#4 2006

DIY BOAT OWNER

THE MARINE MAINTENANCE MAGAZINE

## COLUMNS



## DEPARTMENTS






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*Edited by Jan Mundy*


## A Holey Solution

Since receiving DIY 2006-#3 issue, I've been complaining about the lack of holes for my binders. I have all issues since the beginning (1995-#1) and you can call me old fashioned but I do miss the holes.

*Dick and Lyn Rogers, Mahone Bay, Nova Scotia*

We know lots of readers were disappointed with this change and, if you, like this reader, prefer storing your DIY back issues in a binder, check your local office supply stores for three-ring, plastic, hanger type magazine organizers that fit into binders or have a quick print shop (e.g., Kinkos) punch the holes for you.

## Sharing Knowledge

Armed with the information DIY's Steve Auger provided through the Technical Helpline, I worked on my faulty engine, starting first with the fuel pump, to track gas leakage into the oil pan. This proved not to be the culprit so I replaced the distributors, something I meant to do as the originals were worn and corroded. The engines now run smoother and quieter but this didn't cure the gas leak. So, following your advice, I had the carburetors overhauled and asked that the floats, inlet needles and seats be replaced. The engine hasn't leaked since. I never would have suspected this without your help.

*Charlie Hope, Quispamsis, New Brunswick*

## Drain Plug Appeal

I found your article regarding drain plugs (DIY 2006-#3 issue) quite interesting as I once struggled with this same dilemma when dealing with my 16' (4.8m) center console. When placed inside, the plug can be pulled to drain when running but placed outside you have hydrostatic pressure on your side. So which is most important? Then, one day, I had a revelation: on boats that are so small they have no real bilge or bilge pump, and would be drained in this fashion, they are without fail also small enough to reach over the transom and yank the plug from outside. So, outside it is, problem solved for me.

*Lenny Rudow, Annapolis, Maryland*

## Rules of Leaks

For the past year I've routinely removed a small amount of water from the bilge in my sailboat's empty motor well. After a recent cleaning of the head compartment I decided to check this area only this time there was a little more water than usual. Lucky for me I leaped into the cockpit to check something and returning some time later I noticed more water, which was cool to touch. I knew at once I had a leak but where? After some wiping and a very close inspection I discovered water gushing from the hose connection on the toilet water intake. I had opened the seacock to flush the head after cleaning it. The hose was loose, hence the small amount of water I routinely wiped up but my cleaning pushed the hose off the seacock and as it was out of sight I never noticed. Rule one: close seacocks when the systems they serve are not in use. Rule two: each year check all hose clamps for tightness.

*David Bakody, Dartmouth, Nova Scotia*

## Water Check

A few years ago you published an article on the dangers of raw-water cooling systems having too high a thermostat and that water could boil in the block and cause damage. Recently, while researching a low-water pressure alarm system for my boat, I ran a pressure test to determine the low-water alarm pressure settings. To my astonishment the water going into the exhaust header was only 1 psi at idle and at 2,500 rpm (my cruising speed) it only rose to 2 psi. Obviously, it wouldn't take much temperature to boil water with so little backpressure.

*Jeff Perry, New Tripoli, Pennsylvania*

## Restore Foulies

After four years of use, my light-duty Gore-Tex rain gear has become a "wet out," that's when water saturates the outer fabric above the Gore-Tex membrane, giving a damp and clammy feeling. I was going to trash the suit but I learned that the water repellency of Gore-Tex must be restored on a regular basis. To do this,


*Need more product information? Just use DIY's product information request at diy-boat.com and you're automatically entered to win one of three Davis Key Buoys.*

# Product Info Winners!

The three winner's in DIY's Product Information Card Giveaway from DIY 2006-#2 issue who received a Capt. Phab Purge Tank Cleanser are: Jerry Brems, Heath, Ohio; Keith Hickey, Richmond Hill, Ontario; Gary Knox, Oceanside, California.

When you need information from marine manufacturers, log onto DIY's website at diy-boat.com and click on "Marine Product Info." This automatically enters you into this issue's draw of three Davis Key Buoys.

just machine-wash and rinse and put it in the dryer. The washing removes dirt and other contaminants and the heat from the dryer helps redistribute the water repellent treatment on the fabric surface. If water then fails to bead on the surface apply a topical water repellency restorative used for outdoor fabrics.

## Buzz Word: Nano

Technology has elevated beyond micro and into the ultimate in miniaturization, known as nano. There are nanocrystals, nanoceramics, nanofabrics, nanoparticles, nanotubes, bio-nano materials and not to miss, Apple's iPod Nano.

Nanotechnology was first introduced in 1959 and it's the term used to describe a manufacturing technology for producing materials and substances atom-by-atom or molecule-by-molecule. This nanoscale level is measured in meters and one nano equals one billionth of a meter. This equates to a million times smaller than a pinhead. To further appreciate the infinitesimal sizes consider that human hair is 100,000 nanometers thick, virtually outside the nanoscale range. Nanotechnology will revolutionize production, making systems that are smaller, lighter, stronger, more efficient and eventually, cheaper to produce.

What's this new nano-world mean to boat owners? We now have rock hard nano-polishes that seal and protect gelcoat, long-lasting protective nano-coatings that return the shine to stainless steel, chrome and polished aluminum and engine nano-oils that molecularly bond with internal engine components to reduce friction and improve engine performance. Nanotechnology is expected to transform the performance of batteries, coatings, electronics, paints and polymers, according to the Institute of Nanotechnology (nano.org.uk).

Long-term potential includes: nanoparticle paint to prevent corrosion; miniaturized data storage systems with the capacities of today's main frames; carbon nanotube fuel cells to power boats; scratch-proof plastic windows that clean themselves; nano-coated fabrics that resist stains and control temperature and nano-membrane water filters.

It's no wonder that more manufacturers are venturing into the tiny domain of atoms and molecules.

## Why do Outboard Powerboats Sink?

The July issue of "Seaworthy," the damage avoidance newsletter published by BoatU.S. Marine Insurance, looked at claims files and identified the myriad reasons why outboard powered vessels sink. The article confirmed that most boats sink while tied up at the dock, outnumbering sinking while underway claims four to one. Nearly half the outboard powered boats that sank at the dock were victims of heavy rain or snow and ironically, almost all had "self-bailing" cockpits. Failed underwater fittings accounted for 20% of at the dock sinkings; above waterline fittings, 10%; poor docking arrangements, 9%; water over gunwales/transom, 9%, and "other," 5%. Water over gunwales/transom accounted for 32% of sinkings while underway, followed by 20% with livewell/baitwell plumbing failures; 16% due to bilge drain plugs; 12% struck a submerged object. Construction problems accounted for 8% and "other," 12%.

"Seaworthy" (BoatUS.com/seaworthy) associate editor, Chuck Fort, offers these tips to reduce your risk of sinking. Use a good-fitting boat cover that keeps out precipitation. Ensure that marine grade plastic, e.g., Marelon, or bronze thru-hull fittings are used. This is often more of an issue when a boat owner unwittingly installs a common, hardware store plastic fitting that eventually degrades and cracks. When underway, avoid putting your boat in a position to be swamped over the transom from following seas or large boat wakes. Too many floodings and fatalities are related to anchoring by the stern in low transom freeboard boats.

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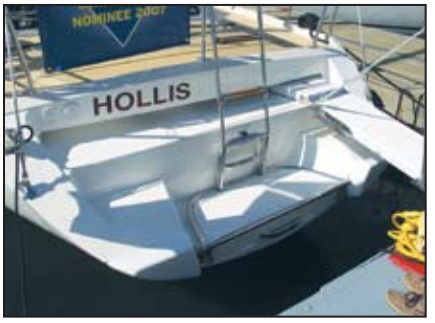
# Quips and Quirks

Every fall the DIY team attends in-water boat shows so here we share are picks for the best and worst in new boat design.





*Keeping up with the times: Due to an ever increasing lack of dock space, the Mediterranean mooring, where boats are docked stern-on, is becoming more commonplace and new models accommodate with redesigned transoms.*

*Dinghy hideaway: A custom, protective storage for the RIB with self-launching ramp. Ya gotta love it!*

# Quips and Quirks

*Head smacker: At least I wasn't the only one who stepped up on the bridge deck and made contact with the bimini top frame, the fault of the canvas maker not the boat builder.*

Survivor for four: TV is a good way to entertain the kids but does a 35' (10.6m) cruiser really need one in the salon, forepeak, aft cabin and a fourth one in the cockpit?

*Foredeck sunpad: It's about time that designers realize that sailboaters might like some of the comforts a powerboat offers.*

*"I've often thought that people who pay for boats that please the eyes and stimulate the imaginations of passers-by ought to get some kind of tax break." Designer Phil Bolger.*

*For boats only: This one-piece molded vanity and shower makes for easy cleanup. I wonder if a home version is available….*


*Just for show: These vertically challenged V-berths are not built for the average height adult.*

# Repairing Pitted Aluminum

**Q:** I want to repair small (pencil eraser sized or smaller) pits caused by corrosion and oxidation on an anodized aluminum boom. What is the repair process?
*Nat Abbott, Southampton, Bermuda*

Most corrosion on aluminum spars is merely cosmetic. Refinishing involves sanding, followed by an etching primer, filling of any craters, more sanding then painting.

**A:** Assuming the corrosion pitting is merely an eyesore, other than replacing the extrusion, the only option available to you on a DIY basis that would significantly improve the appearance is complete refinishing. This includes filling the pits and surface irregularities and then applying a high-quality polyurethane paint finish. Use whatever paint system you can get locally but be sure to follow the instructions from the paint manufacturer. In general, the procedure is as follows.

1 Remove the boom and remove all hardware and fittings.
2 To remove all the anodizing and bring the surface to bright bare metal, aggressively sand the extrusion with a dual action (random orbit) power sander using 80-grit paper. Use a rotary (e.g., Dremel) tool with a grinding bit to sand into the recesses and pits the sander can't reach.
3 Blow off the surface with compressed air and clean with acetone or thinner and then apply the recommended primer. Allow the primer to dry overnight. Some paint systems will also recommend a pre-primer wash or etching primer step that goes on right after the initial prep sanding.
4 Fill any pits, porosity or recesses with an epoxy resin thickened with colloidal silica and/or microspheres or vinylester resin and allow it to cure overnight.
5 Block sand the filler (i.e., sand by hand with the sandpaper wrapped around a flat wooden block) until smooth, using 120-grit paper. Refill if needed and block sand again.
6 Touch up the primer anywhere you inadvertently sanded it while addressing the filler.
7 Hand sand the primer with 320-grit paper.
8 Hang the boom by inserting a piece of wood in either end and cradling it between two sawhorses.
9 Blow off the dust and wipe with a tack rag for final cleaning and apply a high-quality polyurethane paint (spray or brush). Don't bother trying to paint the end castings, just the extrusion.
10 Reassemble the boom and reinstall the fittings.

*— Nick Bailey*



## Trailerable Bottom Coating

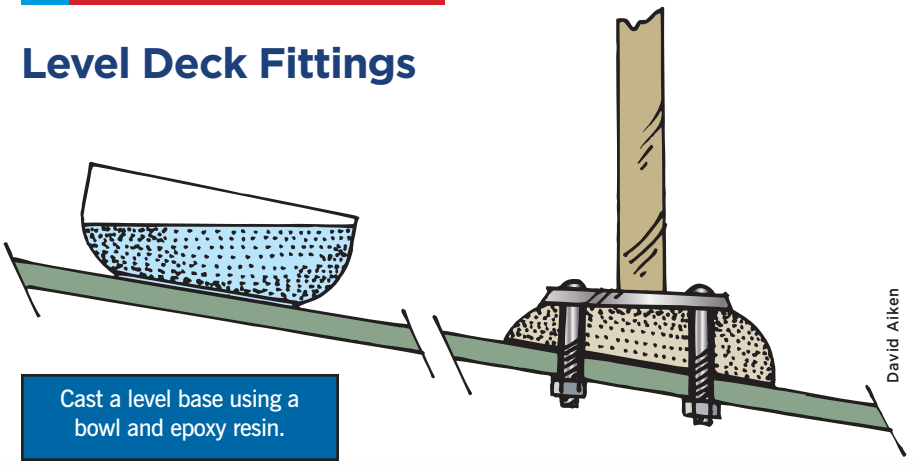
**Q:** After reading an Interlux ad for its VC ECO bottom coating, I think I want to use it on the bottom of my boat instead of colored anti-fouling paint. Could you please provide any information you may have relative to this product and do you recommend it?
*Gary Woods, Orillia, Ontario*


*Applied below the waterline, Interlux VC ECO provides trailerable boats with a smooth, colorless, easy-to-clean surface. Pity it's only available in Canada.*

**A:** Interlux VC ECO is a hard, super-slick translucent coating for application below the waterline. It uses thin film Teflon technology to provide a smooth durable finish that lasts longer than wax and yields an easy-to-clean surface that increases hull efficiency by reducing drag with no paint build up. VC ECO requires minimal prep before application and dries very quickly. A boat bottom can be cleaned, two coats of VC ECO applied and launched the same day. Designed for the boat owner who does not want antifouling paint but needs an easy-to-clean surface, the translucent finish keeps that "new" boat look and is ideal for rack-stored and trailered boats as well as boats that are moored in the water. VC ECO's biocide-free technology won't cause corrosion, which makes it an obvious choice for application over underwater metal parts.

*— Jan Mundy*

## Level Deck Fittings




Cast a level base using a bowl and epoxy resin.

**Q:** I'm reattaching the stanchion base on my Grampian 30 and the deck is uneven. Any suggestions on leveling the surface with epoxy resin?
*Roy Mitchell, Tweed, Ontario*

**A:** You can use wood to make a wedge-shaped base, but that takes a lot of fitting time. Instead, make one out of epoxy resin. Find an appropriately sized, low-sided casserole dish. Spray the inside with nonstick cooking spray or coat it with paste wax to prevent the epoxy from bonding to the dish. Mix up a batch of epoxy resin thickened with microballoons. Set the dish on deck in the place where you want to install the fitting. Pour the epoxy into the dish to the amount required. The resin will flow naturally and level out on top. When it hardens, pop it out of the dish and turn the blob upside down. The angle side now matches the deck slant and the dish-bottom side is a true horizontal surface for your fitting base. Sand and paint, then glue and fasten the base to the deck and attach the fitting.
*— Jan Mundy*

## Fuel Fouling Carbs

**Q:** My project boat is a 1984 Sea Ray with a Mercruiser MCM 120 power package. The engine has been tuned to shop manual specs. When I "gun" the engine to pull a skier out of the water, the engine stalls momentarily and I have to throttle back and accelerate again. I have sprayed carburetor cleaner down the throat of the Mercarb per the directions on the can but there's no improvement. Any suggestions?
*Eugene Corcoran Jr., Spring City, Tennessee*

**A:** Your engine was produced in an era where alcohol was not an ingredient of the gasoline that the engine uses as fuel. Alcohol (namely, ethanol) in today's gasoline may deform rubber parts in an older carburetor, reducing its ability to perform as required. Assuming the ignition system is working correctly and that the carb has not been recently rebuilt, it's quite likely that the accelerator pump seal has become deformed and doesn't push the correct amount of fuel through the discharge ports, which results in a lean condition upon acceleration. Purchase a carb repair kit from your Mercruiser dealer and send it along with the carb to a carburetor specialty shop. Have the carb cleaned and the repair kit installed.
*— Steve Auger*

## Head Beasties

**Q:** I have spoken to sailors from both sides of the Atlantic and have heard from many that the mixing of urine and saltwater accelerates the calcium precipitation onto the output hose of marine toilets. I have never read about this in print. Do you have any knowledge about this phenomenon?
*Robert Glassman, "Bon Accord," David's Bay, Grenada, West Indies*

**A:** The calcium in your head hoses is not a simple chemical precipitate but is deposited by marine microorganisms. In a similar fashion to coral, barnacles and plankton whose microscopic corpses eventually form thick beds of limestone, these creatures are busy lining your head hoses with calcium carbonate. Urine accelerates this process, containing as it does urea (carbamite), a superb fertilizer and source of fixed nitrogen (about 46% nitrogen by weight). If you provide nutrients for the saltwater microorganisms, they will certainly grow.
*— Nick Bailey*

## Removing Fittings on Hypalon

**Q:** I wish to put a set of Weaver davits on my Achilles dinghy. The problem is that there is a small fitting glued where one of the pads has to go. Any suggestions as how to remove it without destroying the fabric?
*Brian Hicks, Thunder Bay, Ontario*

**A:** Achilles inflatables are made of Hypalon and according to Howard Shure of The Air Works in Annapolis, Maryland, the glue holding the hardware is released with heat. Use a heat gun (not a hair dryer) applied judiciously to gently heat the area. Continue heating and slowly pry up the fitting using a blunt instrument (pros use a boning knife) until removal is complete. If you overheat it, you'll blister the fabric and cause more problems.
*— Jan Mundy*

## Why Seasonal Oil Changes

**Q:** Is it better to change oil in the fall or spring?
*Tony Cabral, Portsmith, Rhode Island*

**A:** The correct answer is both as it makes sense to change the oil at least twice a year. Here's why. First, oil in a vented atmosphere, like your engine sump, is good for six months maximum and then the oil starts to break down. After that time, the oil needs changing

before running the engine or serious engine damage could result. Secondly, if temperatures are above freezing and the engine is not operated for extended periods of time, condensation accumulates in the oil pan sump. Changing the oil after off-season lay-up ensures this water is removed from the oil pan before running the engine. Finally, engine oil is quite inexpensive compared to the cost of a repair to an engine that has a lubrication system failure. Though I do not do this, some DIYers use cheap bulk oil for winter storage and then change to marine-grade premium engine oil before spring relaunch. Just be sure to change the oil before recommisioning or you risk engine damage.
— *Steve Auger*

## Dressing Threads

**Q:** A previous owner of my 27' (8.2m) Hunter damaged the threads on the zinc mounting plate on the 1GM Yanmar engine. The original bolt size is 7mm. I used a tap to clean the threads but there isn't much hold left with the old threads. Should I retap for a larger bolt size? If so, what size would you recommend? Should I use an insert or is there a better fix?
*Peter Bothner, Brick, New Jersey*

**A:** The standard procedure to replace damaged threads is to install a Heli-Coil (helicoil.com). These come in kits from fastener companies and auto repair supply stores. Threads are tapped out to the next larger bolt size with a special tap and then the Heli-Coil is installed with a special tool and Loctite. It gives a stronger hold than the original threads and as Heli-Coils are used to hold commercial aircraft together, it should work fine in your engine.
— *Steve Auger*

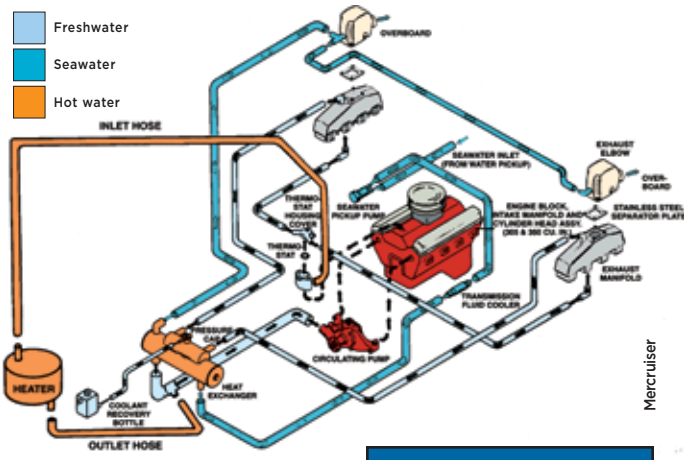
## Running Solo

**Q:** Is it advisable to run on one engine only in a twin sterndrive-powered boat?
*Rudy Palladina, Toronto, Ontario*

**A:** It's not uncommon to idle on one engine only in a twin-engine application but there are some drawbacks.

Most sterndrives only have power steering on the starboard engine. Running only on the port engine makes for tough steering yet running on only the starboard engine racks up the hours on one engine. Handling in tight quarters gets tricky on one engine so this activity is usually feasible only in open waters. Also, some house battery charging systems are connected to the starboard engine only. To run on both engines alternately, you would need battery isolators on both engines.
— *Steve Auger*

# Closed-Cooling Winterizing




Typical schematic shows water flow through a Mercruiser V8 engine with closed cooling and auxilary heater.

**Q:** I have a 1987 Carver Montego model 3257 with twin 454 Mercruisers. Although I have owned the boat for four years, I'm doing the winterizing myself for the first time and am unsure of the procedure for draining the heat exchanger for the hot water tank. The engine manual details where all of the drain plugs are on the engine but does not mention the freshwater heat exchanger. I have drained the hot water tank, which I believe also drains the heat exchanger. Is this all that I have to do?

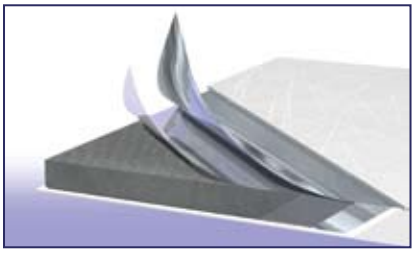
*Doug Peace, "Summer Daze," Nepean, Ontario*

**A:** A closed-cooling system uses antifreeze in place of seawater to cool the engine block and manifold. Hot antifreeze is sent to the heat exchanger where it passes through a series of tubes filled with cold seawater to lower the antifreeze temperature and then it's routed back to the engine and manifold to start the cycle over again. A water heater maintains the heat in the tank when underway. When winterizing your engine, you need to ensure that all seawater is drained from the engine's seawater supply system. Check the antifreeze and, if it tests at -35F, you need only to ensure that water has been drained from the water heater, heat exchanger and transmission cooler. If you are unsure if all water has drained from these systems, use non-toxic antifreeze and back fill the system. To do this, remove the hose that runs from the heat exchanger to the exhaust elbow and pour antifreeze into the hose until it comes out the water pickup on the bottom of the boat. The water section of the hot water tank should only require draining but can be flushed with non-toxic antifreeze to be on the safe side.

*— Steve Auger*

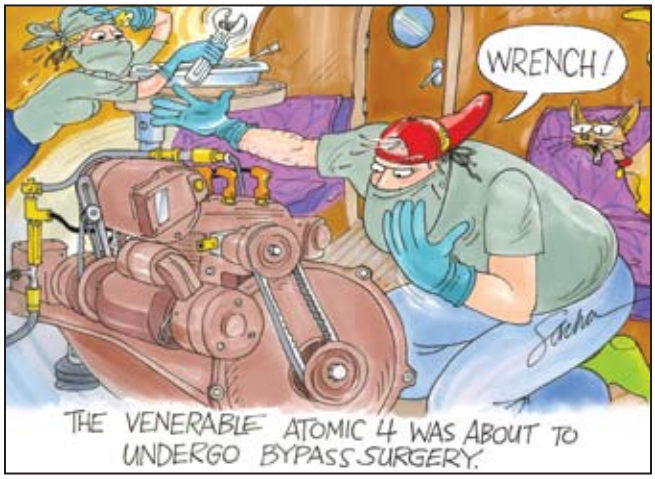
## Boosting R Values

**Q:** I want to add insulation to my refrigerator box. What are the latest and best products to consider? I am aware of Glacier Bay panels but they are quite expensive.
*Mike Dunn, Annapolis, Maryland*



*Glacier Bay Ultra-R superinsulation panels utilize a carbon-silica aerogel core and while more expensive than common foam insulation, these panels offer the highest R-values.*

**A:** Glacier Bay is the best-known builder of superinsulation. These are vacuum insulation panels and they are in a class by themselves in terms of insulating capacity per inch of thickness, having R-values ranging from over 20 to around 70 per inch. While expensive, they carry a 25-year warranty. Cheaper panels (with shorter warranties) are more fragile and should be avoided. The next best insulating materials are urethane and foil covered polyisocyanurate boards at around R-6. Conventional Styrofoam "blue board," the common house insulation, rates slightly lower at almost R-5 per inch. Traditional two-part, open-pour urethane foam is in the same general R-5 region but it's more difficult to get consistent results with cut and fitted boards due to hidden bubbles and voids. A combination of board material assembled with gap filling foam works well. The only reason anyone would require the superinsulation is if there is just not enough room for more conventional insulation. If you have room for 6" of conventional insulation it will perform nearly as well as a superinsulting panel. Insulation is only one part of a well-made icebox. Construction quality, especially the details of how the insulation is fitted around the icebox to avoid gaps and "thermal shorts" and a well-sealed gasketed top are equally important. [Ed: For complete details on rebuilding an icebox refer to DIY 1999-#4 issue.]
*— Nick Bailey*



# Fitness for Service

## Clothesline and house paint

**might work just fine on a boat but are they fit for the service they are intended to perform?**

By Pat Kearns

Every project, installation, repair or maintenance task comes to the point of being completed to some level of satisfaction, a boundary of acceptance as being finished and ready for use. Every product has been manufactured with the intent of it meeting some defined or undefined need. Sometimes, you make that determination yourself; other times, the "good enough" call is somebody else's. Is it perfect? Not likely. Good enough? How do you know?

There are boundaries that define almost everything we do and staying within those boundaries, parameters, rules of play, etc. is important to our satisfaction about work, an event or transaction. How does that apply to determining "fitness for (intended) service" of our boats and accessories?

The question becomes: "What's good enough?" There is a practical answer and there is a legal answer. The former is subjective and personal and, to some extent, depends on the knowledge and experience level of the person making the determination.

An example of this dilemma is rope. Can you use clothesline to tie your boat to the dock? Sure, you can and we've all seen lash-ups that defy admonitions to the contrary. Would you? If not, why not? Possibly, you already know, from experience or training, that clothesline is not suitable for the job. The latter, the legal answer, uses language like "suited to its intended service" and is often subject to lots of debate and, sometimes, the definition comes down to the decision of a judge or jury or some other form of adjudication.

That answer requires assessing whether the clothesline is "suited to the intended service," a judgment that does not require that you use the best rope (line) for the intended service, but that you use rope that is suitable for the job and suitability is determined by the boundaries of the service requirements, some of which include strength, resistance to the elements, elasticity and other performance characteristics of rope, the generic term for any line until that line is put into a specific service, e.g., anchor rodes, docklines, halyards, sheets. Of course, there are times when the determination of "suitability" is overcome by the practical urgency to get a job done and, in the case of a dockline, anything faintly resembling string will be pressed into service, relatively speaking.

> The question becomes: "What's good enough?"

"Fitness for intended service" is a term that provides for an almost infinite number of variables. Those are parameters for performance and, in addition to cost, there are factors like feasibility of design, durability and strength of materials that apply to determining the suitability of anything to do something. Clothesline might be suitable as dockline for a limited time, provided the knots are "suitable" and the line is strong enough for the anticipated load but we can probably all agree, it's not intrinsically suitable for this service.

If you are the only person assuming the responsibility for choice and the outcome of the use of clothesline as dockline (intended service), then it's all up to you. The best quality clothesline then is not equal to a minimum quality dockline of the same diameter and the reasons for that distinction are not always obvious. Can you use house paint on a boat hull? Sure but it won't last very long because it's not formulated with boat service in mind.

How do we establish whether a product or a process is suited to the intended service? Suited to intended service should not be confused with assessing the quality of a product or process. Cheap dockline can be suited to the intended service but still cheap. Value in dollars is relative. Suitability is not.

Boats float but that's about all they have in common. Choosing a boat that fits your need, that's suited to your intended service, is where the line gets drawn in the sand. This is where you have to have to make insightful decisions about how you want to use the boat so that you pick a boat that is closest to meeting your need. There are multiple "fit" issues to consider, not the least of which is the budget fit.

If you go to a boat show looking for a cruiser with twin sterndrives, you'll see rows and rows of possibilities that will challenge both your objectivity and subjectivity but you'll have to pare down the options using your own parameters for the choice. Of course, if you really want to shore up your decision, you look for the "union label," the "seal of good …" (in this case, boatkeeping), the NMMA seal of boat and yacht certification, the built to ABYC standards seal, etc. None of these will tell you that the boat you're considering is a good, better, best nor will they tell you that can cross the Gulf Stream safely. This is where smart boaters engage expert opinions by consulting with a marine surveyor or other marine professional who can help you define the kind of boat that suits your need, your "intended service."

If you're intending to take more than six paying passengers fishing on your boat, the boat will have to meet certain USCG standards to be considered suited to the intended service; another crimp in your control of suitability. There are other circumstances that involve getting other people or entities to agree with your idea of what is suitable for a specific use. Insurance companies, marine bankers, the Coast Guard and, in other parts of the world, regional regulatory entities that govern what kind of boat can do what, where and when, will prevail in making suitability judgments.

When it comes to the bits and pieces that go into the boating experience, there are areas that are critical to observe such as fuel and electrical systems. Here we have no wiggle room in keeping the course for being absolutely fit for the service. If your boat has a gasoline inboard engine or inboard with sterndrive and you are replacing the alternator, there's no bucking the extra cost for a marine alternator without putting your life on the line. No matter what the guy at the local auto parts store says, the auto alternator (fuel pump, distributor, etc.) is not the same as the more expensive one marked "marine." The latter is ignition protected to prevent electrical sparks from escaping from the unit, sparks that could ignite any volatile vapors present. Such vapors could be present because a previous owner took the low road and cheaped out when he replaced a hose in the fuel system. After all, black hose is black hose, right? These are places where a component might fit just fine and it might work but it's not fit for the application.

Another example is the installation of a diesel generator to replace the old gasoline one. The well-intended decision to go diesel was made because it would eliminate the carbon monoxide (CO) hazard that goes with a gasoline generator. In an actual case, this gen-set was installed in a gasoline propulsion engine space and that means the non-ignition protected accessories on the diesel generator (not required by any standard) present an ignition hazard to gasoline fuel vapors that might accumulate in this engine space. The original gas gen-set would have to be equipped with ignition-protected devices as required by law and voluntary safety standards. Money spent to buy and install this new and expensive diesel gen-set and a new diesel fuel tank to serve the gen-set is a financial bust with deadly potential but it fits.

Remember this: even if it fits and it works, it may not be fit for the service.

About the author: DIY's technical editor, Patricia Kearns, is a NAMS certified marine surveyor and operates Recreational Marine Experts Group, a marine surveying and consulting firm based in Naples, Florida.

**Sun Protection Factor 100:** Erect a lightweight, inexpensive garden canopy and move it as needed to protect you from harmful UV when working on your boat in the yard on a sunny day.

**Bag It:** Install removable Blue Performance sheet bags on a bulkhead to reduce cockpit clutter. Made of tough, UV-resistant nylon, these bags come in seven styles, priced from US$39 to US$59, and include mounting hardware.

**Barbie Mount:** When you want to add a LPG (propane) fired barbeque grill but there's no suitable mounting location onboard, mount it to a standard pedestal seat base and securely fasten the base to the deck.

**Hatch Latch:** Mount a "latch" (part number RF6010C, US$5.70) and use with 3/16" or 1/4" (4.7mm or 6mm) shock cord to secure hatches and lockers in the open position.

## TECH TIPS WANTED

Do you have a boat-tested tip or technique? Send us a photo (if available) and a description, your name, boat name and homeport and mail to:

**DIY TECH TIPS**
**In the US:** P.O. Box 1072, Niagara Falls, NY 14304
**In Canada:** P.O. Box 118, Lindsay, ON K9V 4R8
***Or fax us at 705/359-2097, or E-mail to: tech@diy-boat.com.***


If we publish your tip, we'll send you an ABSORBER PVA CLOTH

**Lift and Hold:** Install gas struts on heavy locker and hatch lids and your body will thank you.

**Engine Venting:** To prevent heat damage to equipment installed in the engine room, operate the engine exhaust blower(s) for 45 minutes in summer and 15 minutes in cooler temperatures after engine shutdown. If you'd rather not wait, install a timer switch on the blower circuit to shut off the motor automatically at a preset time.
*Dave Gerr, naval architect and director of Westlawn Institute of Marine Technology (westlawn.edu).*

**Line Stowage:** Stow anchorlines and docklines in a plastic bucket that has plenty of holes drilled in the bottom so it drains and then tie it to a stanchion on deck.
*Hal Roth, "Whisper," Easton, Maryland*

**Brighten Up:** If you're tired of a dark cabin at night when off the grid and you're not happy with the limited selection of 12-volt DC lighting fixtures available, then purchase a 120-volt AC lamp with a screw-in bulb from a lighting shop and replace the bulb with a 12-volt DC one (screw-in base) available at many RV retailers. Cut off the AC plug and replace it with a 12-volt plug or wire it directly into your boat's DC system.
*Paul Drouillard, Windsor, Ontario*

**Bleaching Salts:** Add some trisodium phosphate (TSP) with boat soap in your wash bucket to deter mildew on gelcoat or teak decks.

**Float Scrubber:** The float-type probes that read the level in waste holding tanks often become clogged and cause an unreliable readout. After pumping out the holding tank, toss in two bags of ice cubes per 30-gallon (113.5L) tank then go for a ride to dislodge any jetsam stuck on the float.

It's not too difficult to remove a superficial scuff by wet sanding. This step is followed by buffing and waxing.

# Should you DIY?



Don't try this at home. TIG welding stainless requires the right equipment and years of experience. (Having leather-skinned forearms helps too.)

Nick Bailey

***Be it for love or for money, it's hard work to achieve a truly well maintained boat. Read on to find out the pros and cons of doing it yourself and which jobs are best suited to the average DIY boater.***

By Nick Bailey

Judging from the boats I see in any given harbor, it seems to me there are two kinds of boat owners: them that's interested (in boat maintenance) and them that ain't. Like most stereotypes, a closer look often reveals that things might not be that simple.

The neglected boat may suffer from an owner who would dearly love to do more but can barely find the time to use the boat, let alone maintain it. Many feel guilty about ignoring the boat but, for one reason or another feel even worse about hiring someone to look after things, thinking instead "I'll get around to it one of these days." Sure you will.

At the other end of the maintenance spectrum are two very different boats, both meticulously maintained. One is an older 30' (9.1m) boat owned by a retired couple. They don't have much money but they do have plenty of time available to devote to maintenance. This boat is as perfect as their diligent DIY efforts can make it. The other yacht is only a few years old, 50' (15.2m) in length, and owned by a successful entrepreneur. This individual uses it occasionally but no expense is spared on the boat's needs. To achieve the required exquisite presentation, the yacht is maintained by professional yard staff under the watchful eye of a full-time captain.

These two examples represent opposite paths to achieving the same end. What they have in common is the dedication required to achieve a truly well maintained boat. Somebody has to put in the hours, be it for love or for money. The trick is to balance the time versus money equation in a way that is manageable for your particular situation in life and your particular skill set. For most of us, time is in greater supply than money. It's the ability to do maintenance, repairs and even (if you really know what you're doing) full refits

*Unless you already have experience with major glass repairs don't jump in the deep end and try to replace a section of damaged core.*

*If you don't have the experience you are better off to leave major collision and storm damage repairs to a pro. The results must be "like new" otherwise it's a wasted effort.*

Nick Bailey

*The outdrive is worth more than the motor. Leave it for the factory trained tech with the right tools and know-how.*

more or less yourself that makes boating affordable for the likes of us.

Nonetheless, depending on your skill level, there are many critical jobs that you should leave to the pros.

## DIYer, Know Thyself!

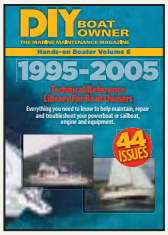
I like to think there are three basic task categories based on the skill level required: category 1, unskilled; category 2, semi-skilled and category 3, skilled. Before you undertake a DIY job, you must know what skill level is required and also have a realistic idea of your own abilities within that category. Unfortunately, judging from the number of botched DIY repairs I see, a little knowledge is a dangerous thing. The optimists among us have a tendency to overestimate our abilities and blithely wade into a difficult repair armed only with the thought, "How hard could it be?" It might be harder than you think. Before undertaking a tough job, be prepared to do thorough research and complete some smaller scale projects to upgrade your skills and hands-on knowledge of the materials before jumping in at the deep end.

## Category 1 Jobs

These are the labor-intensive tasks that are ideal as DIY jobs for the amateur looking for the payback of a high level of job satisfaction for the effort. Some product knowledge is required but the most important element is hard work, patience and the meticulous attention to detail necessary for quality results. In this category, the right attitude is the most important tool for the task. Listed more or less in order of difficulty and risk, this category includes: cleaning and detailing; compounding, waxing, buffing and polishing gelcoat, wood care, bottom cleaning and painting.

Few professional cleaning crews can equal the cleaning and detailing efforts of an obsessive owner but it's important to know enough to avoid costly errors, such as using acetone on Plexiglas or an abrasive cleaner on a high-gloss polyurethane finish. The ongoing debates over which is the best cleaner for this or that task are unending. Find solutions that work best for you but make sure that they work for the application and are friendly to the environment.

The fundamentals of buffing and polishing are straightforward but optimum results may be impossible to achieve on an older boat. The work can become drudgery and most pros are interested in saving time so they use a general purpose single compound that cleans, polishes and waxes all in one step. Materials and methods notwithstanding, the resulting gloss is temporary and the gelcoat gets thinner every time it's compounded. For the DIY boater, I think the annual spring ritual of compounding is more about renewing that devotional




## Additional Reading

In 11 years of publishing DIY Boat Owner magazine, we have covered the hands-on steps for DIYers to undertake most of the work mentioned in this article. For a complete listing of DIY articles go to diy-boat.com and click on "Editorial Index 1995-2005." You'll find past issues all archived on CD-ROM. Refer to page 2 in this issue for the DIY CD library.

bond between boat and owner (and crew) than any mere cosmetic purpose. Turning the job over to a dispassionate, albeit competent, mercenary just doesn't fulfill this yearning for intimacy.

The position of "marine natural materials coatings technician" is ideal for the DIY boater. This gussied-up job description is a euphemism for varnishing or otherwise coating wood. It's not rocket science. For the most part, reading and following the directions on the can is the prerequisite skill for achieving varnished perfection. Be patient, don't be tempted to take shortcuts, do the stripping, prep-sanding and masking with due diligence. Sand between multiple coats and you'll be rewarded with gleaming teak or mahogany. A superior varnished finish is worth the devotion to duty as dictated by the method. Once qualified as a genuine brightwork artist, your opinion will carry weight during any discussion of the relative merits of various varnishes, urethane clear coats, teak oil, etc.

Most boaters consider the application of a fresh antifouling coating to be a DIY job. It's not difficult but does require some product knowledge. Even if you're an old hand at this, it's a good idea to refresh your approach with a visit to the paint manufacturer's website and a thorough review of the instructions on the can with special attention to protecting yourself from exposure to hazardous ingredients in bottom paint that make it so effective on limiting marine growth. If the existing paint is in poor condition and really ought to be removed, the job will require 10 times as much labor as a routine recoat and may only be affordable if you do it yourself. While not technically demanding, this is a dirty job that might leave you with some stiff joints and aching muscles. In addition to the usual painter's tools, make sure you have the protective clothing and the respirator you must use. The times of paper face masks and blue (green, red, etc.) faces as the mark of a real DIYer are long gone in favor of proven safety gear and apparel.

## Category 2 Jobs

These jobs require more knowledge but are still within the capability of the average boater. Some are still labor intensive enough to preclude hiring a pro but the cost of making a mistake starts to become a factor. There are, however, some popular DIY tasks in this category that entail significant safety or financial risk, enough that a DIY boater should think twice before rolling up their sleeves. Included in this category is the rebedding of deck hardware; painting

*Epoxy barrier coatings as well as antifouling paints are not rocket science. They are designed to be applied on a DIY basis. Just follow the instructions to the letter.*

Nick Bailey

*A DIY inclined owner of a boat with wood trim should master the essential art of varnishing.*

gelcoat; minor fiberglass repairs; blister repairs; equipment installations; carpentry; thru-hulls and mechanical work.

Prevention is the best approach to avoiding repairs in this category. To keep moisture from seeping into cored decks, the repair of which is a category unto itself, any fasteners that penetrate the core must be kept well sealed. The removal and rebedding of hardware is not inherently difficult but it sure is time consuming. The man-hours required to remove and rebed all hardware on a typical 40' (12m) sailboat deck are astonishing and if all the core penetrations are to be properly potted, you can double the time. As a preventive maintenance item, most surveyors recommend all hardware be rebedded "periodically" (whatever that means) and DIY recommends at least every 10 years. This is a proactive DIY job that must be done properly to avoid expensive damage to the deck from poorly sealed fittings.

If the gelcoat is just too faded and worn, and you can't afford a costly professional spray paint job, refinishing the boat with a urethane designed for DIY application is an option. Using a paint roller and tipping with a brush won't give you the same spectacular gloss as a good spray paint job but it may be hard to tell the difference from a boat-length away, especially on deck and in the slip-resistant patterned areas. Patient prep and careful masking are required (as always) for good results. Follow the directions scrupulously.

Anyone with a DIY ambition to do major glass repairs has to start somewhere, preferably somewhere in the boat's interior where cosmetics are less of an issue. Replacing a delaminated piece of tabbing or reinforcing a cracked stringer is a good place to start. Do some experimentation first to learn how to handle the resin without starting a fire. Working with fiberglass not only demands a steely mental attitude but also good protective gear and apparel.

Bottom blister repairs are labor intensive but call for only modest skills. Most of the time, it makes sense to hire a subcontractor to peel all the contaminated gelcoat. The remaining prep steps as well as the application of barrier coats and antifouling are exhausting but not too technical. Both West System and Interlux have excellent DIY instructions available for their products.

Everybody loves to tinker. Go ahead and install electronics, do some wiring, plumbing or rigging. This is your chance to have some fun! Just remember a certain minimum of knowledge is required and there are standards (ABYC for one) to meet. Unfortunately, when it comes time to sell your boat or your insurance company requests a survey update, a surveyor is not likely to overlook a messy tangle of wiring, poor plumbing or rigging. Surveyors look at these items closely for good reasons. If a DIY installation isn't up to par, it could lead to a "do over." Speaking of surveyors, it's a good idea to partner with one if you're embarking on a complex task, such as a blister repair, deck repairs, upgrades to electrical and fuel systems, etc. A "do over" in these areas can cost dearly in time, money or, worst of all, cause a personal injury. Careful relamination of a blistered bottom that is not fully dried or cleared of damaged laminate is a waste of all the resources involved in the effort and a "something" repair may be worse than doing nothing.

Small to medium size carpentry jobs are a mainstay of the DIY boater. You can take your time and enjoy the work as a relaxing hobby. Keep your expectations reasonable and you'll bask in your successes.

Servicing a thru-hull or installing a new one while the boat is afloat is not that difficult but you might want to let a pro do it anyway. The consequences of a mistake could be disastrous. If the yard messes it up and the thru-hull leaks, the yard is obliged to cover the cost to haul the boat to get the job done.

I have one customer who loves to do his own engine maintenance and swears it runs perfectly because he never lets a marine mechanic touch it. Along the way, he has picked up the necessary know-how to keep that little diesel humming. Today's engines are designed so that the basic maintenance of oil changes, fuel filter replacement and engine winterizing are within the scope of a knowledgeable amateur.

## Category 3 Jobs

These jobs require special knowledge and/or certification and/or special tools and are for skilled pros or the rare fully qualified amateur shipwright. Typical DIY jobs they are not.

Within high Amp DC wiring lays flames and molten metal. The slightest elevated resistance on a cable connection carrying 500 amps to a big inverter or high draw DC motor can lead to thermal runaway and melt down. Been there, seen that and it ain't pretty.

AC wiring is for genuine marine electricians only. Mistakes here are also punished by fire, serious injury or death. When hiring a pro, don't ever let a household electrician work on your boat. He has likely never heard of ABYC, he won't know you can't use wire nuts for connections and may never have heard of multi-strand tinned wire. This is the age of specialization in marine systems.

Pat Kearns

*Without the proper tools and mechanical skills the chance of failure dramatically increases and can result in a more costly repair.*

Major structural glass repairs from a severe collision or storm damage are best left to the experts, the best you can find. Penny pinching here is a false economy. If not done right, the repair and the boat are worthless.

Major mechanical jobs, such as sterndrive work, engine rebuilds and repowers are the master mechanic stuff, not jobs for apprentices or the "wannabe." Yards send their best mechanics to factory authorized service schools for certification training and invest thousands in the specialized tools that are absolutely necessary to carry out many of these jobs successfully.

Major installations, such as bow thrusters, require a "combined arms assault" on the problem. Many different skilled marine trades are involved in a project like this, ranging from glass work to electrical to metal fabrication to fine carpentry to mechanical and hydraulic specialists. There may be some DIY aspects that some yards will permit you to accomplish yourself but don't presume to meddle with an installation in progress without making sure (in writing) that both you and the yard know who's doing what.

When it comes to spray paint refinishing, some yards may let you help with some aspects of the prep (especially hardware removal and reinstallation) but, when it's time to apply the topcoat, step aside and let a master of the trade work his magic.

There are definitely opportunities for skilled DIYers but be aware of your limitations. To get good results and protect the boat's value, your own workmanship must be of sufficient quality. The trick is to know when to involve professional help and when to DIY.

About the author: Nick Bailey is DIY Magazine's repair specialist and has spent 26 years in the boat repair business.

# Beyond Volts

***A simple test of your engine's charging system means dead starting batteries could be a thing of the past.***

By Lee Mairs

My Passport 40 sailboat was originally equipped with a Pathfinder diesel engine, a marinized version of the early (and short-lived) VW automotive diesel engine. The engine has four glow plugs, each drawing about eight amperes during the starting cycle, that activate a pre-heating function for a minimum of 30 seconds before an attempt to start the engine. If the battery was down to begin with, starting was a dicey operation and my first few sailing seasons were filled with anxiety about whether the engine would start.

You don't need sophisticated tools to verify that your engine's charging system is working correctly. A digital voltmeter (DVM) does the trick. [Ed: Refer to DIY 2000-#1 issue for a discussion on the selection and usage of multimeters.] Look for a DVM that reads up to 20 amperes of direct current. A beeping alarm for continuity is also quite helpful.

The reason you need a digital voltmeter, instead of an analog meter, is that the first step in troubleshooting the engine's charging system is to ascertain what percentage of charge is in the batteries. The difference between fully charged and 50% charged is only 0.6 volts. You cannot discern the difference in voltage reading to the necessary one decimal place with an analog meter.

Disconnect the battery charger, if running, and wait at least one hour. Turn off anything else that draws current from the battery. The idea is to insure that the chemical reactions of either charging or discharging have a chance to come to equilibrium within the batteries.

Place the DVM positive lead on the positive terminal of the starting battery. Hold the DVM negative test lead to the battery's negative terminal. Note the voltage read.

Peukert's equation is a formula that shows how the available capacity of a lead-acid battery changes according to the rate of discharge. The equation captures the fact that at higher currents, there is less available energy in the battery. Short of a long physics lecture, the remaining charge versus voltage can be roughly approximated from the table in **Table 1**. If the voltage is 12.2 volts or less, then I sure wouldn't advise heading out for a weekend at that remote anchorage. Suppose the DVM reads 12.6 volts. This gives us a provisional okay, unless the battery charger had been connected for a week immediately prior to taking the reading.

## Load Testing

With the DVM leads on the corresponding positive and negative battery terminals, have a helper start the engine while you read the DVM. Marine starter motors draw about 75 to 200 amperes, depending on the model and vintage. While the engine is cranking, the battery voltage drops to between 10 and 11 volts as a result of the heavy starter motor load. Keep the meter attached even when the engine starts. As soon as the DVM reads above the resting voltage you observed before starting the engine, you know the engine's alternator charging system has kicked in and it's replenishing power lost from the starter motor draw down in the battery. I like to see about 14.1 to 14.4 volts for a lead-acid battery, when the engine is running. Don't be discouraged if the voltage doesn't kick up immediately. Some systems don't let the alternator begin charging for up to a minute after the engine starts. This neat feature helps the starter motor by letting it work easier since it's turning the engine over without the added alternator load.

What have we done here? First, we measured the resting voltage of the battery. We found that the battery was in adequate condition. Next, we noted that, as the electrical starter motor began turning the engine, the battery voltage dropped below the resting voltage as a result of the heavy load. Provided the battery voltage doesn't drop much below 10 volts while starting, the battery passes. Now, the engine is started and the alternator has begun generating the charging current so battery voltage rises above its original resting value. Lead-acid batteries should not have a charging voltage in excess of 14.4 volts; gel cells should not exceed 14.1 volts.

If the battery voltage only returns to the resting voltage (12.6 volts in our example above) with the engine running, then you know that the charging system is not performing properly. You may be able to start the boat and get to that isolated anchorage this weekend but the chances of getting back on Sunday afternoon aren't quite as good as I would like. There is a problem with either the alternator or the voltage regulator, if one is installed. Now, this doesn't mean you have to immediately rush off and purchase a new alternator.

Experience taught me that most electrical problems can be traced to a bad connection. Some engine manufacturers bury a small fuse for the alternator circuit in the middle of a cable bundle. You won't be able to find it until you make a wiring diagram of your boat's electrical system. Since you're sure not heading to that anchorage this weekend, this might be a good time to start on that diagram.

**Table 1**

| Battery Voltage | % Charge |
|---|---|
| 12.8 VDC | 100% |
| 12.5 VDC | 75% |
| 12.2 VDC | 50% |
| 11.8 VDC | Dead |

*Note: Readings are approximate only for a resting battery, one that has been neither charged nor discharged for at least one hour, preferably more. This gives time for the chemical action within the battery to stabilize.*

About the author: Lee Mairs is a graduate engineer and a retired Navy commander. Lee holds a USCG 100-ton ocean operator's license for both sail and power.

The scorching is a symptom. Replacing the cable end fitting and/or the outlet is not the solution. There's a bigger issue here.

# AC System Troubleshooting

***Fault finding in an AC electrical system is not so different from troubleshooting a DC electrical system but it does require extraordinary and diligent attention to personal safety.***

By John Payne

AC electrical current is potentially lethal and you must take every precaution to ensure that onboard systems are properly and safely installed and maintained. There are some basic tests you can do to troubleshoot AC power systems without calling in a specialist. However, if any of these exercises give you the jitters, consult a qualified marine electrician. While a licensed electrician should be generally well versed in electrical systems of all kinds, marine electricians are specialists, especially those who hold ABYC certification. Unintentional contact with live circuits can seriously injure or kill you so, before troubleshooting your boat's AC electrical system, there are some fundamental safety rules you must adopt to ensure your safety.

Never work on AC equipment, connections, wires or the service panel when the system is energized, i.e., "live." All power sources must be disconnected before touching any part of any circuit. Isolate and lockout circuits and equipment before opening them up. Before even opening the AC electrical panel always remove the shorepower supply plug from the boat's inlet fitting, make sure the generator is shut down and locked out and disconnect an inverter, if one is installed.

## Voltage Connection

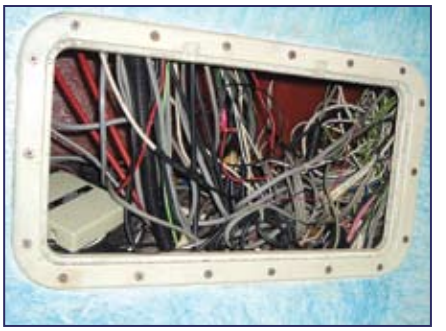
The nominal AC electrical system voltage configurations in common use in North America are 120/240 (single phase and Delta three phase) and 120/208 (Wye three phase). Though lower voltages reduce electric shock hazards to life and limb, special caution is still required. Though the standards that apply to marine electrical systems are the bare minimums, compliance with them saves lives and you should, at all times, follow the recommendations contained within the U.S. National Electrical Code (NEC) and the American Boat & Yacht Council's (ABYC) group of "E" standards.

In 120-volt systems, the shorepower is normally supplied through a 30-amp circuit. This electrical configuration provides for three wires; the black wire is "hot" or energized; the white wire is the neutral conductor and the green wire is the ground conductor. In a 120/240-volt system, there are some differences: namely, the red wires are "hot" but the ground

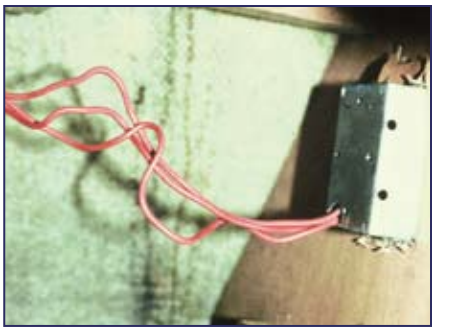
## Safety with AC Power

- Before working on AC circuits onboard, disconnect the AC power from its source. Take your time and observe correct polarity. Have a reverse polarity indicator on board, either integrated into your AC panel or in a hand-held model. Check for correct polarity every time you plug into shorepower. Dockside AC with reverse polarity (the hot and neutral wires are crossed) can damage onboard AC equipment and be a definite safety hazard if the neutral and ground wires onboard ever become shorted, carrying hot AC current through the ground wiring.
- Use GFCI receptacles on each circuit. A GFCI at the head of a branch circuit can protect outlets downline in the same circuit.
- Install an indicator light that clearly shows that live AC power is present onboard.
- Make sure your boat is wired by a competent marine electrician and adheres to ABYC recommendations.

*This is an electrical stew recipe from a shade tree electrician: a little AC; a little DC; some electronic cables; and a fuel hose.*



*Troubleshooting this wiring spaghetti is an electrical nightmare. This is a candidate for a "do over."*



*All red wires in an AC outlet? You could die laughing if you fiddle with this while it's energized.*

and neutral wires remain the same as in the 120-volt arrangement. To add to the confusion, many other countries use IEC standard color codes and, in 240-volt systems, a brown wire is the "hot" conductor, a blue wire is the neutral and the grounding conductor is a green/yellow stripe wire.

## About Circuit Protection

An understanding of the basics of circuit protection is essential successful troubleshooting. Most boat AC installations have a circuit breaker on the marina distribution pedestal along with a ground fault circuit interrupter (GFCI) to detect and isolate ground leakage conditions. The GFCI is an important safety feature. If your dock power pedestal is not so equipped, it should be. The main circuit protective device is the circuit breaker. You should also have an AC main circuit breaker at your control panel with individual circuits also protected by circuit breakers.

There is a lot more to selecting and installing circuit breakers than meets the eye. The interrupting capacity of the circuit breaker must be able to break any prospective fault current levels. The important thing to understand is the breaker is there to protect the circuit wiring and not the connected equipment.

The main purpose of the protection system is to prevent currents from rising to a value above that of the wire rating. Overcurrent protection devices, i.e., fuses and circuit breakers, also protect the wires and connected equipment from the potentially destructive and excessive currents that happen under short circuit conditions.

## AC System Commissioning

Most AC faults begin with improper installation and testing and the latter is also the foundation of troubleshooting. The following is the accepted practice for all shore installations (including your home). Step one is to check the ground resistance and continuity. The maximum resistance should be no more than 2 ohms between the main ground and between any other grounded points. Next, check the insulation resistance of an AC circuit using a 500-volt, DC-insulation tester (also known as a megger). Before doing this, always disconnect all the connected electronics and appliances and switch off all power sources. Turn on all switches so that all parts of the circuit are interconnected. The insulation resistance measured between the ground and all live conductors must have a minimum insulation resistance of 1 megohm (1 million ohms). Consider hiring a professional electrician with a meter to do these checks.

One check you can safely do yourself is to perform a polarity check using a standard polarity tester. All of the switches, the circuit breakers and the equipment terminals must all be at the same polarity. You cannot have any crossed neutral and active conductors. Also, check for conductor short circuits. Use your ohmmeter and check between active and neutral conductors to ensure that only load resistances are present. With all switches set to the on position, check that there are no short circuits that are often caused by cable damage or possibly incorrect equipment connection.

## Troubleshooting Ground Leakage Protection

A much more reliable and acceptable way to protect circuits and people, both on shore and on the boat, is to install ground leakage protection devices. Many marinas now have these installed on each circuit. Ground leakages are relatively common and nuisance tripping does happen at marinas (they do at mine), usually when someone plugs in an extension cord and power tool. If a GFCI trips and then trips immediately again when switched back on, then you should investigate and troubleshoot a more serious fault condition. The main and common causes of nuisance tripping are as follows: a connection between the neutral and ground downstream of an GFCI; crossed neutral between protected and unprotected circuits, often caused by extension leads with incorrectly wired plugs and sockets; damage to the cable insulation, a popular fault with old extension leads; water and moisture in a junction or terminal box or plug and socket (very common); cumulative leakages from several sources with many small leakage paths; absorption of moisture into heating elements; some tracking across dirty and moist surfaces to ground commonly caused by condensation and salt, particularly in a shorepower receptacle, where water ingress causes tracking. Never ignore any of these.

## AC Jargon

**What is a short circuit?**
A short circuit occurs when two points of different electrical potential (positive to negative) are connected. In this condition, extremely large currents can flow, causing heat that can lead to fire. While a short circuit can be created intentionally, it's the unintentional one that causes the big problems.

**What is an overload?**
An circuit or current overload occurs when the circuit current carrying capacity is exceeded due to the connection of an excessive load. This conditions arises when too many electrical devices are attempting to operate on a circuit or a condition such as a stalled cranking motor or other electrical motor that creates excess load on a circuit. Current overload should cause an overcurrent protection device, such as a fuse or a circuit breaker to "trip" and interrupt the current flow until the overload condition can be corrected.
— *JP*

## Circuit Troubleshooting

Most AC faults manifest themselves at the main switch panel. A circuit breaker "trip" is often the first clue to where to start your troubleshooting. The main criteria in any troubleshooting exercise is whether you have voltage or not and what current demands are being made. It's important to know that around 95% of all problems in AC power systems are due to failing or failed connections. When a connection becomes loose, it develops a high resistance. This is aggravated under load as current flow increases and the connection may simply melt or generate enough heat to cause a fire. The connection failure points include the source at the switch panel or, more commonly, within junction boxes or termination boxes at the connected equipment.

*You get a small tingle or shock when you touch the case of any connected equipment.* Any fault that occurs on an ungrounded or inadequately grounded equipment may lead to any exposed metal, e.g., the case or equipment cover, to be "live" up to rated voltage. Any person who contacts this equipment, even intentionally, may suffer a electrical shock, resulting in serious injury or even death. The purpose of safety grounding is to provide a low resistance path to carry any fault current and, during fault conditions, extremely high currents often flow. In normal practice, this high current ruptures fuses or trips circuit breakers.

The source of a shock or even a tingle needs immediate investigation. Immediately, turn off and disconnect all power and check the main grounding point first. Then, check the ground connections in the power outlets that supply the affected equipment. If you have a galvanic isolator, it should be checked. Always check your shorepower lead plugs and sockets and replace if they show signs of charring and burning. Remember that these conditions are symptoms of a problem. Just replacing the cable end fittings will not fix that problem.

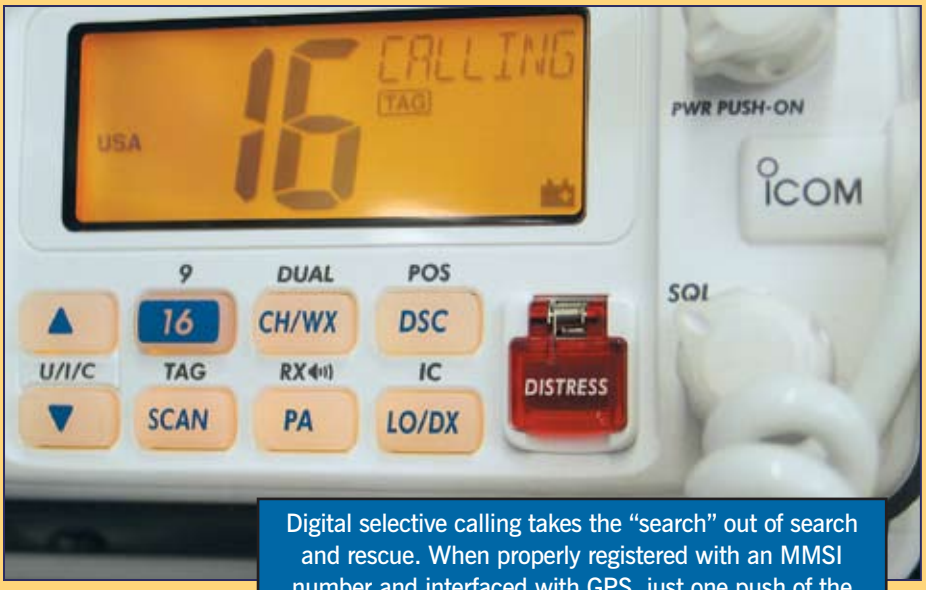
*The circuit breaker trips immediately after being activated.* If you have a panel ammeter, it generally shows an off-the-meter full-scale deflection. This indicates a high fault current condition. Check if it's a load short circuit. To diagnose this fault, you need to find out whether it's within the load on the circuit or the circuit supply wire. Disconnect the load and recheck again. In most cases, it's the connected load, such as a light fitting, an appliance or a motor. If the fault is localized to the circuit cable, then the most common cause is a cable connection, in particular a junction box. Cable failures are relatively uncommon but, when they do happen, it's often due to chafe of the cable where it runs through a bulkhead transit point.

*The circuit breaker trips off several seconds after activation.* The panel ammeter will show a slower increase in the current to a high value before tripping the breaker. This is typical of an overload condition. Check that any connected motors or pumps are not seized or whether the bearings themselves have seized. In some cases, a damp terminal box can lead to a slow and gradual breakdown in the insulation between terminals and a slow increase in fault current.

*There is no power after the circuit breaker is closed.* The first thing is to verify that you have power at the switch panel. If you have power, check that the circuit connection has not loosened, come off or burned the back of the circuit breaker. On many switch panels, the buss bar is soldered to one side of all distribution circuit breakers, so check solder joints. In many panels, the circuit breakers have a buss bar strip connected between them. Check that the breaker screw terminals are tight. It's also good to operate the circuit breaker several times. Some times the breaker mechanism makes poor electrical contact and several on/off operations often solve the problem. If all your tests show that the positive electrical supply is present, check that the negative wire is secure in the negative connection block.

Whenever you troubleshoot an AC system, always consider your safety as the highest priority. Once you have checked for voltage on a live system, remove the power and isolate before you continue troubleshooting. All electrical systems require a logical approach to isolating faults. The most common faults are always the most simple and often easily identifiable.

About the author: John Payne, DIY's electrical consultant, is author of "The Marine Electrical and Electronics Bible" and "Motorboat Electrical and Electronics Manual," (Sheridan House).




Digital selective calling takes the "search" out of search and rescue. When properly registered with an MMSI number and interfaced with GPS, just one push of the red button automatically transmits the boat's identity and position to a shore-based rescue coordination center.

# MARINE 911

**Just as GPS and electronic charting have simplified navigation for many boaters, so does GMDSS significantly improve your safety at sea.**

By John Payne

The technologically advanced global maritime distress and safety system (GMDSS) was fully implemented in 1999 for all commercial shipping. This new system has a significant impact on recreational boaters. Previously, safety communications systems were based on voice systems that included both VHF and HF radio. Distress calls were generally though voice signals, with those familiar "mayday" transmissions and, for those who had invested in an EPIRB, a satellite signal distress alert that improved one's chances of rescue at sea. While you could hope that your voice distress signals would be heard by one of the thousands of merchant, naval and fishing boats underway, it might not and tales of people repeating mayday messages over the radio as the water rose above their knees were the tragic consequences.

Satellite-based systems have brought tremendous advances in the success of at sea rescue efforts. For decades boaters relied on Morse code and a VHF radio, which were the primary "mayday" resources in the merchant ships I served on in the mid-70s. These technologies are now virtually extinct and mariners rely on radios with digital selective calling (DSC) and Inmarsat C for distress messaging along with satellite EPIRBs, Inmarsat C and NAVTEX transmit weather and navigation information. GMDSS is a multi-layered system that ensures maximum coverage. The discussion of EPIRBs, Inmarsat and NAVTEX is separate from this article but each is a part of the GMDSS system.

## Safety Net

The principal function of GMDSS is to coordinate and facilitate search and rescue (SAR) operations. This applies to both shore-based rescue groups and other boats. The system is also designed to react to distress calls with minimal delay and locate those in distress with maximum accuracy. The system also provides marine safety communications and maritime safety information (MSI). This includes navigational and meteorological warnings, weather forecasts and other urgent safety information.

The adoption and installation of GMDSS is not compulsory for pleasure boats but, due to its global implementation on commercial vessels, most boaters will want to install partially GMDSS compliant equipment simply to remain "plugged in" to the system and DSC radio is the entry point for most small boat owners and, arguably, is the most important safety device onboard.

GMDSS certainly maximizes SAR situations for boats so, in most cases it will enhance offshore safety, and these changes are good for the recreational boater. GMDSS equipment accurately identifies your own boat (all the physical details) and your current position (exactly where you are) and this information is broadcast automatically. Push one button and you automatically activate alarms at coast stations and on other boats.

## Why DSC?

VHF Channel 70 is the nominated DSC channel and a VHF marine radio with digital selective calling is a primary component of GMDSS. It improves the accuracy, transmission and reception of distress calls.

Digital signals in radio communications are at least 25% more efficient and significantly faster than voice transmissions. Consider the time it takes to say "mayday" and give all the position information versus the moment in which the one button pushed takes effect. A DSC VHF transmission typically takes a second and MF/HF takes approximately 7

seconds, and both depend on the call type you are making.

A DSC radio requires the use of an encoder and decoder. A dedicated DSC watch receiver continuously monitors the specified DSC distress frequency. This means that your DSC radio is always listening ready to decode and always ready to encode and send your distress alert. Affordable VHF DSC radios are available from Horizon, Icom, Raymarine, Simrad and several others.

## Identity Alert

DSC radios enable the transmission of digital information that is based on four priority groupings: distress, urgency, safety and routine. This information can be selectively addressed to either all stations or to a specific station or to a specific group of stations.

Every owner of a DSC radio must register the radio and obtain an ID number called a Maritime Mobile Selective Call Identity code or MMSI. The radio's owner, a vessel description and emergency contacts are all collected as part of the registration and forwarded to a SAR database kept by the Coast Guard. In the U.S., the numbers are issued by the Federal Communications Commission (FCC) and in Canada, by Industry Canada. Once issued, the boat owner programs this unique, nine-digit number into their radio.

MMSIs are managed by each nation for its own registered boats and the first three digits are a country code. For those cruising internationally or who otherwise require an FCC license, it will include an MMSI if the applicant requests one. For boaters who do not need a license, BoatU.S. and Sea Tow have been authorized by the FCC to assign MMSI numbers to boats with DSC capable radios. To get a free MMSI number from BoatU.S., go to BoatUS.com/mmsi. There is also a list of frequently asked questions at this site as well as a free radio tutorial, "Can You Hear Me?" that anyone can take online to become more familiar with DSC radios. Canadians who need an MMSI may register with Industry Canada, also free, at http://sd.ic.gc.ca.

A DSC distress alert message is configured to contain the transmitting boat's MMSI, the exact time, the nature of the distress and the boat's position, all of which comes from your interfaced GPS unit. One common problem is that owners don't properly interface the GPS with the DSC radio and, without a position, no one will know where you are. Similarly, many don't program in the MMSI code, so when you are in distress, the rescuers don't know anything about you and the alert may get overlooked. The same applies to proper registration of an EPIRB.

## Distress Chain

So, what happens in the various GMDSS distress call situations? A distress alert is activated from a DSC VHF or MF/HF radio, a 243/406 MHz EPIRB or Inmarsat B and C terminals from a boat to shore. Other boats within the area may hear your alert, however, it's important to understand that the shore-based rescue coordination center (RCC) is responsible for responding to and acknowledging receipt of your alert and not other vessels.

When the RCC receives and acknowledges an alert, the RCC then relays this alert to other boats in your geographical area. This properly targets the local resources available and does not involve boats that are outside the distressed boat's area. Alerts are received on a DSC VHF or MF/HF radio, Inmarsat terminals or a NAVTEX unit MSI message. When a boat receives the distress relay message, it should contact the RCC to offer assistance.

When the SAR phase of the rescue commences, the previous one-way communications channel changes to a two-way channel for efficient coordination of both aircraft and other rescue vessels. Local communications between various SAR elements use short-range, terrestrial MF or VHF on the various specified frequencies. Large ships have a SAR transponder and/or a 121.5 MHz homing frequency of an EPIRB that allows the precise location of the boat in distress.

## Coverage Limitations

The GMDSS system categorizes requirements for equipment and services into four specific sea areas, though only two relate to most pleasure craft. This effectively defines a boat's specific communications' system requirements.

**Area A1.** This is for boats that are sailing within shore-based VHF radio range. Typically, that distance is in the range of 20 to 60 nautical miles (nm). You require a DSC VHF radio operating on channel 70 and of course, channel 16. You should also have a 406 MHz EPIRB. I also have a handheld VHF radio in my abandon boat kit. In general, this category fits most boats that enjoy coastal waters.

**Area A2.** This area is for boats within shore-based MF radio range and that distance is around 100 to 300 nm. The same VHF requirements as Area A1 are applicable, as are survival craft requirements. I have a Navtex, as it's useful (and permitted) in both A1 and A2 areas and there are several good yacht and small boat units available.

For now, Channel 16 remains the primary distress channel in the U.S. as the Coast Guard is not officially monitoring Channel 70 in all regions. Rescue 21 is the $730 million upgrade of all Coast Guard coastal communication equipment that will utilize DSC technology. It's being installed, by region, through 2011. For a map of the current installation schedule, go to www.uscg.mil/rescue21/about/impsched.htm.

If you go cruise any distance, a DSC radio is a valuable investment in your safety at sea. It's not complicated and it's easy to operate.

About the author: John Payne is DIY's electrical consultant.

# Crack Repairs: A Different Approach

***An unconventional repair method that combines epoxy and polyester resins to repair fiberglass boats uses a specialized technique employed by professional aircraft repairers.***

Identical damage locations on both sides of the hull, caused by flexing of the laminates against oversized screws protruding from interior structures.

By Wilson J. Boynton

When that shiny, smooth gelcoated surface of a boat's hull propagates spider cracks, the problem is often presumed to be cosmetic but those hairline cracks that radiate out from a central point are usually the result of localized internal pressures or they are the emerging evidence of the hull's struggle to get out of the mold. Crack repair is a demanding task but one that can be performed by the determined DIYer without too much difficulty.

A friend called our shop one day and asked if I could help him determine the cause of some nasty spider cracking in the hull of a customer's 36' (11m) Carver motor yacht. The boat owner was a bit baffled by the very sudden appearance of six areas of gelcoat spider cracking on the port and starboard sides of the bow.

This yacht was in otherwise immaculate condition. There was no external sign of impact damage and the owner stated that he "never bounced his baby off anything!" We were curious if this was just his ego talking but we were even more curious as to why nearly identical sized spider cracks appeared in the same location on both sides of the hull and extended roughly 12" (30cm) out from the center. A few more questions brought forth the cause and effect.

## Cause and Effect

During a recent cruise on the lake, a storm front suddenly approached and everyone agreed it would be best weathered at the dock. With the rising winds, the waves had become significant and the owner decided to charge, all ahead full, crashing through the waves, for home port.

The hydrodynamic pressure of the water against the hull at high speed caused an abnormal amount of flexing in the fiberglass laminate hull structure. Unknown to the owner or anyone else, except the carpenter who built the interior of the master stateroom, some very long stainless steel screws were installed to secure interior joinery. Once we gained access, we observed that there was less than 1/16" (1.5mm) between some of these screw tips and the inner laminate surface of the hull. The impact of the hull flexing against the screw tips caused several areas of point-load against the inner side of the fiberglass laminate. Point-loads are not endured very well by laminated glass-resin structures and, as the screws repeatedly hit the inner hull surface, the gelcoat responded by developing numerous cracks all around the center of the impact site. The ugly appearance of spider cracks radiated from the impact "point."

Wilson Boynton

*A die grinder with a 50-grit, 3" (76mm) disc provides the best accuracy and control over speed when removing damaged gelcoat.*

Unlike the resin and fiberglass-reinforced material making up the hull structure, the outer layer of gelcoat has no form of reinforcing fiber within it. The gelcoat is flexible to some degree but, as it lacks reinforcement, it will crack before the underlying structure cracks or fails.

Not all gelcoat cracks are caused by the scenario described above. (See "Crack Anatomy" on next page.) Repairing small, localized cracks typically requires the complete removal of the gelcoat and repair of the laminate beneath or, for long and/or deep cracks, the removal of gelcoat along the entire length of the crack and beyond. In each case, new material replaces a portion of the existing laminate, new gelcoat is tinted to match the existing finish and then the repair is buffed and polished to a like new luster.

Remember, if the cracked gelcoat resulted from a failure of the structure due to flexing, caused by inadequate laminate panel stiffness or impact, a simple cosmetic repair to the gelcoat surface is not going to solve your problem. The structure must be repaired, stiffened, if necessary, by the addition of glass and reinforcing materials to the inner hull. If the laminate or core material are wet, they must be dried out completely before the gelcoat repair work begins.

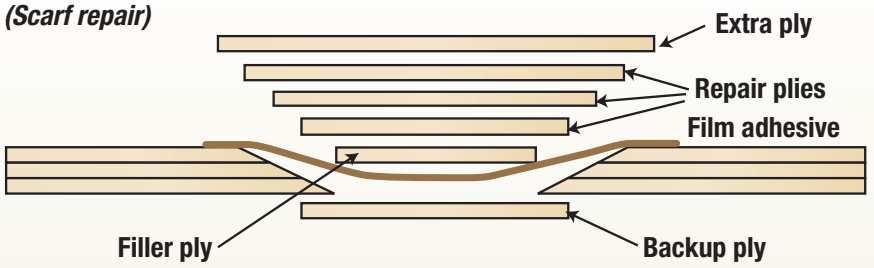
## Surface Prep

We used the following procedures to repair the spider cracks on this boat. Checking for moisture and the possibility that water had been adsorbed into the fiberglass laminate or core was our first task. We accomplished this easily using a GRP33 moisture meter, a pinless (non-destructive) meter that detects moisture levels in a fiberglass laminate by using a radio frequency sensor on it's surface and giving a reading on an analog scale. A practical, inexpensive tool for any DIYer, this meter is used by marine surveyors to help locate areas of concern on hulls and decks and other structural parts of a boat.

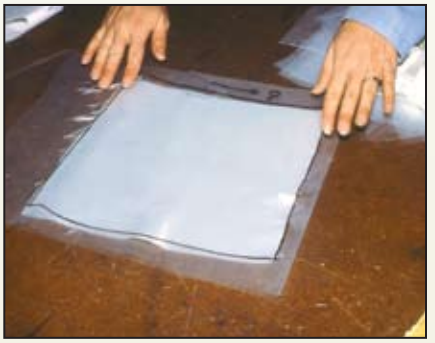
Removal of the cracked and damaged gelcoat began with a heavy abrasive 50-grit disc on a 3" (76mm) die grinder, removing all gelcoat within a 16" (406mm) diameter around the center of the cracks. There was no puncture of the hull but the resin-rich surface of the laminate, which was cracked along with the gelcoat, was also removed.

**Taper Sanded Repair**
***(Scarf repair)***

Wilson Boynton/Joe VanVeenan



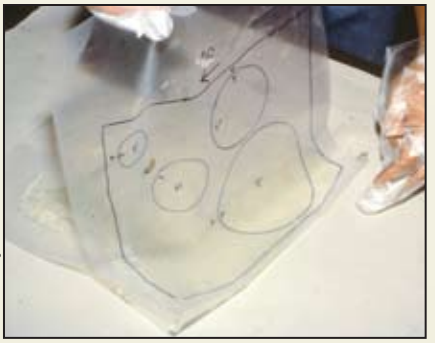

*Stacking sequence of repair plies. A thin layer of resin and cabosil is added to fill in any surface voids and assist with strong adhesion.*



*Placing the plain weave fabric between sheets of poly plastic allows easy resin wet out of fabric and keeps work area, tools and hands clean.*

*Patches are cut and protected from contamination by the poly plastic sheet. Don't forget to remove the plastic when applying the patches to the hull.*

Wilson Boynton



*Patch diameters are drawn on the plastic. Arrows indicate the direction the patch is to be installed on the hull in reference to the zero-axis ( keel direction ) of the hull. The "T" marks indicate the warp and fill fiber directions of the fabric.*

*Look closely and you can distinctly see the eight layers of fabric. Peel ply produces an even surface though with a rough finish that replicates the weave pattern of the cloth and that is free of amine blush to ensure good adhesion between the epoxy resin and polyester gelcoat.*

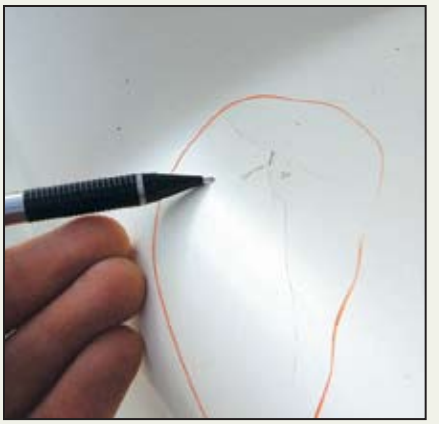
The laminate panels in the areas of the cracks required stiffening reinforcement to ensure the hull would not flex, crack or delaminate in these areas again and also to rebuild the profile (thickness) of the laminate that had been ground away. The die grinder cut a straight scarf of the resin layer, the deepest cut being in the center and tapering out evenly to the edge of the circle.

Layers of 6oz, plain weave glass fiber were stacked in an upside-down or reverse-pyramid fashion, starting with a 2" (50mm) diameter circle and each layer growing by 1" (25mm) in diameter from the one below. The glass layers were stacked with the warp and fill fiber yarns alternating in a 0°/90° and +/-45° pattern, relative to the keel of the boat, to create a quasi-isotropic laminate. The distribution of the fibers

## Crack Anatomy

By Nick Bailey

*The classic star crack often exists in the middle of a flat panel completely isolated from any obvious stress. Sometimes these are caused by problems releasing the part from the original mold and take years to become visible.*



*A random crack with no obvious source of stress may indicate an underlying laminate problem, such as a void or air bubble.*

*The crack network around this cabin top handrail screams "wet core" to any surveyor. If frost heave is not the main contributor, then excessive flex due to reduced panel stiffness could be causing these cracks.*

*The hard corner of this engine bearer concentrates stress from engine related flex and vibration. The cracks look bad but in fact are strictly cosmetic. Grinding proved there was very little wrong with the underlying laminate. The gelcoat layer has no fiber reinforcing of its own and contributes zero strength to the laminate. In this case the gelcoat was a bit too thick and certainly too brittle to endure the ride.*

*The core in this cockpit seat is completely rotten and the whole panel is flexing excessively. This leads to "hinging" (the ultimate stress riser) at the 90° outer edge and the laminate has cracked all the way through. Note the dreaded brown ooze emerging like some unspeakable corruption from an H.P. Lovecraft story.*

*The classic stress crack, like the cracks at this stanchion base, typically radiates from the point of load. The high intermittent stresses transmitted to the deck by the 24" (61cm) lever arm of the stanchion may eventually lead to laminate damage. A gelcoat repair may only be a temporary fix. It's best to deal with the disease, not just the symptom, and install a reinforcing plate underneath to spread the load.*

in this fashion allows the patch to bear loads and flex evenly in all directions, which reduces the chance of further cracks developing again in this area.

After applying the glass and epoxy, a sheet of peel ply, a removable woven nylon fabric, was smoothed onto the surface and the epoxy allowed to cure fully before applying the gelcoat. When placed on the surface of a laminate, peel ply provides a chemically clean surface for bonding when removed. It leaves an even textured surface on the fiberglass that requires no further sanding and promotes a strong bond with the filling and fairing compound, prior to the spray application of gelcoat.

Filling and fairing of depressions and the uneven surface of the repair areas was accomplished by spreading a uniform coat of AdTech Ultra Fair 860 epoxy filler. Once cured this compound produces a strong, resilient and blush-free surface that is easy to sand to a featheredge and bonds well to the gelcoat without an intermediate bonding coat for adhesion.

The entire hull was given a thorough washing to remove the typical build-up of surface contaminates. The area surrounding the repairs was masked off using thick poly plastic to prevent overspray of the new gelcoat. This area

was given a very light buffing using AquaBuff 2000 paste compound to remove the thin layer of oxidization on the existing gelcoat and gave us a true surface to work with in attempting a color match.

## Gelcoat Mixing

Gelcoat selection and color matching was the next step in the repair process. Being able to obtain a batch of the boat manufacturer's original color gelcoat for this boat's exact make and model from a local dealer was a bonus for us as it relieved a great deal of the time and effort and the potential for disappointment in tinting a batch from scratch. This gelcoat was premixed with air-dry additives and promoters and created a near-perfect match for the existing gelcoat on the hull. As with all gelcoat finishes, the sun's UV rays, weather and time had dulled and slightly yellowed the original gelcoat color. Adding a pinch of RayPlex #202 medium yellow polyester pigment equalized the intensity and value (brightness) of the supplied gelcoat.

Remember, color matching is more art than science and requires a lot of patience and practice to become proficient. Polyester pigments should be used in very small amounts; just one drop can have a dramatic effect in altering the gelcoat color.

## Final Finishing

We were now ready to spray the repaired areas and feathering the new gelcoat over the existing hull was next. Gelcoat initially applied by the boatbuilder varies between 0.020" and 0.25" ( .07mm to 6mm) in thickness. Attempting to spray this much material all at once in a small repair area can easily lead to running and sagging. Therefore we applied the gelcoat in several thin layers to build up the thickness and then over-sprayed the repair areas once the proper thickness was achieved.

The use of a high volume, low pressure (HVLP) spray gun gave us a smooth and sag-free application. Once the new gelcoat had hardened, we wet sanded the area first with 600 grit, then 800 grit, followed by a buffing with rubbing compound (in this case, we used AquaBuff 2000) to remove any evidence of a spray edge or line. Using a power buffer with a 3M Perfect-It foam polishing pad is the preferred method. The foam pad resists the build-up of dried polishing compounds on it's surface, doesn't cause streaks from knotted fibers as a wool pad can nor does it build up

**TIP**

### Color Kit

The best gelcoat color matching kit we have used is sold by Rayplex, product 01800 ( www.fibreglass.com). It comes complete with an excellent instruction manual on how to blend just the right amount of different pigments to obtain a perfect match to your existing gelcoat surface.
*— WB*

## ADDITIONAL READING

**DIY 2002-#1** Steps to a Shiny Hull
**DIY 2002-#2** Selecting and Using a Moisture Meter
**DIY 2006-#1** Meter, Meter on the Hull, Who's the Driest of Them All


"Fiberglass Boat Repair" MRT CD-ROM shows you how to professionally survey and repair cosmetic and structural damage in fiberglass hulls, decks, transoms and cabin interiors. Includes the step-by-step rebuilding of delaminated hulls and decks, rudders and stringers, replacing wet foam flotation, the installation of thru-hulls and hardware in cored decks, moisture meter usage, crack repairs, filling and fairing and more!

heat as rapidly as polyfiber pads. Foam pads are far more expensive but well worth the cost in terms of the quality and ease of use.

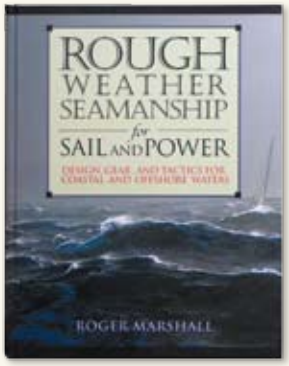
Taping and masking off areas of the boat where there is any possibility of gelcoat overspray landing is very important. Though HVLP spray guns atomize gelcoat much less than a standard air-assisted gun does, if you do not want to be removing gelcoat overspray from railings or cabin windows, take the time to cover them in poly plastic or painter's masking paper (e.g. 3M Ready Mask) before you start the job.

Health and safety is priority one when using polyester gelcoat, epoxy resins and many fiberglass cleaners used during any repair or restoration application. Use common sense with these chemicals and always ensure you are protected by working in a well lighted and well ventilated area. Wear protective clothing, eyewear, gloves and dust masks when sanding, an organic vapor respirator when mixing and applying resins and ear protection when grinding and buffing.

Since we were working with such a large surface area of the hull, once the gelcoat had been applied to the repaired areas and then faired and sanded, a complete compounding and buffing, followed by rewaxing the hull, was accomplished to give it a high gloss.

With careful planning and preparation, getting advice on selecting the right tools and materials for the job, excellent results in removing the long legs of the spider can be accomplished by a committed DIY repairer.

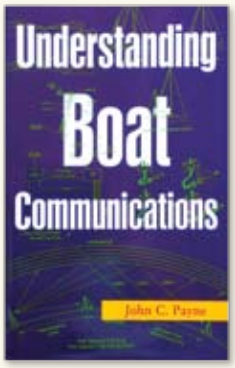
About the author: Wilson Boynton is a certified engineering technologist, a licensed aircraft maintenance engineer, a certified composites technician-instructor with the American Composites Manufacturers Association and president of Advanced Composites Training (ACT), a division of Renaissance Aeronautics Associates (raacomposites.com) located in London, Ontario.




## Rough Weather Seamanship for Sail and Power by Roger Marshall

300 pages, Hardcover (McGraw Hill US$29.95)

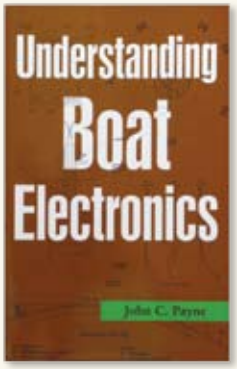
DIY columnist, Roger Marshall, combines his love of sailing, his racing experience and his expertise as a boat designer to produce this book for those who fear a storm at sea. The focus is safety onboard. There are chapters that help you monitor the weather, read wave patterns and decide whether your boat can face a storm. While other books of this genre deal solely with worst-case scenarios, Marshall also deals with minor squalls and gales and the kind of gear and techniques you, your crew and your boat need to stay safe in rough weather at sea. This is a must-have for the novice and experienced sailor alike. This read puts 40 years of Marshall's experience and that of other veteran sailors at your fingertips.




## Understanding Boat Communications and Understanding Boat Electronics by John Payne

106 pages each, Paperback (Sheridan House US$14.95)

DIY's electrical specialist, John Payne, has a long history of merchant shipping and marine electrical engineering and these books are the newest additions to the "Understanding..." series of publications from the same author (Boat Batteries, Corrosion, Lightning Protection and Interference, Boat Diesel Engines, Boat Electronics, Boat Wiring). Each volume is thorough and comprehensive and easy to understand. These books are a valuable addition to the serious recreational mariner's library.



David Heilman

# Snapshot Interiors

## Step-by-step procedures for refinishing interior wood bulkheads.

By Jan Mundy

Brightly finished interior bulkheads do not require the routine maintenance of exterior brightwork as they are not normally subject to weathering from the sun's rays, salt, acid rain and other climate hazards but, with time, the gloss fades, surfaces become stained and it's time to renew the finish.

Refinishing your boat's interior bulkheads isn't a difficult job and like most maintenance jobs, the pros that make their living detailing boats know the tricks for achieving a quality finish. To this end, I persuaded Duarte Picanco of Noah's Marine Supply (noahsmarine.com) to divulge his trade secrets.

Teak is the wood choice for interior bulkheads to which the boat builder applies either a saturating oil or varnish and the first step is to determine the coating type used. Oiled wood appears dull and dry, especially if it hasn't been recoated for a long time. Varnished wood typically retains its gloss, regardless of age, when not exposed to UV. Restoring an oil finish requires less effort in surface preparation and application, assuming the wood is in good condition. Simply clean, lightly scuff the surface and you're ready to coat. Mildewed or stained oiled or varnished surfaces require additional pretreating before refinishing.

### Surface Preparation

To treat surface mildew, clean with a mildew stain remover or use a solution of hydrogen peroxide, boat soap and water. To remove water stains or for spot bleaching, use a teak cleaner. Wipe down the bulkhead with one-part MDR Teak Cleaner poured on a sponge. For more stubborn stains, my favorite is Cape Ann One-Step Teak Cleaner. Because it's a thick gel, it stays on the stained area. Apply with a brush and, in a few minutes, simply wipe or rinse off with clean rags or paper towels. If the surface is in good condition, clean and degrease with a solution

*Don't sand vigorously or you risk going through the very thin face veneer.*

Ncik Bailey

*Removal of coating to bare plywood reveals water stains at the bottom.*

of trisodium phosphate (TSP), sold at hardware and paint stores, applied with a sponge. Mildew or water that migrates under the coating causes the surface to turn a milky color and the varnish to lift. If the finish is salvageable, then clean with TSP.

Follow any cleaning with a very light sanding. This is not the occasion for aggressive power sanding or you risk breaking through the plywood's face (a veneer), actually not much thicker than a few sheets of paper. If you sand through the face veneer, you'll get a different color wood running in a perpendicular direction underneath. The only fix is to camouflage it with a matching stain or paint a wood grain color using a small artist's brush (not always successful), hang something decorative over the spot or paint the entire bulkhead.

Avoid using a power sander, which could butcher the thin veneer with deep scallop-shaped indentations or leave swirl marks that are only noticed after applying a glossy finish. A rigid sanding block held level against flat surfaces gets the job done without damage. Use a soft pad for round or contour areas. Select the finest grit sandpaper that effectively removes the old finish; usually, 240- to 320-grit paper. Never "hand" sand. Instead, always sand with a rigid block. Its flat profile evenly distributes the pressure and reduces the risk of sanding through the veneer. Rather than using sandpaper, Duarte prefers using a 3M Scotch-Brite General Purpose Pad to gently scuff the surface in preparation for coating as well as for sanding between coats. The goal here is to lightly scuff the surface to create a rough pattern that grabs the oil or varnish for better adhesion.

Removing a peeling varnish finish may require a chemical stripper applied with a brush. An effective stripper wrinkles the finish and then it's scraped off using a plastic blade or modified steel scraper. Apply light pressure so you don't scrape through the wood. If you prefer to use a coarse pad, select a bronze or synthetic one. Never use steel wool. It can leave tiny steel fragments that create rust stains

*Must-have tools of the trade consist of: various foam, wood and rubber sanding pads, sandpaper, putty knives, teak cleaner, chemical stripper, TSP, oil and/or varnish.*

**TIP**

### Reuse Foam Packing

Save the Styrofoam packing from electronics boxes, cut into square chunks to whatever size fits the purpose, wrap them in sandpaper and you've got the ideal blocks for hand sanding flat areas like a big bulkhead. The larger the area, the larger the sanding block and its flat profile reduces the chance of sanding through the outer plywood veneer.

*Always manually sand with some type of hand pad: (top) Ferro rubber pad fits the hand comfortably and accommodates 3M Hookit sand paper; (middle) sand paper wrapped around a foam pad for sanding flat surfaces; (bottom) 3M hand pad with elastic strap for scuff sanding contoured surfaces with Hookit discs.*

*3M Scotch-Brite ultra fine maroon pad is the tool of choice for mild cleaning and lightly scuffing wood surfaces in preparation for recoating with oil or varnish.*


*Putty knives come in various grades. Choose a flexible one for scraping plywood and round the corners with sandpaper or a grinder so you don't inadvertently gouge the wood.*

on interior surfaces. Sanding is often more effective than a chemical stripper, depending on the condition of the varnish. Chemical removal is the only means for removing a recent oil finish.

After sanding or stripping, you may want to apply a teak brightener (part "B" of a two-part teak cleaner) to bring back the color. Where teak is mildly discolored or has turned a grayish color, Duarte prefers a light sanding with 320-grit paper to restore the wood's natural color. If you're satisfied with the surface color, the next step is to apply the oil or varnish.

Should you decide to switch from oil to varnish, your success depends on the time span since the last oil recoating. For bulkheads that haven't been recoated in a long time, there's likely little oil left on the bulkhead. Simply wipe down with a solvent (acetone, lacquer thinner or the recommended varnish thinner) and then lightly scuff with the maroon pad and you're ready to varnish. Do a spot test first to be sure no contaminants remain that might lift the varnish or consider using a clear finish, such as Bristol Finish, MDR Teak Luster or others, that claim to overcoat oiled surfaces without additional surface preparation.

Remove all dust by vacuuming the bulkheads and the entire interior and then rub down the bulkheads with a tack cloth. Change your clothes so you're not wearing the same duds you were during the sanding. Allow at least an hour for the dust to settle before applying the finish.

Always protect your eyes with goggles, especially when sanding. Make sure you have sufficient fresh air ventilation when sanding and applying any coating. Protect your lungs with a dust mask and don a respirator with carbon filter when applying any coating.

## Clear Finishing

Oil selection depends on the desired color and finish. Some products change the wood color, some texture the wood. Oils come in three finishes: matte, satin or gloss. They soak into the wood without any surface buildup, resulting in a natural wood-like finish after the necessary six or more coats. Varnish builds up faster with fewer coats and requires a light scuffing between coats.

Before coating, the wood must be dry. I always spend the extra time to mask the edges using a fine striping tape. This is a great time-saver when applying multiple coats for it avoids the need for exactness when applying. Apply oil with a foam brush then wipe down with a rag. Duarte prefers "ragging" oil by pouring a small amount on a cotton rag (old T-shirts or diapers work great) and then rubbing the oil into the wood, always working with the grain. Apply just

*Applying an oil like a stain using the "ragging" method and working it into the grain gives the best finish. Oils come in all colors and flavors. This professional detailer chooses Blend 55 because it goes on thicker than most oils, he likes the texture and the finish, it contains a little varnish so it lasts longer and it smells like olive oil.*

enough oil so it soaks into the wood. Never apply so thick that oil floats on the surface. After a light rubbing, a visible oil slick confirms there's enough oil. Let dry for a day and then reapply. Apply three coats and then lightly scuff the surface with the maroon pad. Some users prefer to sand with 280- to 320-grit paper wrapped around a block. No matter how you sand, do it lightly. A minimum of six coats provides the necessary protection for most oils but check the label for coverage instructions.

Varnish comes in either a single or two-part, which requires a catalyst. Two-part varnishes are more difficult to apply but are longer lasting, more durable, offer higher gloss retention, better scratch resistance and, generally, tolerate more abuse than one-part varnishes. A conventional varnish requires eight to 12 coats to obtain the same deep luster accomplished with three to four coats of a two-part varnish. The high toxicity of two-part coatings make some unsuitable for application in confined interiors without the proper respiratory equipment. (For a detailed discussion on varnish types and application refer to "Different Strokes" in DIY 2005-#4 issue.) Recoating a one-part with a two-part varnish can lift a new finish but may not pose a problem with an aged finish after a thorough cleaning and sanding. Best to do a test patch first. Apply one coat per day, lightly scuffing the surface with the maroon pad between coats. Only before the final coat does Duarte dry sand with 320-grit paper wrapped around a foam block.

There is nothing quite as satisfying as a professional finishing job and success is easily within reach of the dedicated do-it-yourselfer.

— Jan Mundy is editor of DIY.

# Surveyors and Boat Yards

## The Bad and Not-So-Bad

***Surveyors and boatyard personnel can fall short of their customer's expectations during their respective processes of inspecting and repairing a boat. This DIY reader and first-hand witness offers his advice on how to judge a good marine surveyor and boatyard and what to do when they're not performing up to par.***

On February 28, 2001, I began my graduate education in marine repair when the Nisqually earthquake rocked South Puget Sound. My 41' (12.5m) masthead sloop was sitting on the hard. It didn't roll over and nobody was hurt but it was damaged and the next 20 months saw only one trip on the water, towed by a tug, to yet another repair facility. During the ensuing period, an inept conspiracy of insurance company bureaucrats, dubious marine surveyors and incompetent boatyard personnel effectively boat-napped my sailboat.

Some of the blame is imbedded in surveyor training or, more to the point, the lack of it. I naturally assumed that becoming a surveyor required a rigorous apprenticeship and some formal education. It doesn't. Anyone with the inclination to obtain a business license can hang up a shingle purporting to be a marine surveyor. Apprenticeships in surveying appear to exist as short courses, with some hands-on lessons and some classroom work, like the course offered at the Chapman School (chapman.org), but more commonly comprise time spent shadowing an established marine surveyor around during his normal rounds.

In preparation for this article, I contacted several marine surveyors regarding training and expertise. One Coast Guard captain and certified master surveyor assured me that in one month in his program I would become more than qualified and comfortable going into business for myself. "Completing the survey paperwork properly is the biggest hurdle in order to satisfy insurance companies and marine mortgage companies," he explained. He even assured me I would be competent to expertly testify in court! By his own account, he performs 450 surveys a year for an average price of US$500 per survey. This is real money and obviously a strong incentive to go into the surveying business.

It's a fact that marine surveying is a legislatively unregulated area of professional practice, not unlike automobile repair facilities. There exist reputable and experienced surveyors with deep experience gained by years at sea and acquisition of special knowledge of marine structures, mechanics, electrical systems and rigging. This is often the result of previous training and careers within the Coast Guard, Navy or maritime industry. Unfortunately, bad surveyors are contained in the mix. Marine surveyors are not required to pass any formal test prior to determining the value and soundness of the boat you plan to purchase or need repaired. In fact, a surveyor may have little actual experience determining the severity of damage incurred during an accident or verifying the quality of repair work done to your boat.

### Do you have an Apple or an Onion?

Several associations of "certified" marine surveyors exist. Through e-mail, I contacted several independent (unaffiliated; not certified or accredited) surveyors as well as the National Association of Marine Surveyors (NAMS) and the Society of Accredited Marine Surveyors (SAMS). I queried each respective organization regarding surveyor training and how a boater might be reassured that a surveyor is knowledgeable, fair and that he will represent a client with integrity. I also asked each how the respective association handles complaints.

The common refrain was "buyer beware." I had a fairly good exchange with a representative of NAMS. Like some of the others, membership in NAMS requires five years of marine survey experience, submission of sample surveys and recommendations from several NAMS members. It offers certification tests for surveyors but these are not required for initial membership.

The NAMS representative didn't offer an explanation of the organization's process for auditing and sanctioning surveyors delinquent in continuing education and he remained moot on the point of complaints about its members.

Unlike other professionals, including doctors, lawyers, nurses or even home inspectors and appraisers, no state or federal board monitors for ethical or competency violations. No investigating body exists for filing reports of shoddy surveys unless outright fraud occurs, a situation falling to the Attorney General for each State, who is usually too bogged down with more serious crimes to commit resources to the complaints of irate recreational boaters. It's left up to the courts and attorneys. Most boaters just throw up their hands and walk away.

## Rule One: You Choose

Always pick your own surveyor. Look on referrals from yacht brokers with a jaundiced eye. Brokers are most interested in making a sale. They want bad news about "their boat" about as much as they want a colon examination. Use the resources of the national accreditation organizations. Certified marine surveyors are listed on the ACMS website (acms-usa.com) and NAMS (nams-cms.org) supplies lists of NAMS certified surveyors. Ask the surveyor questions about your type of boat. I'm a boarded surgeon and have spent much of my life around sick patients educating myself about all manner of arcane illness in the clinic, in the hospital and in the operating room. I still don't know it all. Many boat owners, me included, perform very adequate work on their boats and acquire a great deal of knowledge about their own and other boats. Society doesn't tolerate less from us doctors, so why tolerate it from a surveyor who may have fewer qualifications than you, the boat owner or buyer?

Insurance surveys for damage pose a particular problem. Boat owners have a vested interest in seeing to it that their pride and joy is properly repaired. The insurance company wants to spend the least amount of money possible to effect repairs and to comply with its contract terms. The initial function of some marine surveyors seems to be to harass, intimidate and discredit a boat owner who makes a claim. Check around. You might find that the only survey work done by this type of surveyor is for certain marine insurance companies. He is "their" man.

## Rule Two: Managing Repairs

If you disagree with a survey report, hire your own surveyor. Always ask for a disclosure of his/her conflicts of interest; for example, does he/she do significant work for that insurance company? Insurance work often ties a surveyor over during the slower winter months when the boating public isn't purchasing watercraft. If involved in a repair, an owner should diligently pursue the timely submission of reports to their insurance company and follow-up in person when each critical phase of repair work is completed.

In the same vein, beware the surveyor who frequents certain boatyards for he may be attached at the hip. That is, he enjoys a large referral practice due to the graciousness of the yard manager. If the yard is ethical and professional, this relationship may be a good thing, with repair work expedited by prompt inspections out of the surveyor's desire to remain on the yard's "A List." Be wary, however, if your damaged boat is steered by an insurance surveyor along the path toward a yard with a large population of seemingly derelict and damaged boats.

A yard manager must be an expert, knowledgeable about a wide variety of marine repairs, marine systems and craft. He must be able to give a reasonable timetable and accurate estimate for repairs. Lacking mitigating factors, the yard should adhere to the repair timetable and estimate. If not, the yard may be operating with few skilled personnel who slowly perform insignificant and incremental repairs on multiple hulls, jacking up each invoice to the insurance company. The yard delays repairs all the while "their" surveyor inspects each and every minor detail to extract his fee. The insurance industry is quite aware of this scam and tacitly complicit. I once complained about an inflated bill directly to the insurance company; they were indifferent. An insurance company representative incredulously asked, "Why do you care? You're not footing the bill."

The insurance industry unquestioningly pays surveyor charges for mileage and time, often when the surveyor is already planning to be in the boatyard to survey another boat for a "private" customer. This behavior can be the source of delays, too. The surveyor waits to assess repairs until he can get a "twofer," that is, by surveying an additional boat during the same visit.

A yard may temporarily abandon an insurance job, altogether, in favor of completing another project. Cash customers want fast repairs. They won't wait and can take their boats anywhere. As the yard sees it, an insurance job can wait to be completed whenever and however the yard and "its" surveyor see fit.

## Rule Three: Yard Tolerance

Never let an insurance company or their surveyor steer you to a repair facility. Pick your own yard based on interviews with other boat owners, yacht club members or recommendations of repair certification organizations and your own surveyor (see Rules One and Two above).

Visit the prospective repair yard and interview the manager. Check to see if the yard contracts out the paint, electrical or engine repairs. If they do, the yard may not be a complete repair facility. Check to see if the yard is a warrantee station for the better brands of boats, including yours. Also, do they build boats? Boatbuilding keeps workers skilled at repairing and fabricating fiberglass, repairing and installing electrical systems and marine mechanical systems. Boatbuilding maintains workers' skills when not performing repairs.

Better yards have an established ratio of management to certified technicians. The Marine Industry Certification process, listed at nmma.org, contains information on the process of boatyard certification and lists certified companies — information crucial to selecting a good yard. The American Boat & Yacht Council (abycinc.org) has certification processes for technicians in a wide variety of marine repair

specialties. Certification is a stamp of approval and leads an owner along the path to getting an expert repair.

The average boat owner can quickly become expert enough to judge the quality of repair work being performed on his boat simply by searching the web and reading a short list of books on do- it-yourself marine repair. I recommend any of the books by Nigel Calder, Linda and Steve Dashew, Daniel Spurr and West Systems as well as do-it-yourself magazines, like "DIY Boat Owner." These are good resources for the avid do-it-yourselfer. Combine these resources with the rigid expectation of a quality job and a willingness to ask a lot of questions. It's not a guarantee of excellence but it's a start.

### Cautionary Matters

Surveying a boat takes time and is physically and mentally demanding, often dirty work. Be wary of a surveyor who shows up toting only a digital camera and a hammer. Without tools, a flashlight, electrical multimeter or overalls, it's difficult to do an adequate survey. Be even more concerned if the survey is brief, especially on a larger boat, or the surveyor doesn't bother to venture inside all of the boat spaces. Some mega-yachts require two weeks to a month to inspect and utilize the skills of a team of specialized surveyors. In the end, you do get what you pay for. Be patient and prepared to pay for a good survey.

Don't hesitate to ask a surveyor if he is familiar with your particular type of boat. All hulls are not the same. Solid fiberglass is different from cored fiberglass and wood is completely different from steel or aluminum. Not all surveyors are knowledgeable about sailboat rigging. Ask the surveyor about his background and request a resume. Ask for references of customers who have had surveys performed by the surveyor and then call them. Further, if you disagree with the details in a survey report, question its accuracy, ask for an amendment and if need be, get a second opinion.

Check the Better Business Bureau for complaints. Persist in pursuing a proper repair. I received no relief from a national organization concerning complaints I made on a surveyor who hit me with a whopping US$1,500 survey bill on a damaged hull. The repair survey was brief, inaccurate and completely missed defective repair work. I prevailed by hiring an independent marine fiberglass contractor to assess the problem. The yard corrected it but only after I threatened litigation.

Nothing replaces knowledge of one's own boat in assessing the need for repairs. There is no substitute for doing your homework prior to buying a boat. Brokers and surveyors are less likely to confound you if you are knowledgeable about the problems peculiar to certain hulls, production years of a particular model and the deterioration that occurs over time. Obviously, not everyone can be well read or craves crawling into a strange bilge. It takes a little luck and a critical eye.

— Dr. Edwards lives in Olympia, Washington and is a board certified general surgeon and a senior FAA aerospace medical examiner. He is currently rebuilding his second yacht, a 41' (12.5m) masthead sloop.

*[Ed: The opinions of the writer are not necessarily the opinions of DIY Boat Owner Magazine and DIY does not endorse, reject, object to or support these opinions by virtue of its publication.*

## REBUTTAL:
# Formula for a Best Survey

***This NAMS-certified surveyor and instructor to the marine trades, former executive director of a national boatbuilders and repairers association, ABYC assistant technical director and one-time yacht broker says reputation is the key to finding a quality surveyor. If you want the best you'll need to do your homework. Here are some suggestions to get the best survey product available.***

I heartily concur with most of the issues raised in Dr. Edwards' missive. He's right on some points and wrong on others but, nonetheless, what he is saying can be applied to nearly any service provider, in any field or trade.

If you are shopping for a doctor, you would want at least, good treatment and you would certainly prefer the best available. The same applies in the search for marine surveyors but the one big difference is the lack of willingness of some consumers to educate themselves about what makes an adequate marine surveyor, a good one or a great one. These parameters are pretty well established for medical practitioners but not so familiar to those seeking marine survey services. What continues to confound me is that so few of the boaters who contact me for information about a survey express only their concern about how quickly it can be arranged and how cheaply it can be bought. It's as though they see the survey as something of a nuisance that they need to endure to get the money to buy the boat and the insurance to protect their investment. They just want to know that the boat is "safe."

Often the client is in an adrenalin driven state of material lust, encouraged and further excited by a yacht broker. He submits to almost anything that will let him have it and have it fast and without resistance or complications. Few inquiring minds ever ask for my resume or anything about the what, the how, etc. When the fee is quoted, many express astonishment at the cost and attempt to argue me into an abbreviated (cheaper) survey protocol. Admittedly, I probably have the one of the highest rate structures in my business community but I deliver an extraordinary product and I am selective about my clientele, just as selective as they are when they chose me as their surveyor. That goes for both the public consumer and my corporate clients. In my practice, even if you don't

ask, you get an extensive survey preparation packet. Even if you don't engage my services, you will have something to compare with the competition. If you find my fees too high, then shop for what you want to pay. It's the difference between Nordstrom's and Walmart but there are no bargains to be had in either medical practice or marine surveying if you want to come out of the experience with your physical and mental (and financial) health intact. Generally, it's been my experience that you get what you pay for and you get the benefit of his or her reputation. In marine surveying, reputation is everthing.

In every transaction, there are boundaries of behavior for each participant. Some are presumed, some explicit. "Naturally assuming" anything on the part of anyone is a big mistake. The only thing that is safe to presume is that each party to the transaction is looking out for himself. What must be made explicit is the respective boundaries of each person or entity. No good broker would be worth his salt if he or she did not do everything possible, short of dishonesty and fraudulent activity, to earn the commission the boat owner will pay to get the job done. The broker works for the boat owner and the seller. Everything he does and should do must represent that interest. I'm not, by any means advocating slimy ethics in the matter but I know the broker is doing his job and that I must do mine and we must respect each other's agenda. The broker has a fiduciary obligation to the seller. The surveyor is solely accountable to his client. The agendas are different but not necessarily antagonistic or

*The author at work.*

adversarial. Brokers are most interested in making a sale for that's their agenda and it's the right one for them. The buyer needs to look after his own agenda and not thrust the responsibility for a decision to buy or not buy a boat on someone else's shoulders. I don't tell my clients to buy or don't buy. I give them information so they can make that decision.

Ask the guy who operates the lift in the boatyard and you may learn something different from the broker's suggestion for a surveyor. Ask the yard manager who he would engage to survey a yacht he was preparing to purchase. You'll really learn something. Ask a broker about me and you'll likely hear a groan and see his eyes roll to the back of his head and yet few of the boats I survey for prepurchase are not eventually bought by a very well informed client. The key is that they are making an informed decision.

The American Boat & Yacht Council (abycinc.org) has certification processes for technicians in a wide variety of marine repair specialties. ABYC does not teach the field skills needed to service and build boats. The ABYC courses certify that those who successfully complete the courses have a mastery of the standards that affect their work product. It's important to make that distinction. There are places to go to learn the field skills and sometimes that means shadowing an experienced technician for years until those skills are in place but that's not what ABYC courses do. "Board Certified" surgeons are already surgeons before they achieve "boarding." They have endured years of "shadowing" their predecessors, albeit in a formal learning structure. The same is true for ABYC certified marine electricians or other technicians who are skilled professionals before they become ABYC certified.

As to the matter of redress when a surveyor is deemed to have failed in his/her duty to a client. Both NAMS and SAMS have internal machinery in place to deal with complaints about member performance. But, just as it is with complaints about malpractice of a physician, attorney or any other professional, those complaints must be proven true and any damage must be the result of neglect to duty. I acknowledge that the basis for making determinations about what a surveyor's specific duty is can be frustrating but that is an evolving professional issue within the trade.

Furthermore, each association has levels of membership that are clearly

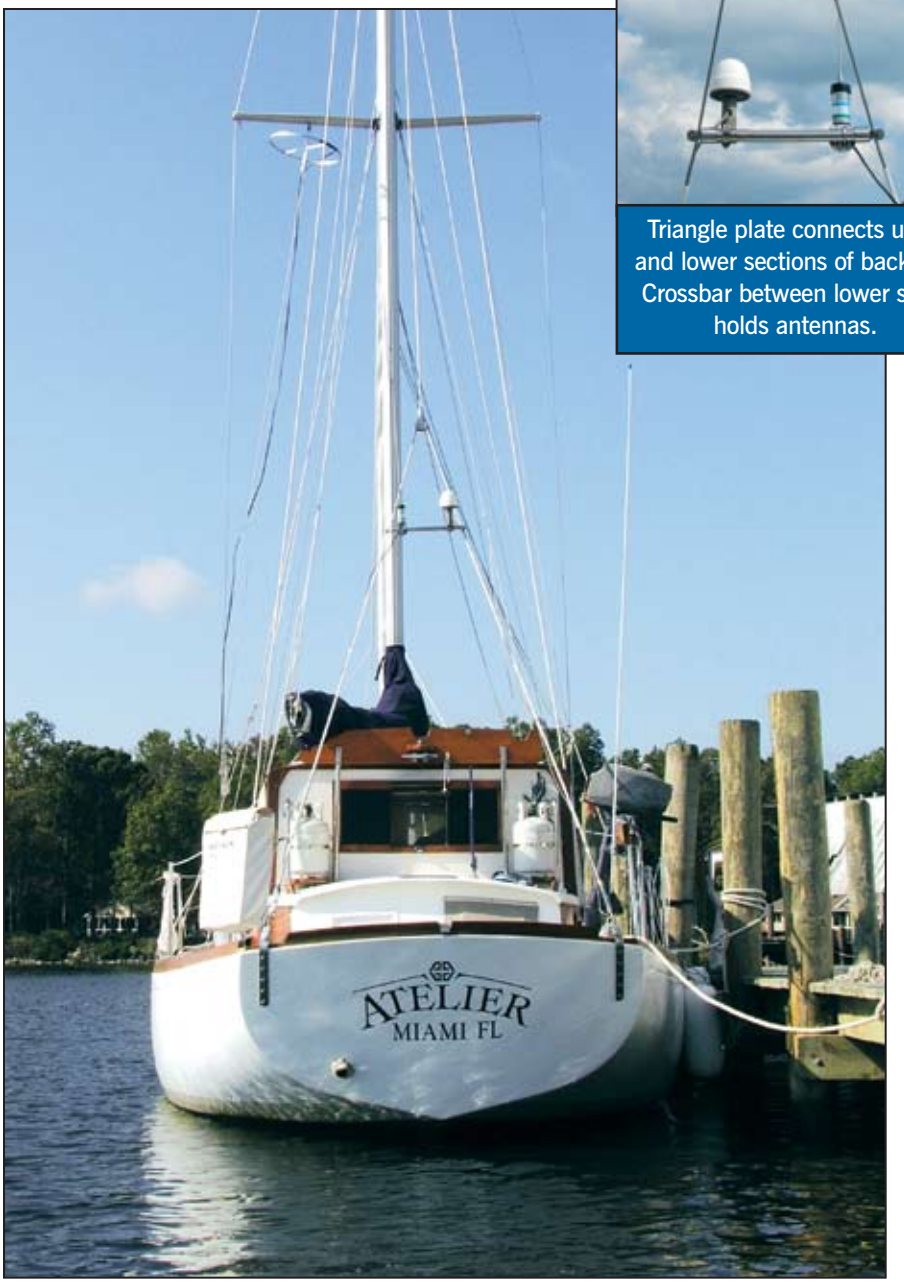
*(Continues on page 62)*

# Make Way for the Dink: Split the Backstay

***A split backstay arrangement makes it easy to launch, retrieve and stow a hard dinghy.***

Story and photos by David and Zora Aiken

Triangle plate connects upper and lower sections of backstay. Crossbar between lower stays holds antennas.




*Overview of new split backstay assembly. New chainplates attach to the transom and are bent to match the angle of the new stay. Note stern light and cleat for dinghy line on boom gallows.*

Over many years of cruising, we've owned a number of dinghies. Each new acquisition revived the question of how to carry the thing. No answer was entirely satisfactory, partly explaining the periodic changing of the dink.

Because our sailboat is a 35' (10.6m), center-cockpit design, there's no room behind the mast for a dinghy. The space forward of the mast is long enough but a dinghy carried there blocks the helmsman's view when underway and it's in the crew's way when docking or anchoring as well as being awkward to launch and retrieve over the lifeline.

Carrying an inflatable, partly or completely deflated, is a space-saving possibility but it's hardly an ideal solution and the air transfer routine gets tiresome quickly. Davits proved impractical on our boat. Hoisting the dinghy into carry position was clumsy at best. Worse, both the dinghy and the davits were often bumped or caught on a bollard or wall during docking maneuvers. The aft-deck, aft-cabin area seemed a likely spot to park the dinghy. There, it would not obstruct any ordinary boating maneuvers. Unfortunately, the backstay was in the way of the only logical launch and retrieval path; namely, the stern.

In order to remove the offending stay, we had two choices. We could replace it with a completely new double backstay rig or we could split the existing stay partway down from the masthead. Either way, the chainplate that blocked the center of the stern would have to be replaced with two chainplates positioned port and starboard on the stern. The dinghy could be hoisted or lowered over the center of the transom. No inverting, no turning sideways, no lifting over lifelines; just ease it in or out right-side up. We chose the split backstay option.

## Measure Twice

If such an arrangement would work on your boat, careful measuring is the critical first step (and maybe the second and

third, as there's no such thing as being too careful). If you already have a dinghy, or you're planning to buy a specific model, measure or check the specifications for the beam and the height.

Measure the boat's transom and determine the approximate location for the new chainplates. Position them a few inches from each side of the transom, to allow as much space as possible between them. Estimate the height at which the backstay might be split. If you're lucky, you'll find a boat in your size range that has a split stay; that will give you a starting point but the most important consideration is how much space the dinghy needs to fit between the stays. While the chainplate placement will establish one measurement, the angle of the stays also affects that space. If the split is too far down, the cables will be more sharply angled to meet the primary stay, leaving less space where the dinghy must pass through.

Make a scaled diagram of the projected plan, taking lines from the planned dividing point on the backstay to the location of the new chainplates. Measure the width between the stays at dinghy height. Measure again a few inches higher to allow for the "hoisting angle," the tilt of the dinghy as it's hauled up over the transom.

As a final check, take all measurements directly on the boat. Tie two lines to the backstay at the estimated height of the split. Extend the lines to the deck and tape them in place at the estimated position of the chainplates. Check the width between the lines at the height where the dinghy will come aboard.

When you're sure the dinghy will fit, take the plan to a naval architect or a rigger to be sure the planned alteration is appropriate for your rig. An architect will provide specs for all components. The entire job can be done on a DIY basis using fittings available from a chandlery or a specialized rigging catalog. Since we wanted to use swaged fittings, the rigger who did the swaging provided the specs and components.

If any changes are made to your original plan at this stage, check all measurements one more time.

## Transom Prep

First, remove the stern pulpit. Grind out the screw holes so all edges are clean. Bevel the edge around the top of each hole and fill all with epoxy resin thickened with colloidal silica. Use a syringe or fill the holes in stages to ensure no air bubbles are trapped.

Second, install the chainplates. Add backing plates before attaching chainplates. Use blocks of marine plywood fiberglassed in place or pieces of teak or a synthetic material held in place with an adhesive caulk. If in doubt, ask the rigger for a recommendation.

Place each chainplate in its proper location, positioned to follow the angle of the stay (from deck to the site of the split). Enough of the plate must extend above the hull-to-deck seam or toerail to allow proper connection to the stay. (It may be necessary to trim sections of



*(left) Bring the dinghy close to the stern and lift the bow; (middle) Haul the dinghy up to deck level; (right) Move it forward and tie to the boom gallows.*

a toerail.) Install the chainplates with stainless-steel bolts and appropriate caulking.

Depending on your boat's transom configuration, you may need to bend the top portion of each chainplate so that the bent section will follow the deck-to-masthead line of the original stay (perhaps leaning forward). This step will probably not be required on a boat with a reverse transom but it must be done on an older design with a classic transom. A big crescent wrench can do the job.

Third, assemble. As noted earlier, the backstay assembly can be done with swaged fittings (requiring a rigger to do the swaging) or with individual components (the complete DIY choice). Since we'd chosen swaging, the rigger supplied all components for the job: a Norseman eye terminal fitting; triangle connecting plate; clevis pins and cotter pins; two lower stay sections with eye terminals swaged to upper end; and turnbuckle/toggle assembly swaged to lower ends.

If the existing backstay is old, you should remove it and use new materials for the entire assembly. You may prefer to do so in any case. If you will be using the top portion of the existing stay, cut it at the appropriate place using a cable cutter or a hacksaw.

Attach an eye terminal to the cut end of the upper portion of the backstay and then attach that terminal to the top of the triangle plate, using a stainless-steel clevis pin and cotter pin.

At the upper ends of the two new stay sections, the rigger swaged eye terminals to the cable. Attach these terminals to the bottom of the triangle plate with the stainless clevis pins and cotter pins. At the bottom of each lower stay section, the rigger swaged a turnbuckle and toggle assembly; we simply connected the toggle jaw to the chainplate. The DIY method would use swageless eye terminals (e.g. Norseman or Suncor) to connect the separate elements of triangle plate to wire, and wire to turnbuckle and toggle assembly. Adjust the turnbuckle as needed for proper tension on the stay.

## On Water Testing

With new stays in place, it was time to test dinghy retrieval. Painter in hand, David pulled the dinghy up to the transom, lifted the bow off the water enough to grab it and then hauled it the rest of the way up between the new stays. It's not difficult to bring our 10' (3m), 90lb (41kg) Boatex dink onboard, even when underway. Once the dinghy is in place, the bow sits on the aft cabin and the stern extends about 12" (304mm) over the boat's transom. One line holds the bow tightly to a cleat on the boom gallows. Another line, tied across the dinghy, prevents any sideways movement. Use a trucker's hitch or a cinch strap to secure the dink. Launching, of course, is even easier, with the standard caution of making sure the painter is secured to a cleat on the transom before sliding the dink into the water.

The new backstay arrangement solved all aspects of our dinghy dilemma. No more difficult davits. No more awkward launch and retrieval. No more unusable deck space. We're able to carry a larger, more stable, "permanent" dinghy that also sails.

## Fine Tuning

Just below the point where the two lower stays meet the triangle plate, we attached a crossbar of stainless-steel tubing to hold the VHF and GPS antennas. Because the dinghy overhang obscured the boat's stern light, we moved the light up onto the boom gallows.

Since the stern pulpit was gone, we attached a stainless steel brace to the last stanchion on each side of the boat. This served as a stronger anchor for the lifeline and it provided a more substantial support for the outboard motor. Stainless-steel rub strakes attached to the toerail and cabin top protect these surfaces as the dinghy slides up and down.

It's possible to alter the arrangement by using a single turnbuckle on the upper portion of the backstay (just above the triangle plate) rather than the two at deck level but it's easier to adjust the tension by using two at deck level.

When towing the dinghy, tie a line or two between the backstays to function as lifelines. For even easier retrieval, use a block and tackle or run a line to a convenient winch.

Don't forget to pull the drain plug (or use a boat cover) so the dinghy doesn't fill with water in a rainstorm. Don't be tempted to stow things in the dink. We keep a hard-surface antifouling paint on the dinghy, even though it's usually kept out of the water when not in use; this has not created a rub-off problem.

About the authors: David and Zora Aiken authored and illustrated "Good Boatkeeping," "Fiberglass Repair," and "Cruising, the Basics."

# Neat Boating Stuff

Edited by Jan Mundy

## Collapsible Troller



Winner of the 2007 IBEX Innovation Award in the Outboard Engine category, the Torqeedo Travel is an ultra lightweight, foldable and yet powerful electric outboard motor ideal for dinghies, day sailors or any small craft up to 25' (7.6m). This four-piece engine comes in a storage bag and a unique folding mechanism allows for easy assembly in just five minutes. A high-density lithium-manganese battery powers the engine for up to one hour at full throttle or 10 hours at low speed. With a weight of merely 6lb (2.7kg), the battery easily lifts off for storage. Included with the engine is an integral battery charger and battery level indicator; recharging takes four to five hours. Available in two sizes, 400 watts (US$1,399) and 800 watts (US$1,599), both have adjustable height shaft lengths and the latter has the same power output of a 2-hp gas engine and a maximum range of 13 miles.

## Affordable Self-Tailing

Wish you had self-tailing winches but don't want to purchase new ones? If your boat has Barient or Barlow 27s or 28s, the WinchMate (winchmate.com)

offers an upgrade at a fraction of the cost of a new winch. Installation takes a few minutes and the kit includes tools and an assortment of shims to tighten drum play as a result of a worn drum. No drum modifications are required and the multi-positional stripper arm can be set where convenient. Cost is US$499 and a larger model to fit size 32 winches is planned for a spring launch.

## Bailer and Hook in One

If you've attended a major boat show in the past two years you've likely seen the Bridgenorth Bailer (bridgenorthbailer.com). This sturdy, anodized

aluminum, three-in-one product can be used as a boat hook, hand bailer or washdown pump. We purchased one and used it frequently this past summer when entering and exiting locks on the Trent-Severn Waterway. As a boat hook, the patented locking pin mechanism secures the Bailer in the fully extended position so it doesn't collapse under pressure as some twist lock systems do at a critical moment. Its non-flexible Lexan hook doesn't bend with force as some lesser hooks do. Perfect for bailing bilges, cockpit lockers and other hard to reach places, the Bailer siphons all but a few drops out the hook. And just for fun, it can shoot a stream of water over 50' (15m). Self-lubricating leather cups are used instead of O-rings to pick up the water. Though these better resist oil, cleaners and saltwater, we found that, when not used regularly, the two sections of the pole were hard to extend. Flushing with freshwater after use in saltwater environments will help keep the sections free for smooth operation. Available in two sizes, 5' and 8' (1.5m to 2.4m) prices are US$46 and US$56.

## Rapid Handling

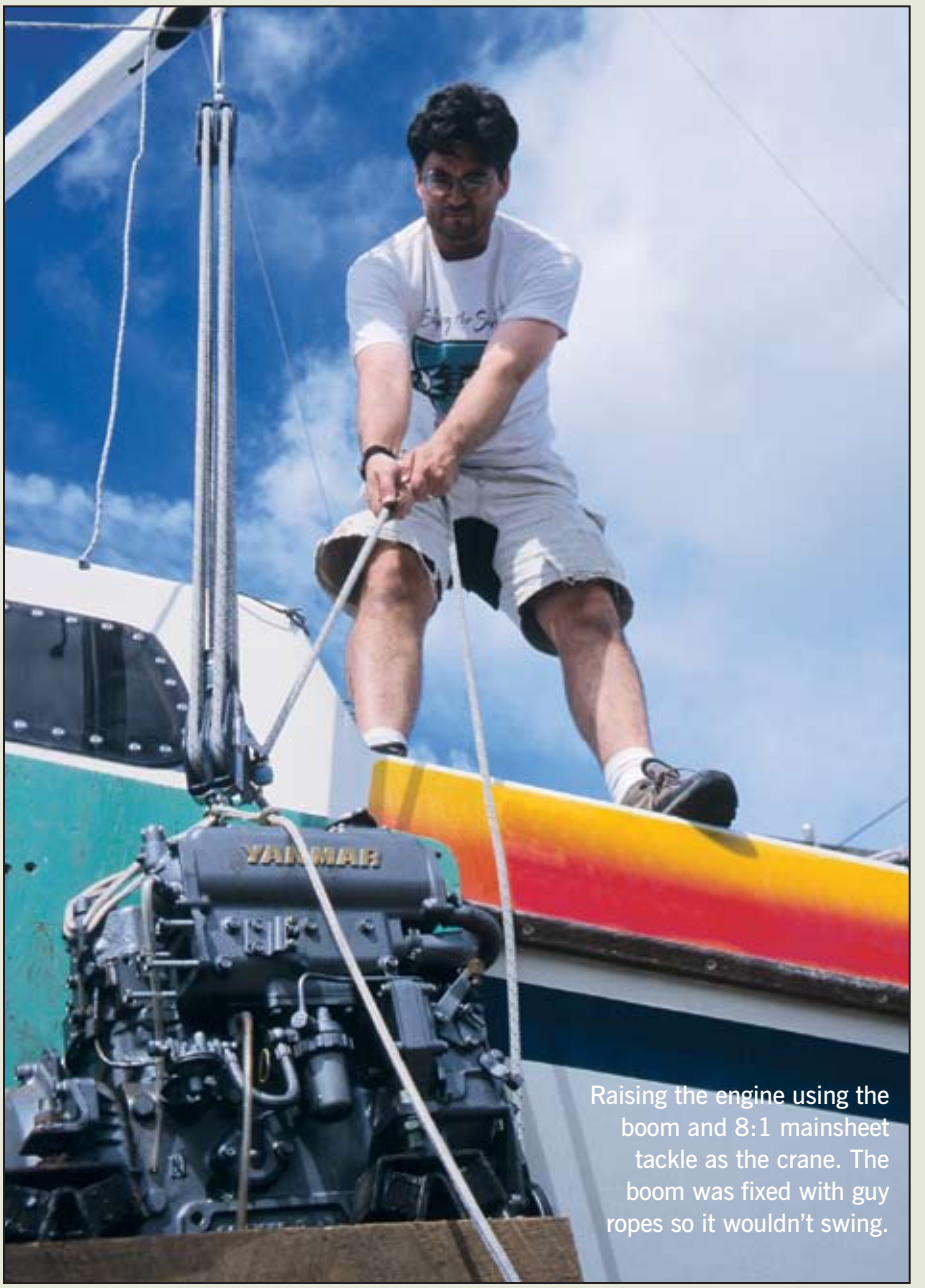
Lewmar's (lewmarusa.com) OneTouch winch handle uses a plunger pin and ball mechanism similar to that employed by the quick release steering wheels in Formula 1 racing cars. The mechanism is operated by a lever that runs the length of the winch handle. To insert, simply squeeze the handle and place it into the winch. To remove, squeeze and remove it all in one motion. Both operations can be performed one-handed. Available in three versions, depending on the grip, it fits any manufacturer's winch. Prices start at US$103 for the single grip up to US$145 for the double grip. OneTouch received the top DAME award at METS, the Marine Equipment Trade show held every November in Amsterdam, Holland.

UPGRADE

# Repowering with Diesel

***Replacing two gasoline outboard engines with a single inboard diesel made cruising under power simpler and more enjoyable for this intrepid couple. In their experience, it all came down to "less is more."***

Story and photos by Diane Selkirk and Evan Gatehouse




Raising the engine using the boom and 8:1 mainsheet tackle as the crane. The boom was fixed with guy ropes so it wouldn't swing.

Our 40' (12m) catamaran was originally equipped with twin 9.9 hp outboards. One engine died and the other spun its propeller hub during our first trip as new owners. A prop swap from the failed engine to the operational engine gave us enough power to limp home on one engine. The next sailing season began with both motors repaired, or so we thought, but one of them threw a rod putting us right back to motoring with one outboard. Clearly, outboards were not our preference for reliable power.

The planned conversion from twin outboards to a single inboard engine required us to discern the proper size engine and propeller to power our boat. For engine size, we looked at similar boats for comparison. We also used a 1.5- to 2-hp per 1,000lb (453kg) of boat displacement rule of thumb for boats in the 25' to 40' (7.5m to 12m) range. Propeller suppliers gave us recommendations for a range of propeller sizes that would suit the engine, gearbox ratio and the boat.

Since our boat moved at 7 knots with the two 9.9 hp outboards, we presumed that the lightly used Yanmar 3GM30, three-cylinder, 27-hp diesel we found would provide ample power. Our diesel technician gave the Yanmar a thumbs up and we bought it.

## Prop Fitting

The next step was determining the optimum propeller location relative to the hull and the rudder. In general, for maximum thrust from input power, select the largest propeller diameter your installation will tolerate. We purchased a used, 17" (43cm), feathering, Autostream propeller. It's 1" (25mm) larger in diameter than our targeted size but the price was right and adjusting the pitch compensated for the increased diameter.

The desired blade tip clearance from the hull was 15% of the propeller diameter and the formula for positioning the prop (50% of its diameter) put this prop 8.5" (215mm) forward of the leading edge of the rudder blade with a tip clearance of 2.55" (64mm). Achieving adequate prop tip clearance can be challenging but, to minimize vibration, the right clearance factor is important.

Measuring the spot on the hull to locate the hole for the shaft reference wire.

## Engine Placement

Unlike monohull sailboats, where the engine would probably be best located under the cockpit, our nearly new diesel engine fit under a berth in the port hull. We experimented with various shaft angles that would enable the desired propeller position and still keep the engine under the berth. The hull shape dictated a 5° shaft angle, which is well within the maximum 15° angle.

An installed engine requires at least 1" (25mm) clearance from its bearing surfaces to allow for its normal motion during engine operation. Also, we needed another drawing showing a sectional view of the hull where the engine would be located to confirm that the selected space was adequate.

We also considered the need for additional room inside the hull for a stern tube, stuffing box and shaft coupling aft of the gearbox and engine.

(left) Checking shaft position with laser level. (right) Engine mockup in position to locate engine beds. On this engine, the mid-point of the adjustable engine mounts lined up almost exactly with the gearbox output flange. If they were lower, we would have had to make a wooden support at each end of the plywood to position the reference wire.

## Bearings and Shaft

On hulls with a long keel, the propeller shaft may exit the trailing edge of the keel. In this case, the cutless bearing is located in the trailing edge of the keel, affixed inside a fiberglass stern tube. For fin-keeled boats, a strut ("V" or upside down "P" shaped) is typically used to support a cutlass bearing. That strut should be no more than one shaft diameter's distance from the prop hub.

We fabricated a carbon fiber cutlass bearing strut to minimize weight and save some money. (A fiberglass strut would be too flexible; a cast bronze strut is much simpler and they are available to suit any shaft angle.) We found that you could easily drill and tap the carbon fiber laminate for setscrews to hold the cutlass bearing in position.

Shaft diameter is usually calculated using engine horsepower, gear ratio and shaft material properties. Dave Gerr's, "The Propeller Handbook," is the biblical reference for these calculations and rules of thumb. ABYC Standard P-6, Propeller Shafting Systems, is also an excellent reference on these matters. Suppliers of shafting often make recommendations based on these sources. You can also find aids to calculating prop size at websites like rbbi.com/folders/prop/propcalc.htm. Many engine manufacturer websites also offer shafting and propeller sizing formulas. Some post-installation tweaking of pitch and/or diameter might be necessary to get the optimum effect in actual performance.

## Installation

With the boat out of the water, we located the approximate position where the shaft would pass through the hull. We drilled a small pilot hole for the reference wire that would establish the shaft line, ensuring that the hole was large enough that the wire did not touch the hull when it was pulled taut. With our shaft line drawing in hand, we positioned the wire to represent the proposed position of the shaft, using the center of the propeller and the forward end of the shaft at a convenient bulkhead as

Engine beds glued together and clamped in position while the epoxy putty sets.

reference locations, making sure the propeller tip clearance still matched the drawing.

(left) Measuring fiberglass to cover the engine beds. (right) Applying peel ply to the fiberglass to leave a smooth appearance.

To position the engine beds in reference to the shaft line, we made a wooden engine mock-up and marked the hull for the position of the beds. Following a final check inside the engine compartment to make sure we had enough room for the engine, both vertically and transversely, we measured the heights of the beds for shaping the timbers, taking care to shape the beds at the bottom so they fit against the hull.

After the bed timbers were shaped, we cleaned the hull with acetone then sanded with a coarse grinding disc. We used epoxy resin thickened with wood flour and colloidal silica to glue the wood beds to the hull and fill any gaps. We then formed large radius fillets between the wood and the hull and then glassed over the beds with several layers of biaxial fiberglass. Using many layers of fiberglass creat-

ed a stiff engine foundation that would transmit less vibration to the hull when used with flexible engine mounts. The engine beds did not need to be exact in height to the last 1/8" (3mm) because the adjustable mounts allowed us to adjust the engine to its final position.

## Stern Tube and Strut Bearing

The boom and mainsheet tackle was used to lift the engine from the ground onto the deck and down into the hull. With the engine in its approximate position on the engine beds, we adjusted the engine mounts so they were in the middle of their adjustment range.

Enlarging the pilot hole where the reference wire passed though to fit the stern tube enabled us to adjust the final position of the stern tube within the hole. With the prop shaft fit into the fiberglass stern tube, we slid this assembly into the hull, installed the shaft coupling on the front end of the shaft and bolted the coupling to the gearbox.

(left) There wasn't enough height over the engine for a block and tackle, so a lifting rope was lead through a block to a winch outside on deck. The overhead lifting beam was suitably braced. (right) Engine on the beds.

Using wood wedges, we adjusted the propeller shaft so that it was centered at both ends of the stern tube. We deferred installing the flexible coupling between the gearbox output flange and the propeller shaft flange because it would flex too much while we located the final shaft position.

Because the propeller shaft and stern tube were now rigidly connected to the engine, their installation position was correct. We could easily rotate the engine slightly on its beds by hand, so that the shaft and stern tube were lined up with the center of the hull.

Next, we fitted a cutlass bearing into the strut and slid the strut onto the outboard end of the shaft, sliding it into position just forward of the propeller hub and marking its location on the

Propeller shaft initial fitting and marking for strut.

Stern tube and strut in position.

hull bottom. We moved the strut out of the way and cut an oversize hole in the bottom of the hull as a pass-through for the strut.

The stern tube, propeller shaft and cutlass bearing strut were now all loosely fit in oversized holes in the hull but firmly connected to the engine in sequence and alignment. Gaps were packed with high-density foam to hold these parts into position and then thickened epoxy putty applied to fix them in place. Once the putty had hardened, we removed the propeller shaft and cut off the excess stern tube protruding though the outside of the hull. Any remaining gaps were filled with more thickened putty and the stern tube and strut were fiberglassed into position. An additional transverse gusset was mounted on the bracket inside the hull. With the propeller shaft in place, we bolted the engine to the engine beds.

## Auxiliary Systems

The final aspect of installing an engine is connecting the engine's auxiliary systems, which included relatively uncomplicated plumbing, mechanical and electrical work.

We drilled a hole in the hull for a seacock to serve the seawater cooling intake. The foam core was removed from the perimeter of the hole, which was then filled with epoxy putty. We then glued a plywood backing pad in position, sealing it with two coats of resin before caulking and screwing the seacock in place on the backing pad. We bolted the sea strainer to a bulkhead and made the hose connections to the engine's saltwater pump. A vented loop, installed inline ahead of the connection to the exhaust outlet, prevents siphoning cooling water into the engine.

A waterlift muffler installed 6" (152mm) below the engine exhaust

outlet and hose carries the exhaust discharge to its terminus in the hull side near the transom. We glassed a 2" (50mm) fiberglass tube into position for the outlet. At this point, we connected the components, looping the hose upward under the deck, where it was supported by a section of durable and non-chafing nylon webbing. The electrical system hookup was straightforward: connect the positive battery cable to the starter motor; the negative cable to a grounding bolt on the engine block; and plug the engine wiring harness into the engine control panel.

Ensuring the engine has an adequate supply of fresh air required the installation of a vent, designed to allow air flow but not admit water, in the side of the hull. A blower removes accumulated hot air from the engine compartment via a flexible hose.

The Yanmar and the control head directions guided our installa-

(left) Overlength stern tube ready for epoxy putty and fiberglassing. (right) Trimmed stern tube. (bottom) Stern tube fiberglassed in place on inside.

tion of the engine control cables to the engine and gearbox. A drop of Loctite on each clamp bolt ensured the cables wouldn't vibrate loose.

We then installed a new polyethylene fuel tank, a fuel filter and all U.S. Coast Guard-approved type A1 fuel hose.

## DIY Bill of Materials

*Cost totals, in U.S. funds, grouped by task, to repower a 40' (12m) catamaran with a 27-hp inboard diesel.*

### Engine

| | |
|---|---|
| Yanmar 3GM30, used | $4,132 |
| Mechanic | $217 |
| Engine beds: glass, foam, wood | $55 |
| Stainless-steel lag bolts | $5 |

### Fuel

| | |
|---|---|
| Fuel tank, Tempo 27 gal plastic | $213 |
| Fuel filter, Racor 500 FG | $82 |
| Miscellaneous fittings | $5 |
| Deck fill cap | $11 |
| Fuel fill hose 1' (12cm) | $7 |
| Fuel vent hose 1' (12cm) | $2 |
| Fuel vent fitting, Seadog | $6 |
| Fuel supply and return hoses, 30' (9m) | $96 |

### Shafting

| | |
|---|---|
| Shaft seal | $174 |
| Shaft, 1-1/4"x72" (31mmx182m) stainless steel | $100 |
| Machining prop shaft for coupling, custom coupling | $587 |
| Shaft log 2" OD x 3" (50mm x 76mm) | $36 |
| Flexible coupling, R & D Flexible Coupling | $165 |
| Carbon fiber shaft strut | $25 |
| Cutlass bearing, 1-1/4" x 1-3/4" x 5" (31mm x 44mm x 127mm) | $25 |
| Folding prop, 17" (43cm) three-blade Autostream | $2,142 |

### Cooling

| | |
|---|---|
| Hose clamps | $7 |
| Miscellaneous fittings | $14 |
| Cooling water hose | $15 |
| Seacock, Marelon 1" (25mm) | $45 |
| Sea strainer, Vetus 3/4" (19mm) | $34 |

### Exhaust

| | |
|---|---|
| Exhaust hose, SAE J2006, 2" x 108" (50mm x 274cm) | $81 |
| Exhaust outlet, 2" (50mm) fiberglass tube | $36 |
| Waterlift muffler, Vetus NLP50 | $94 |
| Hose clamps | $10 |

### Ventilation

| | |
|---|---|
| Sound insulation, Soundown, 54" x 72" (137cm x 182cm), 3 sheets | $150 |
| Pins, clips, glue for installing insulation | $40 |
| Blower | $10 |
| Blower hose, 5' x 3" (1.5m x 76mm) diameter | $11 |
| Vent intake air fitting | $7 |

### Controls

| | |
|---|---|
| Control head, Morse SL-3 | $134 |
| Battery cables | $31 |

### Engine stop cable (included with engine)

| | |
|---|---|
| Control cables, diesel throttle, Morse 33C, 14' (4.2m) | $70 |
| Control cables, diesel gear Morse 33C, 14' (4.2m) | $70 |
| Hour meter (included with engine) | |
| **Total** | **$8,944** |

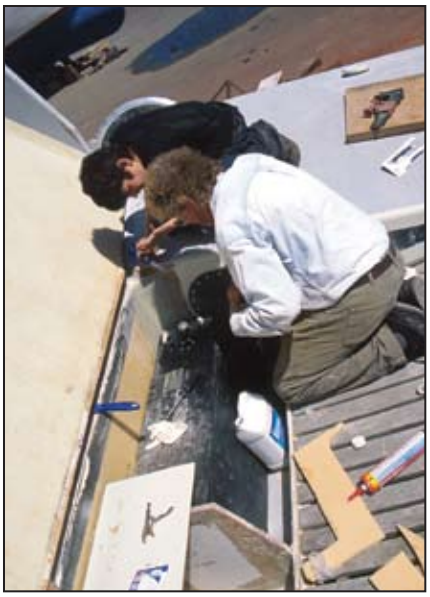
## Post Launch

The final shaft alignment, adjusting the engine alignment by sliding feeler gauges between the shaft coupling and the gearbox, was done after the boat

Trimming excess foam shims at the carbon fiber cutlass bearing strut prior to shaping fairing compound.

Shaft seal with vent hose and exhaust hose outlet, which has to pass through a watertight bulkhead so the connection is made through a fiberglass pipe glassed to the bulkhead.

Vetus sea strainer on raw-water intake mounts to bulkhead.



Installing the fuel tank and fittings.

## Material Sources

### Stern Tube and Exhaust Outlet

Fiberglass tube and pipe for stern tubes and exhaust outlets can be purchased through many industrial suppliers of fiberglass pipe, such as Max-Gain Systems at 770/973-6251; mgs4u.com/fiberglass-tube-rod.htm

### Shaft Seals

| | |
|---|---|
| Duramax | 440-834-5400; duramax-marine.com |
| Lasdrop | 800/940-7325; lasdrop.com |
| PSS | 800/523-7558; pyiinc.com |
| Sure Seal | 800-420-0949; tidesmarine.com |

### Conventional Bronze Stuffing Boxes

| | |
|---|---|
| Buck Algonquin | 302/659-6900; buckalgonquin.com |
| Glen-L Marine Designs | 562/630-6258; glenl.com |

### Cutlass Bearing Struts

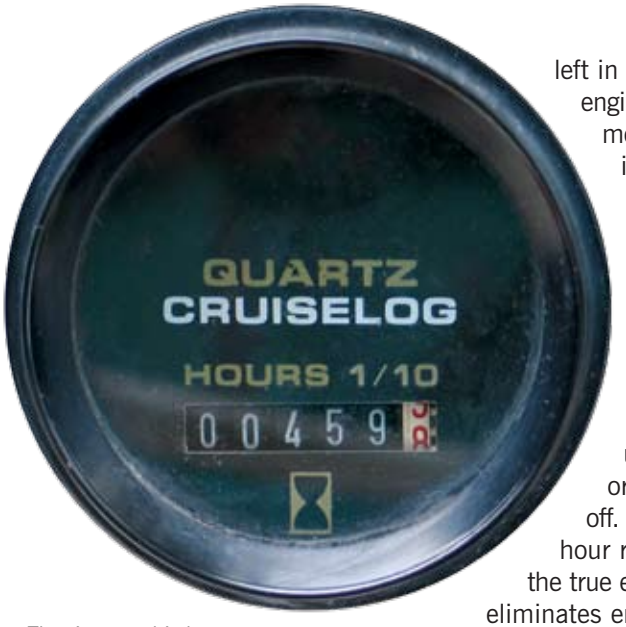
Buck Algonquin (see above)
Marine Associates 800/544-1487; marineassociates.com

was launched. Once we were satisfied that the alignment was right, we installed the flexible coupling. Since we had a dripless shaft seal, we needed to "burp" the seal to make sure there was no trapped air. With a conventional stuffing box we would have had to adjust the tightness of the stuffing box. After a final check of fluid levels we happily motored back to our slip.

About the authors: Evan Gatehouse is a naval architect and mechanical engineer, with extensive experience in composite boat design and boat mechanical systems. Diane Selkirk is a freelance writer and sailor with stories and photos published in a variety of magazines. Together they are completing a total rebuild on "Ceilydh", a Wood's Meander 40' (12m) catamaran.

# Tracking Time

***Hour meters help you log your routine engine maintenance on both gasoline and diesel engines.***




*The time on this hour meter may not necessarily count the total engine run hours — meter adds engine hours even when the engine is not running if the engine ignition switch is in the "on" position.*

By Steve Auger

The engine hour meter or chronometer is a useful tool to keep track of the actual operating hours of your outboard or inboard engine. Knowing the engine operating hours means you can manually monitor and determine fuel or oil consumption values in gallons (or liters) per hour and ensure maintenance is performed at the correct intervals. Hour meters can assist in verifying that your navigation and or propulsion systems are functioning correctly by comparing fuel used per hour verses distance travelled.

Never use hour meter information to assess the engine condition of a used boat you are considering for purchase. An hour meter can be replaced very quickly to one that has fewer hours. This is dishonest but it's not illegal.

Never use an hour meter to reflect the total time that an engine has been operated. Why you ask? Simply, hour meters run on battery voltage supplied by the key switch. If the key switch is left in the "on" position and the engine is not running the hour meter continues to run adding engine operating hours that never really occurred. Technicians and DIYers doing engine diagnostics in the key on-engine off mode may forget to shut the key off when they pack up and leave the boat. The hour meter runs until the battery is dead or the key switch is turned off. A computer-based engine hour readout does display only the true engine running hours. This eliminates engine hours that can pile up on the meter when the key switch is unintentionally left in the "on" position.

## Selection

Most hour meters are provided with a kit (about US$100) that includes all the required wiring and hardware to install the gauge in a standard 2-1/8" (54mm) instrument hole. Some owners choose to install the hour meter in the engine compartment if there is no suitable location at the helm.

Hour meters show accumulated hours in an instrument face similar to the odometer on an automobile. If you are going to install the gauge at the helm, pick an hour meter that matches or complements your existing instruments. Manufacturers offer different face and bezel color combinations in order to enable closely matching the existing instruments installed at the helm console.

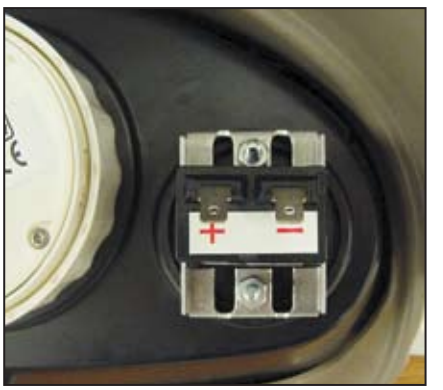
## Installation

Select a location at the helm that does not have any wiring or other obstructions behind the cutout area. This often requires relocating some of the existing instrument wiring. You will need around a 3" (76mm) radius area that is flat on the front so that the hour meter seats correctly on the console surface. A paper template is provided with the instructions for reference.

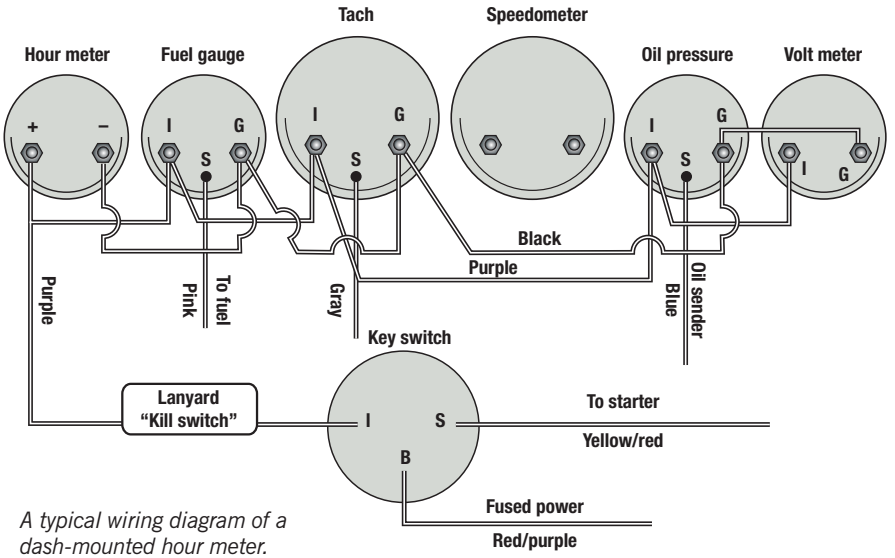
Before cutting the hole, drill a pilot hole with a 1/8" (3mm) bit first. Check that there is sufficient clearance behind the dash (or other mounting surface) for the depth of the gauge and for wiring. Cut out the helm using a 2-1/8" (54mm) hole saw. Taping the perimeter


*Hour meter kits come with instructions and the required wiring. A meter of the same brand and model as your existing gauges gives your dash panel a coordinated look and might simplify wiring.*

*Cut out the helm opening using a hole saw. Be sure to check behind the intended area to ensure it's clear of other wiring or obstructive bracing.*

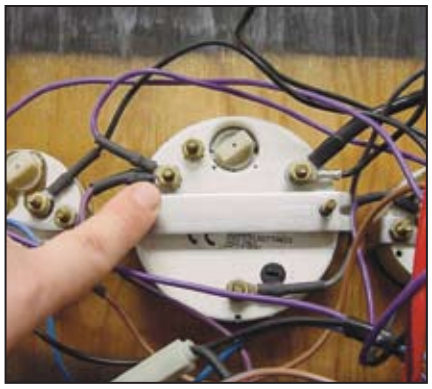



*Install the gauge with the provided hardware.*




Joe VanVeenan

*A typical wiring diagram of a dash-mounted hour meter.*



*Connect the purple wire to the tachometer "I" terminal. The hourmeter negative (black) wire connects to a known good ground, in this case, the tachometer ground terminal.*

of the hole with masking tape helps to prevent the gelcoat from chipping. Install the hour meter with the provided hardware and tighten the fasteners until snug.

Wiring the meter is simple. Before doing this, turn the master battery switch to the "off" position or disconnect the battery cables. Connect the spade terminal of the provided black ground wire to the connection marked negative ("-") on the back of the hour meter. Connect the other ring terminal to a ground on one of the existing instruments, preferably the tachometer (look for a black ground wire or post marked "GND"). Now, connect the spade terminal end of the provided purple power supply wire to the positive ("+") terminal on the back of the hour meter and the ring terminal of the purple wire to the tachometer "I" terminal (or "IGN" on older gauges). Support wires as needed to prevent chafing. Since this location might be moisture prone, seal the terminals on the hour meter with liquid neoprene gasket.

Follow the same procedure to install an hour meter on a bulkhead in an engine compartment and add these three steps. Seal the hole with sealant when mounting the meter to prevent water damage and bulkhead delamination. Make up extra-long wires and route these to the dash. The ground wire can be attached to any ground. It's easiest to follow the same path as the control cables and/or engine wire harness. Install heat-shrink tubing on all connections to prevent corrosion. Be careful not to compromise the vapor tight integrity of a gasoline engine space bulkhead. Don't run any wiring any lower than the horizontal plane of existing annular openings for original wiring or hose in such a bulkhead. This is key to maintaining the boat builder's design for complying with ignition protection requirements.

Your hour meter is now installed and wired to run each time the key switch is in the "on/run" position. Because the hour meter adds engine hours even if the engine is not actually running, never hook an accessory, such as a stereo or VHF radio, that requires the engine key switch to be on to operate or false engine hours will be counted by the hour meter.

## Troubleshooting

Your new hour meter runs on battery voltage. If the hour meter ceases to function, check for voltage (12-volts) at the positive (+) and negative (-) terminals on the back of the hour meter using a multimeter set on the 20-volt DC scale with the key in the "on/run" position. If there is voltage present, the gauge has failed. If there is no voltage, look for a blown 20-amp instrument fuse or a broken power supply (purple) or ground (black) wire.

About the author: Marine mechanic, Steve Auger, is DIY's engine technical advisor.

# Retrofit a Dodger Grab Rail

***A grab rail added to a bimini or dodger improves onboard safety.***

*In less than an hour a grab rail can be added to any 1" (25mm) diameter frame that can be disassembled.*

A new kit from Sailrite makes it easily to retrofit a bimini or dodger with stainless-steel grab rails. These rails mount on the side or along the aft frame to provide a convenient handhold. The kit (part number 102193) costs US$59.50 and includes everything necessary to install one rail with a maximum length of 30.5" (77.4cm) on any frame made of 1" (25mm) diameter tubing. The key part making this kit possible is the sliding post (**Figure 1**). When two posts are placed on a span of the dodger frame and made to protrude through the canvas, a rail with two eye ends can be securely attached as shown.

Installation is straightforward. First, determine where to attach the rail. Using a marker, put a dot on the metal frame. If there is fabric in place over this location (as will certainly be the case with a rail mounted on the side of a dodger), cut a small slit (about 1/4"/6mm) and mark the position on the frame through this slit. Make sure that the slit and the mark are centered on the round tubing. If both sides are to have a grab rail, remove the fabric cover and mark the second side on the frame and place the slit in the cover by measuring up from a reference point, such as the end of a frame leg (**Figure 2**).

To install the sliding posts requires disassembly of the frame. Most dodger frames are assembled from parts that are secured with set screws. If the frame in question is welded together, this kit will not work. Before disassembling the frame mark the positions of the hardware to facilitate reassembly (**Figure 3**). Having removed the eye ends and jaw slides, the sliding posts easily slip over the end of the frame and move into position over the placement marks.

For frames where the sliding posts aren't going through fabric, i.e. a typical bimini, just slide the sliding posts into position and put the frame back together (**Figure 4**).

If, however, the mounts need installing through the top material, the opening in the material needs preparation. Accomplish this by sewing small squares of leather over the slits in the canvas. It's normal to place these "patches" on the outside of the canvas since they then protect the cover from


Sliding post with eye end attached.


*Marking for the second rail.*


*Mark the position of hardware before disassembly.*


*Grab rails installed.*


*Sewing a leather patch in the topside of the canvas.*


*Sealing the fabric slit with a hot knife.*

chafe as well as adding strength. Center the patches over the slits in the canvas. Sew around the outer edge of the leather square with a straight stitch (**Figure 5**). Now enlarge the 1/4" (6mm) cut to a 1" (25mm) length centered on the fabric and then sew around that larger slit with a straight stitch. Use a hot knife to prevent raveling in the fabric slit (**Figure 6**). Once the leather patches are installed the canvas top is repositioned over the frame on the boat.

To determine the exact length to cut the stainless tubing, measure from the center of each sliding post and cut the tubing 1-3/4" (44mm) shorter than your measurement. The eye ends add back 7/8" (22mm) on each end of the tubing. Now, install the eye ends on the tubing and secure them over the sliding posts. Make sure the eye end is between the two nylon washers on the side mounts to isolate the rails and keep them from vibrating.

The finished grab rail is not only good looking; it also contributes to increased safety on the water.

About the author: Jim Grant founded Sailrite (www.sailrite.com) in 1972 to supply specialty marine fabrics, component hardware and tools, sewing kits and sewing machines for boaters to build or repair canvas and sails.

# Curing the Soggy Deck Syndrome

7

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

**A simple approach to repairing soft spots on wooden decks.**







Owners of wooden boats know only too well that even the best-kept decks can develop soft spots. Cloth covered plywood decks are especially vulnerable to water intrusion. My 1966 36' (10.9m) cruiser is no exception.

Built by the Avro Aircraft Company, "Sea Arrow" has an aluminum hull with a wood superstructure. When the Canadian government cancelled its contract for the Avro Arrow, an aircraft design that was years ahead of its time but too expensive to manufacture, the company laid off 5,000 employees. Avro tried to branch out into other aluminum products, including boats, of which 200 hulls were built using aircraft technology. Constructed of aluminum frames and 1/8" (3mm) aluminum plate, the strong and light hull will probably last forever. Hulls were shipped to the Richardson Boat Company in North Tonawanda, New York, for addition of the wood superstructure and completion.

The deck, conventionally built of plywood covered with fiberglass, has lasted well, but now, 40 years later, a soft spot had developed at the corner where the cabin meets the deck, a common area for rot to develop. When tapping with a light hammer or even a finger, the solid deck makes a sharp note, whereas the soft area gives a dull sound (**Figure 1**). Using this method of percussion, the soft area was readily outlined.

My repair method, which suits my level of craftsmanship and is best described as "making things safe and strong that look good from 20' (6m) away", started with drawing a line along the edge of the soft area (**Figure 2**).

Using a strong pocketknife or blade, I cut through the fiberglass (**Figure 3**). Next, I dug out the soft, rotten plywood to expose solid plywood. This was then left to dry (**Figure 4**). Having plenty of sunshine accelerates the drying process.

Next, I drilled numerous small holes into the good wood and painted Git Rot over the area. This two-part, very thin epoxy resin penetrates into the wood, especially at the edges. I then cut pieces of fiberglass matting to fill the space, starting small and increasing in size until the hole in the deck was filled (**Figure 5**). This took eight layers of fiberglass bedded in epoxy. When it cured, I sanded the surface flat and then applied Evercoat Formula 27 filler to fill the repair so it was flush with the surrounding deck. Once cured, it was power sanded, another coat of filler added, then more sanding. Painting the deck was the final step.

The resulting repair is very strong, tapping it gives a sharp note and it's invisible from a distance (**Figure 6**).

— Dr. John Crocker has sailed the world, most recently completing a circumnavigation in his 73' (22m) yacht, and is the author of "Sailing in Stitches."

8

# Non-Corrosive Fiberglass Windlass Backing

**When saltwater corroded the original backing plate for the windlass, this owner molded a custom plate of fiberglass and polyester.**

*Always looking for an effective short cut, the author used the top of his boat's fiberglass companionway spray hood for the windlass backing plate mold as it matched the foredeck camber. This assured a good fit to the deck and avoided making a box shape mold of 1/2" (12mm) medium density fiberboard from scratch. The sidepieces are made of plywood with Arborite (Formica) and attach to the spray hood with hot glue. Waxpaper lines the bottom and sides are treated with mold release wax for easier removal. Modeling clay fills the corners to make laminating easier and also prevent resin getting under the plywood.*

Tremendous strain is placed on a windlass while retrieving an anchor in choppy seas, freeing a stuck anchor or repetitive anchoring while cruising. That strain must be transferred to the deck and the deck needs a substantial backing plate to distribute the load over a large area. During anchor retrieval, the chain locker also receives a generous splattering of seawater while bringing aboard the wet road.

After 25 years of heavy use, the strain and saltwater had taken its toll on the 3/8" (10mm) aluminum windlass backing plate inside my 38' (11.5m) sloop, "Daniel K."

Although the exposed aluminum didn't look too bad, it was severely corroded on its interface surface with the plywood where saltwater had penetrated. I could have simply replaced the corroded aluminum with a new piece but as I'm always seeking better and more permanent methods, I designed and built a fiberglass backing unit that would last the life of the boat.

My boat is a traditional design with a balsa-cored fiberglass hull and a wood deck that I built of laminated spruce, mahogany and oak beams. The deck and cabintop are two layers of 1/2" (12mm) fir plywood bonded with 1-1/2" oz mat and polyester resin. The first layer was glued and fastened to the beams with bronze boat nails. Three ounces of mat with polyester resin and skid-resistant gelcoat finish the outside of the deck and cabintop. Cabinsides are solid Honduras mahogany, epoxy-glassed and painted and the interior is varnished mahogany and teak.

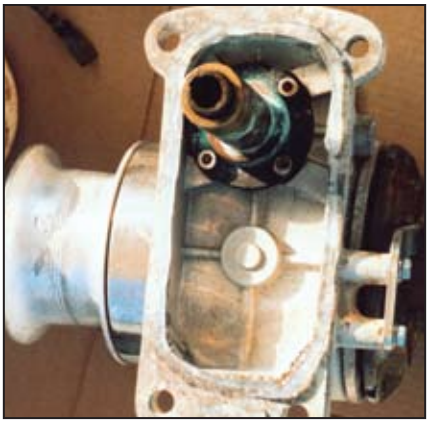
*The first layer of 1-1/2" oz mat is dry fitted and used as a pattern for more layers of mat and biaxial roving. Tearing the mat at the corners feathers the edges, resulting in a smoother laminate.*

The Lofrans Panther electric windlass is controlled at the foredeck or from the cockpit pedestal. This is a back saving installation but, with time, the backing plate suffered significant corrosion, as did the motor, which was mounted to the windlass under and through the deck.

To minimize the deck strain, I constructed a box-shaped fiberglass backing unit and mounted it under the deck. This

*For a small part like this, a brush gets the resin into corners better than a felt roller. Wetting the mat adequately and evenly is essential to achieve a smooth and solid laminate. The polyester resin should be catalyzed at about 5cc to 10cc per quart at room temperature. Be sure to use unwaxed resin.*

*It's important to roll all the air out to achieve a smooth laminate. Two layers each of 1-1/2oz mat and 24oz biaxial roving, rolling quickly between layers, followed the skin coat. Once cured, two additional layers were applied. Checking the thickness with a calliper, additional layers were then added to achieve a 3/8" (9mm) laminate.*



*After thoroughly cleaning the anodized aluminum windlass housing with acetone, a bead of silicone set around the base forms a thick O-ring to keep water out of the casing cavity and, just as important, away from the motor.*

*Modeling clay is scraped off and the residue cleaned with acetone and then edges are trimmed with a hacksaw and mini-grinder. For extra stiffness, without significantly increasing thickness, two strips, six layers each of carbon fiber (visible in black), are added at the bolt locations before the final layer of mat. Hawseholes and the motor installation hole in the center are marked using the old backing plate as a template and then cut out with a holesaw and jigsaw. As the box fits neatly between the deck beams, the fore and aft flanges are cut to the same depth as the beams. Finishing the box inside with a one-part polyurethane paint is optional.*

created a non-corrosive reinforcement to the foredeck when it was bonded and screwed in place. The flanges of a box shape produce much more stiffness than a flat backing plate. In this case, the forward and aft flanges are bonded to the wooden deck beams. This ties everything together. The flanges add to the strength of the beams and, in turn, the structure helps spread the load out from the windlass to the beams, instead of just straining the plywood and fiberglass deck.

I had previously considered having a bracket fabricated in aluminium or stainless steel but discarded those options. Stainless steel is excessively heavy and both metals required the job be outsourced, resulting in higher costs. Neither material bonds as well as fiberglass and both are subject to corrosion. I chose fiberglass because I could build the unit myself on board to fit precisely and bond it into

*After a dry run to be sure of a good fit, the underside of the deck was ground clean and resin-coated to seal the plywood. A filler of polyester resin, two-parts microballoons, four-parts milled fiber, one-part Aerosil to the consistency of thick peanut butter and catalyzed at 2% relative to resin content, bonded the box to the deck.*

the deck so that it became a structural part of the boat. For less than 20 hours of labor and about $50 of materials, I was able to beef up the foredeck and enjoy thousands more secure hours at anchor.

— A designer, boatbuilder and surveyor, Van Markos and his wife Lynne have cruised the Caribbean for 12 years on their custom Markos 38, "Daniel K," currently berthed in Vancouver, British Columbia.

*(top) To protect the windlass motor from saltwater, it's sheathed in a plastic container punched with small drain holes in the bottom. The top is securely duct-taped and wires and shaft housing are protected with sticky cork insulation. (bottom) Windlass motor installed under the box.*

## PROJECTS WANTED

If you would like to share one of your own boat-tested projects, send your articles to DIY PROJECTS via mail, fax or e-mail. Include a brief explanation and photos and/or sketches (don't worry, we'll redraw the art). Also, please include your mailing address and a daytime phone number or email address. If we publish your project, we'll send you between $50 and $250, depending on the published length.

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# Cure for a Malodorous Tank

3

**A quick fix to eliminate any unpleasant odors from holding tank vents.**

*Vetus No-Smell filter (model NSF16S) contains carbon-like particles to eliminate unpleasant odors that escape through the tank vent.*

The vent for the waste holding tank on our sailboat was thoughtlessly located upwind of the cockpit, which is fine if you never use the toilet. However, our boat is our floating home and the insufferable reek of sewage would defeat those who took an aft deck seat. After our last vacation onboard, we knew something needed to be done. Adding a filter on the vent hose was the solution.

The Vetus No-Smell filter (vetus.com) mounts inline with the vent hose and contains a special odor absorbing material. Four models fit hoses from 5/8" to 1-1/2" (16mm to 38mm) ID. Simple to install, the filter mounts in a convenient location, usually a bulkhead, between the tank and the vent fitting. Installation takes about 20 minutes and requires no special tools.

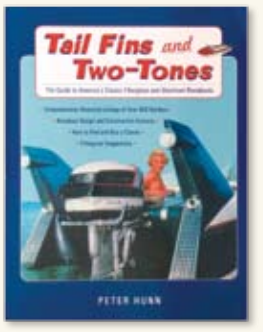
First, I needed to relocate the inline self-dispensing toilet chemical deodorizer to make room for the filter, which was then fastened to the battery box. After carefully measuring the distance from the tank to the filter, I cut the vent hose with a utility knife. The hose leading from the tank was slipped over the filter's "intake" connection; the vent hose over the "out" connection and both were secured with a stainless-steel clamp.

— Alain Solari's homebase is Ottawa, Ontario.

*Integral bracket secures filter to a bulkhead in the engine compartment. Vent hose is routed from the holding tank to the filter and exits out the hull.*

*Hoses connect to molded barbs on the filter.*

## •BOOK REVIEW•




### Tail Fins and Two-Tones by Peter Hunn

175 pages, Paperback (Devereux US$23.95)

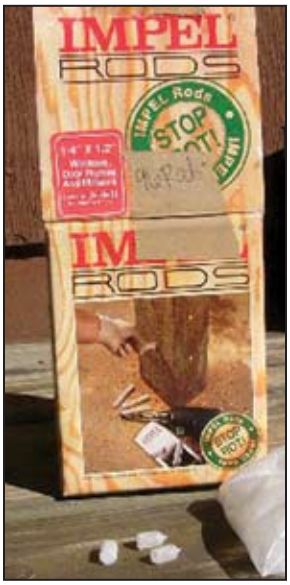
What a delightful book for lovers of the waterborne sports cars of the 1950s! This book uses wonderful archived photographs and advertisements that complement a comprehensive chronicle of classic fiberglass and aluminum runabouts. These designs, mirrored from popular carmakers, are widely sought after today for their classic quality. This book tells the enthusiast where they can look for a classic runabout, what to look for when inspecting the boat and fitting out suggestions. It's an excellent resource and a nostalgic indulgence. Tail Fins and Two-Tones is a delight.

# Chemo for Dry Rot

1

**An unusual method of delaying wood rot might buy you time before it becomes necessary to tackle a major refit.**

Although fiberglass boats don't present the problems of preservation that wood boats do, some older plastic boats contain a substantial amount of structural wood. For those owners blessed with wooden rudders, hull stringers, decks or cabins, rot can be a major headache.



*Solid borate pellets for rot protection.*

After a fateful foray onto eBay, my husband ended up with an elderly wooden Tancook schooner. That's when, through a Google search, we learned about Impel rods, borates and antifreeze, all used by the U.S. Navy and the National Park Service, as a way of stabilizing rot.

The use of borates, which are mixtures of borax and boric acid, and/or ethylene glycol antifreeze, as a wood preservative is on the increase. Borates have a 50-year history in New Zealand and Europe and are gaining acceptance in the home construction business here. We decided to give both antifreeze and borates a try and treated several soft spots on our boat's decks and dosed the bilges with a generous application of a homebrew mixed according to David Carnell's recipe posted at Simplicity Boats website (simplicityboats.com). Carnell has been using antifreeze for a number of years and shares his knowledge and his experience with it in a lively and detailed account at boatbuilding.com/article.php/ChemotherapyforRot/print.

After one hot, wet summer season, the preliminary results of our boat chemotherapy experiment are promising. A small untreated area of decay on our oak boom gallows that went undetected during my spring fling with antifreeze and borates had spread to involve about 18" (45cm) of wood by July. Yet immediately adjacent to that, a treated area of rotten wood at the bottom end of the gallows frame remained apparently unchanged from the time of initial treatment. After I dosed the newly discovered spot, it remained unchanged for the remainder of the summer.

Borate wood preservatives can be used as liquid, foam or solids. One widely used solution of borax, boric acid and ethylene glycol is available commercially in quarts (946ml) or gallons (3.78L) as Bora-Care. Carnell provides directions for mixing your own version of the stuff, if you need a large amount. We obtained the ingredients from McMaster-Carr's online store (mcmaster.com) and the neighborhood auto parts store. Carnell also describes using straight antifreeze against rot in his boats and a friendly mechanic suggested that we could use recycled antifreeze drained from cars in his shop to save money.

With or without borates, ethylene glycol antifreeze is hydrophilic and mixes readily with water. It also soaks into wet wood, unlike petroleum-based copper preservatives like Cuprinol, which must be applied to well dried wood but, because of its affinity for water, antifreeze also leeches out of wood that is constantly exposed to water. So, for a bilge stringer, rudder or other underwater boat parts it may not be effective.

Borates are also water soluble, though less so than ethylene glycol. Solid borate pellets, called Impel rods, are still more persistent and longer-lived in wet situations. The rods come in various diameters and lengths. To use, drill a hole and push the pellet or rod in and then cover the hole over with epoxy or putty to keep water out. The solid borates leach into the wood to provide rot protection whenever its moisture content hits 25% or more.

Because the minimum size they come in is about 1/4" (6mm), they're best used in larger timbers, such as found in an all-wood hull. If the hole isn't sealed and left exposed to water, they'll quickly leach away. The rods aren't particularly

# Surveyors

*(Continued from page 39)*

defined. The NAMS-CMS has met the requirements for full certification. The NAMS associate or apprentice is not fully certified but is on the path to that level of membership. A SAMS-SA is a "surveyor associate" who is in training, not a fully certified SAMS-AMS (Accredited Marine Surveyor). They are not unlike the "intern," "resident" designations for physicians but most consumers are cognizant of those distinctions.

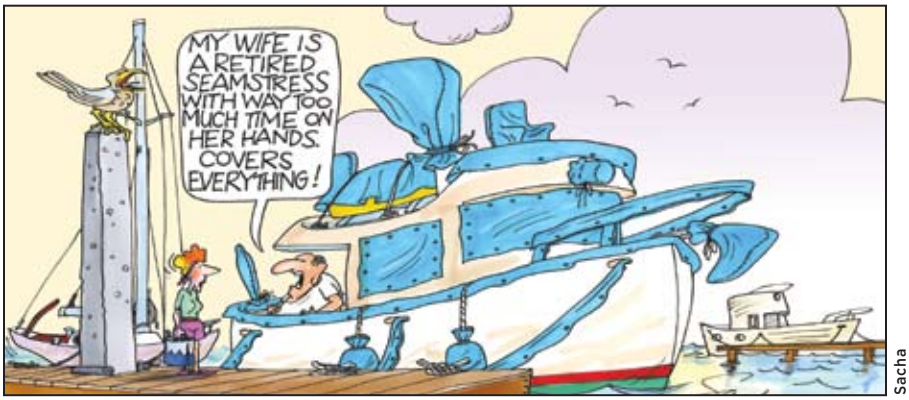
To get the seal of good boatkeeping on a surveyor, the key word in the search engine is "reputation." I can't speak for boat service and repair providers but my experience and intuition tell me that the same premises hold true there. Good reputations are well known and getting the services of those who have those reputations is only a matter of asking the question. "Who's the best?" That's pretty much what the doctor ordered and he and I are in agreement on that point.



cheap but, in some situations, they are worth every penny. They work best if, after using them, you can prevent further water leakage from reaching the timber. These anti-rot substances are less toxic than the oil-based preservatives like creosote (all carcinogenic hazards) and pentachlorophenol (penta) or arsenic-based preservatives to mammals. Ethylene glycol is attractive to pets so be sure to keep open containers away from wandering critters. And don't pump it overboard!

For more information and/or to order ready-made products, try these sites or do a Google search on wood preservatives and borates or check outewoodcare.com a log home site with various borate preservatives. An article by David Casebolt detailing experience since 1985 with borate wood preservatives on the San Francisco Historic maritime park ship collection is found at maritime.org/conf/conf-casebolt.htm.

— Susan Peterson Gateley sails a 1950 Ray Stevens-built Tancook schooner.




Sacha

(Continued from page 64)

and intercoolers on diesel engines are all sources of air within the compartment.

Boats also have ventilation openings in the hull or air ducting installed so the air from outside can be drawn into the compartment, diluting the hot air that the machinery inside generates. Air is drawn passively into the compartment through these openings whenever an engine is running. That engine sucks the ambient air into the combustion chambers via the engine air intake.

Powered ventilation (via a blower motor) is required by USCG regulations and ABYC standard H-2, in boats with gasoline engines, for dissipation of accumulated gasoline vapors, which as we have already cited, is a separate function from the air needed for combustion. In fact, it's not necessary to run these blowers beyond initial engine startup. Note, though, that blowers can also be useful, in any boat, to purge the engine room of accumulated heat after run time.

Testing a boat's engine space for sufficient air availability is done with a manometer, a simple pressure-measuring instrument at the engine's air intake. The boat is run at wide open throttle with the engine compartment securely closed, all hatches down and latched. Any reading other than zero inches of vacuum means the engine compartment requires more air to meet the needs of the installed internal combustion machinery (propulsion and auxiliary generator).

So, what's your engine's "appetite" for air? That depends on the size of the engine, the size of the engine compartment and the temperature of the outside air. It's critical that engine compartment ventilation capability exceeds the amount of air that the engine demands. In general, the larger the engine, the bigger the volume of air needed. A 350 cu. in. Mercruiser (gasoline fueled demands a minimum of 600 cu. ft. of air per minute (CFM). This, incidentally, also relates to the carburetor classification, which, for this engine, is rated at 600 CFM. The Volvo diesel manual suggests that the minimum volume of air for combustion should be 1.65 times the engine horsepower output. Don't forget that the genset needs its ration of air, too.

If you have engine performance concerns, are planning a repower or you're designing your own boat, use a manometer to verify that compartment ventilation is adequate for engine combustion. It's a lot simpler method than mastering the physics of making the complex calculations.

About the author: Roger Marshall is a boat designer and author of 12 books on sailing and yacht design. He has a boat design company in Rhode Island and he is the president of Boating Writers International.

View from the Stern

# Breathing Easy

***Restricted ventilation in the engine compartment directly affects the performance of your boat's engine.***

By Roger Marshall

Pat KEarns

*Air intakes enable air exchanges that deliver fresh air and dilute heat buildup within the engine compartment*

When a marine engine doesn't get adequate air, power and efficiency are sacrificed. The dynamics in play are actually quite simple. Engines take in a mixture of air and fuel, compress it and/or ignite it and the physics of internal combustion convert the energy to horsepower. Without enough of any of the required menu items, the engine suffers a form of mechanical malnutrition and just doesn't perform well.

Let's look at the facts related to this process. First of all, the availability of air for combustion is a completely separate issue from the need for "ventilation" of a gasoline engine space for the purpose of removing volatile fuel vapors. The issue we are addressing here is that of ensuring adequate air for engine combustion. Failure to provide for that will only result in less satisfactory engine performance. Failure to provide for the other could result in a catastrophic explosion, fire and personal injury or death.

Moving on to bringing combustion air into the engine space, we learn that cool air is denser than warm air and, the cooler the air an engine ingests, the more power it creates. So, taking in air from a hot engine compartment on a summer day can result in reduced power output from the engine and cost you money in terms of fuel economy.

Engine manufacturers recommend a maximum ambient temperature of 176F (80C) for an engine compartment. On a naturally aspirated diesel engine, power output drops about 3% for every 9F (5C) rise in ambient temperature.

The best thing you can do for your engine is to ensure that cool air flows freely and constantly, without obstruction, into the engine compartment. Blowers (powered ventilation) on gasoline-powered boats and turbochargers

*(Continues on page 63)*


*Manometer hose attached to air intake system inside engine compartment.*


*Fail: Manometer showing 2.5" (63mm) of vacuum at wide open throttle with engine compartment closed. This boat needs more air vents and the engine will be down on power and could vapor lock.*


Steve Auger

*Pass: Manometer showing no engine compartment vacuum at wide open throttle with engine compartment sealed.*