or gouge the surfaces.
2. Use a long rod and wire brush to clean out heat exchanger tubes.
3. Inspect each part for cracks or other damage. Replace as necessary.
4. Clean and paint the exterior surfaces as required to prevent corrosion.

Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Do not melt the other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in the cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.



6747

a - Heat exchanger
b - Gasket
c - End cap
d - Sealing washer

Description	Nm	lb-in.	lb-ft
Heat exchanger end cap screw	6	54	

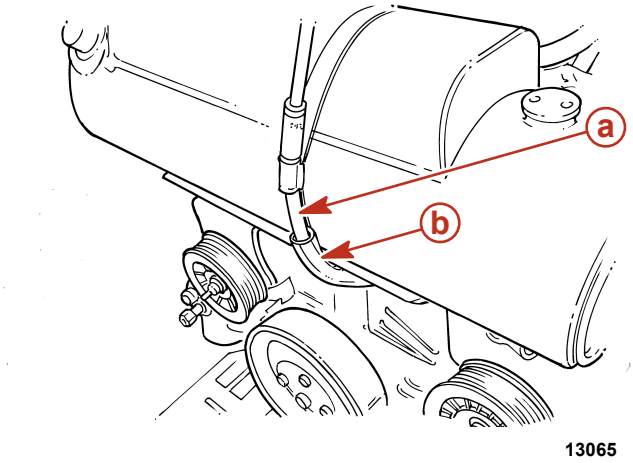
3. If applicable, fasten the air pump bracket to the heat exchanger. Tighten the screws securely.
4. Fasten the air manifold to the heat exchanger. Tighten the screws to specification.

Description	Nm	lb-in.	lb-ft
Air manifold screws	3	27	

Installation

1. Lower the heat exchanger onto the bracket and simultaneously attach the water hoses.
2. Ensure that all hose ends are aligned and fully seated on the heat exchanger fittings. Tighten all hose clamps securely.

3. Install the large hose clamps around the heat exchanger bracket and heat exchanger. Position the rubber hoses underneath the bracket to prevent the bracket from directly contacting the hose clamps and breaking them.



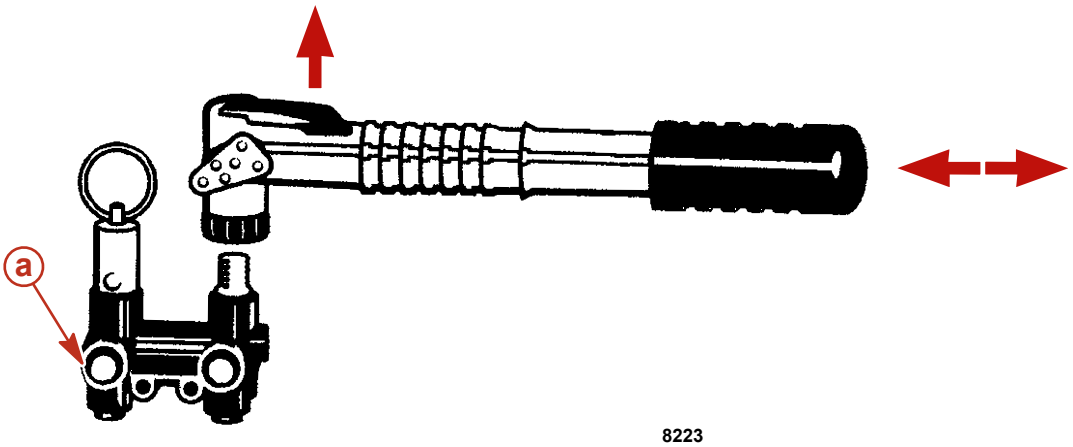
13065

a - Hose clamp
b - Rubber hose

4. Tighten the hose clamps to specification.

Description	Nm	lb-in.	lb-ft
Hose clamps around heat exchanger and bracket	3	26	

5. Connect the air lines to the air manifold by inserting the line into the fitting until a positive stop is encountered.
6. Ensure that the air lines are installed properly.
   a. Attach the air pump to the fitting on the air manifold.



8223

a - Green indicators

   b. Pull up on the air pump lever (vertical) to lock the pump onto the fitting.
   c. Pump air into the system until both green indicators extend. If the green indicators do not extend, the air lines are not attached properly.
7. Fill the closed-cooling system with the specified coolant.