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DIY BOAT OWNER

THE MARINE MAINTENANCE MAGAZINE

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DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE
#4 - 2008

Electronics

COLUMNS

DEPARTMENTS

Compiled by Jan Mundy

Buying a Used Boat: Lessons Learned

Our previous boat was an 18' (5.4m) aluminum runabout and, after seven years without a boat, my wife and I decided the time was ripe to get another boat. We set a budget of $10,000 plus or minus a couple thousand depending on what we found and the parameters: a 19' to 21' (5.8m to 6.4m) boat with a cuddy cabin, big enough to overnight in yet small enough to be somewhat fuel efficient and with a cockpit layout conducive to fishing.

We found one boat that fit the bill and signed an offer with two conditions, a survey and a sea trial, but withdrew upon receipt of an unsatisfactory survey as there was significant moisture in the hull. We continued looking and found a privately owned 1988 20' (6m) Sunray Cierra. We liked the look of this boat and it was visually in good shape. We struck a deal with the owner agreeing on a price for the boat and the heavy-duty tandem trailer of $11,500 and again conditional of a survey and sea trial. We received a positive survey on the boat, took the boat for a drive and then purchased it.

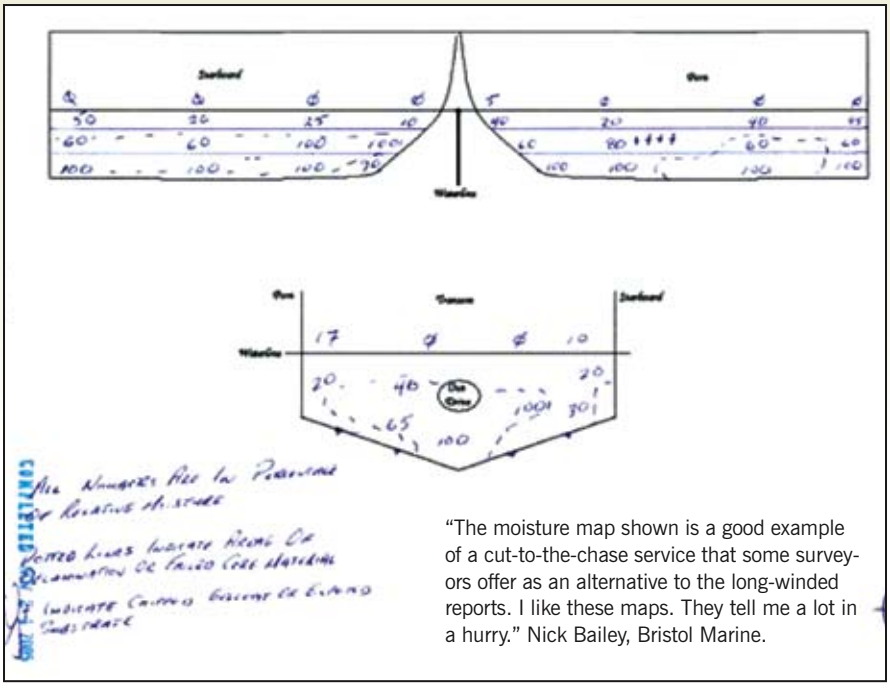
When I hauled out this boat after just two months' use, it had a number of cracks and some crazing on the hull that concerned me and that had not been noted by the surveyor or myself. The insurance company adjustor inspected the boat and we hired a second surveyor to do a moisture survey, which showed significant moisture and delamination issues. We were now looking at extensive and expensive repair bills or a significant loss on the resale of the boat. I contacted three boat repairers and received quotes ranging from $6,000 to $10,000. All three had different repair approaches but had one comment in common: the boat wasn't likely to sink or fall apart and it was probably not worth the expense to repair.

All this exploration had been to determine whether to repair the boat, sell it or to use it until it was no longer safe to do so. It is my contention that the original survey was misleading and did not provide a complete and accurate picture of the boat's condition. We would not have purchased this boat had we known its condition.

We continue to have the engine professionally maintained and have done a few minor repairs to the gelcoat but we are not looking at spending any money on major repairs to the hull.

As a lesson learned we would definitely have a couple of surveyors inspect any future used boat we buy. I think it would be a good comment to print in your magazine that used-boat buyers need to be very careful when they buy a boat and that a survey, even a couple of surveys, should be solicited only from accredited marine surveyors.

We'll run this boat until it drops or we decide to move on to a bigger boat



"The moisture map shown is a good example of a cut-to-the-chase service that some surveyors offer as an alternative to the long-winded reports. I like these maps. They tell me a lot in a hurry." Nick Bailey, Bristol Marine.

with the knowledge that we aren't going to get much for it when we do sell.
Liam Thomas, Halifax, Nova Scotia

ED: There are some good buys on used boats if you know what to look for. For details on how to evaluate a boat's systems and performance before making a purchase offer and how to choose a surveyor refer to the article titled "Buying Right," (www.boatus.com/diy-articles/2007_05_buying.asp), in DIY 2002-#2 issue.

What's Happened to Civility?

Every day, boating is getting harder on the Great Lakes. Everyone is in a hurry and if you happen to be in the way of another boater who is navigating via a chart plotter, you just might have to get out of his way to avoid being run over.

During a cruise this past summer we were following a prescribed channel and another boater came up behind


Jan Mundy

us in a 35' (10.6m) Sea Ray, waving his arms at us and then passing less than 20' (6m) from us, almost swamping our 1972 Danish-built, 27' (8m) Coronet Express Cruiser. We caught up to him when he was buying gas and I stopped to ask him what all the arm waving was about.

It seems we were "obstructing" his chartplotter route and I had not moved over to let him by.

The marine police were fueling their boat at the same time and I suggested to him that we ask them what the proper procedure is for overtaking a slower boat. He abruptly jumped onboard his boat, started the engines and drove away. So ended the conversation.

Later that day, six boats approached us, traveling at a high rate of speed, and instead of passing behind, they chose to pass in front of our boat forcing me to come to a stop to avoid being too close. We got bounced around like a cork and some of them laughed.

We're not enjoying boating much anymore when we have to put up with such discourtesy and shameful disregard for the basic Rules of the Road.
Art Moseley, Shady Lady, *Lake Simcoe, Ontario*

Cooling System Woes

Q: After having our Mercruiser 140-hp engine rebuilt last year, I allowed a friend to borrow my boat and something blocked the water intake, causing the engine to overheat and set off the alarm. The immediate shut down and subsequent restart of the engine cracked the manifold, which my mechanic subsequently replaced, but now the engine overheats. After resurfacing the head, replacement of the riser, thermostat, intake pump impeller and housing, the engine still overheats. The intake is clear and clean, all hoses are clear and clean, the coolant circulates in the tank, the heat exchanger is clean and the thermostat works correctly. What am I missing?
Ian Waymark, Gabriola, British Columbia

A: You indicated coolant is flowing through the heat exchanger tank so I will go with a closed-cooling system diagnosis. Start by attaching an automotive radiator pressure tester to the closed-cooling tank. Pressurize the system to 15 psi and observe the pressure gauge. The pressure should remain constant at 15 psi. If the pressure drops, the failure is in the closed-cooling system. Start the engine and run it at 1,000 rpm with the pressure tester attached. If the pressure rises above 15 psi, there is a leak in to the closed-cooling system. The problem could be a cracked head, cracked cylinder liner, cracked cylinder head or a failed head gasket. If the closed-cooling system includes the exhaust manifold, check this for cracks or a failed exhaust elbow gasket.

If the closed-cooling system passes the test, check the seawater system. Install a pressure gauge into the riser drain, heat exchanger or some other seawater supply fitting and run the engine at 1,000 rpm. There should be about 5 psi of pressure. If higher, you have an obstruction on the outlet side of the system, such as a water shutter blocking the exhaust or an incorrect riser gasket or burnt and collapsed exhaust bellows. If the pressure is low (1 psi), you likely damaged the water pump system in the drive unit. Verify this by installing a clear hose on the hose that supplies seawater to the heat exchanger and look for air bubbles in the water supply exhaust being drawn into the seawater supply. Consider replacing the water pump body, impeller and base, and water pocket cover in the top of the drive unit as these were surely fried during the original overheat. If these parts are burnt, so is the shift shaft seal in the drive bell housing; replace it now (Mercury part 23-805041a2) so you are not buying a new shift cable in 3 months. Be sure the antifreeze mix is no stronger that 50/50 antifreeze to water as too much antifreeze promotes overheating.
— Steve Auger

Sourcing Crusader Overheating

Q: I have a 1989 Carver Santego with twin 454 Crusaders with closed cooling. I bought the boat knowing that both engines had an overheating problem. Professional mechanics have tried to resolve the problem to no avail. They have performed flow tests on both engines, checked the seacocks, hoses, even replaced one of the heat exchangers and still the engines overheat. Mechanics pulled the heads, checked the head gaskets and looked for blockages but gaskets were fine and no blockages were found. The advice of the experts is to repower the boat. On a whim, I added Stop Leak to the cooling systems and experienced no overheat problems for three days but then both engines overheated again. Am I destined to repower the boat?
Dave Verbeke, Plymouth, Minnesota

A: DIY contacted Max Brazen at Crusader on Dave's behalf and his response follows: "If there is evidence of external coolant leaks, have the cylinder heads inspected for cracks. In some cases, hairline cracks can be present, which expand as the engine warms allowing coolant loss. Coolant can also escape internally through exhaust manifold and/or heat exchanger leaks so it's a good idea to have these components pressure tested as well. Be sure that the coolant is good and is properly mixed: 60% water and 40% antifreeze. Make sure there isn't too much oil in the engine. If the exhaust elbows are getting too hot to touch, your problem is most likely with the raw-water circuit. Perform a flow test of the raw-water pump. It should flow 5 gallons (19L) in 15 seconds at 3,000 rpm. If it does not, you may have a worn pump or a hull obstruction creating turbulence at the strainer. Check the exhaust system for restrictions. There may also be a restriction in the exhaust elbow water jacket or at the oil cooler. Is the engine circulation pump functioning properly? Is the correct thermostat installed and is it installed properly? Dig deep and you will find the source."

Filters and Vapor Lock

Q: My engine currently uses a Quicksilver spin-on fuel filter 35-802893T. Is there a finer micron filter I can switch to that uses the same spin-on mounting base?
John Lyons, Toronto, Ontario

A: There is no lower micron replacement spin-on fuel filter from Mercury. Adding additional or lower micron filters may filter out smaller impurities but that may also increase the allowable vacuum, which could promote vapor lock. The maximum allowable vacuum on your fuel supply line is 2.0", measured at the engine fuel connection. If you are going to add an additional filter, be sure to mount it as low as possible in the engine compartment to reduce the chance of "heat soak." With engine compartment temperatures as high as 175F (79C), this happens when a fuel filter mounted high in the engine compartment absorbs or "soaks" the heat, raising the fuel temperature, which is normally 72F (22C) in the tank. If the fuel temperature rises above 110F (43C) in any portion of the fuel delivery system, vapor lock occurs.
— Steve Auger

Stuffing Box Caveat

Q: I need to repack the rudder stuffing boxes on my 1989 DeFever trawler and need recommendations on what packing to use, how best to proceed and the tools needed.
Robert Van Gemert Rockford, Michigan

A: I can't tell from your description if you have the "gland" type box where the flax packing is compressed by an adjustable sleeve or the "nut" style where the packing is imbedded in the top nut. To repack the gland style box, completely loosen the sleeve and raise it out of the way so you can access the layer of packing underneath and add a layer or two of fresh packing. (Or dig out the old packing

Patricia Kearns

Out of sight, out of mind is the rudder stuffing box, which is typically hidden deep in the lazarette and often corroded or worn.

and repack it with all new stuff). Tighten down the nuts on either side to clamp the sleeve down onto the packing inside the stuffing box. This squeezes the packing more tightly against the rudder shaft and so reduces leakage. A very small leak at this location is not a big concern. Tighten the nuts a little at a time on each side so the sleeve squeezes the packing evenly.

On the nut style box, first loosen the lock nut in contact with the underside of the packing nut. If you have trouble locating where the lock nut ends and the packing nut begins, feel for a slight gap between the hexagonal faces of the packing nut and lock nut assembly. You will need a pair of really big spanners or adjustable Channel-Lock pliers. Move the lock nut and packing nut in opposite directions to loosen. Once loosened, slide the lock nut up the rudder shaft for access to the packing reservoir. The packing reservoir is in the nut itself. Tighten the packing nut by turning it down onto the stuffing box/rudderport tube and then tighten the lock nut firmly against it.

Many marine inboard engine and parts dealers stock packing. You need to specify what size and length needed. To determine this, measure the width and depth of the packing reservoir in the tube or nut. For example, you might find the packing occupies a space that is a ring 0.25" thick by 1" deep with an outside diameter of 1.5". This converts to a stack of four layers of 0.25" square packing (1" depth divided by 0.25" packing thickness equals four layers). The layers wrap around the rudder shaft four times so you need, for our theoretical box anyway, a length that is 4 times Pi times diameter, which is 4 by 3.14 x 1.5" or just under 19" of packing at a cost of about $1 a foot.

There are all kinds of things that can complicate a repacking job or even adjusting any stuffing box. If the boat is afloat, beware that once the stuffing box is loosened the water starts pouring in, so maybe arranging a haul out first is a good idea. It might be necessary to dismantle the upper bearing or remove the steering arm to get enough room to back off the clamping sleeve to access the packing. On a saltwater boat, the nuts may have seized. If there are enough hours on the boat, the rudder boxes may be worn and ovaled to the point where they won't stop leaking no matter what. If in any doubt whatsoever, call your local marine mechanic. Know your limits. When it comes to the things that are literally keeping you afloat, often the least expensive route is to call in a professional to fix it before you need one to bail you out of a flooding situation.

— Nick Bailey

Additives 101

Q: What diesel fuel additives do you recommend and when are they added? Also, how long can fuel remain in the tank without adding any additives?
Mark Randall, Sarnia, Ontario

A: You are storing the fuel in an "open" container on your boat; unlike your car, the fuel system on your boat is vented to moisture-laden air. As you don't know how long it has been in the fuel dock tank or storage facility, it's certainly a good practice to mix additives with each fill up. Additives help maintain performance levels and also protect your investment by keeping your engine's lubrication total base number or TBN, a measure of reserve alkalinity, which is the ability to control combustion acids, in place between lube oil changes.

Diesel fuel additives fall into two basic descriptions: cetane enhancers and lubricity additives. As fuel ages it oxidizes, changes the foundation of its structure (loss of ignition quality due to degradation) and this effects the cetane rating, somewhat like octane in gasoline. Fuel also loses lubricity, which is its resistance to break down under pressure and ability to be consumed properly. There are other additives to reduce algae (fungus) growth.

Additives tend to be very concentrated and care must be taken when blending. Always premix or add while fueling so they blend and do not simply fall through the fuel to the bottom of the tank. Use additives year-round and only add the correct amount. When boating in cooler temperatures consider adding an anti-fogging agent to keep the diesel fuel from phasing out paraffin and clogging filters.
— Randy Renn

To Replace Fuel or Not

Q: I repowered my twin gasoline engine Silverton and now, nine months later, I'm ready to launch. The boat was laid up with two near-full 75-gallon (62.7L) fuel tanks to which I added fuel stabilizer after two months on land. I've been told to dump the fuel and start with a fresh batch. As I did take steps to prevent the fuel from degrading is this necessary? Is there a way to test the fuel to verify that it's still usable. With fuel prices as high as they are I would hate to dump the fuel if it's still usable.
Louis Vincze, Ft, Lauderdale, Florida


Jan Mundy/Robinson Marine

To preserve gasoline, add fuel stabilizer at the proper ratio with every fill up and when prepping the fuel system for long-term storage.

A: I recently pulled my own boat out of an extended storage period of 10 months. The tank was three-quarters full of regular grade gasoline and had stabilizer added at the time of storage. I topped up the tank with premium fuel and launched the boat with no running problems. If your engines were stored correctly, it's unlikely the fuel needs to be replaced, especially if your boat is equipped with a quality water-separating fuel filter. Topping off the tanks with premium fuel should address your octane reduction requirements due to long-term storage. Low-grade fuel or very high alcohol content in the fuel can cause a condition called phase separation. A fuel sample in a clear clean glass container can be analyzed by a test lab, such as Wearcheck or similar company, for a lot less money than replacing the fuel at $4 bucks a gallon.
— Steve Auger

Weighing in on Chris-Craft

Q: I am currently looking to move up to a larger cruiser, a 1985 Chris-Craft Catalina 381. It's my understanding that this boat is solid fiberglass construction, which I take to mean no wood coring, and has a semi-displacement hull design. If the latter is correct, in general terms, how much more fuel efficient is a semi-displacement than a planing hull?
Tom Smith, Rochester Hills, Michigan

A: The 1985 Chris-Craft Catalina 381 is the big sister to the very popular 350 Catalina that began production in the mid-'70s. "Solid" fiberglass construction, in this case, implies the hull has no coring but the deck surely is cored, most likely with plywood and/or balsa where reinforcement is needed to stiffen the laminate panels. If you pursue this boat to survey, make sure the surveyor is scrupulous about the deck inspection,

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especially where fittings are installed through the deck, e.g., cleats, handrail stanchions, windlass and anything else that penetrates the deck and its substrate.

The hull is a modified-V form and is most efficient on plane. That does not mean that operating at displacement speeds (non-planing) is undesirable. These boats usually have gasoline engines and, at top speed, fully loaded for cruising, run at about 20 knots. Cruising speeds are in the mid-teens, which, by today's standards, has become a speed range for boats of semi-displacement hull design, such as trawler types with diesel engines that operate most efficiently at displacement speeds but have the power available to run at semi-displacement speeds. The cost is fuel consumption. You can drive the hull faster with the extra power but you'll pay for it at the pump. This is the short answer without going into a dissertation about the fine points of hull design.

A great deal of the appeal of the various hull designs (deep and modified-vee, displacement, semi-displacement) is weighed in how you plan to use a given boat. Aside from the fundamentals of hull form, there are many other factors that affect how a boat rides and some of them are quite subjective so make sure you are able to put this boat through its paces in the kinds of conditions in which you normally operate before to open your checkbook.

All the foregoing notwithstanding, the '80s were not kind to Chris-Craft as the company endured operational issues, changes in ownership and management and some of its production during that period may reflect the turmoil. Don't be stingy when it comes to surveying a Catalina of this generation. Pay the best surveyor you can find to gather the information you need to make an informed decision.

— Patricia Kearns

Electrical Wiring Conundrum

Q: I have purchased and am restoring a 1978 48' (14.6m) Tollycraft. The wiring is a real mess and I have probably removed 100lb (45kg) of wire that was added and then abandoned and am now getting down to the original boat system wiring. This wiring is, of course, non-tinned wire and it appears to be functioning well but replacing it would be an extensive job. I do need to extend some wires in the bilge. In cutting back the badly corroded ends of the wires, I easily get past the green corrosion but, no matter how far I cut back, I never reach bright shiny wire; it always has a dark oxide coating on the strands. What would be the best way to clean the ends of the wire before crimping a terminal to obtain good conductivity? Would it be desirable to use an antioxidant compound on the wire ends before crimping? Also, how should I deal with color-coded wires when extending a wire as it's impossible to match the original factory color codes. I have a pet peeve about changing color codes. I have already found situations where Tollycraft spliced a green wire from the water level sensor in a water tank to a white wire to the display panel and buried it in a 2" (50mm) bundle of wire.

Dan Winchester, Portland, Oregon

A: This is a familiar tale and getting rid of redundant wiring is a good move. The dark oxide coating means the conductor is going downhill and I recommend changing these wires. Where this is not possible, scrape the wire end with a sharp knife, twist the strands together, insert into the crimp terminal and then crimp. Using an antioxidant is of little benefit at this stage of deterioration. When, as you describe, color-coding wiring is not possible, use numbers on those circuits, applying the same number at each end of the wire. Though you should never ignore color-coding standards as this can present problems with future surveys for insurance or at point of sale, there are surely times when compliance in a retrofit is not practical. In such cases, an alternative wiring identification method such as numbered tape or slide-on numbers, is needed. [Ed: For help in designing a wire labeling system, refer to John Payne's article in the DIY 2007-#2 issue.]

— John Payne

A wiring labeling system simplifies troubleshooting when circuits fail.

If the Hose Fits, Use It?

All for one and one for all is not the rule of thumb when selecting hose for onboard plumbing systems.

Story and photos by Patricia Kearns

A cracked hose shows that even "certified" hose can fail when it exceeds its service life.

There are many myths, mysteries and wives' tales enshrouded in smoke and confused by mirrors when it comes to hose for use in boats. Unfortunately, there is very little written, except what's published in hose makers' brochures and is observed in the accepted practices of boat builders and boat yards who install hoses for a host of applications on a boat. When the smoke clears and the mirrors crack, you learn that there are only a few sentences in volumes of written rules that apply to marine hoses. How do you know what hose is used where and when? Like so many of the product choices you make, you have to read the label and do a little homework to match the product with its application.

What's Hose

The United States Coast Guard (USCG) regulations for recreational boats address only fuel hose in boats with gasoline engines. Even that reference is limited as it applies solely to boats that have gasoline engines for propulsion, mechanical power and/or electrical generation and exempts boats with outboard engines. The American Boat and Yacht Council (ABYC) standards go further with hose requirements for fuel systems (gas and diesel), wet exhaust systems and LPG and CNG fuel systems. Other than those standards, the only other written guideline appears in the ABYC H-27 standard for seacocks where the requirement is as follows: "Hull penetrations that are not equipped with a seacock shall use reinforced piping or hose that resists kinking and collapse." That's it.

In the absence of rigid pipe, metal or plastic, "hose" is known as "flexible piping" to distinguish it from PVC and aluminum, bronze, brass, copper, stainless steel or other metallic pipe. Hose is the generic term for anything that carries fluids, gasses and air. The work of marine hose is varied and demanding. It works in the most hostile environment and under the most severe conditions that can exist at sea.

One hose manufacturer with an excellent reputation offers more than 30 different classes of hose for marine use. Each has very specific performance requirements, service demands, exposures to heat, cold, chemicals, flexibility and wall thickness.

These hoses must withstand temperature extremes, resist permeation and survive operational pressures. Some hose applications require heavy wall thickness, super abrasion resistance and/or flexibility. Fuels, oils, hydraulic fluids, potable water, sea (raw) water, black and gray water all have special fluid characteristics that affect the choice of hose for use on a boat. Above all, safety in fuel and exhaust hoses is top priority and these are subject to stringent test standards in order to achieve compliance with the respective standards.

In order to accomplish the performance requirements, hoses are not just made of rubber. They are fabricated of rubber and silicone rubber or blends of these materials, PVC and vinyls, polyethylene and polypropylene, many with multiple plies and reinforcing materials like polyester and Aramid or helix wire.

Bragging Rights

There are labels to look for on hose, beyond the brand markings of the maker. These markings describe the DNA of the hose and tell the story, usually in acronyms and alpha and numeric codes. ABYC, NMMA (National Marine Manufacturers Association), SAE (Society of Automotive Engineers), UL (Underwriters Laboratory) and USCG are acronyms that indicate compliance for an explicit purpose found on hoses used in marine fuel and exhaust systems. RINA (Royal Institution of Naval Architects) and ISO (International Organization for Standardization) are foreign designations. SAE and UL hose labeling always includes numeric markings that indicate the type of hose and its suited uses.

Hose not marked in any way is considered anonymous and, as such, all bets are off on what it's supposed to be used for and how it's made. If you're buying hose to use in places on your boat where there is no margin for error, avoid unmarked hose that is touted as "just as good …" as the more costly, marked hose. If hose isn't bragging by means of markings about its genetic makeup, it doesn't belong on a boat.

Besides hoses for fuel and marine wet exhaust, hoses are marked for other applications including marine water heater hoses used on engines, air-conditioning systems and other pressure sensitive applications. The marking you'll see on these hoses is SAE J20R3.

Modern marine hoses are reinforced type or molded. "Garden" variety hose does not belong anywhere on a boat except at a washdown pump or coiled ready for use to fill a water tank or swab the deck (see "Hose Alert" on next page).

Hose Bits

Beyond the hose markings already discussed, there are pros and cons on the uses of clear or reinforced vinyl hoses. Clear plastic hose, even with fiber reinforcement, can kink, suffer vacuum collapse, soften in heat and can foster bacterial growth on the inside wall from light exposure. Bilge pump hose design

Left to right:
- Hose with ISO marking eliminates the guesswork when plumbing fuel systems.
- Any hose not labeled doesn't belong on a boat. This one has USCG marking.
- Vetus hose with Lloyds and SAE markings in yellow stripe.

can diminish the efficiency of the pump if it's the corrugated type.

Installation is half the battle in preserving hose life. Avoid runs that expose the hose to chafe points, extreme radius bends and routing that leads to kinks. Lack of support and clamp damage sabotages even the best quality hose with the markings to prove it.

Hose must be considered perishable and service life depends on quality, installation practices and exposure to the elements. Unless the hose manufacturer puts limitations on service life, there are no hard and fast rules that dictate the end of a hose's useful life. Frequent, inch-by-inch inspections are vital to ensure the integrity of all hoses.

The last word on hose: always select a hose specified for a given application. When hose is the only thing that separates your boat from fire, explosion or drowning, ignorance is far from bliss.

About the author: Patricia Kearns is a National Association of Marine Surveyors certified marine surveyor (CMS) and she is DIY's technical editor.

HOSE ALERT

A word on "garden" hose: when filling potable water tanks, make sure you are using a hose made for use with drinking water. Garden hoses can come into contact with harmful chemicals sometimes used with nozzles and sprayers or chemicals used on lawns. Bacteria can also form on the inside of the hose because it is dark, damp and warm. If you drink from a garden hose, you risk ingesting any of these items, as well as insects that may inhabit an empty hose section. When filling potable water tanks, use only hose that is "drinking water safe," i.e., is manufactured with medical-grade plastic resin and nickel-plated brass fittings. Any other garden type hose is likely to have trace lead in it or its fittings (brass nozzles, connectors).

Tech Tips

Two-hour Impeller Tool: Raw-water pump impellers are difficult to remove without the proper tool and should never be pried out as you risk distorting the sealing surface. Rather than purchase an expensive impeller puller, make one using a water faucet handle remover available at hardware stores for less than $10. Grind the "finger" ends narrower to fit between the impeller blades and add a couple of screws between the fingers to clamp them to the impeller.
Ron Polomski, Grand Portage, Minnesota

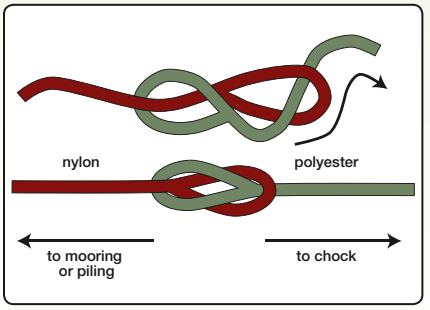
Combating Rust: To thwart rusting tools, soak a bilge absorbing pad with a corrosion blocker (e.g., CorrosionX, Corrosion Block) and toss it in the bottom of your toolbox before adding tools that were wiped with the same solution.

WD-40 Fan: To remove grease and tarnish from the exterior of your stainless-steel barbeque, spray with WD-40 and wipe clean until dry. Cleaning requires almost zero elbow grease and residue won't flare up when you fire up the barbeque.
Kim Discher, Bear Boat*, Long Beach, California*

Rust Clean-up: If your tools have already rusted, soak them in a diluted, 10% solution of Bar Keepers Friend for a few hours or longer at room temperature. Several long soaks in a fresh solution may be necessary if heavily rusted. Rinse well afterwards. Spray with a moisture-displacing solution to remove any remaining moisture or bake the tools at low heat in your oven (but never put metal tools in a microwave oven).
Reed and Judy Whitten, Cary, North Carolina

Jan Mundy

Stowage Safety: On many boats lifejackets are stowed in an out-of-the-way locker where they are not only difficult to reach but are liable to become mildewed and smelly. Next time you are aboard your boat, try to retrieve and don your life jacket in less than a minute. If it takes longer than that, you need to find a better storage place. Consider installing a canvas hood under a T-top on a center console or a second layer of canvas under a bimini or sew in pockets in a canvas dodger to keep life jackets close at hand in the cockpit.
Author and DIY columist Roger Marshall, from Rough Weather Seamanship for Sail and Power*; 304 pages, McGraw Hill.*



Hurricane Rode: To make an anchor line or mooring line that utilizes the high breaking strength and chafe-resistance of polyester with nylon's ultra-stretch properties, use a combination of three-strand polyester rode from the cleat through the chock with the remainder being a nylon rode. Join these together with spliced eye-to-eye loops to avoid having a knot in the rode, which weakens a line by as much as 50%.

Tissue Test: Often a cheap toilet paper does as good a job at dissolving quickly and avoiding clogs in the sanitation system as an exclusively labeled and more expensive "marine" toilet paper. To find out whether any toilet paper is okay for use onboard, do this simple test: tear off a sheet of toilet paper and put it in a glass of water overnight, then stir the glass a little and if you see only fine pieces of paper (looks like snow) or the water is cloudy, then you have your "marine" toilet paper. If the paper is still intact or mostly intact, it is not suitable for any marine toilet.

Got Corroded Connectors?: To clean the sockets of corroded female electrical connectors or the pins on male connectors, soak a pipe cleaner with your favorite electronic/electrical cleaner, insert into the connector and twist the pipe cleaner around. Cleaning just might save having to purchase a new and expensive wiring assembly.
Susan Meckley, Dharma*, currently on a three-year solo cruise of the South Pacific.*

Although reader tips are accepted as submitted in good faith, DIY has not tested or proven those tips. DIY offers no guarantee or warranty as related to their fitness or suitability for service or application as reported.

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Just send us a description of your boat-tested tip or technique, along with a photo (if available), your name, boat name and homeport to:

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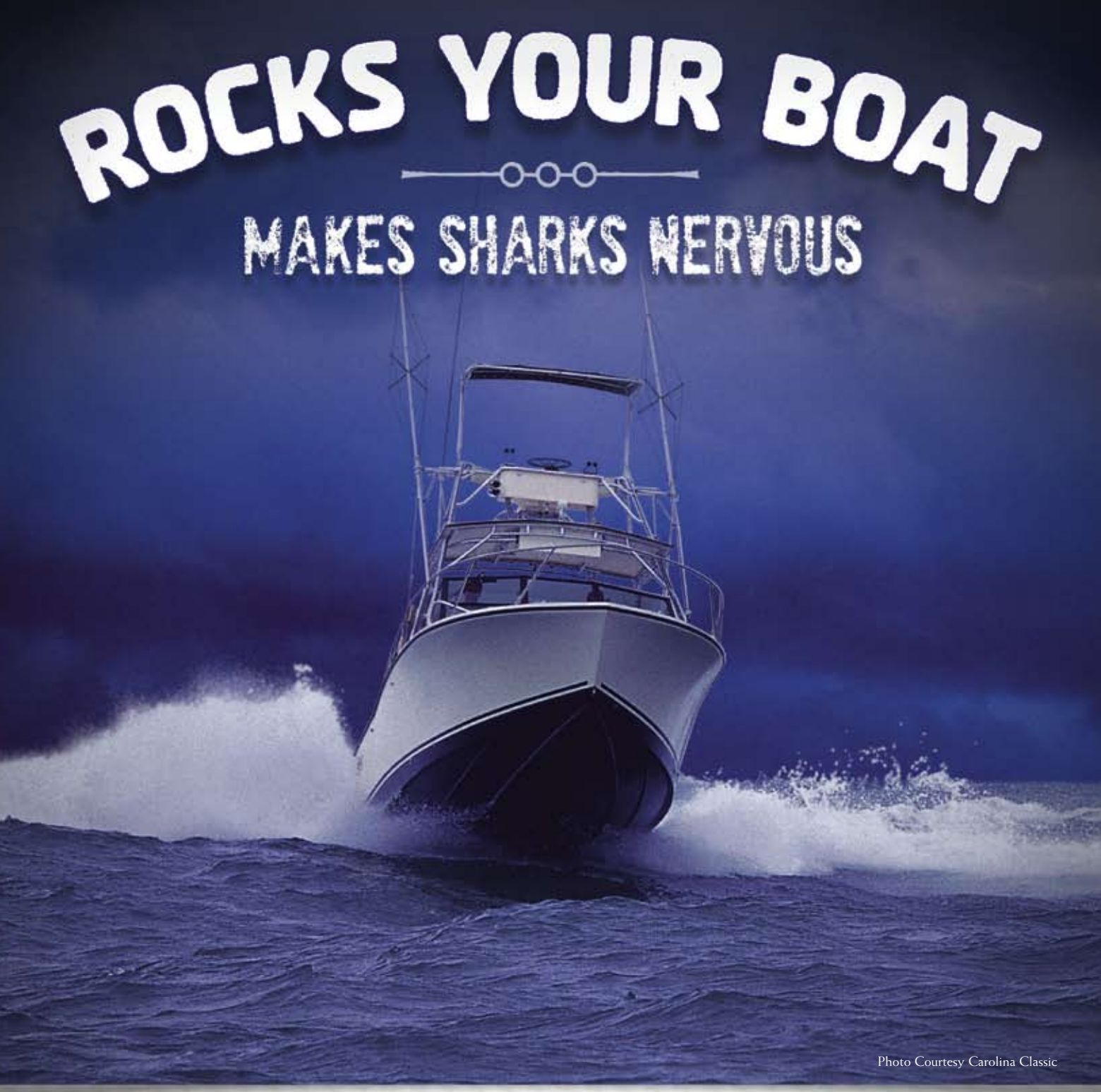

Photo Courtesy Carolina Classic

For 20 years, do-it-yourselfers like you have turned to King StarBoard® marine-grade polymer sheets for their boat projects—you know, the ones that make your boat "your boat." From simple rod holders to the most sophisticated tackle and navigation stations, there has never been a material more versatile, durable and easy to work with than King StarBoard. Ask for it at your favorite marina or boat shop or visit www.kingstarboard.com to learn more

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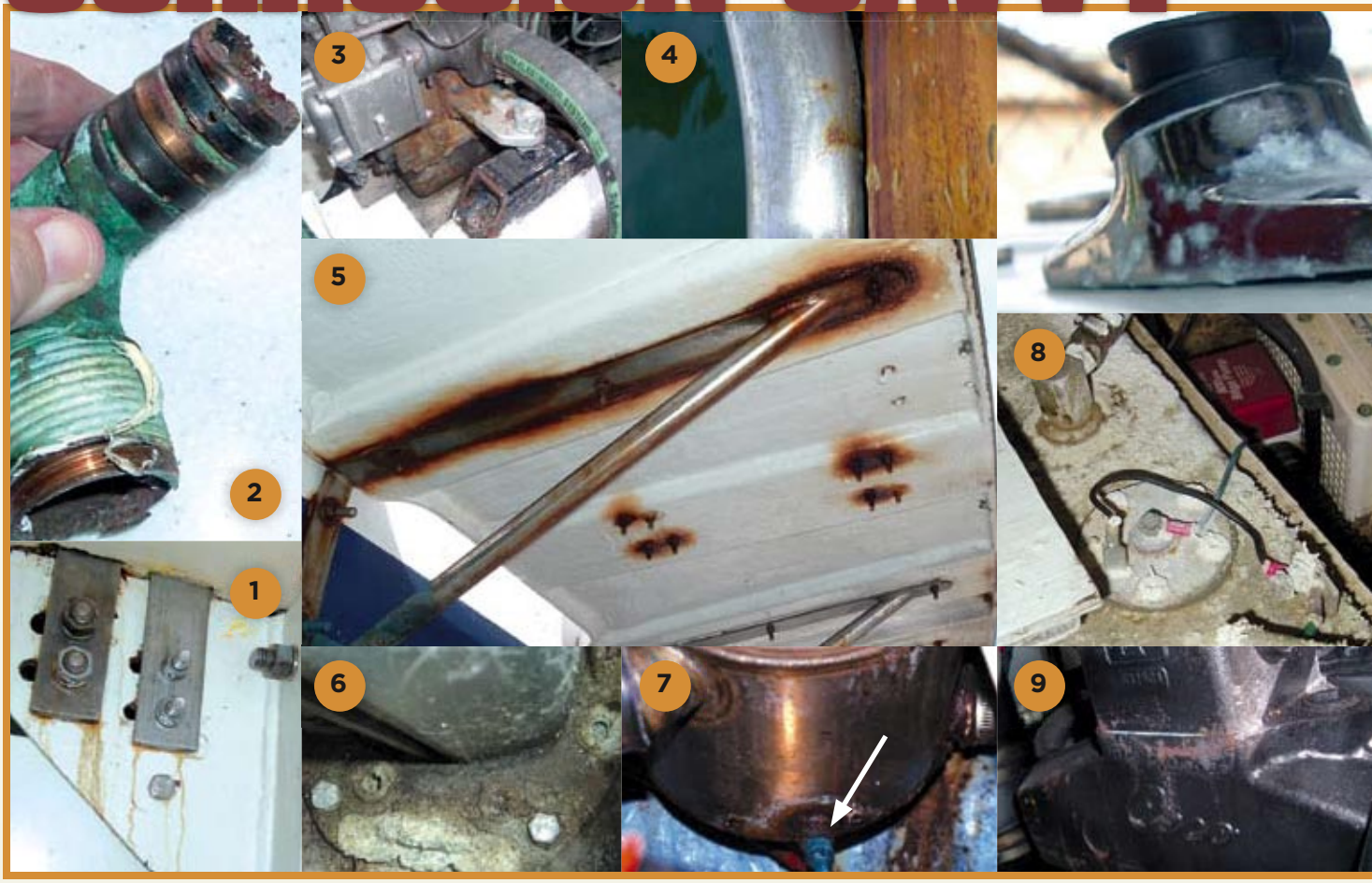
CORROSION SAVVY



Keeping a sharp eye out for corrosion and taking action early is a critical part of preventative maintenance.

Story and photos by Patricia Kearns

Most of us don't have the time to study corrosion science or to master the chemistry and physics of corrosion activity. The entire corrosion problem is relative. You can't stop it but you can probably control or mitigate its effects if you can just identify it.

Corrosion by any other name is still corrosion but knowing the types of corrosion is a leg up on resolving corrosion issues. Every known material used to fabricate anything from metal begins its product service life with the first steps of its lifelong journey of returning to its elemental state and, ultimately, failure.

Below are some of the most common types of corrosion that occur on boats. The definitions are not intended to be scientific but rather to simply illustrate the direct cause and effect.

• Atmospheric corrosion is what happens to virtually every metal exposed to the air in my homeport in Southwest Florida. The air is laden with moisture and salt and it's a contest of will to keep rust from forming overnight.

• Immersion corrosion: Put metal in water, especially saltwater, and it will corrode. This is a no-brainer. Regional variations affect this process.

• Galvanic corrosion occurs when you marry dissimilar metals and they get wet. The more noble metal will try to protect itself by "stealing" mass from the other (less noble). The transfer of mass occurs in the electrolyte (water). My description here is an over-simplification but the concept should not be unfamiliar. This is not "electrolysis."

• Stray-current corrosion happens when electrical current is added to the formula for galvanic corrosion. This is not "electrolysis," either.

• Pitting corrosion can grow a tiny pinhole into a big, not always readily identifiable, perforation and its potential is often overlooked on stainless steels. This is insidious stuff that most affects metal surfaces that are hidden from view, e.g., the area of a stainless-steel shaft that is totally isolated in a cutless bearing.

• Poultice corrosion, like pitting corrosion, is hard to see easily since the corrosion takes place where the metal bears

on a wet, porous material. An aluminum fuel tank supported directly by plywood that has become wet might suffer poultice corrosion.

• Erosion corrosion is just that. The constant velocity of moving water gradually wears away the metal.

• Cavitation corrosion damage can occur on any metal, anywhere in or on the boat that is exposed to the constant shock and explosive shock waves of air or vapor bubbles in water.

• Stress corrosion cracking is commonly seen in metal fittings that have been formed (controlled bending or working), e.g., swaged fittings in standing rigging, angle brackets and such. The hairline cracks look like a tree without leaves, with cracks branching out from the main crack. One minute, these fittings are giving good service and the next, they fail without warning and the mast comes down. Did I say "no warning?" you can find cracks if you look closely and with a magnifier in hand.

• Corrosion fatigue is similar to stress corrosion and results from a combination of corrosive action and a recurring stress that causes a fracture to develop.

• Crevice corrosion is opportunistic. Any flaw in a metal can be subject to this form of corrosion when it's contaminated by stagnant water, specks of dirt or other contaminants.

Notice that none of these terms is tagged "electrolysis." Corrosion and electricity are entwined. Mix water, metal mass and electrical current and you can have corrosion but that condition is not electrolysis and the word should not be used as a synonym for corrosion of any kind. Electrolysis is the breakdown of a chemical compound, e.g., metal, in solution by passing an electric current through the solution. The process requires a source of direct current (DC), two electrodes, e.g., metals, and an electrolyte (seawater).

We've all seen the evidence that makes certain kinds of corrosion obvious but what about the kinds of corrosion that are not so easy to differentiate? The physical evidence of corrosion activity is a symptom and seeing the color and textures of the process at work is a call to action. If you see rust, you know something is corroding. To keep corrosion from ruining your day you need to know what causes it and what it looks like. If you spot corrosion and can't identify the type or cause, it's time to call in an expert.

About the author: Patricia Kearns is a National Association of Marine Surveyors certified marine surveyor (CMS) and she is DIY's technical editor.

Corrosion Examples

1: Custom-made sailboat chainplate assembly is being attacked by water leaking through the deck at the chainplates. Stainless-steel chainplates are subject to crevice corrosion, hidden from visual discovery without disassembly, when water soaks the deck core where it bears against the chainplate.

2: Both the threaded and hose barb sections of the pipe elbow have wasted from erosion corrosion. Only two threads were engaged at the thru-hull fitting and the leak was a mystery to the boat's owner until a technician disassembled the fitting and removed the hose.

3: Engine mounting hardware compromised by corrosion from leaks from engine exhaust fittings.

4: Rust forming at microscopic cracks in this sailboat's bow pulpit railing likely due to a combination of stress corrosion and fatigue.

5: Stainless-steel swim platform support brackets and platform ladder bolts rusting is an example of atmospheric and immersion corrosion aggravated by the platform's core (wood) being saturated from water intruding into the substrate at the hardware fastenings.

6: Mast step footplate is crumbling from corrosion perpetrated by stray current activity arising from improper bilge pump wiring.

7: Stainless steel is not recommended for use in exhaust waterlift fabrication. Wet exhaust by-products are highly corrosive and this unit, installed in a boat built in the Far East, is leaking at every weld and the drain plug of an incompatible metal has wasted away from galvanic activity. When the plug fails, exhaust water will leak into the bilge and flood the boat.

8: A bad installation of an aluminum fuel tank installed low in bilge and exposed to bilgewater splash. These is no drainage provision for tank surfaces and water is trapped within tank support structure, precipitating corrosion. When the tank was removed, poultice corrosion had destroyed the bottom panel.

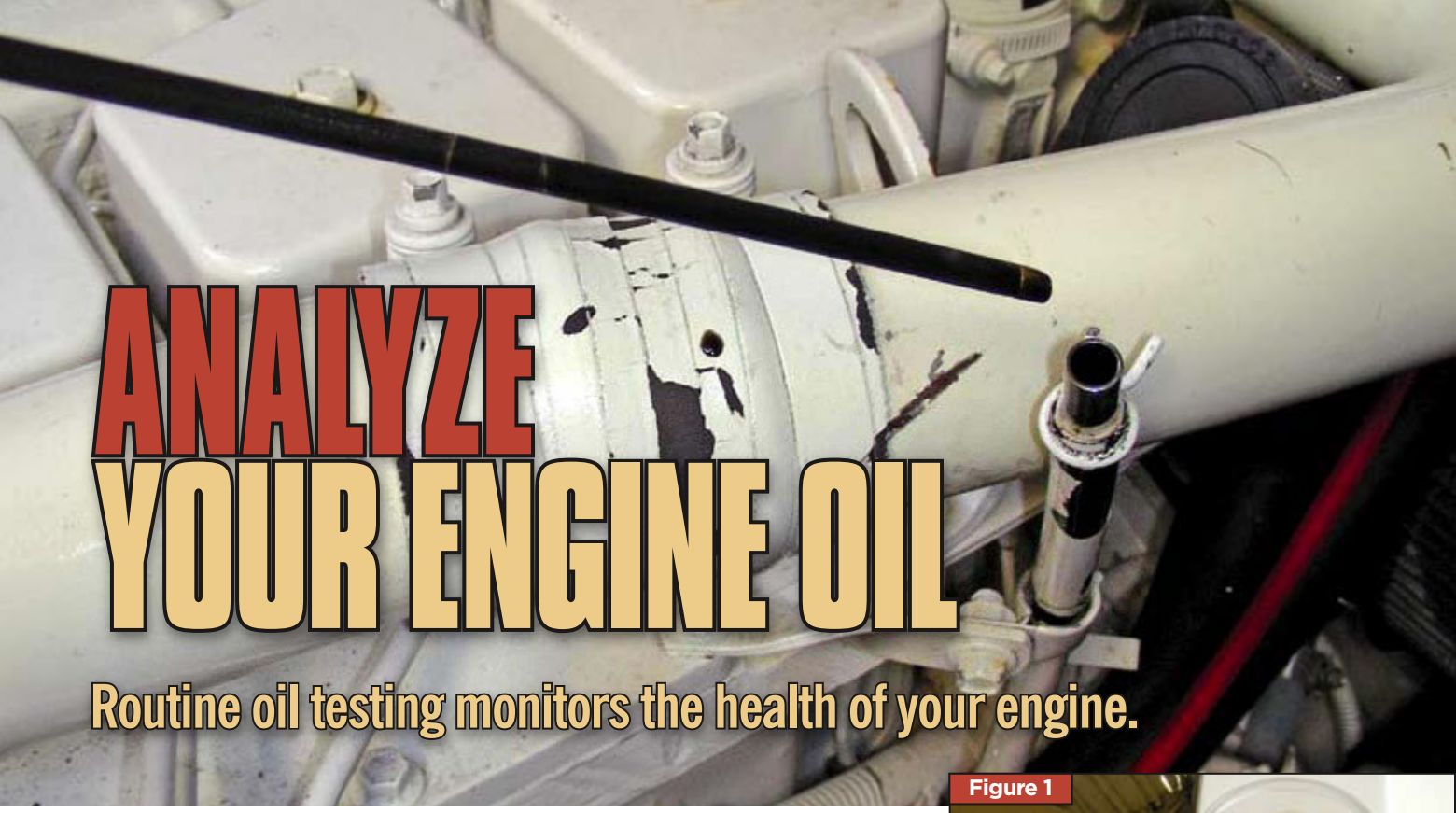
9: Sterndrive gasoline engine exhaust system leaks at manifold and riser are causing rust to form on surfaces around gaskets. If water is leaking, so are toxic carbon monoxide (CO) vapors.

10: Zamac (zinc coated steel) fitting corroding from atmospheric corrosion. Zamac is not durable in marine environment applications.

11: Rust staining should have clued boat owner to problem with valve control handle, which has now completely separated from valve and shut off would be impossible without another tool. Emergencies are not good times to go hunting for the tools.

12: Rust and cracks observed at the welded ring on this stainless-steel stanchion railing are the result of weld sickness and stress corrosion.

13: Stainless-steel prop nut showing large void that propagated from a tiny crevice under attack from crevice corrosion. When the nuts were separated, their facing surfaces looked like metal lace.



ANALYZE YOUR ENGINE OIL

Routine oil testing monitors the health of your engine.

Story and photos by Garrett Lambert

Feeling guilty every time you check the dipstick because your engine is overdue for a routine oil and filter change? Maybe that oil is fine; maybe not. Perhaps you're buying a boat and someone has recommended having the crankcase oil analyzed for clues to the engine's condition.

Oil analysis usually involves getting an oil sample into a container and sending the sample to a lab. The turnaround time to receive the report ranges from 24 hours, for a premium fee, to a week or more. Costs vary but are usually $50 or less per engine. The report details the presence and concentration of water, fuel, minerals and other contaminants in the oil. Even an excellent report means little unless a skilled expert is on hand to decipher the report's meaning. Experts also warn that a single analysis isn't very useful without a historical series for reference. Once you buy a boat, however, creating a monitoring schedule is a good practice that might catch incipient problems before they turn into major expenses. Even a first-time report can detect potential for catastrophic damage.

During normal engine running time, oxidation and acids accumulate. Additionally, carbon, coolant, dirt, metal particles, sludge and water accrue to contaminate the oil in the engine or hydraulic lube system. There are many opinions about the optimum timing for routine oil and filter changes with advice to change oil at the beginning of the season, twice a season, at the end of the season, etc. How could such divergent recommendations all be right?

Many factors affect the longevity of engine oil. Sportfishing boats tend to be driven fast and hard; trawlers slow and steady. Many pleasure boats are run less than 100 hours per year; others multiples of that. Engines used only occasionally and left to sit for long periods are subject to premature wear because most of the oil eventually drains back into the sump leaving no lubrication on start-up. Cold weather boats are more prone to crankcase condensation. High-powered engines driving boats at hull speed for fuel efficiency could be under-loaded and producing carbonization, some of which is absorbed into the engine oil. The simple fact is that just about every boat is an individual case study and the most effective oil change routine differs accordingly. Best to check your engine service manual or consult with your mechanic.

How can you confidently determine when to renew your engine's oil and filter? Certainly not by looking at the dipstick or rubbing some used oil between thumb and finger, because new diesel oil turns black within minutes of engine operation and the contaminants that matter are too fine to feel. If you can feel them, you have worries that are likely more serious than when to change oil. There are products on the market that enable you to do the analysis yourself with relative ease and to establish and create that all-important data series so you'll not only know when to change but also whether and how your engine condition is changing over time.

Figure 1

Two products tested by *DIY* are the electronic Racor OilCheck by Parker Hannifin and EngineCheckUp, a visual comparison between a sample and images on a supplied chart.

My boat's engine is a 2001 Cummins turbocharged 210 hp straight six. I last changed the oil and filter on April 20, 2007 and, since then, have accumulated 198 engine hours. Some oil remained from this last change so a clean oil sample was no problem. However, getting a large enough used sample from dipstick drips was impossibly awkward due to the very long dipstick under a low overhead. Fortunately, the boat is equipped with an Oil X-Change System and it was easy to pump enough into a large container to ensure that the line was drained of any standing oil. I then pumped a quantity of well-used oil into another container and poured the first lot back into the oil sump. Oil should be sampled warm and put in a scrupulously clean container. I gathered the kits, the oil samples and a box of tissues and began testing (**Figure 1**). Let's see how the two products faired.

Oil Reaction

Racor OilCheck ($702) is a portable, electronic oil monitor about the same size and shape as a bulky stud finder and comes with manual in a fitted soft case. David Cline, Parker Hannifin's rep, told me that: "OilCheck measures oil quality by sensing a change in the dielectric constant of an oil. This constant changes in proportion to the type and relative concentration of contaminants present in the oil. By comparing the measurement from an unused sample of oil and a measurement from a used sample of oil of the same make and grade, the oil monitor detects any change in the oil's make-up directly related to contamination or degradation of the oil." Because I didn't know what a "dialectic constant" is, I asked. Essentially, the meter measures the electrical resistance of the samples and a comparison is viable because contamination lowers resistance.

The instructions for the OilCheck are clear. After ensuring the sensing cell is clean, half fill the cell with clean oil (same grade and type as in the sump) and then turn the rotary switch to "LO." The display performs a full sweep, returns to the zero position and the display shows a flashing "Cal," all of which occurred too fast for me to capture with my camera. Press the "TEST" button and the "CAL" graphic disappears. After calibration with clean oil, you can barely see a single bar on the left and the numeric display shows zeros (**Figure 2**).

Now, dump the oil, clean the reservoir with a tissue and then half fill it with used oil. Press "TEST" for 10 seconds or until the segments stop moving. The display now showed two bars and a digital reading of +2.36 (**Figure 3**), indicating that the oil is still in very good condition, notwithstanding that my last change was 17 months and 198 hours ago. I repeated the test three times with consistent results.

I mentioned the readings to Cline who commented that, "Looks like your engine is running pretty clean but a little moisture can get in and you would never notice it by looks or feel. However, the OilCheck will pick it up immediately. In my testing, I put 0.01% by volume of water in some oil and the monitor picked it up quickly. With OilCheck, you can actually plot the oil degradation over time."

Luckily, the more harmful or devastating of the engine contaminants, namely,

Figure 2

Figure 3

Figure 5

Figure 6

Figure 4

water, coolant and metal particles, are readily distinguishable with the OilCheck. Water and coolant traces effect the LCD display very rapidly in a quick swing around the display, while metal particles drop out of the oil more slowly and can be seen as ticks or individual clockwise swings in the display.

Weak Spot

EngineCheckUp kit ($29.99) comes in a clear plastic envelope containing a chemically impregnated test medium with six windows for six tests, image charts for diesel and gasoline, and an instruction sheet (**Figure 4**). The literature claims that this product displays results for fuel, grime, oil condition and water in the oil, which is an appealing factor.

The instructions seem simple. Open a window, place a single drop of dipstick oil on the pad and hold the pad level until the oil is absorbed. The instructions state that oil in good condition can take as little as two minutes to be absorbed, whereas oil in very poor condition can take up to 45 minutes. When the oil is fully absorbed, compare the three rings of the spot on the test medium with the relevant chart. After an hour, however, my test drop had produced a uniform medium gray center surrounded by a narrow ring only slightly lighter in color. It never produced a third ring (**Figure 5**).

None of the images seemed to be a near match but the "Good, Engine OK" profile seemed the most closely matched. On that basis, the sample contains normal sediment, no oxidation, no water and no diesel fuel (**Figure 6**).

Since there was so much divergence between the sample and the chart, I was concerned I had somehow bungled the procedure. So, two days later, I performed two more tests with the same oil and got exactly the same result. Since I still had three clean windows, I tested the oil from the gasoline engines in each of our six-year-old cars, one a high performance sedan, the other a small SUV. Both are theoretically "overdue" for oil changes, yet both produced images similar to the boat's engine except the base color was amber and neither one produced a third ring. Neither of the gasoline engine spots could be compared to the gasoline chart with confidence.

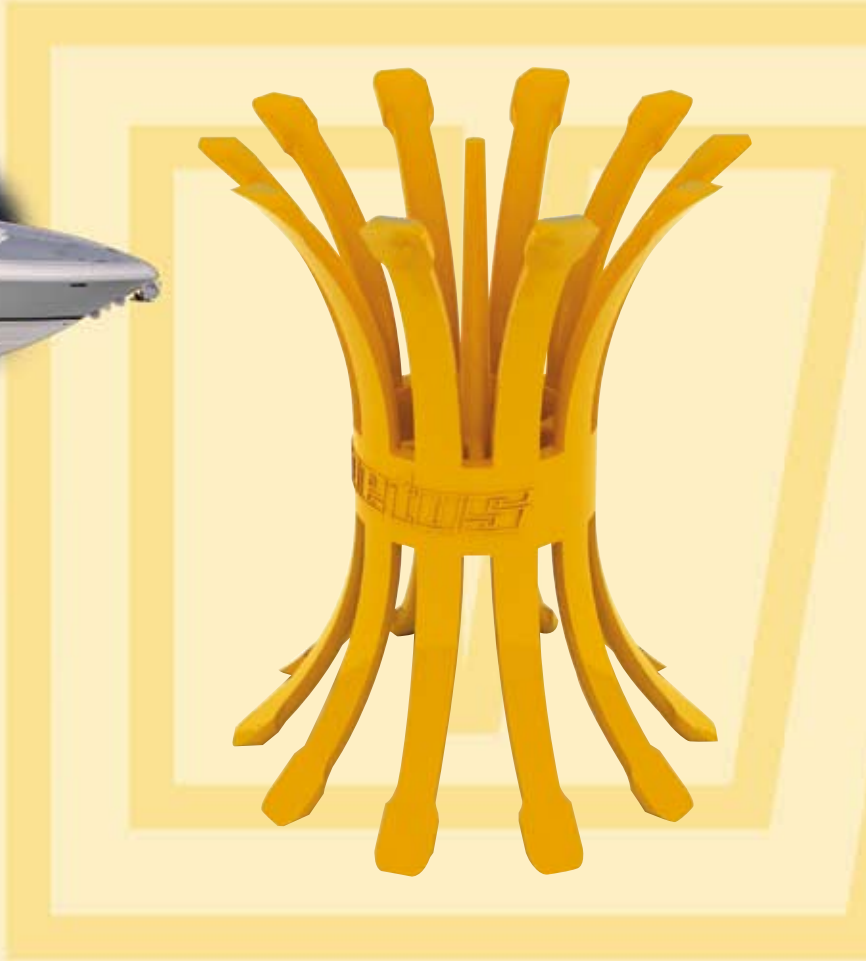
EngineCheckup is so easy to use I had high hopes for it. However, if my experience can be generalized, the spot of oil on the test media will always require best guesses as to which four of the 12 images on the charts are most relevant. I would never be confident enough in my choices to forego an oil change based on those guesses and I certainly couldn't depend on these results when considering a used-boat purchase.

Top Pick

The Racor OilCheck might seem expensive but could soon pay for itself, especially on boats with twin engines and one or more generators. Perhaps more important, once purchased it is likely to be used regularly to monitor any changes in engine condition and it can do the same thing for a car, truck or any other four-stroke engine, such as an outboard, ATV, motorcycle or even a lawn mower. It generates a numeric result that requires no interpretation and although it does not provide the precision and detail of a laboratory analysis, careful attention to the display during analysis can reveal individual factors.

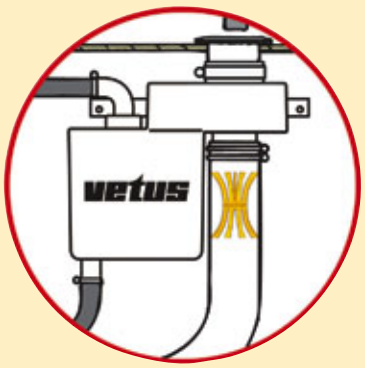
An "OilCheck" of the generator is my first task next time I'm aboard. These results and those of the main engines above will start a monitoring series for all engines that I'll update every six months. Note that these devices are not replacements for scheduled oil changes and you should never ignore your engine manufacturer's recommended oil change intervals.

About the author: Garrett Lambert cruises the Pacific Northwest in a 40' (12.1m) trawler and is a frequent contributor to DIY.



STOP FUEL THEFT!

Fuel prices have risen to such a level that siphoning the fuel from your boat is now an attractive proposition for thieves. With many boats holding hundreds of gallons of fuel, this is a lucrative activity.



Vetus introduces a simple device to prevent a siphon hose from being inserted into your deck filler and down into the tank. ***With little reduction in fuel flow when filling the tank.***

The Vetus Fuel Safe is supplied with a plastic tube, designed to be inserted quickly and easily into the fuel filler hose. There is no need to dismantle anything and the clever design ensures that it cannot be removed by potential fuel thieves.

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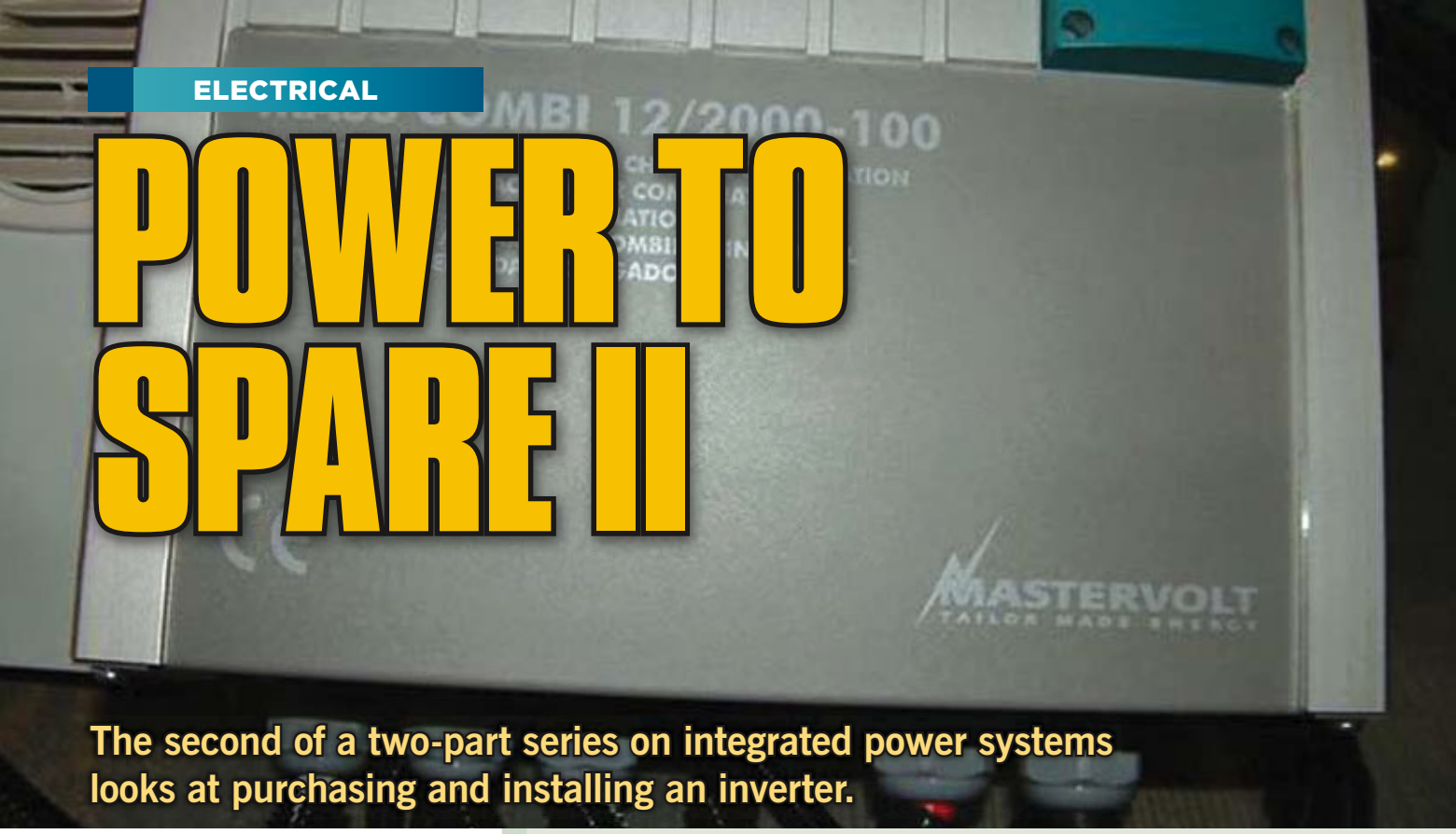
POWER TO SPARE II



The second of a two-part series on integrated power systems looks at purchasing and installing an inverter.

Story and photos by Paul and Sheryl Shard

Living on land we become complacent about being able to plug things in to the wall and voila, everything works. Almost all electrical devices we use on land are designed to operate on a 120 volts and 60 cycles alternating current (AC) power source. Boats are a different story and generally have a battery or bank of batteries producing 12-volts direct current (DC).

You could use DC adapters, such as the 12-volt devices sold to plug a cell phone into a vehicle's cigarette lighter plug but this would require an expensive pile of additional adapters if, like us, you have a number of devices onboard. Our list would include cameras, cell phone, hand blender, laptops, power tools and more.

FIGURE 2

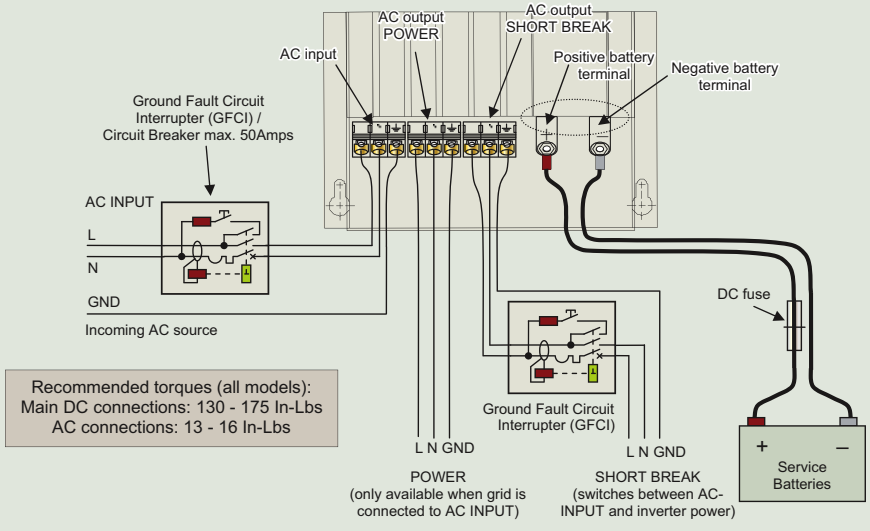


FIGURE 1

Wattage	Appliance
1,300	Washing machine
1,000	Vacuum cleaner
700	Hairdryer
600	Power jigsaw
750	Microwave oven
85	Laptop computer
45	Video camera charger
40	Cordless drill charger
5	AA battery charger

The alternative is to provide a more convenient source of AC power on your boat. An inverter converts DC to AC power, changing steady, 12-volt DC into AC at 120 volts 60 cycles (or 230/50 cycle if you are in Europe).

Power Vitals

The first thing to decide when choosing an inverter is how powerful a unit you require. What devices will use it for power? Make a list of all appliances you want to use and the power consumption of each one. Measuring in watts is best since that's how most inverters are rated. Most appliances have the power requirements noted in small print on a label somewhere on the device. Specifications for many devices are available on manufacturers' websites if you can't easily see the labels. In some cases, such as an electric drill, the rated power requirement is just for the short periods when the tool is under heavy load. You will not really need that much power con-

(top) Mounting board cut and drilled for inverter/charger and vent grilles. (middle) Mass Combi 12/2000-100 and 3" (76mm) vent grilles fitted to backboard that is secured to a floor bearer. (bottom) Vent ducting attached to grilles.

(top) Generator and shorepower input cables connect to terminals in the Masterswitch. (middle) Auto changeover switch and connections (visible on the right side of the switch box). (bottom) Protective see-through cover shields switch box wiring.

Removal of the front protective panel on Mass Combi provides access to AC terminal connections. The "short break" output is the right terminal block.

Positive and negative battery cables connected to inverter/charger.

Temperature sensor connects to a battery on the house bank and signals an alarm should the battery overheat when charging.

stantly but the inverter must be able to supply it. Next, sort the list by wattage and looked at the most power hungry ones first. **Figure 1** lists the devices for *Distant Shores*, our Southerly 42 sailboat.

The second consideration is the unit's output waveform. If you are powering sensitive equipment, such as a computer, microwave oven, fluorescent lights, battery chargers for cordless devices, etc., select a sine wave output inverter. More expensive than square wave or similar modified or quasi sine wave units, it offers the best performance and lowest electromagnetic interference levels.

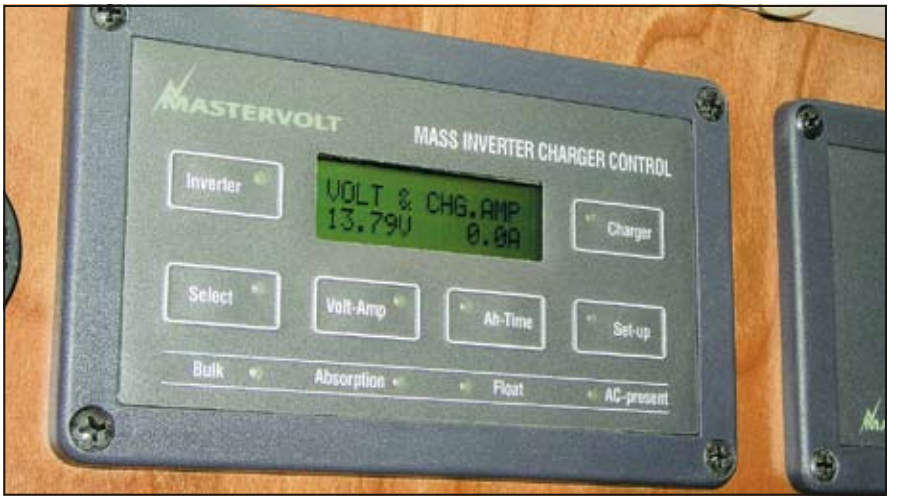
Size Versus Power

Should you have a small task inverter or integrated system? If you will power any device larger than 250 watts, you will likely need a built-in unit. On our previous smaller boat, we chose a small 150-watt inverter just to run chargers and computers. Since these inverters

CODE WARNINGS

The American Boat and Yacht Council (ABYC) now specifies visible warnings after a death occurred because a surveyor did not know an inverter was installed. Per ABYC A-31, boats require a visible means (e.g., voltmeter or lamp) of determining that the inverter is "on line" and/or in "standby" mode as well as a warning label to indicate that the electrical system includes an inverter with both placed at the AC main electrical distribution panel. — *Patricia Kearns*

Black wire connects the remote control panel via a telephone jack connection.



Masterlink MICC features an LCD readout and LED bar to quickly determine the system voltage and system charge or discharge current; amp-hours consumed from the battery; time of operation remaining until the battery is discharged and remote operation of the Mass Combi inverter/charger.

are quite inexpensive, they generally are a better investment than trying to get 12-volt chargers for all the portable items you take onboard. One small $50 inverter allows you to plug in most of your little chargers.

The bigger alternative is to have a large, integrated inverter/charger. This is increasingly becoming the norm since it's much more convenient, providing power at all the vessel's AC outlets. An automatic switchover handles switching internally, recognizing when shorepower is connected, and the system becomes a charger as needed. This substantially reduces installation time and wiring runs. We equipped our new boat with a Mastervolt Mass Combi 12/2000-100 unit.

Installation

After finding a suitable location for the unit, the main job is wiring. Disconnect all power including the shorepower and vessel's batteries when doing this work. Do not reconnect until installation is complete.

In our case, there is a machinery space under the raised saloon suitable for the inverter/charger. This unit needs adequate ventilation when operating at maximum power. Our installation required supplementary vent ducting since it generates a fair amount of heat at full load. The six basic wiring connections for our unit include: AC input, two AC outputs, DC input/output, control unit and battery sensor. Our unit is a 2,000-watt inverter that draws less than 200 amps (2,000 watts divided by the voltage, in this case 12, equals 166 amps). It's also a 100-amp charger but, since the charging function is carried over the same wire, the load must be calculated for the inverter. This required a very heavy gauge wire connected to the boat's 12-volt system. [Ed: For conductor sizing and voltage guidelines refer to the DIY CD-ROM *Marine Electrical Systems*.]

Installing an inverter takes the DIYer into the potentially hazardous world of electrical wiring. Before you tackle an inverter installation, make sure you are intimately familiar with the installation recommendations of ABYC A-31, *Battery Chargers and Inverters*, and that you select an inverter that complies with A-31 and UL 458, *Power Converters/Inverters ... Marine Power Converters/Inverters and Power Converter/Inverter Systems*. Ensure that your wiring complies with ABYC E-11, *AC and DC Electrical Systems on Boats*.

Our unit has a remote control and information panel that we placed in the nav station. It's easily connected by simply running the included telephone-type cable and connector from the unit to the remote panel. This system also utilizes a battery temperature sensor connection to safely charge the batteries. Mastervolt makes this quite simple by using a telephone jack connection and wire connected to a small self-adhesive patch that sticks onto the battery. This unit also connects to shorepower via the AC input, AC output and AC output that is not run through the inverter and is called short break (described below). If you are not confident working with 120 volts, consider having a marine electrician help with this.

The Mass Combi also has two separate AC outputs. One rather confusingly called "short break" is actually a clever way to make the automatic switchover work safely. When plugged into shorepower, you want power into the boat to charge the batteries plus be available at outlets and for other built-in items, such as the electric water heater in our case.

DIY MATERIALS

Mass Combi 12/2000-100	$2,725
Masterlink MICC	$581
Masterswitch 50 amps/7kW, two in, one out	$576
Cables, wiring (estimated)	$200

On the other hand, when not plugged in, you want the inverter to switch on and make power available to the outlets; however, you do not want to waste battery power running the water heater as it could easily flatten even a large battery bank. Mastervolt's unit has two AC connections to the inverter. One is for the items powered by the inverter and the other is for items powered only when connected to shorepower.

Our installation was complicated by the fact that we have a generator. Now, there are three potential sources of AC power. The generator, shorepower and the inverter. We added a Masterswitch to do this automatically. Shorepower input connects the switch, which also handles the input from the generator. Output from this switch connects to the input on the inverter/charger.

The switch positions are as follows: "1," shorepower is available and power passes to the inverter, which turns on the battery charger function and also passes power to AC outlets and short break items, including the water heater; "2," generator is running and Masterswitch sends generator power to the inverter/charger so the charger runs automatically when the generator is on; "3," neither shorepower nor generator is available so the Mastervolt inverter/charger switches the inverter on and provides power to the AC breakers but not the water heater.

System in Use

We now have had this system running for nearly a year. Having a central large inverter/charger is wonderful and a big change from the compact unit in our older boat of 18 years. Things such as my soldering iron, electric tools and Sheryl's hairdryer run effortlessly. This unit even powers our small washing machine if you don't choose a hot-water cycle or we run the generator for a while to top up the batteries and start the washer and then switch it off partway through the cycle. The inverter takes over and finishes the wash. As Sheryl says, "Life on board just got better."

About the author: Paul and Sheryl Shard produce *Distant Shores*, a TV show based on their travels onboard a Southerly 42 of the same name that airs in more than 50 countries (distantshores.ca).

Ed: *Part One discussed choosing and installing a Mastervolt Whisper diesel generator and appeared in DIY 2008-#2 issue.*

Air-to-Fuel RATIOS

The causes, effects and cures for minor engine flooding and extreme cylinder flooding.

Story and photos by Steve Auger

Gasoline powered engines can suffer component failures that could lead to a condition that often is referred to as "engine flooding." This condition occurs when the actual amount of liquid fuel supplied to the cylinders is too great for proper ignition compared to the amount of fuel required to operate the engine correctly. It also occurs when the correct amount of fuel is supplied but the airflow system and/or ignition system are not working correctly.

The correct air-to-fuel ratio for most gasoline engines is approximately 15 parts air to one part fuel or 15:1. If left unchecked, a rich running or flooding four-cycle engine eventually self-destructs as the solvent properties of the excess fuel strip away the lubrication normally supplied by the engine oil. Two-cycle engines that are running rich or flooding typically emit more smoke than normal and run on reduced power. On both engine types with a flooding condition, fuel consumption goes up and performance goes down.

Vaporized gasoline is very explosive and must be treated with respect or you'll get hurt or worse. Never attempt to diagnose or work on a fuel system without the proper service manual, which alerts you to any precautions, hazards and tools that are approved for fuel system work. Know your limitations and, if you don't have the right tools, including the informational ones, leave the work to a professional.

Symptoms

If you suspect a rich or flooding engine condition, always start diagnostics with the basics. Ensure the ignition and charging systems are in good working order, including spark plugs, and that the flame arrestor is clean. Verify that the air inlets to the engine compartment are clear. Check the fuel by pouring a sample into a clean, clear container and check for water or debris. If contaminated, the fuel delivery system needs pumping out and cleaning by a qualified fuel recovery company.

On four-cycle engines, check the engine oil after 10 hours of use. The oil should be as clear as it was when first put into the engine. If, however, the oil is black after only 10 hours use, you have an over-fueling rich or flooding condition.

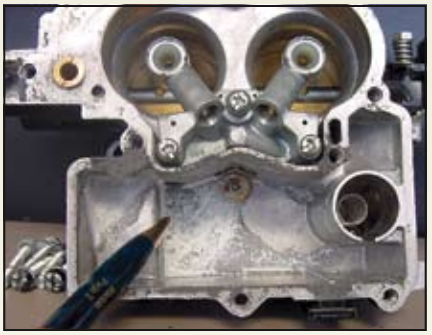
Check the transom of your boat after a few hours of use and if it's covered in a gray haze or black soot, the engine is running rich. Excessive over fueling or flooding is often accompanied by a distinct exhaust odor.

Most engines that have a flooding condition emit a black smoke on start up and are typically hard to start or restart, especially when the engine warms up to operating temperature. Starting often requires that the throttle be advanced beyond the normal starting position in order to get the engine to actually fire.

Origins

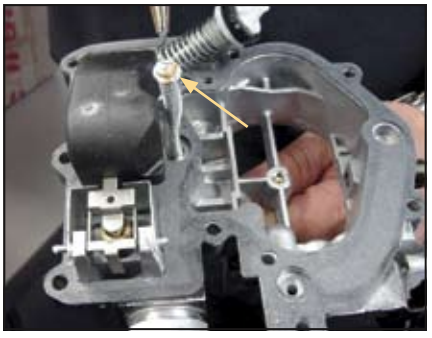
Reformulated gasoline, fuel delivery system failures, carburetors and fuel injectors can all cause flooded engines.

In North America, the fuel you use in your boat is designed for automobiles that are operated on a daily basis.



Modern fuel contains alcohol, which holds water that corrodes and affects carb performance.

A specialized tool sets carburetor floats to the correct height to prevent flooding.



Debris on the power valve plunger can cause the valve to stick open.

This fuel has additives that work well when the engine is operated regularly but can gum up and damage a marine fuel system, which is more often than not operated on an occasional basis. You can't change your fuel so you must be proactive and ensure that fuel stabilizer is added to every tank fill during the boating season and even greater amounts of stabilizer for long storage periods.

Each gasoline engine has a fuel delivery system that usually consists of a pre-filter, fuel pump and fuel metering system, such as a carburetor or electronic fuel injection. Each of these

systems has a specified fuel pressure that cannot be exceeded. Surpass the recommended fuel pressure and too much fuel is now delivered to the cylinders, resulting in a rich condition, which eventually creates a flooding condition over time as the other parts of the engine are compromised by the rich running condition.

Engine manufacturers introduced higher fuel pressure as part of an ongoing battle with reformulated gasoline, which vapor locks more easily than prior fuel formulas that did not contain alcohol. (Vapor lock occurs when an engine stalls because the liquid fuel turns into a vapor, usually caused by a weak fuel pump or high engine compartment temperature.) Extremely high fuel pressure on carbureted engines forces the fuel bowl inlet needle open, allowing raw fuel to bleed out the fuel bowl vent holes and into the intake to the cylinders. This can actually cause the cylinders to hydraulic lock (a.k.a. hydrolock, which happens when the combustion chamber fills with liquid fuel or water that immobilizes the pistons).

Years ago, your engine would require a carb rebuild if the unit was very old or fuel was contaminated with diesel or water. Not so in the new millennium. Modern fuel has additives, such as alcohol and dispersants, that can gum up or ruin accelerator pumps, metering jets and fuel inlet needles to the point where the system fails to shut off the fuel supply to the engine at the correct time, resulting in engine flooding. Fuel injectors are not immune to this contamination and may leak fuel when the engine is not running, which gives the same result: flooded or hydraulic locked cylinders.

Electronic fuel injection systems on modern engines use a device called a fuel pressure regulator to accurately control the pressure of the fuel delivered to the fuel injectors. The fuel pressure regulator has a rubber diaphragm inside it that can rupture allowing fuel to escape. U.S. Coast Guard regulations state that a hose must be installed on the regulator to route this fuel directly to the intake manifold, which causes engine flooding.

An Ounce of Prevention

If you address the possibility of your engine being affected by a flooding condition, the cost is considerably lower than if you have to repair the engine after the fact.

Add a quality fuel stabilizer, following the directions for the correct amount per gallon (or litre) for daily use, to each fuel fill up. When storing your boat, use quality fuel and stabilizer if you plan to fill the fuel tanks for the storage period. Do not store boats with half full tanks with a plan to add fresh fuel in the spring as this does not work. You'll end up with a full tank of expensive low quality fuel that may have suffered phase separation. Store fuel tanks full or empty and use stabilizer at the proper ratio. For portable or removable fuel tanks, empty the tanks completely and fill with fresh fuel in the spring.

EFI fuel pressure regulators have a rubber diaphragm as shown in the cutaway regulator (top right) that can leak. The pencil indicates the hose connection point that routes raw fuel back into the engine in case of a diaphragm rupture.

Mercury fuel pump kit features a special soft fuel line to minimize flooding due to pump pulses.

When requiring a carb rebuild, always supply the repair shop with an OEM kit.

A rough running or vibrating carbureted engine can actually flood due to vibration caused by the poor overall condition of spark plugs, spark wires and ignition components. Keeping the engine tuned eliminates this as a possible cause of flooding.

Pump Test

Follow the procedure outlined in the service manual for your engine and verify the fuel pressure is within specification. If it's not within spec, the fuel pump on carb motors or fuel pressure regulator on EFI models need changing. Early marine engines (up to 1980) had glass sight bowls that show when the fuel pump diaphragm had ruptured. If the sight bowl has fuel in it the pump needs replacing. [Ed: Any fuel pump with a sight bowl on it should be considered obsolete in terms of safety and should be upgraded immediately.]

Newer engines (1980 to 1996) with mechanical pumps have a clear plastic hose called a "sight tube" that routes fuel to the intake manifold in case of a diaphragm rupture. Fuel visible in this sight tube may be the source of the flooding engine and requires replacing the failed pump. Do not use automotive fuel system parts on a marine engine as they are not tested for compliance with U.S. Coast Guard and/or ABYC safety standards.

Carb and Injector Service

Carburetors that are flooding during or after operation should be disassembled, placed in a carburetor cleaning solution and reassembled using a repair kit to replace any contaminated components. I advise you to purchase the OEM kit from your dealer and then send the carb, accompanied by the correct kit to a professional carb repair center. Do not use an automotive carburetor or carb kit on a marine engine as there are major safety related differences in the two and parts such as jets and accelerator pumps have different safety specs for automotive versus marine fuel systems.

Fuel injectors are easily cleaned without removal from the engine. Automotive stores sell disposable kits that connect to the fuel system to clean the injectors. Consider having a marine engine mechanic do this task with an industrial fuel-injector cleaning system. Severe contamination often demands replacing the fuel injectors.

I have not seen much success using additives that are added to the fuel tank to clean fuel systems; therefore, I cannot advise you to use them as a cure for flooding/stuck carbureted or fuel-injected engines.

The best offense is a good defense when it comes to an engine flooding condition. Adding fuel stabilizer to a quality fuel on a regular basis and proper fuel system storage practices go a long way in preventing the fuel system failures that cause engine flooding. Keeping the engine in good running condition also reduces the potential for engine flooding.

About the author: Steve Auger is a Mercury Mercruiser master technician and DIY's engine technical advisor.

Step-by-Step RUDDER REPAIR

Damaged rudder? If yours is a typical fiberglass and foam rudder, repair need not cost a small fortune.

This was the gouge in the side of the rudder. Luckily the foam was dry.

Story and photos by Paul Esterle

Prices for just about every commodity and service are rising steadily and this is especially true for petrochemical products. Epoxy resin is a prime example. Organizing the repair process to maximize the efficient use of these expensive materials is one way to control repair costs without scrimping on quality. This logic did not escape me as I repaired the rudder on our Columbia 35' (10.6m) sloop.

The rudder was a typical fiberglass and foam molding with a stainless-steel rudder shaft and a mild steel plate welded to the lower end. The builder used two molds to form the outer shell of the rudder, one for each side. Fiberglass and polyester resin were laminated in each mold half and the shaft assembly was put into one mold and high density foam poured in and around the shaft. The other molding was then clamped in place and the foam allowed to expand and the fiberglass laminate to cure. Once cured, the rudder was popped out of the mold and installed on the boat.

Rudders of this construction have several weak points. The joint where the two halves of the molding come together is a weak area and the seam opens as a result of normal rudder dynamics and/or moisture intrusion into the molding. The mild steel tends to rust when (not if) water leaks into the foam. Even stainless steel rusts if there is water present along with an absence of oxygen.

The problems with the rudder came to light when I hauled the boat to repair some hull blisters. The leading edge had a few places where the foam core was exposed. There was also a small area of the rudder side that had endured a deep gouge that penetrated into the foam. Finally, there was one small stress crack in the fiberglass near the rudder head.

The first step, before attempting any repair, is to make sure the rudder is dry and the foam is not saturated with water. Fortunately, the blister repairs required the boat be on land to dry out, giving me plenty of time to observe and examine the rudder. I drilled a small hole in the bottom of the rudder to see if any water was present. Several months passed with absolutely no sign of water in the foam core of the rudder. Finally satisfied, it was time for me to start the repair.

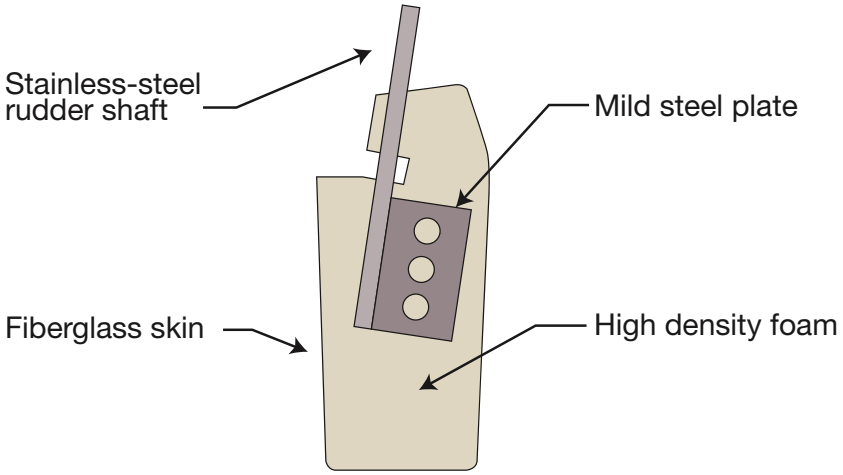
Plan Set

Before beginning work, I had to determine exactly what needed to be done and how to do it, along with deciding what materials I needed. I decided that two layers of 10oz fiberglass cloth should be laminated over all rudder surfaces, with three layers of cloth on the rudder bottom and the leading and trailing edges, the known weak spots.

A scale drawing of the rudder allowed me to try various combinations of fiberglass cloth widths and lengths. Glass cloth comes in a variety of widths, so it was important to choose a width that would minimize waste. I found that 38" (965mm) wide cloth was just right to reach from the bottom edge of the rudder to a point just below the lower rudder gudgeon.

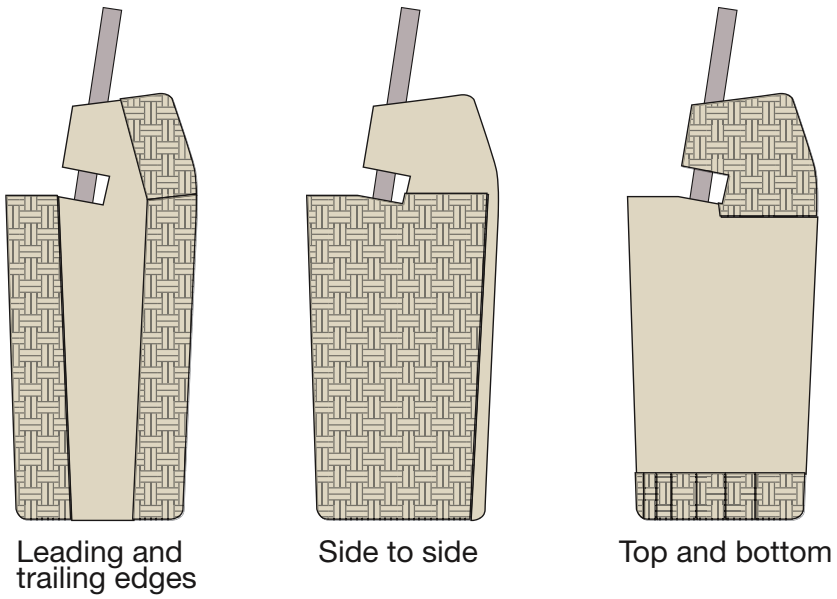
The final layout schedule was to place a 12" (304mm) wide piece of cloth around the trailing edge of the rudder seam. That was followed by a single piece of cloth that started 1" (25mm) forward of the trailing edge and continued all around the rudder to the opposite trailing edge. Additional pieces of cloth were then laminated to each

Typical Rudder Construction

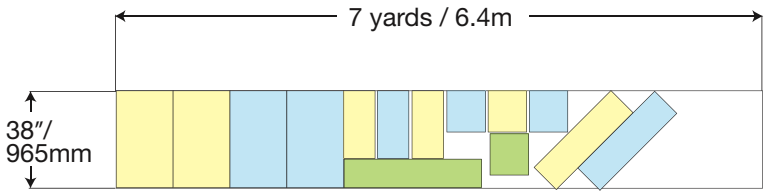


Drawing illustrates the typical construction of a foam and fiberglass sailboat rudder.

Location of Fiberglass Cloth Laminations



Scale drawing for fiberglass cloth layout



Drawings shows the configuration of the different layers of fiberglass that the author laminated to the rudder.

side of the rudder above the lower gudgeon and overlapping the lower piece of cloth. These layers were alternated with the laminations on the bottom of the rudder.

The bottom of the rudder was a particular concern for me as that was the first part of the rudder to be affected by a grounding. At first, I considered just buying longer cloth, cutting darts in the lower edge and lapping the cloth across the bottom. This posed several problems. The space between the bottom of the rudder and the ground was less than 18" (457mm), which restricted my working space. This also would have resulted in noncontiguous laminations at the bottom of the rudder. In the end, I found an easy way to apply layers of cloth to the bottom of the rudder and make the darts on the sides of the rudder.

Finally, a 12" (304mm) wide strip of cloth was applied to the leading edge of the rudder. This provided three layers of cloth in that area. The lamination resulted in two layers of 10oz cloth over the entire rudder, except the leading and trailing edges and the rudder bottom. These areas had additional laminated layers added for extra protection.

As a final aid for calculating how much fiberglass cloth I needed, I made a scale drawing of a 38" (965mm) wide piece of cloth and placed outlines of the individual pieces on the drawing. I could have saved a little more cloth if I had slightly rotated some of the pieces for a better fit. However, I was more concerned about the fiber orientation in the cut piece, so I kept them properly oriented.

Having done all this work and planning, I was able to shop for the best deals on the materials I needed to complete the project. Everything was ordered or purchased at the same time and it was all on hand within a week.

Pattern Making

While I was waiting for the materials to arrive, I started the next phase of the project: making patterns. Trying to cut fiberglass cloth while doing the lamination is a ticket to frustration. I always make patterns and pre-cut the cloth before mixing the first batch of resin. I made brown paper patterns for the top of the rudder, the cloth on the sides of the rudder and the 12" (304mm) wide strips, which were simple rectangles and needed no patterns.

A small hydraulic jack supports the foam board in position for tracing. This also was the technique the author used to laminate the cloth on the rudder bottom.

A line drawn 4" (101mm) out from the rudder outline formed the outside of the pattern.

Here is the complete cloth cutting setup: rotary cutter, pad, markers, yardstick and cutting layout. A rotary fabric cutter and pad is the best way to cut fiberglass cloth. Note the crisp, unfrayed edges.

The rudder bottom also required a pattern. I needed to test my lamination strategy for the rudder bottom as well as make the pattern. Using a small hydraulic jack to support a sheet of artist's foam board against the rudder bottom, I marked the outline with a marker. Then, after measuring 4" (101mm) from the outline to establish the final shape for the cloth, I cut the pattern with a hobby knife. Foam patterns were also made for the cloth at the rudder top.

Artist's foam board is ideal for making patterns as it is stiff and easy to trace or cut. The best way to cut fiberglass cloth is with a rotary fabric cutter and the associated pad. Cuts are razor sharp and the cloth fibers fray much less than when cut with regular scissors. Don't be afraid to mark the cloth with markers, drawing centerlines and other marks to help align the cloth during lamination.

Foam board pattern was placed on the cloth and traced around with a marker.

One of the three pieces of cloth needed for the bottom of the rudder. The outline helps center the cloth under the rudder.

Surface Prep

With the patterns finished and the fiberglass cloth cut and rolled up in newspaper to keep clean, it was time to begin the repair. The rudder surface was already free from any paint as the bottom and rudder were sandblasted when the boat was hauled. A wipe down of the rudder surface with Interlux Fiberglass Solvent Wash 202 removed any contaminates and the surface was lightly sanded.

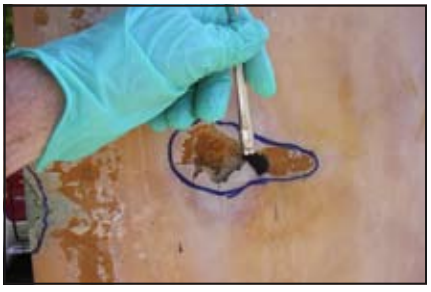
The few dings and gouges were filled before continuing. To do this, epoxy resin was brushed into the damaged areas and then these were filled with a mixture of epoxy, colloidal silica and fairing compound. The colloidal silica helps keep the epoxy from sagging.

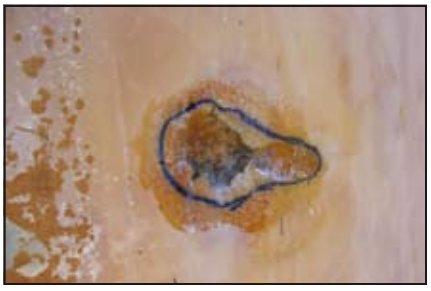
With the filled areas now sanded smooth, the lamination process could begin. A portable work bench near the

(continues on page 29)

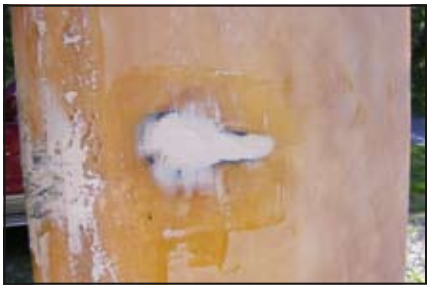
The rudder had one small stress crack just above the lower gudgeon, which was highlighted with a marker to make it more visible.

An acorn-shaped cutter in a Dremel tool widened the crack before filling with epoxy.





(top) Epoxy resin was worked into the foam and all the crevices of the gouge were left to cure until tacky before proceeding (bottom).



While the epoxy was still tacky, gouges and dings were filled with a mixture of epoxy, colloidal silica and fairing compound.

(top) Cutting the darts in the bottom lamination just prior to epoxying it in place lessened edge fraying. (middle) The bottom lamination jacked into place and the darts brought up the sides of the rudder. (bottom) Foam board removed and the plastic ready to be peeled away. The darts make for a rougher surface, requiring a bit more sanding.

The first side laminations lightly sanded and ready for the first bottom lamination.

(top) The first layer of cloth laminated to the trailing edge of the rudder. (bottom) Note the marks on the rudder that help align the cloth and indicate where to spread the epoxy.

Epoxy fairing compound spread on the rudder.

A light misting of black lacquer (visible at the top) highlights any low areas when sanding.

The final result: a reinforced rudder with five coats of Interlux InterProtect 2000E ready for antifouling paint.

(continued from page 27)

rudder held the epoxy and all mixing supplies and I placed the box of precut cloth nearby. Marks on the surface of the rudder identified where each lamination would begin and end.

Lamination Set Up

After donning the first pair (of many) protective gloves, I mixed up a batch of epoxy thickened with a little colloidal silica to keep it from sagging. A thick coat of this mixture was brushed on the rudder area that received the cloth. The alignment marks placed on the cloth and rudder earlier helped orient the cloth. Bubbles were worked out of the cloth with the epoxy brush and followed by a fiberglass laminating roller. This grooved roller works out the air from under the cloth and forces it into the epoxy.

To place the cloth on the rudder bottom, I first covered a piece of artist's foam board with plastic wrap, to keep things from sticking to the foam board, and then placed the cloth on the plastic wrap and cut darts from the outsole edges of the cloth to the outline of the rudder bottom. After applying a thickened coat of epoxy to the center of the rudder lamination, the wrapped foam board was pushed up against to rudder bottom and supported with the hydraulic jack. Once again, the marks placed on the cloth helped keep things aligned.

After each lamination cured, the surface was lightly sanded with 80-grit discs to remove any bumps and runs and to prep the surface for the next lamination. With good weather and good preparations, I was able to complete the laminating in four days.

Sanding Tips

Once the final layer of cloth and epoxy had cured, the surface was again sanded to remove any bumps or runs. None of the cloth was sanded as that would weaken the laminations. Epoxy mixed with fairing compound was applied over the entire rudder. One trick when fairing something large like the rudder is to lightly mist the cured filler with black lacquer from a spray can. Not a solid coat, just a light misting that dries quickly. When sanded, low spots are quickly evident by the black areas the sanding doesn't reach.

Once the sanding and fairing were finished, Interlux InterProtect 2000E was applied over the rudder. If I was not going to barrier coat the rudder, I would have used an epoxy filler, such as Interlux Watertite Epoxy Filler, that withstands water immersion without any other protection. InterProtect is very forgiving in terms of recoat times. You now can go as long as six months between coats without any problems. [Ed: For tips on applying InterProtect, refer to "Barrier Coat Blues" in DIY 2008-#3.]

The advantages of properly organizing a repair like this were soon evident. The entire repair from organizing to completion was done over the span of two weeks. In fact a neighbor in my boatyard complained that I had done it too quickly as he didn't have time to stop by and take notes.

About the author: An inveterate DIYer, Paul Esterle is a boating writer and editor when he isn't working on his fleet of old boats.

SCOPING The Stern View

If your boat's cabin obstructs your field of vision when backing up or you cannot see the dinghy when towed then a closed-circuit TV system is a useful investment.

(across right) Checking the dinghy while at anchor. (above) A bird's eye view of the surroundings aft of the transom.

Camera bracket bolts to the trailing edge of a small aluminum extension plate that fastens to the existing tower plate.

Story and photos by Garrett Lambert

Recreational vehicles are often described as "land yachts" because they share so many attributes with their seagoing brethren. Poor visibility in reverse is one that is shared by both "vehicles." One big difference is that, when RVs stop, they stay stopped. Boats just drift in a different direction with no "brakes."

The explosion in security and safety concerns over the past decade has produced a flood of new and inexpensive closed-circuit television (CCTV) equipment. The passenger car business has been quick to adopt and adapt. Infiniti now has a system providing 360-degree views around the car and the after-market sector provides consumers with many options.

RV drivers were quick to mount CCTV systems on their rigs to guide them when backing up. However, boaters seem to have been slow to recognize the benefits of being able to see the back end of the boat and beyond, monitor a towed dinghy, or, with extra cameras, check on engine room gauges or other areas of the vessel.

After some Internet research and visits to RV dealers and major electronics outlets, I concluded that almost any one of the available systems is better than having none and a few stand out as superior. I know some boaters who are proponents of wireless car license plate kits but that's primarily because of prices well below US$100. License plate camera optics are designed for closeups, and the 2-1/2" (63mm) monitors become difficult to interpret with a big picture on the screen. For

Lens Comparisions

Horizontal Lens Angle	Width 5' from back	Width 10' from back	Width 25' from back	Width 50' from back	Width 100' from back	Fish-eye	Diagonal Lens Angle
42°	4'/1.2m	8'/2.4m	19'/5.8m	38'/11.6m	77'/23.5m	None	53°
60°	6'1.8m	12'/3.6m	29'/8.8m	58'/17.6m	115'/35m	Minimal	75°
90°	10'/3m	20'16m	50'/15m	100'/30m	200'/61m	Slight	106°
100°	12'/3.6m	24'/7.3m	60'/18.2m	119'/36m	238'/72.5m	Yes	115°
110° (standard)	14'/4.2m	29'/8.8m	71'/21.6m	143'/43.5m	286'/87m	Yes	123°
130°	22'/6.6m	43'/13m	107'/32.6m	214'/65m	429'/131m	Strong	NA

The Provix, a small multi-system, flat-screen television with no tuner but a pair of built-in speakers, could also be used with other devices, such as a DVD player. A solid-state remote control and a ball-joint stand are included.

A foot "operated" fixed mount Standard Horizon VC10 color camera placed near this trawler's masthead offers a great field of view.

our needs, they also require optional wide-angle lenses that push the price up and the image quality down.

Single and multi-camera security kits are readily available but the cheap ones tend to be flimsy, particularly the all-important mounts, and detailed performance specifications are few and far between. The few reviews I've found tend to be disparaging and, while good quality security cameras probably offer the best choice and value for multiple camera installations, the cameras are often bulky and the kits are usually packaged with recorders rather than monitors.

Considerations

My search for decent quality equipment, suited to the particular requirements for a boat, found the Winsted Group at www.rearviewcamera.net. This website is uniquely rich in essential information for anyone considering this purchase and includes a chart comparing its Provix system to others. In fact, it was the only one I found that provided complete and detailed specifications for all components.

Wired or Wireless? I had intended to choose a wireless system since it promised easy installation. However, only the signal from the camera to the monitor is wireless and, of course, both the camera and the monitor require wired power. Most wired kits, including the Provix, use a single cord bundle that carries both the video signal and electricity, thus eliminating any advantage to the wireless systems.

There's an even more important consideration. *PCWorld* contributing editor Steve Bass installed a wireless version in his car and wrote: "Another problem is the camera will occasionally act like, well, a wireless device. The gizmo picks up interference and I'll see horizontal lines rolling across the screen; every so often the image will just disappear." I opted for the assurance of a fully wired system.

Field of View: To be useful for backing up, the video system must display an area several feet to either side of the boat and more is better. The problem is that even systems designed explicitly for RVs have too narrow a field of view for boats, which tend to be wider. For my boat's 14' (4.2m) beam, I want to see not less than 5' (1.5m) to either side in order to have time for the boat to react to helm changes so I need an angle of view providing at least 24' (7.3m) at the edge of the swim platform. How to get it depends on quite a few factors starting with where the camera is mounted. If enough height is not available, installing a remotely controlled camera or one with a wide-angle lens is an easy solution but each option has its drawback (described below).

The Camera: Experience with remotely controlled spotlights and discussions with camera suppliers led me to conclude that a remote-controlled camera mechanism in salt air has a limited life expectancy. More important, maneuvering in close quarters requires both hands at the helm, not fiddling with a camera control.

What about lens angle? According to the chart above, a 42-degree lens provides undistorted depth perception equal to the human eye, whereas a 110-degree, wide-angle lens is required to provide the equivalent field of view. Unfortunately, wide-angle lenses promote perspective distortion and, as the chart indicates, the wider the lens angle, the greater the distortion. (Hence the warning on automotive rear-view mirrors that states: "Objects in mirrors are closer than they appear."). Dave Winfield recommended a 90-degree camera as the best compromise for my needs and lent me a 60-degree camera so I could compare the difference.

The last all-important criterion for the camera is that it survive in the marine environment and it must be absolutely weather proof. Claims about "weather resistance" or "water resistance" are made by many suppliers but, all too often, without any substance to back them up. Look for a camera that meets, as a minimum, the IPX6 specifications. See "Camera Ratings" on page 32.

The Monitor: The monitor's backlighting, resolution and refresh rates should be sufficient to provide a clear, no-flicker picture in daylight. The screen should be large enough to enable picture details to be readily discernable from the helm. While a monochrome image would do the job, color helps to distinguish detail. The monitor should also be able to swap the image so that it is mirrored and/or inverted if necessary to reflect what the mind expects to see, i.e., although the camera faces aft, the driver looks forward. Therefore, the image on the monitor should show what one would see in a car's rear-view mirror: the left side of the boat on the left side of the screen and everything right-side up.

(top) Photo of the display with camera fitted with a 60-degree lens; (bottom) Same camera position equipped with a 90-degree lens.

Product Options

The IPX6 rated Provix camera has all waterproof wiring and connectors are stainless steel. The compact camera package measures 4" (101mm) wide by 2-1/2" (63mm) high by 2-1/2" (63mm) deep. The lens automatically compensates for available light and does remarkably well in very dim conditions. In true darkness, 10 infrared LEDs assist the "bulbs" surrounding the lens and, although the manufacturer's information indicates their reach is marginal for a boater's needs, I was surprised at how well they performed one pitch-black night.

This camera's 7" (177mm) flat screen LCD monitor has front controls that include an on-off switch and volume, plus three more to invert and/or mirror the image or adjust brightness, color, tint and contrast. Provix cameras also contain a microphone that broadcasts through the monitor's speakers and there is a volume control on the monitor. An infrared spotlight is available as an option.

There are options from other sources, of course, and fellow boater Brian Shanafelt bought his system through eBay: a new-in-the-box Standard Horizon CP1000C GPS/Plotter with a 10" screen complete with a Standard Horizon VC10 color camera for his pilothouse motor yacht. This plotter has inputs for two cameras and, by punching a button twice; he can switch the display between camera and plotter. "I set it to camera view during docking/

Positioning the camera above the windshield gave the author a better sight line.

undocking and then to plotter once underway," said Shanafelt "I set the view to automatically display the rearview every 60 seconds to see who is coming up on the stern as well as having a regular peek when towing the dinghy."

"This has been a super add-on, as the aft view on my boat is really poor from the pilothouse. Prior to having the camera, it was mandatory to station a lookout on the rear of the boat in tight situations and hope their description of the impending collision was accurate. At the end of the cruise, I rinse off the camera with freshwater and have noticed no image degradation from salt," explained Shanafelt.

Installation

I had planned to mount the Provix camera on the boat deck rail above the cockpit but, since I kept coming back to Shanafelt's comments about the value of being able to check on what might be coming up from behind, I adopted his masthead approach instead. That location also eliminated the vexing problem of finding a protected route for the cable bundle to the lower helm because it just drops through the mast with the anchor light, radar and TV antenna cables. The masthead was already a busy place but it was easy to make and paint a small extension plate out of 1/4" (6mm) aluminum and to sandwich it between the anchor light and the existing top plate. The camera bracket bolts on to the trailing edge. Since there wasn't room for the camera cable in the one small hole already through the mast's top plate, I drilled a new one.

Figuring out what ought to go where and how took longer than the actual installation. After a couple of false starts, the job itself was not difficult but, as usual, did not go entirely as planned. When I carelessly failed to tape the open end of the hook on my plumber's snake, it snagged on something inside the mast and wouldn't move in either direction. It took more than an hour and many round trips on a ladder lashed to the spreader to get it free without doing any collateral damage.

The stainless-steel machine screws holding the anchor light had been threaded into the aluminum top plate and were frozen, so the heads snapped off when I tried to remove them. Having to grind the stubs flush required a trip home for an angle grinder and more ups and downs on the ladder. I used Nylock nuts and Tef-gel, an anticorrosion lubricant on the reinstall.

At the last minute, after removing the wiring race covers inside the pilothouse, I saw a much better option for mounting the monitor than the already cluttered chart table/dash. Not only was just the right space available on the face of the overhead drop-down instrument panel between the VHF radio and the Garmin fish finder, a suitable fused 12-volt power point was nearby.

Still more trips up and down the ladder enabled photos of the monitor showing images from the 60-degree and 90-degree cameras in exactly the same position. Photos (shown on this page top left) confirm Winfield's recommendation for the 90-degree lens.

After a couple of weeks' use, it was clear that I didn't need to see so much of the boat and really wanted to see more of what was happening behind me, so I climbed up yet again and made a small adjustment to the camera's angle.

This is proving to be a very useful augmentation of the boat's navigation aids. Total cost was just under $500; 25 hours of false starts and futzing about and 5 hours of actual work.

About the author: Garrett Lambert writes technical articles for boating and woodworking publications in Canada and the U.S.

CAMERA RATINGS

IPX criteria are prescribed by the International Electrotechnical Commission (IEC) established in 1906. The IEC has set eight levels of performance for challenging operating conditions. IPX1 requires protection against water drips, while IPX8 requires protection for full-time underwater operation in depths greater than 39" (1m). IPX6 states: "The appliance must tolerate water projected at all angles through a 12.5mm (1/2") nozzle at a flow rate of 100 L/minute (26.4 gpm), at a pressure of 100kN/m2 (14.5 psi) for three minutes from a distance of 3m (9.8')."

MADE FOR SHADE

Covers that are intended to shade the interior and provide some measure of privacy during the day also keep the interior of the boat light and airy.

Story and photos by Jim Grant

There are three reasons to cover portlights and windows on a boat: protection, comfort and privacy. Many window frames are made of plastic, which tends to get brittle and dull as a result of exposure to UV and airborne contaminates. Simple covers reduce this effect significantly. Even if protection for the window itself is not a factor, the interior environment is noticeably more comfortable given the shade that covers offer. Finally, covers provide indispensable privacy in often crowded marinas. The covers described below offer seclusion during the day but at night, when lights are on inside, privacy is minimal.

A number of fabrics that are specifically designed to serve as portlight and window covers have been introduced in recent years. Phifertex (**Figure 1**), a vinyl-encapsulated Dacron mesh, was probably the first of these. You probably have noticed this material used as interior shade protection in the greenhouse areas of some fast food restaurants. Phifertex has a 70% shade factor. That is, it reduces light penetration by 70%.

Recently the manufacturer of Phifertex introduced Phifertex Plus (**Figure 2**) with a shade factor of 90%. Both of these Phifertex mesh fabrics are extremely durable and perfectly satisfactory for indoor or outdoor applications. They can even be used as upholstery material for outdoor furniture. Because they are dimensionally quite stable and because they do not ravel, they are ideal for roller shades. The edges are simply cut to size without any hems or special sealing so they roll up smoothly and neatly.

The manufacturer of Sunbrella, clearly the most popular "canvas" cover fabric for boat use, recently introduced two fabrics designed as portlight and window cover material. The first of these, Sunbrella Shade (**Figures 3 and 4**), has an 84% shade factor. It's made of an acrylic fiber just like its canvas cousin but with a much lower thread count and a mesh-like weave. This fabric has a very soft hand that complements interior decors.

The second Sunbrella fabric is called Sunbrella View. It's quite similar to the standard Sunbrella except that it has small 1/32" holes or perforations spaced on 5/32" intervals across the cloth. It has the all-weather durability and color fastness of Sunbrella with a 93% shade factor. In other words, it's still possible to see through it, especially from the inside out, while also achieving nearly complete protection and very good interior privacy, except at night when cabin lights are on.

Cover construction varies, depending upon the material used and the project.

Portlight Covers

The portlights used for this demonstration have a black anodized aluminum frame with a 3/4" (19mm) inside flange. Phifertex, with its 70% shade factor, serves well to shade the interior and provide some privacy during the day while still keeping the interior of the boat light and airy (**Figure 5**).

To avoid drilling holes and mounting hardware, elasticized "skirts" along the edges of the screens are stretched over the flanges to hold everything snugly in place.

Patterns are essential. Made of almost anything, the best pattern material is Canvex, a dimensionally stable material strong enough to be secured with double-sided tape. It can be removed and re-attached until the fit is exact and cutlines are accurately placed (**Figure 6**).

For the portlight pattern, mark the flange outline on this material and then transfer the pattern to the Phifertex and cut out matching pieces. Add 1/2" (12mm) all around the outline to provide a seam allowance for the attachment of the skirt.

Fold a 2" (50mm), 1-1/2oz nylon tape in half to create a 1" (25mm) wide skirt that also provides a sleeve for the elastic cord at its base. This tape is relatively soft and easily gathered. Sew a 1/8" (3mm) shock cord into the fold of this sleeve with a cording or zipper foot in the machine (**Figure 7**). Leave room for the shock cord to move. Then attach the sleeve as a skirt to the seam allowance on the Phifertex with a row of straight stitches just 1/4" (4mm) inside the matched edges of the Phifertex and the skirt sleeve (**Figure 8**). The shock cord in its sleeve sits toward the center of the screen cover as the skirt is attached. Stop sewing 2" (50mm) or so before the skirt ends meet, pull out 5" or 6" of shock cord, trim off the excess, sew across the two cords ends one on top of the other several times to lock them together. Then cut the sleeve so that it overlaps the beginning point a 1/2" (12mm) or so and finish sewing it in place.

The corners here are rather tight. If the Phifertex is placed flat on the bed of the

Figure 1

Finished portlight cover using Phifertex.

Figure 2

Phifertex Plus as an external cover with Permalock fasteners. Velcro closed sleeves cover the wiper blades.

Figure 3

The dodger window cover made of Sunbrella Shade.

Figure 4

A Sunbrella Shade window cover secured with snap fasteners.

Figure 5

View from the outside. Privacy is better but not complete.

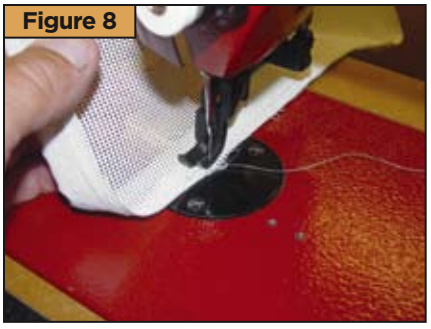
Figure 6

Canvex secured over the portlight with double sided tape ready for markup with a felt tip pen

Figure 7

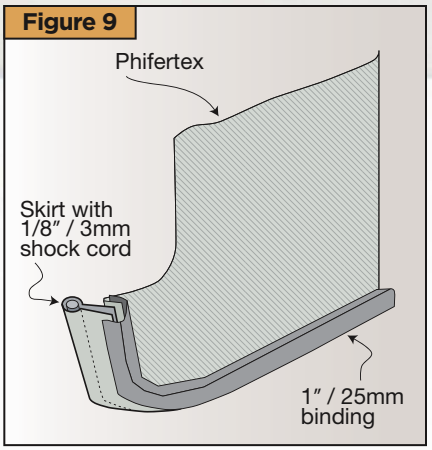
Locking the shock cord in the fold of the sleeve skirt.

Figure 8



Clockwise skirt attachment procedure.

Figure 9



Cutaway detail of the finished portlight cover.

Figure 10

Making a pattern for the dodger window. Double-sided tape holds everything in place.

Figure 11

Cutting the Sunbrella shade with a hot knife to seal the edge.

Figure 12

Guiding webbing and cover into binder jaws.

sewing machine so the skirt must be bent round the corners, the work is very difficult. Instead, keep the skirt underneath and, with the Phifertex "plate" nearly vertical, roll around the corners going clockwise. This is also a useful tip with cushions or anywhere a "plate" and a "boxing" are attached.

Now, we could simply turn the covers right side out and install them but, given the shallow 3/4" (19mm) flanges on the portlights, the seam allowance does not allow them to fit neatly in place. So, making a virtue out of necessity, use a 1" (25mm) binding to finish the raw seam allowance and make it an attractive detail all round the wrong side out cover. Refer to **Figure 9** for additional construction details.

Figure 13

The hole in the leather patch for the grab rail post can be cut with a grommet hole cutter. Note the snap fastener on the binding tape used to close the slit over the post.

Figure 14

Gypsy stud allows attachment of dodger and window cover on the same stud.

Dodger Window Cover

The Canvex pattern material (**Figure 10**) is especially useful for the dodger window cover. Special purpose cutouts can be indicated with accuracy because it's nearly transparent. Here, the pattern needs no seam allowance addition. Cut the Sunbrella Shade material all around the pattern shape with a hot knife, if possible, to prevent ravel and to seal the edges (**Figure 11**). Assembly simply reinforces and binds the edges then secures the cover in place over the dodger.

The reinforcement and binding operation is carried out in one step with a 1" (25mm) binder attachment on the machine. The binder automatically and accurately folds the binding. To use, guide the Shade material inside up (the material has no "in" side but the finished cover will) into the binder with 1" (25mm) nylon webbing on its surface (**Figure 12**). This is the inner surface of the finished cover. Secure with a second row of stitches to secure the inner edge of the webbing.

You can do the binding operation without the binder. Use double-sided tape and a stapler to hold everything in place until it's sewn.

Where slits are required, such as around the grab rail posts, sew leather patches in place prior to cutting the opening. Use a grommet hole cutter to neatly cut through the leather (**Figure 13**) and then sew all around the cut edges to prevent raveling and reduce wear to a minimum.

Since window covers are used only if they are easy to install and to remove, use the fewest possible number of attachment points and make each one work easily and quickly. With this in mind, this dodger window cover is held in place with snap fasteners and, to avoid holes in the dodger, use "gypsy studs" so existing snaps now serve a dual purpose, securing the dodger and cover as well (**Figure 14**).

Each cover project has its own unique challenges but the ideas presented here should help in meeting them.

About the author: Jim Grant founded Sailrite in 1969 and, with wife Connie, steered the business successfully until retirement in 2005. All supplies mentioned above are available at www.sailrite.com.

AIS
The Next Step Up From Radar

An AIS unit integrated with your GPS receiver easily indentifies and locates other vessels.

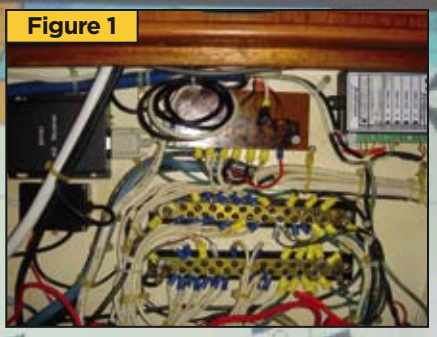


Figure 1


Figure 2

Deltas on AIS screen display represent vessels in a very busy Singapore harbor.

Story and AIS photos by Harry Hungate

AIS, or more formally "Universal Shipborne Automatic Identification System," is a marine VHF radio-based system that allows a vessel to see other AIS-equipped vessels and to be seen by like-equipped vessels. A side benefit includes the ability to receive safety and weather text messages from shore stations, search and rescue vessels and aircraft.

Two types of AIS transponders (transmitters/receivers) are available. Class A is for compulsory-equipped vessels. Since 2003, this class includes cargo vessels over 300 gross tons traveling on international voyages, all cargo vessels over 500 gross tons not traveling on international voyages and all passenger vessels. Warships are exempt. Class B is for non-compulsory-equipped vessels, which includes all pleasure craft.

An increasing number of pleasure craft are now adding AIS for obvious safety reasons. Class B transponders were just recently approved by the Federal Communications Commission (FCC) and are available for around $820. FCC approval only applies to vessels transmitting in U.S. waters. The transmit feature can be switched off so that a Class B transponder only receives.

Several low-cost non-classified AIS receivers are now on the market. These are receive-only models and some have dedicated displays, while the lowest cost models use late model chartplotter displays of several manufacturers. There is also an assortment of AIS software display programs for use on computers and many of the charting and navigation software packages now support AIS. Search the Internet to get the latest information, as this is a very rapidly evolving subject. (U.S. Coast Guard site listed on page 37.)

As with any navigation aid, AIS is only a supplement to your eyes and good judgment, and unlike radar, vessels must transmit an AIS signal in order to be seen. Unlike radar, AIS requires no training to interpret the displays. If you can see, you can use AIS — it's that simple.

After researching AIS on the web, I purchased a single channel AIS receiver, model SR-161 ($189 from www.milltechmarine.com.) The output of the AIS receiver is NMEA sentence VDM, so I also needed a multiplexer, model AIS-C ($239 from www.brookhouseonline.com) to combine the AIS sentence with the sentences from my Raymarine autopilot to the Raymarine C120 multifunction display's single NMEA input.

The AIS-C multiplexer is available with optional Raymarine SeaTalk input and a serial data connection. A serial-to-USB adapter is also available from Milltech Marine (Keyspan model USA-19HS, $39) if your computer has no serial port available.

Installation

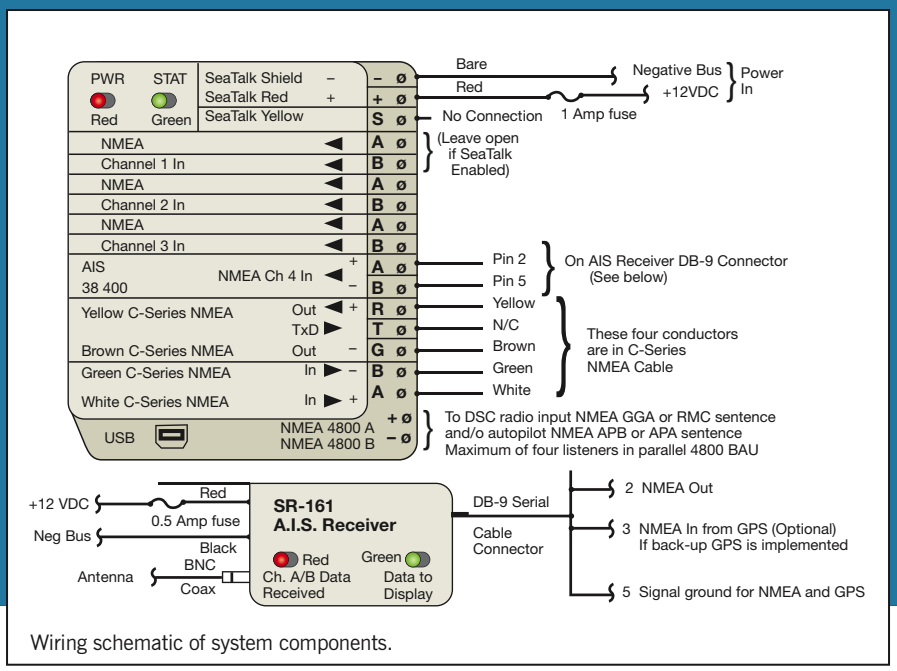
Installing the AIS receiver was very easy. It has no external controls, can be mounted out of sight and comes complete with a power cable and 0.5-amp inline fuse. Power was taken from the circuit breaker for the C120 display.

The receiver has a BNC antenna connector and requires a female BNC connector or SO-239 to BNC adapter on the antenna coax end. I had a separate unused VHF antenna so I simply used it. Alternatively, and much less suitable, in my opinion, I could use the mast head VHF radio antenna with an active antenna splitter, which would protect the AIS receiver from the marine VHF transmitter.

The multiplexer mounts near to the AIS receiver (**Figure 1**), and again, power was taken from the circuit breaker for the C120, and also includes a separate 0.5-amp inline fuse. Follow the instructions in the manual to set up the multiplexer for your installation.

Interconnection wiring is best done after a drawing is made of the devices and proper connections as shown on the next page. Add one wire, confirm its proper routing and termination on your drawing, then cross it off and go to the next. Have another person verify your connections before applying power, even if you are an accomplished electronics type (and if you are, you already know to do this unfailingly.)

For those who like to experiment, this receiver and multiplexer allow for many options and changes internally, but for those of us who would rather sail than experiment, both devices are blessedly plug-and-play.



Wiring schematic of system components.

Harry Hungate/Joe VanVeenan

Figure 3

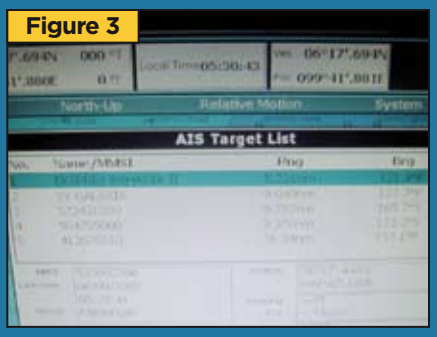
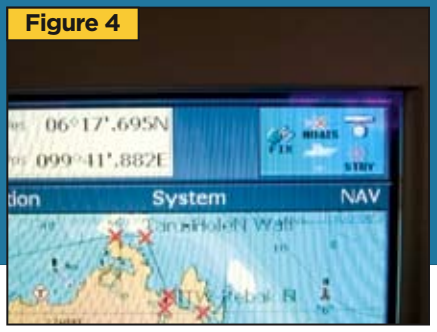


Figure 4



Setting up the Raymarine C120 multifunction display was almost easy, even if the operating manual was of little help. Turn on the display, press the "menu" key to bring up the "Setup" page, scroll down to "system setup," then "system integration," then "NMEA Output Setup" and set everything "off" except "APB" and "RMC" then "NMEA Port Setting" and select "AIS 38400." Now go back to the "Setup" page, then "AIS Layer Setup," then "Displayed Target Types" and select "All" or "Dangerous." Set "AIS Safety Messages" to "On" or "Off." (We learned early on to turn off the AIS safety messages, as nuisance alarms made this feature of little use in our opinion.) This completes the setup of the multifunction display.

Power up the AIS receiver and multiplexer. Neither of these have external controls, only a flashing red LED to indicate that AIS signals are being received and a flashing green LED to indicate that AIS data is being sent from the receiver to the display device (laptop or multifunction display). The red and green LEDs on the receiver flash feebly, and the red LED on the multiplexer shines steadily. The green LED on the multiplexer flashes rapidly.

Verification

To confirm that the receiver and multiplexer are connected correctly, have a look at the system diagnostics pages on your multifunction display. On the C120 multifunction display press the "menu" key to bring up the "Setup" page, scroll down to "System Diagnostics," then "External Interfaces," then "NMEA 0183" to display the NMEA statistics. Press the "buffer" soft key at the bottom of the display. Strings of data are displayed on the page. Watch for the NMEA VDM string that will look something like: !AIVDM,1,1,, 8,169;>0008 etc.

If all you see is gibberish, go back and review the baud rate settings for the AIS receiver, the multiplexer, and the multifunction display and make sure that all are set to 38,400 baud (38.4kb).

If you are using a laptop display program with your AIS receiver, go to the "hyperterminal" feature in Windows to view the NMEA sentences sent by the AIS receiver. To do this, go to "Start," then "Programs," then "Accessories," then "Communications," then "Hyperterminal." Set the Com port for: baud rate: 38400 baud; data bit: 8; parity: None; stop bits: 1. The data string for the AIS should appear as: !AIVDM,1,1,, 8,169;>0008 etc. Both the AIS receiver and the multiplexer come with very good manuals and installation CDs. Consult these for troubleshooting help.

Operation

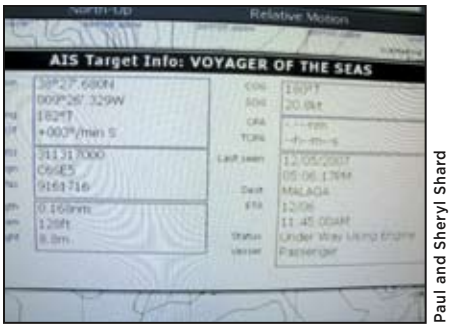
We first installed our AIS receive-only system in Brisbane, Australia, and it was a great help in navigating the often narrow channels through the Great Barrier Reef that always have heavy ship traffic. The ship icons provide instant indication of an approaching vessel, and by placing the cursor over the ship icon, more details appear in a data box (**Figure 2**).

An AIS target list shows all vessels with the closest vessel first (**Figure 3**). It's a real benefit to be able to call an approaching ship by its name, rather than by its approximate position, especially if other ships are nearby. It almost guarantees a reply and being able to tell the ship exactly the distance and time to closest point of approach greatly assists the ship in its efforts to locate your vessel and to pass you safely. If your vessel is equipped with a DSC-capable VHF radio, the approaching ship's MMSI number is displayed on the target list so it can be entered into the radio for direct calling.

As we were approaching Singapore, the busiest port in the world, our AIS display became overwhelmed with targets (shown on facing page), and the C120 bogged down almost to a halt. The AIS list indicated more than 200 AIS-equipped vessels within 18 miles (29km). With a helpful hint from Raymarine, we learned to select the "dangerous targets only" feature when in such incredibly crowded water, and the C120 returned to its normal quick response.

ADDITIONAL READING

For more about AIS, visit the U.S. Coast Guard Navigation Center web site at www.navcen.uscg.gov/enav/ais/default.htm



Paul and Sheryl Shard

(left) If you have a receive-only AIS unit, no one can "see" you; you are just "seeing" who around you is equipped with a transmitting AIS. (right) AIS receivers display information on commercial vessels transmitting with Class A or B transponders. Data is based on the vessel's Maritime Mobil Service Identity (or MMSI).

Usage Hints

Vessels not AIS equipped will not appear on the AIS list or display. Moreover, the IMO states that compulsory vessels must be equipped, but curiously does not state that the AIS must be in operation. So, you must still maintain a careful watch. Remember that warships are exempt from AIS and therefore do not appear on AIS.

Some AIS-equipped vessels either forget or neglect to update status and wrongly show "At Anchor" when they are really "Underway using engine" and vice versa. And, we have on several occasions seen vessels whose heading data is incorrect by as much as 90 or even 180 degrees. Keep that in mind on the next night passage!

Take the time to learn and to understand the various icons on your display. The Raymarine display shows "NO AIS" when there are no AIS signals being received. It could also mean that the receiver is turned off or otherwise inoperative. The icon that shows a red cross through AIS (**Figure 4**) means only that the AIS alarm feature is turned off, and not that there is something wrong with the system.

We quickly learned that AIS is of more value to us than the MARPA feature on our radar, especially when a significant sea is running. With the boat pitching, rolling and yawing about, the MARPA data is hopelessly inaccurate, while the AIS data is very accurate under all sea conditions.

For a relatively modest investment in money and time, the AIS receiver is the best safety device that we added to *Cormorant* in recent years. We hope to upgrade to a Class B transponder in the near future.

About the author: Harry Hungate and his wife Jane sailed their Corbin 39 cutter *Cormorant* from Sydney, Australia to Singapore in 2007, and are spending the 2008 cruising season in Malaysia and Thailand, using AIS to assist their safe passages.

Jan Mundy

PROP FIXES

Ignore your propeller at your own risk.

Story and photos by Bob Musselman (exceptions noted)

Out of sight and out of mind is where propellers reside. In a dark, wet place on boats that live in the water or beyond the stern of a boat on a trailer where only the guy behind you on the highway can see it.

With all due respect to the captain, the propeller drives the boat. Its condition determines how fast you go, how much fuel you burn, how long your engine will last, how smoothly your boat rides, how quickly you pull a wake boarder out of the water, perhaps even if you'll make it home at the end of the day.

Here's a quick primer on propeller repair: Very few marinas or boat dealers fix propellers themselves; it's simply too complicated. Your marina sends your prop to a prop shop or you can visit one yourself. Make sure that shop is reputable, preferably a member of the National Marine Propeller Association, the only organization in the world that provides training and certification for the propeller repair industry. Gone are the days when propellers could be repaired with an anvil, a welding machine and a coat of paint. Today's props require trained technicians to make them run right. While prop makers today deliver accurately sized props, there is still a lot that can be done to fine tune them for a particular application.

So, take a peek at your propeller. For many, the next stop should be a prop shop or marine dealer. Here are some things to look for.

Flat Tore Up

This is pretty easy to identify. Look for damaged and bent blades and chunks of metal missing. The design of most propellers these days is very sophisticated, so damage makes your boat slower and less fuel-efficient. Smooth operation is also compromised, which could transfer damage to expensive engine parts like seals, motor mounts, bearings and struts and drive shafts. If it looks damaged, it is and sensible damage control dictates it should be repaired or replaced immediately.

Looks Good, Works Bad

There are several versions of this. One is the "spray can recondition." You've probably seen this if you've been looking at used boats. All that shiny paint looks great, so the prop must have been just repaired or it might even be brand new.

Look more closely. You'll see edges where the old paint ends and the new paint begins. That's a sure sign that somebody's trying to hide something. You might see little bends or nicks in the blade tip edge or scratches in the surface. A good prop shop won't leave that behind. Plan on fixing or replacing that prop before you run the boat.

Look for repair numbers stamped on the prop. They are easily distinguishable from original part numbers. On aluminum props, you may see black "pot metal" filler or porosity from a welding repair, areas that are prone to failure. A repaired prop isn't a bad thing but it's something you should notice so you're not disillusioned when something that looks good goes bad.

Often, especially with inboards, it's difficult to see a big bend that starts at the root of the blade where it meets the hub.

Results of hitting a rock or a hard place.

What sins is this paint job covering?

Sand "blasted" blade edges.

Repaired leading areas are highly visible on this aluminum prop.

All blades look the same and there's no obvious damage but one or two may be completely out of "index," which is the spacing between blades, or "track," the relative height of each point. On a four-blade prop, for example, each point on each blade should be at a 90-degree angle and at the same relative height as the same point on a neighboring blade. It's hard to see that and it's a good reason to have your props checked every time

PROP TEST

A surveyor can develop a preliminary opinion on propeller problems by devising a simple "eyeball" test method. Here, a clamp attaches to a metal ruler (a section of bar stock or a length of metal rod works, too) to the leading edge of the rudder. The prop is rotated by hand and each blade tip is observed as it passes the straight edge. Blade anomalies are revealed by variations in blade tip clearance as the prop is turned. It's only a rough field test but, short of high tech prop evaluation, it sets a basic reference point for s-otting problems that suggest the prop be sent to a shop for analysis and correction. A super-simple test to detect obvious blade discrepancies consists of firmly and steadily holding a ruler or even a screw driver (tip down) vertically above the prop and against the hull bottom while turning the prop.

Pat Kearns

(top) Barely visible hairline crack. (bottom) If not fixed, a cracked blade will break off and the prop becomes scrap.

Examples of pitting from corrosion that have damaged these props beyond repair.

you haul your boat or when at your dealer for regular service. Most prop shops do inspections for little or no charge.

Little Crack? Big Bad is Next

Ignoring tiny nicks in the propeller edge is a big deal. Those nicks can create stress risers, areas that are more prone to crack as the propeller blade works through the water. You can smooth out those areas yourself with a file, but be careful you don't grind too much. You'll alter the blade geometry and kill efficiency. Best to let a professional handle that.

Many stainless-steel props are heat treated to improve strength, a process that can make them brittle and susceptible to cracks. Carefully inspect stainless props and look for hairline cracks, especially in the leading and trailing edges. Most props so afflicted can be repaired but, if you don't fix it, you'll end up losing the blade, damage that cannot be repaired. Prevention costs much less than the cure.

Worn Won't Work

All blades look the same, so what's the problem? Lots of times they're all worn evenly. Run a prop many hours through the sand and it's like using a grinder on it and, since the prop is spinning fast, the wear will typically be even.

Look for blades that aren't naturally rounded at the tip or are worn to a point. Feel the edges but be careful. That sandpaper effect makes them sharp and tiny nicks make for painful fingertips. On the other hand, the tips may be particularly blunt on the leading edge, where the prop makes first contact. Paint worn evenly is also a clue.

If you know the design diameter of your propeller, you can eyeball its actual dimension by measuring from the center of the hub to the tip of one blade (the radius) and multiply by two to get the approximate diameter.

Diameter and blade area are two of the most critical aspects of propeller design. Missing material causes higher rpm and diminished efficiency, potentially damaging the engine at worst, and slowing the boat and using more fuel at best. A propeller shop can build up diameter and blade area to original specs. If too much is gone, especially on aluminum props, it's often best to buy a new one.

Eaten Up

A metal propeller soaking in saltwater (or any other electrolyte) is subject to corrosion that is often erroneously labeled electrolysis. When metals, like props, shafts, struts, etc., are constantly immersed in an electrolyte, the metals can suffer a form of corrosion that appears to "eat" away the metal, leaving it pitted where some of the alloy has left the metal structure.

What is really happening is that a cathodic (more noble) metal is "absorbing" the less noble (anodic) metal. For example, a bronze alloy prop is an alloy that can contain copper, lead, tin, zinc and other elements. To see where bronze stands in the order of cathodic to anodic elements, you need to look at a chart of the galvanic series. This chart lists metals in order of their nobility with the least noble at one end and the most noble at the other, e.g., zinc versus platinum. In bronze, the less noble metal is being stolen (leached out) from the bronze alloy and taken to another metal. The vehicle for this transfer is the "electrolyte" and, in the case of a boat, that is water.

Another factor affecting this process is the bonding system of the boat or the anodic protection it uses. If this activity is not controlled by a bonding system and/or the use of sacrificial anodes, you'll see pitting all over the blades. Bronze propellers can develop a pink tint that is a symptom of the "theft" of

anodic metal in the bronze alloy and, when you rap a blade, instead of a resounding bell-like "ding," you'll hear a dull "thud." Unchecked, the process can leave prop blades of any metal alloy looking like Swiss cheese.

In that case, your propeller is dead. Especially on a bronze or aluminum propeller, where the missing material likely can't be adequately restored by welding, because the base metal is too corrupted. (Nibral and stainless-steel propellers may be salvageable.) Critical areas, now brittle and soft, eventually crack and fail. The only option is to replace the propeller. Carefully check other underwater gear like shafts, struts, rudders and sterndrives and get to the root of the problem. This is often a topic shrouded in smoke and mirrors and about which there are volumes written.

Tach Check

Every marine engine has a recommended operating rpm range and the correct propeller turns the engine within that range. A typical outboard, for example, might be rated at 5,000 to 6,000 rpm and the proper propeller turns within that range at wide open throttle (WOT). (Consult your owner's manual for the actual WOT rpm range for your specific engine.)

All of the visual symptoms identified thus far can cause the rpm to be too high or low. Worn blades, for example, cause high rpm and prop repair solves many rpm problems. But it's not uncommon for boats to have improperly sized props in good condition, especially as boats get heavier (more stuff added), motors get weaker over time and boat owners fiddle with diameter and pitch to resolve perceived or real performance problems.

In that case, the rule of thumb is that increasing pitch 2" (50mm) decreases rpm 400 to 500, while decreasing pitch 2" (50mm) has the opposite effect. That's pretty much true for all outboards. Inboard applications, with myriad gear reductions and engine rpm, are a little trickier to compute. In general, whatever percentage of rpm you want to increase or decrease, make the same corresponding percentage adjustment in the pitch up or down, depending on which way you want the rpm to go.

A good prop shop can adjust the pitch on most props up or down about 2" (50mm) depending on the material. More than that usually requires a new propeller.

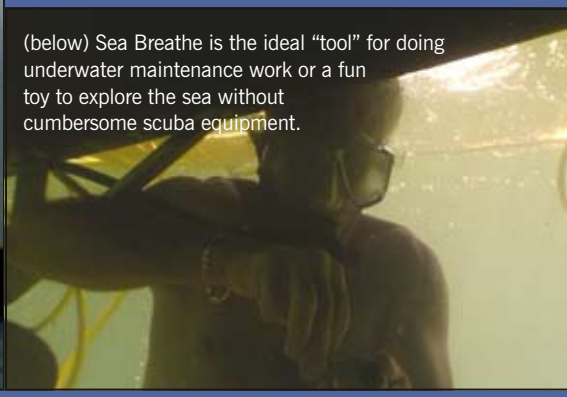
Diameter can also be adjusted to influence rpm, but outboard props are typically designed with specific diameters that work well with each pitch and maximized diameter is almost always critical. Best to work with pitch first and adjust diameter only as a last resort.

The good news is that most of these problems are visible to the naked eye. A simple inspection makes your drive train last longer and gives you one less thing to worry about as you enjoy the pleasures of boating.

About the author: Bob Musselman is the owner of Admiral/C&B Propeller (www.acbprop.com) in Tampa. He is a 20-year-veteran of the propeller industry and a board member of the

AIR SUPPLY

(left) Compact and portable, the deck unit hangs on the rail and feeds air to the air reserve chamber (floating yellow bag) to which attach the two air hoses.



(below) Sea Breathe is the ideal "tool" for doing underwater maintenance work or a fun toy to explore the sea without cumbersome scuba equipment.

Air supplied diving with the convenience of snorkeling gives you the freedom to get under your boat for routine cleaning or emergency repairs or just for fun.

Story and photos by Paul Shard

One of the biggest worries, for power and sailboaters alike, is what to do when a prop is fouled. Can you fix it and get underway again? This is just one reason to consider carrying a device like the Sea Breathe (www.seabreathe.com). It is basically a pump that feeds air to a diver through a long hose, tagged by its manufacturer as an "electric snorkel."

I had the opportunity to evaluate a test unit provided by Sea Breathe. I planned to hook the unit up and see how it worked for performing an underwater job like changing a zinc anode on the prop shaft. If that went well, I also wanted to check out the unit's recreational potential with a shallow dive around the boat in about 20' (6m) of water to explore the sea bottom.

The concept incorporates an electric pump that stays on the surface and a hose that feeds air to a diver who is unencumbered by a big scuba tank. Sea Breathe makes two models: the one we used is aimed at boaters who want to do underwater maintenance without the restrictions of scuba gear. This model (230-D, US$1,500) has a briefcase-sized pump that hangs on the boat's toerail and the supplied power cable has alligator clips for connecting to a boat battery. A larger, self-contained unit (model 2300-F, US$2,300), has a compressor that floats on the surface in a tube-type floating pack. The self-contained battery allows operation without connecting to the boat's battery. This unit is aimed at people wanting to explore the seabed. (The one diver deck unit, model 130-D, is available for US$1,195.)

For the self-sufficient boater who wants to effect underwater repairs, the Sea Breathe unit makes sense. You could carry a scuba tank but a job like cleaning the bottom would likely use more than one full tank. The Sea Breathe keeps operating as long as you have battery power to run it.

Set up

There seemed to be a daunting quantity of hoses, valves and other bits and pieces when I first opened the box but a few minutes spent studying the plans make it quite simple. There is a pump in a modified Pelican case, hoses to feed air to the diver and two regulators to feed air to two divers at a time. The most confusing piece for me was the large yellow bag that acts as an accumulator for the airflow. The electric air pump runs continuously, not just when the diver inhales. Between breaths, the bag inflates slightly and absorbs the pressure and then the diver breathes and air from the bag allows even a very big breath. Actually, the pump produces more air than anyone would normally need and unused air is just vented off.

Now for the fun part — getting it wet! We took the unit out on a 37' (11.2m) sailboat with the plan to use it to change the prop shaft zinc anode and then later anchor in deeper water and test it for a dive to the bottom.

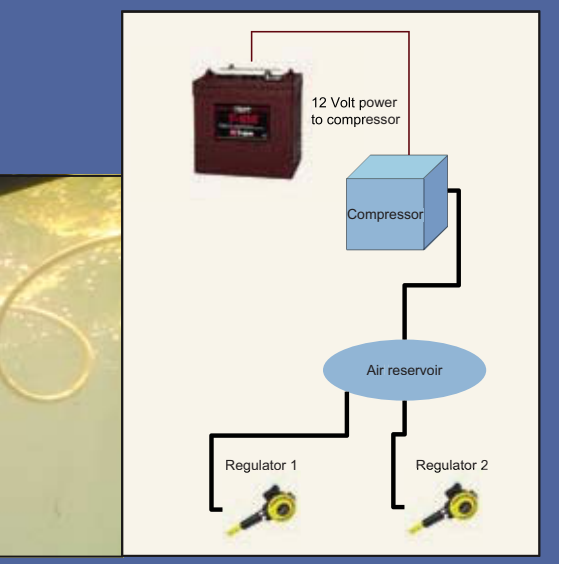
We attached the unit's power cable to the boat's main battery terminals using the alligator clips and hung the compressor unit on the boat's toerail using its adjustable hangars, which allowed us to position the unit in clean air. This intake is the source of your air supply so be careful to place the unit away from any engine or generator exhaust discharge. [Ed: Engine exhaust vapors contain carbon monoxide (CO). While diesel engines generally do not produce toxic levels of CO, the caution to keep the Sea Breathe unit's air supply intake away from all engine exhaust is prudent. A diver using the unit would not be aware of a compromise in air supply at the intake.]

We connected the yellow bag to the pump and connected the two regulators in the configuration so two divers can dive together. The regulators are standard scuba regulators; anyone familiar with scuba diving will be right at home. In fact, Sea Breathe recommends that you only use this unit if you are a qualified scuba diver. As the skipper and I are both certified scuba divers this wasn't a problem. If you aren't a scuba diver, I would agree that, before using it, you should take at least a basic dive course. As a precaution, always have a person onboard to monitor the unit when divers are in the water.

Dive 1: Zinc Replacement

Before climbing into the water we each donned the waistbands that hold the Sea Breathe regulator in the small of your back. This makes it just like a scuba system where the tank is on your back and the hose for the regulator wraps over your shoulder. With the Sea Breathe system, the idea is that the hose from the surface comes down to the diver and fastens on the back. The waistband aligns the hose to keep it out of the way and prevent it from tugging on your mouth. Without this, any kink in the hose or strain between you and the surface might pull the regulator from your mouth.

Without all the scuba diving gear, I found the same sense of freedom of just



Sea Breathe components.

swimming around but, with Sea Breathe, you can keep breathing underwater. And with two of us each planning two dives we didn't need to worry about refilling scuba tanks. First we swam around a bit to get the feel of the system. The hoses are about 25' (7.6m) long running from the floating bag, which connects to the pump by another 15' (4.5m) hose. It felt like we had a fair amount of freedom swimming about but we did have to be careful not to catch the hose around the boat's keel or rudder.

Replacing the zinc was a piece of cake. Plenty of time to clean off the shaft, position the new zinc and tighten it. Even climbing back onboard is easy with this unit since you don't have the extra 60lb (27kg) or more burden of scuba gear making the climb up the ladder so difficult. Verdict on the first dive: Sea Breathe does what it claims, "Diving can't get any easier than this."

Dive 2: Free Dive

We raised the anchor and headed offshore and anchored in around 25' (7.6m). This time we wanted to test the unit in its other configuration. Instead of two divers, I would use both hoses connected in series to extend the range for one diver from the unit to approximately 60' (18.2m). Sea Breathe claims the recommended maximum depth is 25' (7.6m) and we wanted to check this out. Since we were anchoring in deeper water, we were concerned about the boat swinging away from us while diving so we set the anchor with fairly short scope.

Getting into the water again, I swam down to the bottom right under the boat. I kept checking the hoses to see they were not snagged but had no difficulties. What a thrill to stay down on the bottom without the cumbersome scuba gear. When I came back up a few minutes later, the crew took a turn. He was down for almost 10 minutes and when he got back he was laughing. We couldn't get any sense out of him until he was back on board. "That was just terrific." "Fantastic." "Wonderful."

Certainly, as an insurance policy, to be able to do underwater work, the Sea Breathe is worth carrying onboard. Having the sense of freedom when sport diving without gear and, even though tethered to the boat, is great fun.

About the author: Paul and Sheryl Shard produce *Distant Shores*, a show based on their travels onboard a Southerly 42 that airs on WealthTV in the U.S.

EVERY LITTLE BIT HELPS

There's more than size and price to consider when selecting the proper drill bit for a given task.

Jan Mundy

By Doug Cohen

Perhaps the most abused and least understood or appreciated tool in any tool kit is the drill bit. With so many choices, styles, and materials, how do you know what bit to choose for which application?

Let's examine drill bits a bit more closely. Most metal working drill bits are of the twist drill style with a helical flute running the length of the drill body and a round shank for inserting into the drill chuck. The bit tip is designed to cut into the material being drilled, sending the chips or swarfs up the flutes and away from the hole. These flutes are normally right handed and have a raised edge.

The "standard" industrial twist drill bit is called a "jobber bit" and is what most stores sell. Jobber bits tend to flex quite a bit because of their overall length. Since most drilling operations require only 1/4" to 3/8" of actual cutting depth, mechanics' length bits were created. These offer greater relative strength, as they are approximately 20% to 30% shorter than a jobber bit. Mechanics' length drill bits are designed especially for hand-held drilling operations.

Some applications require much greater drilling depths, which are accommodated by aircraft bits, available in lengths from 6" to 24". Many machine shops also utilize stub length drill bits, which are approximately one-half the length of a jobber bit and are used in machine-based drilling operations, such as in a lathe or milling machine.

All drill bits are available in sizes ranging from 1/16" up to 1/2" in increments of 1/64". Jobber bits and stub length bits are also available in number drills, typically from #1 through #60, although some are available to #80 and in letter sizes from A through Z. Number and letter drill bits are utilized when drilling holes for accurate tapping of threads.

Drill bits over 1/2" diameter are known as Silver and Deming bits (S&D), normally available up to about 1-1/2" in diameter. S&D bits are usually 6" overall, with 3" of fluted length and a 1/2" diameter shank.

Shank Styles

Jobber, mechanics' and S&D bits are also available with a reduced diameter shank, usually 3/8", although some are also available with a 1/4" shank. These allow use in a drill motor with less than a 1/2" size chuck capacity.

The typical jobber bit has a standard round shank, which has a tendency to slip or spin in the drill chuck. This not only damages the bit but also the jaws in the chuck.

Mechanics' length and S&D bits are available with three flats machined on the shank, providing gripping surfaces for the chuck jaws. This prevents spinning and damage to the bit and chuck, especially in a keyless chuck, while protecting the size marking.

Bit Mechanics

Drill bits for metal working are made of high-speed steel (HSS), which is a heat-treated alloy steel. Better quality bits use M7 tool steel, as it contains molybdenum for strength and toughness, enabling the bit to stay sharper longer. M7 also is more ductile than HSS, meaning less chance of breakage when drilling.

Some people opt for cobalt drill bits, which are very hard, very heat resistant (up to 1,100F/593C) and designed for drilling in tough, abrasive, hard materials. Cobalt bits, however, are very brittle and often snap off in the hole, leaving an impossible to drill out stub. Cobalt bits are best used in machine drilling operations at slow speeds with cutting lubricants.

There are also several different surface treatments available on drill bits. Titanium nitride (TiN) imparts a gold color to the bit and increases the surface hardness of the drill bit, greatly extending its useful life. There's also gold oxide on the outside of the flutes and black nitride inside the flutes. The gold oxide increases surface hardness, improves lubricity, dissipates heat and resists rust. The black nitride increases lubricity, helping to rapidly eject the chips or swarfs, which cools the drill bit tip.

Grinding Affects

Tip angle is another factor that affects drill bit performance. Standard jobber bits are usually ground with a 118-degree included angle, requiring center punching to start a hole. A better choice

Here's the Drill

What if the drill bit isn't quite cutting the hole the way you expected? Here are some common problems and recommendations combined from several manufacturers.

Condition: Broken drill bit

- **Clogged flutes:** Withdraw the bit at regular intervals to clear clips. Use a drill bit with black nitride in the flutes or polished flutes use a bit with wider flutes or a faster helix angle.
- **Drill binding due to worn outer corners:** Repoint or replace drill. Check for excessive speed or feed or inadequate coolant.
- **Excessive feed:** Reduce feed rate or apply less pressure on drill bit.
- **Improper Point:** Check for correct sharpening angle and clearance.
- **Dull drill:** Replace or repoint (sharpen) before dulling occurs. Check speeds and feeds.

Condition: Chips not breaking up

- **Insufficient feed rate:** Increase feed rate.

Condition: Oversize hole

- **Drill point ground off center:** Repoint accurately or replace drill bit.
- **Drill machine spindle worn or not running true:** Repair or replace spindle. Utilize different drill machine.
- **Work piece loose or vibrating:** Tighten or hold work piece securely. Utilize drill press vise.

Condition: Drill bit tip blue or rounded off

- **Drill bit overheated:** Utilize adequate amounts of cutting tool lubricant.
- **Excessive speed and feed:** Reduce drill motor speed. Reduce feed rate.

is a bit with a 135-degree split point tip grind, which is self centering, requiring no center punch mark. This tip style won't "walk," even on a curved surface. Another advantage to the 135-degree split point tip is that it maintains, on average, its sharpness three to five times longer than a 118-degree angle and stays cooler during drilling.

Cool it

Drill bit life expectancy is greatly affected by heat. The cooler you keep a drill while in use, the longer it lasts. If a drill bit turns blue, it has reached 600F (315.5C) and has lost its heat treating. Whenever drilling into any metals, always utilize a good cutting oil. Cutting oils are formulated to provide extra lubrication and therefore assist in keeping the bit cool, increasing its performance and life expectancy. To solve the problem of cutting oil spraying all over, try the new wax-based cutting aids, such as Brute-Lube, which stays where you put it. They also provide exceptional improvement in cutting or drilling speed and bit life.

Speed and Feed

If the outside edges of a drill bit are rounded off, the bit has had too fast a rotational speed or too much feed pressure. One of the secrets to proper drill bit usage is to allow the drill bit to work at its own speed, not to attempt to force it into or through the material. If you see smoke coming out of the hole, back off! This means that you are providing too much speed or feed, creating too much heat and toasting your drill bit.

Many drill bit manufacturers actually have charts available showing speed and feed for various diameter drill bits, drilling numerous materials. I find some of the recommended speeds very interesting. A typical electric hand drill motor is rated at almost 2,800 rpm, while many drilling speed recommendations are in the 1,000 rpm range or less.

Drilling into hard or tough materials, such as stainless steel, often requires a starting (pilot) hole of a size significantly smaller than the finished hole. You then step up the drill size, effectively enlarging the hole in two or three additional steps. Use plenty of good cutting lubricant, let the drill do the work and be patient.

A major drill bit manufacturer offers the following guidelines. Drill stainless steel (work hardening grades) at between 15 and 50 surface feet per minute (SFM). This translates to: for a 1/8" drill bit, 20 SFM equals 610 rpm, 40 SFM or 1,220 rpm; and for a 1/4" drill bit, 20 SFM or 300 rpm, 40 SFM or 610 rpm. Additionally, the feed rate should be approximately 0.001" per revolution for every 1/16" of drill bit diameter.

Owning a good set of drill bits, while not cheap, pays big dividends every time you need them. A 29 piece, 1/16" through 1/2" index of quality drill bits averages $200. Drilling a clean hole with a bit that stays put in the chuck, without skidding across the work surface, is priceless.

About the author: Owner of an industrial supply company and marine surveyor, Doug Cohen and his wife, Fran, sail *DreamKetcher*, a 1973 Gulfstar 41' (12.4m) center-cockpit ketch on Lake Champlain in upstate New York.

How's Your Boat?

Regular visits to your boat to perform routine inspections this winter could save you a lot of headaches next spring.

The weight of snow on deck causes a boat to sit lower in the water and, if excessive, will submerge open scuppers and seacocks and possibly sink the boat. Priscilla Travis

Sunk ashore: This blocked scupper allowed rainwater to overflow the cockpit and enter the cabin. Water rose to the engine and caused several thousand dollar's worth of damage.

Turning on your bilge pump from the panel switch to test it is not enough. Instead, check the pump by actuating the float switch. If the switch is blocked by debris, your last line of defense is useless. This bilge pump didn't turn on when it was needed because a wiring conduit blocked the switch.

By Chuck Fort

Whether your boat is stowed ashore or afloat this winter, it doesn't take nasty weather to cause problems with an unattended boat. A slow leak or an errant fender can add up to damage that could be avoided with a routine inspection.

The best thing you can do for your boat in the off-season is to visit it periodically. If your boat's at a dock, try to visit it a couple of times a month. If that's not practical, you can make arrangements with other boat owners in the marina to check on each other's boats. If nothing else, call your marina and ask them to do a cursory check.

An inspection doesn't have to take all day. Anything from a quick check to a thorough inspection, if done regularly, can go a long way toward insuring a trouble-free season next year. A glance at your boat from across the parking lot won't do; go aboard and spend time poking around down below to make sure nothing is amiss.

Here are some things you can do to prevent a phone call that starts with, "Hi, this is your marina calling. There's a problem with your boat…."

Exterior

If your boat's in the water, begin by checking the waterline. Is there a change in the boat's floating position? Check docklines at the dock and boat for security and chafe. Adjust the chafe guards if necessary (all lines should have chafe guards). Be sure your fenders are placed properly and check for any hull marks that might signal a problem.

If your boat is stored ashore, check the cradle, jack stands or trailer to make sure the boat hasn't shifted. The boat should sit slightly inclined towards the cockpit scuppers so that water drains and doesn't cause stains or, worse, leaks down below. If a jack stand has shifted, don't try to adjust it yourself; contact marina personnel.

Check cockpit scuppers and drains for blockage. Boats are sunk each year because leaves or snow prevented water from draining. Even boats stored ashore can sink when pooled water finds its way below.

Examine your boat cover. Look for chafe, tears and loose fittings. Be sure that the cover isn't allowing water to accumulate or inadvertently funneling water where it shouldn't go.

If your sailboat has roller furling, removing the sail is the only sure way to prevent winter storm damage to the sail.

A plastic scupper fitting exposed to years of UV degradation in sunlight, became brittle and broke during a hard freeze, which allowed water on deck that would normally flow overboard to drain down below. During winter layup, the boat gradually filled with water.

Jan Mundy

Twelve hours of storm activity caused the chafing on the dock that sliced through the outer jacket of this shorepower cord.

Jan Mundy

During a storm the stern line chafed through causing the bow of this powerboat to grind against the dock.

If you have a sailboat with roller furling, be sure that the sail is wrapped securely and can't unfurl in a blow. Better yet, remove the sail and stow it at home.

With a sterndrive engine, examine the bellows (flexible rubber connection that seals the sterndrive and rigging cables at the transom assembly). Make sure your wheel or tiller is secured to prevent rudder damage from boat movement.

Inspect shorepower cords, beginning at the dock pedestal, and follow to the boat's inlet. Corrosion on the plug's blades or inlet can cause an overheating condition and lead to a fire. Ensure the cord can't get into the water or get crushed against the dock.

Check doors, companionways and hatches. Make sure that no person or animal can easily get into your boat.

Cabin Below

The first thing to do when you get inside your boat is sniff. Does the boat smell moldy? There could be a leak. The aroma of localized high heat might indicate that a circuit could be overloaded or shorted. Find the source. Any other smells like gasoline, propane or chemicals need investigation right away. Check for vermin and/or insect droppings and deal with them immediately. Terminate suspected infestation with traps or appropriate toxic bait.

Check portlights and hatches for leaks and look for water stains. Better to take care of the problem now than have to delay your boating season with repairs next spring.

Inspect your bilge. Any standing water means a leak and even a small leak can eventually sink a boat. Check the operation of the bilge pump and float switch. If you're not sure that your bilge pump is coming on while you're away, consider installing a bilge pump cycle counter.

If afloat, insure that all thru-hulls are closed, except cockpit drains. Cracked or slipped hoses can sink a boat. Open all thru-hulls, including the drain plug, on dry stored boats.

While you're checking, it's good practice to open and close each seacock a couple of times to keep them from seizing. If the boat is stored ashore, now is a good time to take sticky seacocks apart for servicing.

Engine Compartment

Inspect your batteries for terminal corrosion and top off with distilled water if the

Jan Mundy

Due to slack in the docklines and "parking" too close to the dock, this swim platform was caught under the dock during a storm and sheared off, leaving just the hardware, and the sterndrives are also damaged.

Patricia Kerns

Browning in the AC socket is evidence of an overheat.

battery cells are the type with removable caps. Check the state of charge using a multimeter: 12.6 volts is typically fully charged but the readout can be as high as 13.8 volts if the battery is connected to a charger. A bilge pump needs a fully charged battery to work properly but dead batteries don't sink boats. A constantly cycling pump can flatten the batteries as it tries to keep up with a leak. A dead battery is just a symptom of a larger problem.

Check hoses, clamps and wires. Sometimes a gentle tug can uncover a problem and prevent a disaster. If your boat has a generator, be sure to open the sound cover or box to check all its connections and fittings. Look for any rust that could be due to cooling and exhaust water leaks, fuel or oil leaks, loose wires, cracked hose casings, etc.

If your boat is stored afloat, pay special attention to its stuffing box. Leaking stuffing boxes sink boats every year. A stuffing box should not drip at all when the shaft is not turning. Use a mirror to look at the underside of the stuffing box hose. It's a notorious place for hose failure.

Winter usually means that boats don't get visited as much because they're used less or not at all but they still need you. You can prevent mishaps and insurance claims if you visit your boat occasionally and perform a routine inspection.

About the author: Chuck Fort is the associate editor of *Seaworthy*, the quarterly loss-prevention news journal of the BoatU.S. Marine Insurance program. Those not insured with BoatU.S. can subscribe to *Seaworthy* for $10 per year by calling 703-823-9550, ext. 3276 or at BoatUS.com/Seaworthy.

TIE-UP HELPS

Experienced cruisers share their line on slipping a boat into its berth with stress-free grace, almost every time.

Run a line the full length of the slip to help guide the boat in on days when wind and current do not allow a smooth entry.

Story and photos by David and Zora Aiken

Docking a boat isn't as easy as parking a car, something new boat owners learn very quickly. The helmsperson can't simply steer to a stopping point and hit the brake. Traction is not a factor and there are outside influences the car driver never needs to consider, such as how the wind or current (or both) will alter speed or the intended direction of steering and what can be done to counteract those possibly contrary actions. Even constant repetition is no guarantee of success, as conditions are as varied as the weather.

While there is no substitute for good boat-handling techniques, there are ways to give the captain a sometimes needed assist. The boat owner who rents marina space on an annual basis can make use of several medium- and low-tech ideas that offer some distinct home port advantages, making it easier and safer to leave and return to the slip and taking some of the worry out of leaving the boat to fend for itself when it's unattended.

Most permanent marina tenants are assigned a slip and, except vacation times, docklines are left in place to drop and pick up during exits and entrances. Some slips have a full-length dock (catwalk) along one side or both, perpendicular to the main dock. Floating piers almost always are configured to provide finger piers. These are the easiest slips to enter, leaving the fewest opportunities for mishaps. More common where pilings and docks are fixed is the slip with only a short, narrow, sometimes shaped like a piece of pie, finger pier leading from the main dock on one side.

Another slip may have no finger pier at all. Boarding must then be done directly at the bow or stern so there is almost no chance for crew to jump off in time for a tie-up assist. Guiding a boat into a slip requires some expertise and the procedure differs depending on whether the captain chooses to dock the boat with bow or stern to the main dock. Once positioned in the slip, lines must be tied in such a way that the boat is convenient to the dock for boarding at the usual location but not so close that it bumps the fixed structure of the dock.

When leaving the boat unattended, most boat owners adjust all dock lines for the purpose of keeping the boat as close to mid-slip as possible through all the tide and wind changes that take place when the boat is at rest. Here are some tips for less stressful close quarters maneuvers.

Boundary Lines

Run a line the length of your slip on each side, from the outermost piling to the dock piling or cleat, to visually define the full width of the slip and to give you a clear picture that separates your slip from your neighbor's. On days when wind and current don't cooperate to allow a smooth glide into your slip or backing in straight, the crew can grab these lines and encourage the boat into its proper place. The lines also help to keep the boat from getting pushed at an angle that might result in contact with the boat in the next slip. Polypropylene line is a good choice for this purpose as it floats and it's cheap so you won't mind replacing every few seasons when it degrades from UV.

Line snubbers absorb the shock of a quick stop as the boat shifts with wind or current.

If the slip has pilings forward and aft, the slip width is easy to define and mark. If the bow lines are ordinarily secured to cleats on the dock rather than to pilings, it may be necessary to tie the line around one of the deck planks or place an additional cleat on the dock, if the marina approves that option.

Line Snubbers

When the boat is tied in a slip, it moves around with every wind shift and wake roll and an abrupt jerk is not an uncommon occurrence when the boat reaches the end of a line.

To minimize the jerking as well as the accompanying wear on lines and cleats, attach a line snubber to each dockline. Snubbers are made of a material that is capable of stretching enough to absorb the shock of a quick stop. With the familiar black rubber ones, the dockline feeds through an eye on one end of the snubber and then wraps around the snubber a few times before leading through the eye at the other end.

Tide Aids

TideMinders and TideSlides are fairly recent additions to dockline assists, definitely a "wish I'd thought of that" idea that allows docklines to move up or down on the pilings as the boat moves with the tide. With either system, there's no need to guess how much slack to leave in a line to accommodate tidal range and the boat can be tied closer to the dock without fear of it drifting into the dock.

TideMinders employs nine virtually indestructible balls that are threaded onto the line and secured with two figure-eight knots. As the tide changes, the balls roll up and down on the piling, eliminating the need to adjust lines and offering constant tension with built-in shock absorption. Requiring no tools, TideMinders is simple to install. Available in black, blue and safety orange they fit any size piling and protect lines up to 1" (25mm) for mooring larger boats.

As the boat rises or falls with the tides, TideSlides move correspondingly on the pilings.

During storms, tidal changes or heavy boat traffic, TideMinders protect lines from fouling and chafing.

To use a TideSlide, a stainless-steel shaft attaches to a dock piling. A specially molded polymer block or cleat attaches to the stainless shaft. The dock line is tied between the TideSlide block and the appropriate cleat on the boat. As the boat floats up and down with the tidal changes, the slides (with lines attached) also move up and down the shaft, holding the same tension on the lines no matter what the state of the tide. One slider accommodates a bow or stern line and also a spring line.

(top and bottom) A bracket hanging from the roof of a covered boathouse makes it easy to drop or pick up bow lines.

Line Holders

Those who keep their boats in covered slips have created novel ways to leave bow lines when exiting the slip in order to keep them handy.

The boathouse roof allows for suspending a bracket over the slip, ready for a boathook grab when the boat returns to the slip after a day on the water. In the photo below, one creative captain hung up a cutout of a traditional anchor shape.

Boats kept in a typical uncovered slip often leave bow lines on a hook or bracket attached to the dock at the front of the slip, not quite as convenient as an overhead hanging bracket but still ready for a boathook grab. Placing lines this way not only keeps them reachable, it also keeps

Sturdy hooks attach to any piling to keep lines dry and accessible.

Midship cleats allow a better lead for spring lines. Note the twin cleats for bow lines.

them away from clumsy feet that might trip over them or kick them into the water, ready for an unwary prop to grab them and foul the running gear.

The same type of hook that holds bow lines on the dock is useful for all docking lines. Attach a hook fairly high on each dock piling, so all lines are kept high and dry and within boathook grabbing range. Buy no-maintenance hooks made of PVC or make them out of wood or StarBoard.

Midship Cleats

If the boat does not have midship cleats, it would be smart to add them. They simplify the tie-up procedure, whether the boat is at homeport or away. Midship cleats allow a much better lead for spring lines. They also allow the use of a shorter line, for more control, less wandering of the boat and less risk of crew tripping over an unnecessarily long line.

On the subject of cleats, some boats have only a single cleat forward for securing bow lines; if that's the case on your boat, make the necessary changes so each bow line has its own cleat. The double cleat arrangement also proves practical for those times when you want to use two anchors.

About the authors: David and Zora Aiken have been liveaboards for more than 20 years and are authors of *Good Boatkeeping* and *Cruising: The Basics*.

Boat-size Recycle Bin

5

Boats generally don't have space for separated groups of recyclables but most have space for a "blue box."

David and Zora Aiken

Recycle bin shown against bulkhead hangs on lashing hooks and rests on shelf/bracket.

Figure 1

Figure 2

(top) When installing the shelf that provides access to the bin, notch the shelf's support piece so the lashing hooks are placed at a practical height. (bottom) On the underside of the shelf attach small wood strips around the access opening as supports for the lid.

Luckily, in this age of renewed green thinking, most marinas collect the aluminum cans that are a good portion of a weekend's trash and can be easily stashed by most owners on board.The head seems like a logical place for a "blue box" but often the available floor area is not level.

A few measurements revealed room for a small wastebasket to stand against the bulkhead next to the sink. On our boat a shelf extending from the sink to the opposite side of the room serves more uses than the bin top. A grocery-sized plastic bag fits the wastebasket, replacing the same-size bag, which formerly held crushed cans, hanging from a hook in plain, messy view.

Start this project by first purchasing a plastic wastebasket that fits the allotted space. The top should have a rolled rim, so the wastebasket can hang over lashing hooks that hold it in place against the bulkhead. The space can't be a tight fit in height, because in order to empty the wastebasket, it's necessary to lift it off the hooks (**Figure 1**).

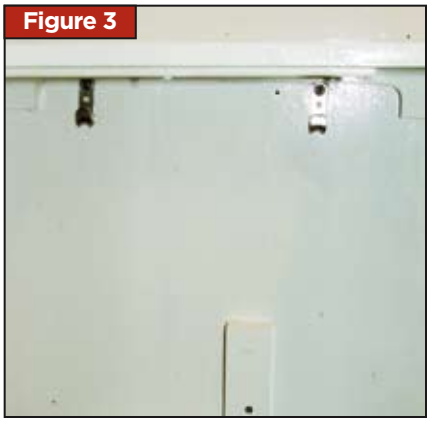
Now, establish the location for the bin. Measuring from the side bulkhead, mark the center point of the wastebasket on the bulkhead. All other measurements are taken from that central mark.

To install a shelf at top-of-bin level first, screw a section of 1" by 2" (25mm by 50mm) to the bulkhead as a shelf support. It may be desirable to notch this support piece so the lashing hooks are placed at the most convenient height.

Cut the shelf of 1/2" or 5/8" (12mm or 15mm) plywood, then screw the shelf onto the support piece. Pencil an outline for the bin's top opening, making it at least a 1/2" (12mm) smaller all around than the top of the wastebasket. Cut the hole and keep the cutout to use for making a pattern for the finished access lid. On the underside of the shelf, attach thin wood strips around the access hole so that half their width extends into the cutout area to act as supports for the new lid (**Figure 2**).

BLISTER FACTOR
INDICATES THE DEGREE OF DIFFICULTY WITH 10 BEING THE HARDEST AND 1 BEING THE EASIEST.

Figure 3



Install a small shelf/bracket under the recycle bin.

Sand, prime and paint the shelf. The shelf could be temporarily placed initially to facilitate attachment of the lashing hooks and a bottom shelf bracket but it's possible to finish the job with the shelf in place from the start. Similarly, you might choose to paint before installation and then touchup afterward as necessary.

Attach the two lashing hooks to the bulkhead so the wastebasket hangs in place. Position them to allow lifting the bin up and off the hooks when it's time to empty it. Hang the wastebasket and then mark a line on the bulkhead at the bottom of the basket. Make and attach a narrow bracket and shelf as added support for the bottom of the wastebasket (**Figure 3**).

Cut a new lid to cover the recycle bin. Use the rough-cut hole shape to start the pattern and sand or plane the lid edge as necessary to achieve a loose, easy fit. Cut a finger hole into the lid or add a recessed pull. Paint the lid to match or contrast with the shelf.

To use, line the wastebasket with a plastic bag. Turn the top of the bag over the edge of the basket to keep it from falling into the bin. Put the wastebasket in place, with the rim resting over the hooks and the bottom sitting on the lower shelf.

This bin holds a surprising number of cans, particularly if they're crushed. If the bag is not stuffed full, you can pull it out through the top access. Otherwise, lift the wastebasket off the hooks to remove the bag of cans.

About the authors: Frequent contributors to DIY, David and Zora Aiken continue to renovate *Atelier*, their floating home.

Replacing the Main Hatch

When you can't replace a worn-out hatch with an exact model, a close-fitting replacement and a couple days' work produces a fine improvement.

Story and photos by Graham Collins

The main hatch on our 1980 Aloha 8.2 *Tardis* had always leaked a bit and was showing its age. The "plastic" was completely crazed, the support bracket no longer worked smoothly and previous owners had attempted various repairs that did not endure, including covering screw heads with sealant.

So, it had to go. The choices were: find a matching new model hatch by the original manufacturer; find a hatch with the same dimensions by another manufacturer; have a hatch custom made.

Purchasing an identical hatch was obviously the first choice but not a viable option for an older boat made by a defunct builder and a custom hatch is more expensive. We were lucky to find and buy a replacement hatch by another manufacturer and there was only an 1/8" difference in overall dimensions. We placed the order for a new stainless steel hatch with Mariner's Hardware.

Hatch Removal

The first critical element of this job was a weather window; two days of clear sky were essential as the hatch would be off overnight. With the tools assembled, namely epoxy, drill, screwdrivers, sealant, masking tape, X-Acto knife and various scraping and prying implements, I was ready to remove the old hatch.

All screws were removed and the old frame pried off. Knowing I was not going to reuse the hatch, the lid was used as a pry bar by sticking a wooden shim between the open hatch lid and the deck. I leaned on the top of the hatch lid and one edge

(above) Before: Badly crazed original hatch. (across) After: New, stainless-steel replacement hatch.

Hatch removal involved some ingenuity and forceful persuasion.

"I was very eager to check the fit just to make sure. The hatch fit perfectly."

New mounting holes drilled using a tape "stop" on the drill bit.

popped up. The rest of the removal did not go as smoothly and required the usual assortment of wood blocks, putty knives and other sharp objects. Eventually the hatch broke free.

The next task was to remove the old sealant. This step probably took the most time. My preferred technique was to shave the old sealant off with a very sharp chisel but I don't recommend this for everyone, as it demands extreme care to avoid gouging the gelcoat. Acetone proved effective for final cleanup.

Surface Prep

Time to mark the location of the new fasteners, which proved not so easy with a slippery deck and a slippery hatch. An assistant would be helpful here. Obviously,

(top) Before applying the sealant, all surfaces are generously taped to minimize cleanup later (bottom).

this task would have been easier if I had removed the frame from the new hatch and simply installed the frame but, when I tried to remove the hinge pins, one pin wouldn't dislodge. This didn't pose a serious problem so I decided to continue with the installation and not bother to get the hatch manufacturer involved.

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Filling the old screw holes followed next. I drilled out the old holes slightly larger to remove any remaining sealant. A drill stop ensured that I didn't exceed the original hole depth. The deck is a solid fiberglass laminate and not cored so it was not necessary to "pot" the new fastener holes. [Ed: Potting involves drilling an oversize hole, removing the wood core, filling with epoxy and then redrilling for the fastener and, when properly performed, potting prevents water from migrating into the core.] All holes were filled with a mixture of epoxy and cabo-

DIY BILL OF MATERIALS

Stainless-steel hatch, 12" by 17.5" (304mm by 444mm) $570
1 cartridge 3M 5200 sealant $8
Stainless-steel screws $5

Labor: 6 hours spread over two days

sil and I departed for home, letting it cure overnight. On day two, I drilled the new mounting screw holes.

Assembly

Masking tape was applied on the deck inside and outside of the frame contact area and trimmed carefully to avoid a lot of cleanup later. Hatch frame sides were also masked. A generous bead of 3M 5200 adhesive polyurethane sealant was applied on the deck. This is a case were more is best. The hatch was then placed on top, the screws inserted and, once all were in place, beginning with the corners, I tightened each screw in a systematic pattern to apply consistent pressure all around.

Sealant squeezes out the edges and screw heads as fasteners are tightened.

After cleaning up the excess sealant and removing the masking tape, it was time to step back and admire the end result. We now have a smooth working and water-tight hatch.

About the author: Graham Collins sails *Tardis* on the waters around Halifax, Nova Scotia with 2-1/2 year old son "captain" Sam and wife Jill.

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Spares Aboard

Jan Mundy

Equipped to repair anything at sea, Hal Roth, a two-time competitor in the around-the-world single-handed race, circumnavigator with his wife Margaret and author of numerous sailing adventure books, carried a multitude of neatly arranged spares and tools, including 41 screwdrivers, onboard *Whisper*.

Prioritize what spare parts are essential onboard and what can be safely left at home and brought aboard when needed.

By Roger Marshall

Do you have the skills to change the head gasket on your engine while at sea? If not, why keep a spare head gasket onboard? Of course, if you are going to sail to Bermuda and have a qualified person onboard who can make engine repairs (and who doesn't get seasick when lying upside down in the confines of the engine room), then certainly carry spare parts with you.

But if you are not a long-distance sailor bound for Bermuda or other far-off destinations, what exactly should you carry in the way of spare parts? The list varies depending on how close to land you typically cruise. For sheltered bay sailing, you might decide that the most important thing to carry is a roll of duct tape. I also like to carry a roll of Dynaglide Teflon tape, rolls of electrical tape in different colors and a roll of Teflon pipe tape from Campbell Hausfeld.

In the spray can department, I carry both McLube and Corrosion Block. I also like 3-in-1 oil for lubing winch gears. (I prefer not to grease winches simply because the grease can bind with exposure to saltwater and eventually clog the pawls and moving parts.) Similarly, after removing stainless-steel screws from an aluminum mast, spray them with Corrosion Block (or Tef-gel) before reinserting to ensure that they don't seize. Spray everything else with McLube to ensure free movement. The only grease I carry onboard is lanolin. I learned from designer Rod Stephens many years ago that it is handy for a multitude of jobs on a boat.

For my Clamptite tool (www.clamptitetools.com), I carry an extra roll of wire. This tool is very useful if a hose clamp breaks and you don't have a spare.

In the electrical department, carry an assortment of terminal ends and heat-shrink tubing in various sizes. This tubing helps to protect terminals and electrical wiring joints. It can be shrunk with a match if you have no other way of doing the job. You can buy a small 100-piece terminal kit for use onboard or a larger 600-piece kit to keep onshore (www.marinco.com/productline/kits).

Be sure to always carry with you a supply of spare batteries for every flashlight, portable GPS and VHF radio onboard. Remember to also keep chargers onboard for GPS and radios that have rechargeable batteries. You should have at least two sets of spare batteries for your emergency navigation lights. I like to keep a battery tester in the same drawer as my spare batteries. Also be sure to carry spare bulbs for all navigation and cabin lights.

Assorted lengths of line are handy to keep onboard. You'll be surprised how often a short length of line can solve a problem. Having several types and diameters onboard makes it easy to pick just the right piece when needed. Keep them all together in a Ziploc bag so that they don't end up scattered all over the boat.

Brushes, polishes and other cleaning supplies are not needed onboard when you are on short cruises. These can live in the trunk of your car or the dock box during the boating season and carried aboard when needed. The only cleaning-related item I keep onboard is a Swobbit (now Shurhold) brush handle that converts to a boat hook by changing the end fitting.

You don't have to carry a mountain of spare gear on your boat. Just consider, by not carrying all that extra equipment on your boat, you have more storage for all the great food and drinks that you really do need to enjoy your time on the water.

About the author: Roger Marshall is the author of 12 books and is currently completing his latest book, *Fiberglass Repair Illustrated*.

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