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Issue #3 2008

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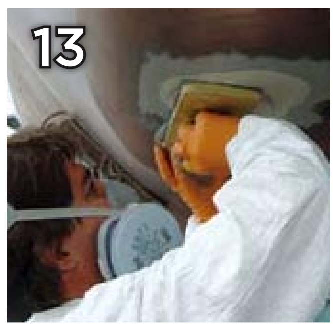


Haulout Special

COLUMNS

DEPARTMENTS

Compiled by Jan Mundy

Trailering Bling

I really enjoyed "Trailering Essentials," written by Pat Kearns in DIY 2008-#2 issue. I'm wondering where she purchased the storage box that fastens to the trailer. I'd love to have one like that to carry my trailer jack, grease gun, tie-down straps and a few essential tools.
Bill Davis, Swansea, Illinois

Heavy duty, weather-resistant poly box attaches to the trailer frame with U-bolts.

Pat Kearns replies: I bought the box in the automotive section at a Wal-Mart Super Store for about $30. This box has been on my trailer for two years and is exposed to the hot Florida summer sun without any degradation. There are no metal parts to corrode except the hinge pins but they are encased in the plastic hinges and haven't shown any damage. I regularly squirt a lube formula on the hinges to keep them free. Inside, I added plastic bins with snap lids to contain specific items stored in the box and I keep a supply of freezer grade Ziploc bags in the main box to hold odds and ends. One surprise benefit of the box is that it has never leaked, even when the trailer is on the road in rain. I now keep my charts and cruising guides inside with confidence. Make sure that, when you install any box, you fit it so that you can open the lid fully. This may require a little ingenuity on small trailers. The bigger the trailer, the bigger the potential for box size. All this "bling" really makes trailering a boat much easier.

Steam Situation

The diesel engine in my CHB 42 has always produced excessive steam and I checked everything to determine why, including using a laser pyrometer to read the cooling water temperatures at different points in the piping around the engine. The exhaust water discharge also looked like there was plenty of water coming out and I even took its temperature and it wasn't hot enough to make steam, yet I had steam. I replaced the impeller, exhaust elbow, thermostats, etc. and dived under the hull to check the seawater intake thru-hull. I was in the process of installing a new strainer when I found the problem. The elbow after the thru-hull valve was a street elbow fitting. The water flows from the female side to the male side. This made a sort of funnel and some mussels were lodged in the elbow, which restricted water flow. I cleaned these critters out and the steam went away. Sometimes the simplest things are the hardest to find if they aren't among the obvious causes.
Chris Davies, Sea Mist, Olympia, Washington

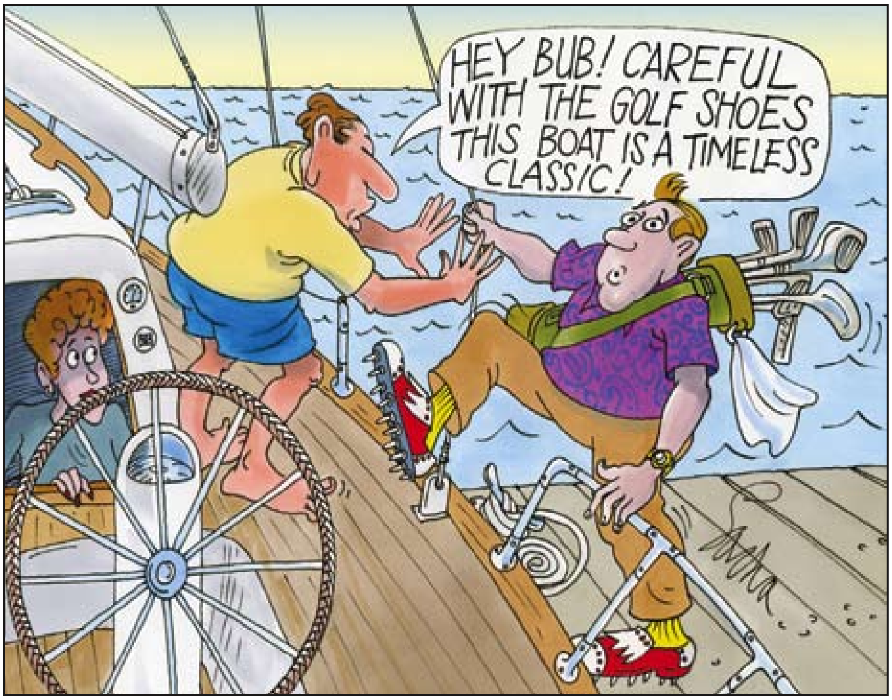
Needing NMEA PGNs

Regarding the article about the NMEA world written by Peter James, titled "Building a Better Highway," and published in DIY 2008-#2, you should publish an article regarding just what data items the various multi-function display manufacturers support in the way of displaying NMEA 2000 items. Generating devices create a lot more data than what some of the displays have coding to present. The most glaring case being the Raymarine E-80 series that can only display one data item even though these units have display screens that indicate the capability to display additional data. We found this out the hard way after purchasing FloScan NMEA 2000 units only to find out that the one data item, e.g., gph fuel burn, was all that we could see on our E-80. There's a running blog on this disaster on our boat's website at www.makaicruising.com.
John Peoples, Carson, California

Peter James replies: Some manufacturers are more transparent than others in publishing details of the NMEA 2000 messages (PGNs) that its equipment supports. Raymarine has assured me that they do intend to publish a list of the PGNs handled by their displays and I have seen a preliminary list. Hopefully, this list will appear on the Raymarine website (www.raymarine.com). One other issue here is that manufacturers may publish a PGN list but they don't necessarily explain what data each PGN contains. You can buy a full listing from NMEA at www.nmea.org but, at $995, that may be pricey for the average recreational boater. The JackRabbit Marine website (jackrabbitmarine.com) publishes extracts from the full listing as a free service to boaters.

Saloon Wins

DIY received plenty of email from readers responding to the comments in DIY 2008-#1 regarding the salon versus saloon deba-



Sacha

cle. The majority vote goes to "saloon," and as you'll read below in three responses, all for myriad, defensible reasons.

It's actually saloon and comes from the days of Mississippi river boat steamers. In many of these vessels, the cabins were named after states, the Texas room being one of the largest. The saloon was the common space where everyone gathered and drinks were served. The term stateroom comes from the naming of staterooms and saloon is the common space or, as it was then, the bar.
Roger Marshall, naval architect, author and DIY columnist

While working for a broker, I also was perplexed by the salon versus saloon dilemma. However, I consulted my *Chapman Piloting & Seamanship*, a respected nautical reference, for my answer. Turns out, the correct word is saloon, and salon is a term used by the modern day media.
Capt. George Sechrist, Oriental, North Carolina

While I will agree that landlubbers and even some respected mariners have come to use the word "salon" when referring to a vessel's accommodations, those of us who are nautically obsessed insist that a salon is where one gets their hair done while, in a maritime sense, a "saloon" is a common area aboard a vessel. Respected nautical dictionaries, such as *Overlooks Illustrated Dictionary of Nautical Terms*, *Encyclopedia of Nautical Knowledge*, *Sailors Word Book* and *International Maritime Dictionary*, to name a few, all agree and make no mention of "salon" having any nautical meaning. As editor, it is your choice to use salon if you wish and, while I may cringe a bit and mutter under my breadth about the lack of respect for tradition, I'll get over it and I won't take it personally.
Jack Hornor, NAMS-Certified Marine Surveyor, Davidsonville, Maryland

No Permit Required

The Clean Boating Act of 2008, signed into law in mid-July, protects all recreational boats throughout the U.S. from the Clean Water Act federal and state-permitting system designed for commercial ships and land-based industrial facilities, like sewage treatment plants.

"This is a fabulous victory for common sense and it just goes to show what can be done when the boating public, the marine industry and its representatives in Congress row together in a bipartisan way," said BoatU.S. President Nancy Michelman.

BoatU.S. has worked for more than a year with the National Marine Manufacturers Association and a coalition of stakeholders as well as a bi-partisan group of House and Senate legislators to resolve the problem before the permitting deadline.

"The real success of this campaign rests squarely on the shoulders of this country's millions of recreational boaters and anglers," said Margaret Podlich, BoatU.S. vice president of Government Affairs. "Without their loud collective voice, we would not have reached this momentous event."

Rerigging an Alberg

Q: I am refitting an Alberg 29 and installing a new aluminum toerail at the same time. The existing genoa track location is between the cabin side and the old toerail. Since the new toerail fastens with bolts on 4" (101mm) centers, the same as on the existing genoa track, I'm considering placing the new genoa track over the toerail and bolting both at the same time. Is this feasible?
Jean-Guy Friolet, Caraquet, New Brunswick

A: I presume you are removing the teak toerail that most Alberg 29s came with originally and that you are installing a typical L-shaped aluminum toerail with oval cutouts in the vertical part of the extrusion. The only technical problem with relocating the inboard jib track on top of the toerail is having enough clearance between the vertical part of the new toerail and the edge of the old jib track to accommodate the car for the jib sheet block. Be sure to apply sealant between the track and the toerail at the bolt holes so water does not leak between the track and the toerail and down the fastener hole.

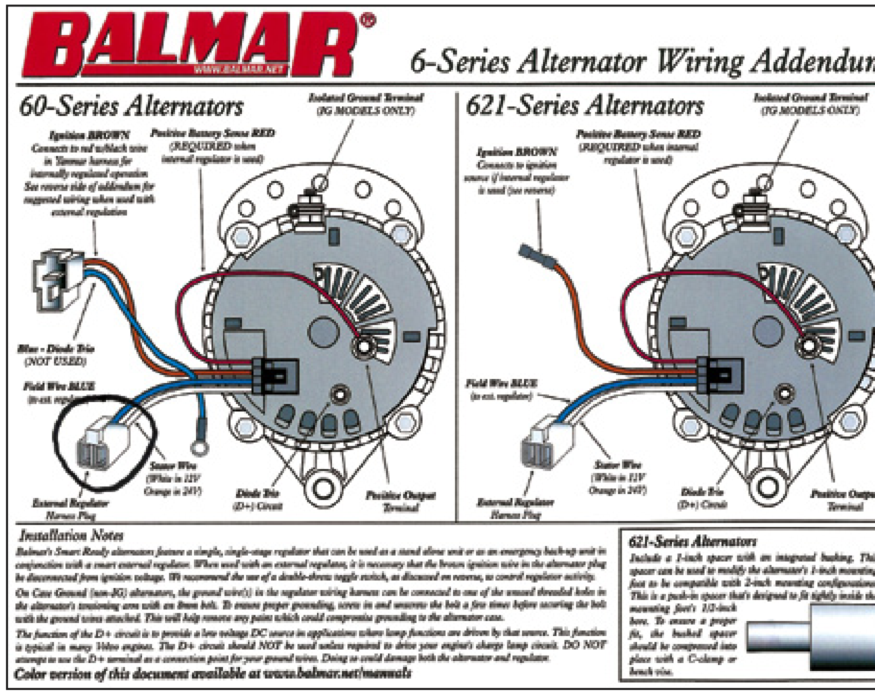
Pat Kearns

Single block attached to the toerail makes a acceptable and uncomplicated lead block for jib sheets.

An alternative and simpler approach is to leave the existing track in place and just use the traditional snatch block attached to the toerail cutout as your jib sheet lead block. This approach used to be the standard method until people (racers and sailmakers) began to demand closer jib sheeting angles, which in turn required inboard tracks for the jib sheet lead block. As you propose, the jib track is redundant when mounted all the way outboard on top of a toerail since the toerail itself can serve as a perfectly good place to mount a block.
— Nick Bailey

Wiring Doubts

Q: I'm looking for a wiring diagram for an alternator and starter so I can complete a project. I have a complete wiring diagram but I cannot find where one wire connects as circled on the image (below).
Henry Rawlings, Pascagoula, Mississippi



Pat Kearns

Wiring Balmar's 60-Series alternator.

A: According to Balmar, the circled plug connects to the harness from the external regulator, if one was installed. If you only use the internal regulator, the blue wire is not used. The white wire connects to the engine tachometer. If you have an alternator-driven tach, connect the white wire to the orange wire in the original engine harness.

Running Hot

Q: When my boat's twin 150 hp Volvo sterndrives are in gear and running around 2,500 rpm, the starboard engine overheats. This doesn't happen with the engine in neutral, even at higher rpm. What's the problem?
Joe Tighe, Santa Barbara, California

A: Under normal operating conditions, the symptoms you describe indicate a worn water pump impeller or an impeller that has taken a set due to age hardening of the rubber vanes. Water pump impellers should be inspected annually or every 100 hours, whichever comes first. A service manual can guide you through the inspection process.

If the impeller checks out okay, other causes of engine overheating include: kinked or crushed water supply hose; over advanced ignition timing or stuck distributor advance weights; lean fuel mixture and faulty carburetor; failed head gasket; loose hose connections allowing air into the water flow; clogged or obstructed water inlets; sticking thermostat; failed exhaust elbow gasket; sand build-up in cooling passages; seizing sterndrive unit from no oil in the drive; and clogged heat exchanger (if freshwater cooled).
— Steve Auger

Oil Loads

Q: When I run straight weight 50 motor oil, my 1993 454 Mark 5 Gen 4 Mercruiser runs better. Will this hurt the engine?
Mark Cavanaugh, Hudson, Ohio

A: I'm not sure what you mean by "run better," however, running a straight weight 50 motor oil only adversely affects engine operation during the warm-up period when the engine is

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started cold. In areas where air and water temperatures are normally higher than 80F/26.6C, the 50-weight oil would have minimal warm up time requirements. Areas with cold air and water require lighter engine oil to minimize engine wear during the warm-up period. Your service manual has a chart that indicates the required grade of oil based on the air and water temperatures where you do your boating.
— Steve Auger

Tranny Failure

Q: I have a 31' (9.4m) 1973 Trojan F31 with twin 318 Chrysler engines and Borg Warner transmissions and when backing out of my slip, the starboard remote control shift lever jammed and then broke. The lever is easily fixed but I now have two problems: the engine runs normally but the drive shaft rotates in the neutral position and the front belt pulley does not turn, though the crankshaft pulley does rotate. Also, I cannot tighten the belt enough in order to rotate the water pump and the alternator, which are both in proper working condition.
Stuart Henderson, Toronto, Ontario

A: As for the drive shaft, it appears from your observations that the transmission's drive clutches and steel friction plates are either warped, stuck or damaged. To repair this, the transmission must be removed and the warped plates replaced. Normally, warped discs are caused by overheated transmission oil, low oil pressure, low oil level or operating the vessel without the transmission fully in gear. The pulley doesn't turn likely because the belt is either worn out or the belt is too narrow in overall width or glazed and will not grip the pulleys. Remove the existing belt, jot down your engine's serial number and give both to a Crusader parts supplier in order to obtain the correct replacement belt. Be sure that no rust, oil or antifreeze is on the pulleys as this accelerates belt wear. DIY addressed this common problem in the article titled, "Belt Scrutiny" in the 2008-#2 issue.
— Steve Auger

Checks After Overheat

Q: I removed the exhaust hose from my Volvo 260 engine after it reached temperatures of more than 240F (115.5C). The hose was charred and, at the time of the incident, gave off a heavy smoke that caused the crew to jump overboard. My mechanic says that such high heat results in a blown head gasket and compromised rings. Is there any way I can regain confidence in this engine?
Don Barlow, Pensacola, Florida

A: An engine overheat condition can cause a failed head gasket but often the gasket is not damaged. To check for a failed head gasket, connect a cylinder leakage tester to an air compressor. The compressed air is delivered to each cylinder one at a time to test the sealing of the valves, piston rings and head gasket. Leakdown values higher than 30% indicates that the engine has been compromised and needs repairs. Remove the water intake hose at the thermostat housing and both exhaust elbows. This opens the water inlet and outlet points. If the air leaks out the exhaust then the exhaust valve is damaged. If air leaks out of the carburetor throttle body, the intake valve is damaged. If air leaks out the dipstick tube, the piston rings are stuck. If air leaks out the water inlet/outlet fitting, it's likely that the head gasket is damaged. If leakdown numbers are low, use an engine decarbonizer, such as Quicksilver Power Tune, to try to loosen the piston rings, if stuck. [Ed: For details, refer to page 35 in this issue.] Always change your water pump and all exhaust hoses after an overheat incident and change engine oil and filter before putting the boat back in service. Most engine manufacturers offer an audio alarm kit to warn the operator of engine temperatures higher than 212F (100C). It costs less than $200 and is installed with basic hand tools.
— Steve Auger

Case of a Missed Connection

Q: I have an older Carver with twin 220 Crusaders and dual helm stations. Both engines started and ran well until I routed a new transducer cable from the bilge to the flying bridge. Now, the port engine does not start. I might have disturbed a wire from the lower helm ignition key back to the engine, which is causing the starting problem. What is the best way to troubleshoot the problem? Turning the key to "on" from either helm station activates the helm

lights but does not engage the starter. I bypassed the port engine starter relay and ran a wire from the battery to the starter and it started. What is the color of the wire I'm looking for, which could be broken or disconnected from the ignition key? Also, how do I determine it's not a starter relay problem?
Bruce Bittenbender, Malvern, Pennsylvania

A: We contacted Crusader on Bruce's behalf and received the following: "Since you seem to be getting power at the dash, the culprit is most likely in the starter circuit. There is a yellow wire with a red tracer that leaves the ignition switch, travels through the neutral safety switch (on transmission), the starter relay and on to the starter solenoid, wherein the problem will likely be found. Trace this wire back, checking connections and terminals along the way. Check both the neutral safety switch and relay for continuity, if no problems are found in the wiring. Since you were able to crank the engine by bypassing the relay, your starter solenoid and starter are most likely okay."

In Need of a Lift

Q: My 26' (7.9m) sailboat lacks a topping lift. There is a single becket, non-swiveling block, which takes 1/4" (6mm) line, attached to the aft end of the boom, but there is nothing at the top of the mast. What type of block do you recommend I attach to the top of the mast and should it attach to the mast or masthead that holds the radio antenna, Windex, etc? Is it better to mount a cleat at the base of the mast or on the boom with the other end of the line fixed to a pad eye at the bottom of the mast? Do you recommend disconnecting the topping lift and attaching it to the pulpit when under sail or leaving it attached to the boom at all times?
Bob Griffiths, Parry Sound, Ontario

A: It sounds like you don't have an extra sheave at the masthead but, if you have space at the masthead, you can drill a hole for a small shackle to which is spliced a 3/6" (4.7mm) polyester braid line. Run the line down to a small block on the end of the boom, along the boom to another block at the goose-

Jan Mundy

Small shackle attaches to the masthead for a topping lift. A rope thimble would prevent chafe though this was rigged for 10 years without any line chafe.

neck and then 90 degrees down to a stand-up block (block held in an upright position by a spring) on deck and then aft to a small cam cleat by the cockpit. When you need to lower the mainsail or put in a reef, let out the mainsheet, raise the boom by pulling on the topping lift, lower the sail and tighten the mainsheet. Once all is set, place a mark on the topping lift line at the cam cleat so you know how much to pull in for the correct boom height. Another method is to rig the line in reverse: ending at the boom block, up through a block at the masthead and then down the mast to deck but I prefer running a line along the boom and then down the mast. When sailing downwind, it might be necessary to release the topping lift so it doesn't chafe the sail; otherwise, it's a permanent fixture. Depending on the boom weight, rigging a 2:1 block and tackle at the boom end gives a better purchase.

— *Jan Mundy*

Mounts and Alignment

Q: While traveling between Panama and Ecuador in my 31' (9.4m) Camper Nicholson sloop, I detected an unusual vibration in the Yanmar 2QM20H. Looking at the engine, I could clearly see an up and down motion at the forward left-hand motor mount. The mount nut was almost at the bottom of the stud. I stopped the engine and managed to loosen the mount nuts and raised the engine one or two turns on that side. This resolved the problem but after some five hours of motoring, I had to repeat the process since the nut appeared to have moved back down to the bottom even though the nuts on top were tight. Before moving on to Peru and probably a long motoring trip, I want to fix this problem. Should I replace the motor mount or just stop the nut from backing off with a thread locker? If replacement is required, must I replace all motor mounts?

Bruce Richardson, Chance Encounter, *Bahia de Caraquez, Ecuador*

A: In the dynamics of propulsion, the motor mounts actually push the boat and if the mount continues to loosen, it is quite likely the threads are worn or corroded to the point of slipping. Also, it's possible that more than one mount has broken. Always replace all mounts, not just the suspect one. Measure your old mounts to stringer height before removal to get a heads up with the installation of new mounts.

Engine alignment is crucial to avoid gear bearing wear, shaft failure or damaging the cutless bearing or stuffing box. Your engine model was never known for being wonderfully smooth running and if you have heard or felt something that has attracted your attention, trust your instincts that something is wrong. The vibration may be symptomatic of a misaligned shaft that has worn the shaft log and/or cutless bearing and the shake, rattle and roll can be transmitted throughout the drivetrain. An engine out of alignment strains the transmission and shaft. On a good day, the transmission wears prematurely but on a bad day, the shaft breaks and/or the shaft log and its seal (stuffing box/packing gland) fails and leaks. The interface between the transmission coupling and shaft coupling must be within .004" in two planes without binding and easily fitting together. In your vessel, this could be tricky due to the limited workspace. Begin by replacing all mounts and start from a zero point by jacking the mounts up and down and side to side with pry bars and wedges. Not technically difficult but the job requires some brute force. Be sure to disconnect the coupling before removing any mounts. Final alignment adjustment will be down to quarter turns of the mount fasteners and tightening nuts and this should be done with the boat in water.

Check that the shaft coupling is tight on the shaft and does not move on the shaft. If it moves, replace the shaft. Do not reuse old couplings worn in the bore. It's impossible to match an off-the-shelf coupling to a shaft without the aid of a machine shop to ensure the shaft face and the shaft Euclidean center are at true right angles. The transmission coupling must not move at all. This means that the only tolerable movement is rotation. Any sound that indicates other movement is a sure indication of oncoming failure. In any case, change the transmission fluid. This is also a good time to service the shaft log, stuffing box and cutlass bearing. You can replace the mounts in the water but anything else along the drive train requires hauling out.

— Randy Renn

Merc Diagnostics

Q: My 1999 Formula 34PC has twin 380 hp Mercruisers and there is a thin sheen of fuel in the starboard exhaust water. Figuring that the problem was unburned fuel making its way to the exhaust, I replaced the spark plug wires and spark plugs. The mechanic checked compression, the electronic diagnostics and talked directly with a Mercruiser representative who suggested checking for a pinhole in the fuel pump. As the pump was rusted, it was replaced. Still nothing has solved the problem and I paid a lot of money to have this problem fixed. The exhaust water also has a lot of tiny air bubbles. I'm now considering having the engine head removed and inspecting each fuel injector. Since the engine runs fine it makes it equally perplexing. Do you have any thoughts about what could be causing this problem? The port engine has no such problem.

Paul Bollinger, Alexandria, Virginia

A: There are several conditions that can cause the symptoms you describe. The following list is in order of probability. First, a malfunctioning (flooding) fuel injector(s) due to reformulated gasoline deposits. Identify this by performing an injector balance test, which determines if the injectors are flowing the proper amount of fuel. If the injectors do not pass the balance test, clean them without removal or remove them and then clean or replace. Second, excessive fuel pressure, caused by a clogged fuel pressure regulator screen. This increases the fuel pressure above specification, which causes the engine to run rich. Third, a stuck open thermostat that results in an engine that runs below the required 160F (71C) and causes it runs rich. An out of range or failed EFI coolant temperature sensor also causes the engine to run rich. Last, your engine uses an MEFI fuel injection computer. Any EFI engine fault (trouble code) that is present causes that circuit to default to a rich running condition. Have the engine computer scanned for faults.

— Steve Auger

Easy 5200 Removal

Q: A leak around the steering pedestal is dripping on the cushion in the aft berth. The former owner had the same problem and he sealed the inspection port with 3M 5200 sealant. Now, I can't remove the port to search for the leak. Any ideas how to remove it without damaging the gelcoat?

George Selkinghaus, Columbia, South Carolina

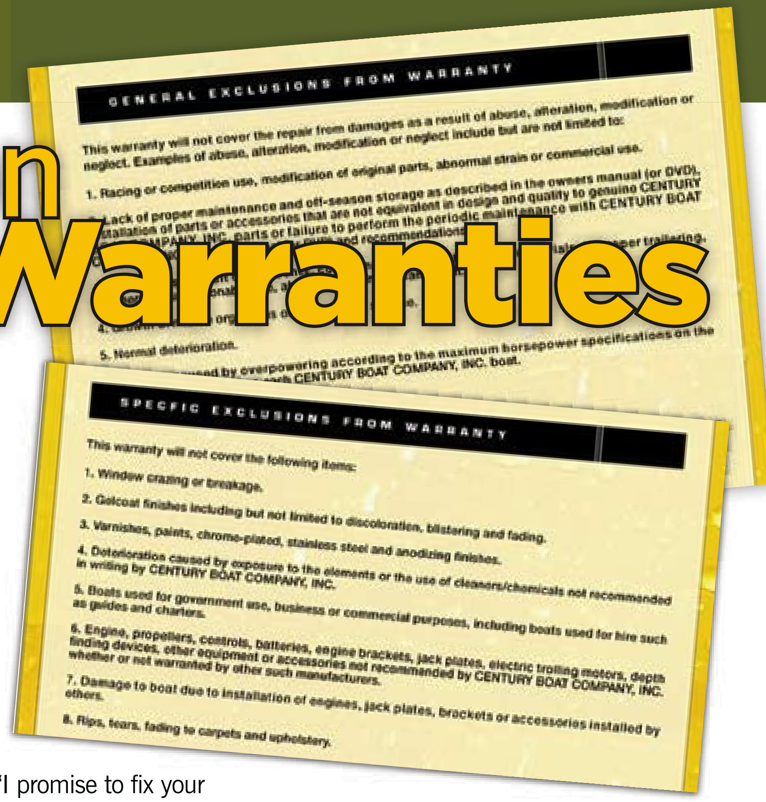
A: Smash, bash and brute force won't remove hardware that was properly bonded with 3M 5200. When you need to remove hardware use Debond (www.marineformula.com). Spray on a thin coating of Debond to the bond line around the inspection port. Wait 5 to 10 minutes and then, using a sharp utility knife, cut along the bond line to agitate the sealant. Apply a second thin coating of Debond around the opening perimeter and wait a few more minutes. If the port won't unscrew, spray on additional applications as needed to penetrate the threads. A 4oz can costs $19.95.

— Jan Mundy

Jan Mundy

Normally hardware installed with 3M 5200 is not engineered to be removed but, when it becomes necessary, the only proven product is Debond.

The Word on New Boat Warranties



Boat builders are reaching out with warranties to comfort boat buyers seeking a no-hassle boating experience. Now is a good time for comparison shopping.

By Patricia Kearns

If warranty is about experience, expectations and exposure, how do you quantify these essential safeguards in advance of a new boat purchase? Extensive warranty coverages are part of the deal if you take the time to study and understand the value of what is at stake in a new boat warranty. In fact, once you've identified the type of boat, your price range, engines, performance factors, equipment and other personal preferences, the boat builder's warranty should be at the top of your list of comparative points.

While I have yet to hear of an unlimited, lifetime warranty for a boat, the advances in coverage and terms of boat warranties are developing rapidly in much the same way as boat builders embrace technical advances in the physical product. The quality of product and a comprehensive warranty are combining to assure prospective new boat buyers of the pleasures of ownership, truly approaching the "add water; have fun" that the industry's Discover Boating campaign wants to deliver with every new boat.

If you've been shopping for a new boat and I mean "new," not just new to you, you have probably noticed that the economic challenges in today's economy have created a buyer's market and builders and dealers are working hard to have you see the "Buy Me" sign on their brands. Evolving as one of the most attractive lures are long-term, all-encompassing and reliable warranties, many even transferable to future owners. This is a good time to get a big bang for your buck if you have the bucks.

What's in the Promise?

A warranty is a promise. This promise must always be in writing. While oral promises are enforceable under the law, going to the justice system with your boat warranty problems is not a practical alternative on any level. "Warrant" is the act of making that promise, e.g., "I promise to fix your boat." "Warrantee" is the person receiving the promise. Pretty basic concepts but not always fully appreciated until the warrantee wants to exercise his/her warranty. The quality of the warranty is often found in the entity that warrants the warranty. Make sure the boat you buy comes from a company that keeps its promises, both the boat builder and the dealer. Duking it out with an obstructive boat dealer who is making it tough for you to put your warranty into action is not in the boating fun catalog.

The nuts and bolts of a written warranty are pretty fundamental. Read the warranty contract; ask the dealer questions or check with the builder before the sale. This is not rocket science and few warranties nowadays speak in legalese. The warranty language for what's covered and not covered should be specific. What the warranty doesn't promise is just as important as what it does promise. For a timeless overview of warranty basics, read the BoatU.S. discussion, *Warranting A Closer Look*, BoatU.S. Magazine, July 2001 (http://my.boatus.com/consumer/CloserLook.asp).

Less easy to assess is the willingness of the dealer and/or builder to honor the warranty and do it in a timely fashion. Reputation is relatively easy to verify and it's definitely up to you to do it. Bad news travels fast and you usually find it pretty readily. The Internet is a vast resource for information of this nature. In my research for this article, I was able to read the actual warranty commitment for at least six major U.S. boatbuilders. Put your keyboard to work for you and let Google do the walking. A boat dealership that has generations of operational experience and handles lines of popular boats will have a hard time ducking the aim of unhappy boat owners. Most enduring businesses have long since learned the value of a happy customer, sometimes to the point of stretching warranty coverage to maintain good will. Dealing with the new kid on the block does not preclude an excellent experience but you'll have to be more vigilant about your rights and responsibilities with a company that does not yet have an earned reputation for good service.

Good places to check are with the BoatU.S. Consumer Protection Bureau (my.boatus.com/consumer/default.asp?WT.mc_id=400056) and the Consumer Q&A Messageboard at BoatUS.com.

Getting The Goods

Let's look at the kind of warranty experience most of us know and love. You've bought a high-quality, new car from a dealer with an excellent reputation. When you encounter a problem, you are confident that it will be resolved by the dealer under the manufacturer's warranty. Can you take the same confidence for granted when a problem arises on your new or almost new boat?

It does not matter that the problem developed on your long planned for vacation, far from the boat dealer, and that you are in a far-off boatyard with a warranty problem. Your new best friend in the yard says he can fix it and you can get on your way but don't be surprised if you get short shrift from your boat dealer when you hand him the bill for the emergency repair and you submit your claim for warranty coverage as a fait accompli. Reimbursement rates from builder to dealer for warranty work are set up in advance and using an "outside" repairer who is charging different rates might leave you holding the bag.

Stuff happens but the protocols for enacting warranty coverage are sacrosanct and pre-empting the warranty process by your sense of urgency to continue your cruise may have compromised the dealer's ability to provide covered repairs under his dealership contract with the boat builder. Get the particulars on the procedures before you need them and know it before you go.

A fundamental of warranty etiquette is taking the required action to register your boat in the warranty program. Opening the warranty book on your new boat is prescribed as the new boat owner's responsibility. Don't ever presume that the boat dealer will register your warranty. Verify the registration process and get some form of confirmation that the warranty period is in effect. Carry a copy of your warranty onboard if you are planning to cruise out of your dealer's territory.

Terms of warranty coverage vary within the warranty agreement. In this context, "terms" refers to how long the boat, its components and the builder-installed equipment are warranted and by whom. "Five year limited warranty" may stipulate that only the hull is covered for five years. Engines may be covered by a separate warranty; builder installed hardware, plumbing and other systems may be covered for less time.

There are warranty extensions available for boats and engines but there is a time-sensitive period for enacting these coverages. Miss the window of opportunity and you may have lost your only chance to purchase a desired benefit. It's not unusual for an extended warranty to be under the administration of a third party. While the primary warranty is most often the purview of the boat manufacturer, an extended warranty might be little more than an insurance policy that covers some or all previously warranted items. The best extended warranty is one that is offered by the original builder, engine maker, etc. Misunderstanding this important difference could put your assurance of protection in jeopardy just when you need it.

There is always good news and bad news. The good news is that new boat warranties and extended warranties are improving as experience parallels expectations. The bad news is that even if a breakdown is covered under warranty, your cruising vacation may be interrupted. Drop the hook or tie up in a slip, grab your cell phone and a cool drink and go confidently into the world of warranty, secure that your knowledge of the rules will pay off sooner than later.

About the author: Patricia Kearns is a National Association of Marine Surveyors certified marine surveyor (CMS) and she is DIY's technical editor. She operates Recreational Marine Experts Group, a survey and consulting firm in Naples, Florida.

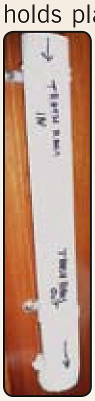
Tech Tips

Wrist Saver: To prevent a holesaw from binding and twisting your arm or wrist, spray a mixture of dish detergent and water on the holesaw before inserting in the hole. It might burn but the soapy water has a pleasant smell. Once through, let the drill stop before pulling the holesaw out of the hole.

Jan Mundy

Steve Auger, Mercury Marine

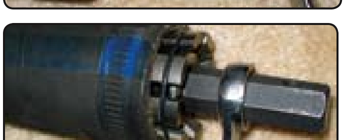
Bag Recycler: To make a simple, inexpensive and easily installed device that holds plastic grocery bags, take a 12" (304mm) section of 1-1/2" (38mm) schedule 40 PVC pipe, wrap two mounting style cable ties, the kind with a screw hole in the end, around each pipe end, orienting the screw hole flush with the mounting surface then fasten the cable ends to a galley cabinet or locker. Stuff the top of the tube with empty grocery bags and pull bags out of the bottom end as needed.



Michael J. Quigley, Sea Flourishes*, Pacific Palisades, California*

Slick and Lasting: Rather than pour vegetable oil in a marine toilet, which gums up components and holding tanks, once a week, I unscrew the pump top on the Jabsco toilet and manually lubricate the shaft and O-ring with grease.

Hose Spreader: To easily fit hoses over plumbing fittings, purchase a tail pipe expander, available in a range of diameters, from an auto parts store for less than $25, depending on the size. To use,



slip the expander into the hose, take an open end wrench and turn the hex shaft to expand the fitting, which forces the hose to stretch. Quickly reverse the wrench, remove the tool and slip the hose on the hose barb before the hose can return to its original diameter. You have to act fast but it works perfectly and saves a lot of aggravation.

Gary Gerber, Bethesda, Maryland

Add to your Toolbox: Keep a bottle of BoatLife Release Adhesive & Sealant Remover in your toolbox to remove excess caulking, tape residue or labels. This solvent-free formulation does not harm gelcoat or wood surfaces and is kinder to your skin and lungs than solvents.

Jan Mundy

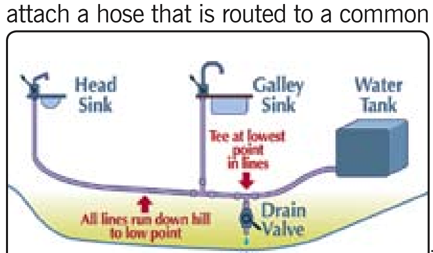
Duped Voltage: When measuring voltage with a multimeter, in this case, while troubleshooting a non-functioning 12-volt bilge pump, always place a load on the device; otherwise, the meter may read 12 volts. You'll think you have power but the device does not operate.

Ron Polomski, Grand Portage, Minnesota

Fruity Oil Sock: For a less expensive solution to off-the-shelf oil absorbing bilge socks, roll up two oil absorbent sheets and stuff them inside an empty lemon or other citrus fruit bag.

Tom McCandless, KTQ*, Georgetown Island, Maine*

Plumbing Aid: To save time when winterizing water hoses, splice a tee and a ball valve into the discharge hose from sinks and even the water tank, then attach a hose that is routed to a common low point and connect all to a valve. This may require a "Y" connector, depending on the number of hoses. To drain water from hoses, simply open the valves.

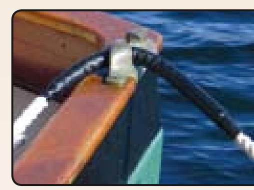


Sacha

Tim Nye, Sea Rose*, Hamilton, Ontario*

Rope Care: At the end of the season, take your sheets and lines home and wash them by hand in warm soapy water and let air dry. Check them carefully for chafing or herniations, places where the inside core has erupted through the exterior cover.

Functional but Ugly: As a temporary protector to prevent docklines from chafe, wrap them with thick layers of electrical tape where they pass over chocks or cleats.



Jan Mundy

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

TECH TIPS WANTED

Published tips receive a BoatU.S. Grill Apron

Apron features a detachable bottle opener, padded oven mitt and towel and multiple pockets for storage including an insulated adjustable pocket for keeping beverages cold. Includes a detachable neck strap and side tie strings for comfortable wearing and is machine washable.

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

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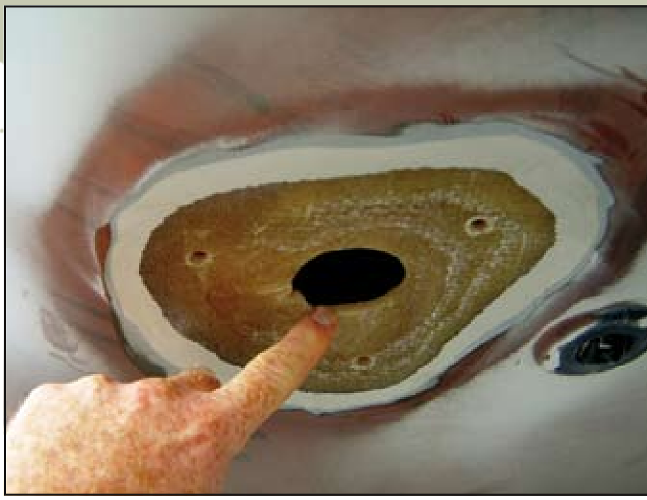
PRO-SERIES



After prep grinding, note the laminate layers exposed.

PATCHING PLUMBING HOLES

When a transducer or plumbing thru-hull below the waterline becomes redundant and begins to leak you have a choice of either installing a new fitting or repairing the weepy one. Follow these steps to seal the hole by the book.

Story and photos by Nick Bailey

A commonplace item on an older boat is the long-abandoned vestigial remains of ancient instrumentation. Those rows of giant holes cut into the cabin bulkhead for the analog meters are bad enough but deteriorating knotlog and depthsounder transducer thru-hulls can be a real source of worry. The impossible-to-find rubber gaskets and O-rings sealing the transducer cap gradually wither away enabling a slow but steady leak. Then there are all the other circumstances where a thru-hull becomes redundant.

A saltwater boat with an overboard head discharge might take up permanent residence in freshwater. A water intake or sink drain may become redundant due to equipment changes or a remodeled interior. What about all those old inboard gas sailboat engines, the OMC Saildrives, Westerbeke Vire 7s and Atomic Twos, long orphaned by their manufacturers? Out of sheer brutal expedience many have been replaced by a transom-mounted outboard, leaving behind abandoned water intakes, shaft-logs and gaping saildrive apertures. As long as the original hardware remains leak free there is little inducement for action but a neglected and useless underwater fitting is always a potential source of trouble.

Following the downhill slide of entropy, leaks commonly develop at a thru-hull as the wood backing block or bedding sealant deteriorates. Attempting to overtighten the clamping nut on an old corroded thru-hull (or cap nut on an aged plastic transducer) commonly results in a cracked fitting that leaks even worst. At this point, you have run out of options, with a haul out required to remove the broken thru-hull. You can expect that even a leaking thru-hull offers surprisingly stiff resistance to removal.

Thru-hull Removal

First, use a pipe wrench or channel lock pliers to remove the valve and then attempt to unwind the securing nut. Remember that counterclockwise, when viewed from above, is the “loosen” direction. If the threads are damaged or corroded and the hull bond poor, the entire thru-hull may start to turn. If you are lucky, there may be a flattened spot to fit a wrench on the upper shank of the thru-hull. If not, an assistant may be required to hold the thru-hull from the outside.

Most bronze thru-hulls have small tabs on either side of the outside flange, which are designed to catch against a large flat-blade screwdriver or a specially designed thru-hull tool that fits into the mouth of the thru-hull to prevent it from moving while the fitting is being tightened or loosened. [Ed: For instructions, refer to page 17.] Often the backing nut comes off okay but the thru-hull itself is well and truly stuck to the hull. In this case, a few modest whacks with a dead blow mallet

Remove the redundant thru-hull, in this case, a seacock thru-bolted in place.

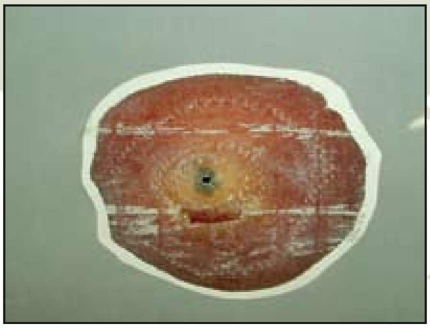
or a hand maul on a softwood block laid across the top of the fitting should break the sealant bond. If you don’t care whether the thru-hull breaks, you can forgo the wood block.

Be careful before you get in there and start wailing away with a mallet. Many thru-hulls are complete seacock assemblies and these combination valve and thru-hull units are often securely bolted to the hull. The fasteners pass through to the outside of the hull but the bolt heads are recessed and buried in fairing putty. It is common to have to do some digging to find both ends of the fitting. Flush mounted thru-hulls also may have a recessed flange buried in fairing putty. In these cases, the inside securing nut(s) must be unscrewed and the outside fairing compound removed (a chisel or grinder does the job) before knocking the thru-bolts and/or the thru-hull out from the inside.

Patching the Hole

During my 30 plus years in the boat repair business I have seen a lot of examples of badly done hole “repairs.” People get all fired up about using a “superior”

Use a grinder and a 36-grit disc to carve a bevel into the hull laminate around the hole.



Note the rings visible inside this prepped scarf. They delineate each layer of glass in the hull laminate. This hole was left by a lightning strike.

The beginnings of a beveled scarf face around a thru-hull to prep it for a glass cap. This one needs to be a bit larger to achieve a 12:1 ratio.

Cut out patches of fiberglass, 1810 stitch mat in this case, of approximately the same size and shape as the layers that were ground away.

resin and somehow end up thinking they can plug holes below the waterline with blobs of unadulterated goo.

If there is any hope whatsoever of achieving a long term patch, the glass laminate must be restored and "reconnected" over the hole. This requires a little prep work and planning as well as some basic skills for working with fiberglass. Above the waterline, you can get away with all kinds of slapdash repair shenanigans; below the waterline any weakness comes back to bite you.

Step 1: Set up and Prep

Fifty percent of any glass repair is the quality of the surface preparation in the areas that are to receive the new patching laminates. Poor prep means a poor bond and then the patch comes off and the boat sinks. To achieve a good bond, a fiberglass patch must adhere to a large uncontaminated, chemically compatible surface with just the right rough texture to develop mechanical adhesion.

To achieve an adequate bonding surface requires grinding away the existing laminate from the edges of the hole to create a beveled or dish-shaped ramp all around the hole to act as a scarf face. The scarf should have a high ratio to allow a large bonding surface. In other words, the ratio of the scarf face width to the hull laminate thickness should be a minimum of 12:1 on a sailboat or around 20:1 or more on a powerboat. For example, a 1/2" (12mm) thick powerboat hull needs a patch radius of at least 10" (254mm) radius and a sailboat hull 0.375" (9mm) thick needs a 4.5" (114mm) patch radius. The best hole repairs also include a patch on the inside of the hull of a similar or larger diameter but a shallower scarf depth.

Now, suit up with a Tyvek hazmat suit and work gloves with cuffs taped for a hermetic seal and don a respirator and visor. Plug in the grinder with a fresh 36-grit disc and wade right in. As you sweat it out under the hot sun, blinkered and oblivious to all around, you just remember that grinding is one of the "manly arts." To avoid the wrath of your fellow boaters use a dustless sander or tent your work area with a tarp to contain that nasty dust and carefully clean up afterwards. Of course, any grinding inside the boat also requires maximum dust control measures. When the grinding is finished, remove the dust from the repair area by vacuum or compressed air and then wipe the freshly ground surface with a clean lint-free rag dampened with acetone.

An alternative prep method for the truly meticulous is to forego the grinder and instead use a router to precisely remove individual laminate layers in concentric rings around the hole. By increasing the depth of the router cut for each laminate depth, as you get closer to the hole, a "stepped" scarf is created. The overall scarf diameter is the same with either technique.

Step 2: Dry Fit

Ideally, the patch should have approximately the same laminate schedule (number and type of glass layers) as the hull but, in practice, since we are just patching a thru-hull hole, good results can be achieved with a less than identical lay-up, provided the overall thickness is at least equal to the original hull.

Examine the exposed laminates and identify the concentric rings that delineate each individual layer of glass in the hull lay-up. Cut out alternating layers of 1 oz to 1.5-oz chopped strand mat and 12-oz to 24-oz woven roving to match the size and shape of each layer. The two outer cap layers should be 1808 or 1810 stitch mat, if available. A product that combines 18 oz woven roving with .8-oz or 1-oz mat is a convenient all-purpose alternative to traditional mat and roving.

If the roving you are using has the fibers running predominately in one direction, orient the next roving patch at 90 degrees from the first. If the roving has fibers in two directions at 90 degrees to each other, orient the next patch at 45 degrees to the first. If you have tri-axial cloth (excellent material), any direction will do.

There is an ongoing discussion in the professional trade publications as to whether the largest patch should go in first or the smallest. In practice it does not make a huge difference in peel strength. The traditional tidy method is to put the smallest patch in first so that the laminate patch edge lines up approximately with the edge of the hull laminate exposed at the scarf edge.

Set up a platform or worktable nearby and cover it with heavy plastic sheeting. Lay out the cut glass patches in order on the table and reserve a space at the end of the table for wetting out each piece. In most cases, it is preferable to do the inside-the-hull phase of the repair first.

Wetting out glass cloth with resin.

Alternatively, a low-tech "tape & masonite" clamping mechanism can be used if a vacuum kit is not available.

The glass layers are pre-wetted with resin and applied, smallest to largest, over the hole. If working with polyester resin, a fast curing "hot mix" is necessary when working overhead. Epoxy resin is a fixed resin-to-catalyst ratio so a vacuum bag works best to clamp the new lay-up in place.

If so, be prepared to set up a workspace inside as each complete lay-up phase (inner and outer) is done in one shot. You don't want to be running up and down a ladder to wet out and place each piece. Blank off the other side of the hole with masking tape and cardboard to provide a backing for the lay-up and to prevent resin from leaking through and running wild on the other side. Do a final wipe with acetone and get ready to mix the laminating resin.

Step 3: Lamination

I don't care what type laminating resin you use. Pick one that is familiar and stick (no pun intended) with it. The hulls of 99.9% of older glass boats are made of polyester resin so in 99.9% of cases polyester or vinyl-ester or epoxy will work just fine if used correctly with glass.

Using a disposable container, mix the resin strictly in accordance with the manufacturer's instructions. Use a small paintbrush or roller to apply resin to wet out the surface of the repair. Pour a few ounces onto the worktable and drop the first laminate patch onto the puddle. Over-roll it with a bubble-buster glass roller (or any roller you have) until it is thoroughly wetted out.

Slide a broad putty knife under the wet glass piece and transfer it to the waiting repair. Roll it with the bubble buster and/or poke with a brush or smooth with a squeegee to remove trapped air and repeat the procedure with the next pieces. In most cases, you can continue

A solid glass and resin plug fills the void between the skins and bulges out of the repair access hole.

A 1,500-rpm sander with a flex pad and 80 grit disc is used to flatten and recess the bulging plug.

the lay-up until all the laminate pieces are in place. Generally, if the first resin batch begins to kick off before you have finished the lay-up, it may be possible to continue with a new batch immediately. Pressing ahead may depend on how lumpy the surface of the patch is and the likelihood of the lumps messing up the next layer. If in doubt, it is better to return when things have hardened and buzz the surface quickly with a grinder to flatten it.

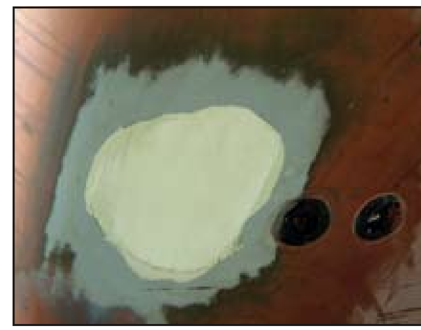
After the inside cures to the point where you can peel away the masking tape plug, repeat the lay-up procedure on the outside. If you are interrupted and must finish the lay-up at a later date, be prepared to thoroughly prep-sand the cured bonding surface with 60-grit or coarser paper before continuing the lay-up.

If you have to return to a fully cured but unfinished lay-up using epoxy resin in a cool damp environment, be sure to first scrub the surface with soap, water and a scouring pad to remove the waxy amine blush and then do a thorough prep sanding. Amine blush is the bugbear and dirty little secret of most epoxy resins. It is a self-generated release coat that occurs naturally on the surface of cured epoxy when it is just outside the

Any hole repair should be an (top) inside and (bottom) outside repair, although only a layer or two of glass suffices for the patch on the inside of the hull.

(top) After a quick grind to level the new glass surface, a fairing putty is mixed and applied (bottom) with a trowel over the glass patch.

"green" or "no-sand" overcoat time window. How sneaky is that? It has caused me much grief but also generated a lot of repair revenue when fixing some other poor fellow's mess.



(top) The cured fairing putty is block-sanded flush with the hull with 80-grit paper to (bottom) yield a smooth, level surface for the patch that is paint ready.

Bottom paint application is the final step. This may or may not include epoxy barrier coat primers prior to antifouling.

Step 4: Finishing

When you're finished with the lay-up, the outside surface of the repair will not be particularly smooth and it probably protrudes a bit above the surrounding hull surface.

Use an 8" (203mm) polisher with a foam disc and 80-grit paper to quickly bring the biggest lumps close to the hull surface. Follow by block sanding with 60 grit to eliminate any remaining high spots. Prep sand any hollows by hand or with a corner sander and then clean off the dust and (assuming we are working below the waterline) prime the surface with an epoxy primer suited for underwater use, such as Awlgrip 545, Interprotect 2000 or straight epoxy resin. Two coats are the minimum. Mix and apply a good epoxy filler. Once cured, block sand with 60 grit to fair. Refill and sand again if needed.

Seal the raw filler and exposed area with a minimum of two coats; five coats of an epoxy primer or barrier coat works best. If the surface is still porous, squeegee a fine epoxy filler (mayonnaise consistency) or even a small amount of mixed barrier coat, thickened slightly with a bit of colloidal silica, into the pinholes. Allow it to come to full cure and prep sand with 120-grit green coat paper then apply antifouling within the primer manufacturer's specified time window.

Paint the inside repair with an air-dry (waxed) polyester gelcoat or an epoxy primer.

The glass repair approach takes a bit of work but is the best solution if you really must lose those extra holes in the hull.

About the author: Nick Bailey is a boat repair professional with 32 years experience.

Simple Seacock Removal

When you have to remove an old seacock or thru-hull fitting and you're not looking forward to the task follow these simple steps below provide by John Cly of Groco (www.groco.net). His method uses hot water to break the caulking bond rather than power tools to cut off the thru-hull fitting or other heat sources (torch or heat gun) that may damage the hull.

1. Haul the boat.
2. Purchase Groco's THT-530 thru-hull installation tool. This fits 1/2" (12mm) through 3" (76mm) thru-hulls.
3. Remove the hose attached to the affected seacock and any angled hose barb or elbow fittings.
4. Open the seacock.
5. From outside the boat, drive a tapered wooden plug sized to fit the thru-hull into the thru-hull with a really big whack of the hammer. Ensure it is tight. You are making a relatively watertight seal of the thru-hull fitting.
6. From inside the boat, pour boiling water into the open top of the seacock. I find it best to take a thermos bottle below decks instead of a coffee cup or saucepan.
7. Wait 60 to 75 seconds.
8. If there is an assistant outside, observing the thru-hull, tell him/her to get out of the way.
9. Using a wooden dowel and hammer, drive the tapered plug out of the seacock. The water and plug fall to the ground below.
10. From outside the boat, insert the THT-530 thru-hull tool into the thru-hull opening and turn. With luck the hot water will have softened the bedding compound to a point where it is easy to turn.
11. Remove the thru-hull.
12. Remove the bolts, nuts and screws anchoring the seacock to the hull.
13. Clean and prep the area.

Good VIBRATIONS

Adding a flexible coupling can be part of a greater drivetrain inspection.

By Randy Renn

A properly installed "flex" coupling can be a silent, nearly maintenance-free, positive amendment to your boating experience. Rarely installed in older boats and not seen often in new production craft, flexible couplings for propeller shafts are mostly aftermarket installations.

Flexible couplings are unions between propeller shafts and transmissions that absorb some shaft and engine movement in order to reduce wear and mechanically borne vibration. Some flexible systems actually eliminate thrust against the transmission by transferring it to the hull thereby removing rear force upon the engine altogether. Flex couplings, in general, are not a single panacea for the myriad of propulsion issues that lead to a vessel's sound levels but their installation can greatly improve motoring conditions.

Workings

How does a flex coupling work? You may not know it but you probably already own several flex couplings in your car's drive train and steering. Certainly, if it is front-wheel drive, there are four flex couplings, called constant velocity joints, on the front axles. You may have rubber flex joints in the transfer case of your four-wheel drive or plastic waffle plates on the rear suspension of your commuter car. Relative to marine engine drivetrains, it was a matter of taking this technology and adapting it to a boat propeller shaft, with the goal to direct the imbalances of several rotationally affected items to a positive end.

If your propeller shaft is fixed, meaning that it has a bearing at each end, namely the strut and a rigid stuffing box, and the engine is on flexible motor mounts, then the transmission needs a true flexible coupling. If so equipped, add one to compensate for engine movement. Should you have a system that uses U-joints and metal truck-type drive shafts, it is time to consider changing to "rubber" type couplings that require very little care and are much less likely to fail. The flexible coupling manufacturer or dealer can tell you what size and style coupling you need according to engine horsepower and shaft size. It is a good bet that your boat's shaft has a non-rigid stuffing box and flexible mounts, which is the most common installation.

Selection

Choices of flexible couplings run from a very simple hard plastic ring, such as the Drivesaver or the R&D flexible coupling that need little more than hand tools and a ratchet to install, to an Aquadrive system that requires some serious engineering, a large investment and hull additions. The middle ground is held by a type of flex coupling that involves reinforced "rubber" inserts or plugs in a metal housing, such as the Vetus Bullflex and Uniflex types. Prices range from $100 for the plastic ring types. The Vetus units start at $550 and the Aquadrive systems takes you closer to $1,000 or more. As in many things, the investment versus return balance is a point to ponder. Further, the performance expectation of flex couplings varies rather greatly, closely paralleling initial costs.

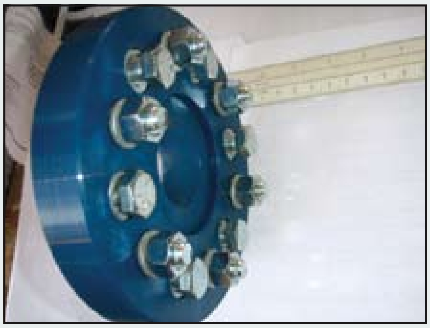
Installation Considerations

The plastic ring type and Vetus flex couplings should be within the scope of the average weekend mechanic's skills. The Drivesaver and R&D require the most basic of hand tools and the Vetus units, while perhaps requiring some light machine shop work, can be installed by most anyone who can operate a hand drill. All are ideal for installation on older boats. The Aquadrive requires some real skills, heavy tools and good drive knowledge; a fair amount of science if not a lot of art.

Your first consideration is to determine if there is enough space to install the flex coupling. Some flex couplings are considerably larger than the steel couplings they replace so measure twice and have

(left) Large Vetus Bullflex couplings. Note the split coupling on the shaft end to allow "clamping" the coupling on the shaft when installing. (right) Vetus Bullflex unit showing the heavy flexible "doughnut" between metal plates that attaches to the shaft and transmission.

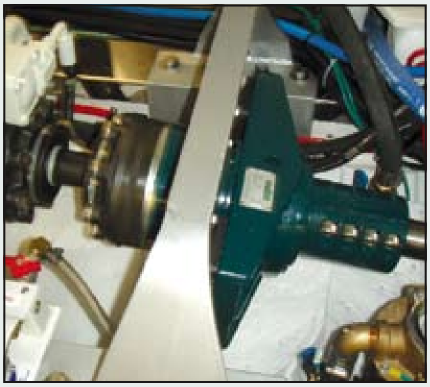
Vetus Type 6 coupling showing the bushings inside the unit. This coupling works with fixed or flexible stuffing boxes and a special conical clamping hub saves installation time.



Made of hard but flexible plastic, the Drivesaver bolts between the propeller shaft and transmission couplings. This unit absorbs some flex and minor misalignment. Advantages are ease of installation using only hand tools and space requirements of possibly less than 1" (25mm).

The durable polyurethane R&D flexible coupling helps to reduce vibration, compensate for some misalignment, isolate the shaft and absorb transmission shock loads caused by the propeller and high speed gear changes.

Vetus Uniflex coupling permits a shaft misalignment of up to 2 degrees.



Aquadrive thrust plate absorbs the push from the propeller shaft directly to the vessel and not to the transmission. Two constant velocity joints, visible ahead of the thrust plate, transfer engine rotation to the propeller shaft. The arrangement allows a more flexibly mounted engine and greatly reduces real and perceived engine sounds and vibrations.

no regrets. Also be certain that the flex unit will not move the shaft aft too far to be outside ABYC P-6 Standard recommendations. As part of your flex coupling installation it is important to consider that ABYC, P-6, 6.5.5.4 states: "The distance between the forward end of the propeller hub and the aft end of the last strut bearing shall be limited to one shaft diameter." As an aside, if your vessel has been or is being repowered, be very careful that the shaft material is of the proper type and has a yield strength great enough to withstand any power changes.

In most installations, the shaft is supported at one end by the transmission coupling and at the other end by the cutlass bearing. Cutless bearing wear is very common and bearings should be replaced as part of a flex coupling installation.

While looking at the cutlass bearing, you may notice a 1/2" (12mm) shiny band on the shaft on the propeller side of the strut. This indicates how much the engine moves fore and aft in the hull as it bounces around on the motor mounts. It is difficult to imagine the engine actually moving that much but the visual evidence is undeniable. If the engine is moving that much fore and aft, how much it is moving side to side? It's fair to presume that action as well. These movements result in a range of vibration felt by the hull and its supporting structures to annoying rattling at locker doors and other fittings that you can hope to reduce with a flex coupling.

Take the time now to service the stuffing box, hose and clamps while the shaft is out of the boat. This is also the time for a close look at the transmission coupling.

Next, look at the motor mounts, the fastenings and adjustment nuts. My column discussed this in the DIY 2007-#3 issue. Motor mounts wear out, get soft or fail so plan on mount replacement as part of the flex coupling install, especially if they are original equipment. If engine mounts are aged, consider the value of proactively replacing all of them for a fresh start and a good result. Often overlooked are the motor mount mounting frames, those plates that bolt to the engine and to which the mounts attach. If the motor mount mounting holes are worn or wallowed out, replace the frames as the new mounts will loosen quickly and it will be impossible to maintain correct engine alignment. Replacing just a coupling may be the cure for any problems or the resolution of any alignment dilemma; in fact, poorly prepped, a flex coupling could make matters worse.

Engine alignment is required as part of your flex coupling installation and must be performed in the water. It is often assumed that, with flex couplings, engine alignment is not required and, because the flexible nature of the coupling causes it to be self-aligning. An initial alignment must be made to position the engine as closely as possible to best alignment.

Benefits

Because flex couplings are absorbing shock and loading, you can expect, barring defective mounts, worn rudder bearings, nicked, bent or out of balance propeller blades, a bent shaft, misaligned stuffing box, flexing engine stringers, worn cutlass bearing, poor engine alignment or reduced engine vibration along with its accompanying noise level. Shifting may be smoother, transmission wear lowered and the risk of impact damage to the power plant minimized.

Greater comfort should be easily recognized even with the simple, easily installed hard plastic type units. The more flexible type, Vetus couplings immediately result in a more quiet drivetrain and the Aquadrive system completely changes the vessel's feel as all propeller thrust is applied to the hull and not to the transmission, tremendously reducing hull vibration. One caveat is that, because the system is now quite a bit heavier and, therefore, has considerably more inertial mass as well as more defined reciprocating cycles and shock loading, the transmission sizing may be a consideration in marginal installations.

All flex coupling styles and types can produce pleasant and, in some ways, surprising results. A flex coupling is something that is often not missed until you experience having one.

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

Jan Mundy

DC Wiring TOOLS

The key problem in doing a wiring refit is selecting the correct wire size and circuit protection device for the job. Here's a review of two free programs that do all the number crunching for you.

By John Payne

When wiring a new boat or rewiring an old boat, there often are many calculations to make as you check each circuit and calculate the wire size accordingly. Even seasoned professionals find this hard work and time consuming.

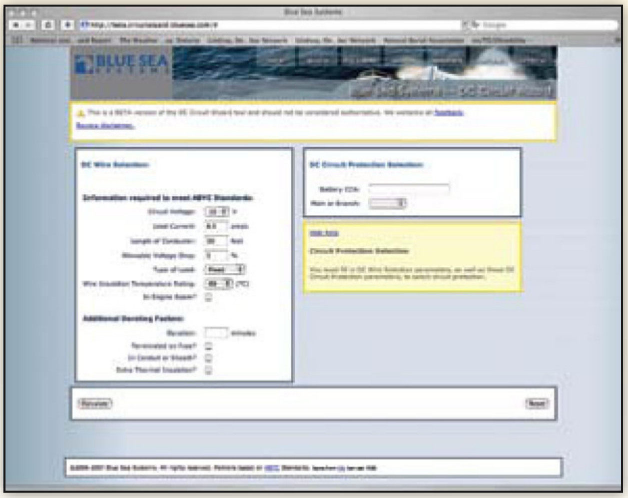
There are three basic questions that must be asked and answered when performing circuit calculations. How long is the wire route? How much current does the circuit carry to the connected equipment? What is the allowable voltage drop? Based on the answers, you select the correct cable size.

There are three methods of determining cable size. The first is using old fashioned basic math, taking the circuit details and calculating the cable size using the formula specified in the ABYC E-11 Standard, *AC and DC Electrical Systems on Boats*. The second method is the use of ABYC tables that allow quick selection. The third method is the use of online and downloadable programs that do all the number crunching for you.

The fundamental information you need to know is the electrical load value in amps. If this is in watts, you need to calculate the current value (basic Ohm's Law). The second value to determine is the length of cable of the circuit. It is important that you either measure or be very sure that you have the correct length. In a DC circuit, the value must include both the distance to the equipment and the distance back to the power source. It is also important to allow for bends and other cable run areas as they can add a lot to the length.

If, like me, you are not keen on doing lots of calculations, you can use one of the calculation tools that are available free on the Internet: DC Circuit Wizard Beta version (http://beta.circuitwizard.bluesea.com) and WireSizer (www.jackrabbitmarine.com/Detail.bok?no=3337). Both programs run on Windows operating systems only.

DC Circuit Wizard



Be very aware that the DC Circuit Wizard software from Blue Sea Systems is a Beta version and this means it's a prototype that may contain errors or may not give exact or proper results and that it should not be considered authoritative. The following disclaimer also states that: "The final decision on wire and circuit protection should come after a review based on additional sources, such as the ABYC standards or one of the many books in the field." It also states that the calculator is partly based on the ABYC E-11 Standard and that it does not replace calculations within these standards or other industry standards.

Another important fact to understand and accept when making either computer or manually based calculations is that the calculator does not account for all the possible variables and factors relevant to the selection of wire size and circuit protection. These variables, stated in a software caution note, are such things as overloads, including changing light bulb sizes or adding additional loads to circuits; wiring errors, loose connections or poor crimps; heated terminations from motor terminals, heating appliances or lighting fixtures; data input errors from entering wrong values into the calculator; unusual environmental heat sources; inadequate or defective wire insulation; software defects and/or malfunctions of a web browser or server computer. As you can see, it means users of the online calculator must be aware that it's only a tool with limitations and it doesn't allow for everything.

It also states that the calculator is not a substitute for the expertise of a marine electrical professional and that the calculator not be used as the sole basis for selecting wire size or circuit protection and that any wire size or circuit protection tentatively selected with this tool should be reviewed for adequacy, before installation, by a professional applying the applicable industry standards. It is important to consider the calculator as a tool and a good method of checking your more critical circuits and circuit calculations.

So, having accepted all of those disclaimers and limitations, let us look at the calculator. When you open up the page, you are presented with a simple and easy to view data entry form. I did like the Help function that opens pop-up windows with explanations as you move the cursor over different entry boxes.

1. Enter the circuit voltage. Usually, this is either 12 volts or sometimes 24 volts. I entered "12 volts" for the test.

2. Enter the load current value in amps. I entered partial values, such as 0.5 amps, 2.5 amps and 5 amps to test things. A useful option would have the capability of entering watts to calculate the current. To find the current in amps when you only have the power in watts, divide the power in watts by the voltage, i.e. 12 volts, to get the current. I entered "6.5 amps."

3. Enter the length of the conductor. This measurement is the length to and from the load device in a DC circuit; if it's 10' (3m) to a pump, you need to enter 20' (6m). Again, a useful option would have been a simple distance to device and automatic calculation as I find so many people get this basic point wrong. I entered "30'."

4. Enter allowable voltage drop percentage value. While you have options at 5% and 10% I have always recommended you opt for 5% for all circuits no matter what the standards recommend. I entered "5%."

5. Enter the type of load, which can be either fixed or variable. In my opinion, this is only valid for things such as an anchor windlass or deck winch loads where duty factors apply in calculations. The help box language can be a little confusing for non-professionals. The duration box and information window on duration explain this more. For this exercise, I entered "Fixed."

6. Enter the wire insulation temperature rating in degrees Celsius. Given so many people better understand the Fahrenheit scale, perhaps a usual option would be both. The calculator states correctly that the engine room space is assumed to have a higher ambient temperature of up to 50C while all other spaces are assumed to have ambient temperatures of 30C. In a higher ambient temperature environment, such as an engine room, there is less temperature range between ambient and wire insulation temperature rating. Therefore, the higher temperature of an engine room limits the capacity of wires and components. This explanation is basically correct; however, it merges two different issues and one is the insulation temperature value and the other is the effect of heat on a copper conductor. I selected "60C."

7. The next is a tick box to click on for "In Engine Room." This applies a temperature derating factor. This I did not select.

8. The next value entry boxes are labeled "Additional Derating Factors." The duration box in minutes means the estimated time the equipment will operate. The next box asks the question "Terminated on a Fuse?" The explanation in the Help box can be confusing and not that useful. I found this question a bit vague and not explained at all. The next question is "In Conduit or Sheath?" The final one is "Extra Thermal Insulation?" To answer these questions only marine electrical professionals with detailed ABYC knowledge know how they affect the calculation outcome. None were selected for the test.

9. With a simple click the calculation is made. The recommended AWG size is 14 AWG (ABYC standards only) and 20 amps capacity. The result also gives 18 AWG ampacity only.

This detailed calculator is, for most people, probably too complicated for basic needs, even if all the considered factors are correct. As an ABYC analysis tool, it's very useful and the disclaimer at the start is probably appropriate.

The calculator also includes a DC Circuit Protection Selector and, given that Blue Sea also sells many circuit protection devices, this may be a useful aid for device selection. It uses just battery CCA, which is fine for perhaps trailerable boats and other small boats, however, most larger sailing and power vessels use ampere-hour-based deep-cycle batteries so you need to determine the correct value to enter here. Perhaps this part of the calculator should open to a dedicated circuit protection page and explained more.

When I selected 500 CCA and branch circuit for my trial circuit, the calculator specified a minimum 6-amp and a 10-amp rating for protective devices for 20-amp wire capacity. The maximum protective device is 20 amps, which equals the maximum current rating of the conductor. The calculator also gives a minimum ampere interrupt capacity (AIC) rating for a protective device used in this circuit, in this case, 750 amps. Below this screen is a very impressive table of protection devices and ratings, color-coded for optimum use or those rated below or above suggested use.

WireSizer 3.0

When entering the Jack Rabbit Marine site to download the WireSizer, you will find two versions and the latest WireSizer 3.0 is dated March 2008. Developed by Alden Trull, this is a Beta version shareware program. The page gives the following information along with a disclaimer that it has not validated the calculations contained in the shareware, that you install and use the program at your own risk and also to always cross-check the results of this software with other sources. I would have thought the developer would have performed some validation so that was disappointing if true.

The site page also explains that the ampacity of a wire is the maximum current in amps that a wire of that gauge is designed to support without overheating (independent of the circuit length and voltage). When sizing a fuse, the fuse rating should always be less than the ampacity of the wire in which it is installed. This statement starts to look at circuit protection, which is the next issue after conductor selection. It makes a somewhat vague statement about rating fuses less than wire ampacity and doesn't expand further as what that might be in terms of factors and values. It also doesn't mention circuit breakers, which are the most common protective device these days so this perhaps should be left out or inserted into a protection-based section to avoid confusing calculator users.

You are asked to click on a link to download a zip file containing the program. I did and initially on the computer I was using I had all sorts of troubles and had to switch computers as there was some glitch in being able to download. Once downloaded on another computer, I opened the zip file and clicked on the setup file to download and, after a few confusing messages, I was able to load the file.

The calculator data entry page is simple and user friendly, with a pull-down menu for ampacity but unfortunately, the Help file doesn't really give any help at all. As a note, the AWG ampacity table is for the American Yacht Design Council and not ABYC so that's going to confuse users just a little. However, it quotes the basis for calculator calculation values, including insulation and ambient temperatures and cable bundling factors.

1. Enter voltage drop percentage. Pull-down options are 3%, 10% or user definable (small window opens to enter defined values). I think this would have been best at a simple 3%, 5% and 10%. I chose "5%."

2. Enter insulation temperature in degrees Celsius and this gives options. Again, as North America uses Fahrenheit, a select option would be better.

3. Enter ambient temperature 30C or 50C. I chose "30C."

4. Enter the number of energized wires in a bundle. I selected "1 or 2."

5. Enter the AWG calculation parameters of voltage, current and conductor distance in feet. This is in very good user-friendly-sized window with larger numerals. I used "12 volts, 6.5 amps and 50'."

6. Click the calculate button and the results come up in three boxes.

In the "Wire Size AWG and Listed Ampacity" box, the value was 14 AWG and can carry 20 amps. The "Calculated Voltage Drop" box listed 4.25% using 14 AWG. The actual voltage drop value of .51 volts was useful to know. There is also a "Calculate" box that allows a smaller or larger manual change of the wire size and in this case, listed 12 AWG and 16 AWG with the revised values. This is a very useful feature.

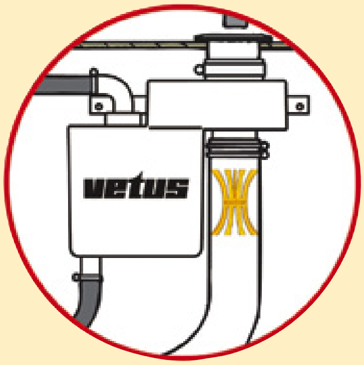
Summary

I trialed both calculators on a variety of circuit lengths, currents and voltage, along with varying other selectable issues. They came up with the same answers, which was reassuring. Besides differing in being online or downloadable, they had varying data input information and both differed considerably in the range of variables and parameters being calculated. The WireSizer 3.0 had greater novice user functionally and overall ease of use. Both programs are useful to the novice and professional. As the disclaimers state, use them with caution and they will be a good check against calculated values.

About the author: John Payne, DIY's electrical consultant, is author of numerous marine electrical and electronics books and recently added two books to the "Understanding" series: *Understanding Boat Plumbing and Water Systems* and *Understanding Boat AC Power Systems*. (Sheridan House).

STOP FUEL THEFT!

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



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Interlux

Barrier Coat BLUES

Help for do-it-yourselfers who are outside their comfort zone and working against gravity when mixing and applying exotic formulas to a hull bottom.

By Rory Harley

Bottom jobs are a bit like root canals. At the first sign of trouble you go into denial that there is any problem and, when conditions deteriorate, it gets relegated to a wait and see mode. Bottom jobs also share another ugly trait with root canals. They fail. I did a bottom job on my previous boat about 20 years ago with VC Tar, a two-part epoxy primer and, in a few years, when I saw telltale wee blisters forming again, my heart sank at the prospect of the work that lay ahead.

When my first epoxy job failed, I initially tried the Interlux 1000 clear epoxy base, followed by the more easily applied, higher-build InterProtect 2000. Interlux has made some improvements since then. The recommendation now is to apply a “soaker” coat of Epiglass epoxy resin, which has a lower viscosity than the old 1000, to wet out and fill the tiny surface voids in the gelcoat or fiberglass laminate. The newer InterProtect 2000E now comes in grey and white, which means it’s a lot easier to apply successive coats, alternating color to ensure uniform coverage. This product now has a maximum time of six months between coats, which gives more flexibility for application time. While the myriad of epoxy brands may work perfectly well, this seemed to me the best solution.

First, a note on safety. Epoxies, their thinners and cleaners, are idiosyncratic and have to be treated with respect. Read and reread all of the information in the online manuals and on the can labels. Get to know which chemicals have strong solvents and require eye and carbon cartridge or respirator protection. Applying a barrier coat is physical, repetitive and uncomfortable work. It is easy to make a mistake. On one occasion, while transiting from my worktable to my crouch position under my boat, I forgot my goggles and got solvent in my eye. That was not the time to be reading the tiny first aid information printed on the can’s label.

The appeal of doing your own bottom job is not that it’s fun or provides self-satisfaction. A DIYer does a bottom job because it is within almost everyone’s skill set and to avoid the astronomical invoices that boat repair professionals have to charge for the grunt work manual labor that is involved. Don’t forget some yards prefer not to do this work.

Bottom Assessment

Although my current boat was blister free at the time of purchase, I reluctantly undertook another bottom job to repair gelcoat stress cracks that crisscrossed the bottom.

While my experiences maybe typical of many bottom failures, this article does not address the repair of larger blisters that have permeated the fiberglass laminate. These gelcoat cracks seldom penetrated the glass and I was able to grind and fill with Epiglass HT9000 resin and fast hardener mixed with HT450 lightweight filler powder. For larger blisters, I suggest using Interlux Watertight epoxy filler. Conversely, if I was just covering a pristine bottom as an additional insurance policy, I’d probably be satisfied with 2000E.

Timeline: Fall and Bottom Removal

Some 20 years ago, I suited up in head to toe protective clothing, a respirator and goggles to remove the antifouling paint on my old boat. However, I’ve since concluded that this filthy job of removing a paint that is purposefully formulated to kill things is not good for my health and I decided that sand or soda blasting or peeling by a pro is the preferred method for removing old bottom paints.

Check with your yard first as some have designated areas for hull blasting


Nick Bailey

Close up of peeled bottom exposes blisters and delaminated fiberglass.

Hull gets a thorough power wash after peeling.


Jan Mundy


Nick Bailey

The only simple, nondestructive moisture detection method is a moisture meter. Readings on fiberglass and core materials just under the outer skin will be relative readings or qualitative, which means they cover a range of wet here, dry over there, for example. For simple diagnostic work you don't require an expensive unit.


Nick Bailey

Consider your neighbors and take the time to build a makeshift tent around the hull to contain dust and debris before doing a bottom job.

or peeling and some forbid any blasting due to environmental issues. You'll need to attend the procedure to move cradle pads as needed and provide direction whether just the bottom paint is to be removed or partially or completely removed to expose the bare glass. I elected to go the middle road to open up any unseen blisters.

Before any blasting, it's also a good idea to seek the expert assessment from a qualified marine surveyor or boat repairer on the condition of the hull bottom laminate to determine the best approach to the planned repair.

I epoxied my cast iron keel soon after treatment and applied a couple of additional coats the following day. All other surfaces must wait until the laminate dries out, and in northern climates, this means spring. I did grind the gelcoat cracks, which resulted in gouges about 1/8" (3mm) deep and wide.

Timeline: Winter Prep

Take advantage of the off-season to research the task at hand and assemble all the equipment you'll need. Interlux guides provide the approximate epoxy volumes required to do the job. I found it a challenge to assemble all the needed paraphernalia: brushes, rollers, paint trays, stir sticks, cans and plastic containers, coveralls, etc. You'll also need a lot of white cotton rags, as the solvents tend to make colored rags run and leave marks on the hull, and gloves. I bought a box of extra heavy latex gloves called Thicksters at an automotive body supply shop.

Working under your boat and holding up a sander, brushes or rollers for hours at a time demands that you consider the access and seating arrangements. Working on gravel is tough on the knees and hands and you may want to scrounge or buy some plywood to put under the hull. I found a large pallet at the boat yard and purchased a couple of plastic sawhorses to improvise a workbench. A bottom job creates a lot of trash so get a large trash can and have lots of plastic liners on hand.

If you don't regularly work with epoxy, it's a good idea to get the feel of the stuff well before you get to the boat. Learn how to prime the pumps and mix the resin with the filler powder to the various consistencies. Make sure you do this in a workspace that is well ventilated as the vapors from these materials are volatile.

Timeline: Spring at Last

I was chomping at the bit to get started in early spring but became frustrated by abysmally low temperatures. While waiting on weather I moved on to confirm that the hull had dried out sufficiently. I followed the instructions described in the West System's *Gelcoat Blisters: Diagnosis, Repair and Prevention* book, which involve taping clear plastic tenting to the hull from the waterline down. The winter in northern climes is pretty dry and after a five-month haulout I had no sign of moisture collecting under the plastic.

The first task is to remove any residue oils or solvents on the hull by applying Fiberglass 202 Solvent Wash. Interlux recommends that all contaminants that might impair the ability of the epoxy to bond have been removed when water doesn't bead on the surface. I was able to establish a "beading" benchmark when I found some trace contaminates around the sink drains. I also found the 202 melted my latex gloves and it was a pain to fold the cleaning rags to expose a clean surface every 4 to 6 sq. ft. as recommended so as not to spread contaminants. In the end, I ran out of rags and used paper towels for the repetitive


Jan Mundy

When refinishing bottoms, always lay a ground tarp to collect debris, runoff and paint spills.

wipe-on and wipe-off process. It was the 202 that I managed to get in my eye so be sure to wear eye protection. The 202 is also volatile, so wear a carbon cartridge respirator. I used a spray bottle as the water source for "bead" testing and as a standby emergency eyewash.

Timeline: Resin 101

After taping, I was ready to apply the Epiglass. I started by using small rollers to apply the Epiglass but gave up, as they seemed to shred and leave fuzzy remnants in the epoxy. I switched to disposable brushes to finish the job. Lee Valley's (www.leevalley.com) package of 30 natural brushes at $13.95 filled my brush requirement for the entire job. Epoxies become more viscous (thicker) with lower temperatures and I had better results if I kept it warm.

Epiglass, like many epoxies, leaves an amine wax on cured surfaces that the manufacturers euphemistically call "blush." Unfortunately, it has to be completely removed or its presence may hamper the adhesion of the succeeding 2000E. Industry specialists recommend using a 3M Scotch-Brite pad to scuff the surface with a soapy water solution to remove the amine. Maybe this approach works right-side-up on a horizontal surface but I found that working against gravity reduces the forces of scuffing and the water runs down your arm, making this approach impractical. To complicate matters, the blush and the resin are both clear so you can't really tell when the amine is completely removed. Ultimately, I opted for a combination of scuffing as recommended and then sanding the stuff off, which smoothes and mechanically roughens the surface.


Nick Bailey


Jan Mundy

(above) Peeling removes a consistent amount of material and leaves a surface that doesn't usually require much fairing. Costs of a basic gelcoat peel for a 34' (10.3m) boat averages $30 per linear foot plus the technician's travel costs. A deeper peel into the laminate requires a second pass at double the price. (across) After peeling, there is usually detail grinding needed around thru-hulls, along the waterline and at cradle pads but the minimal fairing required really cuts down the man hours and cost in relation to an inconsistent blasted surface.

[Ed: Vinegar removes the amine blush with much less effort.]

In anticipation of holding a sander upside down for hours at a time, I purchased the lightest and most comfortable orbital sander I could find: a Dewalt 3 Amp 5" (127mm) with hook and loop paper exchange for $100 at Home Depot. The suction hose from a Shop Vac taped to the sander's outlet sucked away the sanding debris and effectively eliminated the tendency of the amine to clog the sandpaper and the problem of sanding dust settling on my goggles. On the downside, the howling racket necessitated wearing good hearing protection.

My hull only required one coat of resin and once it was sanded and wiped down again with 202, I mixed up Epiglass with the 450 powder to a mayonnaise consistency and filled in the grinding gouges. The very light 450 powder tends to blow away if not covered so I created a temporary, partially enclosed mixing station using a cardboard box with the closed end of its top pointed towards the prevailing wind direction to block the breeze.

The mixture was best applied with a variety of 1" to 4" (25mm to 10mm) metal putty knives being dragged longitudinally along the cracks. It took about three applications of this mixture to fill in the cracks and get a smooth surface. Eventually, I developed a technique of applying additional batches to the still tacky filler. (Ed: This is known as "green on green" in the trade.) This avoided the

Nick Bailey

(below) InterProtect 2000E is available in two colors so an optional method of application is to paint each coat an alternate color to ensure complete coverage and application of the correct paint amount. (left) Interlux recently announced that InterProtect 2000E now has a six month overcoat window, which means you can prep the hull, apply the primer and proceed with the work as time allows.

Nick Bailey

Filler applied after peeling before application of InterProtect.

repetitive process of letting the epoxy harden, washing and sanding off the amine blush, then giving a 202 wipe down. I found the repeated applications of 202 to be the most disagreeable part of a bottom epoxy job. When the hull was sufficiently faired, I sanded it again, gave it another 202 wipe down and I was ready to apply the 2000E.

Timeline: 2000E Application

2000E is quite different than Epiglass in its application technique. Although it looks fairly benign, it is easier to mix and apply but contains a powerful solvent so wear a cartridge respirator and eye protection.

The 2000E also has a required induction time where the mixed reactor and base need to sit for 20 minutes before applying to the hull. I used two standard plastic household mixing cups to measure the volumes of 1 cup of activator to the requisite 3 cups of base, which gave me about 20 minutes of rolling time. The handle on the mixing cup enabled me to dip the cup into the gallon base can and brush the excess back into the container. Be careful not to cross contaminate the two unmixed products. I replaced the cover on the base can and used plastic wrap over the container of mixed 2000E to limit solvent evaporation. I also found that storing the 2000E cans upside down and then turning them right side up before use helped to reduce the hand mixing once the can was opened.

Interlux provides a work schedule on the packaging where the 2000E can be applied coat over coat in rapid succession to give the entire job four coats in just two days. In practice, however, there are a couple of constraints that get in the way of a speedy application.

While 2000E has a six month maximum overcoat time, the minimum overcoat time is 5 hours at 50F (10C) as related to the substrate temperature. Although Interlux doesn't state the rationale for the minimum overcoat time in its literature, I understand it's to allow the solvent to evaporate and prevent its entrapment inside the epoxy. While this may not be a problem in Florida, there are significant hull temperature gradients on a northern spring day. Even if the air temperature rises to a comfortable daytime temp during the day, the cold ground, cold air in the bilge and thermal inertia of the keel keep the vessel's underbelly much cooler than the sun-drenched topsides and deck. I purchased a laser pyrometer for $35 at a discount auto store and used it to measure the various hull and keel temperatures. Unless it was a really warm day with minimal nighttime cool down, I was only able to apply 1 coat per day to be within the specified minimum overcoat time.

Interlux recommends applying 2000E with a 5/16" or 3/8" nap, solvent-resistant roller. I found that the thicker the roller nap, the rougher the orange peel

Jan Mundy

Before applying a primer or paint, take a reading of hull surfaces to ensure you are within the recommended working temperatures, which are typically 50F to 70F (10C to 21C).

stipple on the epoxy. To complicate matters, most thick rollers are fuzzy affairs and as the solvent evaporates, the epoxy becomes tacky, which leads to even more stipple and pullout of the roller hair or foam from its backing tube. Although it was a bit messy and cumbersome, I found that if I placed a plastic shopping bag over the paint tray when applying the 2000E it minimized solvent evaporation and facilitated a smoother application.

In the end, I used 1/8" yellow foam rollers and applied 7 coats to get the required buildup. When finished, I did a very light sanding to knock off the high points from the final 2000E coat. In doing the job again, I would probably begin with a thick roller and reduce the nap thickness before the final coats.

The minimum allowable thickness for 2000E is .010" and Interlux recommends .012" to .014" thickness for optimum protection. I set up a test panel with a strip of tape down the middle. Each time I applied a coat of 2000E on the hull, I'd also lay a coat on the panel. When I got to about the third coat, I'd pull off the tape and start checking the epoxy thickness with automotive feeler gauges and stop when I reached the recommended .014" thickness. Next time, I'd stockpile and test the rollers in advance. Frankly, I would have gladly paid a premium at my chandlery for a brand name roller to reduce the hassles I encountered.

Eventually, the day arrives when you apply the antifouling paint. I choose Interlux Micron CSC, mainly because it gave me the flexibility to go into salt or freshwater and its ablative makeup meant relatively easy removal. [Ed: For details on selecting the proper antifouling paint refer to *Bottom Line: Selecting Antifouling Paint* in DIY 2008-#1 issue.]

You now have up to six months to apply the antifouling. If you're in a hurry, Interlux recommends the thumb print test to determine when the paint film is ready to overcoat with bottom paint. If the primer feels tacky and you can leave a thumbprint without getting traces on your thumb it's ripe for the antifouling paint. Do this test one hour after applying the final primer coat and then every 15 minutes until it reaches the ready-to-overcoat stage. This works with most antifoulings except the vinyl types.

Summary

Costs for the Epiglass and 2000E were about $700 and all the solvents, rollers, brushes and other paraphernalia added about another $400.

This job took upwards of two weeks. It was a lot of work and, given that neither I nor others will see much of the bottom, it doesn't sit high on the self-gratification scale. As I cleaned up my workstation, I was able to take small pleasure tossing the epoxy encrusted goggles and coveralls into the trash. I now know my boat better and after grinding those stress cracks, I know where the hull needs more internal stiffening. I also have the comfort that the job was done well and the bottom is reasonably protected for years to come. I just hope I never have to do another bottom job.

About the author: Rory Harley's current project boat is a Tanzer 10.5 pilothouse with a swing keel.

HAULOUT

Lesssons Learned in BOTTOM PAINTING

When selecting a boatyard to paint your boat's bottom, it is very important that the yard be qualified to do a proper job, especially when working on metal hulls.

The author's Ted Brewer-designed aluminum and steel yacht undergoing bottom repairs.

By Priscilla Travis

When *Nomad*, my 42' (12.8m) sailing yacht, a steel hull with aluminum decks and superstructure, was professionally built in 1989, the steel was sandblasted to white metal, sprayed with epoxy primer and faired with epoxy fairing compound above and below the waterline. The bottom was then painted with antifouling primer and two coats of Interlux bottom paint.

For 10 seasons, the staff at a boatyard, 1,300 miles (2,092km) from my home, handled the bottom painting. The boat was launched and lifted in my absence. The antifouling was apparently applied with very little consideration to surface preparation, judging by the appearance of the bottom paint when I was able to inspect the hull out of the water after 10 years. The yard probably used several different brands of paint and that raised compatibility concerns. Coincidentally, following a move to a different boatyard, where I had intended to remove all the old antifouling and do a proper job, my marine insurance company decided that, prior to renewing my coverage, they wanted an ultrasonic metal hull thickness test.

The company policy was to require this testing below the waterline on metal boats over 15 years old. Non-destructive ultrasonic test equipment is used to gauge the thickness of metal plate. By comparing the original plate thickness to the current plate thickness, a technician can determine plate wastage due to corrosion and, thereby, estimate the boat's remaining service life.

The ultrasound technician inspected the hull prior to scheduling the test and determined that all paint and fairing compound would have to be removed. To do a proper test, the bottom paint must be in good condition, firm and not too thick or uneven, and there cannot be much, if any, fairing material on the metal. Therefore sandblasting was necessary. The work described below was done in Scotland in May, where it is often wet and cool.

Sandblasting

Starting 6" (152mm) below the bottom of the boot top, the hull and keel were sandblasted with a particulate or mix of ground glass and coarse sand, removing both bottom paint and all of the fairing compound. The blasting took six hours per side and required 1.5 tons of grit material.

The old bottom paint came off easily. There was no sign of the fairing material being loose from the metal; in fact, the sandblasting technician had to expend extra effort to remove it. No areas of rust were found under the fairing compound or original epoxy primer. The sandblasting did reveal a few places where integral fuel tank welds had become porous, conditions not yet evident under fairing compound or paint. These were repaired before the final epoxy primer was applied.

Immediately after sandblasting, the bare steel was sprayed with a two-part epoxy, "blast primer." The ultrasonic test was performed over this primer; it revealed no areas of plate thickness deterioration. The sandblasting, removal of blast residue from the boatyard, off-site disposal of the waste and the application of one coat of blast primer paint cost $2,400. The ultrasonic test itself was approximately $500.

The sandblasting process created uneven edges in the original fairing compound 6" (152mm) below the bottom of the boot top. These edges were faired with an epoxy compound to even out the irregularity and were tapered downward another10" (254mm) and sanded. Any bare metal exposed by sanding was immediately spot primed. Because of the cost, I chose not to have the rest of the underwater areas re-faired.

Painting

The boat was moved into a painting shed. The application of the epoxy primer required climate control, with temperatures preferably near 68F (20C). In the shed, the hull was warmed with a large construction heater and work lights before and during the application of each coat of primer. Temperatures of the metal surface and the ambient air were monitored.

Primer was Hempel Hempadur, a polyamide adduct-cured epoxy, applied according to the manufacturer's specifications. Applied by roller, six coats give approximately 0.75 mil overall dry film thickness. The expected service life of this primer is at least 10 years. A coat of antifouling primer, similar to Interlux Primocon Silver, was applied by roller before the final two antifouling coats. I bought the bottom paint and did the job myself.

The cost for moving the boat, fairing below the boot top and application of the primers, labor and materials included, was $8,200. The yacht was moved three times: away from other boats in the boatyard for sandblasting and then into and out of the painting shed. Total cost for the professional services and materials required for the project was $11,100.

It is obvious that all boat owners, especially those with metal boats, should routinely pay attention to the proper bottom paint application and follow the manufacturer's instructions to the letter. In some boatyards, DIY work is prohibited and the owner is not welcome to supervise the yard workers. This restriction may become increasingly common as stringent environmental regulations and controls are applied to exterior work done at marine facilities.

When selecting a boatyard to paint your boat's bottom, make an effort to determine the qualifications of the painters, the level of supervision of untrained personnel, the yard's standards for surface preparation and the selection and application of bottom paint. If a boatyard manager will not discuss these details to your satisfaction or will not allow you to oversee and influence the quality of the work, you should consider another yard.

In some areas of the world, however, there are limited boatyard choices and circumstances may force you into an undesirable situation where you have little control over the work. A one-time poor application of bottom paint may not be a major problem but, if the yacht is painted at the same yard over several years or if major paint removal and repainting is to be undertaken, then it is very important that the yard be qualified to do a proper job. Metal boat owners should check with their insurance companies to determine if or when ultrasonic testing may be required and plan accordingly.

About the author: Priscilla Travis has owned and maintained metal cruising yachts since 1978. She is currently enjoying summers sailing the coastal waters of England and Ireland.

Build A BACKYARD BOATSHED

A few ideas to consider when you need a simple, inexpensive work or storage "shop" for your boat.

Story and photos by Roger Marshall

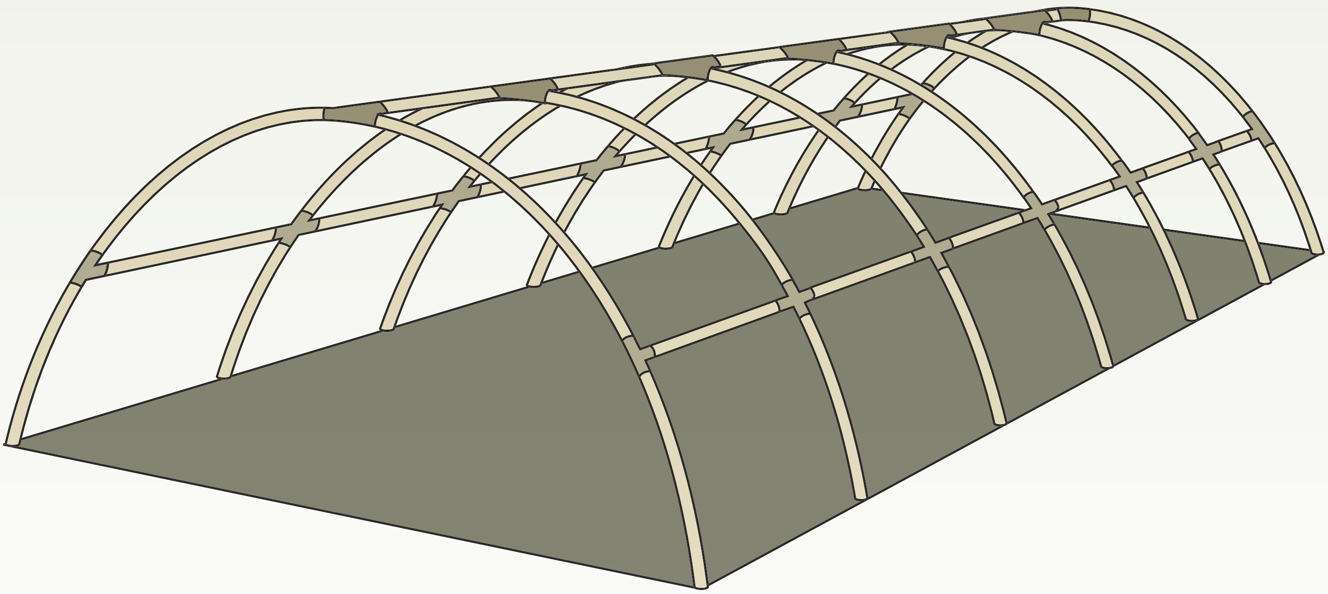
You've hauled your boat at the end of the season and put it in your backyard. You want to work on it during the winter but you must remove the protective tarp and get organized before you can accomplish anything. This added hassle tends to put you off the task. There is also the weather to consider. Cold and snow are real hindrances to working on a boat. As a result, the chances of getting the work done are diminished even further as the weather offers all the excuses you need to defer the work. There is a solution to this dilemma: build a boat shed.

A few years ago, I built a backyard boat shed for about $100. It worked well enough to keep the expected snowfall off the deck and the boat dry but a raging winter gale (with winds over 60 mph/96 km-h) destroyed the industrial-grade polyethylene cover. I temporarily repaired it with duct tape but this shed's life was terminated lest the neighbors start to complain about the eyesore.

Last year, I needed a place to work on two boats during the winter. I found myself back in the market for another temporary boat shed. Below are a few simple and inexpensive sheds for the DIYer to build.

Hoop House

A hoop house shed is easy to make for working on a small runabout and is strong enough in all but the heaviest snowfall. First, mark out the area where you intend to build your shed. Let's say it measures 21' long by 14' wide and you need about 6' of height (6.4m by 4.26m by 1.82m). Buy five 10' (3m) lengths of 1/2" (12mm) concrete reinforcing bar (rebar) and cut each into



Joe VanVeenen

(top) Sample grid assembled and ready for covering with polyethylene sheeting. (left) Author's plastic hoop-style shed.

three pieces with a hacksaw. Hammer the pieces of bar into the ground at 3' (914mm) intervals along the two sides of your hoop house, leaving about 12" (30mm) of bar showing.

Next buy sixteen 10' (3m) lengths of 3/4" or 1" (19mm or 25mm) schedule 40 plastic pipe and eight high-pressure straight joining sections (high-pressure sections are slightly longer than normal sections). You'll also need a can of multi-purpose pipe cement. Glue two 10' (3m) lengths of pipe together using the joiner piece. Place a 20' (6m) length of pipe on each of the rebar pieces and bend it over to fit the other end on the opposite piece of rebar. Now you have a framework that looks like the familiar corrugated metal Quonset hut. With a 14' (4.26m) width, the hoops stand just about 6' (1.82m) high, so you should have plenty of headroom.

Place 2" (50mm) wide lumber, in 6' or 8' lengths (1.82m or 2.43m) against the plastic piping on the outside ground perimeter and use conduit clips or pipe clamps to screw the wood to each pipe. This gives you something to secure the plastic covering to the framework. If you don't want to spend the extra money for the wood, simply place rocks on the plastic to hold it down.

Frame a door in one end and put 1" by 2" (25mm by 50mm) furring strips or other inexpensive wood about half way up the pipes from front to back. If in a heavy snow area, you'll need a 4" by 6" (101mm by 152mm) center support down the middle of the structure. You can laminate this center support out of four 1" by 6" by 12' (25mm by 152mm by 3.65m) to get a clear span for the length of the shed. The span is supported on 2 by 4s at one end of the shed and by the door header at the door end.

You can purchase polyethylene in rolls 20' (6m) wide and 100' (30.4m) long for about $75 or you can buy shrink-wrap cut to suit the length you need from Dr. Shrink (www.dr-shrink.com). The polyethylene gives you enough material to cover the structure about three times.

First, cover the tubular framework. At the sides and back bring the plastic down to the ground and nail it to the 2 by 8s using pieces of furring strip. At the front, add a door; I used an old storm door. With the sheeting on and the door in place you have your winter boat shed.

When you go out to work on your boat, you'll find that the shed heats up quickly on a warm, sunny day and requires no other heat source. On cool, overcast days, a small heater gives you some warmth in which to work. It should be adequate, except in the coldest of overcast weather. If it snows, simply go into the shed and bang the plastic from inside to dislodge the snow.

Conduit Frame Boatshed

If you can bend electrical conduit or metal water pipe, you can easily make a substantial hoop-style shed. Bend each piece of 10' (3m) long tubing into a quarter circle. Using two pieces at the top, each in the shape of a cross, and a tee piece at each end, make a complete metal pipe framework, by placing 3' (914mm) long sections of pipe between each hoop at the top and at the bottom. The “frames” cross the “ridge pole” at the top of the shed and are joined with the cross-shaped pieces. With this method you can construct a much more solid hoop house than the plastic pipe version; however, it will also cost a little more, around $250. Again, you need wooden baseboards to secure the cover and the structure will need a door. An alternative is to buy a hoop style greenhouse that sells for somewhere between $500 to $2,000, depending on size and height.

Covering a Larger Boat

For a larger boat you might want to build a more substantial framework. For covering my boats, I built a shed measuring 32' long by 16' wide by 16' high (9.7m by 4.87m by 4.87m). The extra height was to allow me to walk around on the deck of my J/22 and to store the J/22 rig in the rafters.

This shed was made of: 28, 12' (3.65m) long 2 by 4s for vertical supports; 10, 16' (4.87m) long 2 by 4s for the headers and footers; 4, 16' (4.87m), 8, 10' (3m), and 4, 8' (2.43m) 2 by 4s for the rafters. I also used several additional 16' by 1" by 2" (4.87m by 25mm by 50mm) furring strips to brace the structure. Because I had a tree in the way, I didn’t use a rafter at one end but instead added four braces using 10' (3m) 2 by 4s. Since the structure would be covered with shrinkwrap, the supports could be 4' (1.2m) apart but they would need a cross brace.

Alternatively, you can make the wall supports 3' (914mm) apart or build them as in a regular stud wall with 16" (406mm) spacing.

Another aid for bracing the shed is to buy the least expensive plywood you can find and place it around the base of the structure. Nailing it to the supports gives additional strength to the structure. This plywood also serves another purpose. It keeps animals out and, when it snows, the snow that slides off the roof and piles along the side does not stretch the shrinkwrap.

Each wall was constructed on the ground and then raised to the vertical before being slid into place. I did the majority of this work on my own but an extra person really helps to support the wall structure and keep it from falling on your boat.

With the four walls in place, the next job is to set the rafters. These were constructed on the ground, using a 16' (4.87m) 2 by 4 with a 4' (1.2m) 2 by 4 piece nailed in the middle to make a tee. Additional 2 by 4s were then cut to fit the slope of the roof. I found it easiest to nail a short block exactly 3-1/2" (89mm) in from the end of the rafter. This ensured that the rafter sat on top of the wall without sliding off. By mounting one end of each rafter at a time and then raising the other end, I was able to set the rafters on my own. Again, it is easier to have a helper to hold the rafters upright while you set the ends.

Fitting the ridgepole was interesting in that it was way higher than any ladder I owned. I managed to reach the end rafter by standing on the top of a 10' (3m) stepladder but this is not recommended,

Shrinkwrap shed under construction.

especially when you are working alone. The ridgepole was nailed in place but the second rafter jammed and would not slide into its slot. Unfortunately, it was way beyond my reach. I could reach the other rafters by standing on the decks of the boats. Finally, I was able to get the jammed rafter in place by standing on the deck of a boat and whacking the timber with a 2 by 4. The whole undertaking made for an interesting Sunday afternoon. With the ridgepole in place, the ends were braced. Some of the sidewalls needed a little more bracing, which was easily accomplished.

If you've ever tried to lift a 200' (61m) roll of shrinkwrap, you know that you should call a friend to help. The roll is as slippery as an eel and does all manner of funny things to your back when you lift it alone. The roll I had was 40' (12m) wide, so it easily covered the entire shed.

Getting it over the structure was interesting. I unrolled it on a soft patch of ground and pulled the folded part of the roll over the wall of the wooden frame. Gradually, I worked the folded part over the entire structure. This was not easy when the ridgepole was 16' (4.87m) high and my highest stepladder is 10' (3m). By putting the ladder on the deck of the sailboat, I was able to get high enough to reach over the ridgepole. With the folded part of the roll over the entire frame, it was fairly easy to unfold it to cover from one end to the other. Do this job on a windless day, otherwise you could end up with your expensive shrinkwrap acting like a huge spinnaker and dragging your entire boat shed (or parts of it) down the street. To secure the shrinkwrap, I nailed 1" by 2" (25mm by 50mm) strips to the bottom boards. By tightening the wrap and nailing both sides, I was able to get a fairly smooth cover over the entire wooden structure.

With shrinkwrap, you simply heat the plastic and it shrinks to form a nice tight surface. As I didn't have the proper tool, the local boatyard sent an experienced workman with a propane-fueled heat gun to do the job. He demonstrated how easy it is to blow a hole in shrinkwrap if you do not know what you are doing. Also, if the wrap is wet, the wet portions do not shrink as fast as the neighboring dry portions and a hole can result. You'll need a roll of 6" (152mm) wide special heat- shrink tape to repair any holes. We did the actual shrinking of the plastic on a damp day and created a fog inside the structure as the heat gun warmed the outside.

Once the material is shrunk around the frame, it acts like a drum and holds the structure together as well as keeping out snow and rain. However, the material retains moisture inside the structure, so you might want to install a dehumidifier. If you use both a heater and a dehumidifier, you'll have a shed that can handle most of what the weather can throw at it.

The final job was to install an old storm door for access into the building. This was relatively easy in that I had already made the opening and only needed to cut through the wrap, fold it back on itself and heat it to fuse it to the adjacent shrinkwrap.

So far, the building has been tested by three major storms, with winds to 50 mph, and all that has happened is that one of the sloped reinforcing braces popped off the post it was nailed to. Larger nails solved that problem. We'll see what next winter brings but so far I'm happy with the results.

About the author: Roger Marshall is a veteran writer, sailor and general boat repairer. He is currently working with his sons to restore a 1979 J/24 to full racing condition.

WHY Decarbonize?

Understanding the causes, effects and removal of carbon build-up in your engine helps to improve fuel efficiency and engine performance.

Story and photos by Steve Auger (exceptions noted)

With the price of fuel and oil skyrocketing on a daily basis, the investment in maintaining peak fuel efficiency and performance far offsets the costs of operating an engine that is down on power and performance. As the engine performance deteriorates, so does the engine's fuel efficiency until it becomes a "gas hog."

Carbon is a by-product of the combustion process that takes place in the engine's cylinder head area. All engines produce carbon but, by design, some engines produce more carbon than others. Carbon build up is often referred to as "engine deposits." This carbon build-up is mostly comprised of additives in the gasoline and engine oil that are left over after the combustion process. Several factors contribute to excessive carbon build up: engine tune, engine and combustion chamber operating temperature and the quality of the engine oil and gasoline.

Oil and Fuel Sources

There are many types and quality ranges of engine oil (both two- and four-cycle) and fuel. Although purchasing lower grade fuel and oil saves money initially, these products tend to be the main culprits in higher than normal buildup of carbon and engine deposits. Proper engine maintenance and the regular use of quality fuel and oil is the number one way to reduce carbon build up and is cheaper in the long run especially with today's fuel prices.

For instance, the two-cycle outboard engine that was produced in the 1960s used a fuel-to-oil ratio of 24 parts gasoline to one part oil but it did not incorporate a thermostat to control engine operating temperature and had a low spark voltage. These engines are much more likely to accumulate large amounts of carbon deposits compared to a modern direct fuel injected, two-cycle outboard with thermostatically controlled engine operating temperatures and a fuel-to-oil ratio as low as 100 parts fuel to 1 part oil.

All gasoline engines accumulate carbon in small amounts and this is not usually detrimental to engine performance. However, the continuous use of low-grade fuel and oil accelerates this process to the point of affecting engine performance.

Performance Problems

Excessive carbon build up can cause a number of performance problems, such as lack of power, excessive fuel consumption, engine run-on (dieseling) and poor idle quality.

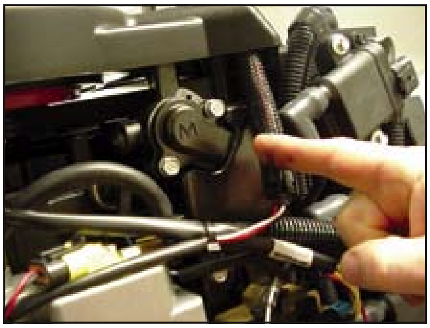
Excessive amounts of carbon cause piston rings to become stuck or seized into the piston ring groove, resulting in horsepower and torque loss in two and four-cycle engines. This "stuck rings" condition reduces the available power the engine can produce resulting in a reduction in performance and increased fuel consumption due to improper sealing of the piston rings between the piston and cylinder walls. This condition is called cylinder leakage and can be measured with a tool called a cylinder leakage tester. A basic cylinder leakage tester can be purchased from most automotive stores for around $100.

Cylinder leakage values below 15% are deemed acceptable and represent a minimal reduction in engine performance. Cylinder leakage values above 15% may indicate problems with the piston rings sealing, which is corrected by using an aerosol additive (a form of engine carbon remover), often referred

Jan Mundy

To decarbonize a two-cycle engine, spray Quicksilver Power Tune in the carburetors following instructions on the can. This photo shows an early '80s 9.9hp Mariner receiving a treatment. Mercury recommends doing this once a year as preventative medicine.

Quicksilver Power Tune breaks down carbon deposits that build up over time in two-cycle engines. Always perform this process in a test tank or on land with a flushing device and a collection mat to ensure the Power Tune and engine deposits (a black goo) do not end up in our waterways.



Location of thermostat on a current model outboard.

(top) Carbon deposits on a four-cycle engine piston. (bottom) Clean piston without carbon.

Cylinder leakage tester

to as engine cleaner. Cylinder leakage past the piston rings is easily identified as the air leaking past the piston rings, which results in the escaping air pressurizing the crankcase. This air exits the crankcase through either the dipstick or valve cover vent or positive crankcase ventilation valve.

Note that high cylinder leakage values (over 15%) are not always the result of stuck piston rings. Poor seating of the intake or exhaust valves due to carbon build up or wear, failed head gaskets and cracked cylinder heads or cylinder liners also produce high cylinder leakage numbers but the point where the air exits the engine is different than for stuck piston rings. Consult the cylinder leakage tester operating instructions for in depth details of how to accurately determine the results of cylinder leakage tests.

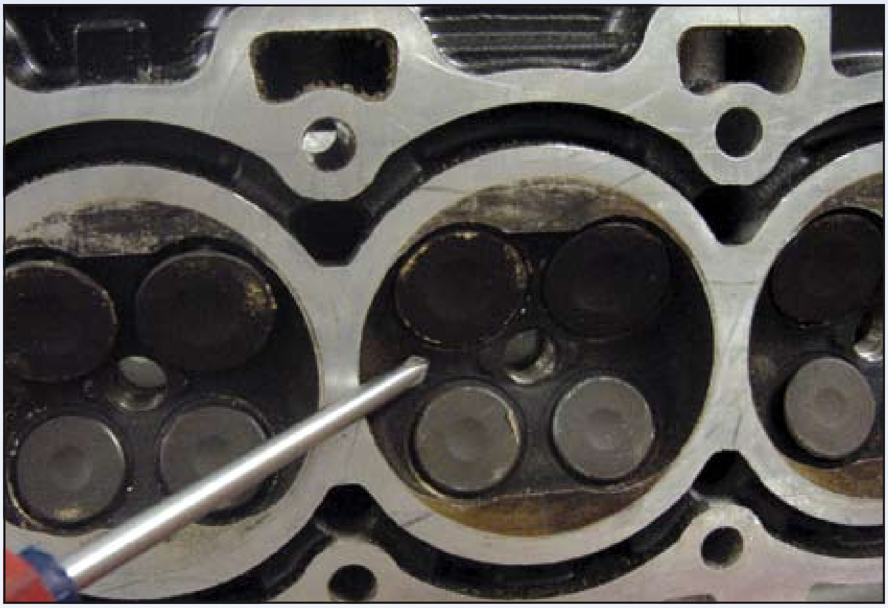
Gasoline engines used in marine applications perform best with a coolant temperature between 120F (48.8C) and 160F (71.1C). However, older outboards of all sizes rarely incorporated the use of cooling system thermostats. Typically, only the small modern, low horsepower engines lack a thermostat. This means that the operating temperature of these engines is uncontrolled and operating temperatures are based on water temperature and load. When these engines are run in cold water with light loads, any unburned fuel and oil turns into a black gum that accumulates in the exhaust passages of the engine. This accumulation of black gum restricts the flow of exhaust gasses out of the engine and dramatically reduces the engine's ability to perform up to specification.

Most modern, two-cycle marine engines can be upgraded to thermostat-controlled coolant temperature with a thermostat kit, which greatly reduces the build up in exhaust passages. Using a quality, TC-W3 marine two-cycle engine oil produces less carbon/engine deposit build up than "bargain" brands.

Engine run on (or dieseling) is a characteristic of a carbureted four-cycle engine that has accumulated carbon build up in the cylinder head area that becomes so hot during engine operation that the glowing carbon deposits allow the combustion process to continue after the engine has been shut down and electrical ignition events stopped. The glowing carbon deposits act just like a spark plug (or a glow plug in a diesel, hence the term "dieseling") and ignite the combustible mixture provided by the carburetor, causing the engine to continue to run, albeit poorly, because the ignition is not timed correctly, but it continues to cycle or "diesel."

Use of a decarbonizing product removes much of the carbon build up. Use of a slightly lower temperature thermostat, e.g., replacing a 160F with a 140F unit and higher grades of fuel also helps to reduce the possibility of run on.

Carbon and other engine deposits accumulate in the small air passages that are used to provide idle speed air and fuel to a four-cycle engine. Removing the carburetor and having it professionally cleaned can often rectify a poor idle condition that is due to a plugged idle orifice.



Carbon deposits on a cylinder head

Finally, electronic fuel injection engines use an idle air control valve to control idle speed. Removing and cleaning the idle air control valve on electronically fuel-injected models often restores idle quality to these model engines.

In summary, keeping your engine tuned by using quality oil and fuel keeps carbon build up to a minimum.

On engines where carbon build up is a fact of life, products like Quicksilver Power Tune Engine Cleaner (see photos on page 35) can remove much of this engine deposit build up and help to restore engine performance. Injecting Power Tune once a year should be often enough to ensure a clean engine. I only need to use Power Tune in my two-cycle engine every three to four years because I use only Mercury TC-W3, two-cycle outboard oil. Also, adding the appropriate quantity of fuel stabilizer with every fill up keeps the fuel octane rating from deteriorating as quickly. Mercury also has a product called Quickleen, which can be added to the fuel to keep engine deposits to a minimum.

When using products, such as engine cleaners and additives, always do everything possible to ensure that these products don't end up in our lakes and rivers. Follow manufacturer's use guidelines and always wear the correct protective gear, such as safety glasses and gloves.

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.

A LIGHT TOUCH

A prism brings a pleasant light into the aft cabin that is sufficient for reading on most days.

A few simple modifications will capture natural light to brighten otherwise dim interiors.

By David and Zora Aiken

It's common knowledge that light or, more noticeably, the lack of it, can significantly affect a person's mood. The trawler's wheelhouse and the motor yacht's saloon are greatly enhanced by the light invited inside by their large windows. Replacing small portlights with big windows is not a practical solution when such a modification could jeopardize the strength of the cabin structure or compromise the security of a companionway but there are other ways to bring more natural light into your boat's interior.

Main Entry: Hatch Boards

The main entryway of a boat can be the U-shaped sailboat's companionway or the standard rectangular doorway of a large powerboat with variations between those two basic configurations. Typically, the sailboat entry (companionway) is closed with hatch boards that slide into vertical tracks on both sides of the hatch opening. Horizontal edges of the boards may be slanted or shaped with a slight overlap to suit the angle of their placement and to keep out rain.

It's easy to change solid hatch boards into light-gatherers. Simply replace the wooden boards with clear or tinted acrylic (e.g., Lexan or Plexiglas) panels. With a two or three-board closure, you can replace all or just one of the boards, depending on the volume of light you seek.

Another possibility is to cut a small opening into the center of one or more of the wood boards and inset a piece of clear, tinted or opaque plastic. Cut the hole (most likely a rectangle to follow the shape of the board). Cut a piece of plastic to overlap the hole by about 1/2" (12mm), round the top edge slightly and then caulk the 1/2" (12mm) border area with silicone caulking and screw the window to the outside surface of the board. To keep the board's surface flush, use a router to create a recess to accommodate the thickness of the plastic.

Another alternative for a companionway hatch precludes the need to stow hatch boards. Replace the boards with permanent hinged doors but leave the original hatch board tracks intact. When the weather's chilly, the doors are left open and a plastic panel is inserted in the tracks to brighten the interior and hold heat inside.

Main Entry: Door

A solid wood door leads from our center cockpit/wheelhouse into the forward cabin. Though not a standard-size door, it is large enough to have a small cutout in the upper section, originally for a screen. A separate piece of wood (half the thickness of the door) connects to the door by a hinge at the bottom. With the wood "flap" hinged down, air circulates through the screen. With the flap up and held in with turnbuttons the door can be closed securely. Since the entire wheelhouse is screened, the screen insert is no longer necessary so, in its place, we added a light option. When it's cold outside, a thin 1/8" (3mm) Plexiglas panel covers the door cutout to retain heat as it brings in much-appreciated light on a dreary February day.

Overhead Light

Though not part of the boat's original design, a permanent hardtop now covers the center cockpit of our boat. With such a top, sailors need a sail-watching window but anyone could benefit from the light of a DIY skylight.

Establish the size and location for a Lexan or Plexiglas panel. To avoid inviting excess heat along with the light, choose tinted plastic. Cut a square or rectangular opening. If the hard top is too thin for the use of suitably sized screws, cut narrow teak strips (about 1/2"/12mm thick) and epoxy a frame around the opening on the top surface to create a more substantial base for attaching the plastic.

If the hard top is constructed with an inner liner, it may be necessary to frame the side edges and underside of the cutout, similar to house window framing. Use 1" (25mm) strips of wood, about 1/4" (6mm) thick, to box in all sides. These can be varnished or painted to complement the surrounding surfaces. When framing is complete, cut the plastic about a 1/2" (12mm) larger than the cutout all around. Caulk the edges where the plastic touches the hardtop surface or the added frame (use silicone caulking specifically for acrylic or polycarbonate) and screw the panel in place.

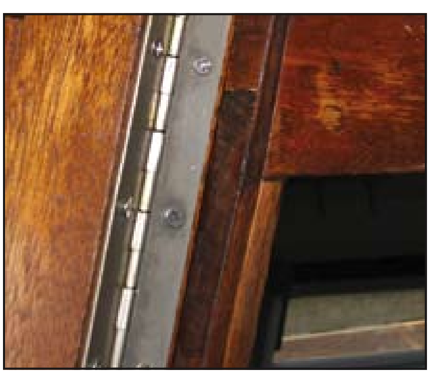
If it is occasionally desirable to block the light from the skylight, it can be done with a fabric cover held up with hook and loop strips or a lightweight wood panel held in place with turnbuttons.

Overhead Light and Hatch

The original forward hatch on our boat was an unusual aluminum design that seemed more suited to a military vessel than a sailboat. Worse, it didn't admit any light inside. The original hatch was replaced early on with an opening hatch framed with teak and topped with etched Lexan. (For instructions on making this hatch, refer to DIY's *Better Boats* CD-ROM, available at www.diy-boat.com). The new hatch is a great

A window in the forward cabin door lets in light when the door must be closed.

The etched Lexan hatch brightens the forward cabin.



(top) Hinged doors replaced the original hatch boards. (bottom) A Plexiglas panel slides into the original hatch board tracks.

improvement toward lighting the interior, which originally depended on four small portlights.

Versatile Prism

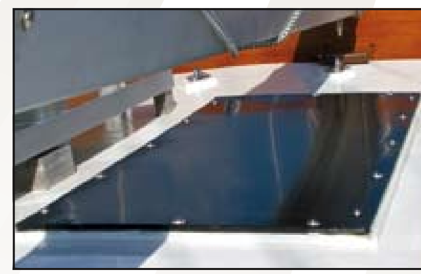
The idea of a flush-decked, no-side-ports sailboat might conjure a dark and claustrophobic cabin but the reality can be the complete opposite with the addition of a number of prisms. Available in rectangular or round shapes and set into the deck at strategic locations, prisms guarantee a constant stream of gently dispersed light below deck.

Before installing a non-opening, Plexiglas port, paint a border of white on the inside perimeter of the plastic where it touches the bulkhead. The white border looks neater than the caulking that would otherwise be visible through the plastic.

If you install one in a protected place (where crew is unlikely to stub a toe on a raised edge), just cut the hole, caulk well and screw the prism in place. If the prism is to be placed in an area that serves as a walkway, it's best to rout an edge for the frame so it sits flush with the deck. This is most easily done on a wooden boat or a deck with plywood core; after routing and before installing the prism, seal the wood with epoxy resin. With other types of deck cores, you will need to remove a section of the core from the area where the prism is to be installed and then refill the void with thickened epoxy, just as you would do with any thru-deck fitting. Caulk well and screw the prism in place. One sailing friend (who coincidentally built the entire boat) placed prisms to direct light into certain lockers, not because he wanted to view the contents, but rather to discourage the growth of mildew. It worked.

Other Possibilities

Other light sources include the addition of small non-opening ports (use Lexan for strength) or round deck plates (sometimes called deadlights) set into



A Lexan panel is set into the hardtop covering the center cockpit.

the deck or cabin. Again, if installing one in a walkway, rout an indent so the plate can be installed level with the deck. Caulking is obviously most important on deck, so use the right stuff, the best you can get, lots of it and check it often.

Our boat has a round deck plate installed in the cockpit directly over the place where the shaft connects to the engine. This one is not intended to light anything. A narrow white stripe is painted on the shaft lengthwise to mark the shaft position that aligns the two-bladed prop vertically. When the helmsman looks through the deck plate and sees the stripe at top center, the shaft can be stopped at the best place for the least propeller induced drag.

Any way that you can bring more light into the boat should be a good thing, despite the occasional times you may choose to block it out. You'll save on light bulbs as well as the power required to use them but, perhaps more important, the crew can forget about light-deprivation and focus on fun.

About the authors: David and Zora Aiken have been liveaboards for more than 20 years and are consummate DIYers.

WEATHERWISE

Weather constantly changes and often without warning so it's wise to monitor your local weather conditions from the comfort of your nav station or cockpit.

Story and photos by Garrett Lambert

Calm sunny weather makes for great cruising; stormy seas not so much. Thus, for safety and comfort, it's important to monitor official VHF radio weather channels. Unfortunately, however, their forecasts are updated only at specific times, cover fairly large regions and cannot be specific about micro-climates within those regions. An onboard weather station enables a crew to make short-term predictions of deteriorating conditions in the immediate area and to take any necessary action quickly. It lets you predict weather fronts by checking wind speed and direction, monitor temperatures and barometric pressure before leaving the dock. Or to facilitate docking in high winds you can obtain a readout of the true wind.

As a weather-wary cruiser, I was pleased to see a Davis Weather Wizard II in the pilothouse of the 2001 boat I purchased a couple of years ago. The Weather Wizard displayed inside and outside temperatures as well as wind speed and direction whose measurements are provided by an anemometer (whirling cups) and a wind vane.

An important caveat is that most weather monitoring systems employ a technology designed for land-based installations and unless a manual correction is applied to the direction shown on a boat's display, the information is worse than meaningless, it's misleading.

Two quite different kinds of wind are usually in play for boaters. With a motionless boat, the wind direction and speed we feel are known as true wind. When

Davis Weather Wizard II in the pilothouse of the 2001 boat the author purchased a couple of years ago. Newer instruments measure and display considerably more information.

the boat moves, what we feel is apparent wind because part of the effect (sometimes all) is generated by the boat's movement alone. Apparent wind direction and speed are different, at times dramatically so, from true wind.

If no wind is blowing, true wind speed is zero. A boat moving at 10 knots generates a "breeze" of 10 knots from exactly the same direction as your compass heading no matter what direction you travel. That "breeze" is apparent wind. Measuring apparent wind is a combination of true wind and movement. If a true wind of 10 knots is blowing from due west and your boat is making 10 knots due west, the effect on the boat or apparent wind is a 20 knot westerly. However, if you were driving east, the apparent wind is obviously zero. (This concept is well known to racing sailors.) As your boat and/or true wind change speed and direction, so does the effect of apparent wind.

On land, the typical wind vane and anemometer are mounted in a fixed location so that a mark on the base points north. It always reports true wind direction and speed. On a boat, the vane and anemometer are mounted so that a mark on the base points to the bow. The wind speed it reports is always apparent wind. However, the reported direction of apparent wind is correct only when the boat is headed due north. For all other vessel headings, determining the correct apparent wind direction requires that you calculate the difference between the display and North. To know true wind direction and speed, several factors must be both known and taken into account. (Refer to "Calculating Apparent Wind" on page 43 for an example.) Since the math is so complex, in practice we're stuck with making very rough approximations.

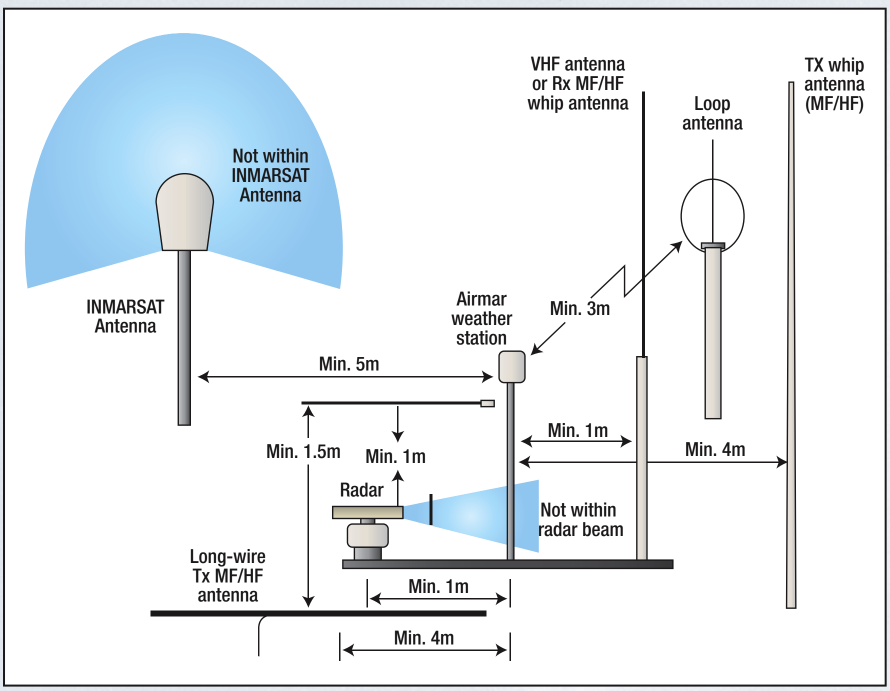
Fortunately, there is a product, available in two iterations, designed expressly for boaters. The Ultrasonic WeatherStation Instrument from Airmar Technology Corporation generates the necessary information, does the math and much more.

Ultrasonic Functions

Airmar's PB100 and PB200 both amaze and confuse. Amaze because each is the size of a clenched fist, about 4" high by 2-1/2" (101mm by 63mm) diameter. Confuse because there are no moving parts and there is no obvious means of operation.

PB100's four ultrasonic transducers are visible through the four holes in the top of the sensor's wind channel.

Included in the PB100 kit is a converter (shown on the right) that transfers the NMEA 0183 output to a video signal suitable for a PC via a USB port.



Airmar/Joe VanVeenen

Installing the PB100 demands careful attention to antenna placement. This chart from the manual shows the minimum offset distances.

I installed the PB100. The tiny two-level PB100 package contains: a microprocessor; two-axis compass; GPS; set of four transducers; negative temperature coefficient thermistor; temperature-compensated silicon piezoresistive pressure sensor and a capacitive cell humidity sensor. The just-released PB200 substitutes a three-axis solid-state compass, accelerometer, adds a WAAS GPS, a yaw rate gyro and outputs both NMEA 0183 and NMEA 2000 data simultaneously.

Geek-speak to most of us, these solid-state components work together to measure and display time of day, direction, both true and apparent wind speeds and directions, humidity, barometric pressure, outside air temperature, relative dew point temperature and wind chill temperature. In addition, the PB100 measures and displays vessel pitch and roll, vessel speed over ground (SOG) and vessel course over ground (COG). A couple of optional components also measure water depth and temperature. Native compass and GPS outputs are also displayed and can be sent to other onboard devices, such as a chart plotter.

The WeatherStation contains four ultrasonic transducers (Airmar's specialization). These transducers operate in pairs. One of them injects a pulse into the air. The pulse bounces off the shiny blue metal plate at the bottom of the wind channel and is carried by the wind to be "heard" by the opposing transducer a short time later.

When there is no wind, the pulse travels at the speed of sound from the sender to the receiver. Whenever the wind is blowing in that direction, the pulse arrives sooner than if the air is still. Similarly, whenever the wind is blowing in the opposite direction, the pulse arrives later than if the air is still. The four transducers take rapid turns sending and receiving pulses to cover all eventualities of wind direction. A microprocessor within the WeatherStation then combines the measurements from all four transducers to calculate the resultant wind speed and direction. Throughout this process, the sensor monitors the air temperature to compensate for the fact that the speed of sound in air changes with temperature.

Is this all too good to be true? No, but the specifications on Airmar's website (www.airmartechnology.com) do indicate that, while measurement tolerances are more than acceptable for boaters, they would not be for NASA. That said, none of the other weather station products websites even mentions tolerances.

In addition to the PB100, the kit also contains the black power/data cord, a short mount with standard VHF antenna thread and a converter that transfers the NMEA 0183 output to a video signal suitable for a PC via a USB port. A CD with WeatherCaster software is in the package and Airmar's website provides free software updates.

NMEA 0183 data can be sent directly to other NMEA devices, such as a chartplotter, but Airmar also offers an optional Furuno combiner to enable simultaneous displays on PCs and NMEA devices. This means that sailors can use a daylight-visible, waterproof chartplotter display in the cockpit and older units that do this job nicely are available relatively inexpensively from several sources including eBay.

Installing this weather station is straightforward once you've found a location with clear air and away from emitting antennae. This was by far the most challenging requirement for me because my topsides are festooned with a flying bridge and bimini plus eight separate antennae. I finally found a mounting space atop a 4' (1.2m) antenna mast extension. That also permitted me to run the cable to its converter at the helm via a readily accessible cable raceway. That done, I ran the USB lead from the converter to the laptop.

Electrical connections are simple once you find a power point. Insert a fast-blow, 1-amp mini fuse and holder, the only item not supplied in the kit, in the converter cable's positive lead and connect

The main screen in blue background before setup. The orange icons on the left permit display customization including color, units of measure, time, direction, etc. There are three display screens and a choice of two background colors and night mode.

The second screen shows a mix of analog and digital information. Wind chill does not display unless air temperature is below 42F (5.5C)

Third screen shows the weather information as well as pitch and roll. Through this display, I learned that my PB100 mount had a lean of 7 degrees toward the bow, now corrected.

it to power. Connect the negative lead to ground. Connect the PB100 cable to the converter and the USB cable to the computer. Install the WeatherCaster software. Done. By the way, I resurrected a 10-year-old laptop from the closet that has minimal everything but it handles the task perfectly.

The PB100 is $800 worth of unique, state-of-the art technology; the PB200 50% more.

Lesser Options

If accurate wind direction is not important to you, there are less expensive options, some ridiculously cheap. Last autumn, I realized just how long seven years is in electronic evolution when I happened upon a La Crosse wireless weather station in a big box store for $69.95. The kit is quite sophisticated and representative of a lot of brands. With variations, the less expensive units provide an array of useful information that can include wind direction and speed (remember the caveats mentioned above); several temperatures (inside, outside, wind chill, dew point); barometric pressure charts; humidity; accumulated rainfall; date, time, and alarm; phases of the moon; times for sunrise and sunset and more.

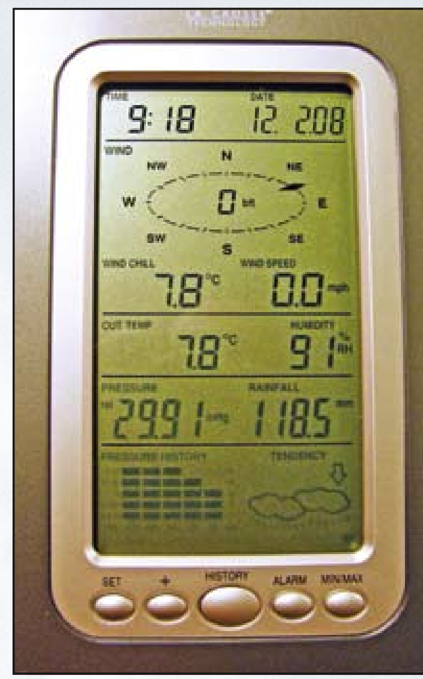
On impulse, I bought the La Crosse (www.lacrossetechnology.com) from the big box store and installed it at home. The display presents a remarkable array of information: time and date; inside and outside temperatures including wind chill; wind direction and speed; accumulated rainfall; humidity; barometric pressures as both current and 24 hour histogram and a short term tendency forecast. The box also contains a small bonus monitor for a second location that shows time, indoor and outdoor temperatures and relative humidity.

The La Crosse and similar kits require three different exterior components mounted separately, two of which are connected to the third by wire. Moreover, the small, cylindrical Thermo Hygro component to which the others report has to be mounted under an overhang of some sort. While relatively simple at a house, it's a little more challenging on a boat.

Despite many brand names, however, it seems there are only a few manufacturers of weather stations that combine electronics with traditional wind vanes, anemometers and self-emptying rain buckets: Davis Instruments (www.davisnet.com), which has been manufacturing in the U.S. since 1963; and nameless Chinese producers who private label essentially similar kits with a few cosmetic variations. All combine traditional technology with modern electronics.

Davis has replaced the Weather Wizard II with the III, which adds wind chill and is priced at $195. Davis also offers the new Vantage Pro 2 that, depending on configuration, is priced from $495 to $1,195.

Unlike its cheaper competitors, the Vantage Pro has an integrated bracket for mounting on a small diameter post, the exterior components are combined in a single waterproof package and it's powered by solar energy rather than batteries. It's actually easier to install than the Chinese kits and thereafter requires no further attention. It also offers some interesting features and measurements, such as solar radiation, not available from anyone else. It displays highs and lows (and/or totals or averages) for virtually all weather variables for the past 24 days, months or years and your own local forecast, all without a PC.



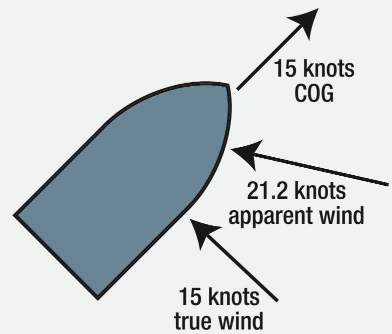
Due to the data collection components, the La Crosse works best for a home-based weather monitoring station.

I rather brashly asked the Davis rep how the Weather Wizard III and Vantage Pro can compete given prices that are so much higher than the Chinese kits. His response was: "I'll give you the answer that consumers give us. Lots of consumers upgrade from lower-priced weather equipment to the Vantage Pro 2 for three reasons: quality, accuracy and durability." Another important factor, of course, is that California-based Davis repairs and refurbishes what it sells.

As to durability, my home is located about 1,000 yards (914m) from the sea and the La Crosse continues to operate flawlessly after a particularly miserable

As the boxes demonstrate, the well-made Davis Vantage Pro (left) is physically more than three times the size of the Chinese kit (right).

Calculating Apparent Wind



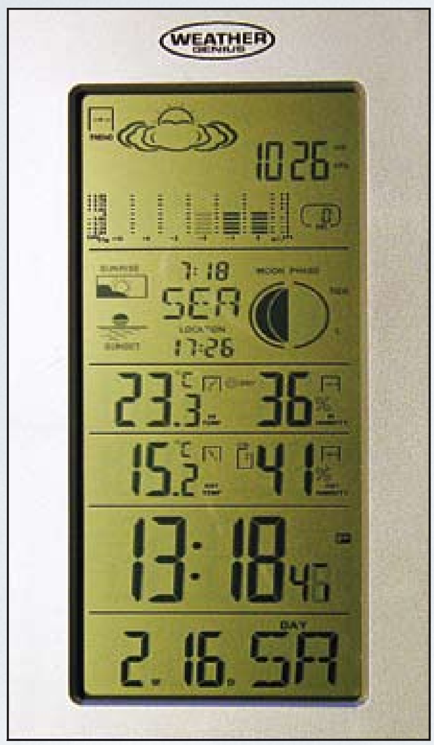
Garrett Lambert/Joe VanVeenen

On a vessel proceeding at 15 knots with a true wind of 15 knots blowing from the side, a passenger would feel an apparent wind of 21.2 knots blowing from an angle 45 degrees off the bow. In order to calculate the true wind speed and direction when onboard a moving vessel, it is necessary to know the apparent wind speed and direction, the speed and course over ground of the vessel, the compass heading and the local magnetic variation. Note that heading and course are not the same: heading is the direction the vessel's bow is pointing, while course is the direction the vessel is traveling. Heading and course may differ due to the effects of wind and current. (Adapted from Airmar's website at www.airmartechnology.com.)

(top) The all-in-one Davis Vantage Pro 2 measures barometric pressure, humidity, rainfall, temperature, wind speed and direction using wireless stations. (bottom) The Vantage Pro Monitor (data not connected).

northwest Pacific winter including several 80-mph (128 km/h) windstorms and heavy rain.

Oregon Scientific (www.oregonscientific.com) offers several kits priced from $180 to $420 including some labeled for John Deere. They look remarkably like the La Crosse and are differentiated



A $20 bargain, the Weather Genius measures and displays all weather output except wind.

only by the feature sets, some of which include such extras as atomic clocks.

The wireless Chinese systems use AA batteries to power the exterior sending units and monitors. All user settings are lost and must be reset when batteries are removed, so keep the manuals! All these stations use non-backlit, monochrome LCD displays with a combination of numeric and graphical presentation. Quite legible during the day or under artificial light, the display is of no use in a darkened cabin on a night crossing. (The Davis Vantage Pro monitor, on the other hand, is backlit.) Important to note is that "wireless" refers only to the transmission of data from the exterior collection and sending unit to the interior display(s). As noted above, the exterior components communicate with each other via wires (telephone cords and jacks) included in the packages.

However, if you're willing to forego wind measurement altogether, there are even more remarkable bargains out there. While in yet another outlet chain, I came across the Weather Genius.

Also a product of China, it measures and displays everything noted above except wind. In addition, it also shows local phases of the moon and times of sunrise and sunset. Wire-free altogether, the exterior module runs on two AA batteries, the interior on three batteries. Cost is just $19.95. Of course, I bought one, too.

I now know everything about the local weather and its tendency. Too bad I still can't do anything to change it.

About the author: After three decades cruising the world as a diplomat, Garrett Lambert now cruises the Pacific Northwest where navigation and weather challenges play nicely into his interest in technological innovations.

Storm Lines

Why do some nylon anchor lines hold and others break in a storm? Why is the anchor line you've been using for years likely to fail? There are five critical factors that predict how rope fares in a storm.

By Bob Adriance

As sometimes happens in early spring, a line of dark clouds suddenly appeared on the horizon and Dan Arsenault got caught in an especially violent April thunderstorm. He had been bringing his 37' (11.2m) sailboat from its winter storage yard to its summer home near Saginaw Bay, Michigan, when the wind built to near hurricane force (74 knots) and seas grew to 9' (2.7m). It was cold, bitterly cold.

Dan's boat passed through a narrow channel and was bounced off the bottom several times, damaging the rudder. After a brief attempt to work his way into the marina, Dan crawled up to the bow, set the anchor and went below to wait for the wind to subside. Moments later, amid the horrific noise of the storm, he heard a loud "explosion." The anchor line had parted.

In less trying conditions, nylon's ability to stretch makes it an almost perfect choice for an anchor line. The stretch absorbs shock, which means less strain on the anchor, less jerking and a more comfortable night's sleep. One of the most frequent complaints from BoatU.S. Hurricane Cat Team members, however, is that the same nylon rodes that are fine for everyday use have proven to be woefully inadequate in a violent storm. In the past Florida hurricanes, hundreds of boats were driven ashore because their nylon anchor rodes, usually more than one, had parted.

When a boat winds up on the beach after a storm, it's easy to look at the frayed remains of the anchor line and announce that it had chafed. The solution has typically been to recommend more and better chafe protection. The fact is that the "chafed" line could have broken, even exploded, under the tremendous load because it lacked strength or failed suddenly because it lacked elasticity or failed internally, actually melted, by the tremendous heat generated by friction or it failed for a combination of these reasons.

While there are plenty of examples of nylon anchor lines that failed, there have been at least as many examples of anchor lines that survived, despite being tested for many hours by the same high winds and seas.

Critical Factors

So why are some anchor lines and boats more likely than others to be counted among a storm's survivors? Consider these five critical factors that predict how rope will fare in a storm.

1. Breaking strength is determined by wrapping new rope around two large diameter capstans and slowly tensioning the line until it breaks.

All things being equal, a braid-on-braid line has the most breaking strength followed by plait and then three strand (**Figure 1**). You might think that breaking strength (tensile strength) is the ultimate criteria for selecting an anchor line. After all, the line that's the strongest has the best chances of surviving the tremendous forces in a storm. Alas, the forces on a rope in a hurricane are not applied slowly on large diameter drums; it takes more than breaking strength for a rope to survive something as violent as a hurricane. Breaking strength is only one of five factors.

2. Stretch. While breaking strength is clearly important, stretch (elasticity) is also essential to act as a shock absorber to absorb the tremendous amounts of energy. There are two ways that a rope absorbs energy: the material itself stretches and the weave of the material expands and contracts mechanically. Before the fiber itself stretches, the lay of the rope untwists and absorbs energy.

Nylon stretches more than polyester and a three-strand twist line stretches more (and absorbs more energy) than a braid-on-braid line. A plaited line (similar to three strand but softer and with a square profile) stretches more than either three strand or braid-on-braid.

Without something that stretches to act as a shock absorber, the intense gusts and surging waves are much more likely to yank an anchor out of the bottom. The greater its ability to absorb the sudden and violent stresses, the less likely an anchor line will fail.

3. Chafe and cleat location. All of this stretching back and forth across a chock

Cleat considerations: If the chock isn't smooth and well-rounded, the line quickly chafes through as it moves back and forth in a storm. Also, when a line is being compressed at the chock under storm loads, it can lose half of its strength. Lastly, all of the stretching back and forth under tremendous pressure in a storm generates enough heat at the chock to melt the nylon fibers. Doesn't it make sense to eliminate the chock altogether by locating the cleat directly on the rail as shown in the photo right?

Yale Cordage

Comparison of 150' (45.7m) of three-strand nylon line (left) to the same length of Yale eight-strand nylon Brait (right). When loaded, this line elongates, apparently absorbing up to 75% more energy compared to other anchor rodes, thus increasing the rode's holding power and reducing the shock loading on deck hardware.

has the potential to chafe the line, especially if it is secured to a cleat that is up to 2' (609mm) away from the chock; the increased distance gives it more room to stretch. If the chock isn't baby-butt smooth, all this rubbing under pressure quickly leads to external chafe. Note, however, that the potential for external chafe is only one of several ways a line can fail at a chock. When the line is bent sharply down to the water, only about half the ropes' fibers are taking the load. Because of compression, the remaining fibers are ineffective.

Stretching and rubbing at a sharp angle also creates heat, a lot of heat. Nylon line starts to deteriorate at 300F (148C) and at 350F (176C) it has lost half its strength. There have been many instances at a chock where lines have melted and failed internally.

4. Age. The boating magazine *Practical Sailor* tested some older dock lines and found that the various lines had lost between 49% and 75% of their original strength. That shouldn't be a surprise. The nylon fibers that are woven together to make a rope are thinner than a human hair and have proven to be vulnerable to dirt, which, over time, abrades the fibers and weakens the line. Salt crystals, while not as destructive as dirt, also abrade fibers.

Unfortunately, dirt and salt are found in abundance on the sea bottom, which means that an older line, even one that is healthy looking and supple, may have already begun to weaken significantly. Fibers are also weakened by sunlight and exposure to certain chemicals, including acids and alkalis.

There are other ways that nylon rope is affected by age. Repeatedly expanding and contracting weakens the fibers; the more times the line is used and heavily stressed, the more likely it is weakened. Again, damage and loss of strength may occur without any discernable signs of weakness.

Some types of damage are apparent. As they get older, nylon lines become stiff as they shrink and fibers lose lubricant. Better quality nylon line is pre-shrunk but it's not possible to eliminate all shrinkage; some is inevitable. The lubricant, also found on better nylon line, minimizes shrinkage by keeping water from penetrating the fibers. Lubricant has the considerable added benefit of reducing yarn-on-yarn friction, which helps to reduce heat. As noted earlier, excessive heat can severely weaken nylon line.

Two obvious indications that the line is shot are stiffness and, when it's under load, "squeaking." But what about a well-used nylon line that is still supple and looks healthy? With industrial applications, rope is often retired at pre-determined intervals, typically after two to three years of everyday use, to prevent catastrophic failures. Nobody knows how long an anchor line should be considered dependable but any line that is used hard and often is likely significantly weaker than a new line.

5. Line quality. As noted, better quality line is pre-shrunk and has lubricant added to the fibers. The way a line is woven is also important. Look for three-strand twist with a medium lay construction. This has more twist ("mechanical twist") and absorbs energy more readily than rope made with soft-lay construction. While easier and cheaper to manufacture, soft-lay rope is much more prone to failure. If it's easy to separate the strands, the line is probably soft lay. Braid-on-braid rope can also be made with a soft-lay construction but it "herniates" readily and is far less common.

FIGURE 1

Comparable Average Breaking Strengths For Different Rope Sizes and Types*

Diameter	Braid-on-Braid	Three Strand	Plait
1/2"/12mm	8,300lb/3,765kg	6,100lb/2,767kg	6,300lb/2,858kg
5/8"/16mm	17,000lb/7,711kg	9,350lb/4,241kg	10,400lb/4,717kg
3/4"/19mm	21,000lb/9,525kg	N/A	16,200lb/7,348kg

* Source: Yale Cordage

Possible Solutions

The question for boat owners is what type of line or lines will stand the best chance of surviving a storm?

First, the obvious: the boat's chances of surviving a storm can be improved significantly by using more and larger lines. All things being equal, a 3/4" (19mm) line outlasts a 1/2" (12mm) line and two 3/4" (19mm) lines outlast a single 3/4" (19mm) line. The size of the line is likely determined by the size of the cleat(s).

Another obvious choice: A rode (and storm anchor) that is used purely for anchoring the boat in a storm should be made up before the start of hurricane season. The boat's everyday working rode should not be relied on; it probably isn't big enough and, if used routinely, much of its resiliency and breaking strength has been compromised.

More than a Rode

Using larger and healthier lines is a good start but there are more choices yet to be made. For starters, what type of line works best? After Dan Arsenault's harrowing experience (the boat survived, albeit with a bent rudder shaft and two badly shaken crew), he replaced his failed nylon braid-on-braid rode with nylon three-strand. The reason, he said, was that the three-strand line has greater elasticity (more stretch) to absorb the violent loads. The bow of his boat had been thrown high into the air by waves in the open water and the lack of elasticity in the anchor rode (and perhaps its age) led to the failure. Would three strand or plait have survived? It's hard to say.

The obvious question is how much of a trade off in breaking strength do you want to make for additional energy absorption? Once again, the answer is that nobody knows. It could be (with no studies to back it up) that using three-strand nylon or plait to maximize energy absorption is more critical in an exposed anchorage where the bow could be thrown high into the air by large waves. Loads are applied suddenly and violently and the line has to absorb a tremendous amount of energy if it has any chance of surviving. In a sheltered harbor, waves (and their resultant sudden shock loads) should be significantly reduced. Wind would then become the primary force acting on the boat and opting for increased breaking strength (braid-on-braid or even polyester) might be a better choice.

A few words about polyester are in order. One rope manufacturer's expert, who also happens to own a boat, said he would consider using a combination of three-strand polyester rode with a nylon rode in a hurricane. The two could be looped eye-to-eye to avoid having a knot in the line. (Knots weaken a line by as much as 50%.) Polyester would be used from the cleat through the chock, where the rode is most likely to be stressed, with the remainder of the rode being nylon.

Polyester is much tougher and far more resistant to chafe, both internal and external. Nylon is more comfortable in the under 25% range of its breaking strength but, beyond that, it begins to quickly fatigue. Polyester has the capability of going to 50% to 60% of its breaking strength without fatiguing, at least not quickly. Even when wet, polyester line retains full strength; nylon loses strength, although water is necessary to cool the stressed fibers.

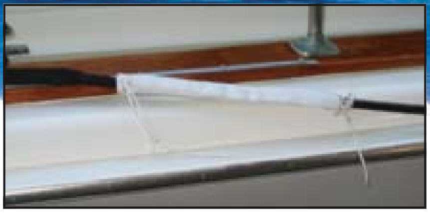
There are other alternatives to conventional nylon anchor lines. Yale Cordage makes a braid-on-braid mooring pennant that has a nylon core for stretch and shock absorption and a polyester outer core to resist chafe. The outer core is woven to produce stretch (mechanical) that is comparable to stretch in the nylon core. The line is sold in shorter lengths with eyes for use as mooring pennants. Yale sells the line in spools for other markets but it can be special ordered by a marine chandler.

Another choice is plait. The main selling point of plait has been that it is soft and pliable, takes up less space in an anchor locker than conventional rodes and can be twisted without hockling. Plaited rope is also more elastic and has more breaking strength than three strand, although not as strong as braid-on-braid. It is also worth noting that plait is easily spliced.

Chafe Protection

Cleat location is a significant weak spot that is often overlooked when preparing a boat for a storm. A cleat located on the rail is ideal because it avoids heat build up, loss of strength and chafe caused by stretching rope across the chock at a sharp angle down to the water. The line is not compressed as tightly, it won't generate as much heat and it is far more likely to weather the storm intact.

On boats where the cleat is located back from a chock, it may be possible to move the cleat. Note, however, that the cleat must be installed properly or the whole effort will be for naught. Use bolts



Jan Mundy

Ideal for anchor rodes and docklines where chafing through a line could cost you the boat, Secure Chafe Guards ($28.99) from Davis Instruments measure 16" (406mm) in length and are made of tough nylon with a Velcro fastener that adjusts to fit lines from 3/8" to 1" (9mm to 25mm) thick.

and not screws to secure the cleat and mount with a wood, fiberglass laminate or metal backing plate to distribute the load (washers are not adequate).

If the cleat can't be moved, the choice of chafe protection is critical. Various types of hoses, such as PVC, garden hoses and even fire hose, have the potential to reduce compression at the chock as well as protect the line against external chafe, which is good. On the down side, such hose allows heat to build up and prevents cooling water from reaching the fibers. The best way to reduce the chances of the line failing at a chock is to use something like polyester chafe protectors, which let heat out and allow water in.

Don't forget that rodes chafe underwater as well. Use chain between the anchor and anchor line to prevent chafe on the sea bottom. If a lot of chain is used, at least a third of the rode should be nylon line to absorb shock. Make sure the thimble splice is snug; loose or broken thimbles have been the downfall of more than one anchor line in a storm.

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

SAFETY

Stowing FOR SAFETY

Jim Roberts

Despite fair-weather planning, there will be times when conditions take an unexpected turn.

The 1986 Albin 43' (13.1m) trawler *Aqua Vitae* in a 35-knot wind with wind-driven waves hitting squarely on the port side. "It was a terrible trip, most of which I spent gripping a waste bin between my knees and the dog under my arm in order to keep her in one place," said Peggy Bjarno.

Peggy Bjarno.

Aftermath: Just one piece of the destruction wrought by a lack of planning in battening down the hatches. Now, "museum" putty keeps the bookends in place on the shelf above the settee and new hardware keeps locker doors secure.

By David and Zora Aiken

Sailors expect to travel on a tilt. With the right sails set to the proper trim, the sailboat can move along smoothly, heeled first to starboard, then to port as it tacks. Knowing the likely travel circumstances ahead of time, sailors stow gear to prevent unsecured flying objects from becoming a danger to the crew or just making a mess of things. Even so, a line of nasty thunderstorms can challenge the effort to make things stay put.

Powerboats don't heel but an exaggerated version of "tilt" can still become part of their motion. Despite fair-weather planning, there will be times when conditions take an unexpected turn or the boat takes the turn, putting it on the wrong course relative to wind or waves, compromising a comfortable motion. Powerboats often roll, sometimes violently, straining both boat and crew.

All boat owners should look at their boats with an eye toward the bad day and think about ways to ensure the crew's safety and comfort on such a day. Offshore cruisers naturally have much more to consider than weekend boaters but anyone who has experienced the bad day firsthand will understand the need for sensible stowage.

Carry-Ons

Experienced boaters have a routine for stowing the loose stuff that comes aboard each weekend, whether expensive breakables or general mess-makers. Cameras and binoculars are kept in their protective cases until needed. Ideally, their carrying straps could loop over or through a fitting in the cockpit so the items stay handy but can't fall. Coolers are wedged between seats, strapped into a galley corner or tied onto a custom-built bracket. Though the obvious safety factor of plastic beverage containers makes sense on a boat not every product offers the choice. When glass items must come aboard, keep them in the cooler or a closed locker or tuck them in the galley sink amidst the plastic bottles.

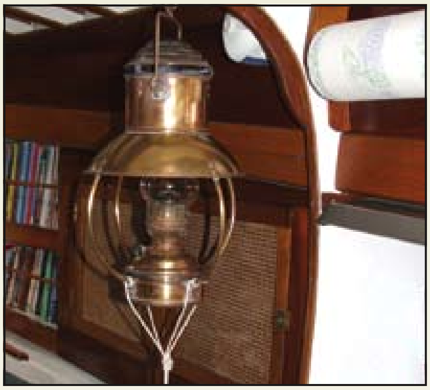
Leave-Ons

Some loose gear stays on the boat all season. Snugly hold the countertop water pitcher in a corner of the galley with a shock cord stretched between two small cleats. Tie hanging kerosene lanterns from the bottom to limit the swinging arc of the lantern and prevent glass breakage or lamp oil leakage. On larger yachts, wine glasses often hang upside down from a framework attached to the overhead. Place a table lamp on its side on a bunk, surrounded by blankets and covered with a pillow. If waves get bigger, move breakables to the cabin sole and cushion with soft goods. If the teapot or other pans are usually left on the stove, use the stove's pot keepers or rails to keep them there during the shake, rattle and roll.

For boating on mostly good days, those basics are probably enough but the smart boat owner will continue to plan for the unusual to avoid unpleasant surprises. What items could get loose if a locker door were to open unexpectedly while the boat was underway? That leads to the next question. What, exactly, holds all those locker doors closed? Unless the boat is an exception to the rule for a production boat, this will be neither a quick look nor a quick fix.

Lockers

Some locker doors are fitted with hardware that is not up to the job of keeping the locker contents from freeing themselves in rough weather motion. Almost any type of latch works in calm conditions but, once a boat starts to roll or pitch, the constant motion adds unusual stresses. Doors shift slightly with each roll, tugging repeatedly against the closing mechanism or the screws that attach it. The older the boat, the greater the chance for some weakness to develop into a problem. If heavy items are not properly secured inside a locker, they can hit the door with battering-ram efficiency, damaging the door and forcing it to open, thus releasing the locker's contents. In



Hanging lanterns must be secured at the bottom to limit the swinging that could cause the glass to break or the lamp oil to leak.

Turnbuttons are neat and strong and easy to install.

Where heavy items are stored, a locking slide bolt may be the best choice to make sure the door stays closed.

Prevent sliding doors from sliding unexpectedly by using a small “door stop.”

Shelves should have fiddle rails to help restrain items stored inside lockers.

Open bookshelves need a fiddle rail and an added restraint about mid-height.

one worst-case example, an entire closet door tore away, damaging both the door and its frame. The lesson is obvious; better hold-downs, better hardware. Here you have a choice of turnbuttons, snap-in brackets or slide bolts.

Turnbuttons are neat and strong and easy to install on any type of door. If the door is inset (door and frame on the same level), the two elements of the turnbutton attach directly to the two surfaces. If the door overlaps the frame, add a spacer to the frame so both sections of the turnbutton are on the same level. Full-sized doors with either a spring-type closing or a standard knob or handle can still bounce open on a rough day; a turnbutton adds insurance.

Small cabinets can probably use a snap-in latch safely, particularly if orientation is athwartships. The best design of this type has a rectangular-shaped closing component, which holds more firmly than the older-style bayonet.

It’s possible to find decorative cabinet hardware with slide closings. With these, it’s easy to see that the latch is completely closed, instead of simply trusting the holding power of a snap-in or spring-type latch. Where heavy items are stored (like a galley locker with stacked pots and pans), an even better choice is a heavier-duty stainless-steel locking slide bolt.

Slide Control

Sliding doors are convenient, except when a sliding section opens unintentionally. There are two ways to control this. Place a small-diameter dowel rod into the open section of the track grooves to block the panel from sliding or drill a hole into one of the sliding panels near the center where the doors meet and insert a short length of a small dowel into the hole. This limits sliding to about a 1/2" (12mm); not enough for objects inside to escape. Attach the dowel to the panel frame with a small screw and some twine, so it’s handy when you need it.

In all lockers, a shelf liner of textured nonskid mat dampens the effects of the shifting that occurs as the boat moves. Also, place small pieces of this material between dishes and stacked pans. As a side benefit, this prevents much of the clunking noise that otherwise accompanies such shifting, so the precautions made for rough water coincidentally keep things quiet when the boat’s at anchor.

Fiddles

If the shelves in closed lockers have no fiddles (rails, sometimes decorative, at edges of tables and/or counters, shelves, etc.) or the existing ones are small, install new ones. The fiddles should be high enough to help restrain the objects stored inside but not so high as to make it difficult to get things in and out.

An open storage area like a bookshelf needs a fiddle and an additional restraint (shock cord or dowel rod) about mid-height. Use shock cord with hooks placed into eye fittings at the sides of the shelf or permanently attach the cord at one end and cleat it at the other. To use a dowel rod, drill a hole into the bulkhead at one end of the shelf. Attach a U-shaped bracket to the bulkhead at the other end. Insert one end of the rod into the hole, and drop the other end into the bracket.

Permanent Attachments

The safest way to hang framed photos or paintings is to screw the frames directly onto the bulkhead. The neatest way is to

A hook and loop tab holds the DVD remote onto the side of the TV.

Custom-built boxes keep small items from getting misplaced or broken.

do it from the back side of the bulkhead, if it's accessible. If that's not possible, attach the frame from the front. Always predrill the screw holes to avoid cracking the frame. Flat-screen TVs should be permanently attached.

For small things that are easily misplaced or are prone to falling and breaking, build custom-sized brackets or boxes. Attach the holders in accessible locations and keep the small stuff in its place. This works for the cell phone, PDA, TV remote, iPod and other tiny treasures. A larger box (formerly known as a magazine rack) keeps magazines or guidebooks confined. Not because they'd break but, if one happened to fall on the cabin sole, a crewmember stepping on it could suffer a back-wrenching slip and fall.

Temporary Attachments

A hook and loop fastener (e.g., Velcro) holds small decorative items on bulkheads or small items on countertops. A clock, framed photo or a small plant can be secured with a Velcro tab. Velcro can hold the DVD remote onto the side of the television set and small stereo speakers stay atop bulkhead brackets with the aid of more hook and loop tabs.

Another handy holder for small stuff is "museum" putty, a thick, white, sticky substance that works surprisingly well. It keeps things in place on vertical or horizontal surfaces and is removed fairly easily without damage to adhering surfaces. With a determined twist-off effort, it pulls away without leaving any messy residue. Buy the putty at a store that sells craft materials or office supplies.

Finally, when everything is stowed with precaution in mind, consider a few related items. Count the handholds inside your boat and check their placement. If the boat doesn't have enough, install more. Be sure the cabin sole has some kind of nonskid in the finish. Don't be tempted to use any loose rug mats that can launch an unsuspecting crewmember airborne.

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

9

Curved Window Makeover

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

While this project was done on the owner's pilothouse sloop, the lessons here are helpful to any boat owner wanting to replace plastic windows or convert a fixed window to one that opens.

Before: Original pilothouse window design.

After: All new Plexiglas windows and a custom opening center section.

Story and photos by Rory Harley

The plastic windows in the raised pilothouse on my newly purchased Tanzer 10.5 sloop were original equipment. They leaked and were badly crazed. I had little choice but to replace them.

This boat has three gently curved windows, two on the coach roof sides and a large center forward window. There are also two 90-degree curved plastic windows, one in front of the galley on the port side and at the inside steering station on the starboard side. The windows are framed with an aluminum extrusion that holds the 1/4" (6mm) plastic sheets in place with solid rubber gasket strips compressed into matching groves in the frame. The frame is held against the cabin sides by caulking and an internal aluminum trim ring screwed into the frame from inside the boat.

If an aluminum frame/rubber gasket window leaks the first instinct is to pull out the caulking gun and try to seal them on the exterior. This had been tried on my boat and resulted in layers of hard and soft compounds that covered the original windows and gaskets. There are only two paths for water to enter: either between the window frame and cabin side or through the rubber channel holding the plastic. To track the source of a leak with this type of window construction, remove the internal trim ring during a rainstorm (or spray with water from a garden hose) and see where the leak originates. The trim ring may not remove easily. In my case, some of the stainless-steel screws had frozen in place and required drilling out to remove them.

If the leak is around the aluminum frame, caulk the gap between the window frame and cabin side. If the leak is seeping in between the rubber and the glazing, first try putting some cyanoacrylate adhesive (Crazy Glue) around the glazing or use crack filler. Such glues have a narrow tip, are fast drying and their low viscosity might enable the glue to flow into the tiny passages. Alternatively, you could try Gorilla Glue, a polyurethane adhesive that cures from moisture and expands. This stuff bonds metal and plastics, which might make future removal of the window difficult or preempt reusing the rubber glazing.

Replacing windows involves removing the gasket and cleaning the frames in preparation for the new window. The large pilothouse windows allow for great visibility but also allow a lot of solar gain, which heats the interior. As I was replacing all windows, I decided to find a solution to convert the large central fixed window into an opening one.

The first step in my project was to find replacement rubber gaskets. The old material was tired and had lost some of its flexibility. The original window manufacturer had long since disappeared but I was able to purchase new glazing from Bomon, a manufacturer of custom boat windows (bomon.com). I bought enough for the circumference of all windows.

Prep Work

Window removal begins by pulling out the rubber gaskets with help from a suitable hooked pulling tool made from a piece of bent coat hanger. Once all the gasketing was removed, the window pushed out relatively easily.

It took a day to remove the old silicone caulking from the sides and channels of the aluminum window frame. This is an important and tedious job that takes patience and a variety of cutting tools, including chisels, knives and several hook tools to clean out the channels and many groves in the frame that grasp the restraining ridges in the rubber gasket. None of the chemical silicone removers seem to remove the stuff as well as grunt mechanical work.

One has the choice of removing the entire window frame or just the window. I tried both ways. While it might seem easier to clean the channels in one's basement, I found it easier to leave the frames attached to the boat rather than completely remove, load, unload, clean and then take them back to the boat and remount.

The slightly curved side windows were the most straightforward as the plastic was easily bent to match the gentle curve of the cabin side. You can buy a piece of oversize plastic and cut it with a jigsaw or have a plastics shop cut to size, which is nicely done with a router. I did the latter and found it easier and faster.

Its best to first do a dry install. First, check to make sure the new plastic window fits snugly in the frame, allowing enough space for thermal expansion. In order to protect the plastic from scratching during installation, I removed the protective backing paper only from around the window perimeter where it contacts the aluminum frame and on the outside beneath the rubber glazing (see "Caulking Choices" on page 51).

Next I carefully cut the rubber gasket to length then pushed the gasket material into place and made sure I was satisfied with the fit before getting out my caulking gun.

During the installation, I applied a generous amount of caulking in the channels

Figure 1

(top) Plywood and particle board mold construction. (bottom) Photo shows the outline of the port and starboard front wraparound windows.

and where the window sits on the aluminum frame and some on the plastic under the rubber glazing. This helped to lubricate the glazing being pushed into the restraining channels. Excess silicone squeezed and oozed out of the interior screw holes that held in the trim ring.

The two 90-degree curved front side windows required a different approach as it was impossible to manually bend plastic to this shape. Plastics are bent to match large curves by a thermoforming process, where the plastic is heated then bent over a mold. Unfortunately, original plastic windows cannot be used as molds as the material distorts when the heated new window is applied over it.

I decided to make the mold but get a plastics shop to do the thermoforming. I first obtained a sheet of 1/4" (6mm) bendable plywood and cut it to size. I then cut two supports from particle board to hold the basic curvature of the removed plastic window (**Figure 1**). The windows had different radii at the top and bottom and in order to get an exact match to the window, I placed cedar shims between the ply and particle board. Both windows were made from the same mold with only minor adjustments made with cedar shims. I left a lip on the mold edge as the shop staff use clamps to bend the hot plastic onto the mold. Installation of these front windows was pretty much the same as the cabin side windows.

Replacing boat windows is a very messy operation. Tape down some cardboard, big enough to hold both you and your caulking gun, on the area in front of the window you're working on and tape cardboard in the cabin underneath the window to catch excess caulking drips. Wear coveralls, as you will probably decorate yourself with a coating of caulking. It is also best to tape off an adjacent deck area to remove your coveralls and change your shoes. If operating under a tarp, make sure you can exit without passing through the work area.

Plastics 101

Plastic boat windows are usually made of either a polycarbonate (Lexan) or acrylic (Plexiglas). Polycarbonate is much stronger and more expensive but is reportedly not as resistant to scratching or UV degradation. Both plastics come in clear and a variety of increasingly darker tints.

The plastics shop asked which material I wanted and I elected to try the polycarbonate due to its extra strength. After I finished installing one thermoformed curved window, I peeled back the protective paper to take some satisfaction on the completed job. To my horror, I discovered a couple of barely noticeable 1-1/2" (38mm) wide, bubble-like mound deformations in the plastic. When I looked from inside the pilothouse through the window's sloped angle, the deformations caused optical distortion, as in seeing double. As this would be completely disorientating in a pitching boat, I reluctantly removed the window, which was still surrounded with a near full tube of uncured black caulking. The boat and I were covered in the messy stuff by the time the window was extricated.

The plastics shop confessed that polycarbonate is more difficult to thermoform than acrylics, which caused the bubble. However, Plexiglas comes in a high impact version and that's what I then purchased for the curved windows. In hindsight, it is best to check any thermoformed window for imperfections before installation by pulling back the protective paper then press it back down for the installation process. I have also heard of a ruined installation where an owner left the paper on the window, which was then baked on by the sun.

Caulking Choices

As most boat windows or window frames will be removed at some time, avoid using adhesive-type permanent sealants, such as 3M 5200, and never use polysulphide caulk as it attacks plastics. This leaves two choices of caulking compounds for bedding windows: a marine silicone or a polyurethane/silicone blend. While both can be applied in cool temperatures, I found that neither seemed to adhere well to the smooth plastic surface. Therefore, I used a sharp knife to carefully remove the protective paper around the edges on the inside where it covered the trim ring and on the exterior where it covered the rubber gasket and roughened these surfaces with 80-grit sandpaper.

Opening Window Construction

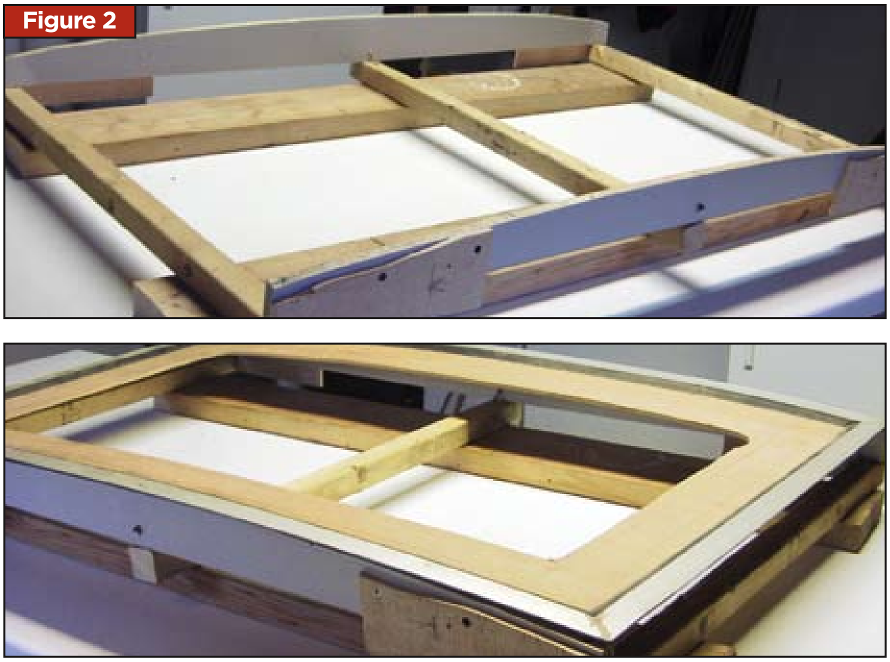
Initially, I considered purchasing a manufactured hatch or hatches that somehow fit into the existing trapezoidal-shaped center opening but soon discovered there were complications with this approach. I wanted to maximize the opening size and had difficulty finding commercial hatches that neatly fit the area. Large hatch sizes are also very expensive and custom hatches made to specific sizes even more so. Frankly, I would have paid the price but every hatch I discovered was built to install only on flat surfaces. This still left me with the problem of how to attach the hatch to the cabin front curved surface.

There were also some other considerations. The boom vang sweeps just in front of the pilothouse and I wanted to minimize the risk of catching it on the hatch. I also wanted a sufficient hatch overhang to allow leaving the window open during light rain so water drops would fall on the outside coaming. I concluded that wood was the best material for building a custom hatch.

After removing the rubber gasket, plastic window and interior trim ring, it took about another day to cut away the caulking and carefully remove the aluminum window frame to avoid bending it. I then scribed the upper and lower cabin front curvatures on cardboard. The sides of the cabin were straight.

All hatches are made of two components. In my case, the interior vertical piece or coaming was glued and screwed onto a 1/4" (6mm) piece of ply-

Figure 2



(top) Wood jig to hold window frame. Jig must be strong enough to hold the frame curvature, as plywood tends to flatten it when bent. (bottom) Plywood cut accurately on the outside dimension and secured into aluminum frame with rubber gasket. Interior cut was made with a router using a laminate trimming bit after hatch lip was laminated.

Figure 3

The combination lip and coaming placement was done to maximize window size.

Figure 4

Closeup of finger joint construction joining the top and side pieces.

Figure 5

Hatch lip was extra wide to make a base for the Vetus hatch locking handles. Note wooden bungs that cover the screw heads.

Figure 6

Finished lip and coaming.

wood inserted into the aluminum frame in lieu of the original plastic. The hatch frame then attached to the plastic with caulking and wood. The frame fits over the coaming and attaches with removable clevis pin hinges.

Using these two curvatures I made a jig to hold the window frame (**Figure 2**) and then I cut a piece of 1/4" (6mm) marine mahogany plywood to match the footprint of the removed plastic. Plywood is more easily bent 90 degrees inline with the wood grain on the outside surfaces. Thus, the easier construction method would have the outside grain running vertically in the cabin.

In order to minimize the possibility of cabin leaks, I elected to have a double gasket system with the lower gasket placed on a 1/4" (6mm) elevated lip and the upper gasket on top of the coaming, 1-1/4" (31mm) above the ply to keep the hatch profile as low as possible (**Figure 3**). My main constraints on maximizing window size were the hinges and the spacing to allow room for the rubber gasket material before it is pushed into place in the window frame's aluminum channels. Once the general lip and coaming placement was determined, the approximate window opening space was cut out.

The lip and coaming were made of 1/4" (6mm) strips cut on my table saw from 3/4" (19mm) thick mahogany plank. I laminated the strips together, alternating lengths to render a finger joint at the ends (**Figure 4**). The two coaming and hatch sidepieces were cut from solid mahogany as there is no curvature on the cabin sides. All wood strips were glued together.

In order to compensate for plywood's bounceback, I slightly exaggerated the curvature in the top and bottom coamings, using tongue depressor shims during the gluing process. I clamped the coaming strips on the ply without the shims to confirm the curvature match of the window frame and jig and then I routed out the interior opening space to accurately match the coaming.

The hatch frame is fabricated in the same basic manner as the coaming. Bounce back from the 1/4" (6mm) plastic insert was negligible and didn't require any exaggeration in the hatch strip material. Care must be taken to ensure that, after fastening the hatch with the hinges, it does not fit so snugly over the coaming that it binds when it rotates. Again, I used tongue depressors as spacers to ensure a non-binding fit. Note that due to the curvature of the hatch, the hinges were placed well to the outside of the hatch to allow it to rotate clear of the coaming.

During the construction I left a larger 1/4" (6mm) lip around the periphery of the hatch as a base for the plastic window insert (**Figure 5**). I glued on a rounded 1/4" (6mm) strip to surround the yet to be inserted window to give it a countersunk effect and to have the smoothest edge possible to avoid being snagged by a rope. I drilled and doweled all corners. I also extended the side pieces of the hatch as low as possible to avoid a small diameter rope being caught under the hatch edge.

I dry fitted two Vetus hatch handles and purchased two hatch holdups that provided the maximum opening. My initial thought was that the hatch would not be opened beyond the horizontal position but I later determined that a larger opening would encourage a much better cooling ram air effect.

After removing all fittings, I removed the wood from the frame and applied three coats of West System 207/105 clear coat epoxy to all surfaces. I took care to coat the plywood end grain well to ensure no water absorption in case of a leak around the gasket. I also countersunk screw holes in the plywood around the coaming perimeter and strengthened the bond with wood screws, their heads hidden by wood bungs. I am not a master wood worker and made sure a judicious amount of epoxy flowed in and around my less-than-perfect finger joints. Once cured, the hatch and coaming received four coats of two-part polyurethane varnish (**Figure 6**). I now reattached all the hardware.

I purchased an oversize 1/4" (6mm) plastic polycarbonate sheet and cut it to size. Polycarbonate is the better choice as, apart from being stronger, it is less prone to cracking than acrylic when drilled. I slightly over drilled the hole sizes in the plastic for all the screws around the circumference and the thru-bolts for hatch stay supports. (Ed: Rule of thumb when drilling holes in plastic is to increase the hole size by 1/16" for every 1' of surface length and never countersink for fastener heads.)

I removed the interior protective paper from the edge of the plastic that would be under the lip, sanded the now exposed areas and coated the matching plastic and hatch lip with Life-Seal silicone/polyurethane caulking and attached them together with brass screws. In a "do over," I would use round head screws instead of countersinking the screw heads. I carefully drilled the holes for the hatch handles through the plastic and the interior wood supporting lip to match a piece of aluminum angle material on the coaming.

To install the unit, I removed the hatch frame by removing the clevis pins and dry fitted the glued and screwed coaming and plywood combination and made sure the entire assembly fit well on the boat. I then brought the unit home and completed caulking the wood coaming plywood to the aluminum frame. When the caulking cured, I took the unit to the boat and caulked the aluminum frame in place and completed the installation by installing the trim ring with stainless-steel self-tapping screws. Installing the hinge clevis pins, hinge pins and hatch support stays was all that remained to do.

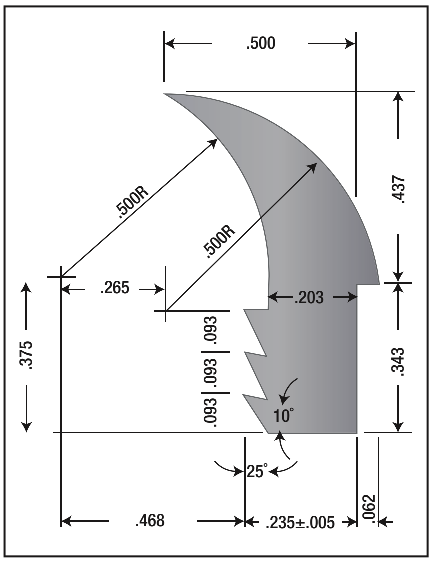
During the construction of the opening window, it dawned on me that these modifications might affect the seaworthiness of my vessel. I found that ABYC has published Standard H-3 for hatches and windows. I ordered it online and

Figure 7

Vertical support bar was added after deflection tests suggest a potential weakness.

Figure 8

View of hatch from cabin interior. Support bar hides the radio wires.



Bomon/Joe VanVeenen

Diagram of glazing rubber.

conducted the tests specified in the standard. My hatch passed all the tests. One test required a loading of 300lb (136kg) anywhere on the hatch and, while my hatch took the load with two people standing on it, I didn't like the amount it deflected. My fix was to add a 2" by 2" (50mm by 50mm) support bar between the coaming, which was dowelled and epoxied in place (visible in **Figure 7**). This brace also serves to hold the conduit carrying the wires to the ship's VHF radio (**Figure 8**). I would encourage anyone undertaking a project that may effect your boat's integrity to engage an accredited marine surveyor familiar with ABYC standards to consult on these matters.

This project completely changed the interior feeling of the boat. The hatch does not leak and it makes the cabin very light and airy.

I'll be sure never to use any polish or cleaner on these windows unless it is specified for plastics and use only scratch-free microfiber towels when cleaning. I'll also be fastidious about covering the windows when not required and making sure solvents, chemicals or even bug spray, which can cause crazing, do not touch the plastic. I'll also be sure all visitors are aware of the sensitivity of plastics to chemicals.

Bottom Line

Windows were replaced for about $1,000 plus $400 for rubber glazing and $100 for hatch locking handles. Price fluctuations from the same plastics shop for thermoforming varied at around $300 during the year period that I did this project. While plastic sheet is readily available at most plastics shops, thermoforming is quite specialized and it may help to nail down material and labor charges before starting such a project.

About the author: Rory Harley is a retired mechanical engineer living in Ottawa, Ontario.

Low-cost Icebox Fix

3

My boat's icemaker died and since it most often served as a beverage icebox that delivered messy soft ice, costly repairs were out of the question and replacement was $600.

I found an economical, home-grown solution at a sporting goods store. For $50 I purchased a 12-volt powered Coleman Road Trip that plugged into a standard 12-volt outlet to chill or warm its interior. It has a small fan and compressor and can operate in a vertical or horizontal position. The Road Trip fit nicely into the space occupied by the broken icemaker if I cut almost 3/4" (19mm) to widen the opening. It is almost 3" (76mm) shorter than the icemaker so there was airspace for the compressor. I mounted a 12-volt outlet in the back of the drink bar cabinet, which is wired off the DC distribution panel; a breaker turns the unit on and off.

The Road Trip has molded recessed handles in the ends. A small piece of wood attached by screws to the cabinet bottom keeps the cooler in position. The top is held by a molded plastic louvered vent through which air circulates around the fan and compressor. Just an hour or so of work resulted in a compact refrigerator. Any ice is now made in the freezer compartment or purchased.

— Bob Trenholm's ongoing project of 10 years is an 1988 11 Meter Trojan.

Dinghy ID

3

To deter theft and increase the chances of recovery, consider leaving your brand on your dinghy and its accessories.

By David and Zora Aiken

Use artist's acrylic paint with a stencil to put logo onto fabric of PFD.

The traditional way to mark a yacht tender is the simple "Tender to YachtName" but, in certain places, this identification may have a serious drawback. It advertises an opportunity for criminal activity. Tied to the town dock, a dinghy so marked tells everyone within viewing distance that the dinghy has carried at least some of the crew away from an anchored yacht. If all crewmembers have gone to town, disreputable persons might choose to board the yacht without permission for devious reasons.

Still, it's a good idea to have a clear identifier for the dinghy and its accessories in addition to recording all hull ID numbers and serial numbers and keeping them in a safe place. You could choose a "go-together" name for the dink (Snow Goose and Gosling, Martini and Olive) or your initials but, in the spirit of do-it-yourself pride, consider a logo.

Some boat names conjure up an immediate image: Osprey, Dolphin, Seal. Others don't lend themselves to simplified artwork but, since you're looking for a consistent marking, any design that pleases you will do. Ask an artist friend to provide an artistic silhouette. Photocopy or scan the artwork to as many sizes as you'll need for the dinghy transom and whatever items go to shore regularly: PFDs, throw cushion, oars, outboard, gasoline or propane tanks, water bottles. Then decide how you want to apply the logo.

If you have a fairly steady hand and the design isn't too intricate, paint it on. Artist's acrylic paint is easy to work with on fabrics, plastic and wood and it cleans up with water.

Stenciling is easy and you can buy plastic stencil sheets with a variety of images at a craft store. Use an Xacto knife to cut the design. If you have no experience with this versatile tool, buy the holder and a pack of #11 blades and practice cutting lines and curves until you're relatively comfortable with it. Be very careful, as the blades are very sharp. Initially, you'll probably cut lines twice; eventually, you'll judge the right amount of pressure. Change blades often for the cleanest cuts. Poster board works well for making a custom stencil.

To color, use a roller and block-print ink (also sold at craft stores) or a stiff brush with acrylic paint (dab the paint on as you hold the stencil down) or spray paint. To avoid spraying your hand, hold the stencil in place using small pieces of two-sided tape. Taping provides a cleaner edge with any of the paint application methods.

Sign makers use an adhesive-backed vinyl material and you can likely obtain small scraps from a local sign shop. Cut out your design and stick the cutouts in place.

Dinghy logo stenciled on oars, PFD, throw cushion and transom.

(top) Adhesive-backed vinyl cutout placed on the propane tank and (bottom) on the dinghy's outboard motor .

You could also use either the stencil process (with more two-sided tape) or the stick-on vinyl for a "negative" result by coloring a background panel and leaving the shape revealed as an unpainted portion. If you choose initials, buy stick-on letters used for boat registration or smaller sizes found in hardware stores for DIY sign making. Or find a nice, fairly simple font on the computer, print the initials to appropriate sizes and cut out the letters, either stencil or stick-on.

About the authors: David and Zora Aiken have been liveaboards for more than 20 years and are consummate DIYers.

DIY Tool Essentials

Often "less is more" when it comes to your onboard tool kit.

By Roger Marshall

Roger Marshall

Most boat owners have an onboard collection of tools onboard but how well thought out is the assortment? Do you really need all of them? Are some very useful tools missing? Often the tool "kit" is a hodgepodge of tools that has evolved without much thought. There are duplicate wrench sets, half a dozen rusting pliers of various configurations and several screwdrivers with a mishmash of head types. Some people rationalize that tool redundancy guards against those accidental losses that happen to everyone. You approach a job on deck, slip and – oops! – the tool ends up in the great tool morgue on the seabed. Even taking these occasional losses into account, most boat owners could carry fewer tools than they actually do and also have a tool kit that is much better designed for their needs.

Over the years, I've compiled a set of tools that I think should be aboard a boat. Mine are all stainless or nickel-plated steel tools that resist rust. Note that I didn't call them rustproof because most tools will eventually rust in a marine environment. I carry these tools in a rollup tool bag so that they can be easily identified and removed for maintenance and replacement of worn or broken items. Also in the rollup are several bags of silica gel and a can of Corrosion Block that I spray on tools to retard rust.

What tools will you find in my tool bag? My list begins with a set of wrenches, both box wrenches and open ended ones carefully checked to fit the nuts and bolts onboard my boat. There's not much point in buying a metric set of wrenches when none of the nuts or bolts on the boat are metric. I also carry a couple of adjustable wrenches for use when my other wrenches don't fit.

Screwdrivers are another important part of my tool kit. I have a set of Wera stainless-steel screwdrivers. These prime-quality tools are specially made for stainless-steel screw heads (no carbon steel contamination from the screw driver tip) so they are perfect for use onboard a boat.

My tool bag also contains the following items: a 1 lb (.45kg) hammer; ClampTite to make wire clamps; Swiss Army knife with pliers; Maglite flashlight (you can now upgrade these flashlights with bright LED bulbs.); 25' (7.6m) tape measure; small metal saw with spare blades and a knife with a sharp, carbon steel blade, which keeps a better edge but rusts faster, so I coat it with Corrosion Block.

For purely electrical work, I include several Ancor tools. Ancor crimping pliers allow you to crimp only to the right pressure, after which they open up, and its wire stripper creates the perfect length of stripped end every time. Ancor also makes a small butane-powered heat gun that I use to heat-shrink electrical terminals and tubing and to cut synthetic rope using the knife blade. This tool has several small end pieces so store them in a Ziploc bag (preferably the "freezer" grade) to keep from losing them.

To my mind, the items just listed make up the minimum for the tool kit you keep aboard your boat. You should also assemble an auxiliary kit that is carried to the boat when needed. In this kit I include: a Ryobi 18-volt portable drill with several batteries and its battery charger; outdoor type, heavy duty extension cord; more wrenches in sizes not often needed; larger hammer; 100' (30m) measuring tape which is handy for checking mast tune; spare fuel tank cap key(and a threaded cap); multimeter and a wire brush. Other tools are added for a specific job on an as-needed basis.

I make no particular provision for storing the tools I bring onboard. I keep the tool kit in the lower drawer of the navigation area and have learned through experience to hold onto the tools when I go on deck with them. If I go aloft, I prefer to take tools in a zippered pouch or in a bosun's chair pocket to ensure that I don't accidentally drop them over the side or onto the deck. People on deck tend to get very upset when they are showered with tools from a great height.

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

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