

DuraCooler® Keel Cooler

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



Available in Flange-Mount
or Through-Hull Designs
And SuprStak™ Configuration

PRODUCT INFORMATION AND SELECTION GUIDE

Duramax Marine® is an ISO 9001:2015 Certified Company

DURAMAX MARINE®



DuraCoolers® With Streamlined Header Design Significantly Increases Heat Transfer Efficiency.

Duramax Marine® conducted extensive research to identify opportunities to improve the operational efficiency of the traditional square-header keel cooler.

Through finite element computer studies, we discovered the traditional square-header keel cooler design caused certain inefficiencies. Full-scale tests were conducted to determine internal and external flow patterns, system pressure loss and heat transfer characteristics for different heat exchanger geometries.

It was discovered that the outside tubes of the keel cooler have the greater potential for heat rejection per lineal foot but due to internal geometry this potential was not being realized.

(See test results on next page.)

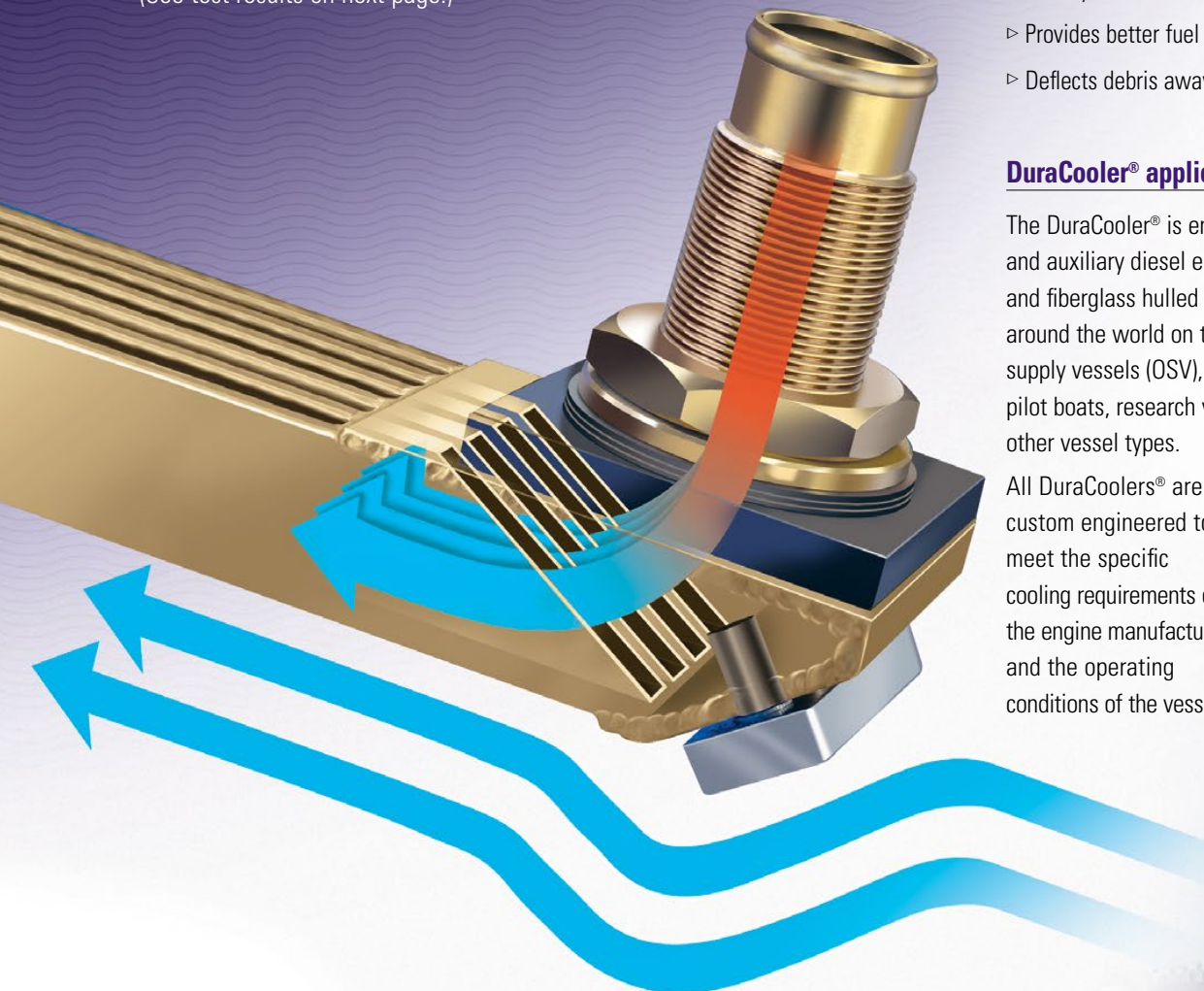
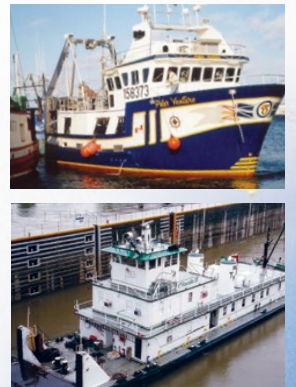
Advantages of the DuraCooler® streamlined header design.

- ▷ Enhanced interior and exterior flow patterns
- ▷ Reduced pressure drop
- ▷ Increased heat transfer efficiency
- ▷ Greatly increased heat rejection in outside tubes
- ▷ Provides better fuel efficiency due to less drag
- ▷ Deflects debris away from cooler

DuraCooler® applications.

The DuraCooler® is engineered to cool main and auxiliary diesel engines for wooden, steel and fiberglass hulled applications. It is used around the world on tugs, push boats, offshore supply vessels (OSV), crew boats, fishing vessels, pilot boats, research vessels, ferries, and many other vessel types.

All DuraCoolers® are custom engineered to meet the specific cooling requirements of the engine manufacture and the operating conditions of the vessel.



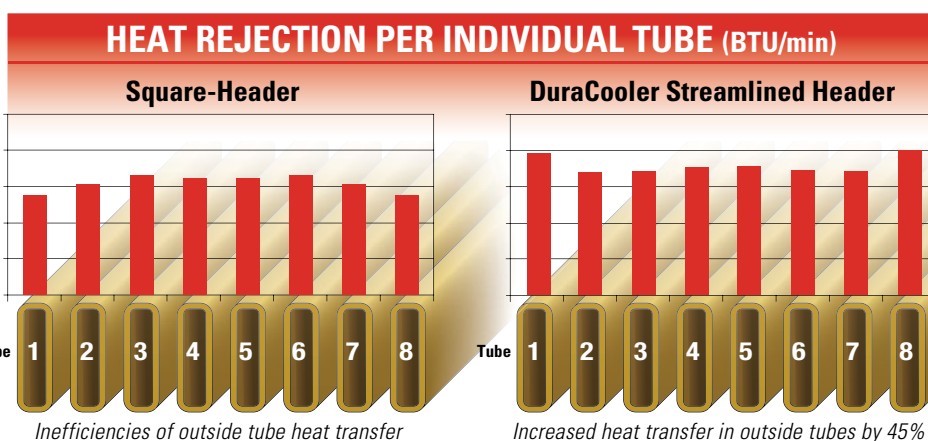
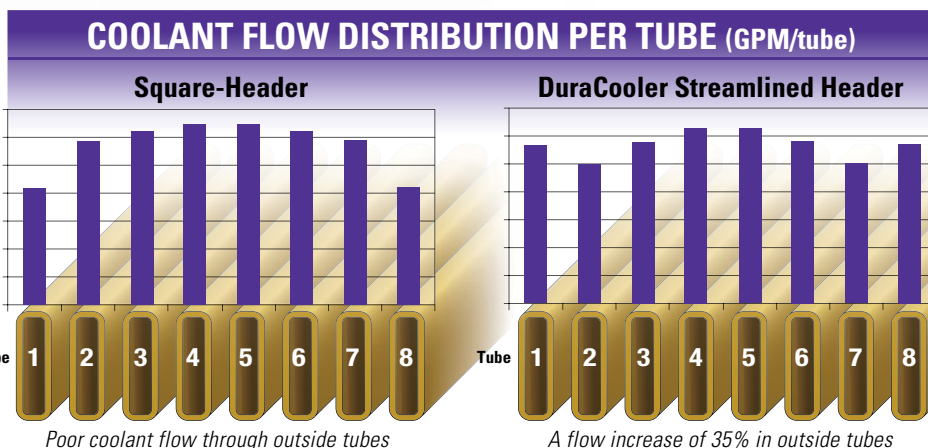
Full-Scale Tested DuraCooler® Design improves flow patterns.

Overall heat transfer in the DuraCooler® increased by 17%.

The patented streamlined header design enhances interior coolant and exterior seawater flow patterns while reducing system pressure drop within the keel cooler unit. This translates into improved heat transfer efficiency.

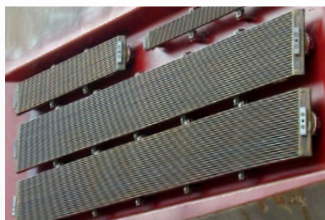
- ▷ Coolant flow distribution to the outside tubes increased 35%
- ▷ Heat rejection in the outer tubes increased 45%

NOTE: Study conducted by Flow Simulations Inc. on a SC-48-96 and equivalent size square-head unit.



Smaller footprint reduces cooling system costs.

The DuraCooler® streamlined design, with increased coolant flow to the outside tubes, reduces the footprint versus the original square head design. It can be easily retrofitted to cool auxiliary engines and other heat sources.

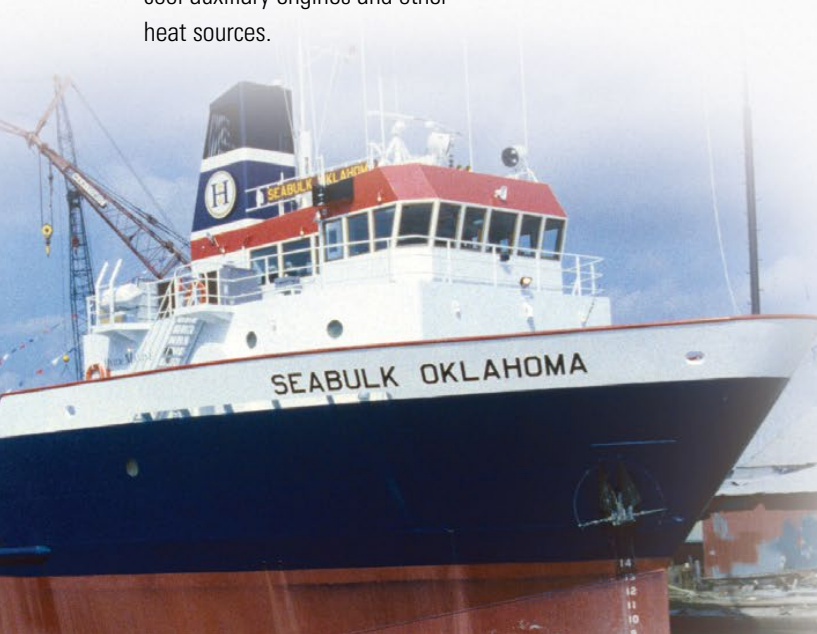


Trust Duramax Marine®. The heat exchange specialists.

For over 40 years, Duramax Marine® has been designing and manufacturing innovative heat exchange products for the commercial marine industry. A 800,000 gallon keel cooler test facility was constructed capable of testing full size keel coolers under various real world conditions – allowing us to optimize our keel cooler design and improved product.

Duramax Marine® has developed an exclusive computerized actual full-scale keel cooler sizing system based on test results. Our proprietary sizing system provides you with a correctly sized keel cooler for the intended application, reducing the risk of overheating.

So, have confidence knowing that you are working with a dedicated group of heat exchange professionals.



Through-Hull Nozzle Design

Manufactured for extreme durability and long life.

1 Nozzle design

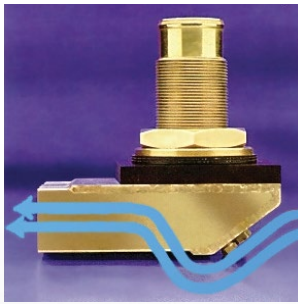
Nozzle size and diameter is manufactured to fit your specific application.

2 Gaskets strategically sized and positioned

Designed to provide stand off from the hull, allowing water to pass the hull side of the DuraCooler® tubes with minimum interruption.

3 Streamlined header design

Significantly increases heat transfer efficiency over square-head design.



4 Two-piece header design

Allows for brazing on inside and outside of the header which, in turn, increases the integrity and reduces the chance of leakage.

Heavy-gauge material for headers

▷ Provides exceptional strength and durability.

Premium-grade silver solder

▷ Provides maximum strength, flexibility and leak resistance at all cooler joints.
▷ Every DuraCooler® is pressure and vibration tested to verify joint integrity.

5 Patented flow port

Exclusive, patented design of internal coolant flow port increases cooling performance of outside tubes.

6 Anodes mounted on beveled edge of header

Results in less stand-off distance from hull, less drag, better fuel efficiency. Also, they are less likely to be damaged by debris.

7 Rigid one-piece construction

Allows for easier installation and removal.

8 90/10 Copper-Nickel tubing

▷ High-strength material has excellent anti-fouling and heat transfer properties. It also resists water-flow erosion.



▷ All tubes come in wall thickness of 0.062 inches.

Tubes come in three different sizes:

- ▷ #2 Tubes: 0.343" wide x 1.500" high.
- ▷ #3 Tubes: 0.500" wide x 1.687" high.
- ▷ #4 Tubes: 0.500" wide x 2.500" high.



Flange-Mount Design



For non-through-hull applications.

With this DuraCooler® design there is no need for through-hull penetration. The flange-mount hardware is located outside the vessel where it is easy to access. This design is recommended when the inside area of the hull is tight or equipment makes the internal fittings on a standard through-hull inaccessible. The DuraCooler® Flange-Mount design and construction delivers the same optimum heat transfer as the Through-Hull design and can be custom fitted to your specific application.

No cofferdam or sea chest saves space and money

Since fittings are outside the hull there is no need for a cofferdam or sea chest, saving valuable space and installation costs.

Perfect for double hull designs

Standard through-hull nozzles may not be long enough to penetrate both hulls. The DuraCooler® Flange-Mount is ideal for this application.

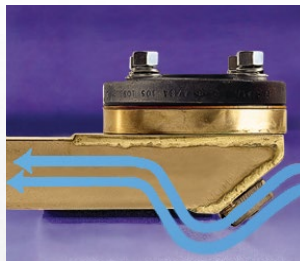
1 Flange-mounted connection

Flange-mounted connection is obtained by means of a copper-nickel flange affixed to the DuraCooler® header coupled to a mild ASTM steel mating flange, supplied with the cooler.



2 Streamlined header design

Significantly increases heat transfer efficiency over square-head design.



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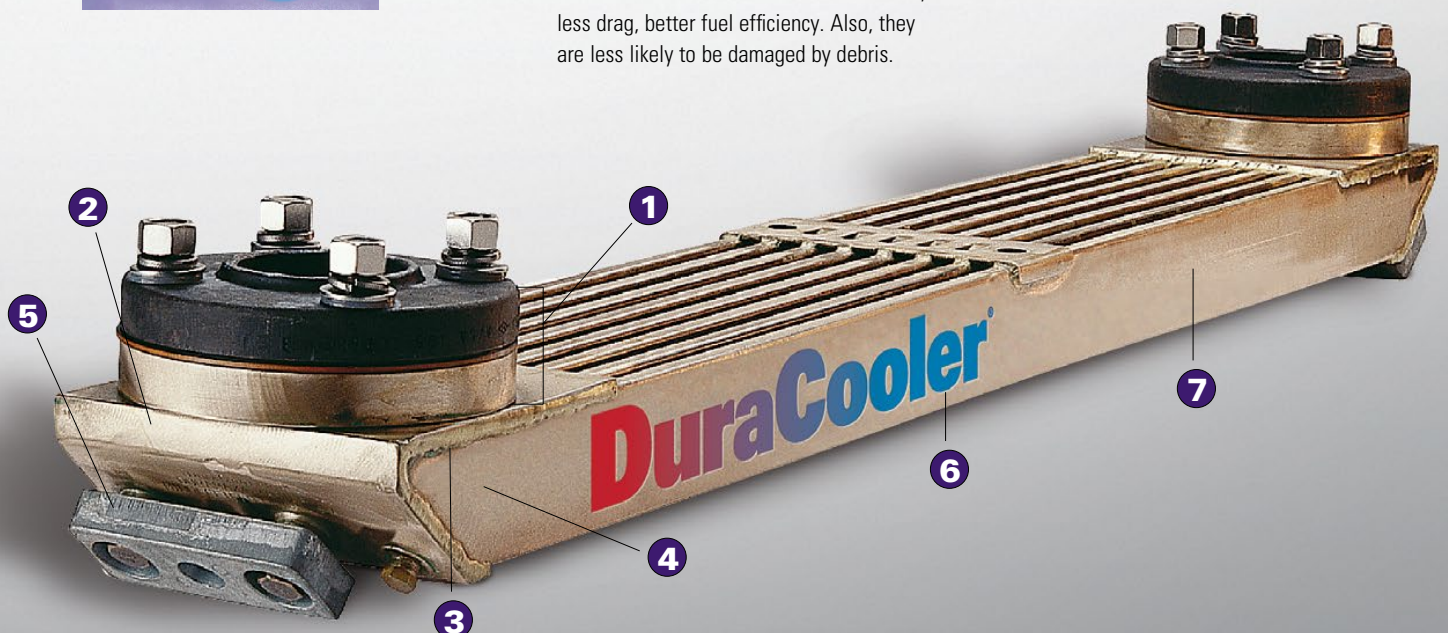
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Mounting configurations and internal plumbing, engineered and built to fit your exact needs.

The DuraCooler® is custom-sized and manufactured to meet your engine specifications, along with space and operational requirements. The cooler can be engineered to cool main and auxiliary diesels, as well as other heat sources that include: generators, winches, compressors, thrusters, air conditioning units, and gears. It is also available to match your specific internal plumbing configurations.

Plumbing options



Single Pass Design.

Designed to accommodate internal plumbing with nozzles on the opposite ends of the cooler, for quick and easy installation. Nozzles are available in various lengths and diameters.



Also available for Flange-Mount

Double Pass Design.

Designed to accommodate internal plumbing that requires nozzles on same end of the cooler. This configuration allows the internal plumbing to be more centrally located. Nozzles are available in various lengths and diameters.

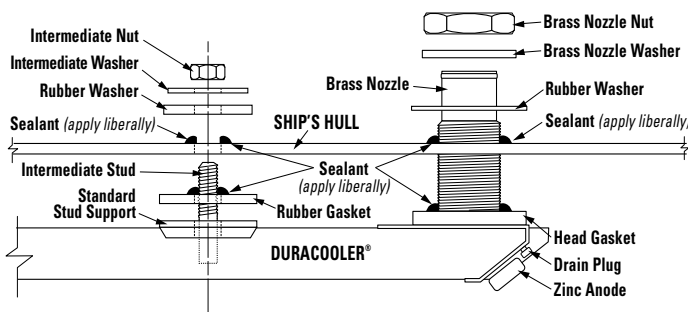


Also available for Flange-Mount



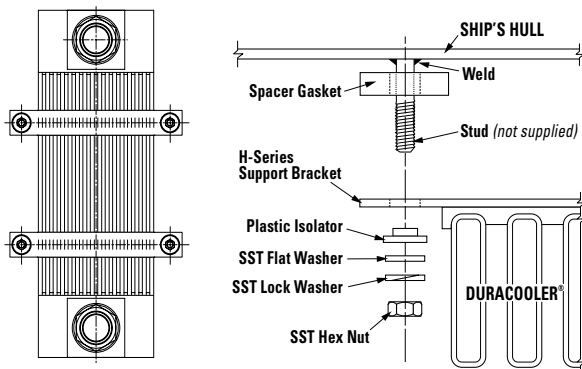
Mounting options: Through-hull

Our standard through-hull system's sturdy one-piece construction makes it quick and easy to install. The standard Through-Hull DuraCooler® is manufactured with robust copper-nickel nozzles and the DuraCooler® assembly system is designed to isolate the cooler from the hull, minimizing the effects of galvanic corrosion.



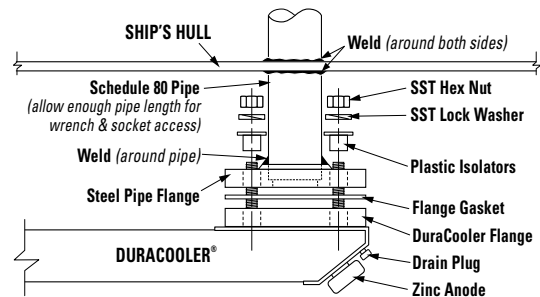
H-Series bracket mounting for through-hull (optional).

DuraCoolers are typically manufactured with through-hull mounting studs (as shown above). The optional H-bracket mounting system eliminates the need for through-hull penetration and the fabrication of cofferdams. The H-bracket extends beyond the sides of the cooler and is permanently affixed to the cooler using silver solder. Studs are welded to the hull and the cooler is attached with fasteners to the H-bracket.



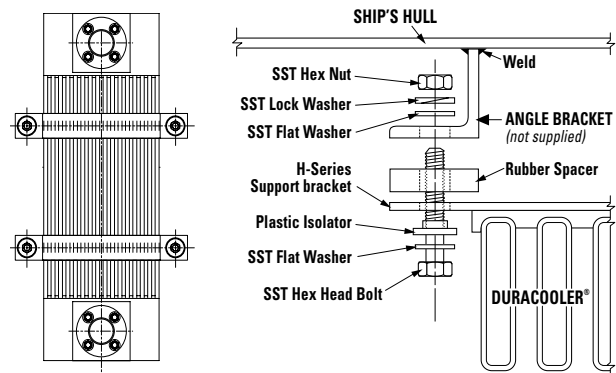
Mounting options: Flange-mount

For flange-mount configurations, a schedule 80 pipe is welded to the steel pipe flange supplied with the DuraCooler® unit. The DuraCooler® flange is bolted to the steel flange, using the supplied hardware. The pipe is extended through the hull and is welded to the hull on both sides. Mounting gaskets and plastic isolating washers isolate the cooler from the hull to minimize galvanic corrosion.



H-Series bracket mounting for flange-mount (standard).

All Flange-mount DuraCoolers come standard with the H-bracket mounting system. The H-bracket is made from heavy gauge copper-nickel and is permanently attached to the DuraCooler®. To mount the flanged DuraCooler® using the H-bracket, "L" shaped support angles are welded to the hull. The Flange-Mount DuraCooler® can then be secured to these small angled pieces, eliminating through-hull penetration.



Revolutionary keel cooler design more than doubles heat transfer in half the hull space

DuraCooler[®]
SuprStak[™]
with TurboTunnel Design

ANGLED TURBOTUNNEL HEADER DESIGN

Increased convergent header pressure "jets" turbulent sea water between the upper and lower tube decks.

TURBULIZER SPACERS

Unique shape spacers create vortex effect to "turbulize" the sea water to increase cooling efficiency (Von Karman effect).

FLOW DIVERTER SCOOPS

Diversion of sea water disrupts the laminar flow and allows stagnant high temperature areas to be cooled.

PATENTS PENDING

Duramax Marine[®] has engineered a unique keel cooler that is the most efficient keel cooler Duramax Marine[®] has ever built. DuraCooler[®] SuprStak[™] takes keel cooling technology to the next level. It can deliver more than double the cooling efficiency, using half the hull space.

This cooler will be the newest addition to the Duramax Marine[®] long line of custom engineered heat exchange solutions, and the best answer for the marine industry's ever increasing cooling requirements.

DuraCooler[®] SuprStak[™] with TurboTunnel Design (patent pending) is a double-stacked, completely redesigned DuraCooler[®].

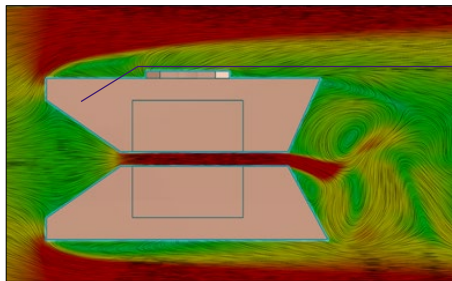
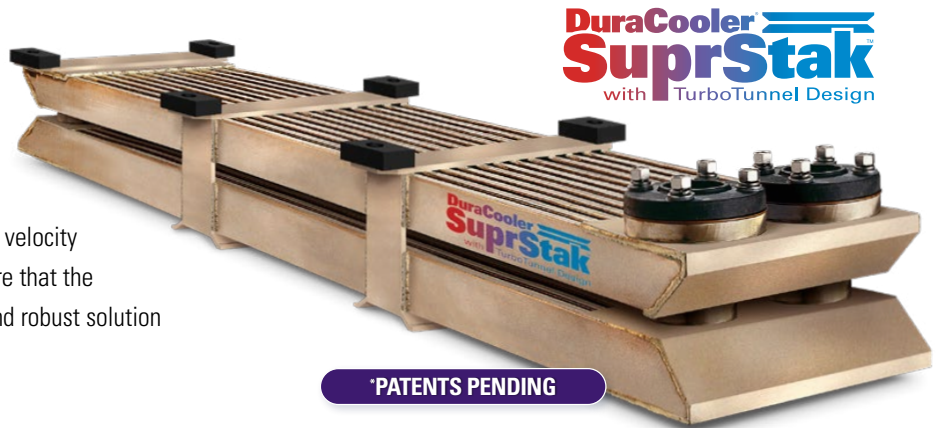
SuprStak[™] is engineered to "jet" turbulent seawater in a tunnel-like configuration between its top tubes and lower tube assemblies. It is the latest in engineered cooler technology that greatly enhances heat transfer in half the hull space. There is nothing else like it on the market.

It has long been understood that turbulent flows allow for great enhancements in heat transfer.

However, little consideration is given to the flows around a marine keel cooler. At low to moderate hull speeds, seawater flowing axially along a 90-10 Cupronickel keel cooler tube is laminar by nature. It is the formation of this laminar boundary layer, which according to classical heat transfer creates a type of insulation, causing reduced heat transfer and restricting heat from properly convecting into the seawater. To circumvent this, advancements have been incorporated into the new DuraCooler[®] design to both enhance and optimize turbulent flow outside and around the keel cooler, yielding a more compact and efficient DuraCooler[®] design.

The **DuraCooler® SuprStak™** design advancements – are a breakthrough in keel cooler technology.

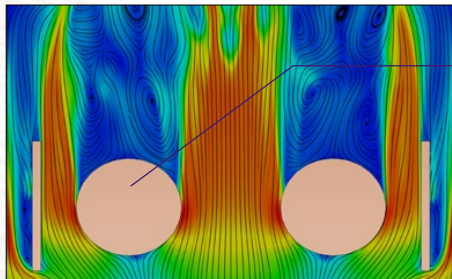
These advancements have been developed using state of the art computational fluid dynamic (CFD) modeling techniques and have been tested and validated utilizing a full scale water tunnel. Each innovation has been specifically engineered to properly promote turbulence and modulate flow velocity over the DuraCooler®. Our R&D team has made sure that the SuprStak™ design offers the best, most efficient and robust solution of any DuraCooler® Keel Cooler design.



TurboTunnel Header Design.

Taking advantage of our current angled header profile we designed a convergent type profile which allows for the development of stagnation pressure due to fluid inertia.

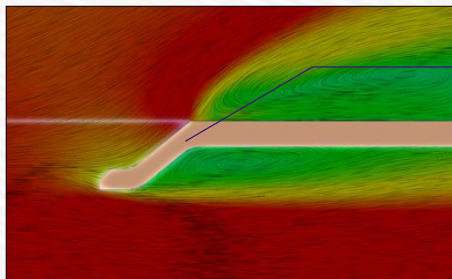
This creates a “jet” like effect accelerating seawater flow between the top and bottom tubes of the double stack increasing heat transfer. The speed of the seawater flowing over the cooler is now significantly faster than the actual speed over the hull. Depending on the application we also adjust the opening size between the stacks to modulate the flow for optimum design and cooling efficiency.



Round Turbulizer Spacers.

Two round spacers on each end of the double stack act as more than spacers separating the upper and lower cooler decks.

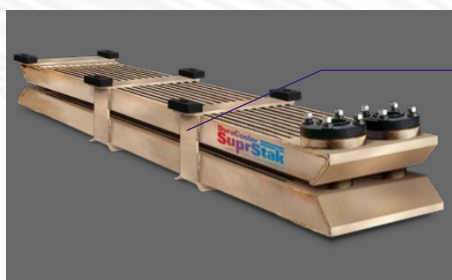
They are designed as turbulence enhancers that naturally develop a swirling type turbulent flow (*Von Karman Vortex Phenomena*) that accelerates the incoming sea water, helping it yield a much better temperature profile than other types of keel coolers.



Flow Diverter Scoops.

Engineered flow diverters run the width of the lower tube assemblies to “flush” the stagnated areas between the tubes with sea water. The diverter is a unique design which must have a specified spacing between the diverter and the tubes.

They are designed to ensure a “scooping” action far enough away from any stagnant regions to allow forced convection between the hot tubes and the lower temperature sea water.



One Piece Brazed or Modular Design.

The DuraCooler® SuprStak™ is engineered to be manufactured in a completely brazed double stack assembly or made in such a way that the 2 cooler decks can be separated.

The modular design is installed in upper then lower sections for easier handling. This will reduce the overall weight of the unit during installation.

Installation location is flexible depending on the vessel's hull design and operating conditions.

Side-mounting.

On shallow-draft vessels, the DuraCooler® can be mounted on the side of the hull or beside the skeg to take advantage of additional water current created by the propeller. Side mounting also protects the cooler if you run aground. (figure A)

Mounting near propeller.

Mounting the DuraCooler® near the propeller takes advantage of the slipstream created by the propeller during heavy towing situations. (figure B)

Recessing the DuraCooler®

Recessing the DuraCooler® reduces the drag on the vessel, streamlines the installation and protects the cooler from damage. On fast moving or planing hull vessels, the DuraCooler® is normally recessed-mounted alongside the keel. (figure C)

Protecting with fairing blocks.

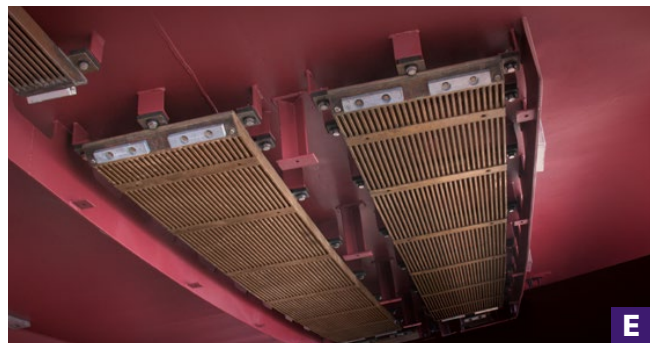
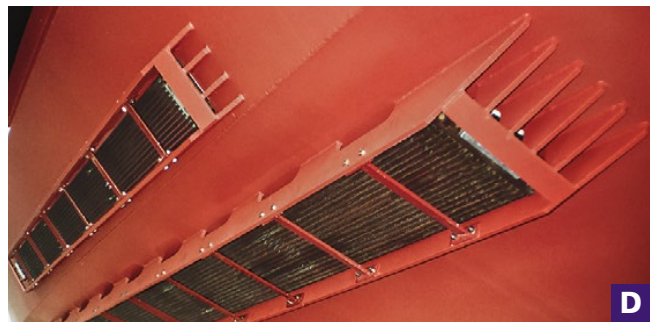
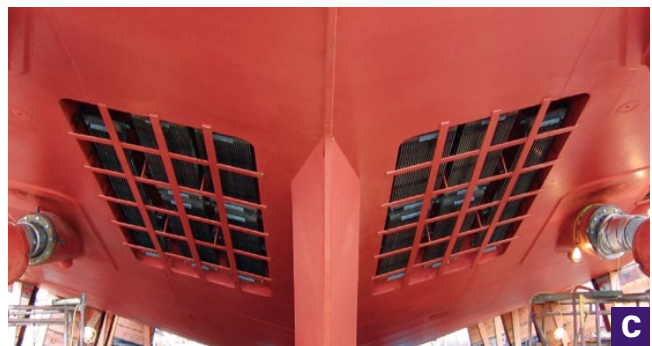
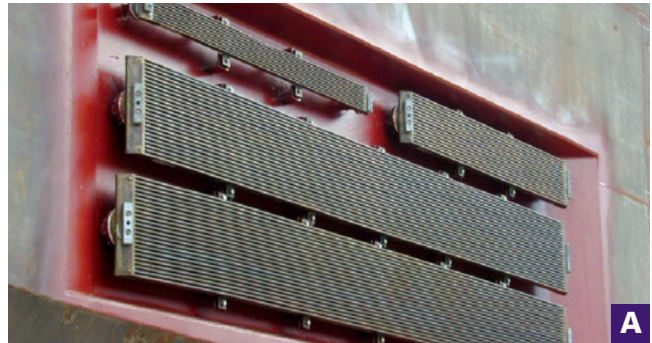
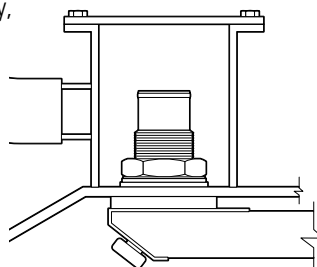
When externally mounting the cooler, fairing blocks and side plates are used for protection from damage. Our engineers can offer assistance in the proper engineering and placement of protective fairing blocks around the DuraCooler® (figure D)

DuraCooler® can be bent to accommodate hull curvature.

If there is a circumstance where the mounting area on your hull is not flat or cannot be made flat, it is possible to bend or twist the DuraCooler®. We can provide this service for you, or our engineers can instruct you on how you can do it yourself. Contact Duramax Marine® for more information. (figure E)

Cofferdam classification requirements.

For a Through-Hull DuraCooler®, a sea chest or cofferdam is required by A.B.S. It should be constructed to meet A.B.S., Coast Guard or other agency regulations. Alternatively, the Flange-Mount DuraCooler® has no through-hull penetrations and therefore does not require the use of a cofferdam or sea chest.



Information needed to custom-size DuraCooler® for your vessel.

To correctly size a DuraCooler® for your specific application, we consider your vessel's external operating conditions, main engine information, generator and other factors used to determine your engine specifications and operational requirements. The following information is required to correctly engineer and size your DuraCooler® Heat Exchange System:

▷ GENERAL INFORMATION

Company Name _____
 Contact Name _____
 Email _____
 Address _____
 City _____
 State/Territory _____ Zip _____
 Country _____
 Phone _____
 Fax _____

▷ VESSEL INFORMATION

Vessel Name/Hull # _____
 New Construction: Yes No/Retrofit
 Type/Use of Vessel: _____
 Dimensions: length _____ beam _____ draft _____ (feet | meter)
 Hull Material: Steel Fiberglass Wood Aluminum
 Preferred Inlet/Outlet Location: *(check one)*
 Same End *(double pass)* Opposite Ends *(single pass)*

▷ EXTERNAL CONDITIONS

Minimum Vessel Speed at Full Power _____ (knots | mph)
 Maximum Ambient Sea Water Temperature _____ (C° | F°)
 Location of Coolers: Bottom Side of Hull
 Space Restrictions on Hull: No Yes _____

▷ MAIN ENGINE INFORMATION

Manufacturer _____
 Model No. _____
 Quantity _____
 Min. Speed at which full Power will be developed _____ (knots | mph)
 IMO/Tier: Tier 1 Tier 2 Tier 3 Tier 4
 Other: _____
 Engine Power (HP | kW) _____
 Engine RPM _____
 Coolant: Type _____ Mix _____ (%)
 Cooling Circuits: Jacket Water (HT) After Cooler (LT)
 Combined Circuit Other Circuit _____
 High Temp. Cooling Circuit (Jacket Water): _____ (C° | F°)
Coolant Temp from Engine to Cooler (Ta)
 Heat Rejection-Ta _____ (BTU/min | kW)
 Pump Flow-Ta _____
 Pump Rate-Ta _____ (GPM | LPM | m³/hr)

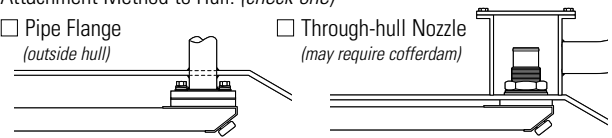
▷ MAIN ENGINE INFORMATION *(continued)*

Low Temp. Cooling Circuit (Aftercooler): _____ (C° | F°)
Coolant Temp. from Cooler to Engine (Tb)
 Heat Rejection-Tb _____ (BTU/min | kW)
 Pump Flow-Tb _____
 Pump Rate-Tb _____ (GPM | LPM | m³/hr)
 Gear: YES NO
 Manufacturer Gear (if cooled by DuraCooler): _____
 If Reintjes® Gear-provide Pump Flow _____ (GPM | LPM | m³/hr)
 System Pressure Drop Requirements _____

Attachment Method to Hull: *(check one)*

Pipe Flange
(outside hull)

Through-hull Nozzle
(may require cofferdam)



▷ GENERATOR

Manufacturer _____
 Model No. _____
 Quantity _____
 IMO/Tier: Tier 1 Tier 2 Tier 3 Tier 4
 Other: _____
 Engine Power (HP | kW) _____
 Engine RPM _____
 System Pressure Drop Requirements _____
(will be sized for 0 knots unless otherwise directed.)

▷ OTHER HEAT SOURCES (Pump, Thruster, Etc.)

Type _____
 Manufacturer _____
 Model No. _____
 Quantity _____
 IMO/Tier: Tier 1 Tier 2 Tier 3 Tier 4
 Other: _____
 Engine Power (HP | kW) _____
 Engine RPM _____
 System Pressure Drop Requirements _____
(will be sized for 0 knots unless otherwise directed.)

**For More Information or a Quotation, contact your
 Duramax Marine® DuraCooler® Expert. Call 440-834-5400.
 Or visit DuramaxMarine.com.**

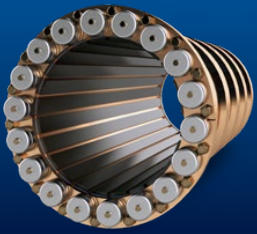
INNOVATION.
EXPERIENCE.
RESULTS.

Duramax Marine® is committed to providing excellence in every product we manufacture. Our Johnson Cutless® marine and industrial bearings, heat exchangers, impact protection systems and sealing systems are known worldwide for their engineered quality and dependable performance. Please contact the factory for information on any of the following Duramax Marine® products:



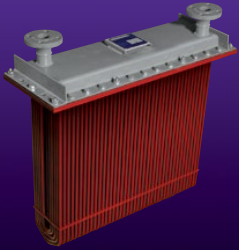
JOHNSON CUTLESS® WATER-LUBRICATED BEARING SYSTEMS

Johnson Cutless® Sleeve and Flanged Bearings
DX 490 Rudder Bushings



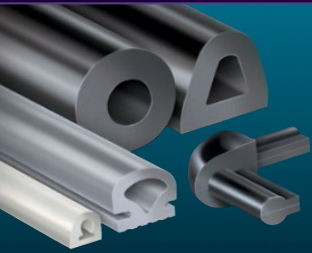
DURAMAX® ADVANCED WATER-LUBRICATED BEARING SYSTEMS

Johnson® Demountable Stave Bearings
ROMOR® I Stave Bearings and Segmental Housings
ROMOR® C- Partial Arc Bearings
DMX® Polymer Alloy Bearings
DuraBlue® Bearings, Rudder & Pintle Bushings, Thrust Washers, and Wear Pads
Industrial Pump Bearing Systems



DURAMAX® HEAT EXCHANGE SYSTEMS

DuraCooler® Keel Coolers
Duramax® Demountable Keel Coolers
Duramax® BoxCoolers
Duramax® Plate Heat Exchangers



DURAMAX® IMPACT PROTECTION SYSTEMS

Johnson® Commercial Dock Bumpers, Fenders & Tow Knees
Weatherstrip Door Gaskets, Window Channel and Hatch Cover Gaskets
LINERITE® Composite Batterboard Systems



DURAMAX® SHAFT SEALING SYSTEMS

DryMax® Shaft Seal & Rudder Seal
Duramax® Mechanical Shaft Seal
Johnson® Heavy-Duty Air Seal Stuffing Boxes
Duramax® Ultra-X® High Performance Compression Packing
Johnson® Strong Boy Stern Castings and Stuffing Boxes

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