5TH ANNIVERSARY ISSUE

DIY boat owner

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## Features

MAINTENANCE

### GELCOAT SOS

Maintain your gelcoat with our professional step-by-step guide to cleaning, oxidation removal, proper application techniques and more.

### BOTTOMS UP

Here's how to select and apply the right antifouling paint for your boat. Includes a paint selection chart and tips from the pros.

*By Paul Noack*

UPGRADE

### KEEP COOL — INSTALL AN AIR CONDITIONING SYSTEM

Everything you need to know about air conditioning systems: what's available, power requirements, installation, troubleshooting and maintenance.

*By Nick Bailey*

## Columns



## Departments

# TALKBACK Q&A

## TROUBLESHOOTING WATER HEATERS

**Q:** I need to repair my boat's water heater. Can you suggest logical troubleshooting steps and repair methods? Is there a simple way to check if the heater element is burned out?
*Mr. Jonntone via e-mail*

**A:** When you turn on the water heater, (assuming you have reliable shorepower) one of two things will happen: nothing or the breaker will pop which indicates a dead short. If the breaker pops, turn the power off making sure no one can accidentally turn it on again. Remove the cover plate from the wiring connections at the heater. Check for a loose wire that may be shorting out. If the connections look okay to the thermostat and the heater element, disconnect the two wires to the heater element and using an ohmmeter check resistance between each element terminal to the grounded heater housing. Any current flow at all indicates that the element has shorted out and needs replacing. If there is no indication of anything happening when you turn on the unit, follow the same procedures as above, but this time test resistance between the two heater element terminals. A healthy element will show 20ohms or so. No continuity through the element indicates that it is burnt out.
If the element tests okay, the next step requires testing to see that power is getting to the heater and will require you to turn the power back on and check with a volt meter for 115 volt AC (or 230 volt) at the exposed live terminals. Don't try this unless you know what you are doing; there is enough voltage here to kill you! If power is not present at the element, check to see if power is getting to the thermostat (adjacent to the element). If there is power here then the thermostat may need to be reset or may be faulty. If there is no power to the thermostat you have a wiring problem further back toward the panel, or possibly a faulty breaker.
— *Nick Bailey*

## FREE SOFTWARE UPGRADES

**Q:** I have a three-year-old Interphase depth sounder. I get very erratic depth readings after and during operation at speed. It may take over an hour at trolling speed to finally get proper readings. I've had the sounder tested, it was okay. I have not had the transducer tested. Any suggestions?
*Dave Fleming, "Off Season," Richmond, Virginia*

**A:** It doesn't sound like a transducer problem, these are usually trouble-free. As your unit's outdated, it's more likely a software error. Turn on the unit and check what version software it's operating; you'll find this below the model number. Call the factory for a return merchandise authorization number and send the unit back for upgrading to current software, a free service from Interphase. In the process, they may uncover the problem. Many elec-

TALKBACK Q&A

tronics manufacturers offer free software upgrades, so you should take advantage of them.
— *Jan Mundy*

## MAKING WOODEN TEMPLATES

**Q:** Do you know someplace where I can purchase templates for the wooden parts of my '84 vintage powerboat? Seems the manufacturer doesn't have the original templates and most of the wood is so rotten I can't use it to make patterns.
*Larry Gill, Honeybrook, Maryland*

**A:** Unfortunately, there is no easy way out for your wooden parts dilemma. Factories usually don't keep templates of boat parts for out-dated models. The best source of patterns would be to find an identical boat in better condition and with the owner's permission, take measured drawings from the boat, then reproduce parts from the measured drawings. Alternatively, you could use what is left of the parts on your boat to extrapolate the shape of the original piece.
— *Wayne Redditt*

## PLUMBING A GRAY-WATER TANK

**Q:** The shower on my newly purchased Nordic 44 currently empties directly into the bilge, which I would like to remedy by the installation of a gray-water tank. There is space in the narrow bilge for a tank; my plan is to use a flexible tank using the existing hose from the shower. I would epoxy tabs to the hull as attachment points for the tank and then run the outlet hose to a tee fitting on the thru-hull fitting for

the bilge pump, which is well above the loaded waterline. I will also need a pump, but what kind? To prevent back siphoning, I would lead the tank outlet hose in a loop above the waterline and use an anti-siphon valve. I suppose the hose from the shower will also need a filter. I don't intend to "hold" this water, just collect it in the tank for immediate dumping. I was also thinking about connecting the outlets from the head and galley sink to this tank and eliminating the need for additional thru-hulls.
*Larry Rudnick, "Destiny," Yorktown Heights, New York*

**A:** A flexible bladder-style tank would be fine for gray water and your proposed system seems reasonable. Just make sure there are no sharp edges near the tank that could chafe. Ideally, the weight of the tank and contents should rest on the bilge bottom and be restrained athwartship by the narrow confines of the bilge sides. The attachment points will help secure the bladder fore and aft as well as torsionally. It's a good idea to carry as little as possible in the tank, especially if conditions are rough. Bladder tanks have no internal baffles so the contents are free to slosh about, leading to chafe and flexing, particularly at hose fittings.
If the tank is large enough it can also serve as a gray-water receiver for the sinks. It's possible to tee the outlet into the existing bilge pump discharge as long as the bilge pump incorporates check valves to prevent back flow (all diaphragm-type manual bilge pumps do). The gray-water pump should also be a diaphragm-style pump that matches the self-priming and anti-backflow criteria of the bilge pump so you don't also fill your gray-water tank while pumping out the bilge. This kind of pump is not too fussy about passing minor solids so a prefilter of the gray water is optional. If your existing bilge discharge is high on the hull and has not shown a prior tendency to back siphon when heeled, you should not need to add a loop and siphon break if you tee into this existing trouble-free plumbing. The addition of your gray-water tee should not fundamentally alter a proven installation. So far, the set up as described consists of two similar pumps drawing from the bilge area, connected to a single outlet. It might make more sense to give each pump an independent outlet (possibly side by side) and install a second bilge pickup with a Y-valve on the gray-water suction line so that the gray-water pump could serve as a second bilge pump if required. This gives you redundancy in an important safety system. Just remember to put the Y-valve somewhere accessible as you might need to get at it in a hurry some dark and stormy night.
— *Nick Bailey*

# TALKBACK Q&A

## LOW SPEED NOSE-WANDERING

**Q:** My 1988 Sea Ray Seville with a MerCruiser drive doesn't steer straight. At speeds below 5 mph, the boat tends to wander and is difficult to keep on a straight heading. The steering system seems to be tight. Any ideas?
*Kevin Dodds, Long Beach, Calif.*

**A:** All single-engine boats wander at idle caused by the paddle-wheel effect of the single propeller and is more dramatic with high-pitched props. Wandering could also be a mechanical problem. MerCruiser drive units manufactured since 1988 have a steering system that is serviceable at the gimbal ring, an aluminum ring clamped onto a steel shaft that the stern drive is basically steered by. Over time, the paddle wheel effect of your single propeller wears out the aluminum ring. This will dramatically exaggerate the nose wondering that you get at low speeds. Servicing of the ring is part of the maintenance schedule outlined in your owner's manual. As long as the steering system is qualified, it's the nature of the design.
*— Steve Auger, Mercury Marine*

**TECHNICAL HOTLINE**

**Need help with a problem? Unable to find information on products or do-it-yourself projects?**

*DIY TALKBACK is a special reader service that makes available to you the resources of marine industry experts on topics such as boat repair, engines, trailers, electricity, plumbing, electronics, sails, maintenance and more.*

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# TECH TIPS

**TOWING POWER:** Many boaters arrive at a launch ramp only to discover a dead battery and that they can't start their engine. An easy hookup used on most RVs, uses juice from the tow vehicle to charge the boat battery. Connect a wire from the positive post of the towing vehicle battery to an unused terminal on the trailer light connector and wire this to the boat's positive battery terminal. Use at least a 12 AWG wire and splice in a 30-amp fuse for safety. The trailer ball supplies the ground (negative) connection and completes the connection.
*Bill Giunta,"Cheers," Beach Haven, N.J.*

**BUG-FREE SLEEP:** In many areas in the summer the flies are murder but what really will get you are the "no-see-ums." Rather than seal up the boat, stuffing rags in the vents and spending the night gasping for fresh air, spray the screens with Pam or other nonstick cooking spray. Bugs stick to the vents, leaving the cabin bug-free.
*Ernie Martin, "Stonecutter," Toronto, Ont.*

**SPIKE-FREE ELECTRONICS:** Turn off your electronics before starting your engines to prevent damage, or power electronics with a separate battery. A voltage drop during starting increases the chance for a spike and potential damage to sensitive electronics.

**A CRATE IDEA:** Fasten a square piece of 6mm (1/4") plywood to the bottom of a milk crate, then cover it with carpet. Use it to store anything, lay it on its side for a temporary bookcase, or turn it upside down for a step up to a high V-berth or boarding from a low dock. Attach a light line to retrieve the crate from the dock when casting off.
*George and Sheilah Van Nostrand, "Dream Catcher," Keswick, Ont.*

**EPOXY CLEANER:** Use vinegar to remove uncured epoxy from tools, gloves, clothing, hands, etc. It's safe to use, non-toxic, non-flammable and cheap.
*Mr. Lapman, "H O Leopard," Santa Rosa, Calif.*

**MARBLE FIX FOR RARITAN HEADS:** While trying to pump two different Raritan heads, the units totally locked up. A small rubber check valve in the valve body caused the problem. It was almost impossible to break the valve loose, apparently it swells and sticks. Not wanting to repeat this process again anytime soon, I replaced the rubber valve with a marble of the same size and I have never had this problem again.
*Peter Knorr, "Moonbarker," Suttons Bay, via e-mail*

**GULL REPELLENT:** Got a problem with seagulls or geese perching on your boat? Here's a solution perfected at many golf courses. Run a single string of monofilament fishing line around the perimeter of your dock, at a height of about 3m (10'). Apparently, the sound waves drive the birds away.

**FUNNEL SUBSTITUTE:** When you need a funnel and don't have one, take three lengths of heavy-duty foil and form them into the needed shape, leaving a drain hole at the bottom.

**RECYCLED TEAK:** Don't discard old bed headboards, worn out dining or coffee tables. The tabletops may be made of veneer-surfaced particleboard, but quite often the trim pieces, doors and legs are made of solid teak. Careful garbage picking and an electric saw can yield a good supply of valuable teak wood for your craft.
*Paul Kett, Arnprior, Ont.*

***Tech Tips welcomes contributions from readers. If you have a boat-tested tip you'd like to share, send complete information along with your name, boat name and home port to:***
**Tech Tips DIY Boat Owner,**
**P.O Box 22473,**
**Alexandria, VA 22304**
**You can also**
**E-mail to info@diy-boat.com.**

# DIY PROJECTS

## WATERPROOF FUSE BOX

Fuse panels below deck often corrode and require regular cleaning of the contacts. Here's an inexpensive solution (**Figure 1**) to this annoying and common problem: a plastic container. Mount it in position, fasten the original fuse panel inside, drill a hole in the corner for wires, plug the opening with silicone and put the lid on. Does it work? Except to take this photo, I haven't touched the box since I installed it 11 years ago. *Capt. Lada Simek, Ossining, N.Y.*

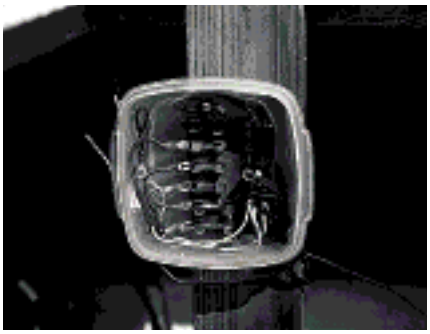
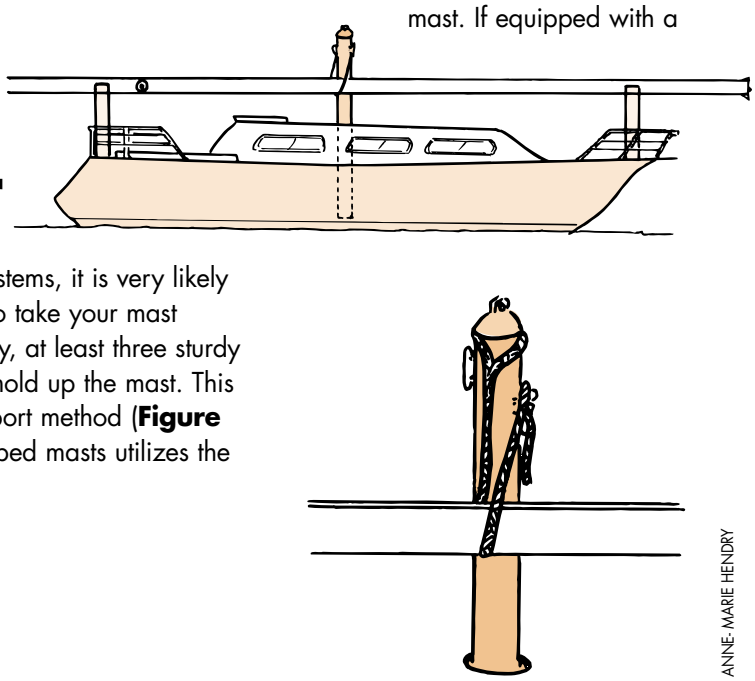


**Figure 1**

## BOOM MAST SUPPORT

If you have to transit canal systems, it is very likely you will have to take your mast down. Normally, at least three sturdy deck supports hold up the mast. This innovative support method (**Figure 2**) for keel-stepped masts utilizes the boom as the center support. Set on the mast step, it takes the normal position of the mast. You'll still need to assemble bow and stern supports.

Tie off a non-stretch support line around the top (gooseneck end) of the boom and thread it under the mast. If equipped with a furling system, run the line inside the furler, otherwise it could be damaged.



ANNE-MARIE HENDRY

**Figure 2**

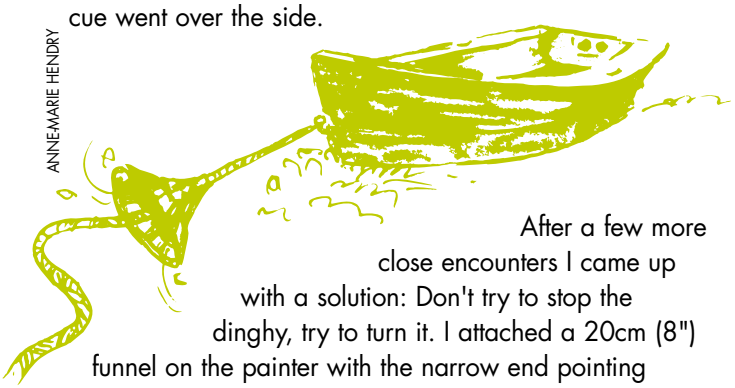
Just before the mast is lowered to its resting position, hold the support line taut and slowly adjust the line until the mast rests on both the bow and stern supports. Cleat the support line. The support line takes up the bulk of the mast's weight. Secure the mast and rigging and if necessary, block the boom through the deckhead to prevent movement.

Besides providing convenient storage for the boom, this system eliminates potential stress on the cabin top and provides excellent ver-

tical and lateral support for the mast while underway. As a precaution, check the charts to ensure the boom will clear any obstructions along your route.
*Kevin Dean, "Via Sophia," Surrey, B.C.*

## TAMING THE DINGHY

When cruising on a small boat, there isn't always room to store the tender on deck. So you tow it and in following seas the dinghy tends to surf, sometimes hitting your boat's transom with considerable force. My attempts to tame the dinghy met with only marginal success. One time it almost ended in the cockpit. The backstay and barbecue slowed it down but not before most of the barbecue went over the side.

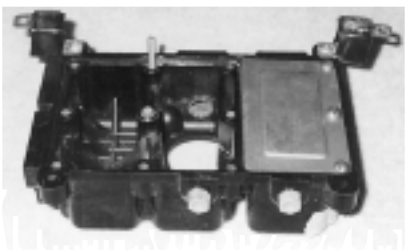

ANNE-MARIE HENDRY

After a few more close encounters I came up with a solution: Don't try to stop the dinghy, try to turn it. I attached a 20cm (8") funnel on the painter with the narrow end pointing towards the transom. When the dinghy starts to surf, the line goes slack and the funnel drops into the water, acting like a scoop and turning the dinghy. The best place for the funnel, I found, was one dinghy length ahead of the dinghy. Here I tied a stopper knot fore and aft of the funnel to hold it in place. Now I don't have to repaint my boat quite as often.
*Ernie Martin, "Stonecutter," Toronto, Ont.*

## EASY WATER PUMP REPAIR

Sometimes, when overhauling pressure water pumps (in this case a Jabsco), a screw on the base will strip the machined threads in the pump body. This usually results in a pressure leak. Don't throw the pump away! Repair it.

Drill out the stripped threads then measure the depth. Find (or buy) a 10-32 threaded 3/16" bolt and nut. Cut off the head to make a stud equal to the length of the stripped hole plus 12mm (1/2"). Pour some two-part epoxy into the hole and insert the stud, leaving 12mm (1/2") or so protruding. Let the epoxy set for about 24 hours. Install the bottom plate with all screws and add the nut to the now fixed stud. You may need to put some washers under the nut.



*George Van Nostrand aboard "Dream Catcher."*

# ELECTRONICS

## RENEWABLE CHARGERS

Charging sources that rely on solar, wind and water power to generate electricity are surprisingly efficient and effective at keeping your batteries full.

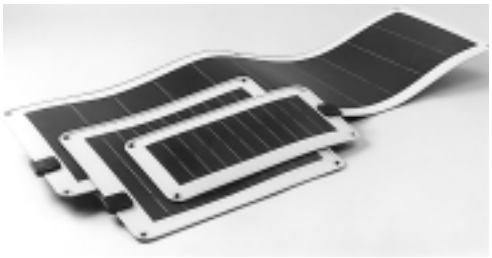
***By Kevin Jeffrey***

Imagine being out on the water, enjoying the sunshine, the wind on your face, and the steady movement of your boat through the water. To me these sensations represent the essence of boating, but they also represent the three main methods of charging batteries using renewable sources of power. In this column we'll review what gear is currently on the market, and why renewables are a good choice for today's boater.

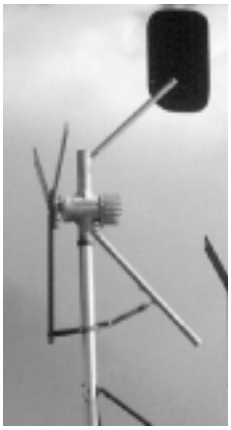
Renewable chargers are clean, reliable and, unlike most marine gear, will eventually pay for themselves in fuel savings. Renewable sources of power are also free for the taking anywhere in the world, although the amounts available vary considerably from region to region. Some boaters use renewable chargers as their main or even sole source of electricity while away from the dock, while others use them as a convenient backup to engine-driven power sources. Either way, they should be given serious consideration when upgrading an existing electrical power system or installing a new one.

### Basking in the Sun

Photovoltaic (PV) solar panels are now an accepted part of a cruising boat's electrical power inventory, and rightly so — they produce consistent power year after year with no noise, smell or moving parts. Unlike solar panels used for heating, PV panels convert light energy directly into electricity through the use of thin, specially treated silicon cells. When exposed to sunlight, each cell in a panel produces about 0.5 volts, regardless of cell size. Roughly 36 cells are connected in series to create sufficient voltage (17 to 20 volts) to charge a 12-volt battery even when light levels are low. When a sun-drenched PV panel is connected to a battery, current flows. How much current relates







***(Clockwise, top) Siemens rigid PV panel; Ferris Waterpower 200; Unisolar flexible PV panels; Kiss; Windbugger; Ampair 100; Southwest Air Marine.***

to cell size as well as how much light is reaching the cells.

PV panels are rated according to their "peak" output in watts (ie. their best performance in favorable conditions). Shade, clouds and facing away from the sun all contribute to power loss. Multiple PV panels can be wired in parallel according to desired current output, available mounting space and budget.

"Standard" PV panels, such as those from Siemens, Kyocera, and Astro Power, have sturdy tempered glass covers, aluminum perimeter frames for rigidity, and long warranties against power loss (up to 20 years). "Marine" PV panels, such as those from Solarex and Unisolar, have polymer covers and no perimeter frames. Both are completely weatherproof and able to withstand tough conditions at sea. Marine panels are lightweight, can be walked on, and can be mounted in a variety of ways. Some Unisolar models are even fully flexible for convenient mounting to biminis and dodgers. The use of blocking diodes between cells (on all Unisolar models) prevent total power loss when part of the panel is shaded, a great asset on a boat. Standard panels are the most cost-efficient in terms of dollars per watt, but they cannot be walked on, are quite a bit heavier, and don't have as many mounting options.

Panels average US$6.50 per watt for the standard ones up to US$12 per watt for the fully flexible models. They are expensive in terms of dollars per watt produced, but their advantages are too numerous to list. If you have the space, solar panels can be your sole source of electricity. For example, four large 80-watt panels produce around 100 amp-hrs per day in average conditions. My family lived on two different catamarans and all our power was produced by a single 40-watt solar panel. Although we had no refrigeration or other heavy loads, we did have lights, music and communications, and I wrote two books on board with a laptop.

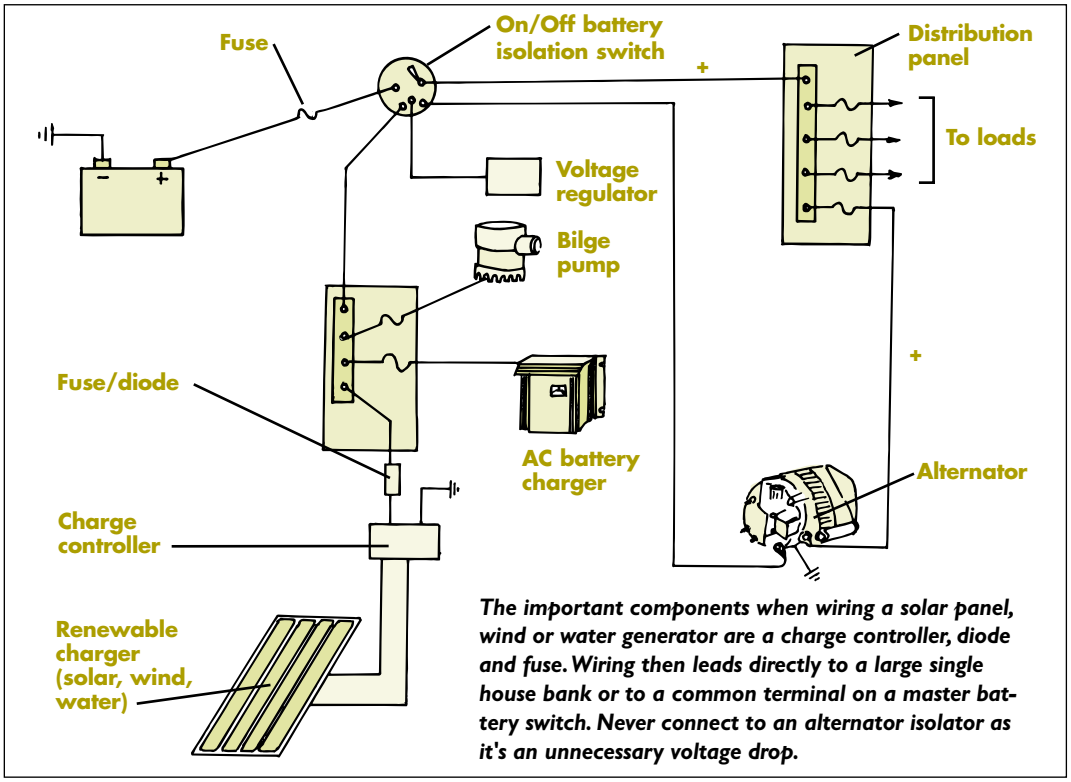
The best way to mount solar panels on a boat is horizontally. This gives the best average solar coverage during the day. If you want to tweak the output, you can reposition them several times a day into the sun.

PV solar panels work well on their own, or in combination with wind and water generators or engine-driven power sources.

## Harnessing the Wind

Wind-powered generators for marine use were introduced in the mid-70s, and they have been constantly improving since then. Wind units currently on the market can produce a formidable amount of electrical power for both sail and powerboats, but only you can decide if wind power is right for your needs and, if so, which particular model is best.

All wind generators consist of a rotor with aerodynamic blades, an electrical generator, a tail vane to keep the




***The important components when wiring a solar panel, wind or water generator are a charge controller, diode and fuse. Wiring then leads directly to a large single house bank or to a common terminal on a master battery switch. Never connect to an alternator isolator as it's an unnecessary voltage drop.***

unit facing into the wind, and some type of protection against overspeeding in high winds. A few wind units can also be converted to a trailing-log water generator for downwind passages, when the apparent windspeed is low.

There are two basic wind unit types, small-rotor and large-rotor. In general, small-rotor units, such as the Ampair and Rutland models from the UK, have multiple blades, a rotor diameter of around 91cm (36") and modest average output. The advantages of this type of unit are reduced size and weight and inherent overspeed protection in high winds. Small-rotor units are good for light electrical loads or as a complement to other charging sources.

Large-rotor units produced in the U.S., such as the Ferris Windpower 200 and Fourwinds, have two blades, a rotor diameter of around 1.5m (60") and high potential output. The main advantage of this type of unit is the high output, although you still need reliable winds for good average performance (you may be cruising in the trades, but if you like to anchor in the coziest part of the harbor you probably won't have exposure to reliable wind). Most large-rotor models are also relatively quiet and have either standard or optional overspeed protection. Large-rotor units are most popular with cruising sailors who have refrigeration and other large electrical loads.

I view Southwest Windpower's Air Marine 303 and new 403 models as something of a cross between a small- and large-rotor type. Its sleek, three-blade design, small size, high rated output and unique feathering plastic blades have created a great deal of excitement in the industry. This design is good but not perfect — when the blades distort in high winds to provide overspeed protection, noise levels can be unacceptable to some boaters.

Wind units can be mounted temporarily in the fore or main triangle of a sailboat (used mostly for combination wind-water units), or permanently on a pole or radar arch at the stern or on a sailboat's mizzenmast. They should always be mounted solidly to avoid vibration and well above head and hand height. Vibration is accounted for with rubber isolation pads, but the installer must also make certain the mounting pole and struts are well-secured and stiff.

Wind units work well for powerboats that spend long periods of time away from a dock. Integrating a wind unit into your independent power system is easy, since the out-

put is compatible with other renewable and engine-driven charging sources and all monitoring systems. Battery protection is important and demands a shunt regulator or charge controller, an all-in-one unit that regulates battery voltage, monitors current and indicates battery states. Wind generators cost between US$550 to US$1,500.

## Water Power

Of the three renewable charging sources for marine use, water-powered generators are the most overlooked and least understood. The fact is that they can be an important part of a sailboat's independent power system, quietly and reliably producing large amounts of electrical power whenever a boat is under sail. Prices for water generators range from US$725 to US$1,100. These units are not recommended for powerboat applications.

Water-powered generators take advantage of the relative motion between a sailboat and the surrounding water, and so actually use the wind for mechanical power, unlike land-based water-powered generators that rely on falling water under the influence of gravity. With a charging rate of 8 to 10 amperes in cruising speeds of 5 to 6 knots, water generators can produce over 200 ampere-hours of electrical power per day. There are several types of water-powered generators available. On Trailing-Log units, such as the Ferris Waterpower 200 and Fourwinds, the electrical generator is typically suspended on a gimbal mount at the stern, while an 20cm to 25cm (8" to 10") diameter rotor mounted on a short stainless-steel shaft trails behind the boat at the end of a 18m to 22.5m (60' to 75') tightly wound braided line. The line spins rapidly, turning the shaft of the generator directly to create electricity for charging batteries. In use for many years, this type of unit is simple, moderately priced, and often converts to a wind-powered generator for use in port. These water units, however, are only intended for blue-water passage-making, and sailors must ensure that the trailing rotor remains submerged or is physically removed from the water at higher boat speeds or in certain sea conditions. Otherwise the rotor may skip clear of the water and cause the rotor line to kink and knot up unmercifully.

Outboard leg water generators, such as the Aquair UW, have the electrical generator submersed on a pivoting bracket at the stern, similar to an outboard motor. These units are heavier, more expensive, and require more mounting space, but they remain operational at any boat speed or in any sea condition or cruising area. Electrical generators can be coupled to a free-wheeling inboard engine prop shaft with good results — high water-driven power output with no additional gear mounted on the stern. They can also be coupled to a small auxiliary rotor shaft placed through the hull for the sole purpose of battery charging — probably the cleanest, most efficient installation for those undaunted by yet another hole below

waterline. Parts for these types of systems can be purchased from several marine power gear suppliers.

*About the author: Kevin Jeffrey works as an independent electrical power consultant and is the author of the "Independent Energy Guide" and publisher of "Sailor's Multihull Guide," now in its second edition.*

## SUPPLIERS

Renewable chargers are best purchased through a company that deals primarily in electrical power systems. Below is a partial listing of manufacturers:

➤Astro Power, N.J., USA; Tel: 302/366-0400 Astro Power solar panels.
➤Everfair Enterprises, Fla., USA; Tel: 954/968-7358 Fourwinds wind and water generators.
➤Hamilton Ferris Company, Mass., USA; Tel: 508/881-4602 Windpower 200 wind generators, Waterpower 200 water generators and components.
➤Hotwire Enterprises, Fla., USA; Tel: 888/430-7576 ext. 2144 KISS wind generators.
➤Jack Rabbit Marine, Conn., USA, Tel: 203/961-8133 North American distributor for Ampair wind generators and Aquair water generators.
➤Siemens Solar Industries, Calif., USA; Tel: 805/482-6800 Siemens solar panels.
➤Solarex Solar Corp., Md., USA; Tel: 301/698-4200 Solarex solar panels.
➤Southwest Windpower, Ariz., USA; Tel: 520/779-9463 Air Marine wind generators.
➤Trillium Windmills, Ont., Canada; Tel: 705/326-6513 North American distributor for Rutland wind generators.
➤United Solar Systems, Mich., USA; Tel: 810/362-4170 Unisolar solar panels.
➤Wind Generator Products, Fla., USA; Tel: 305/247-2868 Windbugger wind generators.

# GELCOAT SOS

Maintaining a showroom-like finish of your boat's gelcoat is no small task. Here's a step-by-step guide to achieving a brilliant, deep gloss and long-lasting shine.

***Story by Jan Mundy***

With proper care, gelcoat can remain in like-new condition for many years. Neglect it and the surface quickly fades and becomes dull.

Maintaining gelcoat involves four steps: wash the surface to remove any loose contaminants; remove oxidation; apply a protectant to restore the oils and nutrients in the gelcoat, protect against the elements and facilitate cleaning; and maintain the finish.

## To Wax or Polish?

What's important in a wax or polish is gloss and degree of protection. A quality wax or polish should go on easy, buff off easy, remove light oxidation, produce a glossy shine, shed organic growth, reduce water friction, resist removal by washing, contain UV blockers and last until you get the urge to reapply.

Wax once represented any natural paste product, usually carnauba or bees wax, but nowadays it's the generic name for any product sold in a can. Traditional "pure" paste waxes are amber in color and tend to be tacky. I'm sure there are aficionados of pure waxes who will never switch. Such products are old technology and there are superior synthetic polymer waxes and polishes that are easier to apply and engineered to protect and shine longer. Hybrids, such as 3M Marine Ultra Performance Paste Wax and Boat Life Life-Wax, are examples of modified waxes containing polymers and glossifiers plus minute amounts of carnauba as a gelling agent. Star brite's Teflon Paste Wax is a gel form of its liquid Teflon polish and contains virtually no wax.

Polishes are formulated blends of hydrocarbons, solvent, water and emulsifiers. Primary differences between natural paste waxes and poly-waxes and polishes are the type of bond each forms with the substrate (in this case gelcoat), application and longevity.

Natural waxes "stick" to the surface forming a temporary physical bond and need heat or friction to crystallize. That's why you let the wax haze over, then buff either by hand or with a polisher. Pure wax requires extra effort to apply an even coat and then get it to shine. Repeat applications stick to the previous coat forming a wax buildup that eventually must be removed. In the presence of sunlight, it starts to go back to its natural uncrystallized form, becomes yellow and dull. Because it's physically sticking to the surface, not attached chemically, any hydrocarbon fluid, including suntan lotion, will remove the wax.

Polymers are engineered to form a chemical bond to the substrate. They become part of the surface, as opposed to sticking to the surface. As solvents evaporate, they start to polymerize, which is a form of crystallizing, and don't need power buffing or rubbing until your arm hurts to create heat or friction and shine. Once they polymerize, they stay in that state until worn off by abrasion or the elements. Polymers, especially liquid ones, are generally easier to apply — you can spread a thin, more uniform coat, and solvents give longer working time. They are more tolerant to sunlight and offer better chemical resistance. Should you spill gasoline, oil or solvent on a polymer protectant, it's not going to come off. Polymers won't stick to themselves; you can reapply, but you'll never have a buildup.

So how do traditionalists know when a wax is a "pure" wax? The only way to know what you're buying is to read the label. If the product contains carnauba or includes a wax ingredient, is in a paste form, amber in color and tacky, more than likely it's a pure wax. If it's in a gel form, says "Presoftened," or it's a white or pastel color, it's probably a polymer product. (Or call the manufacturer and ask if it contains wax.)

For clarity, further references to "wax" denote any generic polymer wax or polish protectant unless specified. Also, the term "waxing" loosely refers to the process of applying a protectant.

## STEP 1

### Know Your Cleaners

Prepare your boat for "waxing" by thoroughly washing it with a non-abrasive light detergent.

What's important is that you remove all surface dirt, foreign matter and all previously applied coatings. Marine boat soaps are engineered to be high foaming, free rinsing and non-streaking. Household cleaners (i.e. Fantastic, Castrol Super Clean) will effectively remove grease, oil and dirt but must not be allowed to dry before thoroughly rinsing (see "Removing Gelcoat Stains" on page 18).

***Pressure wash: a plastic garden sprayer with a spray wand does a great job of hull cleaning.***

***Use an abrasive pad-backed rubber glove to clean side decks, cockpit floor drains, behind stanchions or any area where brushes don't reach as well.***



***Concentrated multi-use soaps that you dilute with water or apply full strength for tougher cleaning jobs help save space onboard.***

Remove any surface rust, oil, tar, algae discoloration, black streaks caused from water runoff, exhaust and waterline scum or other stains before waxing or you'll seal in the stain. This usually demands using an acid-based stain remover. If this doesn't work, try abrading stains off with rubbing compound, but do so carefully or you'll rub through the gelcoat.

One-step clean-and-wax products combine washing and waxing in one easy operation. These are best used on new boats or older surfaces where the finish is in good condition with little or no oxidation. Simply apply, then spray with a heavy stream of water to activate the foaming action, lightly rinse and let dry. Suds react with heat and bond to the surface like one coat of wax. You won't achieve the same results in one step what you can in multiple steps, but you'll have some gloss and protection. Be sure to select a one-step cleaner/wax containing a UV blocker.


***Sea-Safe Boat Wash is one of the few "green" cleaners that actually works. It effectively cleaned a year's worth of road dirt, salt and tar off our RV.***

When your boat's gelcoat is in good condition with no major degradation, bypass the next step and go directly to Step 3.

# STEP 2

## Restoring Color

Oxidation is the dulling or hazing appearance of gelcoat (or paint) caused by weathering and UV exposure. When a cleaner won't remove the oxidized layer, corrective action requires removal using a color restorer or rubbing compound, depending on the severity of the oxidation. The worse the oxidation, the more aggressive the product.

Begin by applying a color restorer. These spray-on, wipe-off liquids will revive all but severely oxidized gelcoat. Mixtures of hydrocarbon with some form of grit, such as ground silica, restorers penetrate the gelcoat,

# WAXING 101

**1 What do you do when it starts to rain before you have time to buff?** Retreat into the cabin and enjoy the rain. Wait until the surface dries and see if you can buff it. Some protectants may wash off and not bond to the surface, reducing durability and longevity; best to wax and buff a small area at a time before the rain hits.

**2 Before reapplying, do you need to remove the existing protectant?** If the surface is dull or not beading rain drops, then more than likely there's virtually no wax left and you're wasting time stripping; just overcoat.

**3 What is the shelf life of a protectant?** Paste waxes containing natural wax have a shelf life of four or five years, unless they become contaminated with mildew spores caused by excessive heat. Polishes have preservatives to prevent mildew growth and will keep for up to 10 years provided they don't freeze. If the polish doesn't mix when shaken, it's gone bad.

**4 Can you use one supplier's cleaner and another's wax?** It's not important that you use one supplier's cleaner with their corresponding wax, with exception: it's possible that a cleaner contains a primer or something that prevents another wax or polish from adhering to it. Best to check with the manufacturer.

**5 What do you do when applying in direct sunlight is unavoidable?** Work in small areas and just prior to applying the wax, wipe the surface with cheesecloth dampened (not wet) with water or mineral spirits. This allows the wax to bond to the surface before solvents evaporate and it dries. Shading the area with a tarp or umbrella helps to reduce surface temperature.

**6 How critical is dewpoint?** Anytime moisture through rain or dew occurs within six to eight hours after applying a protectant, you can end up with spots getting caught in the film which reduces adhesion. Best to wax or polish early in the day.

**7 How do you know when to reapply?** Longevity depends on the color and condition of the surface, exposure to the elements and quality of the protectant. A high-gloss shine, mirror-like reflection and a slick-feeling surface with little resistance are good indications there remains a layer of protection. If dirt adheres to the surface or it feels rough, and there's no reflection, there's probably no wax left.

**8 How critical is water beading?** Most of us consider a wax is not doing its job unless it beads. This is true with natural paste waxes which bead water drops when first applied, a condition that diminishes as the wax ages. With polymer protectants, beading is not necessarily an indication of protection. In the automotive industry the newest trend is towards polishes that "sheet;" rather than pool on the surface, water is repelled. This avoids hot spots that burn the surface and the telltale mineral rings from water spotting. The only boat polish we're aware of that repels water is Capt. Phab Superblue Cleaner/Polish.

**9 Can you apply decals, repair fiberglass or gelcoat or paint your boat after applying a polymer protectant?** Yes, but unlike waxes, polymers won't come off with solvents. Proper procedure is to wet sand with 1,200- to 1,500-grit paper or use a rubbing compound with a soft scrub.

# GELCOAT SOS


***Color restorers are a single-season cure, removing light oxidation and restoring gloss.***

buffing extracts the oxidation, leaving the oil behind and a glossy finish. While there is a very small amount of abrasive in a restorer, its effectiveness is mostly dependent on the chemical compounds saturating the gelcoat; test a couple of small areas first to see what speed and what pressure works best for you.

In the 80s, it was popular among boat detailers to "feed" gelcoat with household oil-based products, like 303 Protectant, Armor-All, Penetrol, even transmission or mineral oil. While they restored the color and helped to block UV light, they soon washed out.

I've had good success with restorers from 3M Marine, Aurora, Boat Armor, Boat Life, Meguiar's and Star brite. Iosso Fiberglass Reconditioner is a one-step color restorer, stain remover and protectant that eliminates the waxing step. Tested by DIY last summer, it effectively removed oxidation and left a brilliant shine. Unlike some restorers, it works better with a buffer than hand polishing.

A short-term cure, restorers usually last only one season. If a restorer doesn't remove the oxidation, you'll need a more aggressive treatment.

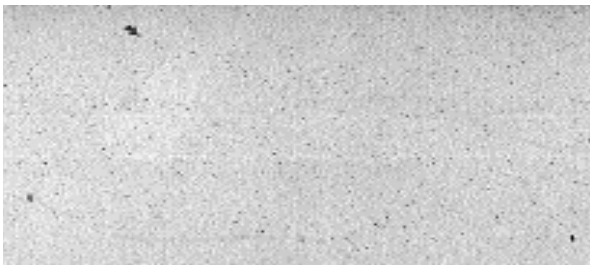
Rubbing compounds contain abrasives that remove a thin layer of gelcoat, exposing a fresh surface. If not used correctly, they can destroy the finish. Gelcoat is only 20 to 30mils thick when new. When buffing with a rubbing compound you want to remove just enough of the gelcoat to correct the problem, normally 12mils or less. A compound leaves a fairly aggres-

***When power buffing use a foam or wool pad and apply light pressure. Don't hold the pad in one spot too long or you'll overheat the surface. On two-toned boats, use one pad for light colors and a separate one for dark colors.***

## REMOVING GELCOAT STAINS

**Q:** A plastic bag was left inside my boat sitting on gelcoat. Because of dampness the ink on the bag stained the gelcoat with an impression of the picture and writing from the bag. I'm unable to get it off with usual household cleaners (Spray 9, Fantastic) or Star brite Black Streak Remover. Do you have a solution to remove the ink stain?
*Dan Goodman,*
*Yardarm, Toronto, Ont.*

**A:** Gelcoat is very porous and the ink, which is a solvent-based material, is now embedded into the pores. A surface cleaner is not going to get into the pores, as you've discovered. Apply a mild rubbing compound or a fiberglass color and restorer, which is more gentle. You want to remove just enough of the gelcoat to correct the problem. Remember, gelcoat is only 20 to 30mils when new and compounding removes about 12mils or less. Once the ink is removed, protect the gelcoat with a coat of polish or wax. Household cleaners will effectively remove grease, oil and dirt but must not be allowed to dry. If you're not very careful and the cleaner dries, like an acid, it etches streaks into the gelcoat. There is no correction for alkaline streaking. It not only looks bad but it opens up the pores of the gelcoat, attracting dirt. We discovered this streaking problem when cleaning one of our test boats last spring with Castrol Super Clean, a cleaner we recommend highly, but it dried before we could rinse it off. The streaking is not visible when looking directly at the hull, but very noticeable when viewed at a 45° angle.



***Is this mildew in the gelcoat? No, the pepper-like specks are minute high spots of the underlying fiberglass laminate exposed by aggressive compounding.***

sive scratch pattern and is often followed with a cleaner/wax or finer glaze such as 3M Finesse-It II to remove the scratches, leaving a slight gloss.

Oxidation removers can be applied by hand or an oscillating buffer that spins at 1,500 rpm. (Carefully follow the application instructions.) You may find that, depending on the amount of oxidation, you'll need to go over the surface several times. Follow with a quality wax or polish to seal in the shine. Older hulls that have seen several treatments for oxidation removal are not as resistant to UV as the original finish.

## STEP 3

### Applying the Final Finish

Most protectants are applied by hand. Apply a thin even layer (don't goop it on), and use a light, but definite pressure. (This allows the cleaners to penetrate the surface.) After the wax or polish dries to a white haze, the surface is buffed by hand or machine. To hand-buff, use rags of clean terry cloth or old T-shirts. Make sure you have enough to buff the whole surface, turning the rag over frequently and continuously using a clean section. An oscillating buffer with a foam (preferred) or lamb's wool buffing pad does the best job of power buffing. Use only light pressure and tip the machine slightly as you cover each area. Make sure buff pads are clean and dirt-free and replace when they no longer are fluffy. Work only

*(continued on page 21)*


***One-step clean-and-wax products are best used on new boats or older surfaces where the finish is in good condition.***


## FROM THE PROS

■ Use only soaps specifically designed for boat washing and don't wash the boat in direct sunlight.

■ Use a terry cloth to hand polish. Dirt ends up in loops of fabric. A chamois, diaper or other flat cloth drags any residue dirt over the surface, scratching the finish.

■ Don't apply in cold temperatures (below 10°C/50°F) which reduces adhesion.

■ Keep containers closed to prevent evaporation of solvents added to facilitate application.

■ Don't work too far ahead of yourself. Some products are very difficult to remove if they dry completely.

■ Oxidation and wax residue will build up in the buff pad and you'll have to "rake" with a screwdriver or a spurring tool (available at autobody shops). With the buffer turning, hold the tool to the face of the pad.

■ Don't apply a natural wax over a polymer. This turns the surface white and you'll have to start over.

■ Paste and gel products adhere better to vertical surfaces than liquids.

■ To remove a natural paste wax, 3M Marine recommends a 70% solution of isopropyl alcohol or 3M Adhesive Remover. Remove all wax before doing any sanding or grinding.

■ Instead of a wool pad, try using a foam one when power buffing. It doesn't pick up dirt nor clogs or knots and doesn't build up glaze so you get a swirl-free finish, provided you keep the buffer moving. But it's more expensive and tears easily.

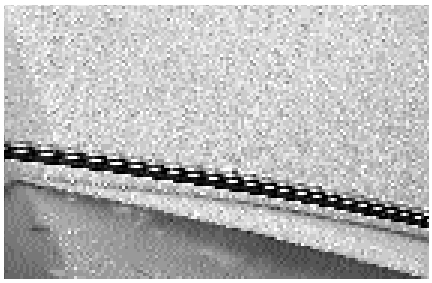
■ If you're an aficionado of natural paste waxes, consider switching to a polymer polish or modified wax. They generally outlast natural waxes by 2:1.

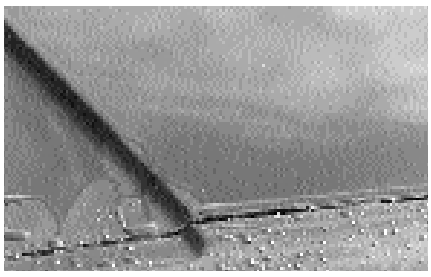

in a 61cm (2') square area at a time, applying the wax, then buffing.

Application in direct sunlight is not a good practice, but sometimes it's unavoidable. This is extremely critical with natural paste waxes; use these only on an overcast, cool day (but above 10°C/50°F) so the solvent doesn't evaporate before you have time to spread out a thin, even coat. When applied in direct sunlight, the solvent evaporates faster than you are able to spread the wax, leaving a thick glob in one area and virtually nothing in another. When buffed you get shiny and dull areas or streaking.

If you must apply in sunlight, work in a small 15cm (6") square area, dab it on, rub in quickly, buff off and continue, overlapping the edges.

Wax will bake on a surface that is too hot when applied and streaks. When this happens, wash with a quality soap to remove the streaks and reapply the wax in those areas.





***Water beading on the surface (top) used to be a good indication of longevity but nowadays, there's a trend towards products that sheet (bottom) to eliminate water spots.***

## STEP 4

### Maintaining the Gloss

There are products on the market that enhance the appearance and revitalize the gloss without going through all the work of "waxing" again.

The next time you wash your boat, before it completely dries, spray on 3M Marine Clean and Shine or Aurora Kwik Shine. Wipe the surface dry with a clean terry cloth (best) or chamois. You'll get a thin layer of protectant over the original coating, extending the life of the wax and enhancing the shine.

When you see the before and after effect, you'll know your patience was rewarded. When you're finished, take a break, you earned it.

*— Technical assistance provided by Adam Bouley, Dolphinite Products, Jeff Tieger vice-president of Star brite and Ray Lemieux technical service representative for 3M Marine.*

# BOTTOMS UP

Preparing your boat's bottom is just one of the many tasks that need to be done to get your boat ready for the boating season. Here's how to select and apply the right antifouling paint for your boat.

***By Paul Noack***

### *WHAT YOU NEED*

*Paint tray, brushes, solvent-resistant rollers*
*Rubber gloves*
*Goggles & respirator*
*Coveralls*
*Brush cleaner solvent*
*Masking tape*
*Sander and sandpaper*
*Paint scraper with extra blades*
*Dust mask*
*Degreaser*
*Rags, paper towels*
*Solvent*
*Plastic sheet to catch sanding residue*
*Paint mixer*

Once fouling has established a hold on a boat it will rapidly spread or "colonize" the surface. Prevention is therefore better than the cure of having to remove the fouling by scraping or applying a chemical remover.

There are a number of key reasons to keep your hull free from fouling. Heavy fouling growth reduces responsiveness of your boat. The added weight of the fouling can make the boat sit lower in the water than intended. This can have obvious implications in heavy weather conditions. Prolonged growth of certain types of fouling can damage the substrate of the hull. For example, the natural glues used to attach organisms to the hull can damage wood and fiberglass. Fouling can also clog water intakes and cause damage to the engines. Fouling causes drag, reducing boat speed and efficiency. As drag increases, fuel consumption increases and speed is reduced even to the point where a planing hull may not be able to get on plane. For racing boats, this can be the difference between winning and losing a race.

## Recipe For Antifouling

An antifouling is a combination of four basic ingredients: biocide, resin, solvent and pigment. Biocide is the active compound that repels fouling. The most common types are copper compounds such as cuprous oxide or metallic copper. Resin holds the product together and forms the coating film and controls the release of the copper or other biocide. This dictates the type of antifouling achieved. Solvent dictates the application characteristics, flow and drying speed, while pigment provides the color and thickness of the antifouling.

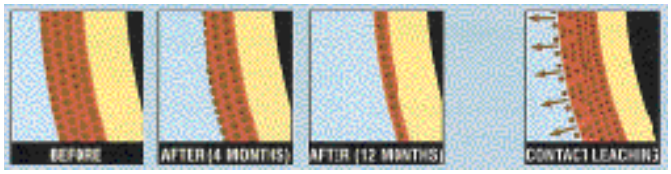
The amount of biocide is not the only determining factor of how an antifouling paint will perform. The resin-binder system, the material that holds the paint together, is equally important. Not only does the resin-binder system hold the paint together, it's the mechanism that determines how fast the copper or other biocide will be released. The resin-binder system must be carefully tailored for the amount and type of copper or other biocide used to obtain maximum efficiency. There's a perception that paints with high copper content are better. The amount of copper or other biocide may affect the life of an antifouling paint but the sophistication of the resin-binder system to hold and release copper or other biocide at the proper rate is far more important to the effectiveness of the antifouling. A copolymer or ablative antifouling will release biocide at a nearly constant rate throughout its life. For this reason, these highly efficient antifouling paints are less dependent on large amounts of copper and other biocides and deliver the best possible performance.

## Types Of Antifouling Paints

The quality, combination, quantity and type of resin dictate antifouling type.

Copolymer and ablative antifoulings are partially soluble which means that as water passes across

***Not all antifouling paints are compatible and previous paints of unknown origin should be removed before recoating.***




INTERLUX

***Copolymer or ablative types of antifouling wash away as the boat moves through the water, reducing the thickness of the antifouling. This results in a layer of fresh biocides on the surface throughout the season. It also reduces the need to sand and eventually strip the antifouling paint off the boat.***

***Biocides leaching out of hard antifoulings on contact with water prevent fouling growth.***

the surface of the coating, the coating wears down, much like a bar of soap would wear away. The action of the water steadily reduces the thickness of the paint at a controlled rate which results in always having fresh biocide at the surface of the paint throughout the season. For this reason these types of antifoulings have the capability to perform in the areas of highest fouling. Because copolymer and ablative antifoulings wear away with use there is no build-up of coatings that will eventually have to be removed from the surface. The minimal build-up reduces the maintenance and preparation needed when it's time to apply more antifouling. Copolymer types, such as Fiberglass Bottomkote ACT and KL990 Koposition, can be hauled and relaunched without repainting as the longevity of this coating is related to the thickness of the paint. Ablative types do not retain their antifouling ability for more than 30 days after being hauled out, with the exception of multi-season ACP-50, Awlstar, BIO C3 and Micron CSC Extra.

The technical term for hard antifouling paints is "contact leaching." The paint dries to a hard, porous film that is packed with biocides which leach out on contact with water to prevent fouling growth. This leaching is chemically designed to release biocide throughout the season

## HOW MUCH PAINT DO I NEED?

Use the formula below to determine your surface area, then refer to the paint category for an estimate of the amount of paint required when applying by brush or roller. Purchase enough paint to apply two coats.

**LOA x Beam x .85 = Area of bottom**

| | |
|---|---|
| Multi- Season | 400-450 sq. ft. per gallon |
| Hard | 400 sq. ft. per gallon |
| Aluminum | 275-375 sq. ft. per gallon |
| Teflon | 300 sq. ft. per gallon |
| Vinyl | 300-350 sq. ft. per gallon |

but the amount will steadily decrease until there is not enough biocide coming out of the paint film to maintain fouling protection. Once the biocide is exhausted, the hard paint film remains on the boat, causing a build-up of old, spent paint.

One of the main benefits of Trinidad and other hard bottom paints are their resistance to abrasion and rubbing. Paints such as Fiberglass Bottomkote, KL990 Super KL, Unepoxy Plus and Ultra-kote are ideal for fast powerboats, racing sailboats or boats where owners have the bottoms cleaned regularly. Most hard antifouling paints can also be wet sanded and burnished prior to launch to reduce drag and improve hull speed. A disadvantage to hard coatings is the build-up of residual paint film that occurs when the surface is not properly sanded prior to reapplication of new coats. When hard paints are hauled and stored for the winter season, the paint film, as well as the biocide, oxidizes and this makes it more difficult to release more biocide out of the film. For this reason they must be sanded and recoated with fresh antifouling before relaunching.

***A fouled hull increases drag, reducing speed and raising fuel consumption by as much as 40%.***

Most people associate Teflon with non-stick household products or with the space program, but the properties that made it perfect for those applications also make it an ideal ingredient in antifouling paint (i.e. VC 17M, VC 18 and Hydrocoat, a water-base formulation containing Teflon).

## ALTERNATIVE TO COPPER

An epoxy underwater paint may be the perfect bottom coating for those who hate the look of antifouling paint.

It used to be that there were only two options available for finishes below the waterline on a typical fiberglass boat: the original factory gelcoat; or some kind of antifouling paint. If you didn't like the appearance of antifouling paint and preferred a nice shiny bottom finish you were restricted to either a bottom wax, which is only moderately effective and has a tendency to attract certain types of algae (see "Results of Bottom Waxes" on page 28) or no coating at all.

America's Cup yachts and custom offshore performance powerboats are usually painted with high-gloss polyurethane finishes, such as Awlgrip, Interspray or Imron, below the waterline and hauled after every use. Paint manufacturers don't recommend this practice if the boat is wet moored; these polyurethane topcoats will blister badly if left immersed for much longer than a weekend.

As a general rule, high-gloss finishes and sustained immersion don't go well together. Remember, even original gelcoats have an annoying tendency to blister after enough time in the water and before long will be covered with a variety of living organisms.

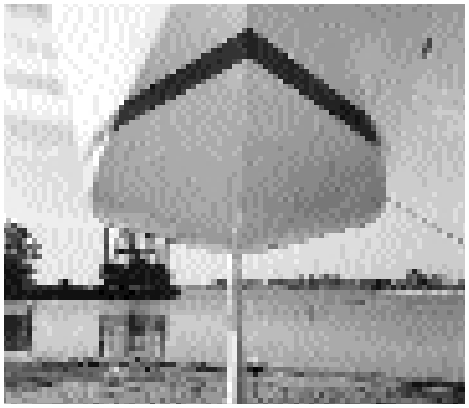
Many boaters haul and scrub their boats frequently enough to keep the bottoms clean or at least would like to be able to leave an otherwise trailered or dry-stored boat in the water for a week or two without worrying about blisters. VC-Underwater Epoxy Paint with Teflon, available from Interlux, will yield at least a semi-gloss finish and could prove to be the perfect bottom paint for those who hate the look of antifouling paint. Be forewarned, however, that this paint has no antifouling properties whatsoever.

Its natural (unsanded) finish is a nice white semi-gloss and like many high solid epoxy paints, it provides excellent protection against osmosis blistering if applied at the recommended thickness. Spray application is recommended, and like other epoxies this coating has a tendency to yield a slightly pebbly or orange peel finish. Careful spray technique can minimize this effect. Nonetheless, to achieve the smoothest results be prepared to do some sanding. It's the ease of sanding, no doubt due to the inclusion of Teflon in the formula, which makes VC Underwater Epoxy unique.

If you have a racing powerboat or sailboat and seek the perfect bottom finish be prepared to put in many hours wet-sanding, polishing and buffing but the results will be an unparalleled glossy finish.

If you leave a boat with this coating in the water for extended periods of time expect to haul out and scrub the bottom every ten days or so. Don't be too alarmed if the coating picks up a yellow stain from sustained immersion. A mild acid cleaner will remove this or a week or two's exposure to acid rain, as I found out to my surprise with my own boat.

***— Nick Bailey***



***Only a light fouling appeared on the hull after two weeks in the water.***

Teflon creates the lowest coefficient of drag of any coating available. The lower the friction, the less energy is required to move the boat through the water. For powerboats this means greater rpms, increased speed and fuel savings. For sailboats, greater speeds are achieved with less wind.

Soft or sloughing antifoulings, such as Bottomkote, Bottomkote XXX and Yacht Copper provide dependable low cost protection for cruising boats or boats with displacement or non-planing hulls. These paints are easy to clean and remove at haulout which prevents paint build-up. These coatings must be launched within 48 hours of painting to retain maximum effectiveness.

In the future, as government legislates lower Volatile Organic Compounds (VOC), you will see more and more water-based antifouling. Paints such as Aqua-Clean, Aquagard, Aquarius and Neptune II offer very low VOC.

Boat speed and type (planing versus displacement), local water temperature, salinity and nutrients all determine the effectiveness of paint. Boats located in southern waters need paints with more antifouling properties; warmer waters allow marine life to grow at a faster rate than in northern climates. Your local boatyard and yacht paint center can help you choose the best paint that is right for your boat and boating area and meets the environmental laws.

***To prepare new bottoms for painting, wipe the hull with a dewaxing solution and a clean rag, working in small areas and changing the rag often.***

## Recoating An Old Bottom

Not all antifouling paints are compatible with each other, as they are made up of different components and use different technology to repel marine growth (see "Compatibility Chart" on page 26).

It's best to remove your old antifouling paint if you are unsure of the paint which is on your boat. To remove layers of old paint you can use chemical strippers, such as Interstrip 299E or 399, Peelaway (a test of Peelaway appeared in DIY 1995-#3 issue), blast with sand or baking soda (refer to DIY 1998-#3 for soda blasting review), sand, scrape or grind. [Ed — a review of some new paint strippers appears in an upcoming issue.]

If you're not sure which type of paint is on your boat and you don't have the time to remove it, you may want to try putting on Fiberglass Bottomkote ACT or Unepoxy and take a chance that they are compatible.

Start by giving the bottom a good sanding with 80-grit sandpaper. Next, apply paint to a small area to see if

# ADD A DASH OF PEPPER

Abnormal amounts of rainfall and changes in water temperature last year have resulted in a higher percentage of freshwater in many coastal areas in the Northwest. The result is an extraordinary increase in marine growth. When switching from a sailboat to a powerboat, *DIY* reader Tom Hammond decided to follow the "old timers" and paint the bottom of his 26-footer with a local formula: cayenne pepper.

He half fills a Styrofoam coffee cup, about five or six tablespoons, with cayenne pepper, adds it to a gallon of antifouling paint and beats well; a mixer attachment on a drill works best. It's applied with a brush or roller, same as with standard bottom paints. Hammond also puts some solution in a spray bottle and sprays the outdrives, bellows and other places that harbor barnacles. According to Hammond, local commercial fishermen on the Fraser river near Vancouver, B.C., and powerboaters south of the border in Bellingham, Wash., have been mixing cayenne pepper in paint for nearly 20 years.

Apparently the pepper is much too hot for mussels and barnacles. After nearly 2-1/2 years afloat, Hammond hauled his boat, gave it a light powerwashing to remove the slime, then repainted. No barnacles, no mussels. Hammond also claims that treated outdrives have about 70% less growth than on boats docked nearby.

Mussels also thrive in an engine's raw-water cooling system. Twice a year Hammond flushes his engines (twin Volvos) with a solution of five to eight tablespoons of cayenne pepper, 1 cup bleach and 1 gallon fresh water. If you do this, collect the solution in a heavy plastic bag placed around the outdrives or over exhaust thru-hulls (inboard) so it doesn't spill into the water. — Jan Mundy

**COMPATIBILITY CHART**

| NEW ANTIFOULING \ OLD ANTIFOULING | ABLATIVE MULTI-SEASON | HARD ANTIFOULING | ABLATIVE SINGLE SEASON SINGLE SEASON | VINYL SINGLE SEASON | TEFLON SINGLE SEASON | WATER-BASED SINGLE SEASON | ALUMINUM BOATS |
|---|---|---|---|---|---|---|---|
| **ABLATIVE MULTI-SEASON**<br>ACP-50<br>Awlstar<br>Micron CSC Extra<br>Nautical Bio C3<br>West Marine CPP | Lightly sand & apply | Lightly sand & apply | Remove | Sand well & apply | Remove | Sand & apply | Remove |
| **HARD ANTIFOULING SINGLE SEASON**<br>Boat/U.S. Coppercoat<br>Boaters World Gulfstream<br>KL990 Super KL<br>Fiberglass Bottomkote<br>Nautical America's Cup<br>Neptune<br>Trinidad<br>Ultra-kote<br>Unepoxy<br>Unepoxy Plus<br>West Marine Bottom Pro Plus | Sand heavily & apply | Sand & apply | Remove | Sand well & apply | Remove | Sand & apply | Remove |
| **ABLATIVE SINGLE SEASON**<br>Bottomkote<br>Bottomkote XXX<br>KL990 Komposition<br>Fiberglass Bottomkote ACT<br>Tropicop | Sand & apply | Sand & apply | Sand & apply | Sand well & apply | Remove | Sand well & apply | Remove |
| **VINYL SINGLE SEASON**<br>Baltoplate<br>Nautical Racing Vinyl<br>Sikkens Vinyl 2000<br>VC Offshore<br>Vinelast<br>Vinylux | Remove | Remove | Remove | Sand well & apply | Remove | Remove | Remove |
| **TEFLON SINGLE SEASON**<br>VC 17M<br>VC 18 | Remove | Remove | Remove | Sand well & apply | Clean & apply | Remove | Remove |
| **WATER-BASED SINGLE SEASON**<br>Aqua-Clean<br>Aquarius<br>Hydrocoat<br>Neptune II | Sand heavily & apply | Sand & apply | Remove | Sand well & apply | Sand heavily & apply | Sand & apply | Remove |
| **ALUMINUM BOATS**<br>Alumacoat II<br>BIO COP<br>Horizon 45<br>Micron 33<br>Trilux-II | Never apply a cuprous oxide antifouling paint on an aluminum boat | | | | | | Sand & apply |

there is any kind of chemical reaction. If the paint looks good after one hour, coat the entire hull.

If you know what brand of paint is on the boat, give the hull a light sanding with 80-grit paper, wipe off dust (or wet sand) and apply another coat. When recoating with copolymer paint, it's important to sand well to prevent mud cracking. If you decide to change brands, refer to the "Compatibility Chart" (opposite) and follow the manufacturer's instructions.

## Painting New Hulls

New fiberglass boats will have mold-release wax on them which will have

*(Continued on page 28)*

## RESULTS OF BOTTOM WAXES

To be honest, we haven't had a lot of success with bottom waxes. We've tested three brands in fresh- and brackish waters and results have been fairly consistent — they all seem to attract living organisms, rather than repel them. The wax coating does, however, seal the pores of the gelcoat and facilitates easier and faster clean up on haulout than on a bare hull.

***Transom of our test boat coated with bottom wax after two months in freshwater. The right side has been cleaned with Castrol Super Clean.***

Bottom waxes are designed exclusively for use below the waterline. Application is easy. Over a clean hull, apply one or two coats liberally with a damp rag or sponge and launch the boat within 1 to 48 hours, according to directions. It's recommended to clean the bottom twice a season and more often if fouling develops. Manufacturers claim they are a good single-season antifouling paint alternative in low-fouling areas.

Our tests of Aurora Bottom Wax, Boat Armor Easy On and Super Slick have not bode well for these products. On one test boat moored in the Hudson River, which is about 50% saltwater, we applied Aurora Bottom Wax and by the end of the second week, the bottom was completely blanketed in barnacles. After hauling the boat, scraping off the barnacles and acid-washing the bottom, Super Slick was applied. Within three weeks, this stuff had attracted all sorts of growth. It has the consistency of peanut butter which made cleanup very difficult. Although not as severe, similar results occurred with Aurora and Boat Armor products in freshwater. All products were applied according to manufacturer's directions.

If your hull was previously coated with a bottom wax, you'll have to completely remove it before you can apply a paint. Removal may prove difficult, depending on build-up. Our test boat has had annual applications of various waxes for the past four years. When we attempted to remove the coating to prepare the hull for painting with VC Underwater Epoxy, no amount of cleaning with a solvent wash (in this case Interlux 202) had any effect. The wax wouldn't come off. As we didn't have any other products in our arsenal and the meter was advancing on the hoist, we power-washed the bottom and relaunched. We've got a handful of fiberglass cleaning products to test this year, hopefully one will dissolve the wax. We'll let you know the results in our next issue.

Unless you can get an endorsement from your local marine store or fellow boater where you dock your boat, I don't recommend using a bottom wax. If you've had good results with a bottom wax, we'd like to hear from you. Drop us a note via mail, fax or e-mail, telling us where you boat and what product you use.

*— Jan Mundy*

to be removed before you do anything (including sanding). Apply a dewaxing solvent (202 Solvent Wash) to a clean rag and wipe a .6m (2') section of your hull. With a clean rag wipe the section dry. Repeat and change your rag often, until the bottom is clean.

Now get a hose or spray bottle and soak the area you just de-waxed with water. If you see any water droplets beading on your hull you know wax is still present and you need to reapply more dewaxing solvent.

When the hull is completely wax-free and dry, it's ready for a light sanding with 80-grit paper. You are sanding to abrade the gelcoat and give the paint something to adhere to.

At this time you may wish to add an osmosis barrier coat to help prevent blisters. If not, remove dust and apply two or three coats of antifouling following the manufacturer's overcoat intervals. Lightly sand between coats.

On bare wooden hulls, sand with 80-grit paper and thin the base coat 10%, followed by two or three coats at full-strength. For epoxy-covered wood boats follow the same procedures for fiberglass hulls.

Bare metal hulls should first be coated with an epoxy barrier coat, a minimum of 10mils thick, followed by Tri-Lux II for aluminum hulls and any copper-based paint on steel.

### Multi-season Maintenance

Antifouling paints dry out and oxidize when left out of the water. They will lose a lot of their antifouling properties and therefore have to be repainted every season. This is not true for multi-season antifouling paints such as ACP-50, Awlstar and Micron CSC Extra. A light sanding or scuffing of the surface with a Scotch Brite pad before launching will rejuvenate the antifouling properties in these paints.

The more coats you put on the longer you can go between applications of paints. It's best to apply the first coat a different color than subsequent coats as it will act as a warning coat letting you know it's time to think about applying more paint. ⚓

*About the author: Paul Noack is a sales representative for International Paints Yacht Division, responsible for Central Canada and Upstate New York.*

## APPLICATION TIPS

■ *Know the laws in your area. In some places it's mandatory to catch all sanding residue and dispose of it in a properly designated area. Others call for catch basins for all water used when power spraying bottoms. And in some states, it's illegal to apply antifouling paints without a pesticide license.*

■ *Pick a nice day (above 10°C/50°F degrees for those who live in northern climates), get your crew out to help you and make it a social event. This is probably the only time you will be glad you don't have that dream boat that is 6m (20') longer.*

■ *Use a chemical-resistant masking tape, such as 3M Long Mask (blue) or 3M #256 (green) for a crisp paint edge.*

■ *Check specs before thinning antifouling paint or you may dilute the performance of the paint.*

■ *Wet sand rather than dry sand to avoid the dust. Wear an old foul-weather suit, rubber gloves and tape sleeve cuffs.*

■ *Follow the manufacturer's recommendations for coverage. You may think it's high but the thickness of the paint affects performance.*

■ *Thoroughly mix the paint (a paint mixer in a power drill works best) and stir often while applying.*

■ *Pour only enough paint for immediate use and keep the lid on the can when not in use. This prevents solvents evaporating out of the paint, making it thick.*

■ *Apply an even coat, avoiding drips and sags.*

■ *Avoid inhaling vapors and wear protective clothing and goggles.*

■ *Apply a minimum of two coats for best performance. Apply extra coats in high-wear areas (waterline, keel, rudder).*

■ *Recoat every season, except with multi-season paints. The way your antifouling looks cosmetically has no bearing on the paint's antifouling properties.*

■ *If you trailer your boat or you have a hoist for your boat and your boat does not stay in the water for more than two days at a time you don't need antifouling paint. You may want to apply an epoxy coating to the bottom of your boat to protect your gelcoat from wear and tear (see "Alternative To Painting" on page 24).*

■ *On aluminum surfaces, use only the recommended paints.*

## SLIME BUSTER BOOSTS PERFORMANCE

The U.S. Environmental Protection Agency (EPA) last year approved Irgarol 1051, a booster additive for copper-based antifouling paints. While copper repels most hard fouling marine organisms, it's less effective against algae. Irgarol, developed by Ciba Specialty Chemicals in the U.S., prevents algae from adhering to painted surfaces by blocking photosynthesis in algae. It won't harm fish or other marine life and degrades naturally in the environment.


Used successfully in Europe for more than eight years, paints containing Irgarol and copper have proven to be effective alternatives to tributyl tin, a restricted compound in North America. One of the benefits of Irgarol is its safety — it's the only algicide approved by the EPA for do-it-yourself applications and meets all air pollution regulations.

Pettit is the first manufacturer to launch an antifouling paint containing Irgarol. The newly formulated Trinidad SR significantly reduces slime in both fresh- and saltwater. — *Jan Mundy*

ENGINE TROUBLESHOOTING

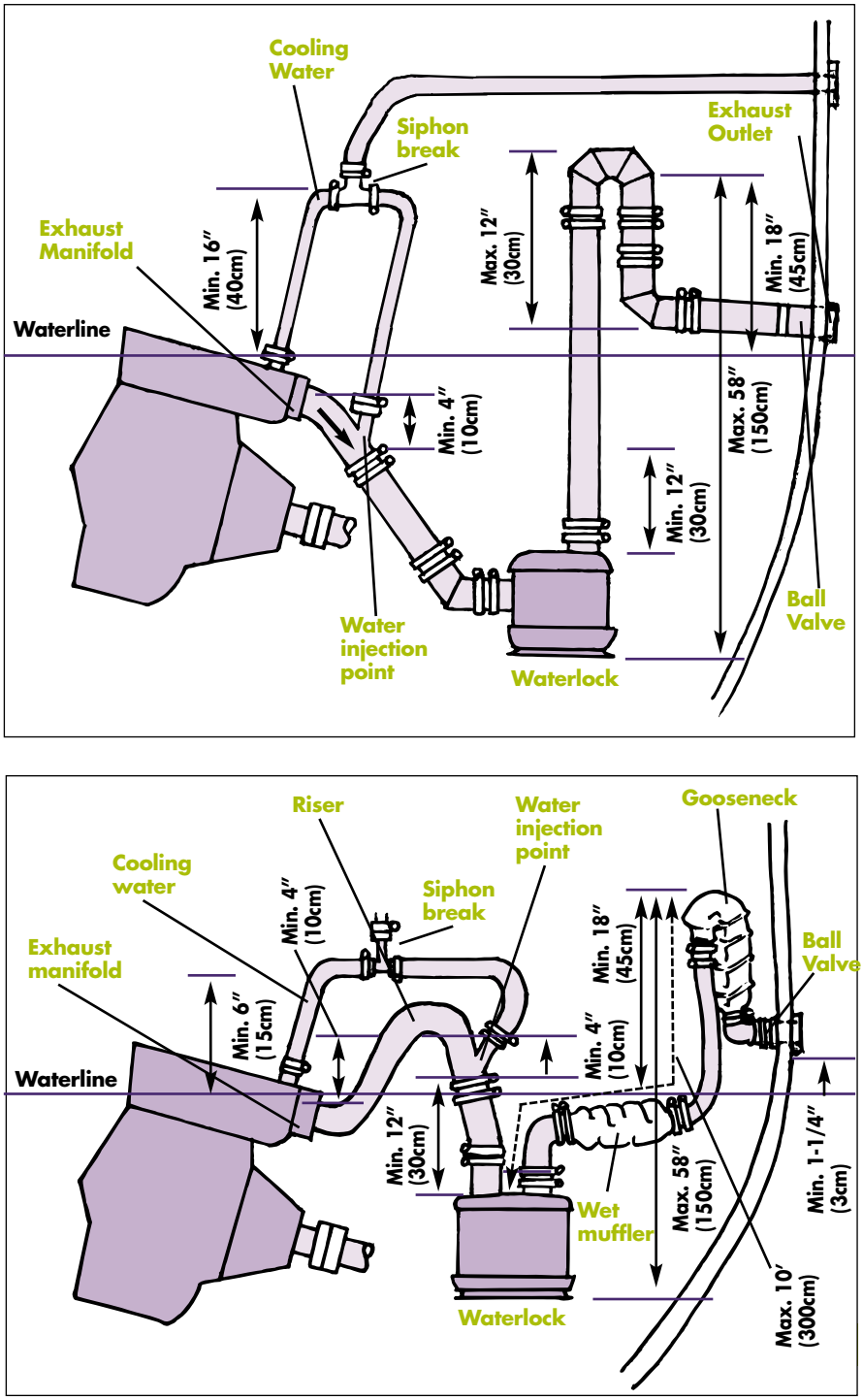
# WET EXHAUST SYSTEMS

When repowering a boat or upgrading an older exhaust system, it should be replaced with a properly designed waterlock system. Here's what you need to know.

***By Robert Hess***

Inboard marine engine exhaust systems are designed to lead the hot, toxic exhaust gases produced by the engine safely out of the boat with minimum heat radiation, and to muffle the noise of the exhaust as much as possible without excessively reducing power output. Many marine exhaust systems also are designed to dispose of engine cooling water.

There are two primary types of marine exhaust systems: dry systems that do not mix the exhaust gas and the engine cooling water; and wet systems which mix the exhaust gas and engine cooling water. Large commercial vessels and some trawlers usually use a dry-type exhaust system that leads the exhaust gases up and away from the engine in the same manner that an automotive or aircraft exhaust does. A dry system can be used whether the engine is mounted above or below the waterline. It's usually made of carbon or stainless steel, and may be led through an automotive-type muffler and then dispersed into the air through a long pipe or "stack," which is high enough to release the exhaust gases well above the cabin and passengers so the wind can disperse them. Dry systems are loud,




ANNE-MARIE HENDRY

**Figure 1: TYPICAL WATERLOCK EXHAUST SYSTEMS**

***Top: Exhaust system with water-injection point below or less than 15cm (6") above the waterline.***
***Bottom: Exhaust system with water-injection point 15cm (6") or more above the waterline. Siphon break is not required where the water-injection point is 15cm (3") or higher above the waterline.***

heavy and obtrusive, however, they are cheap to install, are the only reasonable system that will work with very large engines and eliminate problems related to engine cooling water or seawater backing up into exhaust manifolds.

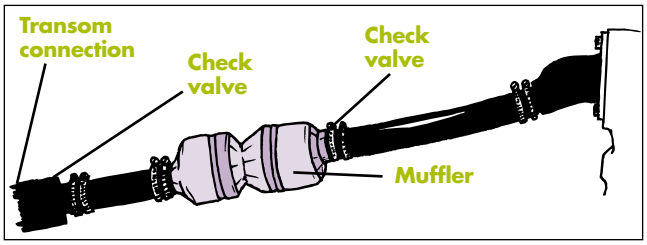



**Figure 2: TYPICAL EXHAUST SYSTEM FOR PERFORMANCE BOATS**

## Types of Wet Systems

Wet systems are divided into two types: above waterline when engines are fitted above the waterline; and below waterline on boats with engines fitted below the waterline. The latter is separated into two types: the water-jacketed system; and the waterlock system. Both of these must incorporate a component called a gooseneck. A gooseneck is a tall, curved section of the exhaust system (shaped like a goose's neck) which rises far enough above the waterline (usually 304mm/12" to 457mm/18") just before the exhaust outlet to prevent seawater from flowing backward up the exhaust system when the engine is not running. Boats that have the engine mounted far enough above the waterline to provide a steep downhill run can use a simple gravity-type wet exhaust system without a waterlock or water jacket (see "Installation Guidelines" on page 36).

On engine installations below the waterline, the water-jacketed exhaust (with gooseneck) was used before the waterlock muffler was invented, and is still used when it's not possible to use a waterlock due to space restric-

### TIPS — *PREVENT BACKFLOW WHEN STARTING*

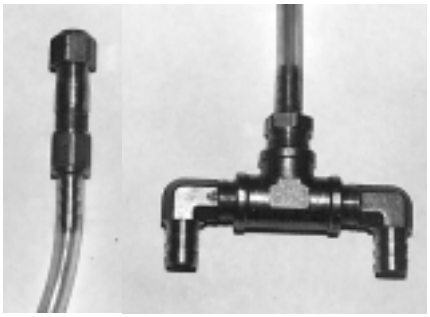
*If the engine is turned over for an extended period without starting, the water pump will continue to pump cooling water into the waterlock even though the engine isn't running, and water will eventually back up into the exhaust manifold. Keep the engine cooling-water intake thru-hull valve closed until the engine starts or when bleeding the engine. Alternatively, open the valve and after long, unsuccessful starting, drain the waterlock.*

ENGINE TROUBLESHOOTING

tions. This system uses engine water-pump pressure to force the cooling water through an exhaust water jacket and then up to the height of the gooseneck where it's injected into the exhaust. The cooling water and exhaust gas mixture is ejected at the exhaust outlet located right after the gooseneck. Although considered a wet type, the water-jacketed exhaust

***Exhaust riser wrapped with insulation secured with stainless-steel wire.***

system is actually a dry exhaust incorporating a double-walled metal (usually copper) pipe assembly that circulates the engine cooling water in an outer jacket around the inner pipe carrying the engine exhaust gases to cool the exhaust assembly. Because the gooseneck is usually located just before the exhaust outlet, most of the system is not really wet, even though the cooling water and exhaust gas exit together. Rubber exhaust hose is usually used between the water-injection point after the gooseneck and the exhaust outlet thru-hull to allow the heavy water-jacketed assembly to flex with engine movement. A rubber "transom muffler" is sometimes fitted to the exhaust outlet on the outside of the lower transom to reduce exhaust noise. This type of exhaust is heavy, expensive, and prone to cracking. It's difficult to inspect the inner pipe, so leaks are difficult to predict and diagnose. The water-jacketed system



***Typical tube-type anti-siphon valve assembly fabricated from brass fittings.***

was replaced by the waterlock system in most boats manufactured after 1980. When a water-jacketed system requires replacement it should be replaced with a properly designed waterlock system wherever possible.

The waterlock system (with gooseneck) uses engine exhaust pressure to lift the cooling water injected into the exhaust system up to the height of the gooseneck where the mixture drops down to the exhaust outlet and is ejected from the boat. The pumping action is achieved by fitting a component called a waterlock at the lowest point of the system, usually close to the engine exhaust manifold so the maximum length of the system can be wet. The waterlock is a metal, plastic or fiberglass canister with the inlet for the mixture of exhaust gas and cooling water at the top and the outlet at the bottom. Exhaust pressure at the top of the canister pushes the water out the bottom of the canister and up over the gooseneck, where the water and exhaust mixture can drop out the exhaust outlet. Because the waterlock only pushes the water up to the gooseneck when the exhaust pressure is high enough, the waterlock system exhaust pushes out water and exhaust gases in regular gushes instead of the steady flow of other systems. The maximum lift distance from the waterlock bottom to the top of the gooseneck is approximately 15200mm (48") for a normally aspirated or turbocharged engine. The greater the distance the greater the exhaust back pressure, because it takes more exhaust pressure to lift the water.

Waterlocks are selected by size. They should have 20% to 40% of the

**Figure 3**

## AVERAGE WATERLOCK SYSTEM DIMENSIONS

| | |
|---|---|
| **Exhaust outlet height** | Minimum 3cm (1-1/4") above waterline at rest |
| **Gooseneck height** | Minimum 45cm (18") above waterline at rest |
| **Distance of bottom of waterlock to top of gooseneck** | Maximum 150cm (58") |
| **Riser height** | Minimum 30cm (12") drop to top of waterlock |
| **Riser water-injection point** | Minimum 10cm (4") below top of riser |
| **Anti-siphon valve height** | Minimum 15cm (6") above waterline; maximum 2m (6'8") |
| **Calculating Waterlock Size** | Waterlock volume = (Volume of exhaust pipe & hose from water-injection point to top of waterlock) + (Volume of exhaust pipe & hose from top of waterlock to top of gooseneck) |

## WINTERIZING THE WATERLOCK SYSTEM

Because the waterlock is usually the lowest point of the exhaust system, and the waterlock system always contains water even when the engine is not running, winterizing a waterlock system requires that the waterlock be drained or flushed with antifreeze. Waterlocks have a drain plug for this purpose. Allowing a waterlock muffler containing water to freeze can destroy it, and may cause a mysterious water leak when the boat is put back into service.

volume of the exhaust hose between the water injection point and the gooseneck — when the engine is shut off all the water in the exhaust system between the engine and the gooseneck falls into the waterlock, and all the water after the gooseneck falls out the exhaust outlet thru-hull. Since the gooseneck is downstream from the waterlock it's also made of light plastic or fiberglass. The rubber exhaust hose can also be rolled into a loop at the correct height above the waterline to create an integral gooseneck. To increase the muffling effect a special wet muffler (which swirls the water and exhaust gas) can be installed between the waterlock and the gooseneck. Because it's located in a wet system, the muffler is made of light plastic or fiberglass.

Manufacturers of marine exhaust components include Barr Marine Products, Elastomuffle, Marine Exhaust Systems, Marine Muffler, Soundown and Vetus.

### Siphon Break

The waterlock marine exhaust provides a light, cheap and efficient system; however, it's prone to cooling water siphon and backflow problems unless properly designed for each specific application. Because engine and exhaust components are below the waterline in waterlock exhaust systems, a siphon effect can pull engine cooling water into the exhaust system through an open engine cooling-water intake thru-hull valve unless an anti-siphon valve is fitted in the system. If a siphon condition begins when the cooling-water intake thru-hull is left open without an anti-siphon valve fitted in the system, or if the anti-siphon valve is plugged, the water rises until it gets up into the exhaust manifold. It passes through open exhaust valves into the combustion chamber(s), then leaks past piston rings into the oil pan, travels past open intake valve(s) into the air intake, then out into the engine room. (If it reaches the engine room, the boat is sinking!) For that reason an anti-siphon valve mounted above the theoretical waterline must be installed in the

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engine cooling water hose between the exhaust manifold and the exhaust system water-injection point on all waterlock systems.

## Monitoring Exhaust Temp

Because the waterlock exhaust system is designed to run with water in it for most of its length, a failure in the engine or exhaust cooling-water system can destroy the exhaust system and cause a dangerous condition quickly. Engine exhaust gas temperatures in a dry system can reach 1,000°C (1,800°F), while wet exhaust system components are only designed to handle 100°C (200°F). The most effective way to monitor exhaust gas temperature is by fitting an exhaust temperature sensor in the cooling-water injection elbow, connected to a gauge and warning buzzer. A sudden rise in waterlock exhaust gas temperature will occur if cooling water flow to the waterlock stops. A water flow sensor mounted in the engine cooling-water system and connected to a warning buzzer is also effective in monitoring the all-important water flow that keeps the exhaust system cool.

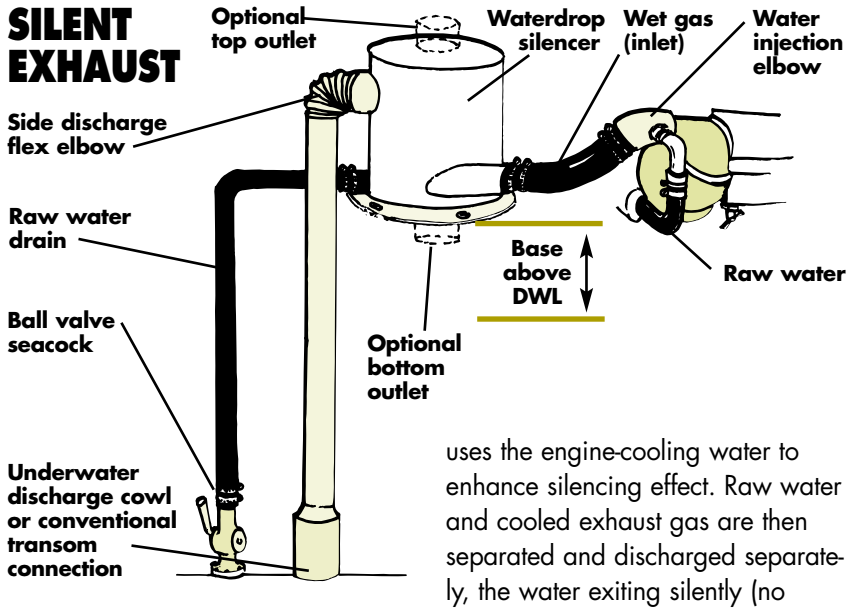
## Locating the Waterline

The dimensions for wet exhaust installation (**Figure 3** on page 32) are average approximate figures designed to provide a functional system in an average boat by assum-

*Continued on page 36*

### TIPS — WATERLOCK EXHAUST SYSTEM OPERATING PROCEDURES

1. *Turn off the cooling-water intake thru-hull valve when leaving the boat.*
2. *Turn off exhaust system outlet thru-hull valve when the engine is not running in heavy seas and at anchor when leaving the boat. Don't forget to open it again before starting the engine.*
3. *Clean and test the exhaust system anti-siphon valve (and any other anti-siphon valves on the boat) annually.*
4. *Don't turn on the engine cooling-water intake thru-hull valve until the engine starts. If the engine does not start right away when the valve has already been opened, turn it off until the engine starts.*




ANNE-MARIE HENDRY

Originally designed for large 200 hp engines, the axial Waterdrop Silencer from Soundown (800/359-1036) has many benefits over conventional wet exhaust systems for boats with 12 hp and larger engines or 8 to 400 kW generators.

Installed downstream of the water-injection point, the silencer uses the engine-cooling water to enhance silencing effect. Raw water and cooled exhaust gas are then separated and discharged separately, the water exiting silently (no water splash) through a below-waterline thru-hull and the de-watered exhaust piped as desired, or you can loop the dry-cooled exhaust pipe through bulkheads, the lazarette or whatever, down to an above-waterline thru-hull. Flexible mounting options allow installation in boats with low freeboard, typically 406mm to 460mm (16" to 18") above the loaded waterline, and on boats with extremely shallow draft (i.e. Hinkley Picnic boat). On sailboats, the silencer must be located above the heeled waterline and the dry-gas flow makes possible long, winding discharge runs. The silencer's pipe attachment options allow side, top or bottom entry and discharge.

Extremely quiet, the Waterdrop reduces exhaust and machinery noise down to a level below typical prop wash noise, or as much as 20 dB quieter than conventional systems. The separate discharging of gas and water also reduces back pressure: 250mm to 380mm (10" to 15") of water column; most average 508mm (20") of water column.

Typical cost for this type of system including all components for a 10.8m (36') cabin cruiser with 300-hp diesel averages US$700.

*— Jan Mundy*

## ENGINE COOLING TROUBLESHOOTING

Raw water problems in an engine's cooling system are not always caused by a faulty impeller. I recently discovered a total lack of water in the exhaust discharge aboard "Spindrift." With only 100 hours on the meter since the last major service, it appeared that the culprit was a bad raw-water impeller.

After removing the cover plate, it was apparent that something else was responsible for the lack of water, as only one lobe on the impeller was cracked. Replacing the impeller was not going to solve the problem. An overlooked culprit, when restricted or no flow is detected in the exhaust discharge, can be the small mixing elbow, where the raw water is introduced into the exhaust. The combination of hot exhaust and saltwater can be cause for carbon and sludge to build up and restrict the water flow.

This is exactly what I found upon removing this elbow. After removing the scale and carbon (scraping works well) as well as installing a new impeller, we were back in business. This mixing elbow should be cleaned every couple of years.

Boats with heat exchangers also have a small 90° elbow where the raw water from the heat exchanger is routed into the mixing elbow. Here, salt-carbon sludge build up can quickly close off the orifice and restrict or eliminate circulation. The elbow is easy to remove and the opening reamed out with a small screwdriver or other small implement.

*— Sean Holland aboard "Spindrift."*

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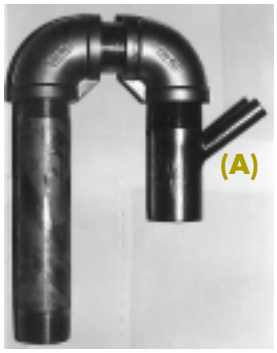



***Exhaust riser made of 318 stainless-steel pipe, showing water-injection point (A).***

***MerCruiser exhaust manifold riser.***

ing a standard drop in the theoretical waterline at the exhaust system cooling-water injection point and at the gooseneck when the boat is heeled, pitched or loaded to the maximum, without actually measuring the theoretical waterline in those conditions.

In order to use the most appropriate dimensions for each individual installation, the theoretical waterline should be actually measured and carefully marked using a clear plastic hose connected to one of the thru-hull fittings at the bottom of the boat and hung as close as possible to the planned cooling-water injection point while the boat is heeled, pitched and loaded to its maximum, either at sea with the old system still installed, or at the dock. The dimensions used to design the new system should ensure that at the lowest theoretical waterline there is still a margin of safety to ensure water in the wet section of the exhaust system will not flow backwards into the engine exhaust manifold at the cooling-water injection point. Also, the dimensions should ensure the gooseneck and anti-siphon valve are mounted high enough so that they are always above the waterline even in the worst conditions, and the exhaust outlet is slightly above the waterline.

**TIPS** *EXHAUST PRESSURE*

*Maximum (at full load) exhaust back pressure measured between the exhaust manifold and the waterlock, tested using a manometer, is usually around 76mm (3") of mercury, although this differs with the engine manufacturer. Back pressure can be minimized by using the correct diameter hose, as short as possible, and having no sharp bends.*

## Installation Guidelines

**(Refer to Figure 1)**

To ensure maximum power, coolest running and maximum silencing, the largest muffler and exhaust components possible should be fitted. Keep the number of bends to a minimum and the angle of the bends to 45° or less. The exhaust components should be routed away from wiring, cables, hoses and other components to avoid heat damage and reduce fire hazard and vibration.

The inner diameter of exhaust system components must never be smaller than the original, engine-exhaust manifold- outlet diameter. Metal exhaust components should be galvanized iron, black iron, copper, stainless steel or carbon steel depending on the exhaust system type. If exhaust system metal components are painted, the paint should be special heat-resistant exhaust paint, matte black in color to aid in heat dissipation. Hot exhaust components should be wrapped with a fiberglass tape secured with stainless-steel wire, and any hot components that could come in contact with crew or passengers should be fitted with metal guards. All components should be securely mounted with stainless steel and rubber mounts to allow the independent flexing and vibration of the boat, engine and the exhaust system itself.

Double clamp all rubber hose fittings with all stainless steel, non-perforated (AWAB) screw-type or "T" bolt-type hose clamps. To ease slipping hoses on fittings use only water and detergent, never products containing grease or oil.

Certified engine wet exhaust hose is labeled SAE J2006 or UL 1129 and made of hi-temp, two-ply, smooth black rubber (Greenline G301 or Trident 134) or silicone

reinforced with polyester (Greenline G382 or Trident 131V Blue VHT). It resists heat, cold, abrasion, oil, antifreeze and aging. Hose made of 100% silicone will last up to six times longer than black rubber. It costs more, but worth the price. For short runs with tight bends use a certified corrugated hose. For extreme conditions use silicone four-ply reinforced Nomex with a 260°C (500°F) temperature rating (Trident 202X).

The exhaust piping must slope down to the exhaust exit point close to the waterline at the stern (or to the muffler) at an angle of at least 20°; water injected immediately after the exhaust manifold will run downhill with the exhaust gases, eliminating the tendency for it to run backwards up into the exhaust manifold even in heavy seas. If the engine manifold exhaust outlet is lower than it should be to ensure a proper slope, a dry exhaust section rising up from the exhaust manifold to provide the correct height should be fitted. This section is called an exhaust riser (shown on page 36), and may be made of metal pipe or a special metal water-jacketed casting, usually available in cast iron or aluminum, although stainless steel and bronze, if available, are more corrosion resistant. In order to prevent seawater from backing up the exhaust pipe into the exhaust manifold when the boat stops suddenly, the exhaust can be fitted with a check valve and the exhaust outlet fitted with a rubber flapper valve. Metal exhaust pipe must be used up to the point of water injection, but rubber exhaust hose can be used after the cooling water is injected. A wet exhaust muffler (shown in **Figure 1**, bottom), some of which incorporate a check valve, can be fitted in the wet section of the exhaust piping, positioned as near vertical as possible, and amidships on sailboats.

In order to ensure the cooling water flows into the waterlock and not backwards into the exhaust manifold when the engine is running, there must be a drop of approximately 100mm (4") before water is injected. There must also be a further drop of approximately 200mm (8"), or a total drop of 300mm (12"), before the water enters the waterlock to ensure the exhaust gas is adequately cooled. Sometimes, the dry section before the water-injection point is fitted with a special water-jacketed piece called a jacketed elbow that incorporates the water-injection point. If space limitations do not allow the waterlock to be mounted at least 200mm (8") below the engine exhaust manifold a dry riser rising up from the exhaust manifold to provide the correct drop to the waterlock must be fitted. This riser is the same component that may be used in a gravity system, made of metal pipe or a special metal water-jacketed casting (usually available in cast iron or aluminum). ⚓

*About the author: Robert Hess operates Atomic Four Engine Service and is an authorized dealer for Universal and Beta engines.*

# KEEPING COOL

"Air conditioning in my Wavewacker 26? Not likely," I hear you say. But today's new marine air conditioning units are smaller, less expensive and simpler to install than ever before.

***By Nick Bailey***

Many boaters in the temperate climates of the Northeast and Northwest coasts or the Great Lakes basin consider the best air conditioning as a nice cool sea breeze through an open hatch. Given the typically cold waters of these regions, relief from summer's heat is usually no further away than the boat itself.

Lately, however, it seems these areas have been getting really hot summers and being on the boat may not always provide refuge from the humidity and heat. This is a reality which Gulf coast and Florida boaters have always had to deal with. Ask any southern boater and he or she will tell you that air conditioning is not a luxury but a necessity. It can make the difference between being able to use the boat and not, particularly if your family's enthusiasm for weekends aboard declines as the mercury rises.

## How Does A/C Work?

Air conditioners (A/C) are similar to refrigeration units and use the same physical principles. They are designed to pump a specially tailored refrigerant (usually Freon 22) through a sealed heat exchange circuit. The fluid picks up heat from the cabin air and transfers it overboard.

In more detail, at the beginning of the heat exchange cycle the refrigerant first travels as a cool liquid to a fluid-to-air heat exchanger known as the evaporator (it looks a lot like a car's radiator). Here the refrigerant expands into a low-pressure gas that, by the normal laws of physics, causes the refrigerant temperature to plunge. This cold gas passes through the evaporator heat exchanger at the same time the cabin air is being drawn through by a blower. The warm humid cabin air cools, usually below the dew point, on contact with the evaporator and the humidity condenses out and drips into a catch tray under the unit to be drained away. Meanwhile, the blower circulates the cool dry air back into the cabin through ducts. At the same time, the refrigerant, now a warm gas, continues to circulate back to the compressor (usually driven by an electric motor) where it's compressed into a hot gas under high pressure. The hot Freon then flows to another heat exchanger, called the condenser, which usually looks like a coil of pipe wrapped around the compressor and in this case, is cooled by seawater. Here it transfers its heat to the seawater and condenses back to a cool liquid to continue the cycle. The seawater, now warmed by the heat removed from the cabin air, is pumped over the side.

It's worth noting that a large part of the A/C's contribution to comfort comes from removing humidity. When the unit is first turned on, a great deal of the initial work goes into condensing humidity which holds a lot of latent heat from the air. Once the humidity is lowered then temperatures will start to come down and even if the A/C is undersized for the job, just the removal of the humidity, even without much lowering of the air temperature, will make a big difference in comfort.

***Cruisair's portable Carry-On requires no installation other than placing it over the hatch, attaching the fabric hood and plugging it into an extension cord.***

***Measuring 30cm (11-3/4") high, 46cm (18") wide, 24cm (9-1/2") deep and weighing just 22kg (48lb), the 7,000 BTU Vector Compact by Marine Air is the most compact of the self-contained units.***

***Ocean Marine self-contained systems offer optional reverse cycle heating.***

## What is Reverse Air?

A/C units with reverse air capability can run the cycle backward to pull heat from sea water for warming the cabin. This is a bonus to boaters in more northern climes but there is a catch, particularly for liveaboards. It will not work if the seawater temperature gets to 4.4°C (40°F) or lower. At temperatures approaching freezing there isn't enough heat left in the water to be useful before it freezes and causes the heat exchanger to ice up internally. This cuts off the water flow and any further heat exchange.

## Types of A/C Systems

Here's a quick review of what's available in the marketplace. All air conditioners are AC powered; there are no DC-powered units.

**Domestic Window Units:** Just cut a hole in the wall, er, bulkhead and prop into place with 2x4s. Perfect for that houseboat permanently tucked away off the waterway or tied to a mangrove in the back bayou.

**RV Units:** RV units are just a more streamlined version of the domestic units and are designed for rooftop mounting on a motor home. They are quite tidy, relatively economical and simple to install. Capacity is from 5,000 to 15,000 British Thermal Units (BTU), and they look at home on the pilothouse of a small tug or work boat. I question how secure they would be in a big sea and you would not want to be tripping over one on a crowded deck; they can be a viable option nonetheless.

**Marine Portables:** The two popular marine portable A/C units are Cruisair's Carry-On and KoolKart by Komfort Industries. Like a domestic window A/C, the 4,800 BTU Carry-On has an air-cooled condenser and mounts outside the living quarters, blowing cool air in through a shrouded opening — in this case, any hatch 30.5cm (12") square or larger. No installation is required other than placing it over the hatch, attaching the fabric hood and plugging it into an extension cord. The KoolKart is a suitcase unit designed to roll on and off the boat as needed. Similar to built-in marine A/C units, it uses water cooling but from portable hoses with a submersible pump on the end. The hoses are simply lowered over the side. It's a 6,500 BTU unit, about 35% more capacity than the Carry-On, but it's also proportionately more expensive. Water cooling means that its efficiency will remain unaffected as the ambient temperature rises. Both of these units are perfect for dockside use in boats from 6m to 9m (20' to 30') but must be stowed while underway.

**Built-in Air:** These are the true marine A/C units installed permanently and water cooled. Once regarded as equipment practical only for larger yachts, prices have dropped and improvements made in the efficiency and packaging, particularly with the smaller self-contained units. All the major manufacturers have new entrants in the economy 5,000 BTU class, targeting the smaller boat market and packaged for do-it-yourself installation.

There are three basic configurations for built-in marine A/C systems: self-contained, remote condensing and chilled water. They are all water cooled and require a pump, plumbing, wiring and thru-hulls.

Self-contained units mount all of the major components, including the entire sealed refrigerant system, together as a single assembly and are most often found on boats under 12m (40'). They range in capacity from 5,000 to 6,000 BTU; larger if 230-volt power is available. They are required to be installed within the boat's living spaces (typically under a berth or seat) and for safety reasons must not share any air circulation with the engine compartment. Well

### TABLE 1: DETERMINING COOLING CAPACITY

For a rough approximation of your cooling requirements, use this formula:

**Cabin volume in cu.ft. x K factor = BTUs required**

The K factor will have many variables but a simplified calculation uses only two factors: Below decks K = 14; above decks K = 17. A pilothouse with lots of glass and heavy traffic in and out can have a K factor as high as 24. Alternatively, a below decks cabin with other air-conditioned areas on three sides can be as low as 7. Consult the A/C manufacturer for more detailed guidelines.

#### Example #1 **9m (30') Sailboat**

V-berth is 6'L and 5'W at mid point x 5' average headroom = 150 cu.ft. x 14 = 2,100 BTU.
Main salon and galley are 13'L x 8'W (average) x 6'H = 624 cu.ft. x 14 = 8,736 BTU.
TOTAL: 2,100 + 8,736 = 10,836 BTU.

RESULT: A single 10,000 BTU unit is not quite large enough but a 12,000 would do the job quite nicely with a double outlet duct kit.

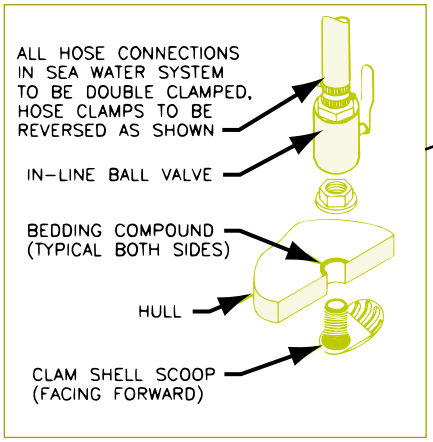
#### Example #2 **7.8m (26') Powerboat**

V-berth and cabin are 15'L x 8'W x 5'H = 600 cu.ft. x 14 = 8,400 BTU

Result: A 9,000 BTU unit is required. If you just want A/C for a single aft berth or V-berth for sleeping a 5,000 or 6,000 BTU unit will suffice.

suited for DIY installation, the installer is not required to open and recharge the refrigerant circuit.

Remote condensing or "split" systems, found in boats up to 22.5m (75') also range in size from 6,000 to 16,000 BTU with 230-volt units to 60,000 BTU. They have the compressor and condenser unit mounted in the engine room, only the air-handling equipment and evaporator are in the living space. Insulated pipes convey the refrigerant between the two units. This requires vacuum collection and recharging of the refrigerant during installation to prevent the release of ozone damaging Freon to the atmosphere. Environment regulations in both the U.S. and Canada dictate a licensed technician must handle this work.




Chilled- or tempered-water systems are used when a large central air system is called for. In large yachts or ships where many cabins need to be cooled it's impractical to run refrigerant ducting. In contrast to the direct expansion systems previously described, a large central refrigeration or "chiller" unit (which includes the evaporator) cools water instead of air and circulates the cold water throughout the boat to individual heat exchangers or "air handlers." These are equipped with blowers to circulate and cool the cabin air. Although the actual refrigerant system does not usually have to be opened during installation, these chilled water systems, which range in capacity from 24,000 to 60,000 BTU, are unlikely to be DIY installed.

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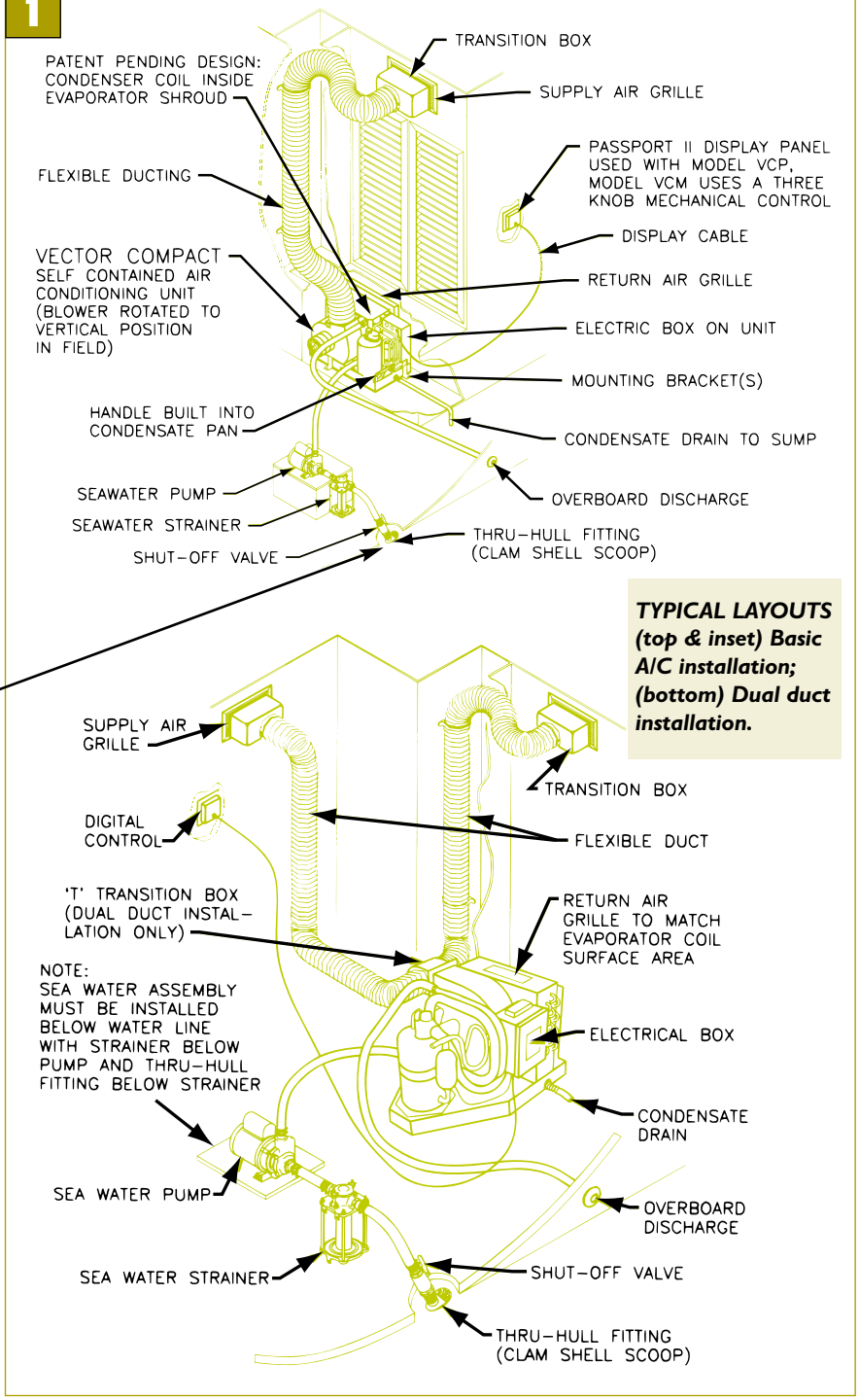



***TYPICAL LAYOUTS (top & inset) Basic A/C installation; (bottom) Dual duct installation.***

Another alternative is Technicold engine-driven A/C systems by Rich Beers Marine. These operate similar to an automotive unit. Its target market seems to be workboats with a requirement for pilothouse A/C.

## Purchasing Guidelines

**1.** Dealer versus Catalog: You can purchase a unit from a full service dealer or buy direct from a discount catalog where you may save up to 20% off the list price but you're on your own with the installation. A dealer may be willing to negotiate on price to stay competitive and will certainly be more inclined to assist with installation if they sold you the unit. Many dealers also may be willing to handle the most difficult parts of the installation and leave the simpler tasks to you. Catalogs are limited to

the available pre-packaged kits; a dealer can assist you with working up a kit from scratch, tailored to your requirements.

**2.** Heat and Cooling: Once you have decided to undertake the installation you first need to decide if you require the reverse air heating option. If your boat remains year-round in a tropical location the answer is no, but remember that even Florida gets some frosty winter nights.

**3.** Cooling Capacity: The next step is to determine what cooling capacity you need. Take some measurements to determine the volume you need to cool, choose the BTU/cu.ft. "K" factor that best matches your plans (**Table 1**) and multiply the "K" factor by the cu.ft. volume to determine your BTU requirements.

**4.** Dockside Power Requirements: You may need to install a second 30-amp shorepower service, assuming you'll want to have other 115-volt loads running at the same time (i.e. water heater, microwave). Check the manufacturer's data for the unit's power consumption. Generally, an A/C unit will draw from 1 to 1.5 amps at 115 volts per 1,000 BTU of capacity while running; starting and cycling loads can be two to three times this amount. This means that a 16,000 BTU unit — the maximum that a single 30-amp 115-volt circuit can handle — that draws 15 amps may pull 45 amps momentarily at start up; a slow trip 30-amp breaker is usually used. This is why single A/C units larger than 16,000 BTU require 230 volts.

## MAINTENANCE

### AT THE BEGINNING OF EACH SEASON:

- Check that the condensate line is clear and pan will drain off within 30 seconds.
- Check and clean return air filter.
- Check that water flow is okay with no leaks.

### DURING SEASON:

- Occasionally check and clean seawater strainer and return air filter.

### EVERY THREE SEASONS:

- Flush condenser coils with 5% muriatic acid or hydrochloric acid solution followed by fresh water to remove marine growth and scale.

### WINTERIZING:

- There are also other techniques but this one is fail safe. After haulout disconnect hoses at seacock, fit hose with funnel and raise over pump level. Pour in straight undiluted ethylene glycol automotive antifreeze while the pump is operating and keep pouring until the undiluted antifreeze comes out of the discharge hose. Carefully collect the discharged antifreeze for recycling. Reconnect hoses and leave seacock in open position.

## TABLE 2: DC REQUIREMENTS WITH INVERTER

| RUNNING AMPERAGE DRAW (RA)<br>STARTING AMPERAGE DRAW (SA) |
|---|
| 5,000 BTU = 5 amp full load @ 115V = 575 watts ÷ 12.8V = 45 amps DC + 10% inverter factor = 50 amps DC = RA<br>15 amp starting load @ 115 V = 1,725 watts ÷ 12.8V = 135 amps DC + 10% inverter factor = 150 amps DC = SA |
| 10,000 BTU = 10 amp AC = 1,150 watts = 100 amps DC = RA<br>up to 3,450 watts = 300 amps DC = SA |
| 16,000 BTU = 15 amp AC = 1,725 watts = 148 amps DC = RA<br>up to 5,175 watts = 444 amps DC = SA |

Use this table to convert AC amps to DC amps. Multiply the AC amps by the voltage then divide by 12.8 volts to determine DC amps.

**5.** Power Requirements Underway: Using your A/C away from shorepower usually requires an auxiliary 115-volt generator with enough capacity to handle most, but not necessarily all, the startup loads. Gensets can usually handle momentary surges 1.5 times above rated capacity (check with the generator manufacturer). A 4.5 kW genset should be able to handle a single 16,000 BTU A/C unit, maybe more. [Ed — a review of gensets appears in DIY 1999-#2 issue.]

It's technically feasible to run some smaller A/C units off an inverter. This would only be practical while motoring and assumes the boat is equipped with an alternator big enough to carry the constant power requirements of the A/C plus 10% for inverter losses and an additional reserve for other DC loads. Most inverters have a generous surge capacity and can handle the startup load. The drawback to inverters carrying any high load appliances is the big DC amperages involved (**Table 2**). Even with proper fusing these large currents can lead to sudden meltdowns, usually at a connector, caused by a tiny bit too much resistance that leads to a runaway local heat build up. Ocean Marine offers an automatic load managing inverter system designed to set AC priorities and avoid meltdowns.

Another approach to 115-volt power while underway is a specialized high-output alternator system designed to provide 110-volt AC power in the lower kilowatt range without using an inverter. (Refer to DIY 1998-#2, page 10, "The Most Charging Amps for the Least" for specifics.)

**6.** Unit Location: Once you have determined what capacity unit is practical, check what is available and the unit's dimensions. The current size versus BTU champion is probably Marine Air's Vector Compact. The next step is to find a location on board that will accommodate it and meet the following criterion: it should be in a dry location with good access for installation and service, as close to the floor as possible. This is usually under a berth, seat or in the bottom of a hanging locker. Make sure you have room for the recommended size for supply ducting and return air grill, otherwise the unit will never perform properly.

It's critical that the location has no access to air or vapors from the engine compartment. Self-contained units are not ignition protected and exhaust leaks can be a source of carbon monoxide. This restriction also applies to drip tray drain hoses.

**7.** Control Options: Electronic digital controls are not necessarily more expensive than mechanical controls and offer greater flexibility in tailoring the system's operation to your needs. A reverse air system, in particular, can be programmed to provide full climate control and will automatically switch from cool to heat as required. Most of the more sophisticated controls also offer an automatic dehumidifying cycle that can operate the unit just enough to keep the

## TABLE 3: JOB PLANNING

Detailed job description and time required to install a very basic unit with one duct and supply air grill. Time varies depending on ease of access.

| | | |
|---|---|---|
| **1** | Unpack, read instructions and get set up. Haul boat (if necessary) | 1 - 2 hours |
| **2** | Install thru-hull, strainer, plumbing, pump and pump platform, condensate line | 4 - 6 hours |
| **3** | Install breaker into blank in shorepower panel and run circuit to unit location | 2 - 4 hours |
| **4** | Remove berth top and fasten down unit (make a platform if needed), cut return air grill opening | 1 - 4 hours |
| **5** | Connect water, power, condensate line to unit | 1/2 - 1 hour |
| **6** | Install control wiring harness, connect wiring to pump | 3 - 4 hours |
| **7** | Cut supply grill opening and run ductwork, install grills | 1-1/2 - 6 hours |
| **8** | Clean up and test | 1 hour |
| **TOTAL** | | **14 to 28 hours** |

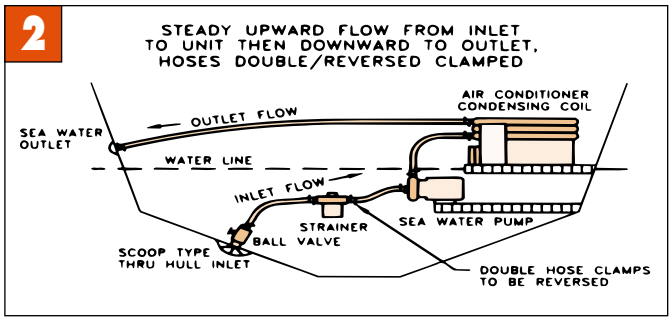
dampness and mildew under control while you are away.

Cruisair offers a remote control option for their SMX II digital climate control. With the SMX Modem (US$410), you dial the appropriate code, probably from your wireless phone while on route to the boat, and it remote starts your A/C unit so the boat is nice and cool when you arrive. It requires a dockside phone line onto the boat and has optional outputs to switch on other devices on board as well.

## DIY Installation

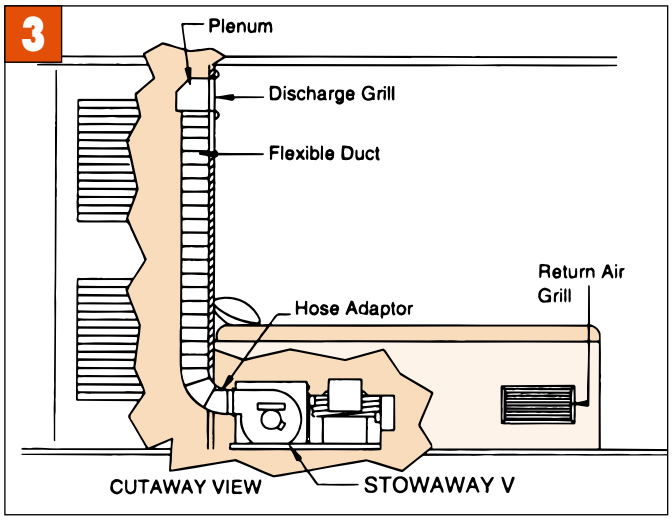
Don't believe the catalog ad that says "Can be owner installed in the morning and cooling the cabin in the afternoon." A simple installation done properly will take 16 to 24 hours. A complex installation can take 40 hours or more (**Table 3**) and that doesn't include hauling the boat to install the thru-hull.

The manufacturers supply very complete instructions, which should be followed religiously. The unit must be securely fastened with stainless-steel screws or bolts to a flat sturdy surface and reinforced if necessary to take the




**PROPER PUMP & PLUMBING INSTALLATION**

***Pump and strainer must be below the waterline, hoses must be below pump and must not have kinks, loops or high spots that could trap air.***




**TYPICAL DUCT INSTALLATION**

***Cool air supply grills are mounted as high as possible on the bulkhead and the return air duct usually right at floor level.***

usual bouncing, lurching and heeling that boats are subject to (**Figure 1**).

The seawater pump location (**Figure 2**) is critical especially in sailboats — it must be below the waterline at all times. The quiet centrifugal pumps with magnetically driven impellers that are supplied are not self-priming. Therefore, the hose routing must also be at a constant slope upwards to the pump with no loops or traps. It must incorporate a seawater strainer, a shutoff valve (use a 1/4-turn ball valve) and the thru-hull must be a scoop strainer facing forward, otherwise the boat's motion through the water will suck the pump dry. Don't attempt to tee into another thru-hull already in use for some other purpose; the pump will have priming problems. Use reinforced marine-grade hose throughout and secure all fittings with double hose clamps. Most A/C water pumps are ignition protected — check the label on the pump — and can go in the engine compartment.

It may be impossible in some sailboats to keep the pump below the waterline. In this case, you can incorporate a quick priming rig or use an impeller pump and expect to replace the impeller frequently. The water outlet thru-hull should be just above the waterline so the water flow can be checked visually but not so high it makes an annoying splashing sound.

Attach a hose to the condensate drain and lead it into the bilge but not to the engine room unless a separate sealed sump is provided. It's also possible to connect it to a thru-hull above the waterline provided it's not near any exhaust outlets.

Locate the return air duct to provide unobstructed air flow to the evaporator, usually right at floor level. The cool air supply grills should be as high on the bulkhead as possible (**Figure 3**). Don't install the supply and return grills too close together, otherwise the airflow will "short circuit" and lead to inadequate cooling. Avoid bends and kinks in the supply ducting as much as possible, they cost in efficiency. Strictly follow the manufacturer's duct and grill size requirements. Aluminum grills may sweat so avoid mounting on wood bulkheads or use wood or plastic grills.

Follow the manufacturer's recommendations when installing controls and wiring. Stick to the manufacturer's color code for connections and refer to "DC Electrical Systems" in DIY 1998-#4 issue for proper wiring techniques.

If you're using a digital control that incorporates a thermostat into the control panel make sure you don't mount it in a sunny location, otherwise your A/C will run constantly. Mechanical controls usually don't have their own thermostat but use one mounted on the A/C unit. If all else fails, remote thermostat kits are available.

With your new A/C unit up and running, you'll find that just like a new backyard pool everyone you know will want to drop by for a visit on a hot summer day, so you had better make sure the fridge is well stocked.

*About the author: Nick Bailey is service manager of Bristol Marine in Mississauga, Ont.*

## TYPICAL KIT PRICES

Prices shown in U.S. funds and include the A/C unit plus duct and seawater kits (except the portable).

| Size | Description | Make | Model | Price |
|---|---|---|---|---|
| 4800 BTU | Portable | Cruisair | Carry-On | $650* |
| 5000 BTU | Self-contained "cool only" economy kits with mechanical controls & basic duct kit (1 return, 1 supply, flex hose, adapters, transition boxes) with woodframe grills | Ocean Marine<br>Marine Air<br>Cruisair<br>& others | SS 5000<br>Cool Mate<br>Zephyr | $1400 to $1550 |
| 6500 — 7000 BTU | Self-contained reverse air with electronic controls, basic duct kit (as above) & seawater kit (strainer, thru-hulls, ball valve, hose, clamps) | Marine Air<br>Marine Air<br>Cruisair<br>Ocean Marine<br>Mermaid | Vector Compact<br>Cabin Mate<br>Stowaway | $2400 to $2,550 |
| 9000 — 10,000 BTU | Reverse air basic kit as above | Marine Air<br>Marine Air<br>Cruisair<br>Cruisair<br>Ocean Marine | Vector Compact<br>Cabin Mate<br>Stowaway<br>Zephyr | $2,750 to $2,850 |
| 12,000 BTU | Reverse air basic kit as above | Marine Air<br>Marine Air<br>Cruisair<br>Cruisair<br>Mermaid | Vector Compact<br>Cabin Mate<br>Stowaway<br>Zephyr | $2,850 to $2,900 |
| Economy kit | | Marine Air | Cool Mate | $1890 |
| 16,000 BTU | Reverse air basic kit as above | | | $3000 to $3,100 |

**Discount catalog price.*

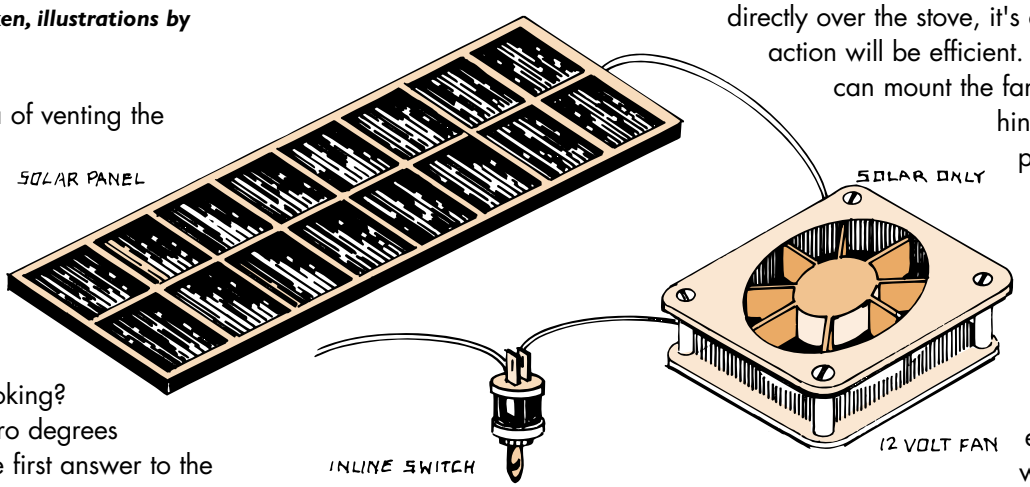
# Good Boatkeeping

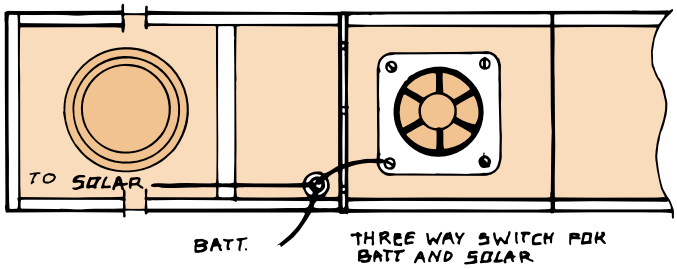
## FRESH AIR BELOW

### Easy-to-install exhaust fan minimizes odors.

***Story by Zora Aiken, illustrations by David Aiken***

Initially, the idea of venting the heat and/or smoke from the boat's cook-stove seemed unnecessary: why not just open the hatch while you're cooking? "Because it's zero degrees outside" was the first answer to the why-not question. Later, when the outside temperature is at the opposite extreme, keeping heat out of the cabin will still be a good thing.



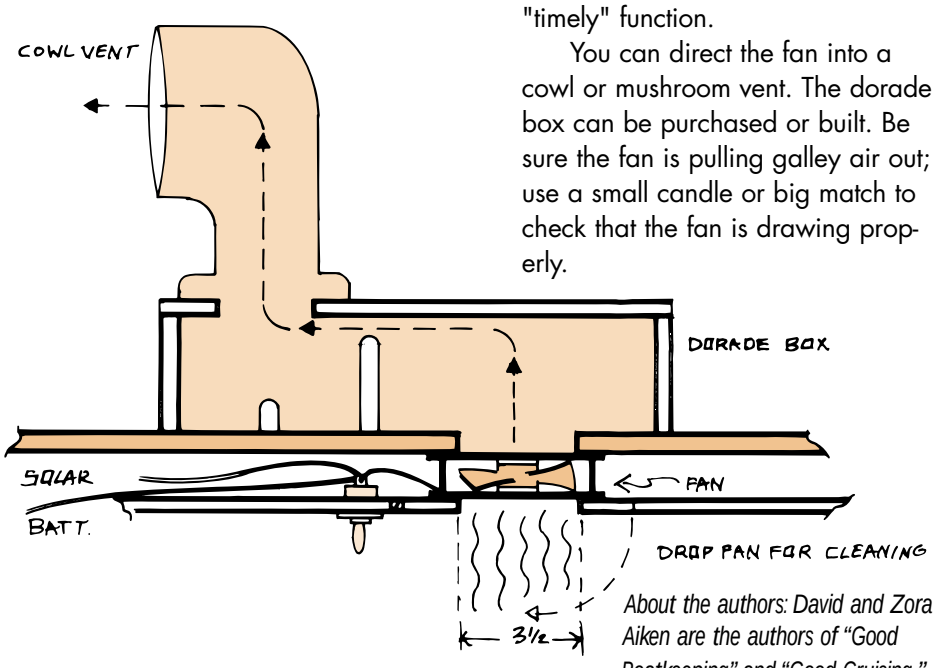




While a house kitchen's "range hood" really isn't necessary, a small venting fan does a lot to minimize the undesirable side effects of cooking. Our boat already has a cowl vent on a dorade box positioned conveniently above the galley. All we needed to add was the exhaust fan and the appropriate wiring.

We purchased a Radio Shack 12-volt Brushless Fan (catalog #273-243b), then cut a 9cm (3-1/2") hole into the overhead where the fan would have the shortest distance to direct the cooking smoke out the dorade vent. Naturally, if the fan can be centered directly over the stove, it's drawing action will be efficient. If you can mount the fan into a hinged panel, it will be easy to pull it down for cleaning. Leave enough wire on the fan so the panel will open without binding.

The fan can be powered by the boat's DC power or by a small solar panel; a three-position switch let's you choose. Whichever fan model you may choose, be sure it has (or you add) an on/off switch. This is not the place for automatic turn-on, since this fan has a very specific "timely" function.

You can direct the fan into a cowl or mushroom vent. The dorade box can be purchased or built. Be sure the fan is pulling galley air out; use a small candle or big match to check that the fan is drawing properly.




*About the authors: David and Zora Aiken are the authors of "Good Boatkeeping" and "Good Cruising."*