

GRIDCOOLER®

KEEL COOLER

Installation and
Maintenance Manual

Form 185

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1.0 PLANNING & LOCATION

To function properly, the FERNSTRUM® GRIDCOOLER® Keel Cooler must be properly located on your vessel's hull. Please consider the following before installing your keel cooler on most types of vessels. For additional details on displacement or planing hulls, refer to the appropriate sections.

1.1 DETERMINING PROPER LOCATION - TYPICAL

- 1.1.1 Sea water must flow over the entire length of the unit.
- 1.1.2 Always install the unit parallel, not transverse, to the skeg or keel. See Figures 1 & 2.

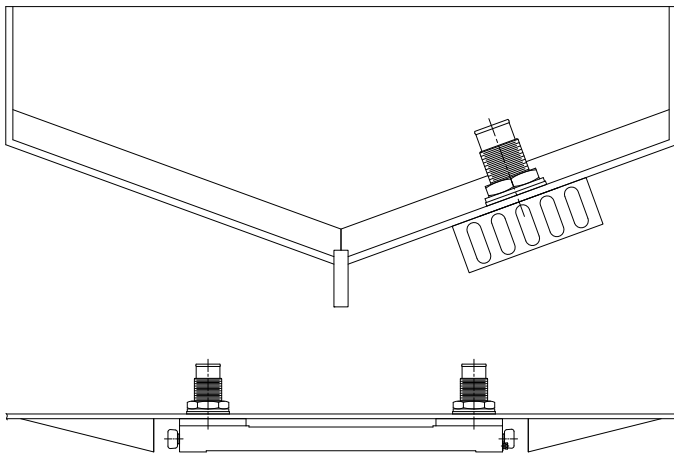


FIG.1 External type installation with E1 OPTION end-mounted anodes using fairing blocks for protection and streamlining.

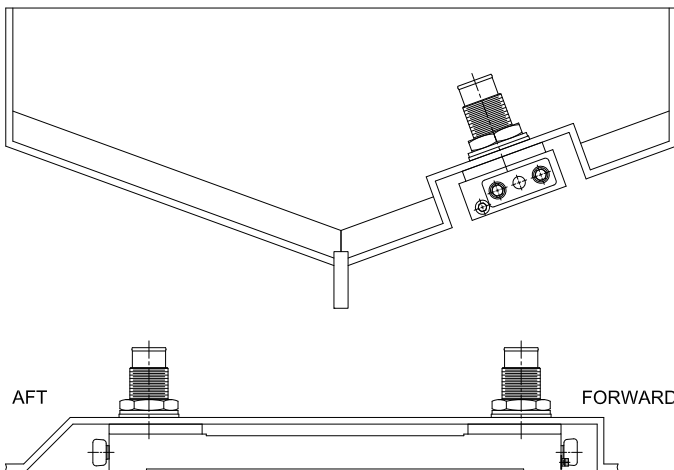


FIG.2 Recess type installation with E1 OPTION end-mounted anodes.

- 1.1.3 When using a two-circuit cooling system, consisting of a high temperature jacketwater circuit and a low temperature aftercooler circuit, make certain the aftercooler circuit cooler is placed forward of the jacketwater circuit cooler. When room allows, they can be installed side by side with the aftercooler circuit lower on the hull (i.e. closer to the skeg or keel) and a divider plate between the high and low temperature units.

- 1.1.4 When the GRIDCOOLER unit is used on a generator set or if your application requires sizing for a hull speed of 0 knots, make sure that sea water can freely circulate past the cooler tubes. Do not recess a generator set unit on the bottom of a flat bottom boat unless the hull section where the unit will be mounted inclines a minimum of 20 degrees (from forward to aft) to avoid entrapment of heated water around the tubes. See Figure 3.

1.2 DETERMINING PROPER LOCATION - DISPLACEMENT VESSELS

- 1.2.1 On vessels performing pushing, towing, dragging or pulling operations, the unit may be installed near the propeller, but not directly above it. See Figure 3. Install the unit to avoid the full impact of the propeller wash as this could cause damage to the unit.

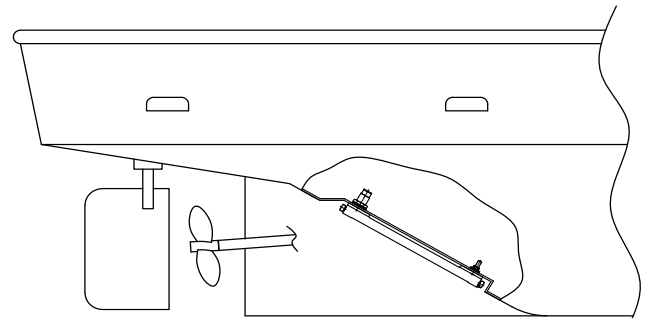


FIG.3 Recessed installation is made by welding in a box-shaped recess in the hull. Note aft end of recess is tapered to prevent hot water entrapment.

- 1.2.2 When installing a unit on the side of a hull, position it well below the water line to avoid aerated surface water. Take the bow wave into consideration. Aeration reduces heat transfer and can cause overheating.

1.3 DETERMINING PROPER LOCATION - PLANING VESSELS

1.3.1 For planing hull vessels, locate the unit as far aft as possible to avoid aeration and impact shock in heavy seas.

1.4 IMPROPER (NOT RECOMMENDED) LOCATIONS

1.4.1 The area of the hull where the GRIDCOOLER® Keel Cooler is installed must not vibrate or flex severely.

1.4.2 To eliminate unnecessary stress and vibration on the cooler, do not locate the unit directly below engine mounts or above the propeller(s).

1.4.3 Make sure that hot water is not discharged on or near the unit.

1.4.4 Do not locate the unit on the front 1/3 of the hull for displacement hulls. Bowthruster coolers could be an exception, depending on the vessel.

1.4.5 The GRIDCOOLER Keel Cooler is designed to be mounted directly to the hull. Do not mount the unit to any external structure without first consulting the factory.

1.5 MOUNTING CONSIDERATIONS - TYPICAL

1.5.1 Some classed vessels (ABS or Coast Guard, for example) may require cofferdams, check with your local officials for more information. For this type of installation, see Cofferdam Installation in Section 3.1.

1.5.2 The GRIDCOOLER unit can be canted from the hull (sideways) to vertically align the nozzles. This can reduce interference problems with stringers on cofferdam installations. See Figure 4. (referred to section 3.1 for cofferdam installation)

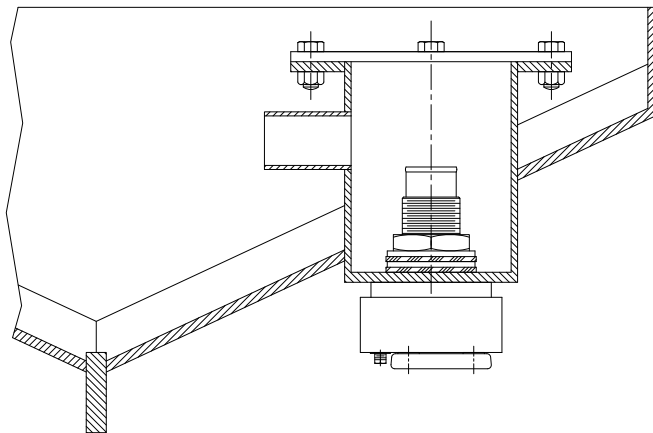


FIG.4 Canted Installation with Cofferdam.

1.5.3 If the unit is recessed into the hull, make sure that there is 1-1/2 in. (38 mm) minimum clearance on all sides (this does not include between the hull and the top of the cooler). The recess should be no deeper than 1/2 in. (13 mm) plus the hull projection (listed on installation drawing) of the cooler.

1.5.4 In extreme cases, where logs, debris, or dragging bottom may endanger the unit, a protective guard may be mounted over the unit. Make certain the guard does not cover more than 25% of the face opening. For examples of protective guards and different installations that have been used, see Figures 5 and 6.

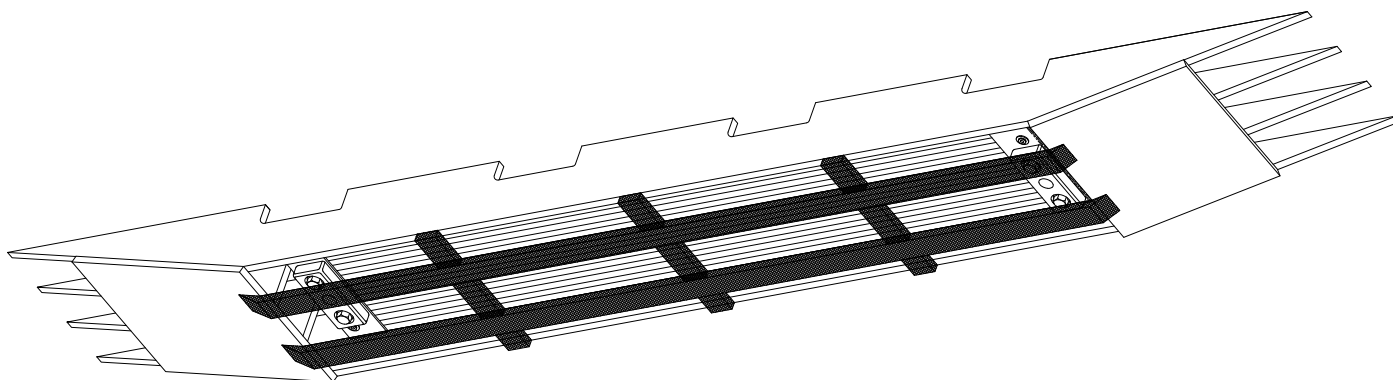


FIG.5 Example of external guarding



FIG.6 Side mounted coolers

1.5.5 Copper-nickel units can be bent to conform to the hull. The bending can be done at the yard or by R. W. Fernstrum & Company. Contact us if you are considering bending a unit. See Section 4.1 – Bending A GRIDCOOLER® Keel Cooler. The bending of aluminum keel coolers is not recommended.

1.6 MOUNTING CONSIDERATIONS - DISPLACEMENT VESSELS

1.6.1 Owners of vessels with displacement hulls moving at less than 10 knots may find an external mounting with fairing blocks to their advantage; provided there isn't much chance of the unit being damaged in their operating environment

1.6.2 When recessing the unit into the side of the hull for generator sets and/or equipment operating at dockside, angle the top of the recess box to improve convection current over the cooler. See Figure 7.

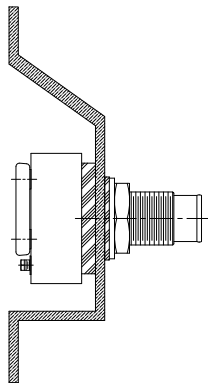


FIG.7 Side Mounted Recess.

NOTE: Recess box with angled top suggested for generator set and equipment operating at dock side only. NOT required for propulsion engines.

- 1.6.3 When installing a multiple-pass unit on an incline, make sure that the nozzles are at the high end to avoid air entrapment. See Figure 8.
- 1.6.4 If coolers must be installed with the nozzles at the low end, special units can be ordered with additional vents in the stud end of the cooler.

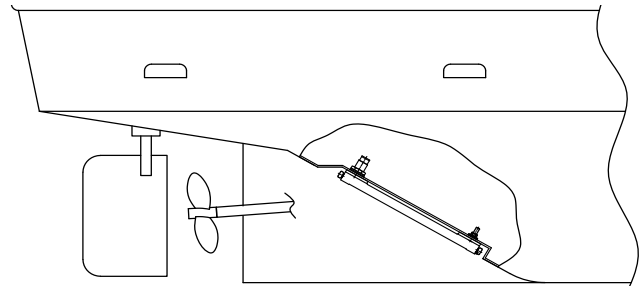


FIG.8 U-Flow unit with E1 OPTION end mounted anodes mounted on rake of vessel with nozzles positioned to avoid air entrapment.

1.6.5 If side plates and fairing blocks are used, make sure that the side plates are scalloped (notched) out so they will not entrap water. Fairing blocks are most effective when installed with a 4 to 1 slope. See Figures 1 & 5.

1.7 MOUNTING CONSIDERATIONS - PLANING VESSELS

- 1.7.1 We recommend using a recess on planing hulls and vessels moving at 10 or more knots.
- 1.7.2 High speed applications (10+ knots) can reduce the 1-1/2 in. clearance recommendation in section 1.5.3 to 1/2 in. minimum due to increased raw water flow over the cooler at high speed.

1.7.3 High speed applications and others that use E1 OPTION™ coolers should take into consideration the removal and replacement of anodes and drain plugs when sizing the length of a recess. See Figure 2.

1.8 BONDING OR ISOLATION TO MINIMIZE CORROSION

- 1.8.1 It is recommended that the installer consult with a corrosion engineer to review the corrosion protection system of the vessel to determine the best mode of installation for their particular situation.
- 1.8.2 Typically, it is common practice to isolate the keel cooler from the hull. This ensures that the antifouling property of the copper-nickel is at full potential. However, there are other variables that may affect the decision whether to isolate or bond the unit.

2.0 INSTALLATION

Once you have decided on the correct location, use the following steps as a guideline for installing your GRIDCOOLER® Keel Cooler.

2.1 MAKING HOLES

2.1.1 Measure the distance between the inlet & outlet nozzles from center to center (also measure to the centers of the support studs when applicable) before cutting holes for them in the ship's hull.

2.1.2 Make the holes through the hull 1/4 in. (6.4 mm) diameter oversized.

2.1.3 Make sure that the hull surfaces where the unit will be mounted are smooth and properly aligned (on steel hulls, if you burn the holes, grind the edges smooth afterwards). This will allow the gaskets to seal properly and ensure that no undue stress will be placed on the cooler.

2.2 FITTING UP

2.2.1 Under normal conditions, the compression of the mounting gaskets puts sufficient tension on the nozzle nuts (and support bolt nuts when applicable) to prevent them from working loose. To seal out

water, apply a bead of sealant to the exterior of the gaskets, and around the points where the nozzles and support bolts penetrate the hull before assembly.

2.2.2 Remember to tighten the nuts again, after the caulking has set.

2.3 COPPER-NICKEL INSTALLATION

2.3.1 Mounting gaskets supplied with the GRIDCOOLER Keel Cooler must be used to provide proper spacing between the unit and the ship's hull. See Figure 9. For exterior gasket thickness see the chart below, all exterior gaskets are available in 1/4" on request

EXTERIOR GASKET THICKNESS				
B	BN	C	CN	D
1/4" 6.4mm	1/2" 12.7mm	1/4" 6.4mm	1/2" 12.7mm	3/4" 19mm

NOTE: INSULATORS: Insulators for galvanic isolation of through-hull installation studs and nozzles are available upon request at time of purchase. When requesting the insulators, provide hull thickness so the insulators can be supplied at the proper length.

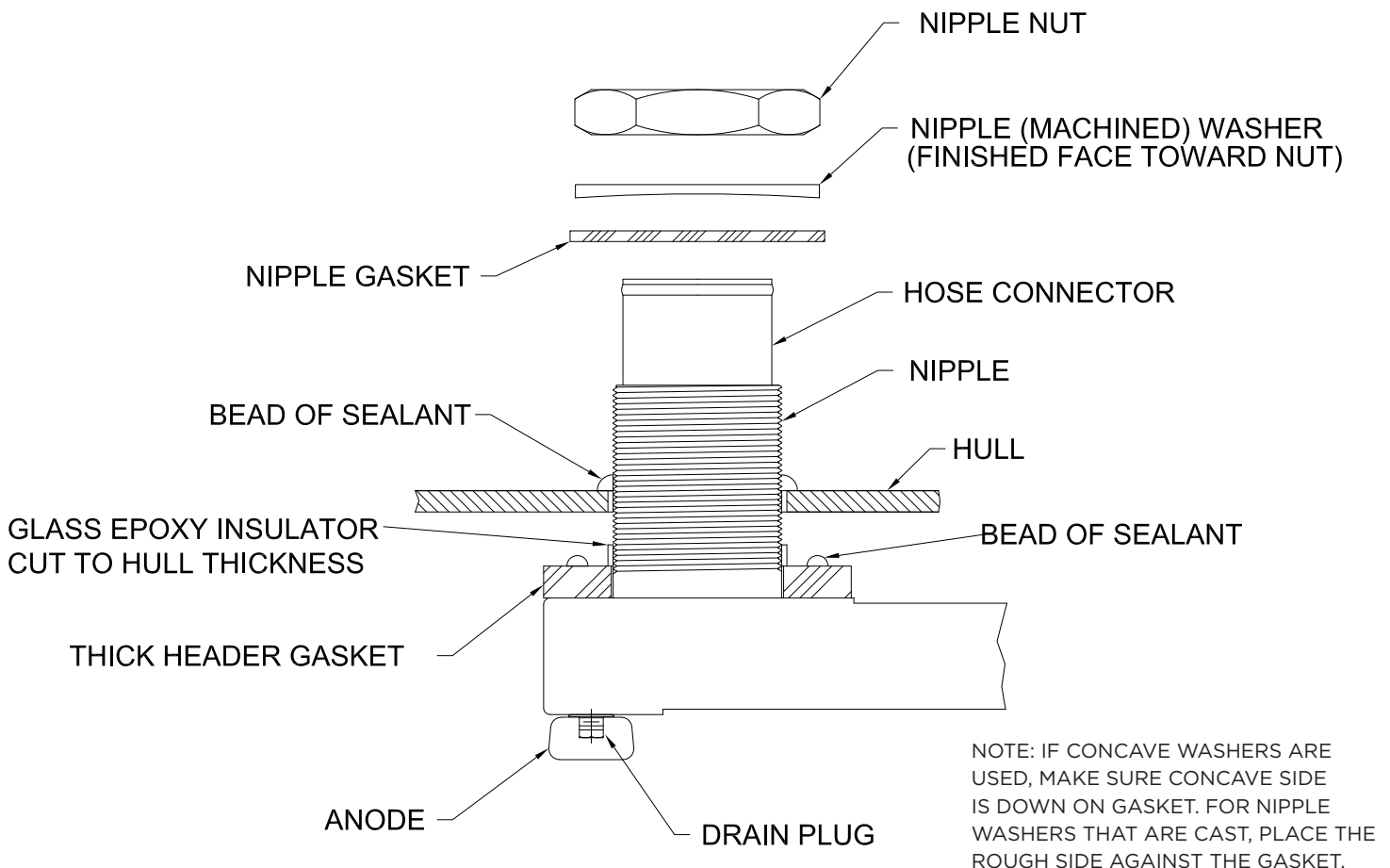


FIG.9 Mounting Parts Placement

2.3.2 To avoid over-tightening any of the supporting nuts, we recommend the following torques for all standard installations:

COPPER-NICKEL UNIT NUT TORQUES FT.-LBS. (KG-M)			
NOZZLE THREAD SIZE			
$\frac{3}{4}$ " 19mm	1 - 1 ½" 25 - 38mm	2" 51 mm	2 ½ - 3 ½" 63 - 89mm
50 - 60 (7 - 8)	75 - 100 (10 - 14)	125 - 150 (17 - 21)	200 - 250 (28 - 35)
HEADER STUD		SUPPORT BOLT	
$\frac{5}{8}$ - $\frac{3}{4}$ " 16 - 19mm	1" 25 mm	$\frac{1}{2}$ - $\frac{3}{4}$ " 13 - 19mm	
35 - 40 (5 - 5 ½)	50 - 60 (7 - 8)	20 - 25 (3 - 3 ½)	

2.3.3 Anodes are standard equipment with copper-nickel units. They minimize the effects of galvanic corrosion and should be replaced when deteriorated. The life of these plates varies with localities.

2.3.4 Attach the anodes using the special bolts and washers supplied with the unit. They can be found in a cardboard box inside the unit shipping box. See Figure 10.

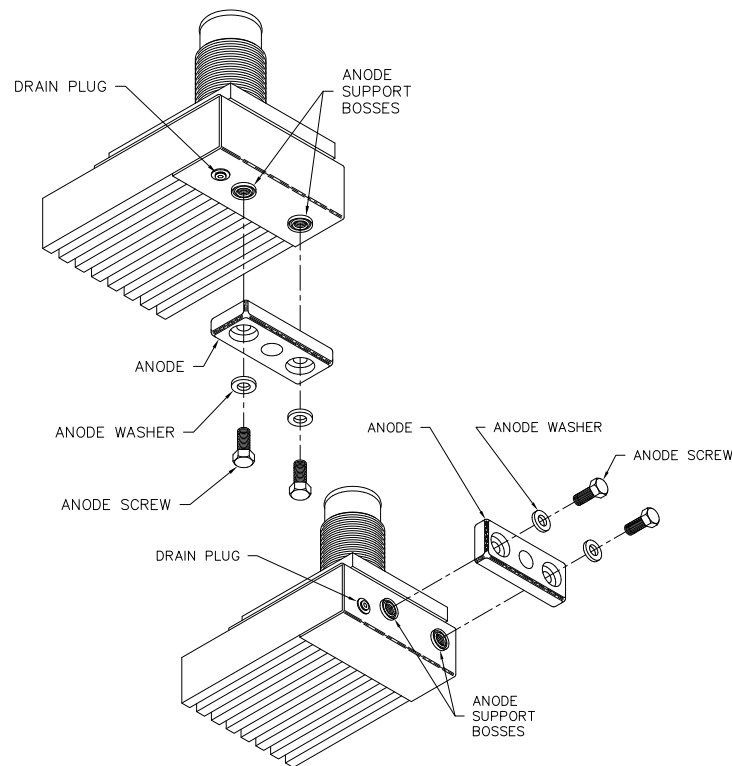


FIG.10 Anode Attachment Detail

NOTE: Anode replacement kits, including anodes, screws, and washers, can be ordered from the factory. They are available with zinc anodes or aluminum anodes upon request. Please provide the model number of your GRIDCOOLER® Keel Cooler to ensure the proper replacement anodes are sent.

2.4 ALUMINUM INSTALLATIONS

2.4.1 Aluminum GRIDCOOLER Keel Coolers should be installed on unpainted aluminum hulls only.

2.4.2 The 1/4-inch mounting gaskets supplied with the unit must be used to provide proper spacing between the cooler and the ship's hull.

2.4.3 To avoid over-tightening any of the supporting nuts, we recommend the following torques for all normal installations:

ALUMINUM UNIT NUT TORQUES FT.-LBS (KG-M)		
NOZZLE THREAD		SUPPORT BOLT
1" 25 mm	1 ½ - 3" 38 - 76mm	$\frac{5}{8}$ " 16mm
75 - 100 (10 - 14)	125 - 150 (17 - 21)	20 - 25 (3 - 3 ½)

2.4.4 Most aluminum units have tapered threads on the nipples and no hose connectors (see installation drawing). These units can be piped directly to the engine, provided flexible couplings are used to remove engine vibration between the engine and the cooler.

2.4.5 If a wire reinforced rubber hose is used to connect the unit to the engine, put a screw-on coupling over the cooler nozzle threads.

2.4.6 Aluminum GRIDCOOLER Keel Coolers do not use anodes.

2.5 PLUMBING

NOTE: Prior to installing cooler, flush entire piping system to remove any debris.

2.5.1 Remove the orange nozzle plugs from the GRIDCOOLER unit before hooking up the plumbing to the cooler.

2.5.2 Engines equipped with inboard raw water heat exchangers may not be able to be converted to keel cooling, please consult your engine dealer and Fernstrum representative for guidance.

2.5.3 As a rule-of-thumb, the expansion tank for your cooling system should be able to hold approximately

10% of the total cooling system coolant. Contact your engine dealer for the exact size.

2.5.4 When piping, do not use tubing or fittings smaller than the engine or keel cooler connections. If those on the engine are larger than those on the keel cooler, reduce the piping at the keel cooler, not the engine. Use a minimum of elbows and check all connections for leaks. All high areas in piping must be vented.

2.5.5 To avoid transmitting engine vibrations to the GRIDCOOLER unit, use wire reinforced rubber hoses and clamps at the engine and keel cooler connections.

2.5.6 When installing a multiple-pass unit in a side mounted position, the inlet line should be connected to the lower nozzle to force air up and out of the cooling system. Special units can be ordered with additional air bleeding vents in the stud end of the cooler.

2.5.7 To avoid air pockets that would restrict coolant flow through the system and cause overheating, install the piping between the engine and the cooler so that it is self-venting.

NOTE: Depending on installation, special air bleeding vents are available as an option.

2.5.8 For piping diagrams for multiple cooler installations, see Figures 11 through 14.

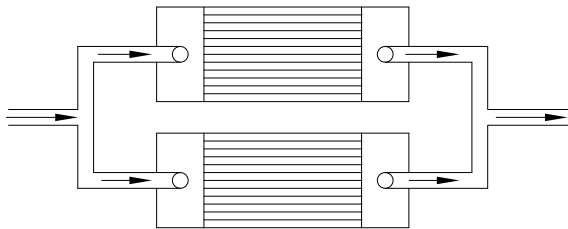


FIG.11 Coolers connected in parallel

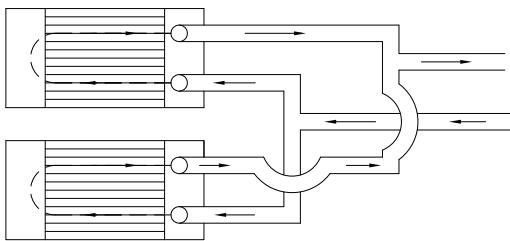


FIG.12 Multiple-pass coolers connected in parallel

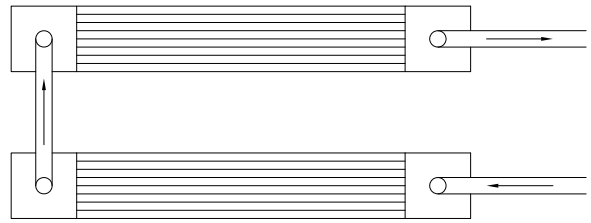


FIG.13 Coolers connected in series

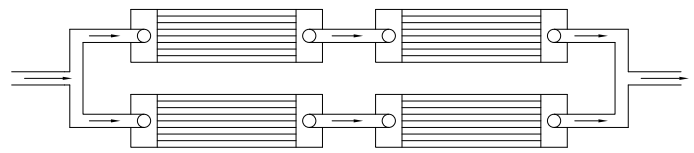


FIG.14 Coolers connected in series parallel

2.6 FILLING & TESTING

NOTE: Do not exceed 35 PSI (2.41 Bar) when pressure testing a GRIDCOOLER® Keel Cooler.

- 2.6.1 Always premix ethylene glycol (antifreeze) with water before adding it to the cooling system. Contact your engine dealer for the proper antifreeze type and percentage for your engine. We do not recommend the use of propylene glycol in your cooling system.
- 2.6.2 Never mix ethylene and propylene glycol-based antifreezes in your cooling system.
- 2.6.3 When installing a GRIDCOOLER Keel Cooler in a side mounted position, it is important that the unit is completely filled with coolant before launching the vessel. This can be accomplished by using the following procedure:
 - 2.6.4 At the outlet end of the unit, remove the upper drain plug and fill the unit with coolant
 - 2.6.5 When coolant runs out of the upper drain, replace the plug.
 - 2.6.6 The unit is now filled with coolant. If the system is ever drained, you must repeat this procedure.

3.0 SPECIAL INSTALLATIONS

3.1 COFFERDAM INSTALLATION WITH COMPRESSION SEALING KIT

- 3.1.1 Place a continuous bead of sealant around the header gasket that separates the GRIDCOOLER® unit from the outer hull. Customers have reported good success with polysulfide rubber sealants.
- 3.1.2 Place a second continuous bead of sealant on the inner hull around the nipple. This bead must be in contact with the hull and the nipple.
- 3.1.3 Hoist the unit up into the mounting position. The exterior header gasket must be in full contact with the hull.

- 3.1.4 Place the nipple gasket (harder of the two interior gaskets) down over the nozzle as far as possible.
- 3.1.5 Place the unfinished cast washer down over the nipple as far as possible. The side of the washer marked “up” must face away from the hull.
- 3.1.6 Place the compression gasket (softer of the two interior gaskets) down over the nipple as far as possible.
- 3.1.7 Place the semi-finished washer down over the nipple, finished side away from the hull.
- 3.1.8 Run the nut down over the nipple and torque to spec. (See chart in Section 2.3.2)
- 3.1.9 Torque the nut to spec a second time after the sealant has set.

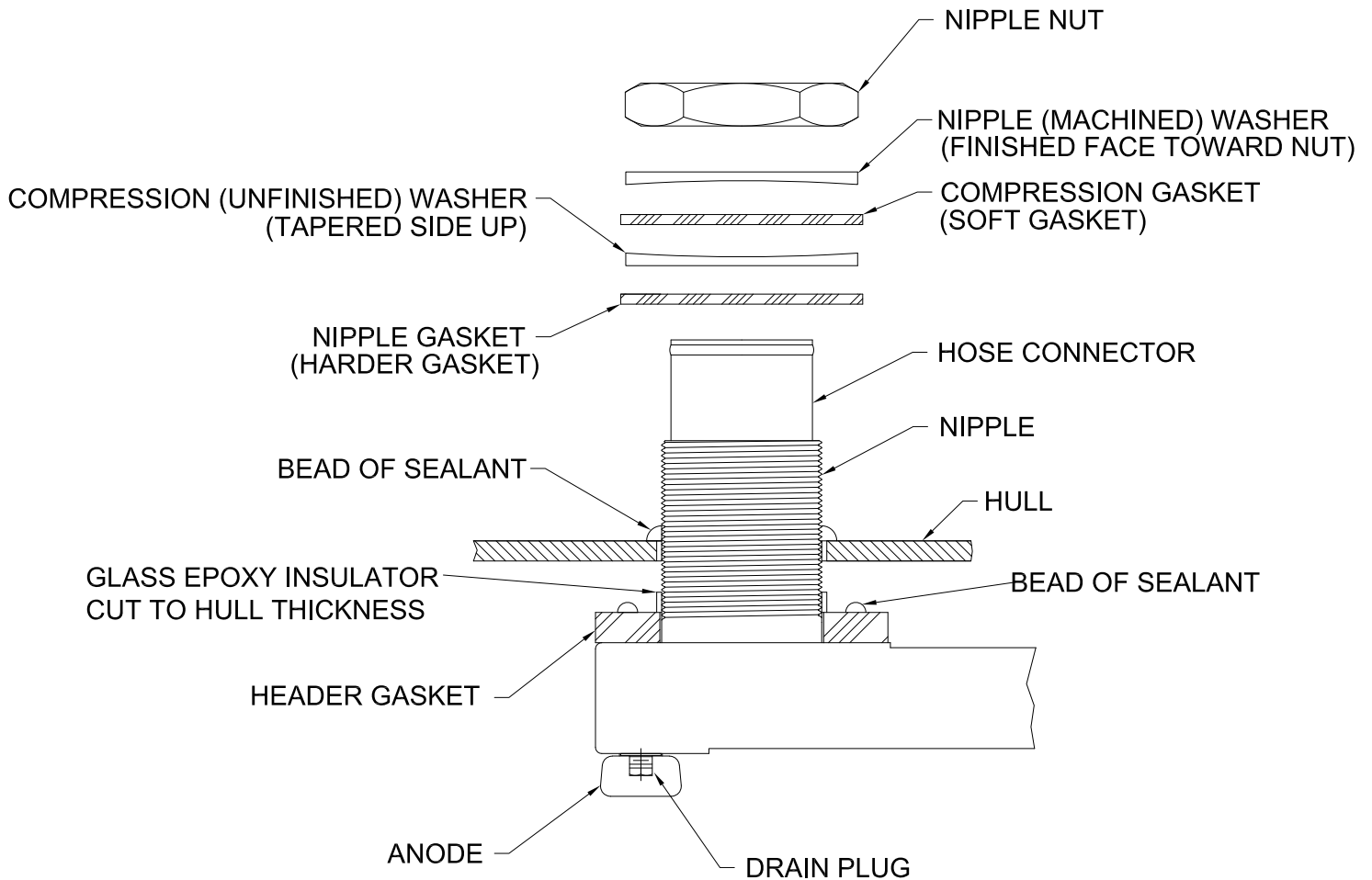


FIG.15 Compression Sealing Parts Replacement

OPTION: For ease of installation and maintenance, pipe to the side of the cofferdams. (see Figure 16)

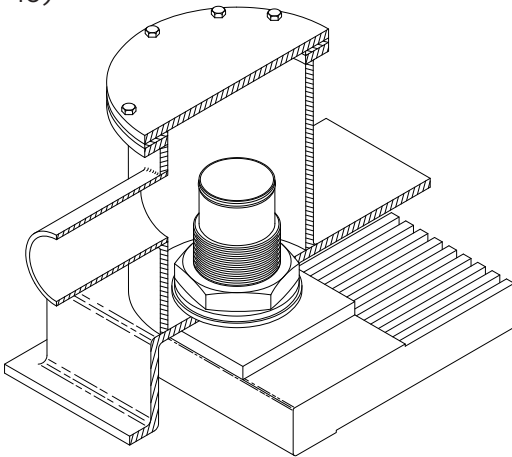


FIG.16 Pipe to side of cofferdam

3.2 Z OPTION™ INSTALLATIONS

3.2.1 The Z OPTION GRIDCOOLER Keel Cooler replaces the standard through-hull nozzle mounting/connecting means with a copper-nickel flange, fused to the header. This flange utilizes a plurality of stainless-steel mounting studs locked in place by set screws to allow replacement in the event of damage.

3.2.2 The unit is also supplied with mating ASTM steel flanges and flange mounting hardware. The supplied hardware illustrated in Figure 17 includes nylon shoulder washers combined with neoprene gaskets to allow isolation from the vessel's hull. Special extra heavy lock nuts and washers are provided for a secure installation.

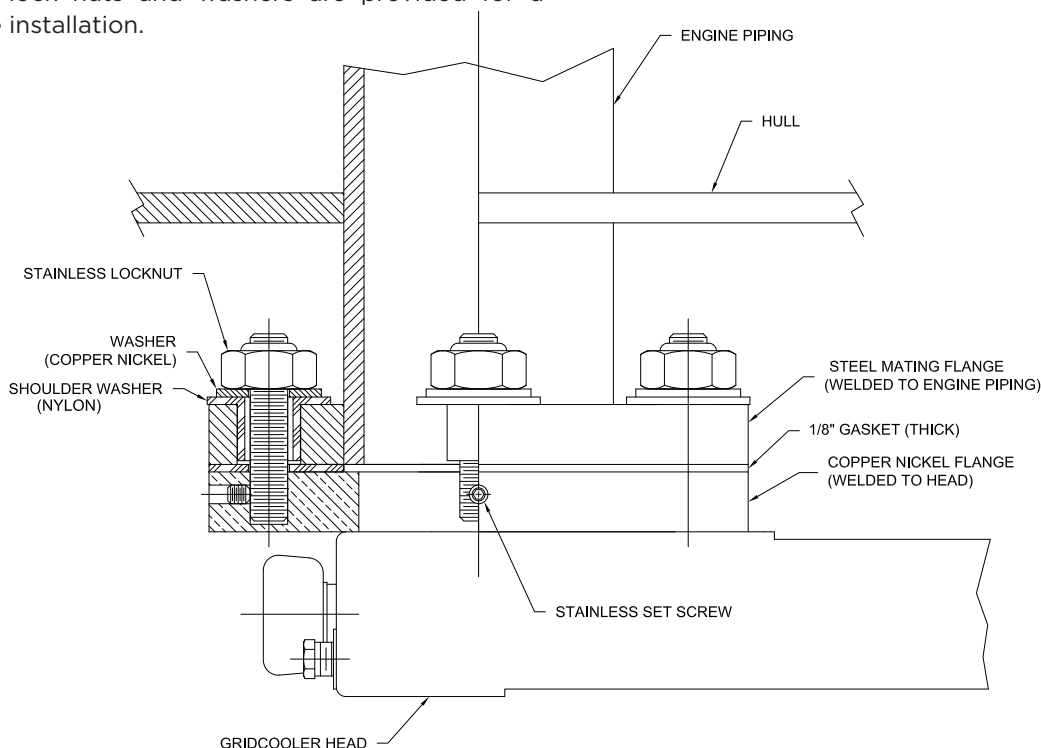


FIG.17 Z OPTION mounting detail

3.2.3 Flange mounting hardware can be found in a cardboard box inside the unit shipping box.

3.2.4 The mating steel flange is welded to a pipe stub extending from the hull of the vessel. This pipe stub must be long enough to allow access to the flange lock nuts for tightening. Alignment of the flanges on the hull is critical. We suggest that a template be made of the cooler to aid with the proper alignment of the flanges.

NOTE: Temporarily remove nylon shoulder washers while welding. Re-insert prior to mounting cooler

The torque specification for the flange nuts is as follows:

FLANGE NUT TORQUE SPECIFICATIONS	
$\frac{5}{8}$ " diameter or larger stud	$\frac{1}{2}$ " diameter stud
35 - 40 FT. LBS.	20 - 25 FT. LBS.

NOTE: Z OPTION units utilize our L OPTION™ support plates for intermediate mounting of the cooler. See the next section for L OPTION mounting instructions.

3.3 L OPTION™ SUPPORT PLATE INSTALLATION

The L OPTION support plates do not require a through-hull penetration. These support plates extend beyond the sides of the keel cooler allowing the customer the option to weld a mounting stud directly to the hull or to weld a short piece of angle to the hull as a securing means. The customer can then install the appropriate fasteners for the support plates.

Figures 18 and 19 show examples of this style of mounting. The combination of the neoprene gasket and the nylon shoulder washer provide isolation of the cooler from the hull.

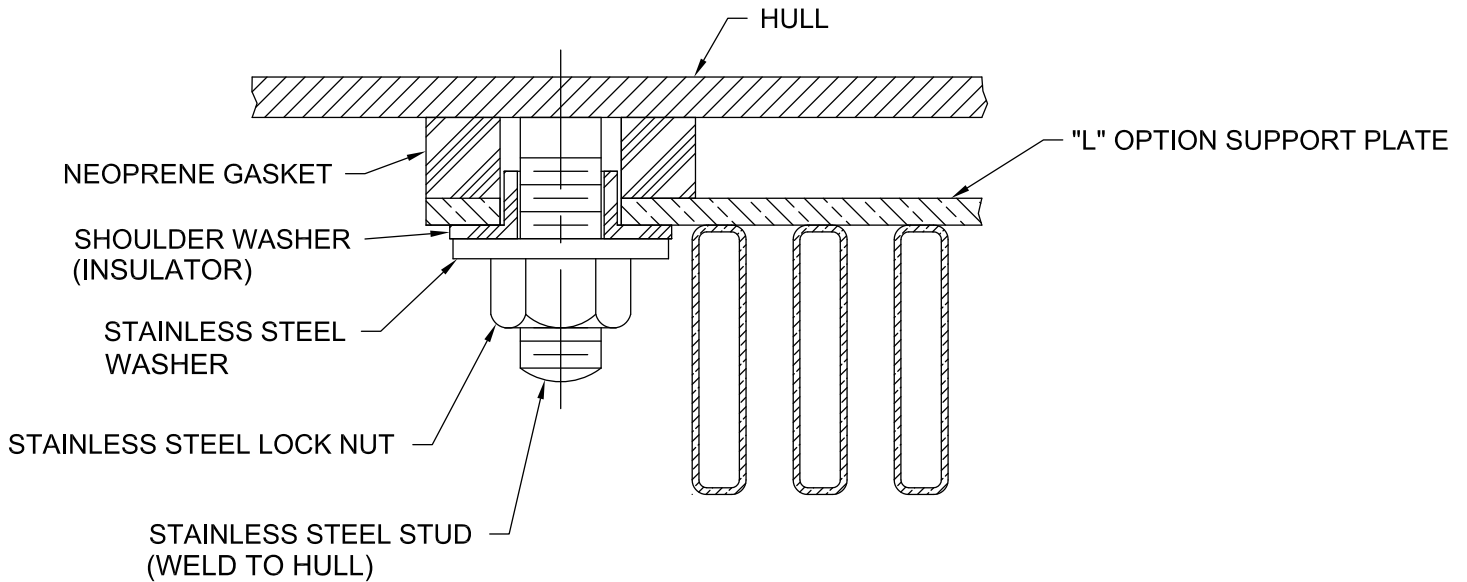


FIG.18 L OPTION support plate with stud welded to hull

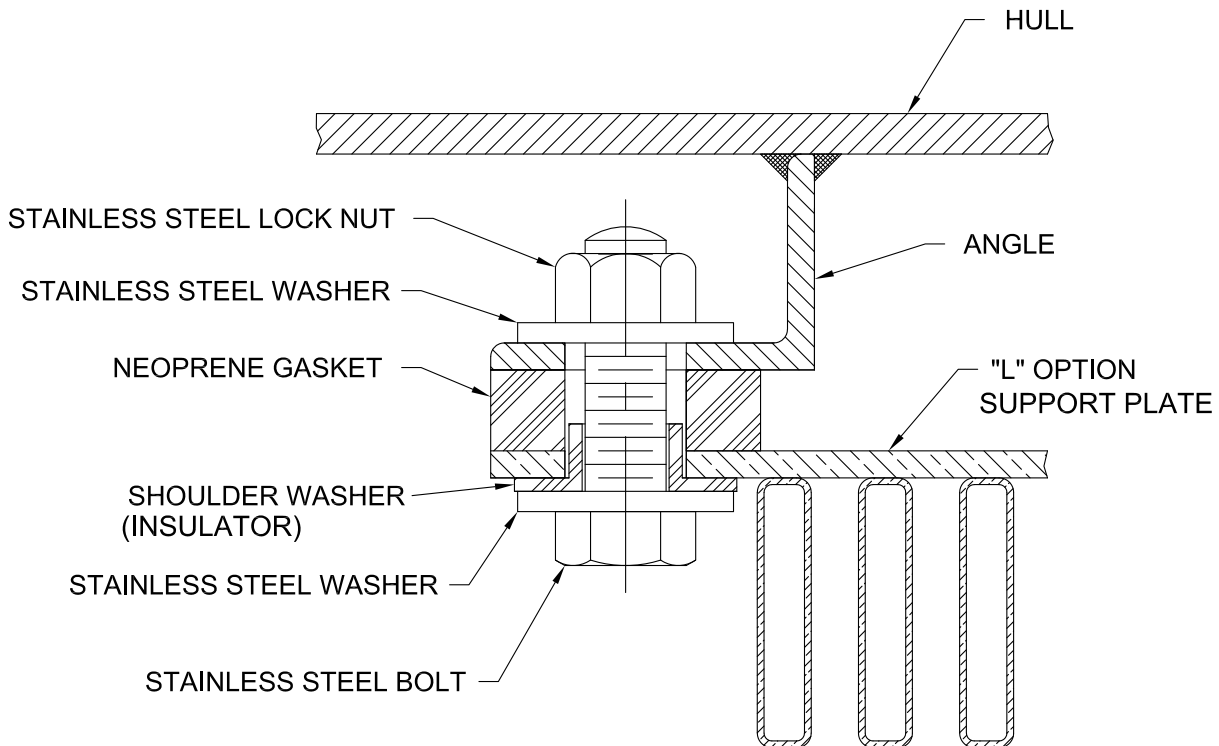


FIG.19 L OPTION support plate with angle welded to hull

3.4 MOUNTING COPPER-NICKEL COOLERS ON ALUMINUM HULLS

- 3.4.1 An electrical barrier must be placed between the GRIDCOOLER® unit and the hull. R. W. Fernstrum & Company does not formally approve any method of installing a copper-nickel GRIDCOOLER Keel Cooler on unpainted aluminum hulled vessels. However, the following technique has been used on hundreds of boats.
- 3.4.2 Sandblast the area of the hull where the unit will be installed.
- 3.4.3 Coat the sandblasted area with a two-part fiberglass epoxy resin.
- 3.4.4 Spray the resin on in four separate coats. Do not use any matting. Spray each coat just heavy enough so that it does not start to run off.
- 3.4.5 After spraying on the fourth coat, and while the resin is still tacky, prime the entire area with the hull priming paint used on the rest of the vessel's hull.
- 3.4.6 Apply the final bottom paint, and then install the cooler.

4.0 FORMING THE GRIDCOOLER® KEEL COOLER

BENDING A GRIDCOOLER KEEL COOLER

When bending a cooler in a press, support the cooler from underneath with wood blocking across the entire width of the unit. Blocking is also placed on top of the cooler, centrally located between the wood blocking underneath the cooler. The location of the wood blocking on the top of the cooler will determine the location of the bend. Since this method of bending exerts pressure on only a small area, the cooler will need to be repositioned multiple times to produce an even bend over the length of the cooler. Care must be taken to ensure that the unit is not bent too far at any one point. A tape measure or other measuring instrument, along with a template of the hull profile can be used to measure your progress. See Figures 20 and 21.

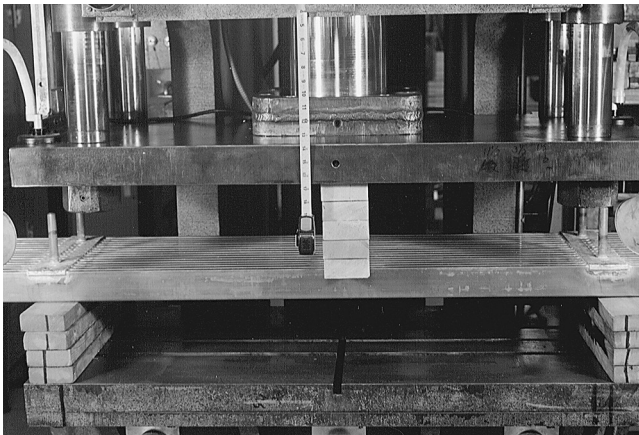


FIG.20 Creating a bend in a cooler using a hydraulic press

TWISTING A GRIDCOOLER KEEL COOLER

To produce a twist, first fabricate a hook onto the end of a short length of pipe using barstock. Hook this bar across the header as close to the nipple or stud as possible. The cooler may be secured in a press or placed on sawhorses with a person at each end. By placing your weight on the end of the pipe, you can produce a twist in the cooler. See Figures 22 and 23.

NOTE: Do Not Bend greater than 1" (25 mm) over 12" (305 mm) of cooler length. Do Not Twist beyond 1° over 12" (305 mm) of cooler length. Do Not Tension Bend the keel cooler.

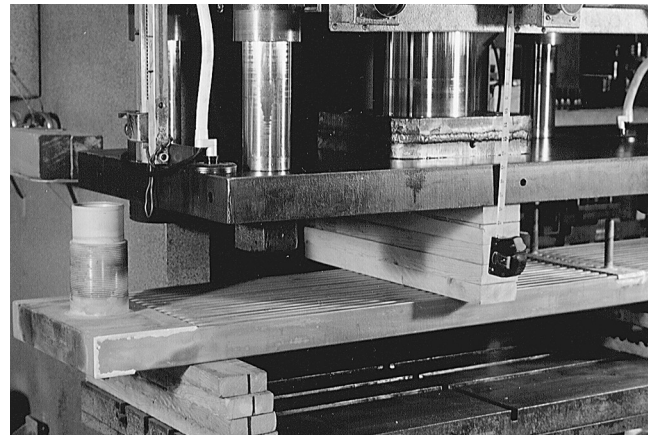


FIG.21 Creating a bend in a cooler using a hydraulic press



FIG.22 Locate twisting hook as close as possible to the nozzle or stud

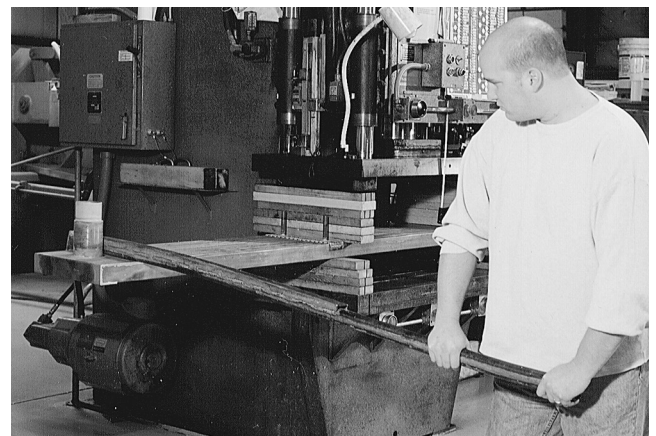


FIG.23 Carefully apply downward force to impart a twist in the cooler

5.0 PERFORMANCE ISSUES

Determining the cause of overheating can be difficult. Here are some things to look for:

WIRE REINFORCED RUBBER HOSE:

Could the rubber hose connecting the engine piping and the cooler be collapsed? This could cut the cooling water supply to the unit and reduce its efficiency. Be sure you are using wire reinforced rubber hose.

PIPING:

Is the piping between the engine and the cooler as large or larger than the engine and cooler connections? (See section 2.5.4 under plumbing.) The piping should also be self-venting and arranged so that a minimum number of elbows are used.

JACKETWATER:

Is the coolant circulating through the cooler? It may be taking a path of least resistance through the bypass (if one exists).

THERMOSTAT:

Could the thermostat be stuck, or could the wrong thermostat be in use? If so, it could give you a faulty temperature.

CIRCULATING PUMP:

Is the circulating pump working properly? If not, it could reduce the cooling systems efficiency.

AIR IN THE SYSTEM:

Was the unit installed in a way to allow all the air in the system to escape? When a multiple-pass unit is mounted on the rake of the vessel, make sure that the nozzles are mounted in the up or high position. See sections 1.6.3, 2.5.6, 2.5.7, & 2.6.3 under Installation. See Figure 8

FOREIGN MATTER:

Could anything have gotten into the cooler nozzles? Make sure that the orange plastic cap plugs covering the ends of the hose connectors were removed and that no foreign matter, such as a rag, was dropped into the cooler nozzles.

EXPANSION TANK:

Could the water level be too low in the expansion tank? This can reduce the cooling system's efficiency.

EXTERNAL COATING:

Is the cooler painted or covered with any other coating? This will have an insulating effect and will greatly reduce the heat transfer rate of the unit. The standard recommendation is to not coat the keel cooler.

WATER AERATION:

Could the water around the cooler be aerated in any way? Aeration will reduce the heat transfer rate of the keel cooler.

MOORED AT DOCK:

Is the engine temperature rising while the vessel is moored in dock? If the unit is installed near the propeller, engage the propeller to circulate water past the unit, after taking the proper safety precautions.

PLACEMENT:

Is an aftercooler circuit overheating? Make sure that the low temperature cooling circuit is mounted forward of or closer to the skeg or keel than the jacketwater coolers.

MOUNTING GASKETS:

Were the mounting gaskets put in place when the unit was installed? The mounting gaskets supplied with the cooler must be used to provide adequate spacing between the unit and the ship's hull. This will allow water to flow freely over the cooler tubes.

GLYCOL:

How much glycol (antifreeze) is in the system? Perhaps the cooler was not sized for the use of glycol in the system.

NOTE: Always premix glycol with water before adding it to the cooling system.

NOTE: Never mix ethylene and propylene glycol.

CRUSHED TUBES:

Have the rectangular tubes on the cooler been crushed or pinched? This could restrict the internal water flow.

BLOWN TUBES:

Could the rectangular tubes on the unit have been blown or bulged by unusually high pressures? If so, the exterior water flow past the unit tubes could be impaired, retarding heat transfer.

MARINE GROWTH:

Has your vessel been in dock for several months? You may find marine growth on the unit which will hinder the unit's heat transfer rate. See Maintenance Section.

OIL DEPOSITS:

Have you had engine problems? Oil may have gotten into the cooling water system and collected in the cooler, coating it with an oil film. See Maintenance Section.

MINERAL DEPOSITS:

Could you be using hard water in the system? Mineral Deposits can collect on the tube in the cooler, lining the inside with lime, calcium, etc. See Maintenance Section.

6.0 MAINTENANCE

A GRIDCOOLER® Keel Cooler that is clean inside and out will dissipate heat most efficiently. To keep your unit clean, a periodic check of the cooling system is recommended. What follows are some ways to clean your GRIDCOOLER unit.

EXTERIOR

If the GRIDCOOLER Keel Cooler is used regularly, the 90/10 copper-nickel alloy in conjunction with the unit's operating temperature will tend to keep the exterior of the unit relatively free of marine growth. However, if the unit is not in operation for extended periods of time, marine growth may result. Below are some ways of removing marine growth, paint, etc. from the exterior of the GRIDCOOLER unit:

SCRAPE:

Scraping is an effective way of removing larger matter from a cooler. The use of a rectangular instrument works best.

PRESSURE WASHING:

Pressure washing is effective in cleaning many things off of a cooler. Do not exceed 3000 psi (206.84 bar).

SANDBLAST:

Sandblasting is also very effective, but very fine sand such as 40 to 60 grit blasting media should be used.

For suction blast do not exceed 90 psi (6.21 bar).

For pressure pot blasting do not exceed 35 psi (2.41 bar).

NOTE: Never sandblast an ALUMINUM GRIDCOOLER unit.

PAINTING:

Coolers do not require painting. Doing so will decrease the unit's efficiency.

ANODES:

Anodes are standard equipment with most copper-nickel units. They minimize the effects of galvanic corrosion and should be replaced when deteriorated. The life of these anodes varies with localities.

Anode replacement kits, including anodes, screws, and washers, can be ordered from the factory. When contacting our sales representatives, provide the model number of your GRIDCOOLER Keel Cooler. Anodes are available in aluminum or zinc material.

NOTE: Anodes installed on coolers provide immediate protection to the cooler only. When using an active protective system, the cooler should be taken into consideration during the hull survey.

INTERIOR

The interior of your GRIDCOOLER unit may need periodic cleaning to remove oil, old glycol, mineral deposits, etc. The easiest and most convenient way of doing this is the use of a radiator flush. Contact your engine dealer for the proper radiator flush type for your engine.

PRESSURE TESTING

Do not exceed 35 psi (2.41 bar) when pressure testing a GRIDCOOLER® Keel Cooler.

7.0 REPAIR

For a unit in warranty, attempt no repairs without first contacting the manufacturer, otherwise your warranty will be void.

For a unit out of warranty, if the unit is accidentally damaged while in use, you can make minor shipyard repairs as follows:

STRAIGHTENING

If the tubes are accidentally bent, they can be straightened with a hard wood block and a mallet. See Figure 24.



FIG.24 Straightening tubes with a wooden block & mallet

COPPER-NICKEL GRIDCOOLER® KEEL COOLER REPAIRS

BRAZING:

Drain the cooler before brazing. Clean the area or joint to be brazed thoroughly with a good degreasing solvent followed by wire brushing. The braze wire should be 56% silver, AWS A5.8 BAg-7. See Figure 25.

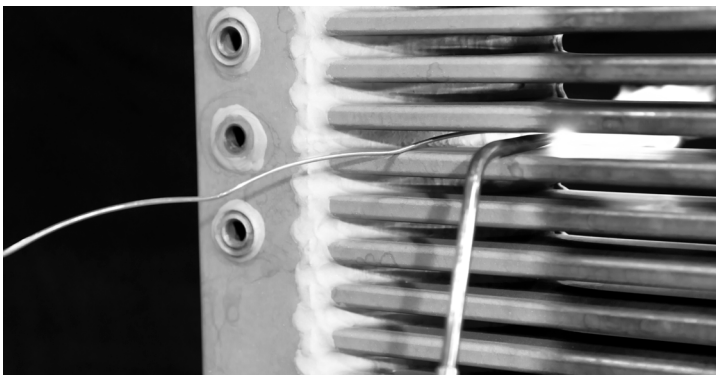


FIG.25 Brazing repair

TIG WELDING:

C70600 copper-nickel or monel 67 wire may be used.

TEMPORARY REPAIR

For temporary repairs, liberally apply an epoxy compound.

Before applying the epoxy compound, clean the surface of the GRIDCOOLER unit and relieve any internal pressure.

For major repairs not covered by our Limited Warranty, contact us. Give us a complete description of the damage, and we will tell you if and how your unit can be repaired.

TUBE COUPLING REPAIRS

A damaged section of D or C tube can be replaced with two couplings and a replacement length of tube brazed in place.

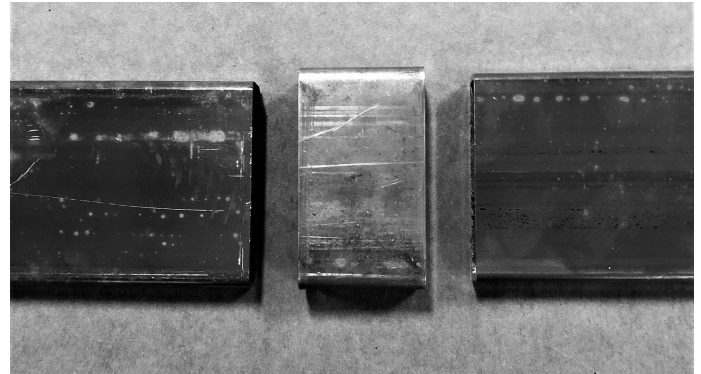


FIG.26 Replacing a section of tube

A single coupling can be cut or split, slid over the tube, and brazed into place to patch a hole in a tube.

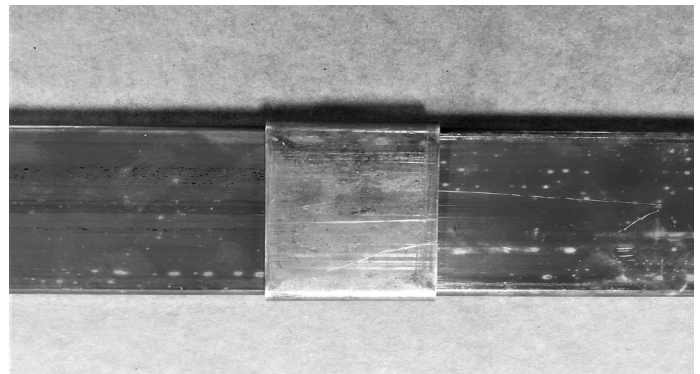


FIG.27 Patching a hole in a tube

ALUMINUM GRIDCOOLER KEEL COOLER REPAIRS

TIG WELDING:

Drain the cooler before welding. Clean the area or joint to be welded thoroughly with a good degreasing solvent followed by stainless steel wire brushing. The aluminum filler rod used in the GRIDCOOLER Keel Cooler is R 5554 aluminum wire.

8.0 STRAY-CURRENT CORROSION

Since Fernstrum's involvement in the design of any particular marine vessel is limited to the heat transfer requirements of the vessel, grounding or bonding of the keel cooler is best left to the person responsible for the design of the corrosion protection system. If the customer needs guidance on this issue it is suggested to isolate the cooler from the hull and monitor closely the condition of the cooler, anodes and surrounding hull area for the first few months. This is for the simple fact that it is easier to ground a cooler after installation than it is to isolate it.

When welding is taking place on the hull while in the water, steps should be taken to monitor the keel cooler for any possible stray current corrosion. For guidance on proper welding equipment connections for waterborne vessels, we suggest consulting either *NAVSEA S9086-CH-STM-010/CH-074R4 Welding and Allied Processes, Naval Ships' Technical Manual Chapter 74 - Volume 1*, or *ANSI/AWS D3.5:1993(R2000) Guide for Steel Hull Welding, Section 6 Stray Current Protection*. Note that the Section 6 of the ANSI/AWS D3.5:1993 standard comes directly from the document provided by NAVSEA.

If an impressed current system is used, it is best to consult the manufacturer of the system for their recommendations as to grounding or bonding of equipment mounted to the hull.

The product warranty is not affected by how the keel cooler is configured into the corrosion protection system, as it covers defects in material and workmanship, not failure due to galvanic or stray current corrosion.

The best plan of action is to have a corrosion engineer evaluate the corrosion protection scheme of the vessel and verify its proper function.

9.0 REPLACEMENT PARTS

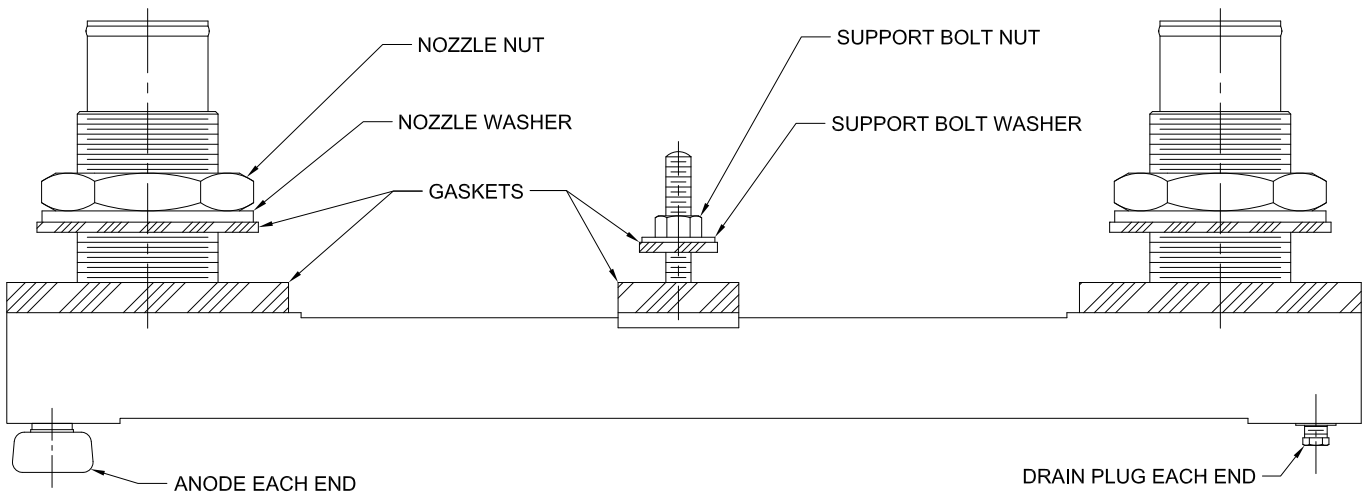


FIG.28 Single Pass Gridcooler Keel Cooler

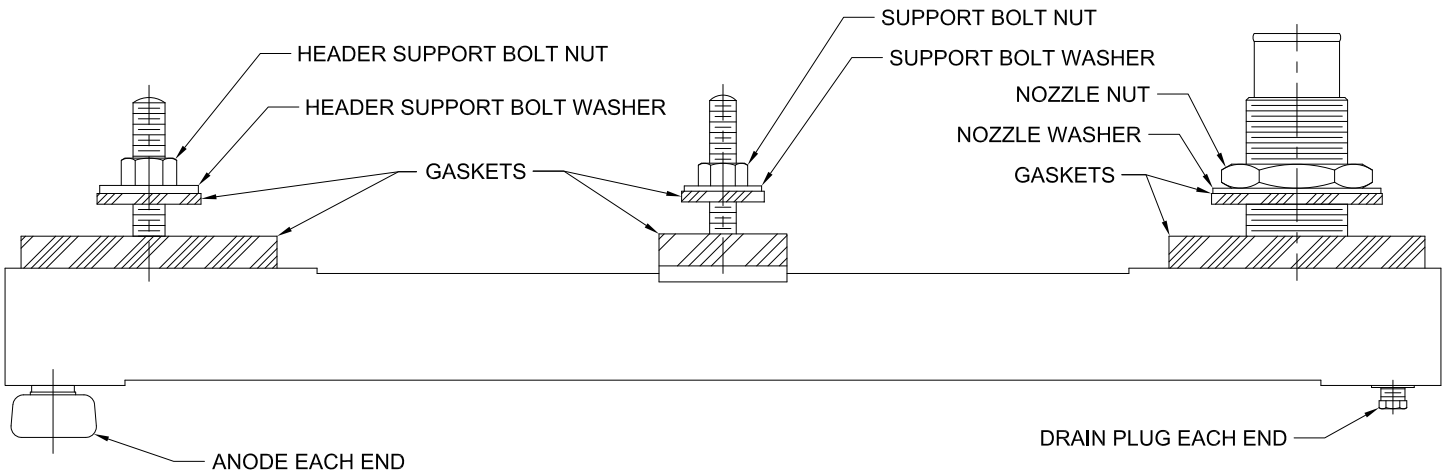


FIG.29 Multi Pass Gridcooler Keel Cooler

9.0 REPLACEMENT PARTS

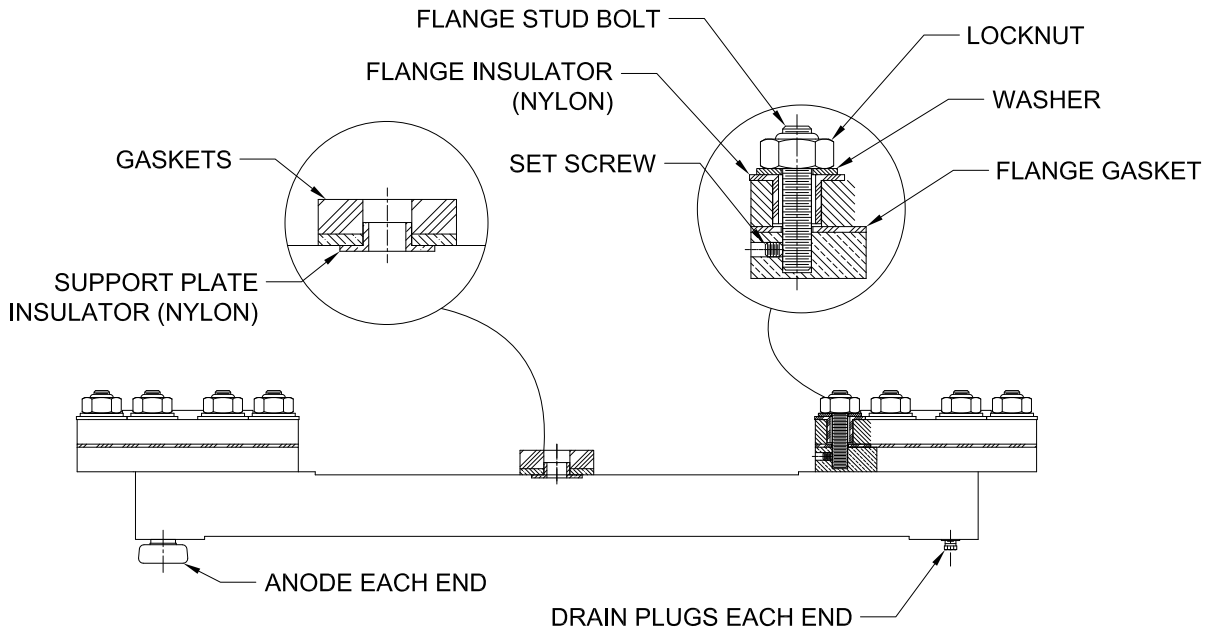


FIG.30 Z-Option Single Pass Gridcooler Keel Cooler

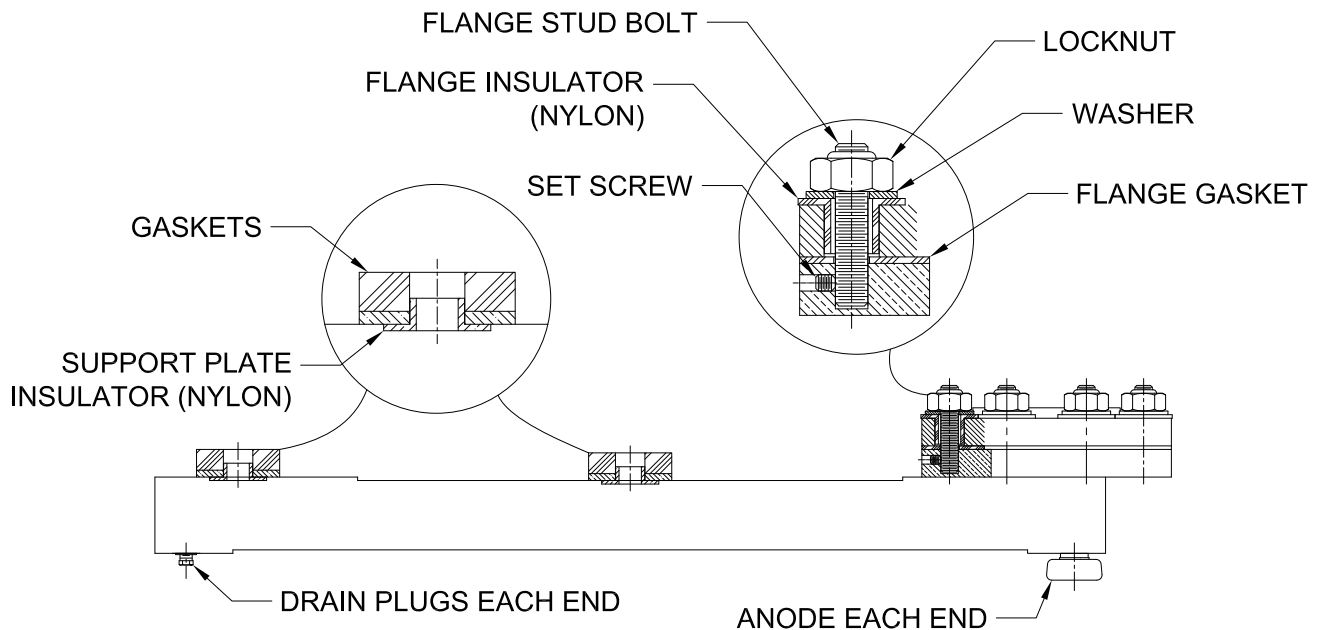


FIG.31 Z-Option Multi Pass Gridcooler Keel Cooler

NOTE: All gaskets are sold in complete sets. Gasket sets include all internal gaskets, exterior gaskets and isolators.

NOTE: Anodes are sold in kits consisting of anodes and mounting hardware. Most Keel Coolers require one (1) anode kit. Larger Keel Coolers may require two (2) anode kits. Keel Cooler model number is needed to identify correct kit. Anodes are standardly sold in zinc, but can be aluminum upon request.

10.0 LIMITED WARRANTY

THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS, WHICH VARY FROM STATE TO STATE.

THE LIMITED WARRANTY CAN ALSO BE FOUND

ONLINE AT <http://www.fernstrum.com/support/grid-cooler-keel-cooler/> AND IN THE DOCUMENTATION WE PROVIDE WITH THE PRODUCT.

WE WARRANT THAT DURING THE WARRANTY PERIOD, THE PRODUCT WILL BE FREE FROM DEFECTS IN MATERIALS AND WORKMANSHIP.

TO THE EXTENT NOT PROHIBITED BY LAW, THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, ORAL, WRITTEN, STATUTORY, EXPRESS OR IMPLIED. EXCEPT FOR THE EXPRESS WARRANTIES CONTAINED IN THIS LIMITED WARRANTY STATEMENT AND TO THE EXTENT NOT PROHIBITED BY LAW, WE DISCLAIM ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. SOME STATES DO NOT ALLOW DISCLAIMERS OF IMPLIED WARRANTIES, SO THIS DISCLAIMER MAY NOT APPLY TO YOU. TO THE EXTENT SUCH WARRANTIES CANNOT BE DISCLAIMED UNDER THE LAWS OF YOUR JURISDICTION, WE LIMIT THE DURATION AND REMEDIES OF SUCH WARRANTIES TO THE DURATION OF THIS EXPRESS LIMITED WARRANTY. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

OUR RESPONSIBILITY FOR DEFECTIVE GOODS IS LIMITED TO REPAIR OR REPLACEMENT AS DESCRIBED BELOW IN THIS WARRANTY STATEMENT.

10.1 WHO MAY USE THIS WARRANTY?

R.W. Fernstrum & Company, located at 1716 11th Ave. Menominee, Michigan 49858 USA (“we”) extend this limited warranty only to the original purchaser of the product (“you”). This limited warranty does not extend to any subsequent owner or other transferee of the product.

10.2 WHAT DOES THIS WARRANTY COVER?

This limited warranty covers defects in materials and workmanship of the GRIDCOOLER® Keel Cooler (the “product”) for the Warranty Period as defined below.

10.3 WHAT DOES THIS WARRANTY NOT COVER?

This limited warranty does not cover any damage due to: (a) transportation; (b) storage; (c) misuse, improper use or improper installation; (d) failure to follow the product instructions or to perform any preventive maintenance (e) modifications (f) unauthorized repair;

(g) normal wear and tear; or (h) external causes such as accidents, abuse, chemical, biological or electrical corrosion or other actions or events beyond our reasonable control.

10.4 WHAT IS THE PERIOD OF COVERAGE?

This limited warranty starts on the date of delivery and lasts for 90 days for the aluminum GRIDCOOLER® Keel Cooler, and lasts for 2 years for the copper-nickel GRIDCOOLER® Keel Cooler (the “Warranty Period”). The Warranty Period is not extended if we repair or replace the product. We may change the availability of this limited warranty at our discretion, but any changes will not be retroactive.

10.5 WHAT ARE YOUR REMEDIES UNDER THIS WARRANTY?

With respect to any defective product during the Warranty Period, we will, in our sole discretion repair or replace such product (or the defective part) free of charge. The cost of repair or replacement does not include labor, transportation, freight, haul-out, launch, towing, dry docking, storage charges, mechanic travel time, inconvenience, loss of time or income, removal and replacement and/or modifications of any boat parts to facilitate repair or replacement.

HOW DO YOU OBTAIN WARRANTY SERVICE?

To obtain warranty service, you must call (906) 863-5553 during the Warranty Period to obtain a Return Merchandise Authorization (“RMA”) number. No warranty service will be provided without an RMA number. The product or part must be returned with the RMA number noted. You are responsible for the cost of shipping the returned product or part. Upon calling the above number, customer service will walk you through the steps to request warranty service.

LIMITATION OF LIABILITY

THE REMEDIES DESCRIBED ABOVE ARE YOUR SOLE AND EXCLUSIVE REMEDIES AND OUR ENTIRE LIABILITY FOR ANY BREACH OF THIS LIMITED WARRANTY. OUR LIABILITY SHALL UNDER NO CIRCUMSTANCES EXCEED THE ACTUAL AMOUNT PAID BY YOU FOR THE DEFECTIVE PRODUCT, NOR SHALL WE UNDER ANY CIRCUMSTANCES BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL OR PUNITIVE DAMAGES OR LOSSES, WHETHER DIRECT OR INDIRECT.

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

WHAT CAN YOU DO IN CASE OF A DISPUTE WITH US?

The following informal dispute resolution procedure is available to you if you believe that we have not performed our obligations under this limited warranty: should a dispute arise, you should contact customer service at (906) 863-5553. You must use this informal procedure before pursuing any legal remedy in the courts. All such disputes shall be governed by the laws of the State of Michigan to the extent that the same do not conflict with the laws of the United States.

11.0 RECOMMENDATION FORM

*Required Information

COMPANY NAME* _____

CONTACT NAME* _____

ADDRESS _____

CITY, STATE, ZIP CODE _____

COUNTRY _____

PHONE* _____ **FAX** _____

EMAIL* _____

VESSEL NAME / PROJECT NAME _____

PRODUCT DESIRED* GRIDCOOLER® Keel Cooler BOXCOOLER

ENGINE TYPE* Propulsion Bow Thruster Generator Other _____

Emissions Data Tier 1 Tier 2 Tier 3 IMO

Manufacturer* _____

Model* _____

Rating (BHP / RPM, BKW / RPM, EKW / RPM)* _____

Minimum Hull Speed at Full Rated Power (under full load)* _____

Maximum Sea Water Temp* _____ **Engine Age** _____ **% Antifreeze Used*** _____

Make & Model of Gear _____

Type of Boat (ferry, trawler, pleasure boat, etc.)* _____

Hull Construction* Steel Fiberglass Wood Aluminum Painted

Cofferdam Installation Aluminum Unpainted

Heat Rejection _____

Fresh Water Flow Rate _____

Fresh Water Temp into Cooler _____

Fresh Water Temp Out or Drop Across Cooler _____ Drop

Out

Comments

FERNSTRUM®

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