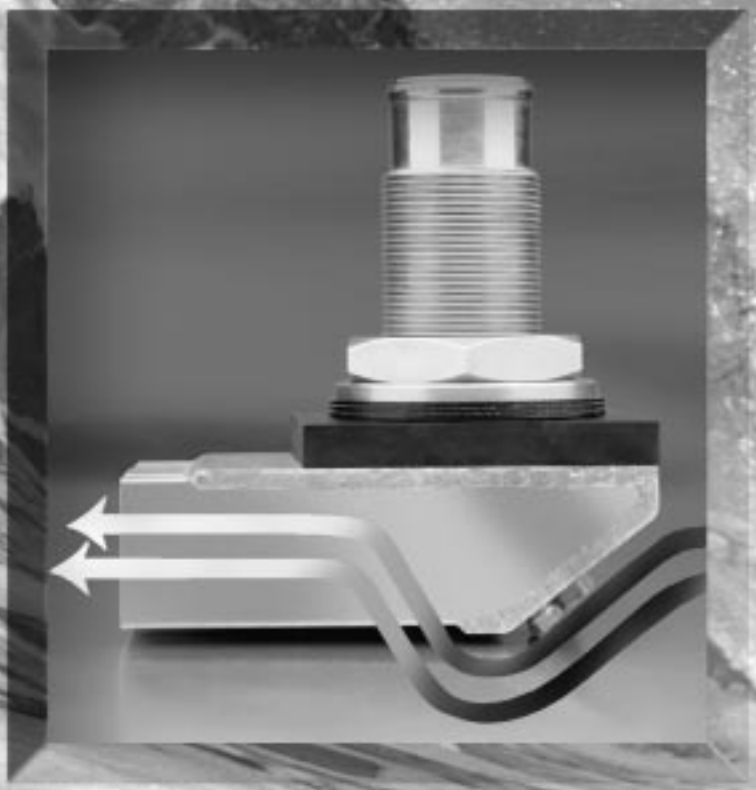
DuraCooler™ by DURAMAX® MARINE LLC

DURACOOLER™ INSTALLATION MANUAL



Get the edge

BASIC DURACOOLER™ INSTALLATION INSTRUCTIONS

Please use these instructions as a supplement and general guideline to the full set of instructions for installation. Installation instructions in this section are based on a typical DuraCooler™ installation and may not be the only acceptable method of installation. Please read the complete DuraCooler™ Installation Instructions for a complete set of instructions.

Typical Installation

1. Select appropriate hull location for the DuraCooler.™ Refer to DuraCooler™ Installation Planning section for further details on this step.
2. Consult with local A.B.S., Coast Guard or other approval agency representatives to see if a sea chest (cofferdam) installation is required.
3. If a sea chest is used, make sure there is adequate clearance inside hull for sea chest plumbing.
4. Use the DuraCooler™ or make a template to mark hole locations on the hull. Follow instructions in Details of DuraCooler™ Installation – Exterior Details.
5. Burn holes in the hull per step 4 & 5 of Details of DuraCooler™ Installation – Exterior Details.
6. Make sure the DuraCooler™ nozzles fit into the holes in the hull without contact with the hull.
7. Build sea chest inside hull according to A.B.S., Coast Guard or other approval agency regulations. A sea chest should protect internal plumbing and prevent internal flooding in the event of the DuraCooler™ being knocked off of the hull.
8. Install the DuraCooler™ to the hull using only the hardware provided with the DuraCooler™ by Duramax® Marine and a polysulfide sealant such as BoatLIFE® Caulk.
9. The square or rectangular rubber gasket should be positioned between the DuraCooler™ and the exterior of the hull. The circular reinforced rubber gasket should be installed between the nozzle nut and the inside of the hull.
10. Tighten the nozzle nuts securely per the recommended torque values in the installation manual.
11. Close sea chest.
12. Install internal plumbing per the instructions in the Details of DuraCooler™ Installation – Interior Details Section.
13. Fill the system with water and/or water/glycol mixture. Bleed air from the system before replacing upper drain plug.
14. Pressure test the water-filled system to 30 psi (2.04 bar). **Do not exceed 30 psi.**
15. Build suitable protection around the DuraCooler™ per the instructions in the DuraCooler™ Installation Planning – Surface-Mounted DuraCoolers™ Section.

The recommended torques are:

	THREAD SIZE INCHES	TORQUE RANGE
Nozzle Nuts	3/4"	50 - 60 foot lbs.
	1" - $1^1/_2$"	70 - 100 foot lbs.
	2"	125 - 150 foot lbs.
	$2^1/_2$" - $3^1/_2$"	200 - 250 foot lbs.
Header Stud Nuts	$^5/_8$" - $^3/_4$"	30 - 40 foot lbs.
	1"	50 - 60 foot lbs.
Support Bracket Stud Nuts	$^1/_2$" - $^3/_4$"	20 - 25 foot lbs.

All DuraCoolers™

1. 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.
2. Avoid mounting the DuraCooler™ where flex or severe vibration could be a problem, as this could cause damage to the DuraCooler.™
3. Efficient keel cooling depends on the continuous water flow over the DuraCooler,™ which can be enhanced by mounting the DuraCooler™ near the propeller. Since air is an insulator, aerated ambient water will diminish cooling capacity. Mounting the DuraCooler™ ahead or forward of the propeller and sufficiently below the water line will help avoid aerated ambient water. *(see illustration A)*

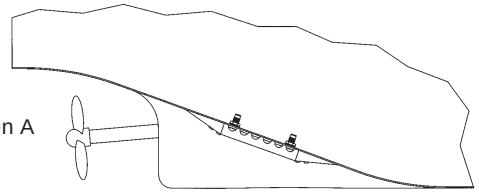


Illustration A

4. 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.
5. Classification agencies may require a sea chest for certain installations. If a sea chest is required, side piping should be designed into the system for ease of installation and maintenance. *(see illustration B)*

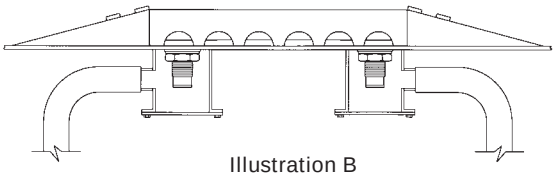


Illustration B

6. Locate the DuraCooler™ away from any hot water discharges to provide the coolest possible environment for the unit.

DuraCoolers™ Multiple Units

1. Do not artificially raise ambient water temperature surrounding the DuraCooler.™ Since DuraCoolers™ can be used to cool multiple circuits (such as jacket water and aftercooler water), there can be a DuraCooler™ located in the close proximity to another DuraCooler™ with a different operating temperature. Always locate the DuraCooler™ with the lower operating temperature forward or lower relevant to the water line of the other units or separated with a separator plate and mounted side by side and closer to the keel.

Recessed DuraCoolers™

1. 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. Recessing the DuraCooler™ into the hull and covering it with bar grating provides protection to the unit from flotsam and mechanical damage from pounding seas. There should be at least 1.50 inches (38 mm) of clearance on all sides of the recessed DuraCooler™ and the recess should be no deeper than .500 inches more than the cooler thickness. 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 flow toward the DuraCooler™. This will allow heated water to escape. *(see illustration C.1 & C.2)*

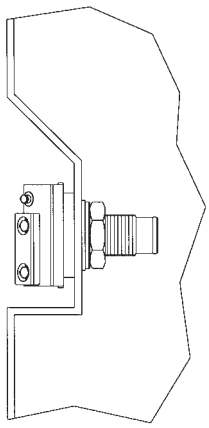
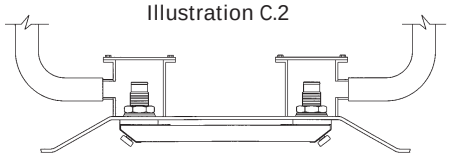


Illustration C.1

Illustration C.2

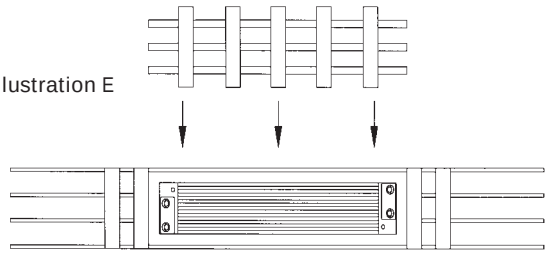


2. For zero knot applications, do not recess the DuraCooler™ on the bottom of a vessel unless the mounting surface inclines a minimum of 20° from forward to aft. Any protective shrouding around the DuraCooler™ must be constructed to allow for free flow of convection currents and other flows. *(see illustration A)*

Surface-Mounted DuraCoolers™

1. 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. Fairing blocks can be constructed of bar grating or solid plates with suitable spacing. *(see illustration E)*

Illustration E



2. Fairing blocks should be constructed with a 4 to 1 slope. Holes should be cut in the fairing blocks to promote proper water flow across the DuraCooler.™ 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 illustration F)*

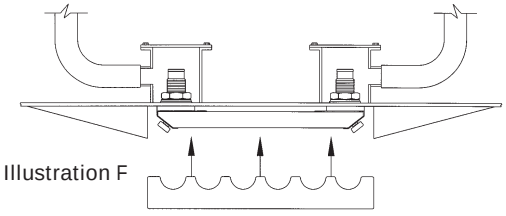


Illustration F

Details of DuraCooler™ Installation

Exterior Details

1. Never pressure test or operate the DuraCoolers™ at pressures in excess of 30 psi (2.1kg/cm 2) gauge.
2. The mounting gaskets supplied by Duramax® Marine with every DuraCooler™ are required to provide the proper spacing between the DuraCooler™ and the hull.
3. All DuraCoolers™ are supplied with zinc anodes. Zinc anodes minimize the galvanic corrosion of the DuraCooler™ and must be replaced during the ship's regular maintenance schedule to preserve the life of the DuraCooler.™ Stray electrical currents can cause galvanic corrosion and rapidly deteriorate the DuraCooler™ if anodes are not used. Replacement anodes complete with mounting kits can be obtained from your Duramax® Marine DuraCooler™ distributor.
4. Prior to cutting holes in the hull of the ship, measure the distance from center to center of the inlet and outlet nozzles on each end, and the distance to any support studs. Make the holes in the hull for the inlet and outlet nozzles .25 inches (6.4 mm) oversized. *(see illustration G)*
5. After cutting holes in the hull for mounting the DuraCooler,™ grind the edges of the holes smooth to allow the entire length of the DuraCooler™ gaskets to lie flat on the surface of the hull.
6. Use a polysulfide rubber sealant such as BoatLIFE® Caulk around mounting gaskets, washers, nuts on the DuraCooler™ and hull penetrations to make a water tight seal between the hull and the DuraCooler.™ After the sealant has cured, verify all torque settings on the hardware. Do not overtighten the hardware.
7. Use only the special bolts and washers provided by Duramax® Marine to attach the zinc anodes to the streamlined headers of the DuraCooler.™ *(see illustration H)*

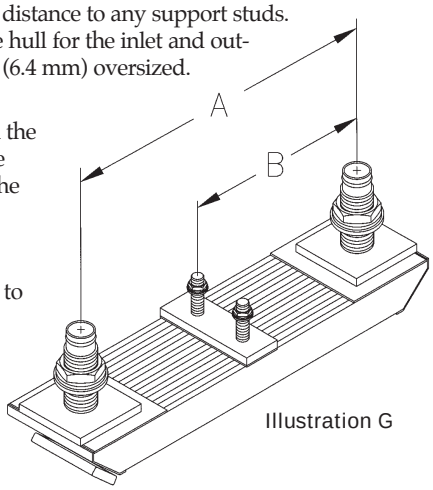


Illustration G

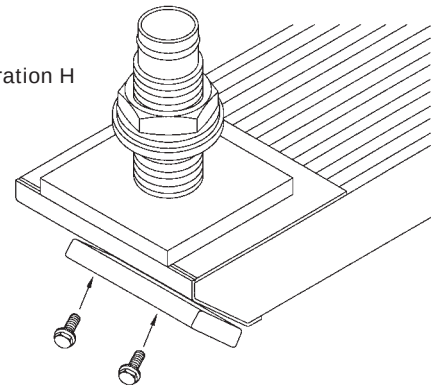


Illustration H

Interior Details

1. 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 illustration I)*

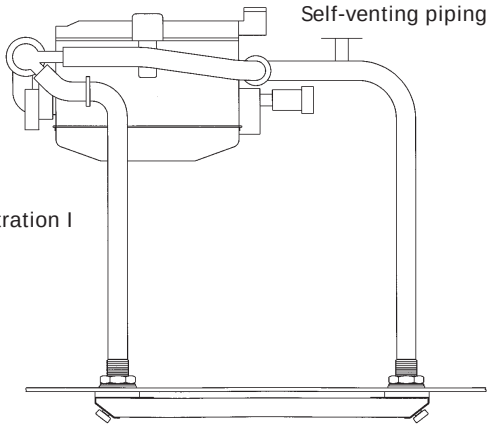


Illustration I

2. If you are 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 cooler. The connection hoses will help isolate the DuraCooler™ from engine vibration.
3. A bottom hull installation: Two-pass type DuraCoolers™ should be installed with the inlet and outlet at the high end relative to the water line.
4. A side hull installation: Connect the DuraCooler™ inlet hose to the lower connection tube to minimize air entrapment in the DuraCooler.™ It is important to completely fill the unit with water and pressure test prior to launching the vessel. Use the following procedure:
   A. Remove the upper drain plug at the outlet end (preferably) of the DuraCooler.™
   B. Fill the DuraCooler™ with coolant.
   C. When coolant exits the drain opening, replace the plug.
   D. Repeat this procedure to refill the DuraCooler™ every time it is drained.
5. See "Recommended Torques" chart for proper tightening on mounting hardware. Do not overtighten hardware.

Contamination & Performance Interference

A. Air in System:
Was all air purged from the DuraCooler™ during installation? If a two-pass DuraCooler™ is used, was it installed with the inlet and outlet nozzles at the highest location relative to the water line?

B. 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.™

C. 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 and 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.

D. 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 carefully scraping, using a high-pressure water spray or sand-blasting.

E. 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 the heat transfer.

F. 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 unmixed antifreeze in the system.

Mechanical Causes of Overheating

A. Thermostat:
Is the thermostat opening properly?

B. Connections:
- Hoses - Make sure that wire-reinforced hoses are being used. Verify that none of the hoses have collapsed. Collapsed hoses 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.

C. 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.

D. Water Pump:
Verify that the water pump is operating properly.

E. Expansion Tank:
Verify that the coolant level in the expansion tank is correct.

F. 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 the ambient water to properly circulate around the DuraCooler.™

G. 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.

Ambient Factors That May Cause Overheating

A. 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.

B. Water Aeration:
Verify that the ambient water near the DuraCooler™ is not aerated. Aerated water will not transfer heat efficiently.

DuraCooler™ Limited Warranty & Terms and Conditions of Sale

Subject to all of the conditions of the Duramax® Marine, LLC Terms and Conditions of Sale, Duramax® Marine, LLC warrants that at its option Duramax® Marine, LLC will, refund the purchase price or repair or replace any part of a Duramax® Marine DuraCooler™ that is determined by Duramax® Marine, LLC to be defective in manufacturing workmanship and materials or fails to conform, at the time of its shipment by Duramax® Marine, LLC to the purchaser, to the description of such DuraCooler™ made by Duramax® Marine, LLC. Before becoming obligated under this warranty, Duramax® Marine, LLC: a) must receive, from the original purchaser, the allegedly defective DuraCooler™ at its manufacturing plant, freight prepaid, no later than the earlier of 12 months from the first use of the original, new DuraCooler™ or 18 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 or that the DuraCooler™ did not conform at the time of shipment by Duramax® Marine, LLC to the description made by Duramax® Marine, LLC. Repairs do not extend the original term of warranty specified above.

Duramax® Marine, LLC shall have no obligations 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, LLC, or any effect of installation on an aluminum hull vessel, use or installation in a manner not specified or recommended by Duramax® Marine, LLC, or improper or incorrect installation efforts. No DuraCooler™ will be accepted by Duramax® Marine, LLC 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, LLC prior to shipment to Duramax® Marine, LLC.

Duramax® Marine, LLC shall have no liability under this warranty for any repairs, replacements or refund if the customer fails: a) to install the DuraCooler™ in accordance with the installation instructions provided by Duramax® Marine, LLC; 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, LLC; c) to use and store the DuraCooler™ in environmental, mechanical, electrical and performance conditions specified by Duramax® Marine, LLC immediately in the event any DuraCooler™ exhibits a defect covered by this warranty. The customer 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 customer.

Duramax® Marine, LLC 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 customer.

This warranty provision is part of the Duramax® Marine, LLC Terms and Conditions of Sale which apply 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, LLC 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 Terms and Conditions of Sale is available from Duramax® Marine, LLC upon request.

DURAMAX® MARINE, LLC WARRANTIES ARE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, EVEN IF THE PURPOSE IS KNOWN TO DURAMAX® MARINE, LLC, AND IN LIEU OF ANY OTHER OBLIGATIONS OR LIABILITY ON THE PART OF DURAMAX® MARINE, LLC. DURAMAX® MARINE, LLC NEITHER ASSUMES (NOR HAS AUTHORIZED ANYONE TO ASSUME FOR IT) ANY OTHER WARRANTY OR LIABILITY IN CONNECTION WITH ITS PRODUCTS.

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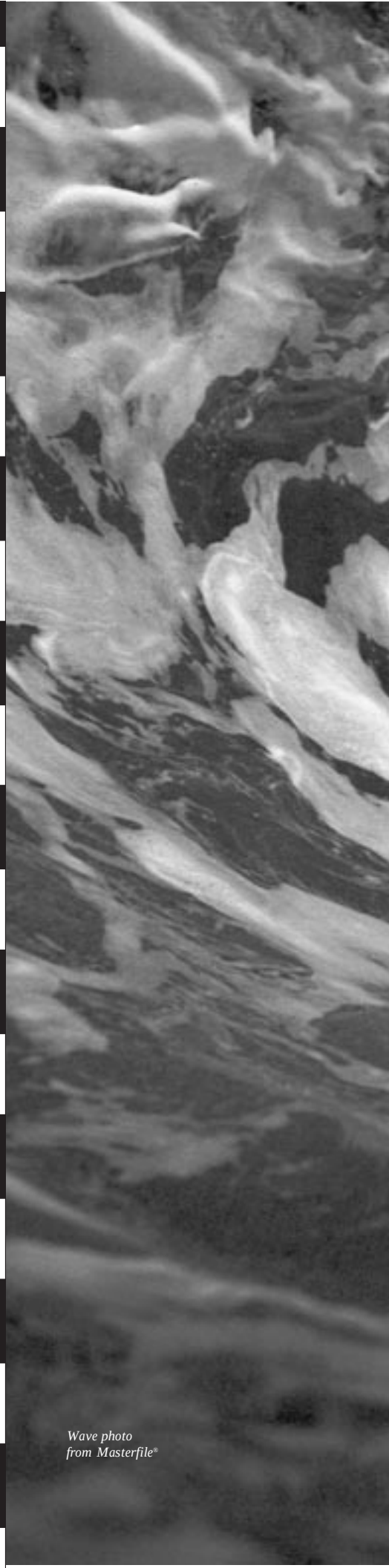

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