

# DuraCooler® Keel Cooler

- ▷ Streamlined Header Design for Improved Efficiency
- ▷ One Piece 90/10 Copper-Nickel Construction
- ▷ Superior Heat Transfer



INSTALLATION INSTRUCTIONS FOR:

- ▷ Flange-Mount DuraCooler
- ▷ Through-Hull DuraCooler

## Installation Manual

Duramax Marine® is an ISO 9001:2015 Certified Company

**DURAMAX MARINE®**



## Proper installation for optimal cooling efficiency

**CAUTION:** It is essential for you to carefully read all of the instructions contained in this manual in order for your Through-Hull or Flange-Mount DuraCooler® unit to operate properly.

### **Designed and built specifically for your vessel**

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The DuraCooler's® unique angled head design and copper-nickel construction provide highly efficient heat transfer, corrosion resistance and strength in all commercial marine operations. All DuraCoolers are custom designed and built to the specific operating conditions and specifications of your vessel.

### **Duramax Marine® keel cooler experts available for assistance**

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If you have any questions or need assistance at any stage of the project – from selection and installation to maintenance and troubleshooting – contact Duramax® heat transfer specialists.



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# Planning for Through-Hull and Flange-Mount Installation

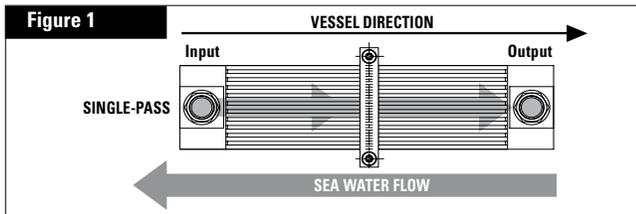
Before installing your DuraCooler® you need to determine the proper placement to assure optimal cooling efficiency.

## SELECTING THE PROPER LOCATION FOR YOUR DURACOOLER®

**DuraCoolers are designed to be mounted directly to the hull.**

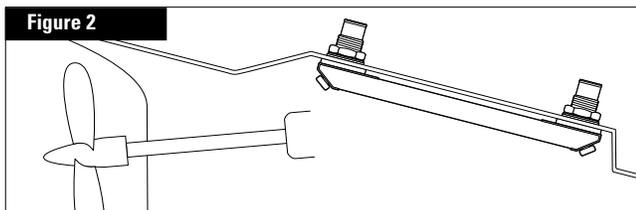
**A DuraCooler® should always be installed parallel to the skeg or keel.**

Specifications for cooling capacity are based on ambient water (seawater) flow along the entire length of the DuraCooler®. Installation where the DuraCooler® tubes are perpendicular to the water flow may cause overheating and should be avoided. A single-pass DuraCooler® should be positioned so the internal coolant flow direction is counter to the flow of the external sea water when the vessel is in forward motion. (See Figure 1)



## Efficient keel cooling depends on the continuous water flow over the DuraCooler®

The cooler's efficiency can be enhanced by mounting the DuraCooler® near the propeller, **but not directly above or in direct line of prop-wash**. Since air is an insulator, aerated ambient water will diminish cooling capacity. Mounting the DuraCooler® sufficiently below the water line will help avoid aerated ambient water. (See Figure 2)



Free circulation of ambient water over the DuraCooler® tubes is essential for proper operation. When operation occurs at zero knots, heat from the DuraCooler® is carried away via convection currents.

**On shallow draft river towboats** install the DuraCooler® on the side of the hull or beside the skeg.

**On work boats** mount the DuraCooler® near the propeller, but not directly above it. This allows you to take advantage of the vessel's slip-stream, especially during heavy towing.

**On faster moving vessels** the DuraCooler® can be recessed into the hull to reduce drag. DuraCoolers are not typically installed on hulls that exceed 20 knots.

**On planing hull vessels** install the DuraCooler® aft of midships in a recessed pocket

## IMPORTANT: VESSEL LOCATIONS TO AVOID

**Near any hot water discharges.** Always provide the coolest possible environment for your DuraCooler®.

**Where flex or severe vibration could occur.** Over time, vibrations can cause damage to the DuraCooler®.

**Directly below engine mounts.** This will cause unnecessary stress and vibration to the DuraCooler®.

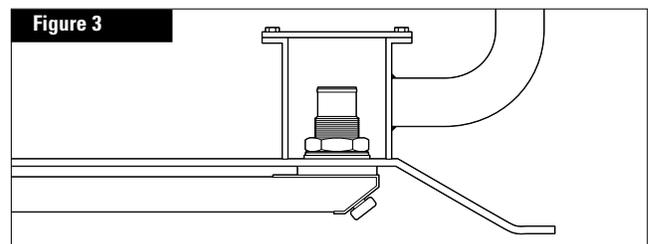
**Directly above any propeller.** This will also cause vibration and cavitation. Cavitated water will reduce the cooling effectiveness of the DuraCooler® directly in blast zone of propeller or Z-Drive.

## COFFERDAM CLASSIFICATION REQUIREMENTS

**Through-Hull DuraCoolers** may require installation of a cofferdam or sea chest to meet ABS® Coast Guard or other Classification Society requirements. This is to protect internal plumbing and prevent internal flooding if the Through-Hull DuraCooler® is damaged. Consult with the local ABS® or Coast Guard for installation specifications.

If a cofferdam is required make sure you have adequate clearance inside the hull for the plumbing. Side piping can be used for ease of installation and maintenance. (See Figure 3)

**Flange-Mount DuraCooler®** does not require a cofferdam since there is no through-hull penetration.



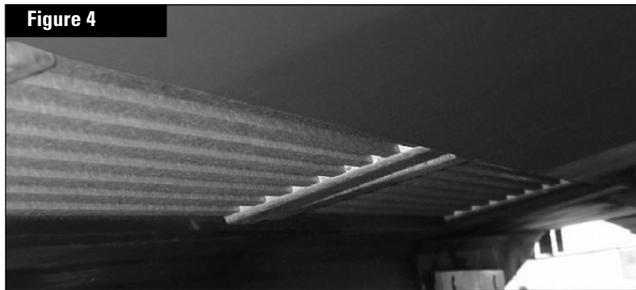
## USING MULTIPLE DURACOOLERS

Since DuraCoolers can be used to cool multiple circuits (such as jacket water and aftercooler water), there can be a DuraCooler® located in close proximity to another DuraCooler® with a different operating temperature.

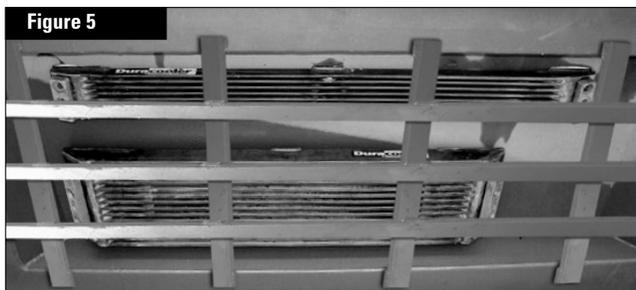
Locate low temperature DuraCoolers out of the escape path of external heat transmitted from high temperature DuraCoolers. Always locate the DuraCooler® with the lower operating temperature forward or lower relative to the water line of the other units.

## RECESSED DURACOOLERS

**For planing hulls and operating speeds equal to or greater than 12 knots.** Although mounting the DuraCooler® on the hull surface provides better heat transfer efficiency, all planing hulls and vessels operating at speeds equal to or greater than 12 knots require recessed mounting. The maximum recommended speed for using a DuraCooler® is 20 knots. (See Figure 4)



Recessing the DuraCooler® into the hull and covering it with bar grating provides protection to the unit from floating debris and mechanical damage from pounding seas. (See Figure 5)



Note: When constructing protective grating or grill, make sure to leave enough clearance to permit access to the anodes located on the DuraCooler® for periodic replacement.

There should be a minimum of 1.50 inches (38 mm) of clearance on all sides of the recessed DuraCooler® and the recess should be no deeper than 0.50 inch more than the cooler thickness (including the gaskets). The recess should be constructed so that the ends and top side are flared out from the unit on a 45-degree angle to aid sea-water flow. This will allow heated water to escape. (See Figure 6)



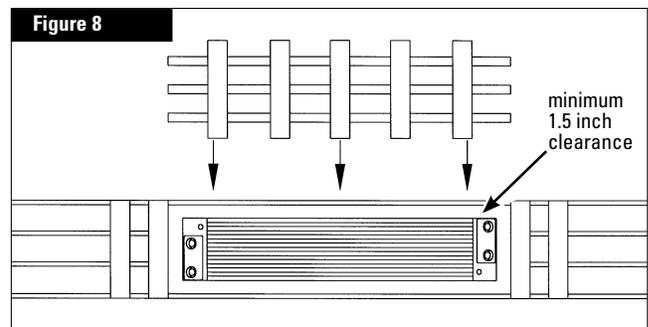
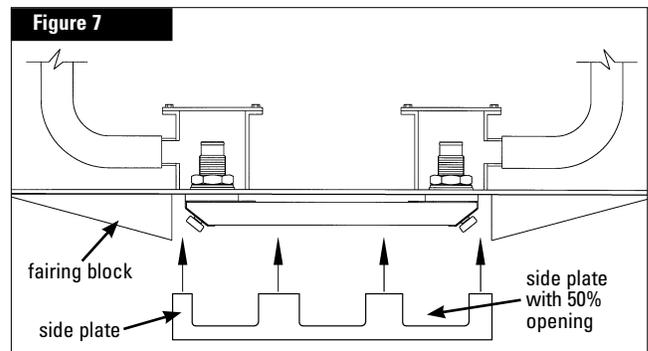
**For zero knot applications.** Do not recess the DuraCooler® on the bottom of a vessel unless the mounting surface inclines a minimum of 20° from forward to aft. Any protective shrouding around the DuraCooler® must be constructed to allow for free flow of convection currents and other flows.

## SURFACE-MOUNTED DURACOOLERS

**Proper protection is important.** If the DuraCooler® is to be surface-mounted, it should be properly protected using fairing blocks, side plates and a protective grill over the cooler. (See Figures 7 and 8)

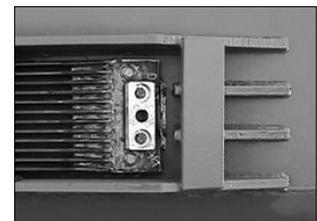
**Fairing blocks.** Fairing blocks with a slope not greater than 4 to 1 should be constructed of bar grating or solid plates with suitable spacing. (See Figure 7)

**Side plate holes.** Holes should be cut in the side plates to promote proper water flow across the DuraCooler®. Make openings in side plates as large as possible. A good target is to have 50% of the side plates opened. (See Figure 7) There should be a minimum of 1.50" clearance between side plates & DuraCooler® (See Figure 8)



**Bar Grating.** Any protective bar grating or grill should never block more than 25% of the area across the opening around the DuraCooler®. Doing so could reduce cooling efficiency and cause overheating. (See Figure 8)

Note: When constructing protective grating or grill, make sure to leave enough clearance to permit access to the anodes located on the DuraCooler® for periodic replacement.



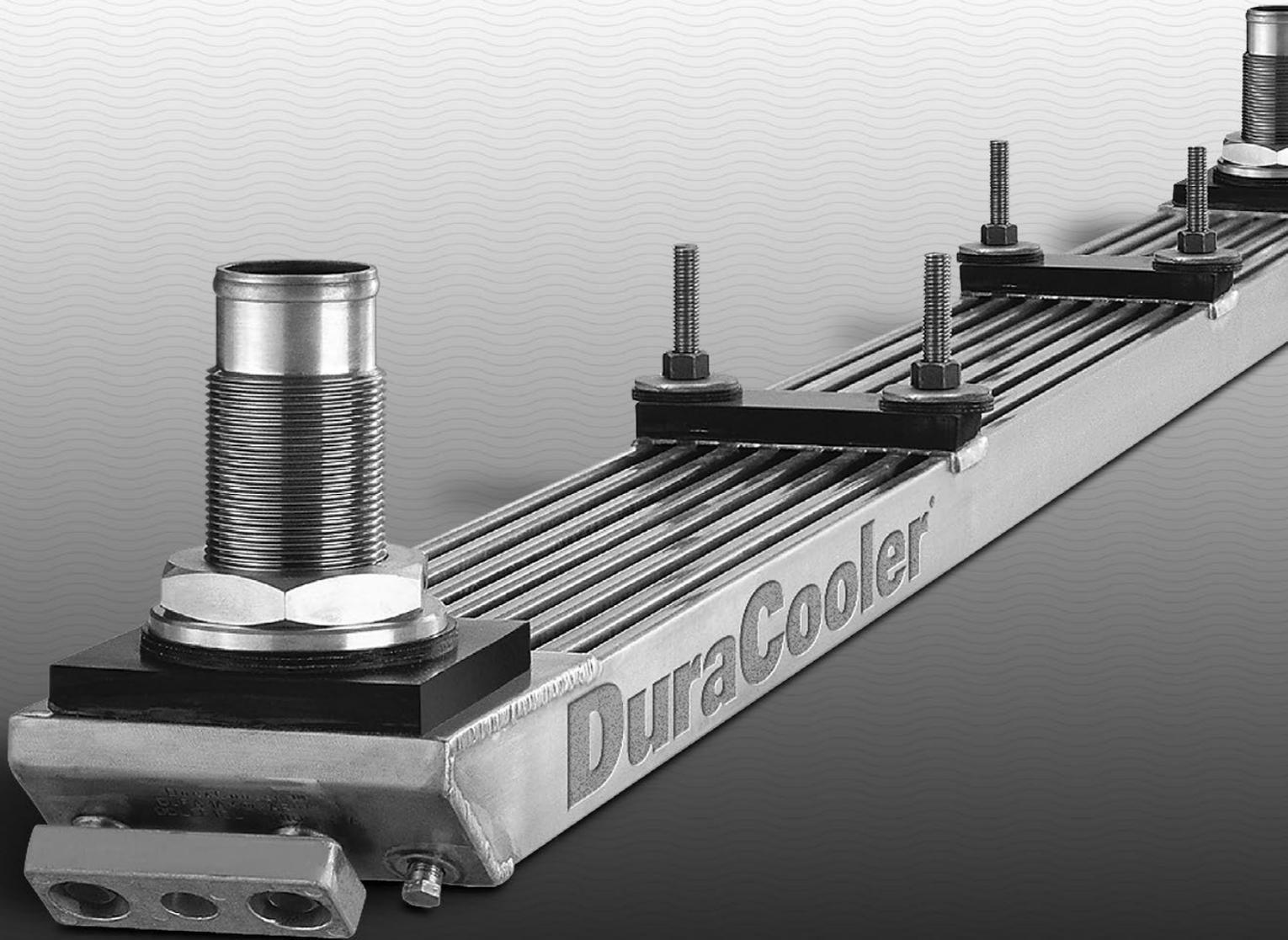
### IMPORTANT: VESSELS EQUIPPED WITH IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.

It is imperative you consult with the ICCP Manufacturer for the correct installation method to insure the DuraCooler is compatible with the total ship's protection system. Serious damage to the DuraCooler and vessel may occur if not properly installed.

## Installing your Through-Hull DuraCooler®

The sturdy one-piece construction of the cooler makes it quick and easy to install.

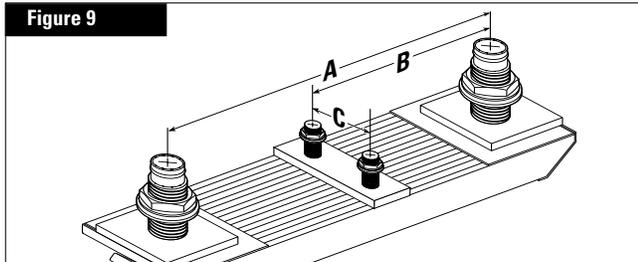
Before installing your Through-Hull DuraCooler®, you must select the appropriate hull location for your unit. Make sure you have read the DuraCooler® Planning Section located at the beginning of this guide.



## CUTTING NOZZLE HOLES IN HULL

### Mark nozzle hole locations on hull

Use the DuraCooler® or make a template to mark the hole locations on the hull. Measure the spacing of the inlet and outlet nozzles, and the distance to any support studs. (See Figure 9)



### Cut the inlet and outlet holes in hull

Cut the holes in the hull for the inlet and outlet nozzles 0.25 inch (6.4mm) larger than the nozzle diameter. After cutting holes, grind the edges of the holes smooth to allow the cooler's gaskets to lie flat on the surface of the hull which will help protect against galvanic corrosion.

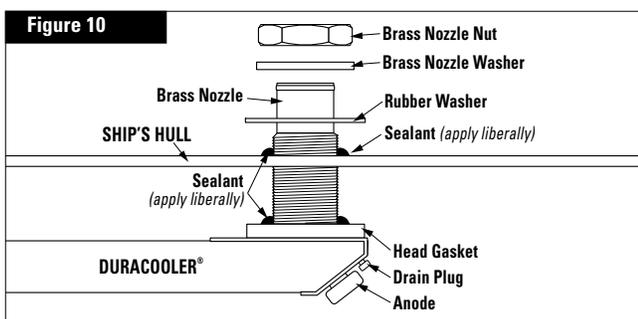
## DURACOOLER® ISOLATION

All DuraCoolers are supplied with components for installing cooler isolated from the ship's hull. However, Duramax Marine recommends that a corrosion expert be consulted to evaluate the protection scheme of the vessel and recommend whether the DuraCooler be installed isolated or grounded to ship's hull. This is necessary to insure the DuraCooler is compatible with the overall ship's protection system (whether impressed current or sacrificial anodes).

## NOZZLE ASSEMBLY

### Mounting gaskets minimize galvanic corrosion

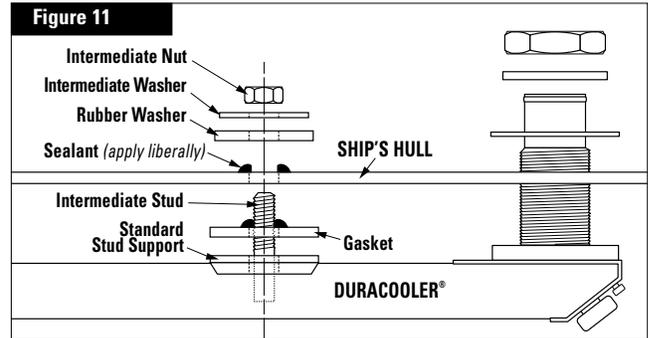
The DuraCooler® system is designed to isolate the cooler nozzle from the hull. All washers and gaskets furnished with system should be used for optimum corrosion protection. The rubber head gaskets should be installed between the DuraCooler® and the exterior of the hull. This will provide proper spacing from the hull and isolate the cooler nozzle. Install the round fabric reinforced rubber washers between the brass nozzle washers and the inside of the hull. (See Figure 10)



## SUPPORT MOUNTS

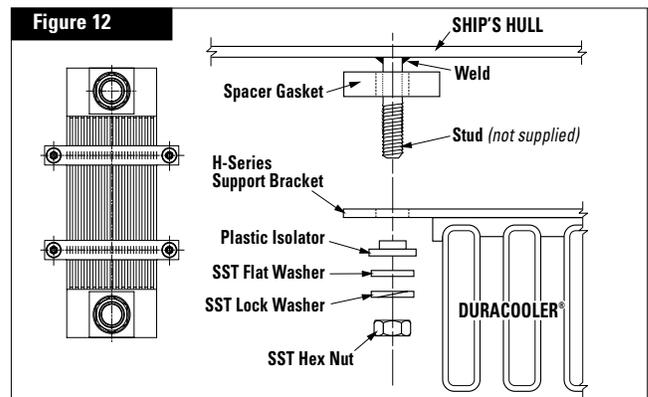
### Through-Hull support mounts (Standard)

When mounting your DuraCooler®, make sure you use the factory supplied rubber gaskets to separate the cooler from the hull, to assure isolation if required. (See Figure 11)



### H-Series support bracket (Optional)

To eliminate through-hull mounting studs, an H-Series mounting bracket can be supplied as an option. Studs or mounting blocks must be welded to the hull to mount the DuraCooler® (See Figure 12)



## IMPORTANT: SEALING ALL MOUNTING GASKETS

Use a liberal amount of polysulfide rubber sealant such as BoatLIFE® Caulk around mounting gaskets, washers, nuts on the DuraCooler® and hull penetrations to make a watertight seal between the hull and the DuraCooler®.

### Snug, but don't tighten

Assemble the parts and "snug" the fasteners enough to squeeze sealant out all the way around. The most common bedding error is fully tightening the fasteners while the sealant is soft. This squeezes out all of the sealant, leaving a dry joint that will soon leak. After the sealant has cured (follow sealant manufacturer instructions for cure times), verify all torque settings on the hardware. (See figures 10 & 11)

# Installing your Through-Hull DuraCooler® (continued)

## DO NOT OVER TIGHTEN THE HARDWARE

Recommended Torque Chart	THREAD DIAMETER	TORQUE RANGE	
	in	ft/lbs	N-m
<b>Nozzle Nuts</b>	3/4	50 - 60	68 - 81
	1 - 1 1/2	70 - 100	95 - 135
	2	125 - 150	170 - 203
	2 1/2 - 3 1/4	200 - 250	271 - 339
<b>Support Bracket Stud Nuts</b>	1/2 - 3/4	20 - 25	27 - 34

## VERIFYING DURACOOLER® ISOLATION

All DuraCoolers are supplied with components for installing cooler isolated from the ship's hull. However, Duramax Marine recommends that a corrosion expert be consulted to evaluate the protection scheme of the vessel and recommend whether the DuraCooler be installed isolated or grounded to ship's hull. This is necessary to insure the DuraCooler is compatible with the overall ship's protection system (whether impressed current or sacrificial anodes).

### Out of Water Readings

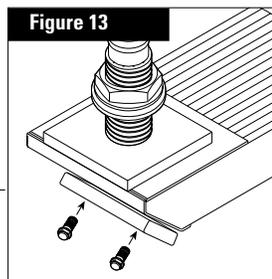
> 2500 ohms = Isolated

< 2500 ohms = Grounded

## ANODES

### Anodes minimize galvanic corrosion

All DuraCoolers are supplied with anodes. Use only the special bolts and washers provided by Duramax Marine® to attach the anodes to the streamlined headers of the DuraCooler®. These anodes provide short term protection to the DuraCooler®. Additional anodes may be required to provide adequate protection. Follow normal shipbuilding rules and consult a cathodic protection specialist (corrosion expert) for advice. (See Figure 13)

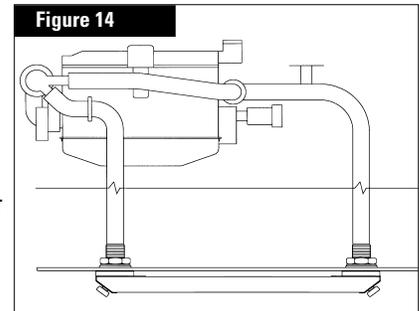


### Anode maintenance

Anodes must be replaced during the ship's regular maintenance to preserve the life of the DuraCooler®. Stray electrical currents can cause galvanic corrosion and rapidly deteriorate the DuraCooler® if anodes are not maintained. Replacement anode kits complete with mounting hardware can be obtained from Duramax Marine®.

## INTERNAL PLUMBING

- If you are retrofitting a DuraCooler® to a system that previously used an inboard heat exchanger, the DuraCooler® piping should bypass the heat exchanger and connect directly to the engine.
- Install self-venting piping between the DuraCooler® and the engine to eliminate air pockets in the cooling system.
- Do not use tubing or fittings that are smaller in diameter than those on the engine or the DuraCooler®. If the fittings on the engine are larger than the fittings on the DuraCooler®, reduce the piping at the DuraCooler®, not the engine.
- Use the fewest number of elbows to minimize pressure drop. (See Figure 14)



### Direct to engine piping

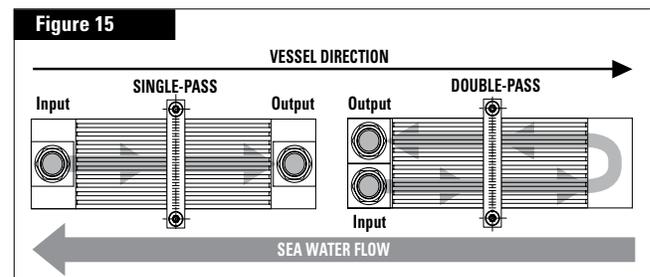
When connecting the engine piping directly to the DuraCooler® nozzle, use wire-reinforced rubber hoses. The reinforcement will prevent hose collapse and interruption of water flow to the DuraCooler®. The connection hoses will help isolate the DuraCooler® from engine vibration.

### Bottom hull installation

A single-pass DuraCooler® should be positioned so the internal coolant flow direction is counter to the normal flow of the external sea water when the vessel is in forward motion. A double-pass type DuraCooler® should be installed with the inlet and outlet at the high end relative to the water line to prevent air entrapment. (See Figure 15)

### Side hull installation

Connect the inlet plumbing to the lowest connection point on the DuraCooler® to minimize air entrapment. (See Figure 15)



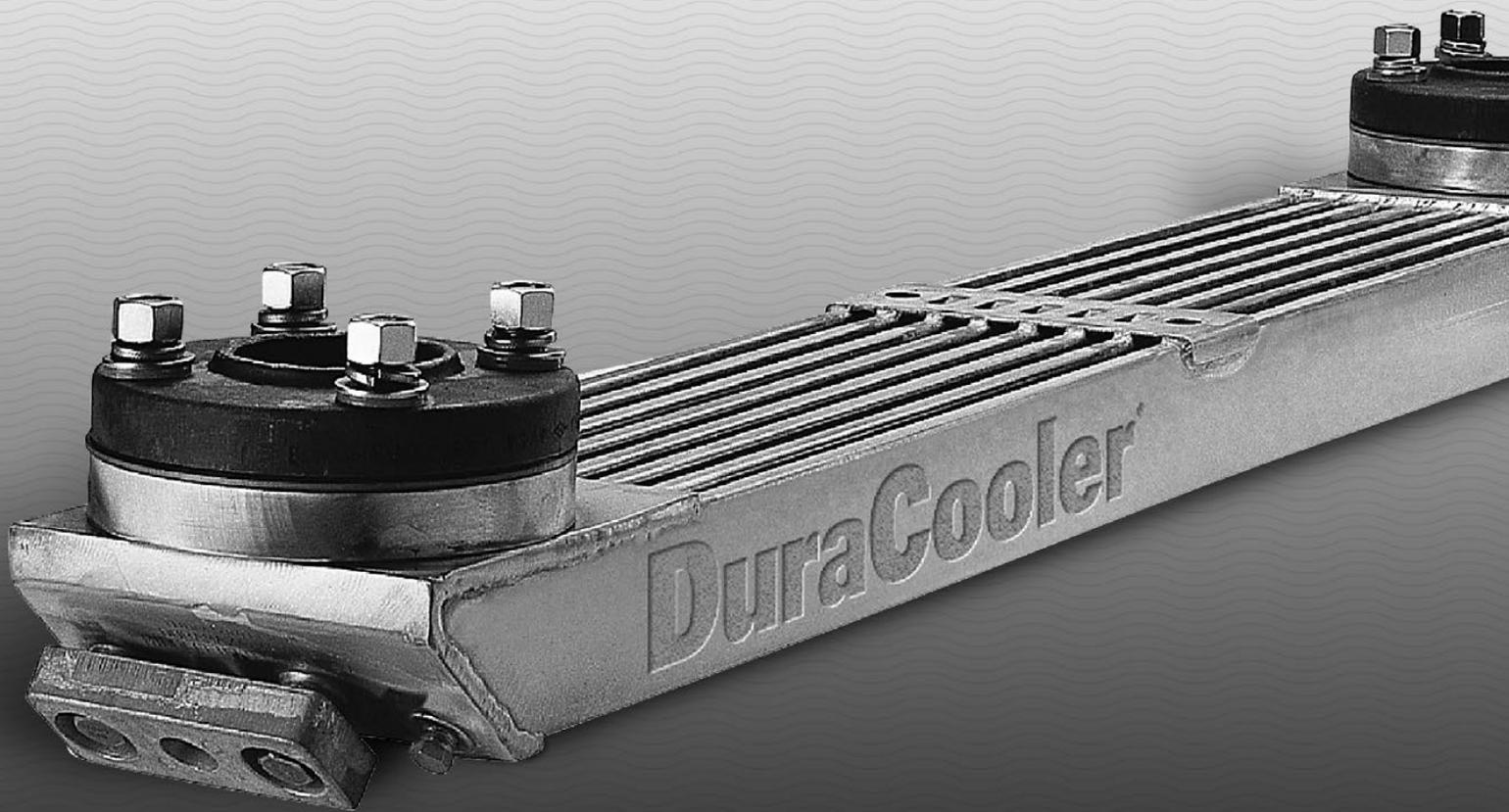
**IMPORTANT:** The condition of the DuraCooler®, anodes, and the surrounding area of the hull should be periodically checked during the first months of the ship's operation. If there appears to be galvanic corrosion, contact a cathodic protection specialist (corrosion expert) for advice.



## Installing your Flange-Mount DuraCooler®

The sturdy one-piece construction of the cooler makes it quick and easy to install.

Before installing your Flange-Mount DuraCooler®, you must select the appropriate hull location for your unit. Make sure you have read the DuraCooler® Planning Section located at the beginning of the installation manual.



## POSITIONING DURACOOLER® ON HULL

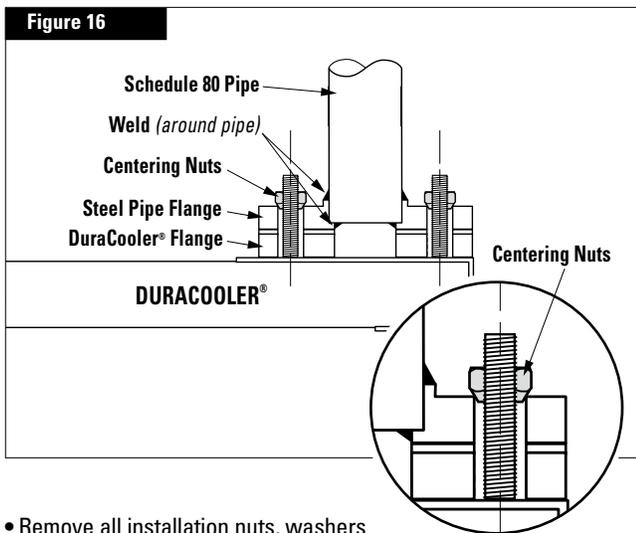
### Welding pipe to steel pipe flange

A Schedule 80 pipe should be welded to the steel pipe flange furnished with the cooler. The pipe length should be long enough to create enough clearance "space" to install the nuts between hull and stud ends that extend through the flange. The pipe length should not be too long as this will weaken the connection between the pipe and hull.

### Centering nuts for alignment of pipe in steel flange

Since holes in the steel flange are slightly larger than the diameter of the studs, you will need to center the studs in the steel flange holes before you weld the pipe to the flange.

For optimum alignment of the flange bolt patterns, use the tapered centering nuts supplied with your DuraCooler. (See Figure 16)



- Remove all installation nuts, washers and isolators (if on stud), and steel pipe flange from studs.
- Weld the Schedule 80 pipe to the steel flange, supplied with the DuraCooler.
- Attach steel flange to the copper-nickel flange using the centering nuts. This will center the studs perfectly in the steel flange.
- The pipe and flanges are now precisely aligned to each other.

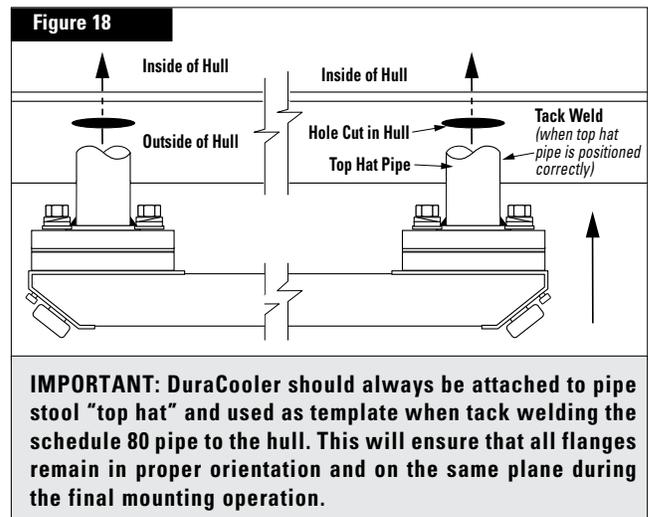
### Cut piping holes in hull

- Reposition the steel flange and pipe on the copper-nickel flange studs using the centering nuts.
- Position the DuraCooler® against the hull or create a template to accurately scribe the hole locations. (See Figure 17)
- Mark the locations where holes are to be cut.
- Remove the DuraCooler® or template
- Cut both inlet and outlet nozzle holes for piping.

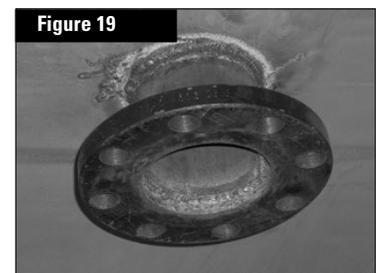


### Attach Schedule 80 pipe and steel flange to hull

- With Schedule 80 pipe and steel flange still attached (with centering nuts) on DuraCooler, position pipe into the holes in the hull. (See Figure 18)



- Tack weld inlet and outlet Schedule 80 pipes. (Protect DuraCooler® while welding.)
- Unbolt and remove the DuraCooler.
- Fillet weld pipe in place both inside & outside hull (See Figure 19)
- Centering nuts will no longer be needed and can be discarded.



# Installing your Flange-Mount DuraCooler® (continued)

## INSTALLING MOUNTING BRACKETS OR STUDS ON HULL

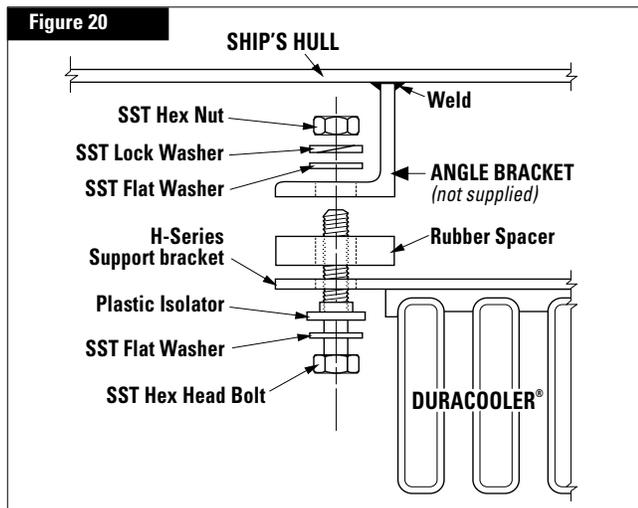
The Flange-Mount DuraCooler® comes with an H-Series mounting bracket as standard. The mounting bracket is used to eliminate the need for fasteners that require through-hull penetrations. The H-Series bracket can be attached using angle brackets or studs welded to the hull.

### Position the DuraCooler® in place

Position the DuraCooler® against hull and snug tighten the flange mounting bolts. For double pass DuraCoolers **make sure the opposite end of the cooler is properly supported. Use DuraCooler® as a template to tack the angle brackets or studs to the hull.**

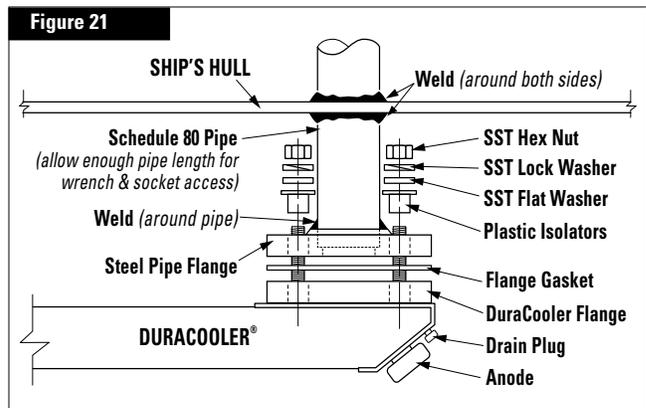
### Weld angle brackets

- Remove DuraCooler® from hull and finish welding the angle brackets to the hull. (See Figure 20)
- If angle brackets are used, they should run parallel with the length of the cooler. (See Figure 20)



## ATTACHING DURACOOLER®

Follow step-by-step diagram (See Figure 21)



## DURACOOLER® ISOLATION

All DuraCoolers are supplied with components for installing cooler isolated from the ship's hull. However, Duramax Marine recommends that a corrosion expert be consulted to evaluate the protection scheme of the vessel and recommend whether the DuraCooler be installed isolated or grounded to ship's hull. This is necessary to insure the DuraCooler is compatible with the overall ship's protection system (whether impressed current or sacrificial anodes).

## MOUNTING H-SERIES BRACKET TO HULL

Plastic isolators and washers are furnished with the H-Series bracket mounting system. These parts must be in place to properly isolate the DuraCooler® from the hull and to minimize galvanic corrosion. (See Figure 20)

## DO NOT OVER TIGHTEN THE HARDWARE

Recommended torque values for mounting flanges and brackets:

	THREAD DIAMETER	TORQUE RANGE	
		ft/lbs	N-m
Header Stud Nuts	$\frac{5}{8}$ - $\frac{3}{4}$	30 - 40	42 - 54
	1	50 - 60	68 - 81
Support Bracket Stud Nuts	$\frac{1}{2}$ - $\frac{3}{4}$	20 - 25	27 - 34

## VERIFYING DURACOOLER® ISOLATION

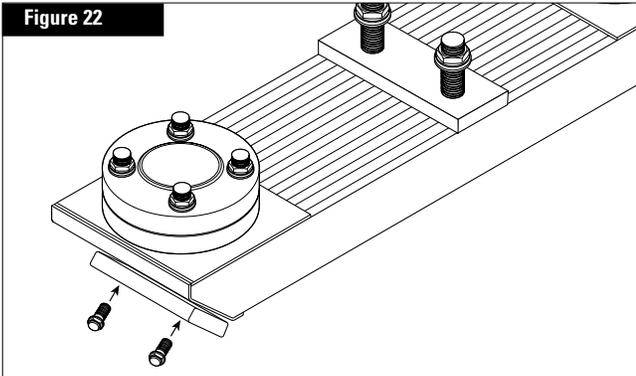
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### **IMPORTANT: VESSELS EQUIPPED WITH IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.**

**It is imperative you consult with the ICCP Manufacturer for the correct installation method to insure the DuraCooler is compatible with the total ship's protection system. Serious damage to the DuraCooler and vessel may occur if not properly installed.**

## ANODES

Figure 22



### **Anodes minimize galvanic corrosion**

All DuraCoolers are supplied with anodes. Use only the special bolts and washers provided by Duramax Marine® to attach the anodes to the streamlined headers of the DuraCooler®. These anodes provide short term protection to the DuraCooler®. Additional anodes may be required to provide adequate protection. Follow normal shipbuilding rules and consult a cathodic protection specialist (corrosion expert) for advice. (See Figure 22)

### **Anode maintenance**

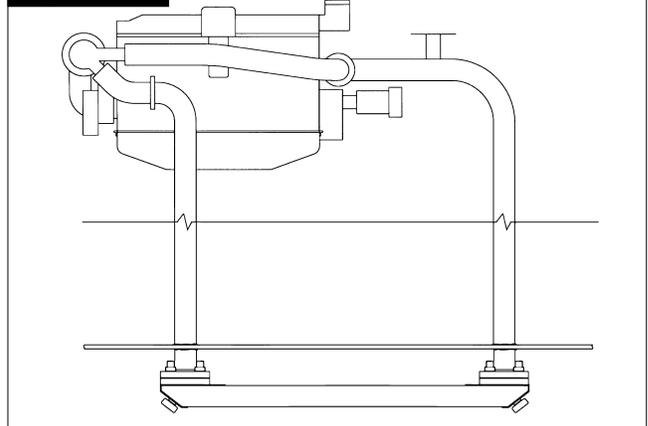
Anodes must be replaced during the ship's regular maintenance to preserve the life of the DuraCooler®. Stray electrical currents can cause galvanic corrosion and rapidly deteriorate the DuraCooler® if anodes are not maintained. Replacement anode kits complete with mounting hardware can be obtained from Duramax Marine®.

**IMPORTANT: The condition of the DuraCooler®, anodes, and the surrounding area of the hull should be periodically checked during the first months of the ship's operation. If there appears to be galvanic corrosion, contact a cathodic protection specialist (corrosion expert) for advice.**

## INTERNAL PLUMBING

- If you are retrofitting a DuraCooler® to a system that previously used an inboard heat exchanger, the DuraCooler® piping should bypass the heat exchanger and connect directly to the engine.
- Install self-venting piping between the DuraCooler® and the engine to eliminate air pockets in the cooling system.
- Do not use tubing or fittings that are smaller in diameter than those on the engine or the DuraCooler®. If the fittings on the engine are larger than the fittings on the DuraCooler®, reduce the piping at the DuraCooler®, not the engine.
- Use the fewest number of elbows to minimize pressure drop. (See Figure 23)

Figure 23



### **Direct to engine piping**

When connecting the engine piping directly to the DuraCooler® nozzle, use wire-reinforced rubber hoses. The reinforcement will prevent hose collapse and interruption of water flow to the DuraCooler®. The connection hoses will help isolate the DuraCooler® from engine vibration.

### **Bottom hull installation**

A double-pass type DuraCooler® should be installed with the inlet and outlet at the high end relative to the water line to prevent air entrapment.

### **Side hull installation**

Connect the DuraCooler® inlet hose to the lower connection tube to minimize air entrapment in the DuraCooler®.

# Installing your Flange-Mount DuraCooler® (continued)

## PRESSURE LIMITS

### Cooling circuit pressure drop requirements

Duramax Marine® provides a specification sheet for each DuraCooler® unit which includes the pressure drop rating across the DuraCooler® (from inlet to outlet.)

It is the installer's responsibility to incorporate the DuraCooler® pressure drop rating into the overall plumbing pressure drop calculations for the cooling circuit.

Please ensure that the overall cooling circuit pressure drop does not exceed the limits of the circulating pump on the cooling circuit. Check with the manufacturer of the engine, transmission or other heat source to confirm the pressure drop limits of the coolant circulating pump.

**Caution:** Do not exceed pressure drop limits set by the manufacturer of the engine, transmission or alternate heat source. Low pump flow or potentially zero pump flow through the cooling circuit could occur.

## PRESSURE TESTING

Never pressure test or operate the DuraCoolers at pressures greater than 35 psi (2.5 kg/cm<sup>2</sup>). It is important to completely fill the unit with coolant and pressure test prior to launching the vessel. Pressure testing in excess of 35 psi can cause "blown" damaged tubes. USE THE FOLLOWING PROCEDURE:

### Filling DuraCooler® with coolant

1. Loosen but do not remove drain plugs on DuraCooler®. This will permit air to escape while filling the DuraCooler® with coolant.
2. Begin filling the cooling system's expansion tank with coolant. This will begin filling the DuraCooler® with coolant.
3. Once air is no longer detectable and coolant exits around the loosened drain plug – tighten plugs.
4. Continue to add coolant and vent the cooling system at the highest elevation in the cooling system.
5. Repeat this procedure to refill the DuraCooler® every time it is drained.

## NOTES:

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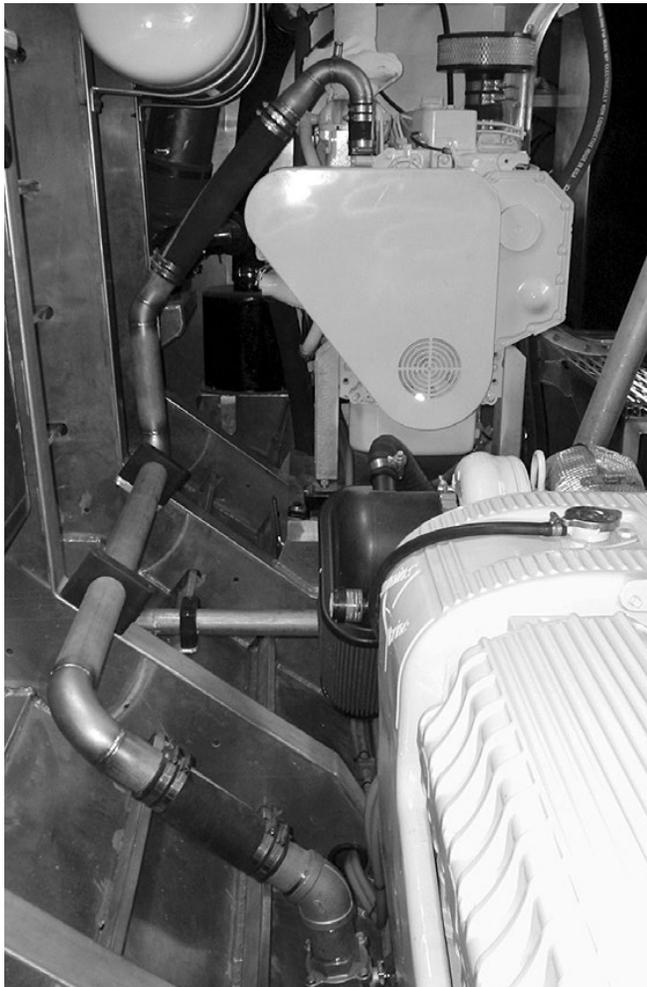
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# Troubleshooting an Overheated DuraCooler® Keel Cooler System

## CONTAMINATION & PERFORMANCE INTERFERENCE

### Air in System:

Was all air purged from the DuraCooler®? If a double-pass DuraCooler® is used, was it installed with the nozzles at the highest location relative to the water line?

### Foreign Obstructions:

Verify that there is no foreign matter blocking the DuraCooler® nozzles. Objects that fall into the inlet or outlet openings prior to or during installation could reduce water flow through the DuraCooler®.

### Deposits:

- Oil - If engine problems have occurred that allowed oil to enter the cooling system, your DuraCooler® may have an internal coating of oil. This will interfere with heat transfer. It may be corrected using a radiator flush procedure.
- Mineral - Hard water in the coolant system can cause mineral deposits to form in your DuraCooler®. This may be corrected by using a radiator flush procedure.

### Marine Growth:

Marine growth on the exterior of the DuraCooler® will interfere with heat transfer. This problem is more likely if the vessel has not been operated for several months or more. If marine growth is present on the DuraCooler®, the cooler should be cleaned by using a high pressure water spray, carefully scraping with a piece of wood or as a last resort, by sandblasting. Use of a pressure washer works the best and should be done immediately upon dry-docking (before growth dries and hardens).

### External Coating:

Verify that the DuraCooler® has not been painted or coated with any other material. Any coatings will act as insulation and interfere with heat transfer. A clean cooler will be naturally anti-fouling.

### Antifreeze:

Was the DuraCooler® sized for the concentration of antifreeze (glycol) in your system? Always premix any antifreeze solutions before adding them to your system. This will avoid accumulations of un-mixed antifreeze in the system.

## MECHANICAL CAUSES OF OVERHEATING

### Thermostat:

Is the thermostat opening properly? Verify that the thermostat temperature is not less than the design temperature of the DuraCooler®.

### Coolant:

Verify that the coolant is circulating through the DuraCooler®. It may be following a path of least resistance through any bypass that may exist.

### Connections:

- Hoses - Make sure that wire-reinforced hoses are being used. Verify that none of the hoses have collapsed. A collapsed hose will interfere with coolant flow.
- Piping - Confirm that the piping between the engine and your DuraCooler® is at least as large as the engine and the DuraCooler® connections. The piping should be self-venting and contain the minimum number of elbows or bends.

### DuraCooler Tubes:

- Crushed - Crushed or pinched tubes could interfere with coolant flow. Confirm all tubes are in good condition.
- Blown - Excess internal pressure can cause tubes to bulge. Bulging tubes could block the flow of ambient water across the cooler. Inspect the cooler for bulged tubes.

### Water Pump:

Verify that the water pump is operating properly. Check the pump flow output to insure it is delivering the required GPM flow.

### Expansion Tank:

Verify that the coolant level in the expansion tank is correct.

### Mounting Gaskets:

Verify that the Duramax Marine® supplied mounting gaskets were used when the DuraCooler® was installed. The gaskets act as spacers to provide room for ambient water to properly circulate around the DuraCooler®.

## AMBIENT FACTORS THAT MAY CAUSE OVERHEATING

### Moored Vessel:

If the engine overheats while the vessel is moored, and if the DuraCooler® is located near the propeller, engage the propeller to circulate ambient water past the DuraCooler®, but only if this can be done safely.

### Water Aeration:

Verify that the ambient water near the DuraCooler® is not aerated. Aerated water will not transfer heat efficiently.

### Vessel Speed:

Verify that the vessel speed is not less than the design speed of the DuraCooler®.

### Seawater Temperature:

Verify that the seawater temperature is not greater than the design seawater temperature of the DuraCooler®.

## Maintenance of DuraCoolers

DuraCoolers will operate most effectively and dissipate heat most efficiently when they are clean, both inside and out. Duramax Marine® recommends the following ways to keep your unit clean.

### EXTERIOR CLEANING OF THE DURACOOLER®

When in regular use, a DuraCooler® should stay relatively free of marine growth. This is due to the copper-nickel construction and the operating temperature of the unit. When not in regular use for long periods of time, marine growth may occur. We recommend the following ways to remove marine growth and paint from the DuraCooler®.

#### High Pressure Water:

This is a highly effective method of removing marine growth. Pressure washing should be performed before organic growth dries and hardens.

#### Scraping:

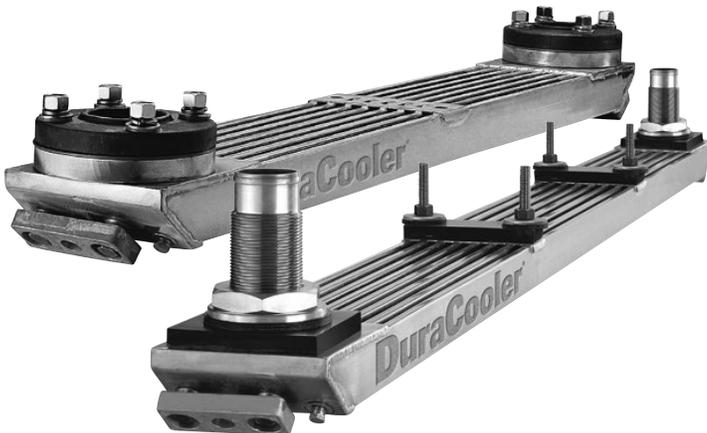
Using a rectangular piece of wood is the best way to remove large pieces of dirt or growth from the DuraCooler®.

#### Sandblasting: (Only use this method as a last resort)

When using this method of removing marine growth and/or paint, use a 40-60 grit at a maximum blast pressure of 90psi (6.21 BAR). Blasting with plastic beads is less likely to remove copper-nickel material.

### INTERIOR CLEANING OF THE DURACOOLER®

Periodically, cleaning the interior of your DuraCooler® may be necessary to remove oil, old glycol, mineral deposits, oxidation or other matter. To accomplish this, a radiator flush is recommended. Consult with your engine dealer for the proper radiator flush for your type of engine.



## Field Repairing Your DuraCooler®

### STEPS FOR FIELD REPAIRING

**In many cases the local radiator repair facility can effectively clean and repair a DuraCooler®.**



**When it is necessary to repair your DuraCooler® in the field, we recommend brazing according to the following steps:**

1. Drain the DuraCooler® before brazing.
2. Clear any biological fouling or debris in the area to be repaired with a wire brush, then clean the area with muriatic acid (follow instructions from acid manufacturer).
3. Dry off any water inside and outside DuraCooler® in the area to be repaired.
4. Use oxygen/acetylene torch with a tip no larger than a # 5. The flame should be neutral.
5. Use 45-56% silver content brazing wire either 1/16 inch (1.59 mm) or 1/32 inch (0.79 mm) diameter. A similar content of silver should also work. Also, use a low temperature brazing flux. Duramax Marine® can supply brazing wire and flux on request.
6. Only use enough heat to sweat the brazing wire. **TOO MUCH HEAT WILL DAMAGE THE COOLER.** The tube wall thickness is 1/16 inch and the support plates are 1/8 inch. **ALWAYS APPLY THE HEAT TO THE HEAVIEST WALL.**
7. Let the brazed joint air cool.

Note: If there is any question regarding the repair please contact Duramax Marine® or any local radiator repair facility. The above information is provided for informational purposes only. Duramax Marine® cannot be held liable for damage or injury that could result from an attempted repair.

## Special Applications for a DuraCooler®

### PREVENTING GALVANIC CORROSION TO YOUR SHIP'S HULL

All DuraCoolers are supplied with components for installing cooler isolated from the ship's hull. However, Duramax Marine recommends that a corrosion expert be consulted to evaluate the protection scheme of the vessel and recommend whether the DuraCooler be installed isolated or grounded to ship's hull. This is necessary to insure the DuraCooler is compatible with the overall ship's protection system (whether impressed current or sacrificial anodes).

#### **IMPORTANT: VESSELS EQUIPPED WITH IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.**

It is imperative you consult with the ICCP Manufacturer for the correct installation method to insure the DuraCooler is compatible with the total ship's protection system. Serious damage to the DuraCooler and vessel may occur if not properly installed.

### COPPER-NICKEL DURACOOLER® APPLICATION TO ALUMINUM HULLS

**WARNING:** Duramax Marine® does not recommend or approve the DuraCooler® (copper-nickel) for use on aluminum hull vessels operating in a sea water environment. However, copper-nickel heat exchangers have been used on aluminum vessels according to the following procedure, which provides an electrical barrier between the heat exchanger and the hull. If a good electrical barrier is not provided, galvanic corrosion may occur.

#### **Mounting:**

1. Prepare surface of hull according to paint manufacturer's recommendation.
2. Apply 2 to 3 coats of Epoxy Primer\* to hull (spray on method).
3. Wet thickness of coating on ship's hull is 0.008 inches, dry thickness is 0.006 inches.
4. Apply coating over entire hull that is below the water line.
5. On top of the primer use any anti-fouling paint.
6. Install the keel cooler - All through-the-hull fittings must be isolated from the hull.
7. After the DuraCooler® has been installed check for proper isolation. (IMPORTANT: Continue to monitor for isolation every 6 months.)

\* The following 2 part epoxy primers are preferred:

*Pittsburgh PPG All weather DTR*

*International 264*

*Walsey Hy-Build Gold*

### BENDING OR TWISTING OF A DURACOOLER®

We recommend that all DuraCoolers be installed in accordance with our printed installation instructions. If there is a circumstance where the mounting area of the hull is not flat or cannot be made flat, it may be possible to bend or twist the DuraCooler. If this is the case, Duramax® cannot be held liable for any damage to the cooler as a result of modifications made in the field.

The following are the limits to which a DuraCooler® may be modified:

- The maximum bend is 1 inch per foot (12 inches) of length.
- The maximum twist of the unit is 1 degree per foot (12 inches) of length.
- Bending should be done under controlled conditions, such as in a hydraulic press using wooden blocks. Pressure should be applied evenly across all tubes.
- Do not kink or split the tubes.
- Do not bend DuraCooler® at a joint on either the header or support bracket.
- Always pressure test the cooler after bending or twisting to check for leaks. Repair as necessary.



NOTES:

# DuraCooler® Limited Warranty

## **DuraCooler® Limited Warranty and Terms & Conditions of Sale**

Subject to all of the conditions of the DuraCooler® Exclusive Terms and Conditions of Sale, Duramax Marine® warrants, that at its option, Duramax Marine will refund the purchase price or repair or replace FOB Duramax Marine manufacturing facilities, any part of a Duramax Marine Product that is determined by Duramax Marine to be defective in manufacturing workmanship and materials, solely by reason of a failure to conform, at the time of its shipment by Duramax Marine to the purchaser, to the description of such Product, including specific performance specifications, if any, made by Duramax Marine for the specific Product. The specific performance specifications may include measurements of thermal efficiency or other measures of thermal transfer that are highly dependent on testing methodology and conditions and computer extrapolations of actual test data. Duramax Marine shall not be responsible for conditions of use and service that affect the performance of the Product. Accordingly, the specific performance guarantee, if any, shall not be applicable to any in-service use of the Product and shall be applicable only to the testing and computer extrapolations performed by Duramax Marine at its manufacturing facility prior to shipment. Before becoming obligated under this warranty, Duramax Marine: a) must receive, from the original purchaser, the allegedly defective DuraCooler at its manufacturing plant, freight prepaid, no later than the earlier of 24 months from the first use of the original, new DuraCooler or 30 months from the date of original shipment of the new DuraCooler to the purchaser; b) must receive the DuraCooler no more than 30 days after the alleged defect was discoverable by the purchaser; and c) have the right to inspect the DuraCooler and to determine, in its sole discretion, that a defect exists in manufacturing workmanship and materials, solely by reason of a failure to conform at the time of shipment by Duramax Marine to the description made by Duramax Marine. Repairs do not extend the original term of warranty specified above.

Duramax Marine® shall have no obligation hereunder for any claim for defects in a DuraCooler that are the result of shipping damage, corrosion, damage caused by conditions of service, accident, abuse, misuse, marine growth, oil, chemical or corrosive substances, repairs made by the purchaser or others, changes made by the purchaser or others, exposure to adverse conditions after shipment by Duramax Marine, or any effect of installation on an aluminum hull vessel, use or installation in a manner not specified or recommended by Duramax Marine, or improper or incorrect installation efforts. No DuraCooler will be accepted by Duramax Marine for a warranty claim without being accompanied by a written claim of defects covered by this warranty and that also reference a Returned Goods Authorization (RGA) number that must be obtained by the customer from Duramax Marine prior to shipment to Duramax Marine.

Duramax Marine® shall have no liability under this warranty for any repairs, replacements or refund if the purchaser fails: a) to install the DuraCooler in accordance with the installation instructions provided by Duramax Marine; b) to comply with the most stringent of generally accepted commercial practices for maintenance and protection of the DuraCooler or the maintenance and protection instructions provided by Duramax Marine; c) to use and store the DuraCooler in environmental, mechanical, electrical and performance conditions specified by Duramax; or d) to notify Duramax Marine immediately in the event any DuraCooler exhibits a defect covered by this warranty. The purchaser acknowledges that the DuraCooler must be protected by an anode at all times and that any corrosion, damage or failure caused or accelerated by the failure to maintain adequate anode protection will not be covered by this warranty and will be the sole responsibility of the purchaser.

Duramax Marine® reserves the right to substitute replaced DuraCoolers with DuraCoolers of similar characteristics and to change its product specifications and configuration at any time without notice to the purchaser.

This warranty provision is part of the Duramax Marine® Exclusive Terms and Conditions of Sale which apply to and govern all sales of our products. Installation or use of any Duramax Marine DuraCooler product or any claim made under this warranty shall constitute acceptance by the purchaser of the Duramax Marine Exclusive Terms and Conditions of Sale as the sole terms and conditions applicable to the purchase and supply of the DuraCooler. A complete copy of the Duramax Marine Exclusive Terms and Conditions of Sale is available from Duramax Marine upon request.

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DuraCooler® Warranty August, 2006.

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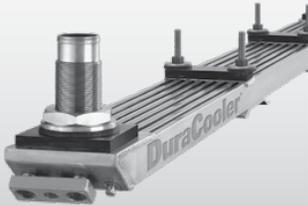
## JOHNSON CUTLESS® WATER-LUBRICATED BEARING SYSTEMS

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## DURAMAX® ADVANCED WATER-LUBRICATED BEARING SYSTEMS

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