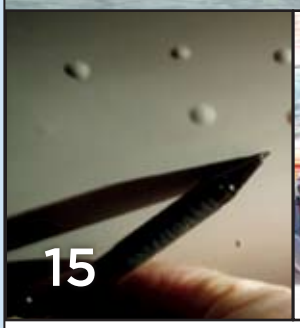
#3 2007

DIY BOAT OWNER

THE MARINE MAINTENANCE MAGAZINE



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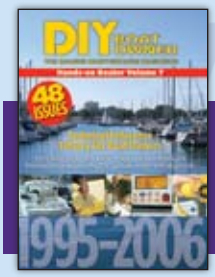

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Edited by Jan Mundy

What's Peel Ply

In DIY 2006-#4 issue, the caption under the photo on page 46 mentions a product called peel ply. Could you please explain what peel ply is and what it does?
Pete Butorac, Peterborough, Ontario

Nick Bailey replies: Peel ply (also sold as release fabric) is a chemically clean, light woven fabric, usually polyester, that covers and seals the surface of a glass and resin wet lay-up (or bonding fillet). It's an absolute necessity with vacuum-bagged laminates to prevent the bag and breather materials from being permanently bonded into the laminate. The layer of peel ply up against the wet lay-up allows easy removal (peeling) of the bag kit after the resin cures. It also acts as an air seal to prevent amine blush when using epoxy resin. Among the other useful features of peel ply is that its weave leaves behind a surface with a micro-texture, which is just rough enough to allow the next layer to bond well without prep sanding, but smooth enough to serve as a finished surface on structural work.

Boat Show Savvy

Boat shows present an interesting dilemma for me, since I have no burning desire to buy a new boat. I like classic ones that I can work on myself without worrying too much about my mistakes.

So, why should a DIY kind of guy go to a boat show with its emphasis on selling new boats? The short answer is to learn what's new in boating that I can apply to my boat. Plus if you attend the big shows, like the U.S. Sailboat or Powerboat shows in

Certified Engine Testing

The Scuttlebutt column titled "Certified Fit," in DIY 2007-#1 issue, suggests that during a marine engine survey the engine exhaust should be monitored during cold start. What am I looking to see here?
Stuart Henderson, Toronto, Ontario

Randy Renn, an accredited marine engine surveyor (SAMS) and DIY contributor, replies: Watching engine exhaust at start up in cold mode is as vague as "what a lovely shade of gray." An engine surveyor has thousands of start up situations, some in freezing conditions, some in tropical latitudes. Depending on the engines the concerns that follow are in a reasonable order.

1. Speed of start up/crank time: The surveyor should have a crank speed indicator and or voltage drop meter/recorder on the engine when cranking. Modern equipment can precisely detect rotational speeds and variances in engine compression by the rise and fall of crank speed. I use a program and a laptop for this activity but there are many versions of special equipment in the field.

2. Smoke (exhaust) at start up: This may be blue, gray or black soot. These conditions tell the technician, depending on engine type, about worn piston rings, valve guides, carburetor issues and injector condition. The technician brings the mirrors and the engines make the smoke in this magic trick and it's as much about experience and exposure to products and component sets as it is about science.

3. Coolant flow or steam: Watching for coolant flow helps the technician know or better understand another part of the system. A meter can detect coolant water pressure and back pressure in the exhaust. Heavy steam may be normal in a Wisconsin winter but a sign of cylinder head issues in Georgia in the spring.

4. Time to warm up: Warm up time varies wildly but generally marine surveyors don't want to do anything too drastic until the engine gets lube oil warmed and the stable water temperature is close to an operating temperature of at least 140F (60C) and higher. The tech also checks oil pressure at start up as part of the procedure and should watch or monitor thermostat function, particularly in raw-water cooled engines.

5. Idle speed and gauges: Idle speed is checked with one or more types of electric, strobe, flux gauge or reflective tachometer. Dash tachometers and other gauges are never trusted.

Your interests are best served to have your engine surveyor have no flag in this battle. Choose an engine surveyor without any repair agenda associated with the product or boat and/or its owner/seller. Also, many sellers warm up the engines before the inspector arrives. This only makes the surveyor wary. There are engine inspectors that are also hull surveyors and vice versa. You will be paying your engine inspector an easily measurable fee, perhaps as much or more than the hull inspector for a complete job. Seek out teams that can perform their inspections in a complementary way at the same time and location. Both experts will want all engine systems to be off and cold to best serve your purpose. Always have oil samples taken. Modern analysis is so refined that minute quantities of contaminates can be detected.

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Annapolis, Maryland in October, or the Miami International Boat Show in February, most everyone in the business has a presence at these shows and not just the retailer who may have only sales knowledge of his product.

Product knowledge has its own food chain with the manufacturers at the top and the retail sales staff near the bottom. Many levels of selling are going on at the show: the parts' manufacturers come as much to sell to the builders as to answer questions the public might ask about their products; the boat builders sell to the public; the discount retailers run boat show specials for all comers.

For those uninitiated to the large boat shows, a specific game plan may help you get the best experience possible. I try to see as much of the show as possible on the first day, before sensory overload leaves me numb. I collect literature and make notes of things I want to look at more closely. The second day I return on a mission to explore targeted products in more detail. If I have another day or two, I will go back to "grazing" on the prowl for more interesting boat bits.

Bill Kenner, Nashville, Tennessee

Launch Ramp Locator

Now, planning a trip to a new lake, river, or bay can easily be done from the comfort of your computer. If you have a trailerable boat and want to explore new waterways log onto boatus.com/trailerclub/locator.asp for a free boat launch ramp locator. Here you'll find 25,000-plus locations to launch a boat including municipal or state boat ramps, marinas, boat clubs, private sites and other locations that offer trailer boat access.

Detailed launch site descriptions also include parking information, hours of operation, boat size or motor restrictions, water depths, docking facilities, camping information, local services available, contact information and fishing tips.

Weighing In

I started this project while preparing "Two-Step," our home at sea for 18 years, for the new owners. Considering all the new gear we were proposing to stow onboard our new boat, a Southerly 42, I was concerned how the extra weight might impact the new boat's waterline and trim. Although I'm keen on many of the new gadgets and comforts available to sailors, I do believe there is a limit to how much equipment you can safely add before the boat's handling is impaired.

Meanwhile, I realized that the accumulation of stuff we were planning to move to the new boat would weigh sub-

stantially more than all the toys that were worrying me. I systematically weighed and itemized the contents of every locker and put the data in a spreadsheet. Rather than list each item, I sometimes grouped a few and listed the bunch and where it was located, such as "Port Bookshelf: cookbooks, 10lb (4.5kg)." At this point, the list has almost 300 entries, total weight is 1,258lb (571kg) and I'm only two-thirds finished.

The fun part of putting this data on the computer is that I can find such interesting trivia such as: all gear stored in the forward sleeping cabin weighs 279lb (135kg) and in the salon (not including galley and quarterberth) weighs 469lb (213kg); all together, the three cockpit lockers contain 441lb (200kg) of gear; clothing totals 152lb (69kg); books weigh a startling 152lb (69kg) and that doesn't include the paperbacks stored in the quarterberth. The category of "food" has a number of entries totaling 130lb (59kg) and we are quite low on provisions at the moment. Wine alone weighs 46lb (21kg) and we usually have at least two to three times as much. (Hey, we're cruising in the Med where wine is cheap.) All the lines stored in lockers total 62lb (28kg) and that doesn't include any running rigging; mainly, dock lines and a spare 196' (60m) anchor rode weighing 22lb (10kg).

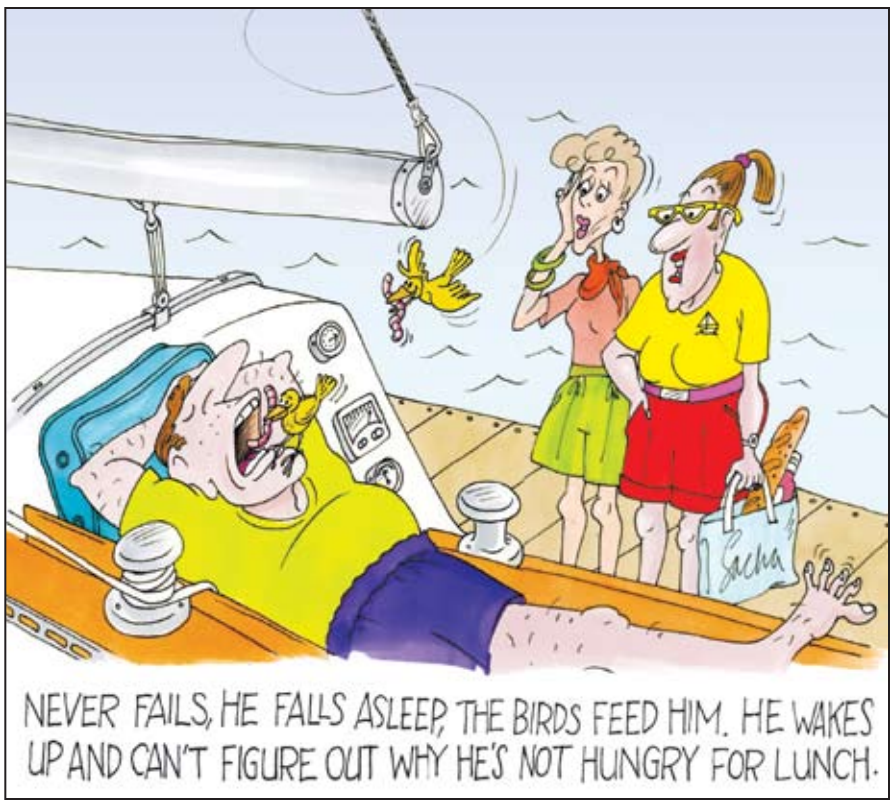
I have everything in separate categories, such as food, electronics, books, clothes, and NGATI (Never Got Around To It) items I bought but haven't installed. This is actually at it's lowest in years but we still carry 11lb (5kg) of NGATI.

I guess the key here is that our boat is just 37' (11.2m) long and we do try to keep an eye on total weight onboard but we'll still likely have more than 1,763lb (800kg), which is heavier than a Mercedes-Benz Smart Car.

So, the next time you are thinking of stocking up on cheap beer just to save a few dollars, consider that four cases of 24 cans would add almost 88lb (40kg). Forget taking up rock collecting.

I'm also working on a weight distribution plan for the new boat. Over the years, we have raised and repainted the waterline on "Two-Step" to cover her weight gains. I'm hoping the new boat will not suffer the same fate.

Paul and Sheryl Shard, international sailors, authors and award-winning documentary filmmakers (searoom.com/shard)



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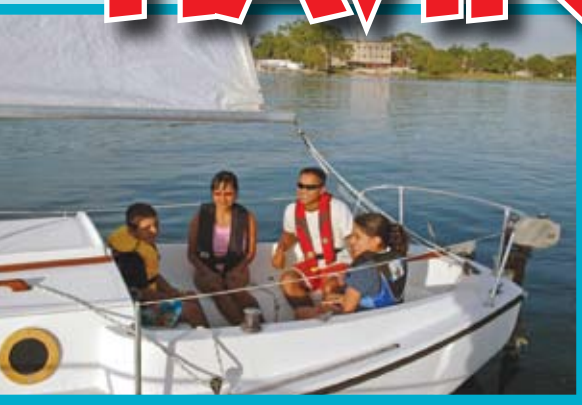
HAVING A BLAST



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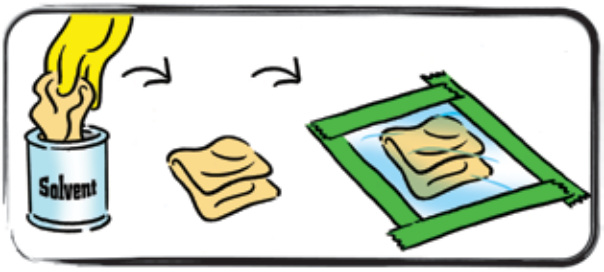
Paint Compatibility Test



Sacha

Use the solvent soaked rag method to test for paint compatibility.

Q: Several paints say that they may be applied over one-part paints. How do I determine if the existing coating is a one- or two-part paint?
Thomas Eason, Lawrenceville, Georgia

A: To check if paint is compatible over an unknown coating, Jim Seidel of Interlux suggests that you soak a rag in the solvent recommended for the new paint you've selected. Lay the rag on the surface, cover with plastic and tape the edges so the solvent doesn't evaporate. Remove the rag after a couple of hours and check the surface. If the solvent hasn't softened the paint or caused any defects then consider the paint compatible. If it has caused a problem then switch to a different paint or completely remove the existing coating by sanding or stripping.
— Jan Mundy

Parquet Refinishing

Q: I need to refinish the water damaged parquet floor on my 1984 Island Gypsy trawler. I tried sanding but this barely scratched the extremely hard finish. Any recommendations?
David Hart, Pulaski, New York


Jan Mundy

Parquet sole is tough stuff and refinishing demands an aggressive approach.

A: As you've discovered the finish of your parquet floor is extremely tough. According to Duarte Picanco of Noah's Marine Supply (noahsmarine.com) the only way to remove the existing coating is with a chemical stripper. Purchase the harshest, nastiest, most toxic stuff you can find. Apparently, the enviro-friendly strippers won't touch the finish. Mask any surfaces you don't want the stripper to touch and then brush it on liberally. Let it "cure" and scrape off the loosened finish (see DIY 2006-#4 issue for tips on scraping). Clean up with TSP and water to remove the residue. If the area is large, rent a floor sander from Home Depot (or other rental firm). The machine you need to rent is called a square buffer or orbital sander. It's essentially a giant palm sander with a handle on it and wheels to help move it around. Sand with 220 to 240 grit paper. If the floor is now looking pretty, apply an epoxy sealer to waterproof the wood. If you plan to stain the wood prior to epoxying, you need to select a chemical stain, e.g., Mohawk. Apply three coats of sealer. Follow with multiple coats of the varnish of your choice. Single-part coatings are easiest to work with but not as durable as two part. A matte or satin finish shows fewer imperfections and scratches. During the whole process, you need to keep your own safety in mind. Most of the chemicals you're using (stripper, epoxy and varnish) emit volatile organic compound (VOC) fumes that are possibly toxic (and explosive). To avoid being overcome by toxic fumes, be sure to ventilate the cabin by opening some ports and setting up fans to ensure a constant supply of fresh air. Wear a respirator with a charcoal cartridge, protective clothing and goggles.
— Jan Mundy

Cool Running

Q: Last year my boat's Volvo Penta 4.3L V-6 engine ran fine, registering 140F (60C) on the temperature gauge, but last fall, after grounding on a sand bar and then winterizing, the engine now runs cool. My mechanic has replaced the thermostat twice and verified the gauge and wiring. When tested with a laser pyrometer the engine records 115F to 120F (46C to 49C).
Reg Rand, Lodi, Wisconsin

A: The normal operating temperature range for your engine's 140F (60C) thermostat is 125F to 155F (51C to 68C), depending on water temperature. Engine temperature should always be checked after a 5 to 10 minute run at three-quarter throttle. To do this, point the laser pyrometer (a.k.a. infrared thermometer) at the cylinder head. Cooler water temperatures in the spring don't allow engines to reach normal operating temperature. Normal engine operating temps return once the water temperature rises to 70F (21C). A marine engine running at 120F (48C) will be less fuel-efficient but should not incur any harm if regular oil changes take place.
— Steve Auger

Checking Tank Grounds

Q: I know that every metal part in a fuel tank fill system (including a metal tank) needs to be grounded. Because of the cockpit configuration on my sailboat, I had to include two 90° elbows in the line between the deck fill and the tank. I grounded the elbows without a problem but I'm less sure about the actual hose sections. I stripped about 1-1/2" (38mm) off a 14 AWG wire and inserted the exposed copper strands between the fill hose and the bronze elbow (barbed portion), then double clamped the hose to ensure that the wire is making good contact with the bronze hose barb. I then connected the wire to the engine block (negative). Is this the right approach?
Bob Griffiths, Parry Sound, Ontario

A: In order to verify that you have a complete grounding circuit you'll need a multimeter that reads ohms. With the meter set at Rx1, touch the two meter leads together and note the reading (should be 0 ohms). Working from inside the boat place one lead on the deck fill ground wire and the other lead on the tank ground terminal. The reading should be the same as when you touched the leads together (0 ohms). If not, you still have an open circuit in the ground system that needs correcting.
— Steve Auger

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Filter Monitor

Q: Is there a benefit to putting a vacuum gauge in line with the Racor filter in order to determine when the filter needs changing? If yes, how specifically should this gauge be installed?
Michael Dunn, Annapolis, Maryland

Jan Mundy

An inline vacuum gauge is a good tool for monitoring a fuel filter.

A: A compound pressure vacuum gauge, 2-1/2" (63mm) liquid damped, provides indication of filter element condition. It normally indicates a slight vacuum. When the vacuum at the filter outlets starts to increase, change the elements. Racor makes adapters for some of their filter housings. They allow you to mount the gauge into the top of or adjacent to a Racor filter. The gauges are durable and read in numerals as well as colors, indicating the level of any vacuum the system is building. You may install a gauge inline after the filter, or on the filter or in/near a fuel selector switch. Care must be taken when you tee into a fuel delivery line that, by virtue of your good intentions, you do not create a restriction that reduces the size of the line interior dimension. Also, the connection of the gauge must be absolutely air tight to avoid drawing air into the fuel system (bad news). To monitor the gauge while underway, wire an electric sending unit to a gauge, light or alarm on the bridge.
— Randy Renn

Hum Cure

Q: I just completed the install of a Cobra VHF radio, following the manufacturer's instructions for the installation of the Shakespeare antenna. The radio is wired to an accessory battery charged by the outboard. The outboard runs off a dedicated starter battery. There is a hum in my radio when the Evinrude engine is not running and the hum becomes louder when the engine runs. What is the most direct way to wire my radio so that I can eliminate the hum and begin my troubleshooting regime?
Jerry Perry, Ahousat, British Columbia

A: Your engine is not the cause of the radio frequency interference (RFI) when not running, although it appears to add to the noise levels when operating. RFI comes from two main sources. One is from noisy electrical equipment that includes pumps, etc., and the noise is impressed on the power supply lines to the radio. The second source occurs when noise is radiated into the radio aerial lines from larger current carrying power cables. In this case, the first step is to progressively switch off all equipment until the noise stops. The battery has nothing to do with RFI and does not contribute to radio noise but charging sources such as a shore charger or outboard engine alternator do. If the outboard is off, at least one accessory or equipment item is causing the problem and this is often a water or bilge pump or a fluorescent light. Do a troubleshooting exercise and systematically isolate the offending equipment. There are two ways to reduce noise. Buy off-the-shelf inline power filters to suppress the radio or route all radio aerial and power cables well clear of all other electrical cables.
— John Payne

Securing Cooler Lines

Q: I need to replace the transmission oil cooler in my 220 Crusader V-drive. What, if anything, should I put on the threads as a sealant for the oil lines coming from the transmission to the OSCO 6" (152mm) cooler?
Bruce Bittenbender, Malvern, Pennsylvania

A: Most transmission oil coolers use flared fittings on the cooler and lines as the pressure is around 300 psi or more. These fittings do not require the use of sealant, which could seep into the oil flow and damage the transmission. When torquing the lines onto the cooler, be sure to hold the fitting in the cooler with a wrench to avoid damaging the cooler. Do not over torque the lines onto the cooler or the fittings may crack.
— Steve Auger

Recycling Dinghy Pads

Q: I'm replacing our dinghy and need to remove the Weaver davit pads from the old inflatable to reuse on the new dinghy. What is the best way of removing these pads?
Jim Bouty, Escanaba, Michigan

Garrett Lambert

It may be cheaper in the long run to purchase new Weaver davit pads for your inflatable rather than attempt to remove the old ones and reuse.

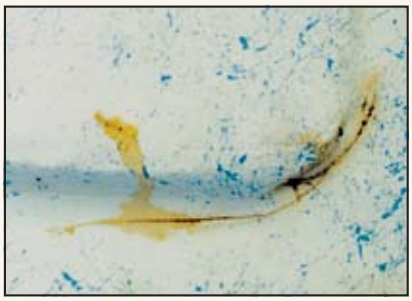
A: Below are the steps provided by Weaver Industries to remove pads from your inflatable. It's a tedious job and, as the price for a new pair is just US$122, new ones might be the better option. If you have any difficulties, contact Weaver's helpline at 800/367-4062.

1. Using a heat gun or hair dryer, warm the edges of the pad.
2. Use a dull plastic putty knife to slowly work the pad away from the tube. Protect hands with gloves as the rubber is very warm to touch.
3. Continue repeating Step 1 and 2 until the entire pad is removed. This process takes a lot of patience. If the dinghy is made of PVC material, removing the pads may damage the tube. Hypalon tubes are much more forgiving.
4. After the pads are completely removed and before being applied to the new tubes, sand the underside to remove any old glue. Wipe the pad with Toluene or pure acetone and then follow the instructions for reapplying the pads on your new inflatable available on Weaver's website at http://store.weaverindustries.com/merchant.cfm?step=4&pid=30.

Sourcing the Dreaded Brown Ooze

Q: Water is leaking from a foredeck hatch and entering the fiberglass core around the hatch. I rebed the hatch and all nearby deck fittings to no avail. For some time, I have been trying to locate the source of this leak by covering one suspected source with plastic sheeting, waiting for rain, then checking for brown water in a bucket under the leak and, as it still leaks, I try another suspect. Several of the boat maintenance shops in town advised me to tap the deck lightly with a small hammer and listen for a change in sound, which tells me where there is water. In doing that I have found an area about 12" by 18" (30cm by 45cm) that sounds like a drum. The deck is not mushy but my hearing is not acute enough nor am I experienced enough to detect a change in sound near a fitting. I have read your article regarding moisture meters (DIY 2002-#2) and am seriously considering purchasing one. Will such a meter show me where the leak is originating? I'm getting somewhat panicky.

Bill Majors, Columbia, South Carolina



(left) Warning sign: A moisture meter can help confirm that the brown ooze seeping from a fiberglass laminate (right) indicates a wet, rotten core.

A: For identifying the source of water leaking into a deck, nothing beats a moisture meter. The hammer technique (percussion sounding) is useful for identifying delaminated core but it can't tell you the condition of the core. A deck with wet core that is still intact will sound normal, indistinguishable from dry core areas. Unfortunately, judging from the dreaded brown ooze coming through your deck, the core (presumed to be balsa) is likely rotten in some areas. I would guess the area that sounds hollow, i.e. "like a drum," has badly deteriorated core. The fact that it does not feel spongy underfoot probably indicates your boat is built with a thick outer skin. Stopping the leaks is always a good thing but I think the boat may also need some core replacement surgery. I recommend the J.R Overseas GRP 33 meter (jroverseas.com), which is calibrated for use on fiberglass. Use the meter to delineate the areas of high relative moisture. Don't worry about absolute readings. It's the relativity of the readings that provides the clues. Usually the leaking fitting is in the middle of the area of maximum moisture but, almost as often, the leak is originating far from the wet area, which is simply where the water is stopped and has concentrated. Using a GRP 33 meter, the usual reading for soaked balsa core is 30+ (often the needle pegs at full scale deflection). If the balsa has been wet long enough to rot away and collapse within the core, the meter may paradoxically read less moisture in the hollowed out area because it's reading air. The core may be, for practical purposes, gone. This is a possibility in that "sounds like a drum" region. Wet core is never good news.

— Nick Bailey

Solving the 45-Minute Run

Q: I have a 1985 Formula 28 PC cruiser with twin 260 hp Mercruisers. When running at about 3,000 rpm for 45 minutes the port engine starts to die. I cleaned the fuel tanks, replaced fuel lines, checked the fuel pick ups and changed fuel filters. When it stalls, I drain about 1 ounce (28 grams) from the valve on the bottom of the Racor fuel filter and the engine starts up and runs again for another 45 minutes. What's wrong?

Mike Healy, "Skyydriver 2," Bridgewater, New Jersey

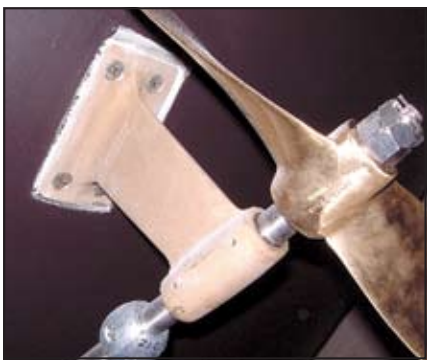
A: The symptoms you've identified relate to a fuel system problem. Check the affected tank for a plugged tank vent on the outside of the hull. Hull wax or spider webs clog the fuel tank vent causing an engine to stall. The maximum amount of vacuum allowed on a fuel delivery line is 2.0" Hg. A well-tuned system usually shows around 0.5" to 1.0" Hg of vacuum. You'll need a digital vacuum gauge for this test. Next, change the fuel supply to the port engine from the usual tank to the fuel tank that supplies the starboard engine and vice versa and run a sea trial. If the starboard engine stalls, it's the fuel delivery system. If the port engine continues to die the check valves in the fuel pump likely have dispersants from old fuel causing them to leak. If all else fails, hook up a 5-gallon (19L) portable fuel tank (outboard engine tank but with no inline primer bulb) directly to the engine fuel pump as your test fuel tank. If the engine doesn't stall after 45 minutes, the problem is with the port tank and or supply hose or filters.

— Steve Auger

Bent propeller shaft strut

Q: I bent the strut on my Beneteau First 345 last summer. The shaft is now removed and will be checked for straightness. How do I straighten the strut without taking it off the boat? No stress cracks appear on the hull or strut and the strut is very solid. The material appears to be some kind of bronze alloy. I have an idea to make a fixture and use a bit of judicious heat with an ice sink to protect the fiberglass. The fixture would not put any strain on the strut bolts. Do you have other ideas for straightening this strut?

Bob Miller, Collingwood, Ontario



Most struts have a thru-bolted mounting flange and are best removed for service to avoid hull damage.

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A: I don't recommend trying to find an easier way to deal with the bent strut, a tack that often results in a more expensive repair. Remove the strut and then heat and straighten it in a press. If that fails, and there is a strong possibility a cast bronze strut will crack, replace it. Don't risk damaging the hull. I assume the strut has a mounting flange with thru-bolts covered by some fairing putty. That isn't difficult to remove but you may need to move a fuel tank out of the way to get access to the mounting bolts. Beneteau USA parts department (beneteauusa.com) is a possible resource for a replacement strut. It's people are very helpful. (I have successfully acquired parts for other '80s vintage First models, though it takes a while to get them imported from France). Failing that, try any dealer for Marine Hardware (marinehardware.com) who makes a variety of stock struts.
— Nick Bailey

Wet Wood Repairs

Q: We experienced water intrusion in our boat's side deck, which for the most part is in perfect condition. Rather than remove the outer laminate, I drilled holes in the underside (after removing the liner) and pulled out about 8 sq. ft (.7 sq. m) of very rotted, wet 1/4" (6mm) thick plywood. I'm running an air conditioner and dehumidifier inside the cabin in hopes of drying the laminate (assessed via a moisture meter). When as dry as possible, I plan to inject material to replace the rotted wood and hopefully re-adhere the deck to the inner laminate using sandbags and spreader boards. We'll tip the boat to promote distribution of material to the proper location (assuming that it's fluid) and remove several stanchions and "top off" from at least two locations. Is there any adhesive material that will tolerate limited wetness and still provide fill and adhesion?
Tom Freeland, Punta Gorda, Florida

A: The fact that you are dealing with a limited area of plywood core, especially one that is only 1/4" (6mm) thick, gives hope that an epoxy saturation technique will work. The key element has traditionally been getting the plywood core dry enough to epoxy. All epoxies I have worked with have a low tolerance for a soaking wet environment. Wet Wood Epoxy from Boatlife (boatlife.com) claims to work in a wet environment but I have not used it yet. Assuming the wood is reasonably dry, use a penetrating epoxy resin (e.g., CPES, Git-Rot, S1) first to saturate any rotten areas you can't reach and to fill any voids. Use it unthickened but, if you want to simply trowel it in to fill any gaps, thicken the resin with colloidal silica or, if nothing else is handy, fine sawdust will do. Gravity helps move the thin resin out into the core but a vacuum works even better to pull the epoxy resin through.
— Nick Bailey

Stalling Diesels

Q: My '85 Bayliner 3270 is equipped with twin Hino W40D diesels, a 100 gallon (378L) fuel tank with fuel in good condition, primary and secondary fuel filters, Algae-X fuel conditioners and the previous owner installed electric primer pumps. Whether cold or at operating temperature, the engines stall after running for 30 seconds and won't restart. After manually priming for 25 strokes, the engines start and run all day. If engines are shutdown and then restarted using the electric priming pumps only, they again stall after 30 seconds. I must always manually prime the system before starting to avoid stalling. My mechanic has replaced a leaking banjo fitting, removed and blown out tank vent lines

and replaced filters but all has made no difference. Any ideas?
Bob Crouthamel, Gettysburg, Pennsylvania

A: The first thing to check are the aluminum O-rings in the fuel return system. When the engine is not running, microscopic leaks may result in a siphoning of air into the injection pump via the top fitting of the fuel filter/fuel pump fitting or return. Electric pumps may actually make the problem worse by creating more vacuum in the system than the diaphragm pump. It doesn't take much air to cause a stall and the fact that both engines have the same problem may be the key insight. If the flexible fuel lines and O-rings are original, especially to the electric pumps, the lines and fittings are overdue for upgrade. O-rings are soft copper or aluminum and seal by being crushed and should never be reused or over tightened. If there is a bypass system in place, be sure the crossover valves are well sealed. Next, be very sure the fuel lines are kept away from the dry sections of the exhaust system to avoid fuel percolating during shut down. O-ring kits are inexpensive and a good starting point in this troubleshooting process.
— Randy Renn

Hurth Alert

Q: My Catalina 380 (2000 model) has a Westerbeke 42B engine and a Hurth HWB 150A transmission with a dipstick bolt that was apparently over torqued. When I attempt to loosen it, the bolt turns in the sleeve but does not back out. Consequently, I cannot check or add transmission fluid. Is there a tool or method that I can use to remove and replace the bolt?
Siamak Masoudi, Manchester, Connecticut

A: This is one of those unfortunate times when I do not have a fix for your predicament. I contacted a number of Westerbeke dealers and a Hurth repair station and they have indicated that the stripped dipstick threads on this model transmission are a common failure. Unfortunately, the cost of repairing the stripped threads involves replacing the transmission case as there is not enough metal to support the installation of a Heli-coil or Keensert. The price structuring for Hurth 150 transmission replacement parts is quite expensive. A good used transmission is likely the least expensive way to resolve the problem. eBay may be a good place to start.
— Steve Auger

Shaft Changeout

Q: I recently read that the material of choice for a propeller shaft is Aquamet rather than 316 stainless steel. I have a Camper Nicholson 31 with a 1" (25mm) bronze shaft that, after some 30 years of use, is showing some signs of age. The boat is presently on the hard in Ecuador and, while the shaft will last until the next time I have to replace the cutlass bearing, it seems a good idea to replace it now while the boat is on the hard. The shaft is approximately 31" (78cm) long. Should I purchase

the readily available 316 stainless steel or opt for the more expensive Aquamet? I can get a propeller shaft manufactured in Guayaquil, Ecuador, for about US$150 but I'm not entirely sure what material they would use.
Bruce Richardson, Ottawa, Ontario

A: There may be more to your upgrade than meets the eye. Certainly there is a difference in the price of shaft material by the inch but is it worth it? The major consideration in your decision should be based on corrosion resistance. Specified shafting will have a greater resistance to pitting, cell creation (pockets of corrosion) and general degradation. This is due to the care taken in material formulation/compound additives. We see shaft failures from many angles but least of all from a strength issue. Most failures are related to some form of pitting so get the best material and take the step to avoiding the potential corrosion failure headache. Contact the Aquamet, Aqualoy, etc. manufacturer for help with resistance characteristics per your underwater equipment/keel/bonding situation. Be very careful when ordering the shaft as diameter may appear to be 1" but may be 25mm (Nicholsons are built in the UK). While you are changing the shaft, remove the shaft log or stern tube and inspect the hull for decay and depletion. The tube should be resealed, stuffing box hose replaced, clamps renewed and all exposed surfaces coated. Consider installing a dripless type shaft seal while you're at it. When installing the shaft, the shaft and the transmission coupling must be taken to a machine shop and put together to be certain the shaft centerline and coupling face are at exactly 90° apart. If the coupling falls onto the shaft you have a problem. The machine shop may mill the coupling to ensure the correct angle. As long as you've come this far, consider changing the motor mounts as part of this effort. After all is returned to normal, two activities are now mandatory. First, align the engine to shaft coupling, initially, on land for a rough measurement and then after launch and the rig is tuned and the boat has been in the water for a day or so. Next, check the boat's voltage potential as you have changed things just a bit with regards to dissimilar metals below the waterline. Most boat yards will have a silver chloride reference anode needed to make the test and it will indicate if you should add or reduce zinc protection [Ed: For details on how to do this refer to DIY 2003-#2 issue.]
— Randy Renn

That Sinking Feeling

There are many ways that a boat that is not afloat can sink while stored ashore on blocks and stands, sometimes in cradles or on trailers and even in dry stack storage.

Story and photos by Pat Kearns

Here's a boating riddle. What kind of sinking poses no chance of loss of life? The answer: the kind that happens when the boat is tucked away in dry storage ashore.

Of all the sinking claims one major marine insurance underwriter handles, the water that sank the boat in 32% of those incidents came from the sky in the form of rain or snow. Of those that "sank" on land, the "sky was ...", indeed, "...falling" and that water accounted for 100% of the damage done to boats blocked for storage, resting on trailers and in outdoor racks.

This kind of sinking doesn't include any kind of encounter with King Neptune. No one was aboard, no call for help went out and no rescue or salvage was necessary. It's even more tragic because it could have been prevented.

It's especially disheartening if you don't notice the flooding until you're ready for the rites of spring. The guilty water has had time to get into every nook and cranny and, in winter, to freeze and thaw. The result is irreparable damage to interior wood, corrosion on any metals in contact with the water and rusting from just being in the damp environment. Depending on the location of the boat's machinery, engines can drown and, left in that state for the long winter's nap, the result can be fatal to the engine's future life.

Count the Ways

While I'm sure there are other documented ways to sink a boat on land, there are a few primary causes for "going down when it's up." Drain plugs keep water out but they can keep it in, too. A boat on a trailer or lift can flood with rainwater, stormwater or snowmelt that fills a non-self-bailing cockpit on a boat not fitted with a cover if the drain plug has been left in place. The same can occur to a boat with a self-bailing cockpit if the boat's attitude in its cradle, trailer, lift or rack is only a few degrees down from level. That position keeps water from flowing out the aft freeing ports or cockpit drains and it will pile up and enter the boat through any of the paths of least resistance, usually a cockpit hatch flange or a low companionway sill.

What about the bilge pump(s)? Pumps are very reliable performers but they need to be constantly fed by electricity. I know of one such bilge pump that was so reliable that it kept running even when its discharge hose had fallen away while securely attached to a poor quality plastic thru-hull fitting that parted at its external, above-the-waterline flange. The flange of the fitting looked fine but the pipe nipple had cracked from UV exposure and had fallen into the bilge where the pump doggedly kept pumping the bilge water from the bilge back into the bilge.

Deck drain piping that fails on a sailboat will fill the bilge as the fitting does its job of scuppering the water from the deck. Nobody notices unless the owner checks the boat routinely. In the depths of a cold winter, boaters are reluctant to trudge to the yard to climb a ladder, shovel snow or chip ice from the deck and fiddle with a frozen cabin lock to look below. If the boat is upright on the stands or cradle, things must be okay.

If you think this phenomena is unique to boats in northern climes, consider this. I recently was charged with solving the mystery of persistent water intrusion into the cuddy cabin of a well-regarded, high-performance, 32' (9.7m) offshore fishing boat that spent most of its life on a lift in a back bay in southwest Florida. The bilges were dry. The pumps all worked fine in both manual and automatic modes. Somehow water had found its way into the cabin and mold had formed all over the teak veneered bulkheads and cushions. The owner was stumped, as were the yard techs who were

Cockpit drain plugged with debris caused water to flow over the hatch flange and flood the engine compartment. The condition went unnoticed for six months of dry storage.

Hatch has shallow flanges in the cockpit sole molding and no drain. The boat was stored on a lift, slightly bow down so that rainwater flowed over the flanges and into the bilge. During a continuous rain, the water ingress overtook the bilge pump's ability to pump it out and everything became saturated, rusting and corroding the transmission, coupling, engine mounts, etc.

A mis-aligned bi-fold door leading into the cuddy cabin of an offshore fishing boat was the entry point of a persistent leak.

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regularly called to find the leak.

I checked the trim and list with a level while the boat was afloat and again when it was put up on the lift and there was nothing awry there. While the boat was still afloat, a sudden squall formed and I took cover in the little cabin, closing the bi-fold type door against the rain and wind. I sat on the vee-berth, facing aft. The hatch was translucent so I had plenty of light. What I saw was the bi-fold door, when closed, did not properly align with its framing around the companionway. The starboard vertical edge allowed daylight to peek through for half of its height and there was no weather seal. It wasn't long before more than daylight was coming through that slim passage. This was not something easily seen when looking at the door from the outside but there it was. I'd found the leak but felt a little funny that I did not have to resort to any rocket wizardry or marine surveyor smoke and mirrors to do the job. Nevertheless, I was the accidental hero of the moment.

If your boat takes its winter holiday in an area of well forested land, airborne leaves and other debris winds up on deck and, with the flushing action of rainwater, this flora collects in cockpit drains. Eventually, this prevents the flow of water out of the cockpit and instead, turns it into a tub of standing water. When that water level rises to flow over the companionway sill or, as in sailboats with cockpit lockers, flows over hatch sills, there is nowhere to go but through the narrow passages between deck moldings and their hatch sills into cockpit lockers and other interior spaces, soaking or drowning everything inside. The engine likely gets submerged, too.

Deck hatch flanges without their own drains are also among the accused in sinking boats. A high-end cruiser, always stored on a lift, was scheduled for an insurance survey and, when the surveyor arrived to do the job, she was greeted with a bilge full of water. This one was a no-brainer. Two large cockpit sole hatches rested on shallow flanges but these flange moldings had no drains. The attitude of the boat, high in the lift was only a few degrees down at the bow and that prevented the large drains just aft of the hatches from doing their job. Water pooled in the cockpit, flowing forward and over the companionway door's sill, which was flush with the cockpit deck sole. The highly varnished interior woods were ruined.

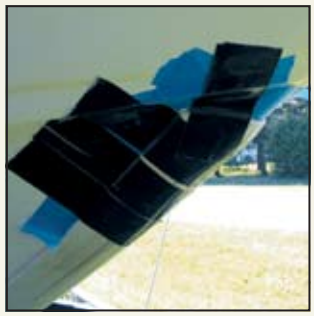
Preventative Measures

Investing in a well-fitting cover yields a good return in a clean and dry boat. Just as in rain gear, cost is a factor in both function and fit. A poorly fit cover that collapses under the weight of rainwater and snowmelt will dump its contents into the boat.

Good attitude can get your boat through lots of stormy weather. Make sure that your boat's dry stored attitude allows for complete drainage through the intended thru-hulls, scuppers and freeing ports. Test for drainage by flooding the cockpit and deck with water from a hose before tucking the boat in for its layup period or leaving it on its lift. Mark the lift cables so that, when raising the boat to its high and dry position on the lift, it is "floating" in the air in the same attitude as it would afloat in the water. Check your boat often during a storage period, inside and out.

A proactive monitoring program will save you buckets of grief over a preventable sinking on land, in the rack or on the lift or trailer.

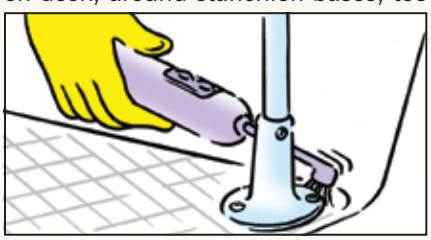
About the author: Pat Kearns is a NAMS certified marine surveyor and as DIY's technical editor she is the undisputed Standards keeper.



Jan Mundy

Quick All-Bond: Plexus pre-mixed, two-part methacrylate adhesive (MA 300) is ideal for rebonding small areas of delaminated plastics, metals and composite materials. A structural adhesive, it works like epoxy but much faster. Working time is a short (4 minutes) and it cures in 15 minutes or less. DIY used this adhesive to rebond a small section of Keelguard installed in 2000 (discussed in DIY 2000-#1 issue), where it had separated from the gelcoat. To use, push piston ends to meter out equal parts of adhesive, mix for 1 minute, apply and then clamp in place using minimal pressure. No surface preparation is required. Replace the cap to store for future bonding needs.

Brush Power: Cleaning tight spaces on deck, around stanchion bases, toe



Sacha

rails and similar places is no longer a chore when done with an inexpensive electric tooth brush dipped in a marine boat soap and it doesn't harm gelcoat surfaces.

Warren Milberg, "CrewZen," Annandale, Virginia

Hole in One: When you need to replace a thru-hull fitting, rather than prying it out, replace it with a larger one and simply drill it out in one step. Fit your hole cutter with the large diameter saw needed as well as a saw that matches the inside diameter of the existing fitting, which acts as a guide bushing when drilling.

Docking with Confidence: When docking, first drop the amidships breast line over a cleat, which stops the forward motion of the boat, then secure the stern line. With the boat sitting stationary in the slip, the stress is gone and you can tie the bow and spring lines at a less stressful pace. Once all lines are secure and adjusted release the breast line.

George Hirsch, "Selah," Port Dover, Ontario

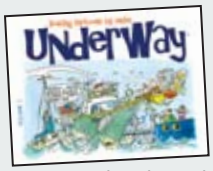
Out of Sight, Out of Service:

Jan Mundy

Often it's the most important equipment onboard that gets buried in a locker and forgotten until needed. Schedule the inspection of fire extinguishers and other safety equipment in your maintenance log and you won't be without should the need arise.

Old but Shiny: Remove any slightly rusted fittings and place them in a bench grinder equipped with a 5" (127mm) or larger cotton fabric buffing wheel. Lightly press some jewelers rouge (or red rouge) compound onto the wheel and instantly buff the hardware to a bright luster and mirror-like finish that lasts for years.

TECH TIPS WANTED



Get your copy of "Underway" Volume 1, a humorous compilation from DIY's cartoonist Sacha Warunkiw. ($14.95 value.) From live-aboard to cruising underway, you'll laugh and relate to the folly boaters encounter.

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:

DIY TECH TIPS
P.O. Box 22473, Alexandria, VA 22304
or E-mail to: tech@diy-boat.com.

To polish non-removable gear, such as stanchions, use a mini grinder and soft wheel with lots of rouge.

Finn Nielsen, "Haro Strait," Toronto, Ontario

Mooring Rule of Thumb: To help you judge the wind effect of being near a shore when approaching an anchorage,

Sacha

hold up your hand at arms length with your thumb up and sight the coastline. If the height of your thumbnail appears to be taller than the height of the coastline then you are likely out of any large shore-based wind effect. If the coastline is taller than your thumbnail than you are in the wind shadow and you'll likely notice some effect from shore winds, possibly gusty or in a different direction than the prevailing wind and, depending on local effects, you could get almost any winds here.

Paul and Sheryl Shard, "Southerly Explorer," currently cruising England enroute to the Caribbean

See Clearly Now: Cleaning glass windshields and windows is another use for the Absorber PVA cloth recently discovered by DIY's test team. Just wet the cloth and wipe the glass for a streak-free, sparkling-clear window. No glass cleaner needed.

Blister Morphology

A typical fiberglass osmosis blister about 1/4" (6mm) in diameter involving the gelcoat layer only.

Boats of all kinds can and do suffer from many different types of blisters. The causes, prevention and repair of blisters are in the details of their structure.

Story and photos by Nick Bailey (exceptions noted)

In the world of boats, "blister" is a nasty word that leads to other utterances of expletives. Like rumors of a lethal pox in ancient times, mention it to a boat owner and they will blanch and brace themselves to hear the rest of the bad news.

A blister forms when fluid or gas collects behind an impermeable layer in a composite laminate or a coating system. Through pressure exerted by either osmotic action or internal pressure expansion in the laminate, the outer layer is separated from those below and is pushed outward to form a bump. Whether gas or moisture fills the blister usually depends on whether or not it's located below the waterline. Although exceptions exist, the mechanisms behind wet and dry blisters are distinctly different, providing us with the two primary categories in the classification of blisters. Let's first discuss wet blisters.

Wet Laminates and Osmosis

Fluid filled blisters usually, but not always, form below the waterline. Blister formation is triggered by a water-soluble chemical contaminant. The resulting blisters can form between the hull and bottom coatings, between layers of bottom coatings themselves or, in the most serious case of the classic blister, between layers in a composite (fiberglass) hull laminate. The soluble contaminant binds water molecules to it to form a liquid that initially condenses in a microscopic void or air space between coating layers or in the laminate. The solid materials around this seed solution are permeable to the water outside but not to the solution inside. Water migrates into the tiny droplet of solution one molecule at a time and becomes trapped there.

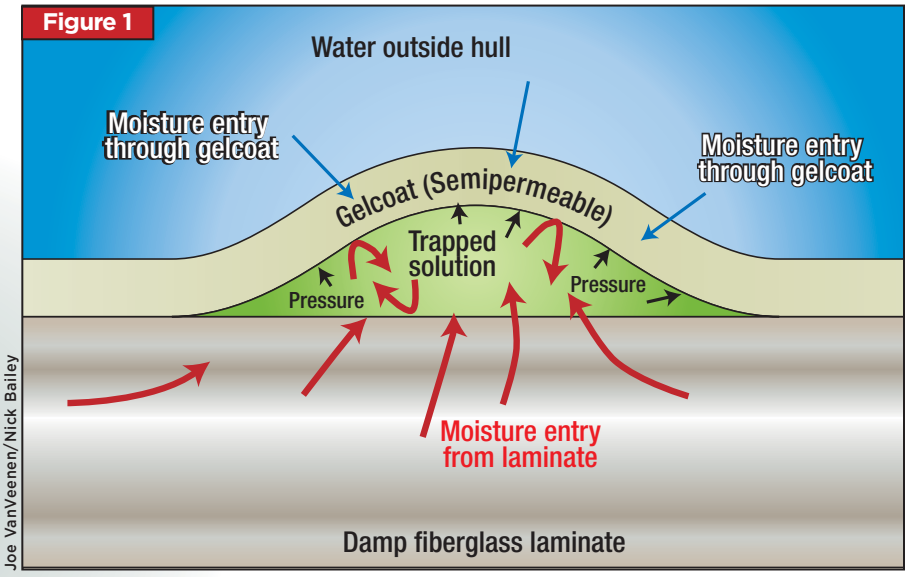
This natural process of one-way flow across a semi-permeable membrane is called osmosis. In nature, it is vital to the biological processes within our cells and powerful enough to drive water to the tops of trees and allow the roots to split rocks.

As the microscopic speck of condensate collects water, it becomes ever larger and begins to push out the surrounding material to form a blister (**Figure 1**). The osmosis mechanism does not stop until one of three things happens: moisture is no longer available, as is the case when the boat is hauled to dry out; the solution inside the blister achieves the same concentration as the water outside (unlikely); the blister grows large enough to rupture and release its contents (in or out of the water).

Most fiberglass hulls have un-reacted resin precursor chemicals remaining in the laminate. These can, in the right circumstances, provide a source of water-soluble seed materials to trigger osmosis blistering. In severe cases, the resin molecules themselves are vulnerable. Water can break them down and slowly leach them away, a process known as hydrolysis.

Depending on the availability of the three key ingredients of moisture, soluble resin and time, osmosis blisters in a fiberglass hull vary from a handful

Figure 1



Joe VanVeenen/Nick Bailey

Cross section of a typical fiberglass osmosis blister.

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Moisture meter shows that this hull is affected by moisture.

A blister spot repair underway. This example is near the outside limit of spot repair practicality.

More severe osmosis requires complete removal of the gelcoat and sometimes part of the laminate using a peeler.

of 1/4" (6 mm) diameter blisters just under the gelcoat, with damage usually limited to a cosmetic problem, to massive aneurisms deep in the laminate over a foot (304mm) in diameter, a major laminate structure issue.

Two primary methods are commonly used to reduce or eliminate one or more of those ingredients, resulting in the reduction or elimination of hull laminate blisters caused by osmosis.

During original construction, the boat builder might use more impervious resins such as epoxy, vinylester or even higher quality polyester for the entire lay-up or a water-resistant skin coat in the laminate of what will be the hull's wetted surfaces. Better resin has the additional effect of controlling the amount of moisture that permeates the hull as well as ensuring there is not enough water soluble stuff in there to dissolve if in contact with water. Builders can use laminating materials and lamination processes that inhibit or prevent blistering entirely but those boats are going to cost more to build. Many builders now feel that their laminating techniques are advanced enough so that they can offer long-term warranties against hull blistering.

Secondly, you can protect a conventional polyester and fiberglass hull by minimizing its exposure to water two ways: keep it on a boat lift or trailer (this also saves on antifouling paint) or, if your mooring is a wet one, apply one of the proprietary epoxy barrier coatings as a primer to the boat bottom prior to any antifouling coating. Note that barrier coatings should only be applied only when moisture meter readings affirm that the hull bottom is as dry as it can be relative to the readings of the hull topsides.

Exposed hydrolized laminate with weeping blisters requires more laminate removal.

A fairing team at work pulling putty.

Wet Repair Methods

Sporadic wet blisters in the gelcoat or laminate can be spot repaired but severe cases require a more aggressive approach. The industry standard method for widespread hull blistering is to strip the gelcoat and any underlying laminate that is damaged by hydrolytic action.

Gelcoat and laminate removal is most commonly carried out with a precision peeler but grinding and grit blasting are still used in many regions. The resulting exposed fiberglass laminate usually has high moisture content and is contaminated with water-soluble resin by-products. Power washing is needed to remove this "leachate" and then the hull must be thoroughly dried. Drying is done by long exposure to the open air or it can be forced by leaving the boat in a heated enclosure or more effectively, employing the patented Hot-Vac system. Removing all the contaminated laminate is key to the success of any preparation protocol.

Only if and when the moisture content of the hull below the waterline is nearly equal to the hull well above the waterline does it make any sense to apply any coatings, new laminate, fairing or fillers. Otherwise, as the expression goes, you are merely "putting lipstick on a pig."

Once dry, new fiberglass laminate can be applied to the hull to replace what was removed and to restore the integ-

Spray in a Bottle

An inexpensive and handy tool for spraying thin, even layers of gelcoat or PVA is a disposable Preval sprayer, available for US$20 or less at autobody and marine supply shops and some hardware stores.
— Jan Mundy

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A rash of blisters, limited to the antifouling, is a very minor repair.

Jan Mundy

Fire-retardard resins used on this boat apparently caused blistering above the waterline.

This topside blister in a custom fiberglass hull originated in original construction when glass was layed over paint primer.

An ugly collection of blisters that is affecting only the keel fillers and bottom coatings.

rity of the original lamination schedule and then seal the exposed area of bare laminate with epoxy or vinylester resin. Next the smooth hull shape is re-established by filling and fairing (using epoxy or vinylester fairing putties) and laborious longboard sanding. Regardless of whether the entire bottom or just local repairs are done, the final step is the application of the wetted surface coating system, including the mandatory water barrier primer followed by antifouling paint.

Other Wet Sources

Not all blisters below the waterline originate in the hull itself. Blisters also frequently occur in bottom coatings and also in the fairing fillers frequently used on sailboat keels and at recessed thru-hulls.

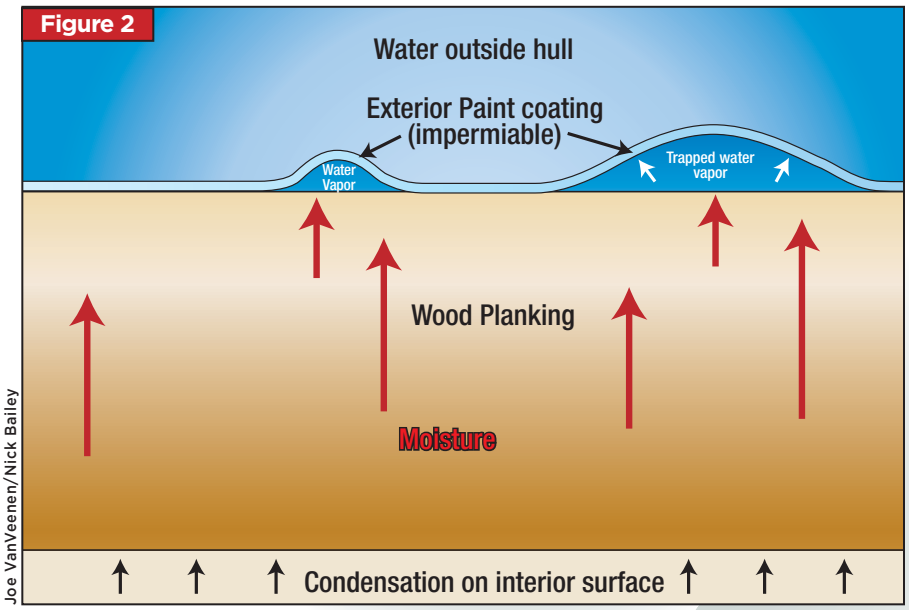
Although blistered paint and fillers are merely a cosmetic issue, the cure often involves removing all or part of the coating system and starting over again. That is a big nuisance and costly. For example, widespread paint blisters on a new bottom may indicate inadequate surface prep-sanding or surface contamination with wax, condensation or petroleum product residues.

Antifouling paint blistering away from a barrier coating beneath it might indicate the antifouling was applied too long outside the "green coat" period for over-coating fresh epoxy. On other occasions, a new coat of antifouling may be incompatible with the previous one and there is also the case of the old, tired and poorly adhering antifouling that flakes off in chunks, taking a new paint job with it. Proper laminate sampling and analysis helps to diagnose these failures.

Dry Blisters

Blisters that occur well above the waterline are usually dry in that they don't usually seem to contain any liquid. Nonetheless, water in its gaseous form can often be the main culprit and the resultant blister can occur within the fiberglass laminate or within the coating system if the boat happens to have a painted finish as well as fairing compounds.

Dry blisters occurring in a glass laminate are usually the result of an original manufacturing defect. The difference between a blister that forms later and an air bubble or void that has always been there can be difficult to determine but the blister usually represents an ongoing chemical reaction creating new gases. In many cases, contamination in the lay-up or the entrapment of volatile materials, such as moisture or solvents, is the culprit. Put the boat out in the hot sun (especially a dark colored hull) and the trapped volatile contaminates become gases that can't escape and build up enough pressure to cause a blister.



Joe VanVeenen/Nick Bailey

Paint blisters on wood hull above the waterline.
Coatings over wood blister often because moisture in the wood works its way to the surface from inside and lifts the coating.

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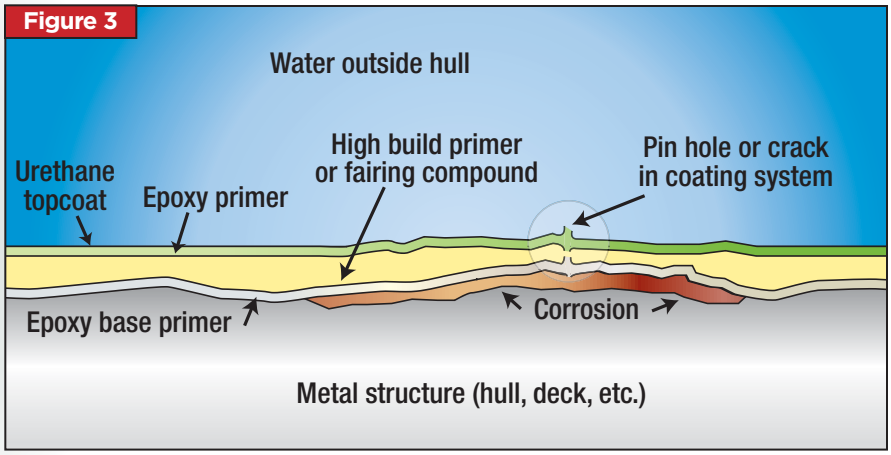
Paint coatings are very susceptible to gas blisters due to a contaminate or trapped volatile compound "out gassing" from the substrate (**Figure 2**). This is most commonly seen on wooden boats where the natural moisture content of the wood makes its way to the surface and blisters the paint coatings.

The most telling example of this phenomenon is seen when older wooden boats of planked construction are used as liveaboards in a harsh northern winter. The outside of the boat is subjected to sub-zero temperatures while nearby, on the inside of the hull, conditions are warm and moist. The inevitable condensation on the inside of the hull drives moisture all the way through the planking and often results in wholesale blistering and peeling of the topside paint after only a season or two.

Faced with the inevitability of frequent paint blister repairs, it makes sense to use a traditional alkyd enamel paint system on a wood boat as opposed to a more exotic two-part coating. A traditional coating breathes better than the more durable two-part paint and is much simpler to touch up when a blister does occur.

Custom one-off composite boats built from a male mold as well as custom steel or aluminum yachts achieve their elegant shapes with the help of lots of fairing putty and multi-step paint systems. Unfortunately, like paint systems, fairing materials are subject to adhesion and blistering problems due to trapped contaminates (air, moisture and solvents), surface contamination and moisture entry to name a few. Particularly problematic are older metal boats that have seen service in saltwater (**Figure 3**). Corrosion often takes place between the metal surface and the paint primer producing everything from local paint blisters to large chunks of fairing material breaking off.

Figure 3



Joe VanVeenen/Nick Bailey

Corrosion blisters on steel or aluminum.
A tiny scratch or coating defect in a coating over a metal substrate results in corrosion that causes a blister and moisture entry.

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Dry Blister Analysis

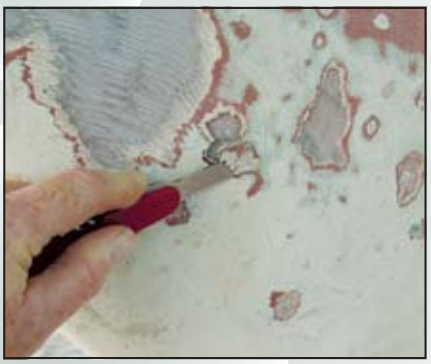
To decide what causes any blister problem some forensic analysis is needed. Regardless of the hull materials or coatings involved, careful examination of the blistered material also helps to determine exactly where adhesion failure has occurred within the stack of blistered material, which may include gelcoat, fairing fillers, primers and topcoat or antifouling paint. This information is essential in deciding on the appropriate remedial action; i.e., to remove the entire coating system or gelcoat or just perform local touch-ups.

To confirm what is going on, a professional pares off a sample of blistered material using the edge of a sharp chisel or penknife and immediately checks for any traces of liquid. If the boat has been out of the water a long time, even a blister below the waterline may appear dry but may still feel a bit oily, indicating chemical contaminates or the accumulation of hydrolyzed resin.

Next comes the sniff test. Gelcoat osmosis blisters, for example, often have a noticeable odor of styrene (akin to maraschino cherries mixed with vinegar) or a chemical smell like old paintbrush cleaner. Alternatively, a dry paint or fairing blister above the waterline may not have any detectable odor but a hint of solvent may indicate a primer or fairing putty was over coated too soon. The primer solvents did not have a chance to evaporate fully and are now trapped beneath the subsequent coatings or the fairing material may not have fully cured.

A visual examination of the blister sample and the remaining blister cavity or crater is particularly important. The material exposed on the floor of the blister is the first clue to the blister's origin. A typical gelcoat osmosis blister exposes strands of the glass laminate layer. If it doesn't, for example, if you uncover a smooth white, buff or gray material, you have something unusual and further investigation is required. It might be a second layer of gelcoat or a layer of filler left from a previous repair.

The thickness of the blistered material is important. Precise calipers or a mil thickness gauge are helpful but not mandatory. An experienced eye knows gelcoat blisters are around 20 to 40 mil (0.5mm to 1mm) thick whereas fillers can be much thicker. On the other hand, a chip of barrier coating is usually thinner, around 10 mil. If there is a "stack" of coatings in the chip, the interface between layers only a few mil thick is not usually apparent to the naked eye so examination under a microscope may be required. A 30 power handheld



Blister analysis requires a sample for examination. A penknife or chisel cuts around the perimeter of the keel blister and peels it back.

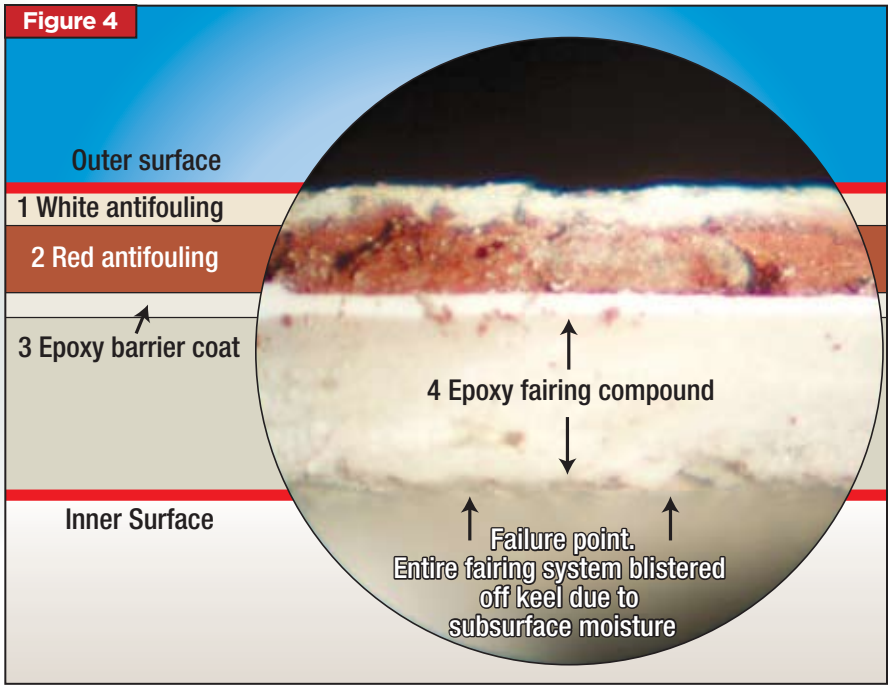
A hand-held microscope identifies what layers of a coating or fairing system are in a blister sample.

microscope works well in this application, making it much easier to identify the different layers in a coating system (**Figure 4**) and pin down where the adhesion failure occurred.

Regardless of the blister type, wet or dry, a hull repair professional familiar with their structure and causes, is a great asset in providing repair and prevention guidance.

About the author: Nick Bailey is DIY Magazine's repair specialist and has spent 30 years in the boat repair business.

Figure 4



Joe VanVeenen/Nick Bailey

Figure 4 View of keel coating chip at 30 times magnification.
Sample consists of four layers (from the top):

1 - White ablative antifouling (mostly worn away);
2 - Red ablative antifouling;
3 - A white layer of epoxy, probably a barrier coat;
4 - A thick layer of light gray epoxy filler, the keel fairing material.

The keel fairing material has released from the lead keel due to corrosion at the lead surface. A base coat primer under the filler might have prevented this failure.

Whole Lotta Shaking Going On

Your engine's motor mounts are silent in the performance of their duties but likely get the very least appreciation of any components onboard. Neglect them and costly failures loom.

Story and photos by Randy Renn (exceptions noted)

Enter the flexible motor mount, which could be the least complex, least understood but most purposeful items we have on our boats. No romance or excitement here; just devoted function.

Your engine's motor mounts are dynamic utensils given to movement and wear. Motor mounts come in sizes from the small, about 2-1/2" (63mm) in length to really huge at nearly 2' (731mm) long, in different levels of firmness. Mount firmness is known as shore hardness or durometer, a term that refers to the nature or stiffness of the mounts that changes with age and use. Albeit the engine manufacturer specified a specific mount range and type, it's never a certainty that the boat builder installed the correct type. What is for certain is that the nature of a boat changes and, in the passing of millions of engine rpm, it's most probable something will shake loose, become misaligned or simply break.

Recently, I inspected a boat of recent vintage and with 500 engine hours of offshore use. Three of the four motor mounts on each engine were very loose and had worn the engine beds. One mount was so poorly installed by the boat builder as to be considered to have failed. The owner indicated that the engine always "clunked" into gear and he thought the vibration was normal.

Mount Elements

Flexible motor mounts come in a range of styles and materials with the most popular types constructed of steel or aluminum with rubber wedges, pucks or plates that allow the flexing. These mounts usually have one center vertical post and two mounting locations for attachment to the boat's stringers or engine beds. Mounts have a slot on one side of the mount base plate and a hole at the other. It's important that the fasteners used are correctly matched to the hole size and not undersized. Undersized fasteners won't hold the mount in place for long. Skimping on fastener size and quality is sure to be penny wise but pound foolish.

Mount post threads are always of a fine cut to allow for very slight adjustments, good thread tension and adhesion of nuts and washers. However, they are given to corrosion even though they are zinc or cadmium plated. Spray from stuffing box leakage, water pump leaks, leaks at engine exhaust joints, fumes from overcharged batteries and normal service stress tend to attack these fine threads. Once threads have visible working corrosion or flake rust, they should be replaced, as successful adjustment can be difficult to nearly impossible.

Often the mount's center post nuts are frozen to the post and must be split by sharp chisel or ground off after removal from the mounting frames or after the engine is extracted from the boat. Therefore, it's very important to keep the posts clean and protected with a corrosion inhibiting formula, e.g., a light grease or corrosion block spray available at boating stores.

Mount Physics

The humble motor mount spends its life at labor pushing the boat forward. Consider that the mounts are transferring all the boat resistance

Motor mounts come in various sizes and hardness from (top) small (red one) to large (green one) to huge (bottom).

An example of two very similar mounts with differently sized fastener mounting bolt holes.

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Incorrect bracket hole to mount post size creates movement in the system, resulting in vibration and possible component failures.

Badly rusted mount needs replacing.

Rusted nut makes it impossible to adjust bracket height.

Pat Kearns

The evidence of extreme shaft movement, caused by broken engine mounts, is seen in the polished areas of the shaft. It's amazing that the owner didn't notice or the shaft did not break.

(left) Poor installation: there's no space to adjust the engine height on this mount. (right) Ideal positioning of the engine bracket on the mount allows for height adjustment as the mount looses stiffness with age. Cross bolts for mounting brackets are loose (shown by arrow) and the stringer likely decayed. Nuts must be tight without crushing the stringer.

from the propeller shaft to the hull whenever the engine is operating. There is no rest for the weary engine mount. Further, those little fellows support considerable weight and take substantial side loads in the normal rocking and rolling motion of a boat underway. The mounts also play a role to insulate the varying engine vibrations or running signature, through a range of frequencies, to prevent them from being transmitted to the boat structure. These mounts accept quite a load of responsibility for protecting the boat's structure.

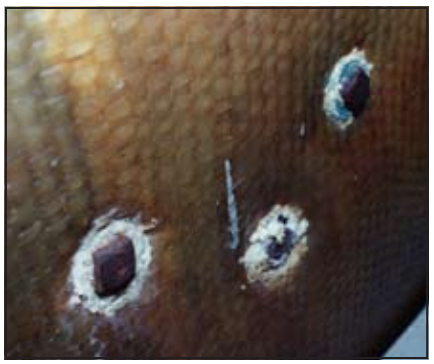
Mounts should not be considered a stationary item. To the contrary, they are moving all the time and in ways not visually perceptible. One method of knowing something about mount movement is to inspect your cutlass bearing for shaft travel, something you would do at each haul out. If the shaft is polished more than 1/4" (6mm) outside of the bearing, then the shaft is moving in and out of the cutlass. This is a good indication of some mount wear and the need for further investigation and service. Also, check that the propeller shaft(s) is centered in the stern tube(s). The shaft can move elliptically when out of alignment and, if any evidence of shaft contact with the stern tube is noted, e.g., the shaft is touching or abrading the tube, it's time to take immediate steps to check the engine alignment, mounts, stuffing box and shaft log for wear and service, repair or replace any suspect components.

Driven to Failure

"The drive train has been fine all this time. What can happen?" Excessive vibration can affect everything from the exhaust system to a sailboat's rigging. Failures in these systems often appear isolated but they are not. They are all part of a whole that suffers when excessive vibration contributes to the normal wear and tear cycle. Sterndrive engines lose flywheel couplers and any boat can have cracked stringers/engine beds from poor mounting conditions.

What can you do? Initial steps are stop, look and listen. Feel the mounts at the post and plate washers. If any are loose to the touch, then it's a sure thing the engine needs realigning. If any mount is badly rusted, count it out and plan to replace it. Inspect engine bed straightness and relationship to the mounts. Mount posts and bases must be at right angles to the beds. Replace any mount if the flex material is swollen (some are not resistant to oil and swell up) or separated.

If any flexible mount is defective, replace them all. Replace just the damaged one and it's like having one different tire on your car from a vibration standpoint. Be certain all fasteners are in good, rust-free condition and replace any that are not so. Remember, those fasteners support the entire loaded weight of the engine and absorb tremendous shock. Inspect stringers and shaft logs for any open cracking or water seepage. "Fiberglass" engine beds are often a composite of wood encapsulated in fiberglass, and water that gets past the fiberglass sheathing attacks the



Pat Kearns

Bolt heads of an engine mounting bracket are in wet wood encapsulated by fiberglass and the wood is suffering electrolysis within the stringer. When the bolts were removed, very little of the wood and bolts remained. The whole boat would shake when the engines were running at cruise and the owner kept trying to align the shafts but the wiggle was in the mounting brackets.

wood and weakens the structure. A moisture meter can be used to detect the clues to problems in the stringer/engine bed system. Generator mounts age as well and should be included in your machinery space inspection but these do not require alignment. Generators that live in sound dampening enclosures obscure the presence of water on and around the mounts.

Heads Up

Even if you're very good at turning wrenches, engine alignment can be a challenge. The alignment procedure, while not complex, must be brutally precise, requiring delicate adjustments. The shaft coupling to transmission interface has to be within .004" in three possible planes of adjustment, that is the thickness of a sheet of copy paper. [Ed: For step-by-step instructions on aligning engines refer to DIY 2002-#1 issue or the "DIY Mechanic" MRT CD-ROM.]

Changing a broken, rusted or deformed mount is likely within the skill competency of the weekend mechanic with a good tool selection and some jacking equipment for raising and supporting the engine while you work. Excluding small horsepower auxiliary engines, leave the final alignment/adjustments to a professional. A strobe test is a good procedure to perform once everything is running and underway and any good technician has one. This test shows movement the human eye cannot see. Disconnect transmission couplings, exhaust systems, controls, fuel lines, wiring looms and cables when replacing mounts in order to not strain other systems when moving engines. Always consult the engine builder or mount maker about the proper mount rating for your engine before proceeding. They may require the mount spacing between posts as well as current mount length and post heights.

Engine alignment and mount integrity adds measurably to your boating pleasure and, most of the time, it's instant gratification.

About the author: James R. (Randy) Renn is a USCG licensed operator, avid sailor, sport fisherman and is one of a few marine surveyors who is also accredited as an engine surveyor. He operates Marine Forensic Technicians in Stevensville, Maryland.

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Engine Electrics

Tips to service and troubleshooting your engine's electrical system.

By Steve Auger

Marine engine electrical systems are required to perform properly in an extreme duty environment that includes high air and engine compartment temperatures, very high humidity and in wet and corrosive saltwater exposures. The process of starting your engine can involve current values of 200 to 300 amps of DC current. To get some idea of the capacity of those ratings, you can weld steel plates with 100 amps.

High amperage flow within an engine wiring harness causes the wiring to produce heat that, in turn, increases the resistance in the wiring. Heat damages the protective insulation and increased resistance reduces power being supplied to the electrical system components, such as (but not limited to) starting and charging system, ignition and electronic fuel injection engine management systems, power trim and tilt and even instrument readouts.

In addition, many boats sit unused for six to eight months a year in winter storage and it doesn't take long before the engine and instrument wiring starts to suffer.

Matter of Volts

In the early years of pleasure boating, 12-volt DC electrical systems were very basic and there just were not any accessories or options that could be applied to a smaller boat.

Today's high-tech boats have changed all that. Now you can have a 22' (6.7m) fish-and-ski combo with everything from multiple livewell pumps and downriggers, stereo system, DVD player, electric trim tab pumps, fish finder, a small galley and on newer boats, a fly-by-wire engine package. Move up to a 38' (11.5m) twin engine package and you can add anything and everything, from a generator to GPS, radar and a fully interfaced autopilot system, all of which require a stable voltage supply in order to operate reliably.

Many electrical systems found on engines use information that is relayed from sensors via the wiring harness to various electronic control modules (ECM). This information is relayed using different milli-volt values to indicate different transitional conditions. An example of this is the throttle position sensor on an electronic fuel-injected engine that indicates a normal idling engine voltage of 0.516 milli-volts. If the wiring from the throttle position sensor to the engine computer becomes corroded, the resistance increases and that condition lowers the voltage reading, giving the computer a false voltage value. This makes it impossible for the computer to do its job and the engine doesn't run properly.

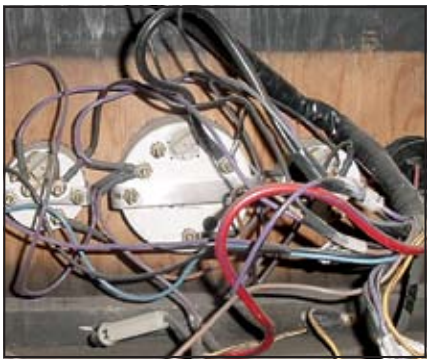
Cable Guidelines

All the direct current systems on a boat begin and end at the battery. For this reason, I always advise boat owners and riggers to install one high quality battery per engine, rated at 1,000 marine cranking amps (MCA), a rating that translates to 750 cold cranking amps (CCA).

In order to extract or replace the current in a marine battery, you need clean battery-to-cable connections and high quality battery cables. Each engine manufacturer has battery cable recommendations. As a general guideline, for a gasoline engine, start with a minimum of a 4/0 AWG cable when the distance between the battery and the engine measures 3' to 4' (91cm to 121cm). For every increase in length of 1.5' to 3' (45cm to 91cm), increase the gauge (size). For example, a 3.5' (106cm) length requires a 4/0 AWG cable; a distance of 6' (182cm) needs a 2/0 AWG cable and a 7.5' (228) length calls for a 1/0 AWG cable. Diesel engines require a heavier gauge cable so they start at a 3' (91cm) cable being 2/0 AWG and increase on the same relative scale as gasoline engines.

Many marine batteries come with wing nuts as the standard fastener to connect the battery cable to the

Protective sleeve contains the engine wiring harness.



This wiring mess should be tied and secured to reduce the possiblity of broken wires.

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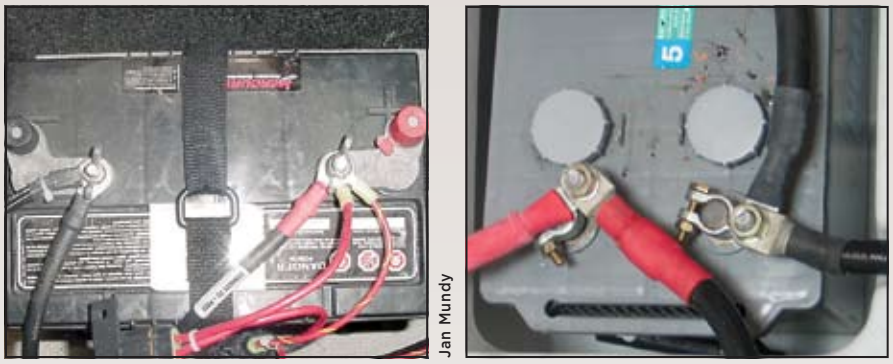

Jan Mundy

(left) New motor rigged with wing nuts holding on the battery cables. (right) Wing nuts replaced with locking nuts tightened with a torque wrench.

battery. These are subject to loosening from the vibration present in normal operation with inboard and outboard engines. For outboard motor applications, discard the wing nuts and replace with lock nuts that are torqued to 20 foot pounds using a torque wrench. For inboard engine applications discard the wing nuts and use only clamping-style battery terminals with the correct gauge cables. Loose cable connections mean high resistance and that means heat, which results in loss of performance and increased risk of overheating the wires and causing a fire.

FIGURE 1

Below are the recommended engine and accessory wiring color codes per ABYC E-11. Always double check your service manual for any variations to the wiring code.

Color	Item	Use
Yellow w/ Red Stripe (YR)	Starting Circuit	Starting switch to solenoid
Brown/Yellow Stripe (BY) or Yellow (Y) - see note	Bilge Blowers	Fuse or switch to blowers
Dark Gray (Gy)	Navigation Lights Tachometer	Fuse or switch to lights Tachometer sender to gauge
Brown (Br) Auxiliary	Generator Armature Alternator Charge Light Pumps	Generator armature to regulator Generator; Terminal/alternator; terminal to light to regulator Fuse or switch to pumps
Orange (O)	Accessory Feed	Ammeter to alternator or generator output and accessory fuses or switches Distribution panel to accessory switch
Purple (Pu) Dark Blue	Ignition Instrument Feed Cabin and Instrument Lights	Ignition switch to coil and electrical instruments Distribution panel to electric instruments Fuse or switch to lights
Light Blue (Lt Bl)	Oil Pressure	Oil pressure sender to gauge
Tan	Water Temperature	Water temperature sender to gauge
Pink (Pk)	Fuel Gauge	Fuel gauge sender to gauge
Green/Stripe (G/x) (except G/Y)	Tilt down and/or Trim in	Tilt and/or trim circuits
Blue/Stripe (Bl/x)	Tilt up and/or Trim out	Tilt and/or trim circuits

Note: If yellow is used for DC negative, blower must be brown with yellow stripe.

Color Codes

Regulations have required boat builders to color code all wiring on new boats since the early '80s (**Figure 1**). Color-coding aids in troubleshooting wiring problems. This system is good but not foolproof so always double-check your service manual for any variations to the wiring code.

Consider this example: the switched power wire from the engine key switch is colored purple but, in the EFI wiring harness supplied to most marine engine manufacturers by General Motors, the color changes to pink at the engine-to-EFI harness connector. Without this information found in the service manual, it's impossible to locate and test the correct wires in order to perform effective repairs. "Historic" pleasure craft built prior to color coding requirements, have their own wiring codes so always refer to the boat's service manual before doing any wiring work. No manual? You might need the help of a certified marine electrical technician to develop a schematic before getting into the system.

Voltage Drop Test

Routinely inspect the engine wiring for any hanging or loose wires. When a failure occurs, look for broken or corroded terminals and broken, chafed or melted wire insulation, especially on the cylinder block.

A quick and easy way to test any cable or connection is to use a digital multimeter and perform a voltage drop test. Each multimeter has unique instructions to operate it without causing damage to the tool or the components being tested and for avoiding injury to the meter operator. Always refer to those instructions in detail prior to performing any electrical system test.

Remember, marine engine electrical systems carry enough current to

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damage good electrical components and cause serious personal injury if tests or connections are not made correctly and with all due caution and respect for the inherent risks of poking around with electricity. Always use an engine service manual to perform electrical tests as the manual outlines any safety concerns associated with that particular test.

To check the battery cables, set the digital multimeter on the 20-volt DC scale. With the key in the off position, measure the battery voltage across the two battery terminals. You should see a voltage of around 13 to 13.5 volts. Leave the negative (black) lead on the negative battery terminal and move the red lead to the point where the positive battery cable (red) connects to the starter solenoid. The voltage difference should not exceed more than 0.25 volts.

For instance, the voltage measured across the two battery terminals is 13.25 volts. Voltage measured with the black lead at the battery negative terminal and red lead at the starter solenoid connection is 13.15 volts. The voltage drop is 0.10 volts, so the battery cable is okay.

Never assume that all electrical failures are on the positive cable as most electronic systems that employ a computer (e.g. your engine) use a pathway to ground to complete the circuit. To check negative connections, place the red meter lead on the battery positive terminal and move the black lead to the negative cable connection point. A voltage drop of less than .25 volts indicates a good wire.

Resistance test

To confirm that a wire has not broken inside its insulation, use a multimeter to perform an ohms test. Place a multimeter lead at each end of a wire to determine the state and resistance in the wire. Resistance in a wire reduces the wire's ability to conduct electricity and produces heat in the wiring, which is a bad thing. Most wiring shows a resistance of zero ohms when tested, unless otherwise specified in your service manual. A reading of infinite ohms means the wire has an open circuit and is likely broken inside the insulation and needs replacing. A reading higher than 50 ohms means the wire is likely suffering from corroded terminals or wire core and must be replaced.

Repairs

Below are some guidelines when making repairs to engine electrical systems.

1 Replace bad wiring with the correct color and gauge of wire. Refer to ABYC E-11, "AC and DC Electrical Systems On Boats," for help in calculating wire size requirements and color-coding tables.
2 Do not place any electrical connectors in locations that are at risk of submersion in bilgewater as this can lead to damaging stray current corrosion to engine oil

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pans and drive line components.

3 Solder becomes rigid after cooling and, despite many electrical technician's opinions, it's not recommended (actually prohibited in ABYC E-11) for marine electrical connections as the soldered connection becomes a rigid pivot point and the wiring can break right next to the soldered connection as a result of the kind of vibration caused by normal operations in the marine environment. I prefer adhesive-lined crimp connectors, covered with heat-shrink tubing and heated to a watertight fit. [For more details on wire terminals, turn to page 28.]

4 Be sure the engine wiring harness and all accessory wiring, from the helm to the engine compartment, is well secured along its runs, using properly sized and insulated clamps and loom. Do not strap any wiring or hoses to mechanical steering cables as this binds up the steering cable housing, reducing the effectiveness of the steering system if connected to a power steering control valve.

5 Keep each electrical system wiring harness separated. Don't tie different systems, such as boat wiring and engine wiring together as this makes for a lot of frustration when trying to diagnose a problem.

6 Never run wiring and fuel lines in the same bundle. The reasons should be obvious: overheat in the wire can transfer that heat to a flexible fuel line, causing the hose to leak or rupture.

About the author: Mercury Mercruiser master technician and DIY's engine technical advisor, Steve Auger, has more than 35 years experience in marine retail, manufacturing and training, mostly with Mercury Marine.

Terminal Links

There's more to purchasing wire and battery terminal connectors than simply color-coding.

Jan Mundy

By Doug Cohen

I'm an accomplished do-it-yourselfer and do most of the maintenance on our boat. When it comes to DC electrical upgrades, I've read countless informative articles explaining the fine points of 12-volt circuitry. My frustration comes when I enter my local marine store to buy wire terminals. Color coding makes it easy to select the correct size but look at the fine print and you'll see that there are non-insulated, vinyl insulated, nylon insulated, heat-shrink style and even solder seal terminals. So what do I buy? Which is best for what?

Non-insulated terminals are just as described, without the benefit of any insulating material, just bare, tinned copper. These can be crimped (with the proper crimping tool) for a secure electrical and mechanical connection. The bad news is that they will short out against any metal surface they get near.

Have you ever seen terminal connections with cracked insulation sleeves? You know, the ones that look like they are barely holding on to the wire? Or the ones only crimped by the insulating barrel. Good chance they are vinyl insulated terminals. Vinyl insulated terminals are cheap and readily available (typically sold for automotive use). The vinyl tends to crack and split when crimping the terminal onto the wire. Additionally, if there is a short or overload causing the wire to overheat, the vinyl insulation expands and literally falls off the terminal, leaving a non-insulated terminal in its place. The metal barrel of the vinyl terminal also tends to be very short, usually less then 3/16" (4.7mm) long, making it difficult to accurately, properly crimp onto the wire.

Nylon insulated terminals have a preformed nylon insulting sleeve over the barrel. Nylon terminals cost more than vinyl and are worth every cent. Nylon doesn't crack or split, even in very cold temperatures, and doesn't expand and fall off the terminal in case of an overload or short. Nylon terminals typically have a 1/4" (6mm) long barrel for ease of crimping onto the wire and most even have a built-in metal funnel to prevent wire strands from peeling back as you slide the terminal onto the wire. In fact, you can crimp on the funnel to secure the wire insulation for tremendous resistance to the tension required to pull out the wire. The nylon sleeve is also normally translucent, so that you can visually determine if the wire is completely inserted before crimping.

Heat-shrink terminals, in their simplest form, are some type of wire terminal with a heat shrink sleeve applied over the body of the terminal. In use, you crimp the terminal and then apply a heat source such as a butane lighter, which causes the tubing to contract, insulate and seal the connection. To further complicate things, there are several styles of these terminals on the market.

Some companies have chosen to use a non-insulated terminal with only the heat-shrink sleeve. The problem with this arrangement is that crimping the terminal often damages or splits the heat-shrink tubing, causing it to separate from the terminal when heat is applied. Obviously, this renders the entire connection useless, giving you the chance to do it over again.

Quality heat-shrink terminals are built on a nylon-insulated terminal and then the heat-shrink sleeve is applied. Installation involves a solid crimp of terminal to wire, followed by shrinking the sleeve for the sealing and amazing strain relief at the connection.

A low-end solder terminal consists of a heat-shrink tube with solder ring inside it for the butt connector configuration. This terminal is installed

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Jan Mundy

Mixture of vinyl automotive use terminals and properly installed marine-grade terminals with heat-shrink tubing connects wires to this gauge.

Steve Auger

Self-adhesive and shrinkable connector is first crimped to the wire (top) then heated to shrink the sleeve (bottom). Note how the glue pushes out the ends creating an excellent bond.

Steve Auger

Heat-shrink tubing overlaps terminal to ensure a watertight connection.

simply by heating, causing the heat shrink to shrink and the solder ring to melt and join the wires together. Holding the wires in place while melting the solder/heat shrink is a bit of a challenge and a cold solder is quite possible. [American Boat & Yacht Council (ABYC) E-11 Standard states that solder cannot be the sole means of mechanical connection and if soldered, the connection must be supported to minimize flexing of the conductor.] This type of connection might be argued to meet the letter of the standard's intent but not the spirit of safe practice.

There is now a quality crimp, solder, seal wire terminal available with a nylon insulated base terminal, precisely measured solder ring and a dual wall heat-shrink tubing sleeve. The result is a connection with a solid mechanical grip, electrical conductivity and the moisture resistance of a good heat shrink. For my money, I'll use nothing but crimp-solder-shrink wire terminals for the best of all connections.

Battery Ends

Battery terminal connections are slightly different, in that non-insulated is the rule. However, even battery terminals are available in a number of styles.

Avoid the cheap automotive lead terminals, in either clamp-on or crimp styles. Lead has no strength and suffers less conductivity than copper terminals. Starter lug or ring style terminals are available in solid copper primarily for automotive usage. Conductivity is excellent; however, the terminals are soft and bend and deform easily, risking a failure.

Cast copper terminals with tin plating are the strongest and best choice for terminating marine battery cables. They are available in crimp or solder styles for convenience.

For a soldering assembly, there is a solder slug system, in which you insert a pre-measured slug of solder into the terminal, heat the system, and make a completely soldered joint.

Battery terminal connections should always be insulated and protected with heat-shrink tubing, using red and black heat-shrink tubing for proper polarity color-coding.

Tubing Savvy

Single wall, heat-shrink tubing is made of a cross-linked polyolefin material that has about a 3:1 recovery ratio. Apply heat and the tubing shrinks to about one-third of its original diameter. However, since it's single wall, there's little sealing ability to this product. Single wall heat shrink is a good chafe protection or an excellent method for securing a wire harness or even for insulating a screwdriver shank.

Dual wall heat-shrink tubing has a similar outer wall but also contains an adhesive sealant that melts and flows when heated, creating a thick, positive weather seal around the wire and terminal connection. This style heat shrink is available from 1/8" (3mm) diameter up to 1-1/2" (38mm) and can be used on battery terminal connections. Dual wall heat shrink is usually sold in 6" or 48" (15cm or 121cm) lengths, and in black, blue, green, red, yellow or white. It's fire retardant and easily shrunk with a lighter, heat gun or carefully with a torch (it will burn!).

For those applications where you are attempting to join wires of differing gauges, such as installing a bilge pump, look for step down butt connectors. They are available in nylon insulated and heat shrink styles and are color-coded to identify which end is which. For instance, a yellow butt connector with a blue stripe on one end is a 12 or 10 AWG stepped down to a 16 or 14 AWG butt connector. Step down butt connectors offer a solid connection for an otherwise difficult situation.

Cast copper battery terminal with tin plating is first crimped then protected with heat-shrink tubing using black to denote the negative terminal.

Hopefully your terminal knowledge is now somewhat beyond terminal.

About the author: Doug Cohen and his wife Fran, sail a 1973 Gulfstar 41' (12.4m) center-cockpit ketch out of Willsboro, New York on Lake Champlain.

A SURVIVAL GUIDE TO "SALE BY OWNER"

You've made the decision to sell the boat you thought was the first, last and always boat of your life and it's now time for action. Use this guide to set a course to selling your boat the DIY way.

Story and photos by Pat Kearns

New boat sales are down. That's the bad news for new boat builders and, according to industry sources, 75% of first-time boaters make their first boat purchase a pre-owned boat. The good news is that boats offered for sale by their owners are a big part of the market.

Open any boating magazine and you'll see some of the many ways boats are offered for sale, both in brokerage and the DIY way. The ads are the catalysts that target the release of the nautical hormone that stimulates the urge to buy a boat. Google "boats for sale" on the Internet and you'll get 12,900,000 "hits" on the topic.

Whether you're going to use print media or the Internet or, better yet, both, these resources illustrate many of the ways to measure the competition when you are getting ready to sell your own boat.

Know Thy Market

You don't have to reinvent this wheel. A little time spent looking at how other boat owners approach the market is a good investment. Gather boating publications that have boats for sale advertising and get the lay of the land. The Internet is a vast resource of first choice for boat sellers (and buyers) scoping out the possibilities. Thousands of boats for sale are featured on every level of the Internet, from professional brokerage sites to eBay, with a choice of specialized sites that are all encompassing in their focus on buying and selling boats and include links to lenders, insurers, surveyors, boat builders and more. (A list of just a few of the Web resources appears at the end of this article.)

In seeing how others approach the task, you'll find clues to developing your own course of action. Here's also where you'll confront the value of your boat, perceived and real. If you want to sell your boat, you have to deal with the real value.

Value Assessment

Perceived value is often what a seller uses to set the selling price. Real value is what the boat actually brings at the time of the sale. Too often, in DIY selling, the values are polarized, frustrating both seller and buyer as they grapple with how to resolve the issue. Inevitably, a surveyor, marine lender and the insurance company will come to grips with the real value if they are involved in the purchase process. Just as in real estate transactions, a seller might get his price but, if the appraisal doesn't come up to the same number or better, a lender and/or insurer won't support the buyer's enthusiasm for getting what he wants at any price.

Establish an asking price that competes well with same or similar boats offered for sale in your area. Check the published price guides like NADA, ABOS and BUC (Google the acronyms for contact information) listings of

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ADDITIONAL READING

The free BOATU.S. "Guide to Buying & Selling a Boat" is available online (BoatUS.com/guide). The guide includes helpful information on how to use the BoatU.S. Consumer Bureau's free services, including the boating industry's only Recall Alert Registry that tracks safety defects for new and subsequent boat owners. Also covered is the Association's unique national online complaint database for boats, engines and service providers as well as information on the BoatU.S. dispute mediation program. For sellers, there's a checklist to help evaluate your boat's condition, information on the pros and cons of selling on your own versus using a broker, and how to write a sales agreement.

actual selling prices and accept them as reality, plus or minus a little fudge factor for condition and regional variations. The law of supply and demand lives here. Consider asking a reputable yacht broker in your area to give you a range of actual selling prices.

Surveyors often have good data as well. You may wind up using the broker's services if you are not successful on your own. You can even give them an "open" listing, which allows them to earn a commission for a sale without obligating you to pay if you sell the boat yourself.

Pricing a boat is not a precise science. The variables affecting two boats of exactly the same age and model are significant factors, the biggest of which is condition. It always levels the playing field and can overcome a slick inventory of racing sails, souped-up engines or exotic electronics.

As for what is "fair" in a current "market," all bets are off unless you accept the universal definition of current fair market value (CFMV), which is "the price, in terms of currency or its equivalent, that a willing seller accepts for personal property from a willing buyer, neither party being under undue pressure to act in the matter and both parties being reasonably informed of the facts pertinent to the transaction, with the property offered for sale in a competitive open market for a reasonable period of time." As a DIY seller, it's important that you overcome an excessive emotional attachment to your boat to get to the market reality that leads to a sale. The real wisdom is in the words of the tune "know when to hold 'em; know when to fold 'em." Beauty is in the eye of the beholder but be realistic if you want to take the money to the bank.

Packaged Perfectly

Ready for disclosure? Prepare for it and volunteer information that you know is important to a buyer, especially that which addresses the boat's "medical" history. (A sample Request for Disclosures form is available at diy-boat.com/diyweb/edit/disclosure.pdf.) It's the surprises that kill deals. Share what you know. The surveyor will find the rest but you won't likely be suspected of withholding bad news.

Put together an information sheet that you can hand, fax, mail, e-mail (as an Adobe Acrobat pdf) to everyone who inquires about your boat. This form should include all inventory items onboard that convey with the boat. It should detail all the major equipment, including engine make and model, sails and their makers and ages, electronics, etc. Don't represent things as "new" that were installed or upgraded two years ago. If it's not still in the box, it isn't new.

Have a selection of photographs to accompany each listing you send. These can be digital images that are laid out on a quality bond (24lb bright white) paper. Be prepared to email the information to inquiring minds. The buying hormones rise and fall so don't delay in slaking a buyer's thirst for knowledge. Do this by attaching your listing information file in, for example, an Microsoft Word file and insert the photographs in the file. Convert the file to a pdf before attaching it to an email to create a smaller sized file for attachment to an email message.

Be prepared for every question a buyer has. If you don't know the answer, don't bluff. Know the specs of your boat backward and forward and be able to rattle them off along with builder history of design and construction. All this tells a prospect that you know your boat and that inspires confidence. As with so many selling situations, the buyer is buying the seller as well as the product. Be prepared to discuss all the costs you have experienced that relate to ownership, e.g., insurance, dockage, fuel and annual maintenance. Have all service and owner's manuals in plain view, preferably organized in a binder or briefcase.

The Showboat Look

Clean, clean, clean! Empty all lockers and drawers so they are ready for the new owner to fill. All that handy stuff that you've collected for the "just in case" times must go. You don't have to pitch it but you do have to get it off the boat. Lockers and drawers that are filled with "stuff" tell a buyer that there's no room for his own belongings. No matter how well those odds and ends have served you, it's all junk to new eyes.

Remove every container of cleaning or maintenance products, rags, sponges, etc. You can keep a cleaning kit in the dock box or trunk of your car and bring it onboard for a spiffing up before every showing. Take food and beverages off the boat. With every nook and cranny empty, you can get down to the previously unnoticed dirt and grime, removing screws and small tools that were long lost in the bilge and the Monopoly pieces, from rainy day game times, that have migrated to that cavern beneath the forward berth.

Clean, clean, clean. If you're not Felix of the Odd Couple, engage a professional cleaning crew and pay them to do their premier detail cleaning. It's worth it. When they're finished, bring a fastidious boating friend onboard to scrutinize the result. If you didn't find that hidden grime, a potential buyer will and so, inevitably, will the surveyor when the real buyer comes along. That professional sniff test can lead to spending money to satisfy a surveyor's findings.

The idea that "normal wear and tear" is accepted on a previously owned boat doesn't play well in a competitive marketplace. An investment to recondition or replace dirty or worn running rigging on a sailboat or faded canvas or soiled, stained or torn vinyl seating on a powerboat brings a return at selling time. Simply removing ratty, soiled, faded canvas or cushions (interior and exterior) is better than justifying its condition. Bare berth flats can fire the redecorating imagination but worn and/or dirty cushions are a big turnoff and tattle of hard use or neglect. The effect of something as simple as new PFDs in a dedicated container and a set of new flares is amazing. Now's the time to attend

to every item on that deferred maintenance list. Leave nothing undone. Put yourself in the buyer's shoes. Everything must work the first time you throw the switch at show time.

Once you've excavated all the gear, supplies, etc. and scrupulously cleaned the boat and all the installed equipment is in working order, consider a pre-sale survey. Most surveyors offer a stem to stern, deck to keel inspection of a boat for owners preparing to sell. For about 50% of the cost of a prepurchase survey, I survey the boat using the same protocol as for a prepurchase survey and I issue a very limited report that includes a list of all findings and recommendations for repair or service but without all the descriptive detail expected in a prepurchase survey. Catch any bad news now and fix things in a less emotionally charged time.

I'm still always dumbfounded when I discover dead fire extinguishers, ragged PFDs, expired flares, a full sewage tank, a foul toilet, dead batteries, drippy stuffing boxes, burned out lights, empty steering or trim tab fluid reservoirs, wasted zincs, science projects in a fridge, rodent or insect droppings and a bilge full of oily water in a boat that has been on the market and is now under contract and is undergoing the purchaser's survey. The psychological and fiscal effect of finding those items in a survey report at this late hour in the selling process will cost the seller dearly on his bottom line and it was all preventable.

Time is Money

Success selling your boat yourself is all about beating the competition, including the boat dealers and brokers. Your real competition, though, is not the professional boat selling community. The real competition is your own kind, others doing it themselves. Rising above the common denominator of their efforts is your challenge. If you can do that, you will earn the commission you see as saving by selling your boat yourself.

In this endeavor, time is money and the longer your boat is on the market, the more time you'll spend in the selling mode (a.k.a., the learning curve). The other, not so easily recognized as affecting the "time is money" aspect is the longer the boat sits unsold, the steeper the penalty you pay for the loss of the use of the money tied up in the boat, plus the expenses to insure, store and maintain it in the condition that attracts a buyer.

Engaging Skillsets

So what does it take to sell a boat? Look at the work steps involved: marketing and promotion, showing and demonstrating the boat, qualifying buyers, negotiating the deal, drafting the purchase agreement, handling the transfer of title, considering a trade-in, the buyer issues of financing, insurance, escrow, etc. These are all now part of your job and you will need to know what to do and when. Put a value on each service, add them up and you'll likely find a commission there. Pay it to yourself? That and getting top dollar for the boat would be the best of all worlds but be prepared for the buyer's expectation that he's the one saving that money by dealing direct with a seller.

The Siren's Call

You can put a sign on the boat and wait or put your boat in a used boat show or place ads in the newspaper and in local and regional boating tabloids found free in boating communities (PropTalk, SpinSheet, Mariner, Waterline, Boat Trader, etc., are the ones I most often see), the yacht club/marina/boatyard newsletter, Soundings, BoatU.S. classifieds (for members of the association), online classifieds, and lastly, word of mouth. Most of these methods are relatively inexpensive, in the short run.

Make sure your ads give the key information about your boat. Builder, year, engine, sails, keel configuration, rig, generator, electronics. Save the marketing lingo for your serious inquiry. Ads that contain lures of "bristol," "pristine," "as new," "ready to go," etc., all set a prospect up for disappointment if those words don't mean the same thing to him as they do to you. Something special about your boat? One owner? New sails or engines? Those things are interesting to boat shoppers. "Needs TLC," "unique one design," "owner maintained," "totally refurbished." These words raise red flags.

Lights, Camera, Action

Unless your boat is on a trailer in the backyard or in a lift at your private dock, you must consider what liberties you have within the marina, your yacht club or the boatyard. Check with the marina before posting for sale signs. Some marinas have rules about selling boats and some charge a commission for sales that take place on their premises, even if they're not involved. Never, ever send a prospect to the boat alone. You're courting problems for the yard (club or marina) and yourself. The prospect presumes he or she can prevail on the facility staff for assistance and information. When you're selling your own boat, you are "earning" the commission and showing the boat yourself is your job. Some yards and

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marinas may be willing to cooperate with you but such arrangements must always be made in advance and kept to the letter of the law. Liability, yours and the facility's, is a real concern. An unrecognized, unannounced person poking about in the yard and on your boat is bound to generate rightful suspicion to be dealt with righteously. Remember that you're playing your game in a business's backyard and you must respect that turf issue.

You'd better be flexible here to take advantage of the heat of every prospect's moment but you also want to make sure you are putting the boat in its best light. Rainy, snowy, icy, bitter cold, gale a' blowin' days are not a good selling environment and could pose dangers, both physical and psychological, to you and a prospect.

Make sure you have an easy to use and safe boarding method. Rickety ladders standing in a pickup truck bed won't do for the boat that is high and dry in the yard. Keep an appropriately sized, heavy-duty ladder locked to the boat stand or a nearby tree or post. Have a safety line on the ladder to keep it attached to the boat. If you're showing your boat in the off-season, consider a preview before the real thing so that there are no surprises like a full bilge or a dead battery. In season, don't be too quick to "take her out for a spin." This exercise should be reserved for the qualified prospect who has established a vested interest in the boat by making an offer that is accompanied by a good faith deposit. Being happy with the test run is one of the contingencies of any buyer's intent to purchase. Any other approach puts you in the position of taking total strangers out for joy rides.

Be prepared to referee your own price negotiations, prepare and execute a purchase agreement with contingencies for survey, a lender's approval for the buyer's purchase money, survey arrangements and post survey issues, which may include renegotiating a price or repairing problems discovered by the surveyor. Here is where your ability to act like a professional will be challenged.

Can you be objective when it gets down to dollars and sense? (That's not a misspelling of "cents.") Emotions run high and low as you take the blows of offers that feel like insults. This is where the wheat and chaff part, especially if you treat that "insult" with a stubborn counter of your asking price or nothing. You might well be left with the latter. An offer is a beginning to get to the middle, which is somewhere between your perceived value and that "insult."

Deal Breaker

A verbal agreement is as good as the paper it's written on. You'll need to have an agreement to purchase ready to detail the flow of the transaction. BoatU.S. finance division offers a settlement service for sellers and buyers that includes coordinating all transactions and can also handle escrow, etc., (boatus.com/boatloans/service/services.asp#seller). The customary buyer contingencies are the right to have a survey, opportunity to obtain financing and insurance and a test run. A not so customary contingency is a buyer surveys the boat himself.

Get it in writing. Have registration/documentation paperwork in order to prepare for closing the transaction. Conveying title to the new owner also means satisfying your own obligations to the boat. That means, if you have a loan against the boat, you must make arrangements to pay it off, either from your own pocket or from the proceeds of the buyer's payment to you. In most cases, a lender will not release the boat's title to a new owner until the loan is satisfied.

Payment from the buyer should be in cash or a certified check, a direct bank transfer or the like. If you do accept a personal check, make sure you allow the time required for check clearance before you give the buyer the title or possession of the boat. If you are accepting another boat in trade, you actually become the buyer of that boat and the same contingencies apply (survey, test run, etc.).

Casting Off

You've sold the boat, paid off the loan, and cancelled the registration/documentation. The slip is empty and your bank account has swelled. You've saved the commission by doing the work yourself but that really boils down to paying yourself for the job. Take that "commission" and deduct the costs of the learning curve and those funds spent to directly market your boat. Keep track of the hours spent in marketing your boat. When it's all over, divide those hours into the commission that you think you've saved and get your hourly rate for the job. Did you get your money's worth from your effort?

If you have any money left over, you might find yourself in different flip-flops, as a prospective boat buyer and you might be dealing directly with the owner/seller. How's that feel?

About the author: Pat Kearns is a NAMS certified marine surveyor and owner and principle surveyor of Recreational Marine Experts Group in Naples, Florida.

WEB SEARCHING

Below are just a few names of the more popular boat buying and selling Web sites. For a complete list type "selling a boat" in your favorite search engine.

boats.com
boatquest.com
boattraderonline.com
boatus.com
iboats.com
marinesource.com
used boats.com
yachtworld.com

A sample of the Boat Buyer/Seller Purchase Agreement from BoatU.S. is available on this CD. Click here to access it.

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Shortening Sail The Easy Way

Schaefer

Taking the easy way out is not the traditionally sought course for hardy sailors but the technology of today's in-boom furling systems makes mainsail hoisting, furling, reefing and stowing safe and effortless.

Schaefer's sail track holds full length batten sail at the precise distance from the mast and battens lie parallel to the boom when furling.

By David and Zora Aiken

A mainsail reefing system is a good idea for many reasons. Fewer crew can handle a larger boat. Solo sailors benefit from the single-handed operation, even push-button if desired. "Too much work" won't keep a sailor from a spontaneous sunset sail. The most important factor is safety. With all lines controlled from the cockpit, nobody has to grope around on a wet deck in bad weather to fight a flogging sail; instead, there is a simple, controlled reef. One caveat, however, is that, when the weather prediction is really bad, it may be better to hoist a storm sail at the outset rather than risk destroying that last tiny triangle of a reefed mainsail.

Different systems are available and these are divided into two general categories: those that furl into or behind the mast and those that furl into the boom. Most require a new spar (mast and/or boom) and all require a new sail. The cut of the sail is significant, not only for its shape but for efficient operation of the system. While an existing sail could theoretically be modified, it would probably not be cost-effective.

What's best? As with most things marine, compromise plays a role. All the usual considerations apply: reliability, safety and cost. Most manufacturers recommend (or require) that a professional rigger do the installation, but doing it yourself is possible with some systems, depending on your mechanical skills. If you're considering this important conversion, study the alternatives to find the right compromise for your boat, your budget and your boating style.

In and Behind Systems

With in-mast systems, a furling rod rotates inside the mast and the sail wraps tightly around it, controlled by a furling screw or a drive gear mounted on the mast. The behind-mast systems have a big advantage in the cost column, as they are used with the existing mast. Early vertical systems suffered from trade-offs that included a flat-cut sail and the absence of battens but today's sails use vertical battens and add some positive roach for better sail shape and performance. In the broadest estimate of costs (with variations based on what's included), a behind-mast system ranges between US$1,800 and US$6,500 and an in-mast from about US$8,000 to US$25,000 for boats in the 27' to 45' (8.2m to 13.7m) range. (These do not include installation fees or a new sail.) There are three suppliers in this category.

Charleston Spar

Cutaway area on Charleston Spar's in-mast reefing system houses a furling screw that turns the furling rod and the sail wraps around the rod.

Charleston Spar (Tel: 704/597-1502; Web: charlestonspar.com) manufactures spars with an in-mast reefing system that uses a furling screw. The mechanism is visible in a cutaway portion of the lower mast. It turns the furling rod inside the mast and the sail wraps around the rod until it reaches the desired reef point or is furled completely. The reefing line and an outhaul are used to control the system. Lines run aft to allow easy operation by one person from the safety of the cockpit.

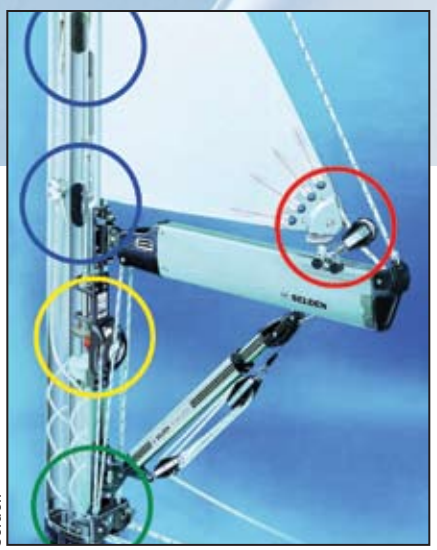
Charleston also offers Facnor, a vertical mast-furling system that doesn't require the purchase of a new mast.


CDI

The CDI system is economically priced and is designed to be owner installed using the existing mast and boom.

Facnor

Facnor contains the furled mainsail in a housing section fixed to the mast.


Selden

Selden in-mast continuous line furling systems are operated from the cockpit or at the mast and a tensioned luff rod with ball bearings reduces friction.

Instead, a separate housing section is installed in the sail track of the existing mast and the sail furls into this section. No drilling or alteration to the mast is required. The furling mechanism is a patented line drive positioned just above the gooseneck.

Cruising Design, or CDI, (Tel: 607/749-4599; Web: sailcdi.com) manufacturer of the Flexible Furler for jibs, now offers a mainsail reefing system. About half the units sold are owner-installed. Besides the DIY appeal, CDI is a very reasonable alternative as it's used with the existing mast and boom. CDI sends everything needed for the job, including drill bits and taps; only the outhaul and reefing lines are missing. To install, a 3/16" diameter stay and a plastic luff track are hoisted behind the mast. Top and bottom brackets and a reefing spool attach to the mast, fittings are installed on the boom and all lines lead to the cockpit. The mainsail will roll up around its luff to reef or furl. Everything is accessible outside the mast and there is virtually no maintenance. CDI is for boats up to 40' (12.1m) with a maximum 39' (11.8m) luff.

To accommodate its in-mast furler, **Selden** (Tel: 843/760-6278; Web: seldenmast.com) manufactures the mast extrusion with two chambers, keeping the furled mainsail separated from running rigging and cable conduits. The drive gear is mounted on the mast and operated with an endless line. Both the reefing line and the outhaul lead to the cockpit and one person can handle reefing or furling. As a safety backup, the drive unit can also be manually operated at the mast with a winch handle. The halyard swivel rotates easily under heavy load, so the sail is reefed or furled, even in severe conditions, without bringing the boat into the wind. A wide sail slot allows the sail to have vertical battens and positive roach for improved performance.

In-Boom Systems

With boom-furling systems, the existing mast can be used but the boom is all new. To reef or furl, the sail drops and rolls around a mandrel (tube) inside the boom. One-person can handle the job from the cockpit. The halyard raises the sail; the reefing line reefs or furls it. An electric halyard winch is highly recommended, especially for larger boats. In the unlikely event of a problem with the furling line, the sail is furled with a winch handle at the mast or dropped in the traditional way. The weight of the furled sail is carried low.

In-boom furling requires a strong boom section that resists twisting or bending. The boom must be set to a specific angle when raising or reefing the sail so a rigid vang becomes a necessary part of the package. The boom itself is heavier than a conventional boom so sailors are advised to consider a boom brake, as a jibe becomes a bigger problem. The sail feed is a critical component, as is a sail made to the system's specifica-

Furlboom

Furlboom features include: (top) Open boom with mandrel and tack connection. (middle) Internal rollers flatten the sail when furling. (bottom) One-piece PVC sail track and self-guiding feeder.

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Forespar Leisure Furl

Details of the Forespar Leisure Furl: (left) Mandrel inside the boom cavity wraps up the mainsail. (right) Simple polyethelyne luff track is easily fitted without the need to unstep the mast. (bottom) Mast-mounted manual winch provides a mechanical override in case of a main halyard breakage.

tions. Approximate prices for the 24' to 60' (7.3m to 18.2m) size range are US$2,900 to US$14,000, not including installation and sail. Several companies supply these systems.

Furlboom's (Tel: 949/642-9530; Web: furlboom.com) patented boom is tapered for lighter weight and less bulk but its strength is not sacrificed because the whole boom is an extrusion. The Furlboom drive system is mounted on the aft side of the mast and the sail hoists in a PVC track that fits into the existing mast track.

Specifications for the sail retain a conventional sail shape with normal roach and full-length battens. A smaller luff rope is used, enabling the sail to roll up flatter in front, thus more evenly overall. A built-in

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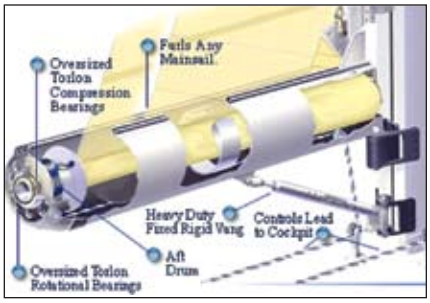
outhaul control assures better sail shape, which translates to improved performance. Sailors are surprised to see the performance capabilities of the boom-furling sail.

A Leisure Furl system from **Forespar** (Tel: 208/642-1312; Web: forespar.com) is easy to identify as the furling spool is mounted on the front of the mast and a stainless-steel shaft leads through the mast to the rotating mandrel. This setup ensures a smooth feed of the mainsail luff into the boom furler. The boom has a tapered profile to minimize weight and maintain aesthetics.



Schaefer

Cutaway of Schaefer in-boom furling system.

Hoisting and reefing or furling is done from the cockpit but, if there is a problem with the furling line, the sail is furled with a winch handle at the mast. The sail can have a full roach, in most cases, and full-length battens. Foot shape and luff tension are adjusted by built-in sail controls. The furled sail is protected by a built-in Sunbrella cover.

ProFurl's (Tel: 800/852-7084; Web: profurl.com) luff extrusion is set back from the mast about 8" (203mm). Positioning the track this way creates a straight line for furling and allows the use of a full-battened, performance-oriented sail. The bottom of the luff extrusion is connected to the top of the boom so the sail follows the angle of the boom, making it easier to reef at various points of sail. A patented vang maintains the consistent boom angle required when raising or furling but it also allows the boom to move up or down when sailing.

The boom is wide-open on top to minimize friction when furling. The decreased overall mass is appealing to those concerned about the size of boom-furlers. The system uses bearings and seals that are commonly available anywhere.

Schaefer's (Tel: 508/995-9511; Web: schaefermarine.com) system uses a patented track and sail feed design. Slides hold the PVC track about 2" (50mm) away from the mast and the track pivots so the sail is aligned with the angle of the boom on any point of sail. The sail feeder transfers the battened sail from the bottom of the track to the mandrel enclosed in the boom. Full-length battens remain parallel to the boom as they roll up with the sail — no snags, no creeping forward. Reefing is done without heading into the wind.

The top of the boom has a narrower opening than other furlers, precluding any possibility of boom twisting. For UV protection when the sail is furled, consider a fabric cover, which slides easily into grooves at the top of the boom.

About the authors: David and Zora Aiken have been liveaboards for more than 20 years and are authors of numerous books on boating,

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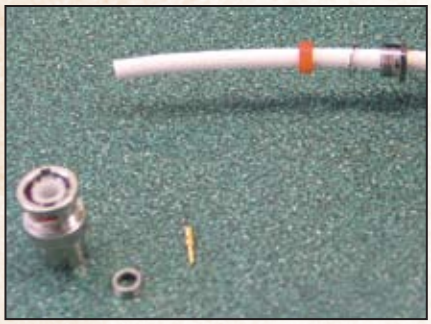
Terminating BNC Connectors

Follow these steps to install connectors on coaxial cable.

Story and photos by Jan Mundy



Components of a BNC connector for coaxial cable.

There may be a time when you need to install a new, a replacement or a second GPS or VHF radio antenna. Most antenna coaxial cables are supplied without the end connectors, namely BNC connectors. These connectors are not difficult to install but they must be installed correctly to prevent future problems.

Below are the instructions from Bill Glowsky of Shortwave Marine (905-278-6541) to install a BNC connector for a GPS on a coaxial cable (similar assembly for a VHF radio, though using a different connector). Installation requires no special tools other than side cutters, needle nose pliers, cable stripper, pen, Vise-Grips, soldering gun and solder and BNC connector of the proper type for the unit and sized for the cable. If you're unsure of soldering techniques, practice first on some scrap wire. Use rosin-core solder, which contains the correct tin-lead ratio, available at electronics' supply stores.

Step 1

Disassemble the BNC connector. Slide the threaded collar, metal washer and rubber gasket over the cable. Cleanly cut back or strip 1/2" (12mm) off the outer cable jacket, being careful not to nick or cut the braided shielding wires. Using a pen, separate the shielding wires into individual strands.

Step 2

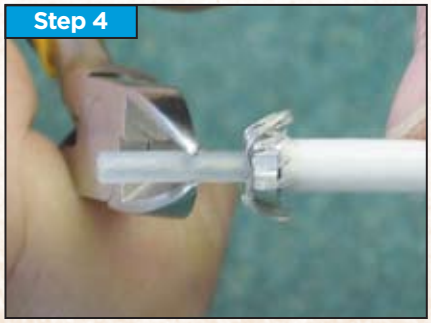
Slide the outer insulation band over the cable end.

Step 3

Take the needle nose pliers and carefully fold each individual strand of the shielding over the insulation band. Push to flatten.

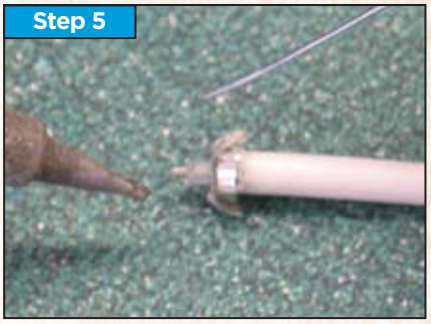
Step 4

Cleanly cut off the excess shielding to the same length as the bottom edge of the insulation band. From the insulation band top, measure 1/8" (3mm) and carefully strip off the inner core. Be careful not to nick the center conductor.



Step 5

Tin solder the center conductor and then cut it off so it extends 1/8" (3mm) past the inner core.

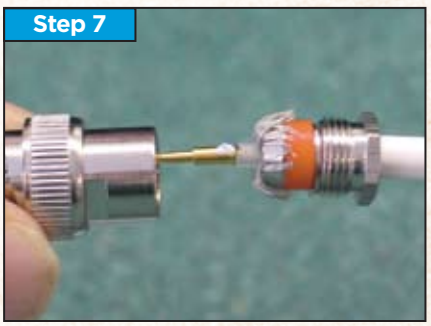


Step 6

Grasp the center pin in the Vise-Grips. Align the tip of the center conductor with the pin and solder together.

Step 7

Slide the washers and collar against the insulation band, insert into the BNC connector body and tighten the collar. A dab of silicone keeps water from getting into the coax.



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SEWING

Welcome Mats

Step-on pads, made of canvas or carpet to protect deck surfaces and collect shoreside dirt when boarding, are easily constructed with these binding and padding tips.

Jan Mundy

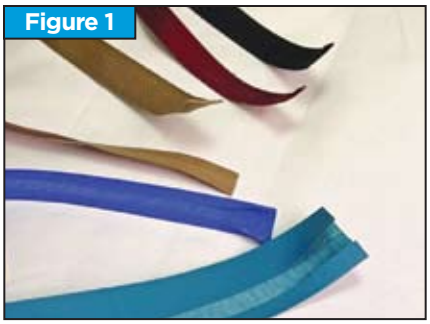
Sunbrella "carpets" with Sunbrella 3/4" (19mm) binding as seen on a boat at the 2006 United States Sailboat Show.

Story and photos by Jim Grant

We all spend a good deal of time on our brightwork and a good deal more cleaning up after visitors who track all sorts of debris onboard. One way to reduce maintenance chores is to use carpets, mats or pads (we will henceforth refer to all as "carpet") to protect deck surfaces and, at the same time, collect dirt for later disposal. With a little care, these useful items can be constructed so they offer an eye pleasing touch over several years of use.

I like to use 72" (182cm) Boat Blanket (available in blue, gray, beige and black at US$19.95 per running yard) for such a project. It's extremely durable (even in an abrasive environment) and it lets water run through rather than soaking it up. Alternatively, you could use indoor-outdoor carpet or, for light-duty use, choose acrylic canvas like Sunbrella (available in many colors for US$13.75 to US$16.95 per running yard) or Surlast (myriad colors for US$13.95 per running yard). Canvas' advantage, in addition to a colorful offering, is that it's easily folded into a very small bundle for storage.

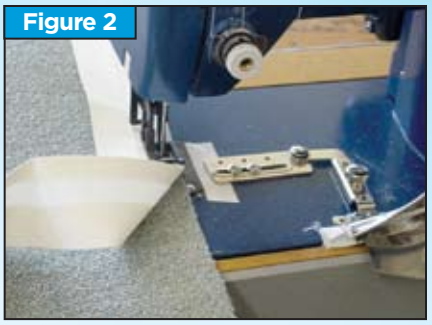
Figure 1



(bottom to top): Fabricated Stamoid vinyl facing; prefolded Stamoid vinyl 1" (25mm) bias binding; centerfold 7/8" woven acrylic (22mm) binding; 1" (25mm) webbing; and prefolded 3/4" and 1" (19mm and 25mm) Sunbrella acrylic binding.

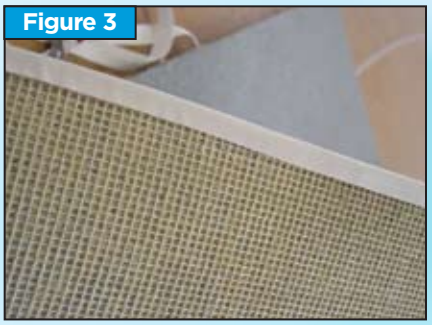
Cut your chosen material to fit between the opening gate stanchions. The most pressing problem with carpet construction is to prevent raveling along their edges. A binding, which is a long strip of fabric with folded or sealed edges and lapped over carpet edges, pre-

Figure 2



Sewing a vinyl facing good side down along the 1/2" (12mm) fold edge to Berber carpet. Notice binder in swing away (unused) configuration.

Figure 3

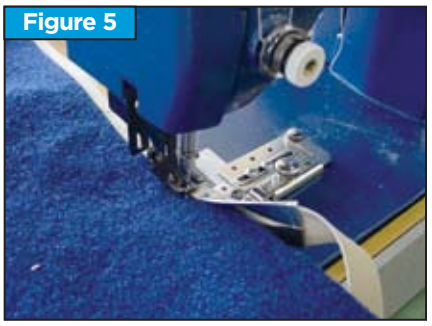


Vinyl facing glued to underside of Berber carpet.

Figure 4

Finished carpet edge bound with a facing.

Figure 5



Using a swing-away binder to install 1" (25mm) binding on Boat Blanket.

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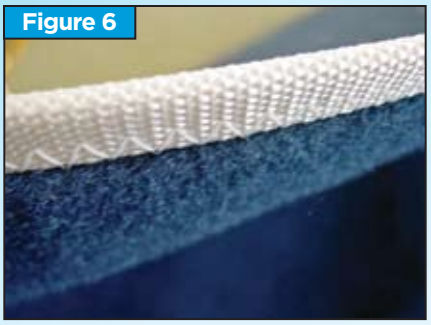

Figure 6 Edge of Boat Blanket finished with 1" (25mm) nylon webbing binding.

Figure 7 Removing the backing paper from adhesive-backed Velcro hook on the underside of Boat Blanket. The binding shown here is Sunbrella.

vents this. There are many binding methods but the following steps are common in canvas work.

Facings

Tapes used to make 2' (50mm) wide facings are cut 3-1/2" (88mm) wide and then the edges are folded 1/2" (12mm) on one side and 1" (25mm) on the other (as shown in **Figure 1**, bottom sample). They are sewn with a straight stitch with the right (front) side down along the edge (**Figure 2**) and then folded out over that edge so the stitches are hidden. This "unfolded" edge is then glued in place along the back (wrong) side of the carpet (**Figure 3**). Sailrite stocks a special acrylic glue stick (part #102210, US$1.95 per stick) for bonding these facings. Just squeeze out a bead of glue, 12" (304mm) or so at a time and fold the binding over, holding it in place for a few seconds to secure it.

Facings are prefabricated with folds glued in place and are available in many colors of vinyl (e.g., Stamoid at US$.60 per 12"/304mm) or acrylic (e.g., Sunbrella at US$.65 per 12"/304mm). They are especially appropriate for binding thick carpets that may be exposed to heavy use, such as car mats. It's possible to make your own facings from any synthetic fabric, just be sure to cut edges with a soldering gun to seal them.

Bindings

The most common binding used for thin carpets is a 3/4" or 1" (19mm or 25mm) prefolded vinyl or acrylic tape (Stamoid and Sunbrella at US$.30 to US$.35 per 12"/304mm) as shown in **Figure 4**. You can fold this tape down its center and install on an edge with a bit of care but there are mechanical folders (**Figure 5**) that make the work much faster and more accurate (Sailrite part 100102 to 100105 from US$45 to US$69).

Clothing manufacturers usually use a bias binding, which is cut on the diagonal across the cloth with seams every 54" (137cm) or so. It's easily shaped to go around corners with relative ease since the stretch of bias cut cloth is easily 10 to 20 times that of cloth tape cut on the thread line. Since seams can cause weak points in canvas work and the bound edges for boat carpets are mostly straight, the tapes used are generally not cut on the bias.

For really sturdy edging on relatively thin carpet, use light weight nylon webbing (**Figure 6**). It's awkward to fold it accurately but, when sewn with a 1" (25mm) binder, it provides an excellent reinforcement for any edge.

Sailrite also offers a centerfold 7/8" (22mm) binding (lots of colors available at US$.30 per 12"/304mm) made of an acrylic fiber that is woven so it's more accurately installed on an edge without the use of a binder tool. Again, it's limited to use on relatively thin carpet, such as those made of canvas.

Finishing

To help keep thinner carpet in place, especially Boat Blanket carpet, you may want to consider adhesive backed Velcro hook strips (US$.40 to US$.65 per 12"/304mm). When Boat Blanket is laid over Velcro hook adhered to the deck surface at strategic places, it sticks quite securely (**Figure 7**) without the need to sew. Other carpet material can be similarly secured if Velcro loop strips are sewn to their undersides so they will mate with the hooked strips. For canvas mats, adding a weighted line sewn into the edge seams and plastic clips that fasten to stanchion bases, ensures your carpet stays put.

About the author: Jim Grant is the founder of Sailrite (sailrite.com), a supplier of specialty marine fabrics, component hardware and tools, sewing kits and sewing machines. All materials mentioned in this article are available from Sailrite.

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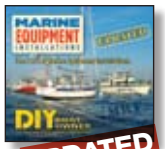

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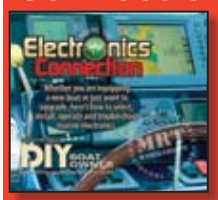

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Cold Storage

Pat Kearns

When the time comes to winterize your boat, proper protection from the effects of a long winter is important. Follow these winterizing tips to service washdown pumps and AC systems, store and protect your boat.

Compiled by Jan Mundy

10 Storage Must-Dos

Follow these tips when storing your boat on shore.

1 Store boats with a slight stern-down angle to allow cockpit drains, deck scuppers and bilge drains to empty. [For details on what happens if you don't, turn to page 12.]

2 Open all seacocks and drains.

3 Unless properly winterized, a marine engine can suffer major and costly freeze damage and the stored fuel can degrade. You'll find step-by-step instructions for decommissioning your engine in the service manual. Follow the instructions to the letter and, if you're in doubt, leave the winterizing to the pros.

4 Provide supports under boat covers to prevent water (snow and ice) from pooling, which can add considerable weight and put additional pressure on hull supports.

5 Never attach tie-downs to jack stands as they can pull the stands out.

6 If storing your boat on a trailer, provide additional support by placing jack stands under the hull. Stands should be placed as far outboard on the hull bottom as possible and should be chained together and lock the chains. The trailer is still the primary support for the hull, so don't block the boat higher than its trailered position. You don't want the trailer to roll out from under the boat. Make sure the trailer wheels are blocked and you've secured the hitch ball receiver on the tongue so that a thief cannot back his vehicle up to your trailer and drive away.

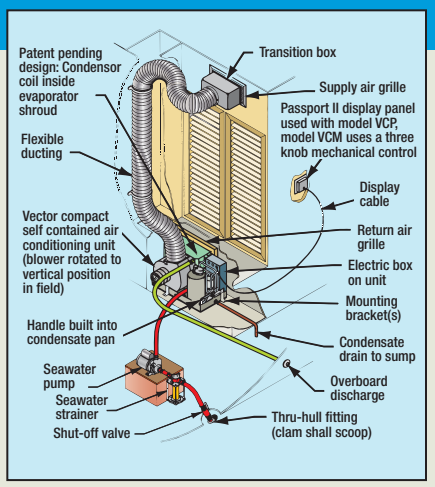
7 Never leave canvas, cushions, sails and other soft goods on your boat over the winter.

8 To reduce condensation and resultant mildew, place DampRid or similar moisture absorber in the cabin and lockers.

9 Never use a workshop type portable light (AC or DC) or forbid, a portable heater or a portable automotive type battery charger in a gasoline engine space. (NFPA 303, Marinas and Boatyards, prohibits unattended appliances.)

10 Inspect your boat regularly to check for symptoms of winter weather damage. If your boat is blocked in yard, watch for changes in the terrain that could lead to "shifting sands," which are known to occur after a freeze/thaw cycle and heavy rains. Any evidence that the stands are moving or sinking into the ground should be reported immediately to the yard staff. Keep your eye on your neighbors' boats as well but keep your hands off. This is the yard's responsibility.

Winterizing AC



Purging with either air or antifreeze is necessary to prepare air-conditioning systems for winter storage in cold climates.

There are two ways to winterize the seawater circuit of any air conditioning system. The first method is to blow the water out with compressed air. This is easier to do with a single unit. Depending on the volume of your air supply, multiple units may need to be individually disconnected and air purged. Disconnect the water supply lines, beginning with the line from the intake thru-hull, to the pump and then the line to each condenser, making sure each component (pump, manifold, valves and condenser coil) is purged of water.

The best way to verify successful air purging is to hook everything back up, apply compressed air to the pump intake and check that all discharge thru-hulls deliver a good solid blast of relatively dry air when all three components are switched on at once.

The second, more common method is to use antifreeze to flush out the

TIP

Engine Aid

When storing marine engines for an extended period of time, it's extremely important to protect the fuel system from today's ethanol-blend (E10) fuels. At the very least, add fuel stabilizer and run the engine for a minimum of 10 minutes. As fuel treatments vary, depending on your engine, refer to your owner's manual or contact the engine manufacturer for off-season preparation specifics.

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water. Pros often use the nasty automotive ethylene glycol, as opposed to the more environmentally friendly propylene glycol plumbing antifreeze, because the toxic stuff is still effective even if diluted 50% with water. Check your local regulations, as ethylene glycol might be illegal to use unless you can recapture it for recycling. Pets are attracted to antifreeze so be certain to contain any spills that might tempt a pet to take a taste.

The usual technique is to disconnect the intake line at the thru-hull and reprime the pump and intake hose with antifreeze. Have an assistant turn on each air unit until they are all running, while making sure a steady flow of antifreeze is supplied to the pump. Do not let the pump suck air or it will lose its prime (AC pumps are notoriously non-self priming). When you see antifreeze coming out each discharge thru-hull you have successfully winterized the system. This procedure can also be done one unit at a time.

Pump Storage

Residual water in the pump froze and cracked the housing and switch.

Connect the hoses and run the pump until antifreeze runs out the washdown outlet.

Proper winterizing of washdown and livewell pumps prevents the plastic components from cracking due to freeze damage. This involves displacing the water with non-toxic plumbing antifreeze. (Details of a washdown pump rebuild due to freeze damage appears in DIY 2006-#3 issue.)

You'll need a jug of -50F (-45C) plumbing antifreeze, two short lengths of 5/8" (16mm) ID hose and a bucket. Place one hose end in the jug of antifreeze and insert the other end in the seawater pickup thru-hull (middle). To one end of the other hose attach a female hose fitting and screw this onto the washdown outlet and place the opposite end in the bucket (right). (A Washdown Quick Connect with bayonet adapter from New Found Metals makes this simple.) Run the pump until pink solution passes through the hose and into the bucket.

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Wrap it!

ShrinkRapid cover before (left) and after (right) heat shrinking.

The best care you can give your boat during the off-season is to shield it from UV and weather damage. Shrinkwrapping provides better protection from the harsh winter conditions than tarps and canvas covers. Besides 100% UV protection, it provides total waterproofing against weather damage and stands up to sub-zero temperatures.

Protecting your boat is now even easier and faster with Dr. Shrink's new ShrinkRapid sewn shrinkwrap covers (Tel: 800-968-5147, Web: dr-shrink.com). These semi-custom fit shrinkable covers combine the simplicity of conventional boat cover installation with the tight fit and durability of shrinkwrap.

With sewn-in perimeter and belly bands, and no tucking and trimming required, the covers are fast and easy to install. It takes just minutes to cover a 20' (6m) boat.

Semi-fit covers are available in 2' (61cm) increments that fit vee-hull and bass boats from 17' to 24' (5m to 7.3m), center consoles from 17' to 28' (5m to 8.5m), pontoon boats from 22' to 28' (6.7m to 8.5m), cuddy cabins from 18' to 29' (5.4m to 8.8m) and PWCs.

Available in heat-reflecting white, these covers include two self-adhesive vents to reduce moisture and resultant mildew problems and they are large enough to accommodate a support structure under the cover for snow-load areas. Covers can be removed and reinstalled and, next spring, recycled using Dr. Shrink's Rebag program. ShrinkRapid covers start at US$112 for an 18' (5.4m) runabout and US$47 for a two-seat PWC.

When it comes time to select a yard to haulout and store your boat there's little you can do to ensure the yard's equipment is up to par but there are some details you can monitor. Use DIY's Yard Rating Worksheet as a report card to rate the yard and bolster your own judgment. It's available by clicking here.

Keep it Visible, Keep it Accessible

Tips to organize your safety equipment so it's readily accessible, ready, willing and able when needed and not out of sight and out of mind.

Shock cord securely holds both the distress signal canister and the horn. PFDs are kept in an acrylic storage bag on the cockpit seat. Throwable cushion is always within easy reach of the helm.

By David and Zora Aiken

Coast Guard boardings and the Coast Guard Auxiliary's Vessel Safety Check are both good reminders for boaters to make sure they carry safety gear, the extras as well as the equipment mandated by law. We hope we'll never need most of these items but, if and when we do, it's guaranteed we'll need them fast.

A fumbling search during an inspection should provide the incentive to revise the storage plan so safety equipment will be plainly visible as well as readily accessible (defined as being available for use without having to use tools to gain access) to everyone onboard and their location not remain the privileged information of the captain who packed the storage lockers many weeks or months ago. In a worst-case situation, that captain may be unable to tell anyone where anything is stashed, much less how to use the equipment.

Personal Flotation Devices (PFDs)

Years ago, a friend showed us a good way to store the rectangular-shaped PFDs many boaters keep for extras. Each was encased in a fabric cover and served double duty as a backrest. While the offshore PFDs don't stow as neatly as the square-cornered style, the idea is still practical. We've used acrylic pillow covers inside the boat for some time as bedding storage and back cushions, so we simply usurped one of them for our in-cockpit PFDs. If you sew, the cover's a quick project. If you don't, any canvas shop can make a cover customized to any size or shape. Make sure that each cover is also prominently and indelibly marked "PFD Inside." Other PFDs are stored together in their own labeled case, in the wheelhouse, whenever guests are aboard. No matter where you stow the PFDs, remove all packaging from new PFDs before putting them away. Donning PFDs quickly should never be complicated by the need to remove packaging.

Emergency Boarding Ladder

A small canvas bag holds our emergency boarding ladder. It's a basic tread-and-line assembly that provides help or support when needed. Since it's small, it could easily drift into a tiny, mysterious place but we always keep it in view. Make sure to clearly label this bag with its contents. It's also a good idea to have at least one practice exercise to make sure the ladder attachment point and the method of setting it up are clear to all who might use it.

Distress Signal Canister

As brightly colored as flare kits are, finding it should be easy but, in our boat's cavernous seat lockers, that was not always the case, much to the entertainment of the boarding officials. The bright orange canister now lives in our boat's wheelhouse on a small wood platform with shock cord holding it in place against the bulkhead. Purchase a mounting bracket for the canister or make a bracket the DIY way.

Horn

With radio communication so popular, the horn, electric, compressed gas or the lung-powered model, sees less use every year. It still needs to be onboard and available for instant use as a sound-signalling device when in fog, when overtaking another boat or for any emergency. Since it's small and seldom used, it needs a permanent storage spot to avoid its being lost to view. The horn should be within arm's length of the helm station, which may have a handy recess that you can dedicate to this small item. Otherwise, build and attach a small shelf, stand the horn on it and strap it in.

Binoculars and bell are both within arm's length of the helm.

Bell

We mounted our bell on the aft bulkhead inside the wheelhouse, just to port of the helm, ready to sound signals when needed. When we owned aft-cockpit sailboats, we used two bell brackets: one mounted inside and one in the cockpit. If the bell was outside all the time, it would occasionally be the source of some unintentional random ringing, the result of either wind or wave action. The inside storage coincidentally extended the intervals between polishings.

Binoculars

Though binoculars are not on the list of required equipment, they do see constant use on most boats and they definitely contribute to safer boating. Rubberized coatings minimize damage from accidental falls but a storage case helps to prevent such knocks from occurring.

Again, placement is the first consideration. Mount binoculars close to the helmsperson, who uses them most and needs them most quickly. We keep ours in a wooden box attached to the aft bulkhead in the wheelhouse, easily reached from the wheel. The box is wide enough to hold the binoculars even when they're stowed in their own carrying case but the main advantage of the separate box is that, while the boat is underway, it allows the helmsperson easy one-handed pick-up and stowage.

Type IV Throwable Device

Because our sailboat is a center-cockpit design and the Lifesling, a man overboard retrieval device, is mounted at the stern, we keep another throwable cushion inside the wheelhouse. It doesn't have a formal storage spot but its bright red color is easily seen and it's always within a few feet of the helm. Throwable cushions are often white, yellow or blue, too, and can double duty as seat and seatback cushions. More are better but remember that the red or yellow cushion is more easily seen when floating in the water; white and blue are virtually invisible in a sea. A throwable ring or horseshoe shaped device should be stowed in a handy bracket suited to the device. It should have at least 50' (15m) of floating line (polypropylene braid) attached for retrieving a heaved throwable that misses the target and for assisting the person overboard, who is hanging on to the device for dear life, to the boat. Marking the throwables with the boat's name is also prudent.

About the authors: David and Zora Aiken have been meandering boat for more than 20 years and are authors of numerous books on boating, camping and travel. They live aboard "Atelier," a 35' (10.6m) 1963 Chris-Craft center-cockpit sloop.

Bleeding the System

When hydraulic steering becomes sloppy or unresponsive, it's time to purge the air. Here's how to bleed the system.

Purging the air from this '90s vintage SeaStar side mount hydraulic steering was long overdue.

Story and photos by Jan Mundy

Loose, sloppy and slow to respond steering, or a clicking or grinding sound in the helm, are signs of air in an hydraulic steering system. Or, as in this case, oil seeped out the overflow in the helm filler nut every time air in the lines got hot and thermal expansion caused the oil to rise and overfill the reservoir. The only way to rid the air is to bleed the system.

Few tools are required to bleed a hydraulic steering system. You'll need a bleeder kit, two quarts (946ml) or more of hydraulic oil, a small funnel, assorted wrenches, collection containers, 1/4" ID drain hose, rags and bottle support tackle (e.g., tape, line, coat hanger).

Check your owner's manual for specifics on the bleeder kit model and hydraulic oil type. I purchased a Teleflex bleeder kit and the fluid for the SeaStar system. Never use brake or transmission fluid or you risk irreparable damage to the unit and the potential loss of steering.

These instructions show how to bleed an older Teleflex SeaStar side mount, single cylinder system with one bleed screw. For front mount, dual cylinders and newer systems with two bleed screws, check your owner's manual for filling and purging instructions. The procedure requires two people.

Step 1

Remove filler plug on the helm pump and fill reservoir with oil.

Step 2

Screw the threaded end of the bleed kit filler tube into the helm filler hole. Attach the other end to the oil bottle. Rig a sling to hang the bottle of hydraulic steering fluid. In this case, it was hung from the convertible top frame. Invert the bottle and, using the pushpin included with the bleed kit, poke a hole in the bottom of the bottle.

Step 3

Attach one end of a long length (about 4'/122cm) of 1/4" ID hose to the nipple on the cylinder end and place the other end in a bucket. Open the nipple nut until oil flows out the hose. Place a collection bucket under the bleed screw.

Step 4

Turn the steering wheel hard over to starboard (clockwise) so the cylinder rod is fully extended. Open the bleed screw. Have a helper manually hold the cylinder rod (see photo above) so it doesn't retract into the cylinder; never use pliers or you risk damaging the rod. Slowly turn the wheel to port (counterclockwise) and stand back as air and oil squirts out the bleeder.

Continue turning the wheel until a steady stream of oil without air comes out the bleeder. When there is a steady flow of air-free oil out the bleeder, while continuing to turn the wheel, close the bleed screw. Release the cylinder rod. Fluid should be flowing out when you

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close the bleed screw or air can back up into the system. This drains about half the oil bottle.

Step 5

Turn the steering wheel hard to port (counterclockwise) until the cylinder rod it fully retracted (side-mount units only; on front mount cylinders the rod is fully extended). Open the bleed screw. Slowly turn the wheel to starboard (clockwise) until all air is purged out the bleeder. (For front-mount units have a helper hold the cylinder while turning the wheel.) Close the bleed screw while continuing to turn the wheel.

At this stage, you might have to attach a new oil bottle. To do this, rather than switch quart bottles, I punched a funnel through the pinhole in top of the oil bottle and refilled from a jug of oil. Be sure that oil fills the filler tube at all times. This prevents any air from entering the system. Tighten the nipple nut.

Step 6

It's often impossible to remove all air from the system. A trick relayed to me by DIY's engine expert Steve Auger is to let the bottle hang overnight (now you know the second reason for the sling) either by rigging a coat hanger to the windshield or a rope and tape sling, as we did in this case. Gravity forces any remaining bubbles in the system back to the helm and they blow out the highest point, the bottle. If you're not going boating for a few days, let the bottle hang longer.

To eliminate spills when disassembling, thread a screw into the pinhole in the oil bottle and tape the screw head, invert the bottle and drop it below the helm pump (rest it on the cockpit floor) so the oil drains from the filler tube, leaving an inch or so in the tube. Place a rag around the filler hole, unscrew the filler tube and quickly replace the filler plug.

Either recycle the discharged oil after passing through a fine mesh screen or dispose of it in a manner consistent with local regulations.

Steering that is quick to respond and has the correct amount of wheel turns when hard over on one side to stop on the other (refer to your owner's manual) are signs that the system is free of air. Downloadable owner's manuals for most Teleflex and Hynautic systems are available at ww2.seastarsteering.com.

Hydraulic systems require little maintenance. Periodically, check all connections for tightness and, at least once a year, clean and grease the tilt tube. Check the oil level in the helm reservoir before every outing and maintain the oil level to within 1/8" (3mm) to 1/2" (12mm) of the top, depending on the model.

Dependable steering is a critical component to the safe operation of your boat. If you have any doubts as to the correct bleeding procedures, it's best to entrust this task to a professional.

About the author: Jan Mundy is editor of DIY.

Multiple Cabin Heating

A custom conversion of a freestanding propane cabin heater supplies warmth to the outer extremities.

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

10

Custom heat exchanger alteration keeps the forward cabin on the author's trawler at a toasty 68F (20C).

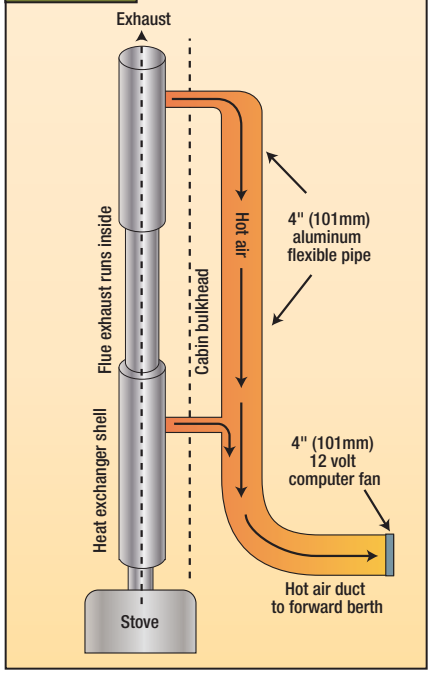
To enjoy fall and winter cruising in the Gulf Islands of British Columbia, adding a stand alone cabin heater to our trawler was a neccessity. The Dickinson Alaska heater was our choice as the right size and BTU output for our needs.

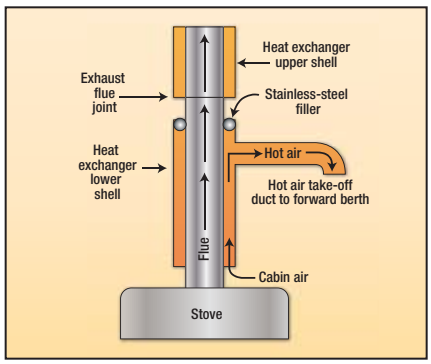
Following the directions supplied by Dickinson made the installation of the heater easy and straightforward. Getting the warmed air to circulate throughout the interior space was the single persistent problem. We rectified the problem in the galley, bridge and salon areas by installing a 6" (152mm) 12-volt computer fan to circulate the air in the upper portion of our boat. Getting heat down to the head and berth, which were both located three steps down from the bridge, was a bit more challenging.

My background as an aircraft maintenance engineer reminded me of the common method of heating lightweight, single-engine aircraft using a heat exchanger coupled to the engine exhaust system. It looked like the same principle could be applied to the stove's existing heater exhaust. I looked at the system of exhaust pipes with a built-in heat exchanger that Dickinson offered and decided that I could build a similar system for less money (**Figure 1**).

The exhaust run from the heater to the deck head was 60" (152cm), about the length of the two standard Dickinson exhaust flue heat shields I had purchased. Using two sheets of .060 stainless steel, leftovers from a commercial kitchen job bought from a local metal recycle yard, I cut the stainless into 18" (457mm) sheets and, after calculating the inside circumference of the heat

Figure 1





Joe VanVeenen/Mike Bullock

DIY BILL OF MATERIALS

Materials		
15lb (6.8kg) stainless-steel sheet		30.00
2 Dickinson flue exhaust heat shields		140.00
2, 4" (101mm) ID aluminum heater ducts, 8' (243cm) lengths		20.00
1, 4" (101mm) 12-volt computer fan, wiring and switch		20.00
Fiberglass insulation		30.00
Miscellaneous hardware		5.00
	Total Materials	**$245.00**
Labor		
Fabrication of the stainless steel heat exchanger shields and hot air ducts		4 hours
Installing shields and ducts in the Dickinson heat shields and sealing joints		2 hours
Assemble exhaust flue and heat exchangers on the boat in sections and then install onto the stove and secure to the bulkhead		4 hours
Route the hot air ducting inside the bulkhead, through the floor to the forward berth		6 hours
Install the hot air suction fan		2 hours
Final clean up and trim work		8 hours
	Total Hours	**26 hours**

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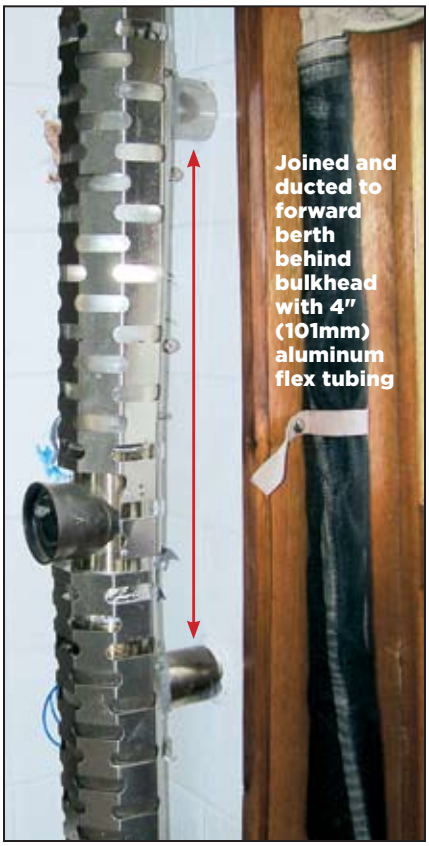

shield, cut these sheets so they measured 18" by 9" (457mm by 228mm).

The next step was to roll the sheets so they fit snugly inside the heat shields. A local sheet metal shop did this job for me. After dry fitting, each sheet was drilled with a 2" (50mm) hole, 1" (25mm) from the top. To hand roll the tube that would be used to extract the heated air, I slit a dowel lengthwise to a depth of 3/4" (19mm) and then inserted the edge of an 8" by 5-1/2" (203mm by 139mm) stainless sheet into the slit and clamped the whole assembly in a vice. The sheet was then rolled around the dowel and secured with hose clamps. After drilling through the overlapping section, they were secured with pop rivets before removing the hose clamps.

Next, the rolled stainless tubes were permanently installed in the heat shields, gently tightened until the joints butted together and then secured with two hose clamps. The assembled tube was fastened midway in the heat shield and locked in place with four 10/32 stainless steel machine screws and self-locking, heat-resistant nuts near each corner.

A total of eight cuts in the smaller 2" (50mm) tube at one end allowed bending it to make a connection without welding. This was then inserted into the main tube and the "tabs" bent back to conform to the face of the interior tube. After ensuring the smaller tube was 90° to the large tube, I drilled several holes and pop riveted this tube in position. The seam of the large tube and the joint, where the smaller tube was inserted, were carefully sealed with gray silicone.

The next step was to install both completed heat exchangers on the heater's exhaust pipe. All joints on the exhaust pipe were sealed using a good quality heat-resistant metal tape. The heat exchangers were carefully positioned on the heater exhaust pipe so that the heat exchanger tubes covered no joints. These were then secured to the pipe using the clamps and hardware supplied by Dickinson for the heat shields. A stainless-steel scrubbing pad was picked apart and packed into the top of the heat exchanger to prevent air from being drawn down.

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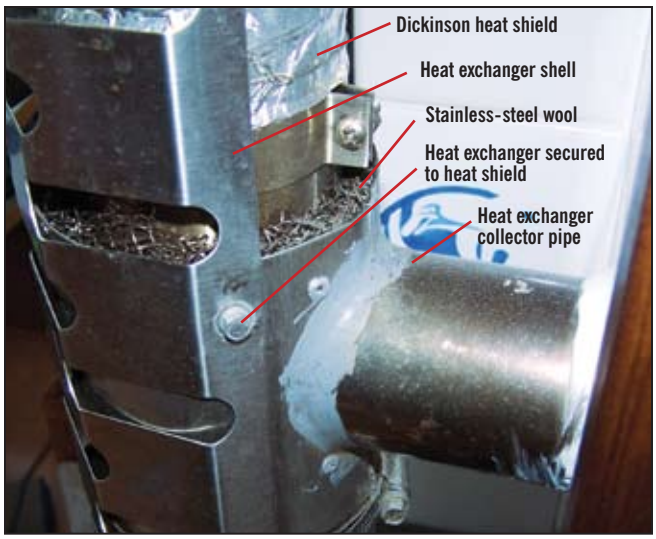

The next step was to plumb the two heat exchangers together and route the heat line to the exit. I used flexible metal tubing and an insulated and lined duct purchased from a local hardware store. A 4" (101mm) computer fan was installed at the exit to the forward berth area to suck the air through the system. This fan connects to a switch on the bridge and is labeled "forward heat."

The results are such that, with the heater running, a considerable amount of the heat from the exhaust, heat that previously would be lost in the exhaust discharge, is now redirected to heat the cabin air, which is then drawn through the heat exchanger and ducted forward to heat the forward berth. This is enough to make the entire cabin quite comfortable in a wet and chilly West Coast winter or a spring trip up the coast to Princess Louisa Inlet.

Project Notes

I used .060 thick stainless-steel sheet because the recycler had it in stock..032 material would be easier to work with and to form.

Stainless steel is hard on tools and drilling requires extra patience and a supply of sharp drill bits. Make sure all corners and edges are filed smooth for safety and appearance.

When making the large heat exchanger tubes, you can use an overlap joint instead of a butt joint, which allows some tolerance in measuring. When doing the initial measuring and installing the heat exchangers, ensure that all horizontal joints are not covered in case they leak exhaust and to allow for future disassembly if required. I also strongly recommend installing a smoke/fire detector/alert and carbon monoxide detector in all boats, especially those equipped with a carbon fuel burning heater or stove.

About the author: "Timeless," a 34' (10.3m) Beaver Glass trawler, is Mike Bullock's second extensive boat refit. Ongoing refurbishing includes new windows, fuel tank replacement, berth reconfiguration and a new wooden cabin sole.

Galley Cooldown

A spare locker accommodates an exhaust fan to ventilate the galley.

6

Blower installed in shelf area above stove. Metal screen filter covers the blower compartment.

How well the galley is ventilated can dictate what you cook, in terms of the food you choose and the amount of time it takes to prepare. If you can't remove the heat and the cooking odors, you won't do a lot of real cooking on board, whether "real" is gourmet or down-home.

Here's one solution. Though planned for a traditional sailboat galley on a Tripp-designed 44' (13.4m) Mercer, the idea can be adapted for other configurations.

Like most sailboat galleys, the Mercer's stovetop is below deck level. The original owner installed a stainless-steel panel above the stove to shield the overhead, but that directed the heat inboard toward the cook. The new owner decided to simply remove the heat.

Lack of space prohibited the use of a range hood/fan, even a scaled-down RV version. Besides, these units often don't vent the air to the outside; they merely filter it. Better to mount a small blower near the stove to exhaust the cooking heat and odor outside the boat through a vent pipe. In this case, a lifeline stanchion was ideally positioned on deck just above the stove. That stanchion could be replaced with one that would also serve the secondary function of a stovepipe.

Planning

Situate the blower as close as possible to both the stove and the underdeck location of the stanchion. Most galleys already have a built-in locker or shelf at the back of the stove where you can fit the blower covered with a metal mesh filter. These filters are sold as replacement parts for range hoods. Look for these parts in stores that sell stove accessories, including the home warehouse chains. It's useful to make a cardboard mock-up of the installation before purchasing anything.

New stanchion/stovepipe installed on deck.

A suitable blower can be obtained from W.W. Grainger (grainger.com), part number 2C646. With a steel housing and components, this blower is not flammable as those made of plastic might be.

Assembly

The stovepipe could be made of another metal but, to match the stanchions, it's likely to be stainless steel, so any necessary welding is probably not a DIY project. Use tubing at least 2" (50mm) in diameter so airflow won't be restricted (larger is better). A standard 3" (76mm) stovepipe would obviously work but it may not pass the aesthetics' test. When designing the stanchion/stovepipe, allow for some of the pipe to extend through the deck, so that you can attach whatever is used to adapt the blower outlet to the pipe.

The best situation is for the blower outlet flange to attach directly to the base of the stanchion. If that's not possible, an adapter block or plate may be needed. A difficult installation may require the use of a pipe or hose. In this case, keep the hose as short and as large in diameter as possible (at least 2"/50mm). Use metal pipe or hose. A muffler shop should be able to supply what you need.

Cut a hole through the deck, matching the outer diameter of new stanchion/pipe and install it using appropriate adhesive caulking or bedding compound and stainless screws.

Blower Install

Once the stanchion's in place, you'll know exactly how to place the blower.

Metal filter installed in front of blower locker.

Box in a separate compartment on a shelf or locker, leaving the front open for now, and install the blower. It may be necessary to add a bracket to mount it properly.

Pick a convenient spot in the galley and wire a blower switch using 14 AWG wire or larger. Install a 10-amp fuse in the positive (power) wire where it connects to the boat's existing wiring. Make sure the existing wiring can support this additional 10-amp load. [Ed: Follow ABYC standard E-11, AC And DC Electrical Systems On Boats when doing any boat wiring.]

Test the venting capability. When you're satisfied that the new vent is working well, screw the metal filter in place over the face of the blower locker.

As with any stovepipe, the top of the stanchion must be covered to prevent water entry, whether from rain or waves. It's practical to have two "caps." For ordinary use, a lightweight, loose-fitting lid allows galley heat to exit but stops rain from entering (a substitute for the traditional Charlie Noble). To make one, shape a wide, inverted cone from a piece of lightweight aluminum, then make a bracket to keep it in place. Use a tightly fitted cap when a brisk sailing day might threaten to carry away the other lid. Wire the cap to the stanchion as added insurance.

— David and Zora Aiken have been meandering by boat for more than 20 years and are authors of numerous books on boating, camping and travel.

Heads-Up

Materials purchased from Home Depot offer a practical, maintenance-free solution to worn and decaying headliners.

7

Two people working two weekends resulted in a practical and maintenance-free headliner that improves and brightens the '77 vintage interior.

We purchased "Orion," a 1977 36' (10.9m) Islander as a project boat and for a place for my son to live while attending Texas A&M Galveston.

The boat had been unattended for many years and unfortunately, the owner, now deceased, had done very little maintenance. There was a lot of water damage inside and, in the past two years, we replaced most of the interior. The headliner was the original and was falling down but we didn't tackle this job until we finished all the other projects, which included repowering, all new DC and AC wiring, new electrical panels, installing a potable pressure water system and a new toilet and holding tank, replacing the existing air-conditioning system, rechroming deck winches and redoing all interior woodwork.

Framework

The old vinyl headliner was removed, along with the plywood strips that were used as staple points to support the headliner. These strips, fastened into the cabin top with thousands of staples, were relatively easy to remove using Vise-Grip pliers. Just clamp the staple and roll the pliers end backwards

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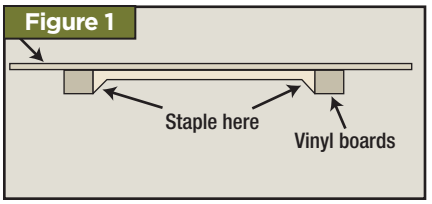
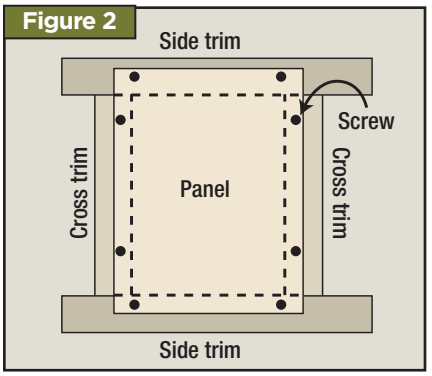




Joe VanVeenen/Dan Martin

PVC strips fasten to the overhead and terminate at any thru-deck fittings.

against the overhead to pull out the staple. Use a small, flathead screwdriver to pry up stubborn staples. Fortunately, we didn't have to remove all the staples, as the new headliner covered some. With the liner removed, it was a good time to rebed the deck hardware.

The 1" by 2" (25mm by 50mm) PVC stringers were measured, cut and drilled, first with a countersink and then a drill so that screw threads passed through easily and then we installed the stringers. PVC was used instead of traditional plywood as it doesn't hold water, won't rot, is easy to cut and drill, holds a screw and most importantly, it flexes and bends to fit the contours of the overhead.

The first boards installed were those around the cabin perimeter. The trick to creating a nice smooth finish is to countersink the screws into the stringers. We used #8, 1" (25mm) long, stainless screws and spaced them approximately 12" (304mm) apart. Our boat has a 3/4" to 1" (19mm to 25mm) overhead thickness and this length of screw countersunk flush in the stringer, biting about 1/4" (6mm) into the overhead. This provided plenty of grip. (Be sure you know the thickness of your boat's overhead before installing.)

To find the boat's centerline we ran a string from the mast's center where it passes through the cabin top to the center of the companionway hatch. From this line, we drew perpendiculars 17" (431mm) apart using a square. This easily contained the 16" (406mm) wide insulation and satisfied our dockside "engineers" who suggested that wider panels might sag. Stringers were then cut to the measured length of our drawn lines and installed in a similar fashion as the perimeter boards. Whenever we encountered deck fitting hardware, we cut the board and continued on the other side of the fitting.

DIY BILL OF MATERIALS

Home Depot	
8 1" by 2" by 12' (25mm by 50mm by 304mm) white PVC trim, Part #0215012011, $10.29 each	$82.32
4 4' by 8' (122cm by 243cm) fiberglass wall panels, Part #MFTF12IXA480009600, $29.97 each	$119.88
2 Reflectix 16" x 25' insulation, Part #ST16025	$30.00
2 Boxes stainless-steel staples	$20.00
Houston Hardwoods	
80' (24.3m) linear, 1/4" by 2" (6mm by 50mm) teak, $2.44/foot (304mm) cut to size	$195.20
West Marine	
Miscellaneous screws	$100.00
Total:	**US$547.40**

Insulation fits loosely between the framework and is stapled to the stringer's sides.

Fiberglass panels customarily used for home bathroom walls are custom cut to fit between the stringers. Snug fits are unnecessary as joints are covered with a decorative teak trim.

Filling and Finishing

Reflectix, an aluminum backed, bubble wrap insulation, was now secured to the PVC stringers using an electric staple gun (PVC is too hard for staples fired from a manual gun) and stainless-steel staples purchased at Home Depot. The insulation's edge has a small lip ideal for stapling and we found that stapling to the stringers worked best (**Figure 1**).

With insulating complete, it was time to install the fiberglass "paneling" sold at Home Depot to frame head compartment bulkheads. Cutting these bulky 4' by 8' (122cm by 243cm) sheets into 17" (431mm) strips proved difficult and, after checking our options and doing a test on a table saw, we found that our Ryobi cordless circular saw did a wonderful job. A plywood sheet placed over the sawhorses supported the flimsy paneling, with just the cutting edge overhanging the plywood, simplified cutting the strips. When cutting the strips to the needed length, remember that the boat curves and the panels are not a perfect rectangle so measure both the leading and trailing edges.

Most of the overhead consisted of straight pieces and these were easy to install with two people, one to hold and the other to drill. Panels were installed using #6, 1/2" (12mm) long stainless steel, flathead screws (**Figure 2**). Holes drilled in the panel were countersunk. The grid centered the panels on the trim, covering about three-quarters of the side stringers.

Be sure to measure the leading and trailing edges of each panel because, on most boats, the overhead narrows towards the bow forward and you must compensate for this on each piece. This required some form fitting because there is not a square edge in the entire boat. To fit the panel around obstacles (e.g., the mast or sharp corners), we cut it with tin snips and/or a jigsaw.

Screws were place on 12" (304cm) centers and we left out the center screw, which was secured when applying the finish trim. Do not drive the screws in hard or they will strip in the PVC stringers. It's better to fasten by hand than to use a power screwdriver. Don't worry about an exact fit. The gaps between the panels are covered, as are the screw heads, with trim.

With all the panels in place, it was time to start the final trim work. We chose teak, 1/4" by 2" (6mm by 50mm), to match the interior, purchased from Houston Hardwoods (Tel: 713/686-6176), who cut all the trim to size for a reasonable price.

Using a chop saw, we attached the perimeter trim, first to the overhead and then the cross members last, with #6, 3/4" (19mm) flathead screws and finishing washers. The teak was drilled with oversize holes so that the screws easily passed through. Placing the string line on the trim provided a guide to evenly space the screws. The center screw was fastened first to allow the teak to conform to the overhead as it's attached.

With two people, installation of the headliner in the main salon (we still have to do the head and forward cabin) took two weekends. These materials offered an affordable alternative to traditional headliners, with the added benefits of a maintenance-free, easily cleaned overhead that's rot and waterproof. Panels remove readily for any future maintenance and they brightened the interior. As for the insulation value? Time will tell.

About the author: Dan Martin holds a 100-ton operator's license earned from time spent on offshore oil field supply vessels and ocean-going freighters. He is an avid fisherman who has owned 20 boats, with "Orion" being his most ambitious project.

Trouble Comes In Threes

This saga of the failure and ensuing servicing of a new 150-hp outboard engine details three engine rebuilds during the first four years of use.

10

Story and photos by Mark Yeates

The author's first engine rebuild revealed signs of damage as a result of a powerhead that was replaced under warranty by a dealer. Shown here is pitting damage to the number three piston and cylinder head damage caused by bouncing metal fragments missed by the dealer during the first rebuild. Note scoring on cylinder walls thought to be from a lean condition.

My engine problems began when, in the same year that I purchased a new 2001 Yamaha 150 hp V-Max for my mid-80s bowrider, the crankshaft broke. I trucked the boat to the dealer who sold me the engine and he replaced the powerhead after receiving authorization from Yamaha. Nearly two months later, I had the boat back and spent the remaining summer weekends breaking in the replaced powerhead.

The next year and less than a month into the boating season, the engine emitted a strange sound and ran poorly so back it went to the dealer. Three weeks later, I received a call saying that the mechanic could find nothing wrong so I collected the boat and ran it for the summer without mishap.

The engine ran fine the following year until an August day on Georgian Bay (Lake Huron), when I ran the engine at wide open throttle to try to outrun a storm. Within 15 minutes, the engine produced that familiar "this is going to cost me" sound.

This time I delivered the boat to a different dealer and waited while the mechanic inspected the engine. Removing the portside head revealed visible cylinder scoring and damage to rings on the number six and number four cylinders. The technician told me that the damage likely was caused by a very lean condition and could be repaired at a cost of $2,000 to $5,500. This was a lot more than I could afford so the dealer suggested I do it myself or do the disassembly and bring it back for any work I didn't want to attempt. This sounded like a fair offer so I returned home, purchased the engine service manuals, and started the disassembly.

Removing the starboard head uncovered damage to the number three cylinder. The cylinder head, cylinder walls and piston were damaged by a metal piece bouncing around in the cylinder and the only time this engine had been disassembled was for the powerhead replacement. Immediately, I contacted Yamaha whose records showed that it had sent the servicing dealer a new powerhead but, as the company hadn't recorded the serial numbers of either the old or new powerhead, the trail ended. In other words, that was all Yamaha was going to do.

I spent the winter months cleaning every inch of the engine, grinding and polishing every surface to remove flashings and rough surfaces in both the intake and exhaust ports (no change to port size openings). When a part or wire was removed, it was put in a Ziploc bag and labeled with a description, the corresponding page number in the manual and the item number on the page. I stored each package in clear plastic bins.

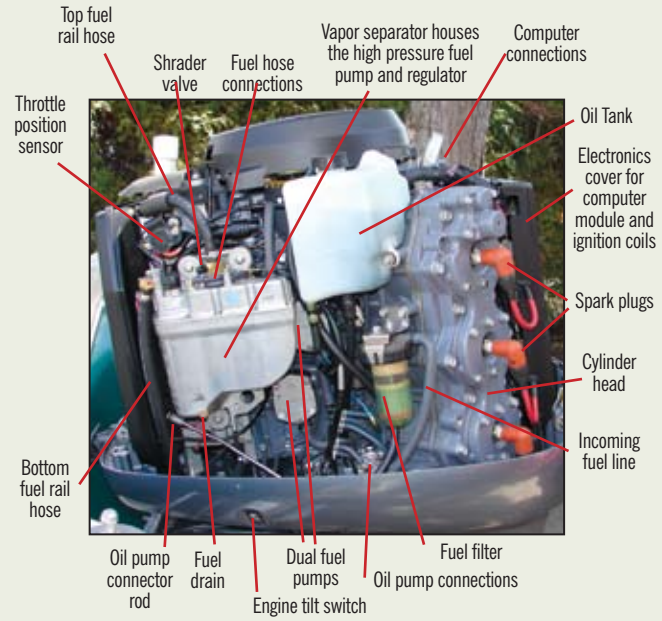
It was now spring and time to start the rebuild. I sent the block to be machined and purchased parts from John's Marineland. Reassembly involved page-by-page reference to the service manual. Everything went together with no left over parts. The only non-Yamaha part was a set of carbon fiber reed valves used to smooth out idle and mid range rpm. The engine started right away and ran great but sounded a little different with the carbon fiber reed valves.

Rebuild #3

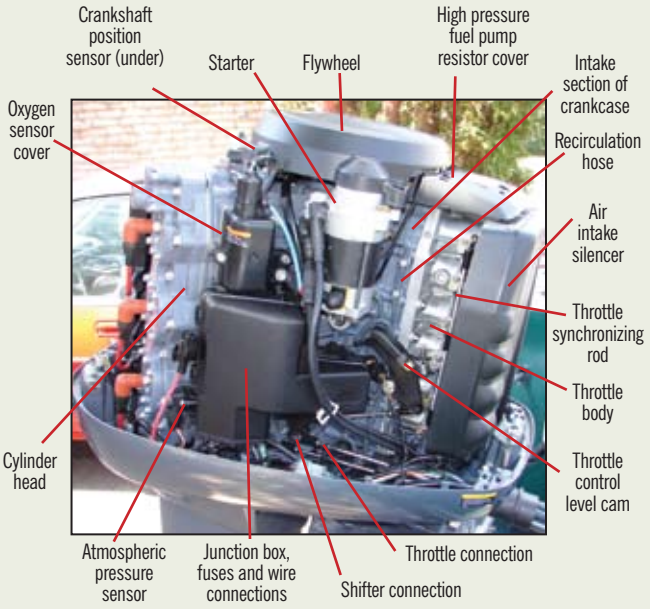
Later that summer, I was boating alone and I decided to check the top speed. The engine was well past the break in period and, at 5,500 rpm, with the speedometer reading 53 mph, I heard that "this is going to cost me" sound, again. Discouraged, I returned home and parked the boat.

During the next few months I spent hours searching the web for clues. I posted my engine problems on iboats.com and received advice from a few members who were Yamaha mechanics. On person who goes by the handle of "Rodbolt," suggested that the problem was a lean condition and that the cracked flange and crushed and broken O-ring could have lead to the damage of number six cylinder. He asked if I had tested the oxygen sensor as this can cause the same problem. I had tested it as per the manual using the torch test, which he advised was not a good test and that a better sensor test was with the engine running per the Yamaha service bulletins. He also suggested that the problem could be the fuel pumps or injectors, which I had not checked or tested.

After calling various suppliers and hearing prices as high as $650 for the oxygen sensor and $80 for fuel pumps, I found an affordable source for these at Boats.net. Fuel injectors were delivered to a carburetor shop that tested and rebuilt the six injectors for a reasonable $30 each. A marine engine shop charged for block machining per cylinder $55 to machine and $10 for honing. When returned, the block was pressure washed and degreased and all passages blown with air and dried with



Engine Port Side Components



Engine Starboard Side Components

clean cloths to remove moisture. Then all machined surfaces were wiped with a clean cloth soaked in new 10W30 oil, as advised by the machine shop, not the outboard oil recommended by the service manual. Finally, the block was wrapped in a clean sheet until needed.

The next step was to install nine new crank seals on the crankshaft. (I broke one when removing the crankshaft and thought it best to replace all of them, though they looked to be in good shape.) This rebuild required three new pistons to replace the scuffed pistons, new C-clips, six sets of new piston rings and, as recommended by Rodbolt, new rod bolts. No rods, pins or bearings needed replacing.

My motor had locating pins in the piston ring groove. The rings are notched at the opening, so they go around the pins when installed. Observing the service manual instructions, I aligned the openings to the pins and then used the piston ring compressor to collapse the rings. A slight twist may set a slightly out of round ring. Piston and cylinder were oiled before installing. The piston must be right side up and positioned on the right side, as there is correct side and origination to a piston. Placing the piston against the ring compressor, I hit it with a rubber mallet. One quick hit did it. (Hit too hard and you'll drive it into the crankshaft.) On the first rebuild, I used two wooden dowels to guide the piston rod into the right position on the shaft. I just used my hand this time. I installed all pistons and tightened the bolts by hand. Once all where in place, I torqued them to the first torque setting and then I rotated the crankshaft to make sure there was no binding. For good measure, I backed them all off and did it again to the first torque requirement then the full setting. I was just trying to make sure the torque setting was true. I thought a slight binding might throw off a setting.

Next, I installed the intake section of the crankcase. I used a very good quality flange sealant as recommended in the manual, coating parts with a thin film so any excess wouldn't flow onto other parts and gum them up. Crankcase bolts were torqued to the correct setting to pre-

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vent squeezing out the sealant.

The next assembly steps differ with each engine. For this engine, it was the crankshaft seals at each end. Orientation is critical as, on this engine, there is a right and a wrong. With the block standing up on its end and chocked to keep it steady, I installed first the exhaust cover and then the heads, followed by the remaining parts.

Once again, I sea trialed the engine and it ran without a glitch. I kept the old oxygen sensor for the initial break-in period for two reasons. One was to test it while running the engine and, with all the new assembly oil and lubricants, I didn't want to clog the new one. The oil oxygen sensor failed this test where, with the burn test, it looked okay.

About the author: Mark Yeates rebuilt "Knotty Thots" from a mid-80s hull and deck he purchased for $600. A detailed account of the reconstruction and conversion to a modern, well-appointed bowrider appeared in DIY 2002-#2 issue.

Engine cover

Engine before disassembly

DIY REPAIR BILL

The following is the cost in U.S. funds of the author's third (and hopefully, final) disassembly, rebuild and reassembly of his Yamaha 150 V-Max.

Materials

Engine block: machine and hone three cylinders	170.00
3 new pistons	213.00
6 piston ring sets	198.00
1 gasket rebuild set	175.00
1 oxygen sensor	289.00
1 oxygen sensor gasket	13.00
2 fuel pumps	64.00
9 crank seals	81.00
12 piston cap bolts	60.00
12 C clips for pistons	24.00
6 Fuel injectors: cleaning and refurbishing	162.00
1 gasket maker	18.00
1 Loctite, purple	22.00
1 Loctite, red	7.00
1 pulley to lift powerhead	17.20
1 label package	4.00
6 clear totes	30.96
Ziploc bags, three sizes	8.00
Total	**$1,556.16**

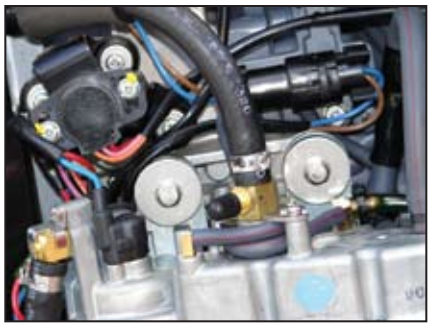
Materials to make flywheel wrench

3, 1" flat bar	14.85
3 sets of bolts, nuts and washers	4.05
Total	**$18.90**

Time Spent

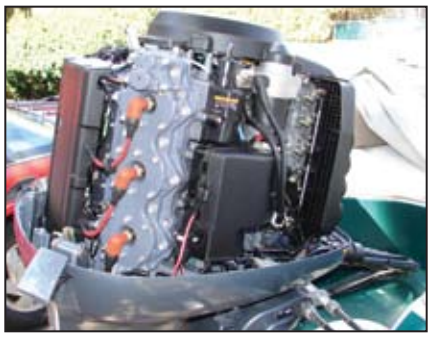
Layout, drill and bolt flywheel wrench	3/4
Remove powerhead to workbench	3
Blow out block after washing and oil to stop rust	1/2
Wash and scrub block twice after machining	3/4
Disassemble engine and bag and mark each item	8
Install carbon fiber reeds	3/4
Reassemble engine	10
Sand heads	2
Test parts, filters, thermostats, regulators	3
Reassemble block to lower unit	2
Total hours	**30.75**

Oil pump and hoses



Schrader valve on top of fuel float bowl. This is used for testing fuel pressure. It also relieves fuel pressure when dissembling the pump.

Oil pump connecting rod to throttle body



Starboard side of engine showing, starter, oxygen sensor, fuse box and shifter connections.

Black cover hides computer module and ignition coils.

CONTENTS PREVIOUS NEXT

Air intake Silencer and flywheel cover. This covers the air intakes and fuel injectors.

Fuel injection pump from the top. Showing Schrader valve and pressure regulator valve.

Flywheel (rotor) and the started motor.

Intake showing air intake and fuel rail for injectors.

Flywheel and hold down nut. This must be torqued as specified in the service manual.

Electrical connection for computer module.

Computer module.

Wire connections running above port head.

Computer module and port head.

Breaker bar shown. This is to get leverage on the nut.

Breaker bar as shown from above. This set up worked fine.

Home-made flywheel wrench (breaker bar) made of 1/4" by 1" (6mm by 25mm) flat bar has two pieces bolted together to fashion a strong handle and then two pieces of flat bar, 10" (254mm) long, bolt to the handle about 6" (152mm) from one end to create a pivot. A minimum 1/2" (12mm) hole is drilled about 2" (50mm) from the handle end, past the pivot point and opposite to the pivot connection bolt.

To use the home-made wrench, insert a long bolt, leaving at least 1" (25mm) of thread sticking out from the nut. Now screw this bolt into one of the flywheel holes. Line up with the second bolt, drill the hole and install the bolt and nut. On my wrench, it was almost equal distances from the pivot point in both directions.

Pulley set is required to remove the flywheel after removing the hold down nut.

It doesn't take much turning on the pulley for the flywheel to pop up.

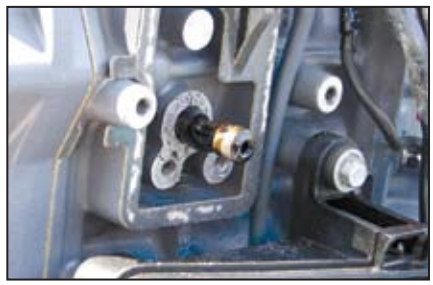
Stator assembly located under the flywheel. You can see the starter at the bottom left corner. The crankshaft position sensor is in the top left corner, and the oil tank on the middle right side.

All parts are put into different zip lock bags. I used three sizes. The bags are labeled to what the parts are, the page number from the manual and the item number on the page, then they are stored in clear plastic totes.

Starter removed from starboard side. All wires labeled. Bolts are bagged and tagged.

Oxygen sensor cover. The sensor is just behind the starter and above the fuse box.

Oxygen sensor with the cover removed.



The oxygen sensor joint gets encased with oil and carbon with engine use. Always remove and clean this sensor when breaking in an engine because of the extra assembly oil, engine oil and oil in the fuel tank. I also clean it every month, as I don't trust them. Never touch the sensor when the engine is warm, as they get very hot.

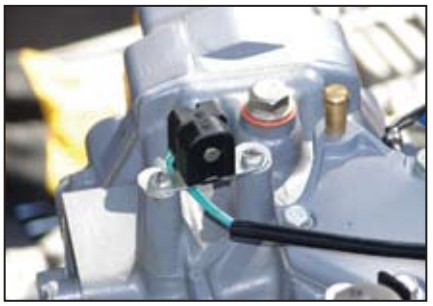
Oxygen sensor joint showing oil and carbon build up.

If the oxygen sensor cover gasket is damaged when checking and cleaning it must be replaced.

CONTENTS PREVIOUS NEXT

All parts, wires and hoses are put into separate Ziploc bags that are labeled with the part ID, the page number from the service manual and the item number on the page, which is then stored in clear plastic totes. Wires were also tagged on each side of the connector; for example, A to A, MM to MM.

The pulser coil is shown, located under the stator assembly. Note orientation of the wire connection before removable.



This is the crankshaft position sensor located beside the flywheel and has a specific gap between it and the flywheel. Check this after reassembly.

Top of engine with stator assembly and pulser coil removed.

Starboard side of engine with the starter and oxygen sensor removed.

Fuse box unbolted from engine and wires marked with various locations.

Cables from driver's control box. For connecting the shifter and the throttle control.

Throttle and shift connections.

Shifting rod disconnected from engine.

Throttle pivot bolt.

Draining fuel bowl on portside of engine.

Cutting the clamp off the top of the fuel filter. This is the feed line from the fuel tanks.

Fuel filter unbolted and sitting on its side. The fuel feed line from the tanks is removed and labeled.

CONTENTS PREVIOUS NEXT

Picture of the ground wire running to the top of the port head.

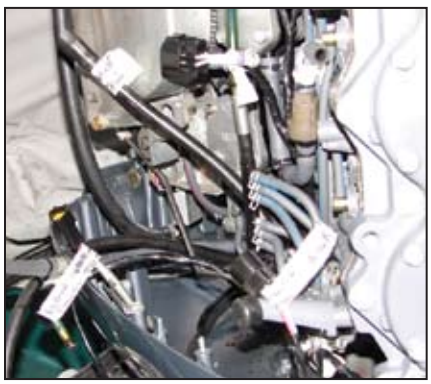
Wire rope and shackle are wrapped around a tree branch and a rope pulley attaches to the powerhead to lift the powerhead off the lower unit.

Rope pulley attached to the top of the engine.

Pully attached to the tree branch.

Lower unit attachment bolts removed.

Removing hidden power head bolts.



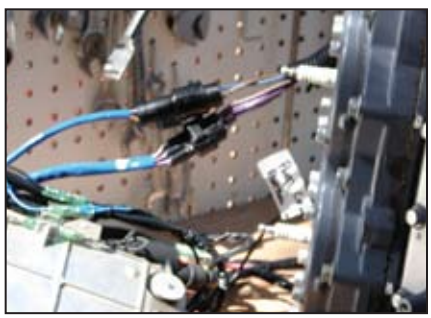
Engine mounted trim button connector and oil pump manifold.

Labeled wiring for the engine mounted power trim.

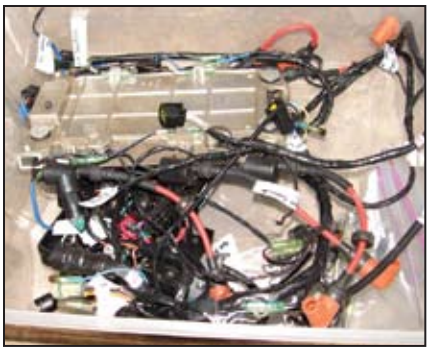
Power head tied off to the tree, while boat is moved out of the way.

Workbench on wheels is rolled under the power head.

Powerhead is lowered and braced on the workbench. Fuse box is removed from starboard side and is sitting behind the engine.



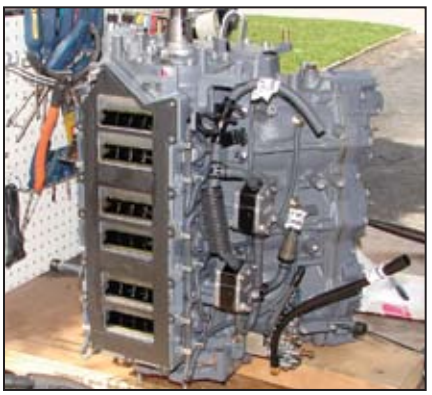
Computer wire harness before labeling.



Fuse box, computer module, ignition coils and wire harness stored in clear plastic tote.

View of the rear of the engine showing both heads and the exhaust port cover.

Intake assembly, including high pressure fuel pump and float bowl, butterfly air intake valves, fuel rail and injectors.



View of the intake without the intake assembly. The six rectangular openings on the second intake plate are for the reed valves.

Port side of the engine. This view shows the two fuel pumps and the oil pump located on the bottom.

Oil pump and screws. The oil control rod attaches to the pivoting section were the cotter pin is located.

Port side of engine. Bleed hoses attached to reed plate on the left side. The silver section at the bottom is the area that the oil pump bolts on to. The pump is driven by a gear that runs off of the crankshaft.

This is the reed plate. Replaced reed valves are carbon fiber and react better than the original steel reeds.

Close up of reed. The smaller reed with the rounded edges lifts at lower rpm the larger at high rpm with increased fuel and air requirements.

Starboard side of engine. This picture was taken for the bleed hose layout. The engine is now down to the heads on the left and the crankcase. It is split in the middle around the crankshaft. The rectangular section and the oily back hole is where the oxygen sensor sits.

Port head removed. Bolts are bagged and tagged. Notice the lack of carbon build up as compared to the first rebuild (shown on page 58) for a timeline that is less than one year.

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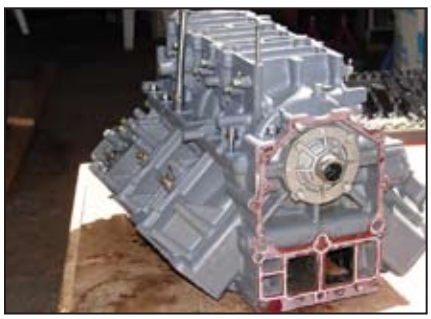
Looking at the back of the engine. This is the exhaust port cover. It was under the computer and ignition coils. Both heads are now removed.

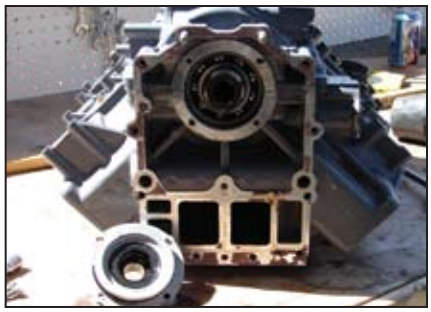
The exhaust cover removed exposes the water jacket section. I had deburred this area to allow good water flow on the first rebuild and touched up the finish with some extreme high heat paint (shown in red) rated at 1,400F (760C) but it didn't survive well on the starboard side. I lightly sanded this area to prevent paint flecks gumming up the cooling system.

Exhaust plate cover removed. This is the carbon and oil build up from the last rebuild just one year before. I removed all the rough areas in the sand-cast block with a small die grinder to allow for better exhaust flow.

View of the scored number four piston through the exhaust port.



View of the bottom of the block. The two exhaust ports can be seen at the bottom. The round section is the lower crankshaft cover. You must mark the orientation of this cover. It also shows the crankcase bolts being removed.



With the cap removed you can see the lower crankshaft bearing.

The two half's of the crankcase are separated. The crankshaft is now exposed.

This is the intake section of the crankcase.

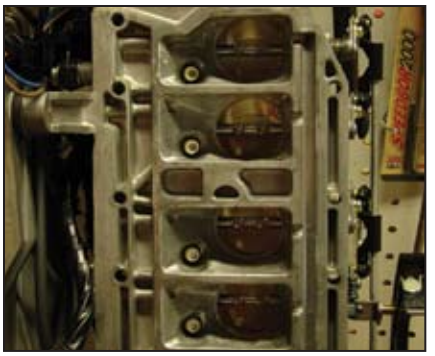
Shown are the six connecting rods attached to the crankshaft, two bearing raceways and locating wire and the nine crankshaft seals. Be careful when removing the crankshaft as I broke one of the seals and decided it was prudent to replace them all.

CONTENTS PREVIOUS NEXT

With the crankshaft out the oil pump gear is removed. It is located on the lower half of the port side, by cylinder # 6. The shaft is driven by the end gears on the shaft. As the crankshaft turns this turns the gears and the oil pump turns.

Crank case bearings, raceway and locating wire clip. The round molded section on the top inside of the case is where the oil pump gear is housed.

View of the crankcase cylinder head section of the motor from the top. Under this cover is the cooling chamber of the cylinder head.



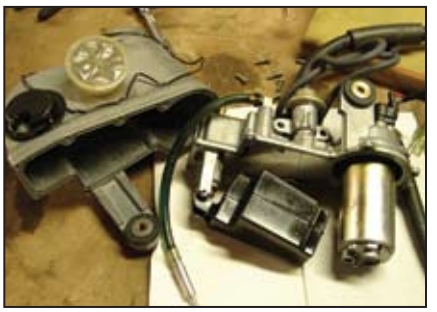
Intake throttle body from the inside. The four round white objects are the fuel injectors from the inside.

Fuel rail has been removed and now you can see three injectors. The wire clips have to be removed to remove the wires. Be careful when removing the clips as they want to spring away. The injectors are mounted in a rubber grommet and just pull out. Check for cuts or wear on the grommets and replace if required. I sent my injectors to Carburetor Rebuilders Co. in Toronto, Ontario, for cleaning and rebuilding.

Number 6 fuel injector removed.

All injectors are now removed.

High pressure fuel injection pump with the float bowl removed.



All fuel pump parts including bowl and pump filters.

Testing the pressure regulator with a vacuum gauge.

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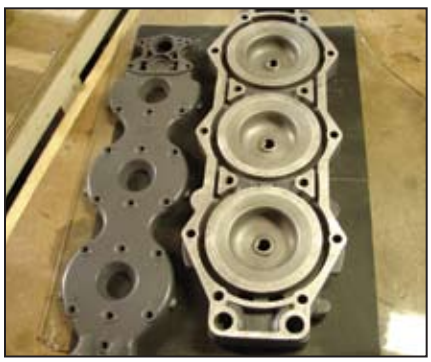
Testing the pressure regulator and fuel pumps with a vacuum gauge. Both pumps checked out but I replaced them anyway. This engine did not need more problems.

Cylinder head sitting between two boards screwed to bench. This stops the head from turning when trying to remove the water jacket bolts.

Water jacket and thermostat cover removed.

Gasket removed from water jacket.

Cylinder head cleaned and now ready for sanding to make sure it is flat. This is recommended in the manual. On a piece of flat plate glass attach 200-grit sandpaper using spray adhesive. Now in a figure eight motion, sand the cylinder head surface. Do this till you get a uniform finish on all surfaces. Next, switch to 400-grit paper and do the same. This took awhile for the starboard head and I had wished I switched to 150. Also block the glass so it does not move and that the surface is clean and flat. I used a scrap ¼" (6mm) thick piece of glass and mounted 400 grit on one side and 200 on the other. Also don't use too much adhesive in case you have to replace a piece or both as I did when it lifted at the joint between the two. I pealed it off and cleaned the glass with acetone.



I also did the water jacket but I don't think it's necessary as they are thin enough to adjust to the head.

One head partly sanded and the other not touched.

Sandpaper attached to glass.

The starboard head partly sanded down. Note the old damage on number 3 cylinder. The damage had been ground down by a die grinder on the first rebuild. Only the high spots were removed as I was trying to minimize the effects this may do.

To test the thermostats, I bent a coat hanger and wired them in place and then submerged them in water that was brought to a boil while monitoring the temperature. Check the manual for the specific temperature when the thermostats start to open and when they are completely open.

Closeup of thermostats.

Thermostats out of the water showing fully open.

Inside of exhaust port plate. Prior to cleaning. Not easy to clean!!

Installing rebuilt injectors.

Old piston beside new piston. No rings installed. Only the piston was replaced. The rod, pins and bearings were in very good shape and only required cleaning and lubing. New C clips were used on all pistons as they had been removed from the rods for checking and cleaning.

Damaged piston.

Ready to install new pistons.

Installing new piston rings on new pistons using a spreader. Be sure the ring is installed the right way up. Also make sure the notch in the ring goes around the pin in the groove when clamping with the piston ring compressor. Some times a little twist of the piston will set it right.

New piston ring installed. Make sure the ring is installed the right way up. Also make sure notch in the ring goes around the pin in the groove when clamping with the piston ring compressor. Sometimes a little twist of the piston will set it right.

Piston ring in the piston ring spreader.

New rings on new piston.

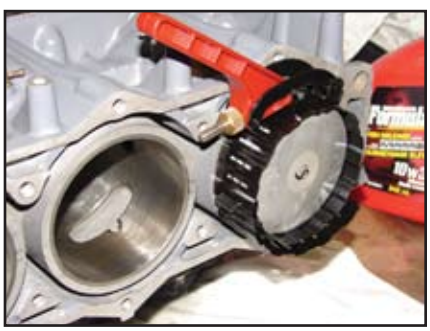
Lube cylinders prior to installing pistons. Wash and dry the block after getting it back from the machine shop to remove all dirt and metal fillings. I washed mine twice and used a pressure sprayer to blow it out then dried it by hand and oiled it down to prevent rusting. Then covered it with a clean sheet to keep the dirt out.

The machine shop recommended using 10X30 oil to lubricate cylinders prior to installing connecting rod bearings and pistons.

Lube connecting rod bearings.

New rings and piston oiled.

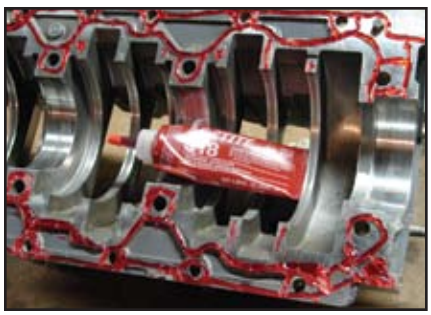
Piston ring compressor installing piston.



Piston being installed.

Torque the exhaust port bolts in sequence as per the manual (each bolt hole is numbered), torqueing half the requirement first and then redo all bolts to the full value.

Installing the internal sacrificial anodes.



Ready to install the crankcase. I used Loctite 518 Flange Sealant material as per the manual. Make sure not to use too much material. Imagine where the material will go when it flattens out. You don't want it getting into bearing or other delicate parts. Do not over torque the bolts.

Installing lower crankshaft cover seals and O-ring.

Pistons, crankshaft, end caps and exhaust cover installed.

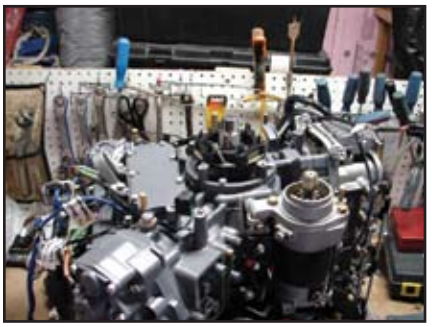
Portside head sanded flat and with a new head gasket. Head bolts (shown in the background) were cleaned with a wire brush on a Dremel to remove old sealant and dirt.

Take a digital photo of the bleed hose layout so that you can refer to it later.

Installing bleed hoses on starboard head.

Starter and the computer and ignition coil module installed. Starting to wire the fuse box.

Computer and ignition module installed.



Installing the pulser coil and the crank position sensor. Make sure you route the wires into the right position and hook them up prior to installing the stator assembly.

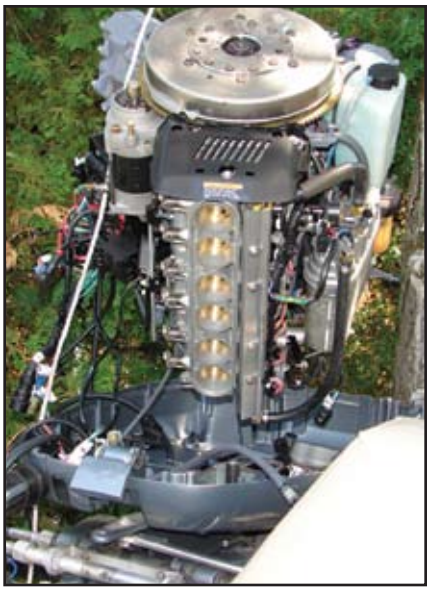
Installing two new fuel pumps. These pumps have a right and a wrong way to install them. Make sure the arrows are going in the right direction.

Install the fuel pumps before installing the high pressure fuel pump. It makes it easier.

Getting the power head ready to lift.

Base and lower unit cleaned and ready for the power head. When cleaning off the old gasket material block all openings to ensure no debris gets in. New gasket in place.

Lowering the powerhead in place requires three people: one to lower and two to situate.



Oxygen sensor joint.

Powerhead installed.

After the initial break in, the oxygen sensor joint is removed. Oil build up is from assembly oil, standard engine oil and oil in the tank for engine break in. Because the break in does not allow for high rev's for the first part I used the old oxygen sensor for this part. This also allowed me to test it as per the new testing method. It failed.

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Without Trailer Assist™

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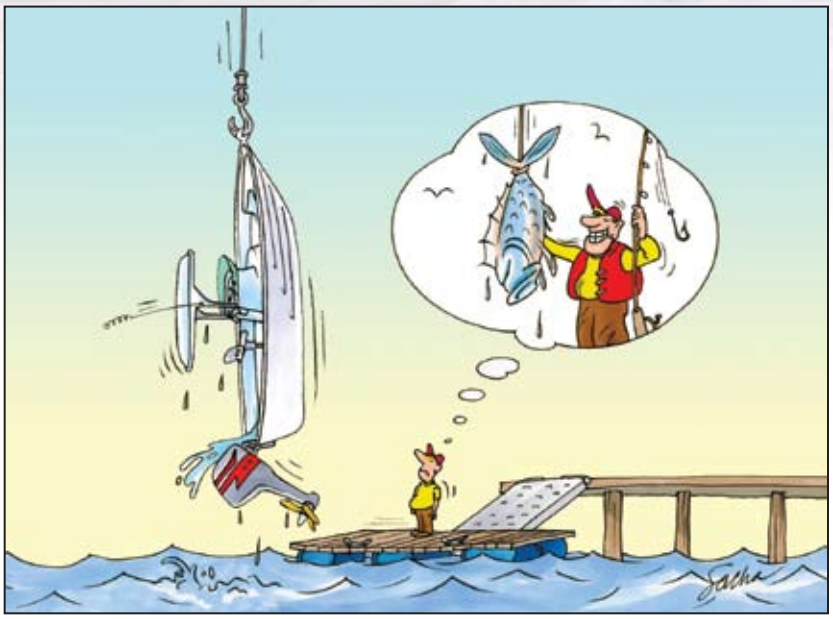
View from the Stern

To Do (or not to do) When Your Boat Sinks

When a boat goes belly up, time is money and a rapid response plan is the best investment in the rescue.

By Roger Marshall

When my boat rolled over and sank at its mooring I never knew why. I suspect that winds over 30 knots, gusting to 40, a wind against tide situation and the wake of a large ship conspired to take a dive. It went over fast, that's for sure.



Getting the boat righted was a major problem. The center console just didn't want to roll back. As a last resort, I hired a crane to lift the boat by the bow eye (not a good idea for lightly built boats) until it was completely vertical and then the stern was tied on either side to stop the boat from rolling over again as it was lowered. The crane arm was moved so the boat would land in the water on its bottom and it was lowered away. The transom acted like a spoon and scooped a lot of water into the stern hatches but not enough to sink it again. With the cockpit sole awash, the boat floated upright. At this point, the crane slings were placed underneath and the boat lifted out. The journey from the marina to my driveway was marked by a trail of water that ran out of the boat on the trip home.

The first task after such a disaster is to get the engine going again, keeping in mind that electronic fuel injection doesn't like going for a swim. The Suzuki 115 hp had been completely dunked and all the dials and gauges were soaked. I removed the cowling and air filter and blocked off the air intakes.

Next, the entire engine and boat were washed with freshwater. I drained the engine oil, replaced it with fresh oil and then removed the spark plugs and sprayed penetrating oil into every cylinder. Now, the engine needed turning over with the plugs out to purge any water in the cylinders. Before doing this, I pulled the electronic computer module (ECM) and dried it off with a blast of compressed air. Behind the ECM are two relays that were also pulled and blasted dry. Unfortunately, I missed the exhaust sensor module behind that.

After connecting the battery, the switch was turned to crank the engine sans spark plugs. A puff of gray smoke signaled that the exhaust sensors were now burned out. We couldn't figure out how to get the engine turned over without the module, so I called all the local Suzuki dealers to find a new one but there were none in stock and getting one from the factory would take days.

At that point, it was decided to take the engine to the local Suzuki dealer who was able to start and run it to dry purge all the water and dry out the innards. After that, I got in touch with the insurance company and figured out what work needed to be done to restore the boat to pre-sinking condition. That work is now progressing. The only thing I lost was an anchor that went directly to the bottom.

I was a bit stunned by the invoice for the services of the boat yard crew and the crane (US$2,800) that rescued my boat but they were all there when I needed them and I had no other alternatives at the time. Any issues with that bill will be the insurance company's problem.

If you are ever faced with needing a salvor's help, make sure you know the fees before you agree to accept the service. If your boat turns turtle, fast action is required. Rescue it quickly. Wash the engine thoroughly and get it going again as soon as possible. Make sure you dry the electronics with a blast of compressed or hot air. Let the motor run for a while to get the engine up to operating temperature and dry out all the odd places where the water migrated. Swift response can save the engine and get everything going again.

About the author: Roger Marshall is a boat designer and author of 12 books on sailing and yacht design.

[Ed: In the case of a boat sinking, the insurance company will pay reasonable salvage costs and it often argues with the salvor if the costs are out of line. Salvage costs include much more than a crane and labor hours of marina staff. They include the know-how to get the job done safely, having the equipment where and when you need it and all the overhead costs of running a boatyard.]

BOAT BUYER/SELLER PURCHASE AGREEMENT

Date: _____

1. Purchaser & Co-Purchaser

Name _____

Name _____

Address _____

_____ Zip ____

Phone _____

2. Seller & Co-Seller

Name _____

Name _____

Address _____

_____ Zip____

Phone _____

3. Broker (if applicable)

Firm name _____

Address _____

_____ Zip ____

Salesman _____

Phone (h) _____

Phone (o) _____

4. Description of boat (manufacturer, model, year, length, HIN, state registration)

_____

_____

5. Location of boat

Name of marina _____

Address _____

_____ Zip ____

6. **Selling price $ _____**

7. Deposit received $ _____ Date deposit received _____

8. Closing date _____

9. Liens or Encumbrances

This boat is sold free and clear of any liens, bills or encumbrances of any nature whatsoever except as stated below. The Owner warrants and will defend that he has good and marketable title and the lawful right to sell the boat and will deliver all necessary documents for the transfer of title or recordable U.S. Coast Guard bill of sale to the Purchaser or, at the Purchaser's request, to his agent.

10 Additional Optional Provisions

(a) Transaction is subject to acceptable survey, sea trials and financing (if applicable).
(b) The boat must be insurable.
(c) The deposit is refundable in full to the purchaser if any of the above items are unsatisfactory.
(d) The following equipment is part of this transaction:

_____

_____

_____

_____

_____ _____
Seller Purchaser

_____ _____
Co-Seller Co-Purchaser

** Copies of current state title & registration and current Certificate of Documentation (if applicable) should be attached to this agreement.

Yard Rating Worksheet

In the Yard

• What is the yard's policy, restrictions or environmental requirements on do-it-yourself work once the boat is out of the water?
• Are outside contractors permitted in the yard if your plan is to hire other than yard personnel to work on your boat?
• If a sailboat, does the yard have a mast in-mast out policy?
• Are there adequate disposal provisions for hazardous materials like fuels, lubricants and other maintenance and repair activity byproducts?
• Are water and power supplies handy to the boat storage area? Are you permitted to use it? Do ground fault circuit interrupters protect the power supply? Without them, you could be in for a shocking experience.
• Is the yard generally tidy?
• Is there a disproportionate population of derelict boats in slips or dry stored? These are clues to the yard's demographics, just like in any neighborhood.
• Is the boat land storage area surface dry, level and free of trash, debris and hazardous materials?
• Are there any tall trees that in a windstorm could fall on your boat?
• Will your boat be protected from the effects of other work projects in the yard (painting, grinding, etc.)?
• Are boat blocking materials stored neatly and well organized? Observe the condition of the timbers used for keel blocking. Observe the materials used for the boats that you see ashore.
• Are the boat stands clean and corrosion free? If they are rusted, they might not be trusted.
• Look at the boats in the yard. Are they level? Are they consistently blocked or cradled in the same method? Are the boat stands secured athwartships by chains so they can't part from under the boat in windy, muddy or icy conditions?
• Is the ramp or haul-out slip clean?
• Discuss which equipment will be used to lift your boat. Make sure it's appropriate to your boat's design and construction. An elderly wood boat might not be happy in straddlelift slings. The decision about which machinery is used is based on the type and size of the boat: power, sail, weight, overall length, deep or shallow draft, etc.
• Confirm your boat's weight (or displacement) with the yard to ensure its equipment is capable of lifting the load. Don't assume the yard is familiar with your boat.
• Does the yard have a checklist or written procedure for its hauling and storage operation? Ask for it. Have it with you when you deliver your boat to the haul-out slip and make it clear that you expect it to be followed.

PIT Operation

• Observe the equipment being operated with the boat onboard.
• Is the operator assisted by a ground-based observer, particularly at turns, under and around overhead obstructions, on rough terrain, and when the boat is set down?
• Is the operator's field of view clear with the boat on the PIT?
• There should be no passengers on a PIT.
• A PIT with a boat must never be left unattended when the boat is overhead, not for one second!
• Is it being operated at a safe speed for the conditions? PIT Rules of the Road limit speed to 9.6km (6mph).

Straddlelift

• Look at tires and cables. If you see dripping threads, filthy with oily residue, or rusted cables, or cables with broken strands, or oil and/or fuel dripping from the engine, or you see tire sidewalls that are mostly exposed plies — find another boatyard.
• Check the condition of the slings. Are they clean? Are the edges frayed? Are they ripped or heavily chafed? Then, find another yard. Oils, fuels, bottom cleaners etc., can erode sling material.
• Is there protective material available for the lifting crew to use to protect your boat from damage from cables, cable sheaves, and slings?
• Are the forward and aft slings securely tied together to prevent them from slipping and sliding off?

Equipment Operators

• Are the lifting machinery operators required to be licensed or certified? If so, are they? Are their credentials current? OSHA (Occupational Heath And Safety Act) requires that only trained and authorized operators be permitted to operate a PIT. If there are any irregularities in this department, find another yard. Operating heavy lifting equipment is risky business at best. You don't need to add to that level of assumed risk, and you can't argue this point.
—PK

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"Caveat emptor." Creating a Boat Owner/Seller Disclosure Request

Surveyors often are asked questions about the past life of a boat. This is an area that has not been well addressed in boat sales transactions, whether they take place under the guidance of a broker or involve private sales with no intermediary. There are few transactions involving large investments where this kind of information is not forthcoming or desired. In real estate transactions, sellers are (depending on the state law prevailing where the transaction is taking place) required to provide a disclosure statement and, by their signature, attest to the truth of their knowledge of the condition of the property at the time of executing the sales agreement.

When we buy a used car, we are preconditioned to inquire about its maintenance records. No one seems embarrassed to make such an inquiry but the level of emotion prevailing at the time of the purchase of a boat often precludes consideration of this simple act of rational behavior. The surveyor is then asked to provide this information. This is not the surveyor's job. It is your job to find out as much as you can about the condition of the investment you are considering. Other investments, such as stocks and mutual funds, offer their prospective purchasers a prospectus about past performance and anticipated activity. This is the kind of data you need to collect about the boat you are considering for purchase.

Because the act of "digging" for the facts of the boat's prior life (the equivalent of its medical history) seems so repugnant to so many prospective purchasers, we have assembled a list of questions that you can pose to a boat owner. We suggest that you put them in the form of a request for disclosure statement and that you ask the seller to sign it. The types and number of questions will vary, depending on the type of boat, its age, value and the specific nature of your concerns. If a yacht broker is representing the seller, he or she can present your request along with your offer to purchase. Someday, we hope this will be a standard for boat sales transactions.

As with anything being done that is new to the traditional ways of doing business, you will likely encounter some resistance. Change is difficult and brokers and sellers may feel defensive when presented with such a request but we routinely do these things when we purchase other items of comparable value and you are at the point in the transaction where it's a good time to initiate the disclosure practice. Our experience has been that brokers come to like the idea as it takes them out of the loop as fact finders. If you are comfortable with a "gentleman's agreement," fine. If you want to be businesslike, which is probably your professional habit, this is the way to go. If tension arises from this request, you may consider that the owner/seller is reluctant to reveal the boat's condition because he/she is fearful that, with such knowledge, you will withdraw your interest in buying the boat. Better now than after paying survey fees to discover what was already known. Such a request for information is not an inference of seller dishonesty. It is simply good business.

Requesting owner/seller disclosures is a simple step and can save a great deal of heartache later on in the transaction. There is a pervasive feeling that, by asking, a purchaser sets up an adversarial relationship. This is not the case when buying a home, a business, a car, etc. and it should not be an issue when buying a boat. You will not get answers to questions that you don't ask. The survey process is the equivalent in medicine to doing a full physical examination without any medical history. Often, the answers to the questions in a disclosure statement can preclude the stress of suspicions or inconclusive opinions that arise from the survey process. This certainly more predisposes an adversarial environment than asking the important questions at the outset. We encourage you to ask. It's been our experience that unhappy survey discoveries are often a surprise to the current owner. Most boat owners are not trying to hide information about their boats but they may not leap to disclosing everything they may know.

Because there is no standard for disclosure forms in pre-owned boat purchase transactions, the following represents only some of the questions that can be asked. We have been requested to draft these forms and we will do so but the fee for the service is in addition to the survey fee. You should consider asking at least the following questions of the boat owner/seller.

Examples Of Questions To Be Included In A Request For Disclosures

- How long have you owned this boat?
- How many owners has the boat had?
- Do you have a service history and maintenance records for the subject boat. Will those records be available at the survey and provided with the yacht if I purchase it?
- Are there manuals for the boat and its equipment?
- Are there any warranties currently in effect?
- Has the boat ever been used in charter or other commercial service?
- In the boat documented or state registered?
- Is there a mortgage on or are any other liens against the boat?
- Is the boat currently insured?
- Has the boat been surveyed recently?
    - For what purpose what the survey performed?
    - Is the survey available for review?
- Did you have the boat surveyed when you purchased it?
    - If so, by whom and when.
    - Is the survey available for review?
    - Did you satisfactorily resolve the deficiencies found in that survey?
        - If not, what remains that should be done?
- Where has the boat been used (current and past ownership)?
- Can you provide engine logs and records of machinery overhaul (if applicable)?
- Do you have a record of machinery fluid [oils, fuel] sample testing?
- Please provide updated engine and generator hours since new and since last major overhaul.
- (for sailboats) What is the age of the standing rigging?
    - Has it been replaced or repaired?
    - Have there ever been any failures? Loss or breakage of mast, boom, rigging?
        - List failures.
            - Can you provide the details of any failures?
- Has the boat been struck by lightning?
- Do you know of any significant groundings, collisions, storm damage or other casualties sustained by the boat?
    - Please provide details of any inspections or repairs?
    - Was an insurance company involved with the damage/repair?
    - If there was a claim for insurance coverage, what was the outcome?

- Have you made any insurance claims in connection with damage to this boat?

- Has there been any other significant damage, e.g., fire onboard?

- Has the boat ever been subjected to extraordinary storm conditions, i.e., a hurricane? If so,
    - Was the boat afloat or on land, on a lift?
    - Was the boat attended to prior to the storm?
    - If the storm was a named type, what was its name? When did it occur?
    - Did the boat suffer storm damage?
        - What was the nature of the damage?
        - Did you make a claim for insurance coverage?
        - Are records of the damage and subsequent repairs available?

- Are you aware of the condition of the fiberglass laminate and core (if any)?
    - In the hull?
    - In the deck?
    - Do you have any knowledge of water in the core of either the hull or deck molding?
    - Has any laminate testing ever been performed?

- Has the boat suffered from any blistering?
    - If so, please provide details of the number, size and location of blisters found, the method of detection and details of how they were repaired and by whom?
        - Was/is the work warranted?