DIY boat owner
the MARINE MAINTENANCE MAGAZINE

# Columns



# Departments



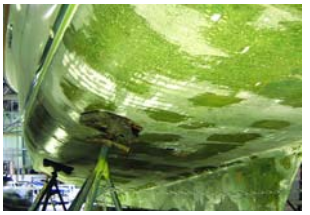
# Features

## 17 WET DECK? HERE'S THE FIX

Deck repairs are certainly within the capabilities of a determined boatowner capable of some simple fiberglass skills. Here is how one professional shop carries out major deck repairs. *By Nick Bailey*

## 24 FIRE ONBOARD!

Few boats have sufficient fire extinguishing systems to combat a fire, and even less are equipped to fight an engine compartment fire. The information in this article will inspire you to fireproof your boat. *By Susan Canfield*



## 36 OSMOSIS: A PESSIMISTIC UPDATE ON THIS PERENNIAL BUMMER

Is a fiberglass boat with blisters repairable or a structural nightmare? Because the inherent chemistry of polyester resin has resulted in an increase in blistered hulls and there are no long-term treatment guarantees, this professional says, "No" to both questions." *By Nick Bailey*

## 44 STAYING ONBOARD

Having a lifeline or railing system can reduce the possibility of a fall overboard but the systems on many boats are poorly engineered and alarmingly inadequate. Such a system gives a false sense of security against the consequences of going overboard. How does your boat fare?

## 48 FUEL WATCHDOG — MONEY IN THE TANK

A fuel computer is the only instrument that determines your engine's optimum running speed and mechanical condition, fuel range, ideal trim and load distribution. Install one and you can save as much as 20% in fuel costs. *By Dwight Powell*

## 53 JUNKYARD PAYOFF

Investing in a used "bargain" boat means you'll likely need to wear a lot of hats: designer, foreman, mechanic, inventor, manager, referee, critic, optimist. Here's one man's recipe for success.

# CURRENTS

[ EDITED BY JAN MUNDY ]

## MRT CLINICS A SUCCESS

From February to June of this year, DIY hosted MRT (Maintenance-Repair-Troubleshooting) Hands-on Clinics at 18 BoatU.S. stores. Here are some comments.

"I have already put some of the information you provided during your presentation at BoatU.S. in Amherst, New York into practice. Some of the products you recommended are excellent. Using the mast cleaning and polishing compound, for example worked better than any other product I have used in the past."

"My kudos regarding your excellent presentation and your publication were shared with BoatU.S. management and staff and other boaters in the area."

These MRT clinics continue with demonstrations on gelcoat refinishing and fiberglass repair at upcoming boat shows. Don't miss out! Below is our tentative show schedule. Check DIY ONLINE at www.diy-boat.com for updates.

**West Marine Trawler Fest**, Solomons Island, Maryland, Sept. 24-28
**United States Sailboat Show**, Annapolis, Maryland, Oct. 10-14
**United States Powerboat Show**, Annapolis, Maryland, Oct. 17-20
**Sail Expo St. Petersburg**, St. Petersburg, FLorida, Nov. 21-24
**St. Petersburg Boat Show**, St. Petersburg, Florida, Nov. 21-24
**Toronto International Boat Show**, Toronto, Ontario, January 11-19, 2003
**Strictly Sail Chicago**, Chicago, Illinois, January 30-Feb. 2
**Strictly Sail Miami**, Miami, Florida, February 13-18
**Pacific Sail Expo**, Oakland, California, April 23-27
**Pacific Powerboat Expo**, Oakland, California, May 1-4

## A Big "Fan"

I was one of the winners of the Vetus Fan 12 from your DIY Product Info Draw. When I received the fan, I wondered what the heck I was going to do with it. Now I have installed it to blow warm air out the compartment that houses the refrigerator compressor and inverter. This compartment has always been about about 20° warmer than the rest of the boat. After installing the fan, the compressor-inverter compartment is much cooler. Thanks for the fan, and your great magazine.
*Rob Linehan, Punta Gorda, Florida*

## Wish I Had Waited . . .

Prior to receiving advice from DIY's Technical Helpline on how to fix a leaking hull-deck joint on my Tanzer 26 (see "Leaking Deck Joint" on page 9 in DIY 2002-#2), I pulled off the rubrail, and as you indicated, it shrunk by about 38cm (15"). I managed to reinstall it with help and a heat gun working it inch by inch, but it's not a tight fit. I've taped the full length of the rubrail as a temporary fix but know it'll peel off. I'll try caulking as you suggested. I've since learned that the proper way is to soak the rubrail in hot water and then stretch it while fastening. A friend said he once helped a guy stretch one by hitching it to his van.
*Peter Henderson, "Tranquility," Mimico Cruising Club, Ontario*

## COVER UP = LESS MAINTENANCE

When laying your boat up for long-term storage or the off-season, purchasing a good boat cover protects your investment with the added benefit of less maintenance when the time comes to relaunch. An inexpensive cover is one made of shrinkwrap. This weatherproof material resists all types of weather conditions. It'simple to install with a support system of woven cord strapping and wooden uprights laid under the shrinkwrap to prevent rain and snow from accumulating on the cover. Then the "wrap" is heat-shrunk, providing a tight seal around the entire boat to eliminate water-related damage. Because shrinkwrap fits like a glove and is lightweight, it won't chafe the hull or rip from movement like heavy poly tarps or canvas.

To reduce moisture and mildew problems, shrinkwrap covers must be ventilated. Mounting several inexpensive push-on, snap-on or self-adhesive ventilators made by Airlette directly to the fabric provides the needed airflow. Adding a zippered access door lets you work on your covered boat.

Installing a shrinkwrap cover is made easier with help from Dr. Shrink (Tel: 800/968-5147; Web: www.dr-shrink.com) who offers a training video that outlines the steps involved. (Shrinkwrap is also a recyclable material. Check with your boatyard to make sure they are taking advantage of this feature.)

Heating a rubrail, either by placing it in hot water or in direct sunlight, softens the rubber and makes installation easy. DIY 1997-#4 issue features complete step-by-step installation procedures for all types of rubrails including the flexible ones, aluminum, rigid and semi-rigid vinyl, stainless steel and sailboat rails.

## Kudos for DIY

I read your magazine cover to cover and my library includes every issue. I stow these in a binder aboard my boat at all times and whenever I get a chance, I review articles of interest, which is most of them. The latest issue containing "Tips from the Pros" is excellent (DIY 2002-#1). *Monte Pacey, "Tanzanite II," Rockport, Ontario*

## More KISS

The article titled, "Mechanic in a Bottle," in DIY 2001-#3 issue, addresses a revered subject from my days working with Texaco. True, gasoline can deteriorate and lose octane. The article didn't mention another fact. As the fuel handling system develops gums, varnishes, sludge, deposits, etc. the octane requirement actually increases. For a clean system, 87 octane is okay; a slightly fouled system may require 88 or 89. Keeping the whole system clean all season long and during storage can circumvent the need for an octane booster. I foresee the need for a gasoline supplement that has to be added with each fill-up to ensure system and engine cleanliness, especially for the four strokes. Additionally, the author mentions methyl hydrate as a water absorber. This is distinctly inferior to using isopropyl alcohol, which forms a true solution and not a miscible, milky suspension as happens with Methanol. *Abe Kelly, Captain Phab Marine and Recreational Care Products*

Steve Auger replies: I have decommissioned hundreds of boats in the past 30 years and I'm still learning new tricks to apply; however, this information on octane and isopropyl alcohol is not new. Though I agree with Abe's comments, for every situation there is going to be a different method of correcting a problem. The procedures identified and outlined in this article incorporate the use of products specifically designed for consumer usage. Go into a marina and ask for isopropyl alcohol and you'll likely be given directions to the nearest liquor store! Most boats don't have a clean fuel system from the factory due

## TIP Shock Treatment

When working on your boat outdoors and operating any AC-powered tools, especially near wet areas, make sure you're plugged into a connection with a ground-fault circuit interrupter (GFCI) protection. Purchase a portable fitting to carry in your toolbox and use it! Should this device sense a short to ground, it instantly trips the circuit.

to assembly debris. If a new boat is test run by the manufacturer then shipped to a dealer where it sits for four months, the dispersant damage has already been done. This is why mid-grade fuel should be used when the boat is put into storage. As dispersants build up each time the boat is not used for a few weeks, adding two-cycle oil in the decommissioning fuel will suspend these dispersants. Best to keep it simple.

## DIY Readers Vote for Performance

In the survey posted on DIY ONLINE for the first two weeks in July, 43.3% of boatowners said they would purchase a new propeller to obtain better performance; 31.5% would purchase a new one to replace a damaged prop; and 24.5% are interested in a new prop to obtain better fuel economy.

Another prop question followed, only this time it asked readers to vote on the type of prop they currently own. Not surprising, it was nearly a tie vote: 44.3% of boatowners said they have aluminum props; 43.5% have stainless props; while just 12% have composite props.

To cast your vote in our next two-week poll, log onto DIY ONLINE at www.diy-boat.com. Results are post in DIY ONLINE and in the next DIY print issue.

## Smart Tab Recall

After installing and testing Smart Tabs (documented in DIY 2001-#2 issue), and one-season usage in freshwater, we had some concerns about the construction and use of corrosive or dissimilar metals. While these tabs certainly enhance overall performance, the piano hinge and ball studs holding the gas struts to the tabs showed evidence of rust. The pin rusting and bleeding through the hinge, as shown in the photo above, caused corrosion on the polished stainless hinge.

According to John DeAgro of Nauticus, Inc., the company has changed suppliers and tab kits are now equipped with all-304 stainless-steel components. Some early units apparently had parts constructed of 301 stainless. Though the company did a recall and replaced the inferior parts, the kit installed by DIY managed to slip through the system.

If your boat has these tabs and you have experienced any corrosion problems, contact Nauticus, Inc., toll-free at 800/233-0194 or log onto its website at www.nauticusinc.com.

## Value Added Bottom Protection

Applying a barrier coating system may not protect your boat's bottom but also increase its resale value. Interlux Yacht Finishes conducted a research project in 2001 to calculate the value of applying InterProtect Epoxy Barrier coat system to hull bottoms.


After surveying more than 1,000 national advertised boats for sale, InterProtect was found to increase a boat's value by as much as 14 times the cost of application. This means that 3.78L (1 gallon) of InterProtect can add up to US$800 per litre (gallon). On a 9m (30') boat, this translates into more than US$2,500. The survey included boats with InterProtect and non-InterProtect hulls.


## Masthead

DIY boat owner the MARINE MAINTENANCE MAGAZINE

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# SPARE PARTS

## Site for Pearson Owners

If you own a Pearson 26, check out this website run by a guy named Dan:http://my.en.com/~danp/boat/boat.htm. For repair info click on the "Repair & How to" icon.

# RUST SOME MORE

We anchor a lot so the anchor and chain are well used on our boat. Yet every time we use our 91.4m (300') rusted anchor chain (FIGURE 1), it leaves rust deposits on the deck and bow pulpit. Rather than replacing the chain, an expensive option, we decided to try coating it with Pettit Trailercoat.

The first chore was to remove any flaking rust. We tried wire brushing but it was neither easy nor expedient. Using West Coast ingenuity, we attached the chain to our pick-up truck and dragged it through a local sand pile (The truck got stuck!). This knocked off most of the heavy rust (FIGURE 2) but still didn't clean between the links. (It did generate a lot of interest at the local gravel pit.) We then tried a chemical scrub, actually a radiator hot-dip tank followed by an immersion rinse in clean water, but without any better results.

Trailercoat is a bright, silver-colored urethane coating commonly sold as a rust arrester for boat trailers. Applying the product with both foam and bristle brushes was futile as painting the individual chain links proved difficult. A better method was to immerse the links into the coating (FIGURE 3). This was messy but fully coated each link. The full 946ml- (1 quart-) can only coated about 45.7m (150') of chain; brushing would go farther with less waste but was much too finicky to cover each link, especially where links connect. Left to dry for one week, the coating appeared very hard (FIGURE 4), though some links were stiff with excess paint, most of which was eliminated by stacking and restacking the chain.

With the chain installed back onboard, we tested the endurance of this product, anchoring in various bottoms composed of sand, rock and sticky mud. After six uses (FIGURE 5), all excess coating had worn off and small rust spots reappeared, particularly where the links rubbed against each other (this could also be where the coating was not perfectly applied). The overall condition of the chain after 11 uses was still satisfactory although the entire coating had dulled considerably (FIGURE 6). There are small chips where the chain wheel meets the chain; these will rust in time.

This is probably not the proper application for Trailercoat, but for those of us stubborn enough to experience with different products, the experience was worth it. It appears we will get at least one more year of use before we need to consider replacing the chain. The conclusion that you only get what you pay for comes to mind when purchasing chain. I saved $100 purchasing chain made offshore, but the galvanized finish quickly gave way to rust.

*— Doug Wade, Langley, British Columbia*

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4

FIGURE 5

FIGURE 6

## CLOSE ENCOUNTERS

How likely is your boat to be struck by lightning? Climate is a key factor. Where there are thunderstorms, there is lightning. The U.S. National Oceanic and Atmospheric Administration (NOAA) publication "Storm Data" summarizes lightning-related fatality, injury, and damage reports for the years 1959 through 1994. During that period, an average of 566 property damage reports were made annually. Casualties were most frequent on Saturdays and Sundays when more people are outdoors, at the beach or on their boats. Recreation was the largest loss category in every region and for the country as a whole. The top five states for total casualties were Florida, Michigan, Pennsylvania, North Carolina and New York. When population was taken into account, however, New Mexico and Wyoming were tops.

— Sue Canfield

# Talk Back Q&A

**HELP LINE 1-888-658-2628**

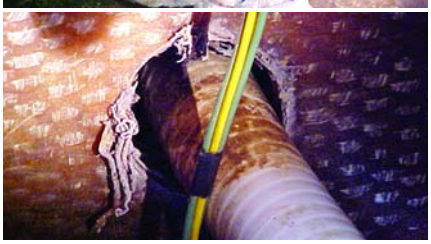
## Fiberglass Eating Fungi

**Q:** Please tell me how to kill these things growing in the bilge on my 10 Meter Trojan. I've pulled it off and sprayed with bleach, yet it grows back. It seems to be growing from the wood core between the fiberglass laminate.

*Dave Baker, Hendersonville, Tennessee*

**A:** This is certainly the weirdest problem we've yet seen on a boat. According to Jeff Tieger of StarBrite, you have a wood-decay fungus that is eating the sugar (residual sap) in the wood. It will, eventually, destroy the layers of wood between the fiberglass. An application of Borate wood preservative is a simple and effective control method. Borate is highly toxic to all fungi, yet it's odorless, non-corrosive, will not discolor wood, environmentally safe and less toxic than table salt, which makes it safe to use in the bilge and to pump overboard. Drill a few holes in the surrounding glass to ensure the Borate migrates into the laminate and kills the spores. It's also recommended that you excavate any damaged wood, apply a coat of unthickened epoxy resin then fill the cavity with epoxy resin thickened with colloidal silica and microfibers. Sand the surface flush and either paint or apply three coats of unthickened epoxy. Fungi grow in areas of high moisture, typically over 20%, which, in a warm environment, spreads quickly. To prevent reoccurrence, you'll need to plug any sources of water penetration to keep the bilge dry and ventilate the bilge by adding vents in the floorboards, bulkheads, etc.

*— Jan Mundy*



## Saltwater Bound

**Q:** I'm taking my 2000 SeaRay 290 Sundancer from fresh- to saltwater. It's powered by twin 5.7L MerCruisers, with Bravo III drives, raw-water cooling and just 90 hours running time. The boat will be dry-stack stored when not in use and after each use, but I'm concerned about the short-term and long-term effects of saltwater on engines, outdrives, hull, canvas and hardware. I have received widely mixed opinions about saltwater boating, including being told that "it'll eat the boat alive." Any advice?

*Ed Hoover, "Present Dreams," Hammond, Indiana*

**A:** Installing a closed-cooling kit reduces the potential for saltwater damage to the engine block only. (Ed: Refer to DIY 2001-#1 for an article on kit selection and installation.) The stern-drive unit, transom assembly and exhaust system will still be exposed to saltwater. Run the engine on a freshwater flushing system and spray the transom assembly and stern-drive unit with freshwater after each use. For longer storage periods, follow with a spray of corrosion guard over the entire engine, drive and transom assembly. Ensure the correct (saltwater) sacrificial anodes are used and frequently

check the Mercathode system operation. While doing this, hose down the entire boat, cockpit, hardware, canvas, etc.

*— Steve Auger*

## Overcoating Epoxy Decks

**Q:** After epoxying and fiberglassing the foredeck of our sailboat, we solvent washed the surface and sanded with 120-grit prior to applying Interlux Brightside primer. It took three days for the primer to dry (high temp, high humidity) but now after seven days it appears to have bonded well. We contacted the Technical Service Helpline (Tel: 800/468-7589) and was informed that Brightside should not overcoat epoxy and must be removed or it will peel or blister off. Do we have to remove it and is sanding the best removal method?

*David Aiken, "Atelier," Grasonville, Maryland*

**A:** Jim Seidel of Interlux doesn't recommend applying any single-part topside paint directly over newly cured epoxy. Apparently, the amine blush, a common byproduct of cured epoxy, mixes with the driers in the paint and the finish won't dry. Two-part finishes, like Interthane Plus, are less susceptible to amine blush. Better to allow the epoxy to cure for about a week or longer, then remove the water-soluble blush with soapy water and wet sand with 120-grit paper (always use 3M Freecut paper to prevent paper loading). As for a primer, it's best to apply a blush-free polyamide epoxy, such as Interlux 404/414, then sand and apply the topside paint. To

solve your problem Seidel recommends sanding well with 220-grit paper and wipe down with Interlux 333 thinner. Then try a small test patch, applying Brightside thinned 10% with 333. If it dries, paint the rest. If it doesn't, sand to remove all the primer, then paint with 404/414 and Interthane Plus. This paint is a better choice for decks as it's much harder than Brightside, but it cannot be applied over Brightside primer.
*— Jan Mundy*

## Fix for Parquet

**Q:** I have a 1985 9.7m (32') Island Gypsy with parquet in the salon. Moisture over the years has caused the joints to yellow and in some places to become lose. What is the best fix?
*Robert Goslee, "Lady K," Wilmington, North Carolina*

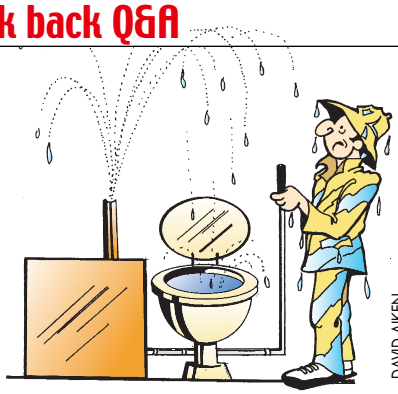
**A:** Ric Steeves of Noah's (Tel: 416/232-0522, Web: noahsmarine.com) suggests that the yellowed glue indicates that it's broken down and is letting go, resulting in some loose panels. He suggests you lift up a panel to check the condition of the flooring. You may find moisture damage and delamination or other damage. A quick short-term fix is to sand the panels to bare wood, (I assume the panels are teak), then coat the entire floor with three coats of clear epoxy (unthickened). Check that the face veneer is thick enough to allow sanding without sanding through (do a spot test first). Depending on the width of the gap between the panels, you may also want to rout out the joints, about 3mm to 4.7mm (1/8" to 3/16") or so, so the epoxy fills the joints.
*— Jan Mundy*

## Head-Mastery

**Q:** My newly purchased Hughes North Star 35 is a beautiful boat with few problems, except a head that doesn't work. Try pumping out the bowl and green liquid (likely antifreeze) spills out the deck pump-out fitting. Do I need to replace the Kracor tank? Please advise my least costly repair option?
*John Czura, "Fandango," Toronto, Ontario*

**A:** It sounds to me that the vent hose from your Krakor holding tank is plugged or kinked. All waste tanks must be vented — air escapes from the tank as fluid is pumped in — otherwise, the tank becomes pressurized when pumping. The vent hose is the smallest of the three hoses connected to the tank. The other two are the pump-out hose leading to the deck fitting and the sewage discharge hose coming from the head. Pressure forcing the

# Talk back Q&A

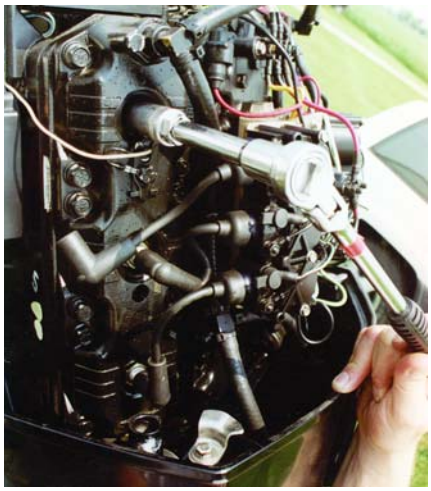

DAVID AIKEN

tank contents out onto the deck also happens when the tank is full to the brim. In this circumstance, provided the vent is not clogged, the effluent is also forced out the vent fitting on the side of the hull (Are you having fun yet?). First, fix or replace the vent hose, then get a pump out to get rid of the antifreeze. Don't to this until you know the vent is clear as the suction of the pump-out machine can crush your tank flat like a kid sucking on the straw of a paper drink container. *— Nick Bailey*

## Binding Cranky Outboards

**Q:** I forgot to remove the battery from my 5.8m (19') ProLine, while stored on a trailer. When recommissioned, the 115 hp Yamaha outboard engine ran great for 20 minutes. On my next trip, the flywheel turned several times then stopped. I ruled out a bad battery and solenoid and brought the starter to an electric shop where it tested okay. The lube system works fine, and there is good water flow. Still the motor turns over, then seizes up after about eight cranks. Could the battery (there is no disconnect switch) have caused some electrolytic corrosion in the dissimilar metals of the bearings, piston rings or cylinder walls? *Rick Paliuca, Westerly, Rhode Island*

**A:** You need to do a few simple engine diagnostics. First, check the spark plugs for rust or water. Reinstall, then crank the motor until it stops and check the plugs again. If there is no water or rust, remove your gearcase fill screw, drain the oil and check for excessive metal filings or water. If either shows in the



oil, remove the gearcase and crank the motor. If it still locks up you may have an internal engine problem or a problem with the flywheel-to-stator clearance. Have these checked by an authorized dealer.
*— Steve Auger*

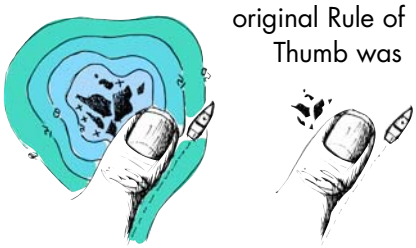
## Resizing Rudders

**Q:** I have a 1937 8.5m (28') wooden boat with a really small rudder. The steering is unresponsive in reverse and at slow forward speeds. I was thinking of attaching a larger plate to the existing rudder to increase its surface area with the hope that it will also increase steering control and responsiveness. Do you know of any sources on this as to how to size and shape the add-on piece, how to attach it to the existing rudder, or the effectiveness of doing it? *Jerry Kerner, Hastings on Hudson, New York*

**A:** Normally rudder size is based on a percentage of lateral plane, or lateral profile of the boat, often factoring in the sail plan for sailboats. If you have the plans, a naval architect can provide the calculations. When drawings are not available, which I'll assume is in your case based on the boat's age, it's trial and error. Mark Ellis, most notably known as the designer of Cabo Rico, Liberty, Niagara and Nonsuch boats, suggests a technique that was once common on wooden racing boats. On meter boats, for example, a strip of copper or Monel is attached to the rudder's trailing edge. This presented a fine edge, unobtainable with wood. Ellis suggests starting the trials by attaching a temporary piece to the trailing edge. Use inexpensive aluminum flashing and start with a 3" wide strip. This low-tech approach may require numerous haul out and relaunching, so you'll need to negotiate a rate with the yard. Once you have determined the most effective profile, make a permanent one of copper (or stainless steel). The copper need not be of a gauge heavier than copper weather stripping. Cut it with shears, cutting pieces out to more easily bend the plate. The finished piece would fold in half and fasten with screws or rivets to the rudder sides. Apparently, it's not necessary to fair the plate into the rudder as the thickness of the plate won't make much difference. Without knowing how fine the trailing edge of your rudder or its construction, you may need to modify this approach. *— Jan Mundy*

# TECH TIPS

**THUMB'S LEAD:** According to "The Small Boat Skippers Handbook" by Geoff Lewis, the original Rule of Thumb was



probably derived from the practice used by shipmasters never to approach a danger at sea nearer than their thumb's width on the chart, regardless of the chart's scale. The theory was that they could navigate closer to dangers on a large-scale chart, which was very detailed, than would be advisable on a small-scale chart with less detail. *Bert Small, Salt Spring Island, British Columbia*

**A CLOSE SHAVE:** An easy way to remove the brown "moustache" that develops at the waterline in southern waters is to use wood bleach sold at hardware stores. Use 2 to 3 tablespoons per quart of hot water, mixing to dissolve. Spray on and wipe off. Surprisingly, this mixture also removes rust stains from clothing without damaging fabrics. *Sharon Duhaime, "Lead Free Too," Harrison Twp., Michigan*

**MORE USES FOR PLASTICER:** Use Plasti Dip, a brushable liquid plastic, to seal the edges of any openings that allow access to storage compartments, such as a ski locker under the seats, or for "donuts," those passageways in bulkheads and lockers for cables, hoses, wires, etc. Instead of a rough-cut fiberglass or wooden edge, you'll have one that's gentler on the contained components and one's hands. *Mark Yeates, "Knotty Thots," Thornhill, Ontario*

**POWER-LESS DRILLING:** Use a cordless drill when drilling into fiberglass to install hardware, take a core sample, effect repairs, etc. Fiberglass laminates can harbor water that could squirt out under pressure and cause an AC-powered drill to short out, even shock the user. When using any AC-powered tool outdoors, especially near wet areas, always make sure you've provided the connection with GFCI protection. It's cheap life insurance. You can purchase a portable fitting to carry in your toolbox.

**BUNK IT:** As a restorer of wooden runabouts, I recommend storing all wooden trailerable boats on bunk trailers as opposed to roller types. Even some "Tupperware" boats, over time, can develop roller dents permanently impressed into the hull. *Doug Powles, Bellingham, Washington*

**STAINLESS CLEANER:** To remove salt deposits and do a general cleaning of stainless steel and other metals, make a paste of water and Bar Keeper's Friend, available at grocery and hardware stores, and apply with a white 3M ScotchBrite scouring pad. *Suzy Holland, Ft. Myers, Florida.*

**GOOD PULSATIONS:** To locate wet areas on deck, take a basic ordinary ohmmeter (multimeter) and measure the electrical resistance between bolts and screws that secure deck fittings. Where the core is wet, resistances are in the 10,000-ohm range. Dry plywood registers resistances over 1,000,000 ohms. Where there are no bolts or screws drill very small holes in the underside of the deck. Tap small finishing nails into the plywood and measure the resistance between them. *Geoff Moore, "Tinker Belle," Toney River, Nova Scotia*

**PULPIT MOP WRINKLE:** Don't throw out your old boat mop. Instead, carefully remove the fibers from the

end piece, then loop and tie them over the ends of the bow pulpit. This provides an effective way to protect the foot of a genoa or jib from chafe. At the very least, you'll have a conversation piece.

**PROTECTIVE CLEAR COAT:** 3M Paint Protection Film is the ideal material to protect hulls from scratches and

dings from dinghies, water skis, swim ladders, etc. This clear, self-adhesive film, more commonly used as an automotive bug shield and sold at auto supply stores, is available in 10cm or 20cm (4" or 8") strips, 1.82m (6') long. To apply, wet the surface with a 50% water and isopropyl alcohol solution, peel off the paper backing and stick it on. The wet surface lets you reposition it easily. Barely visible, the surface color shows through, it won't yellow from sunlight and lasts forever unless it gets torn.

ELECTRICAL

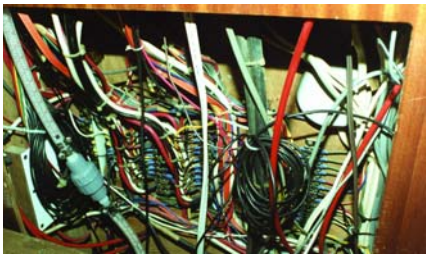
# WIRING MYSTERY UNRAVELLED

The need to replace an older fuse panel leads to an upgrade of this cruiser's entire electrical system.

[ BY DWIGHT POWELL ]

Last year about this time, I wrote about a plan to rejuvenate the electrical wiring onboard "Wiking," an 11.2m (37') Egg Harbor Double Cabin with twin 427 Crusaders. The entire system was housed under the wheel at the main helm console and consisted of household-type components, such as a common breaker panel and solid core copper wire for the AC circuits. On the DC side were Klixon breakers that don't allow shutoff except in the event of a circuit overload. These components have worked well for 34 years, but the installation didn't meet the American Boat & Yacht Council (ABYC) standards and prevented our ability to expand the system.

This major refit involved installing high amperage alternators, new electrical panels, battery switch and charger, and inverter to replace the 7.2 kW gen-set. For the most part, I stayed with the original plan, though there were a few changes made, which are mentioned below.

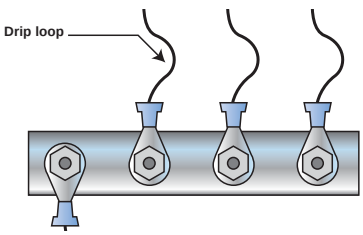


**BEFORE** *"This was intimidating because I'd look at it and say, "How are we ever going to figure this out."*

**AFTER** *"AC and DC are rather simple, straightforward, not hard as hard to do as I thought."*

## Raising the Power Grid

This refit began with the purchase of two new 100-amp "smart" alternators from Battery Shack in Florida. These units have built-in regulators that apparently work like the three-stage battery chargers. Charging begins with high amperage to bulk charge the batteries, and then amperage is lowered while keeping the voltage high until batteries reach full charge, after which volts drop to a float voltage of about 13.25 volts. So far, these alternators have worked flawlessly, and the great thing about them is the single wire hook-up as the case is grounded to the engine. Purchasing and installing a Xantrex TRUEcharge 40+, a 40-amp multistage battery charger, gave the flexibility to charge the batteries on shorepower. These chargers are relatively small, light in weight, make no noise whatsoever




GUY DRINKWALTER

***Building, staining and varnishing the box for the panels took about 6 hours. Box top hinges and opens for easy access to wiring. (right): Though it wasn't done in this installation, you should always provide a drip loop, just after all connections.***

***Terminal blocks were robbed from the original AC panel and securely mounted for ganging all common (white) and hot (black) wires. As it's not necessary to run each circuit back to the AC panel, just the one common heavy-gauge wire to each of the A and B common buses on the panel, this greatly simplified AC wiring. Each individual circuit was "hot spliced" into new stranded cable. Green tape was used to identify circuits.***

and do an excellent job of charging and maintaining batteries.

The boat's current battery set up includes two Group 30 deep cycle batteries for the house system and one group 30 deep cycle used exclusively to crank both engines. As the house and starting (or cranking) batteries are completely isolated, they can be paralleled for an emergency-starting situation using a special 100-amp battery switch panel from Blue Sea (#8080). This DC parallel circuit switch features a 100-amp breaker for the house side, an On-Off switch for the cranking side and an emergency cross connect circuit for starting the engine from the house bank. Each of our two alternators is separated as well, one for the cranking battery and the other for house duties.

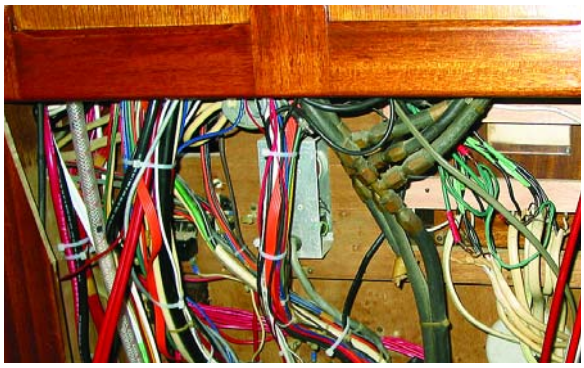
## Panel Picks

Panels were ordered and few weeks later arrived from Paneltronics (Tel: 800/36-PANEL, Web: www.paneltronics.com). This south Florida-based manufacturer designs and builds panels of all sizes to the buyer's specifications. Panels are top quality and shipped completely wired and labeled, where possible. My set up required an AC panel (#3307) measuring 35cm x 25cm (13.75" x 10") with 12 AC breakers oriented in two buses, two 30A shore cords, one 30A inverter and volt and amp meters.

***Adhesive-lined, heat-shrink tubing is "hot spliced" to the connector after crimping, then "melted" with a butane torch. Once the glue hardens, it will never come apart. Tip: Keep the torch moving to avoid damaging the wire insulation.***

## Electrical

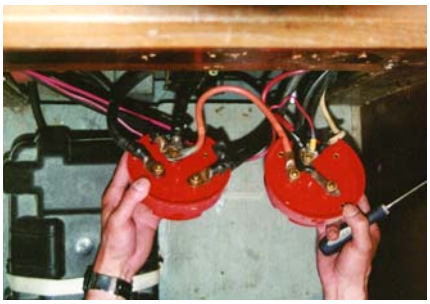
***Identifying the old circuits and cleaning up the old wiring (left) and tie wrapping into bundles (below) was a time-consuming job, taking about 8 hours. Not surprising, Egg Harbor had a wiring "plan," though this wasn't in writing, many wires were color coded, which simplified circuit identification.***



***Terminal blocks from right to left: DC house circuits; starboard engine circuits; port engine circuits; tach circuits and remainder to be identified; and house busbar.***

For the DC panel (#5202), 24 breakers divided into 5, 10, 15 and 20 amps, and a cutout for a Link 10, resulted in a panel that measured 28cm (11") square.

Installation of the AC and DC panels was routine, especially after I decided to move their location from under the wheel to the starboard cabin side near the lower helm. My original plan involved removing the original cabinet, then trying to reconstruct the wiring, a task that left me somewhat uneasy. The change placed the new panels where we could monitor them at a glance and easily operate the switches. Wires and leads were moved one at a time and in the process, we cleaned up a few poorly done prior hook-ups and gained a better understanding of our overall electrical system.



***Two three-way battery switches are removed (top) and replaced by a DC Parallel Circuit Battery Switch (bottom). TRUEcharge 40+ multi-stage battery charger at 40-amp output is one of the biggest available.***

As mentioned above, present on the AC side is solid copper wire leading to each fixture. Rather than tear the entire boat apart and route all new cables, I decided to crimp to these new stranded wire leads to the new panel. I was told that a crimp-type butt connector would work so first I did a test crimp and it held perfectly. Adding adhesive-lined shrink tubing at each joint produced a solid, waterproof connection. I'm sure this method doesn't meet ABYC standards, but it appears to be a strong compromise as routing new cables from the original busbar was totally unworkable.

Fortunately, the terminal strip that carried all the DC house loads was easily located and wiring simply involved removing the old wires and connecting new ones and routing each to the panel. Amperage loads were carefully matched from each AC and DC fixture to the appropriate sized breaker. It was a relatively simple matter to fish wires to the new panels for both the AC and DC connections. All wires were then well secured with nylon wire ties.

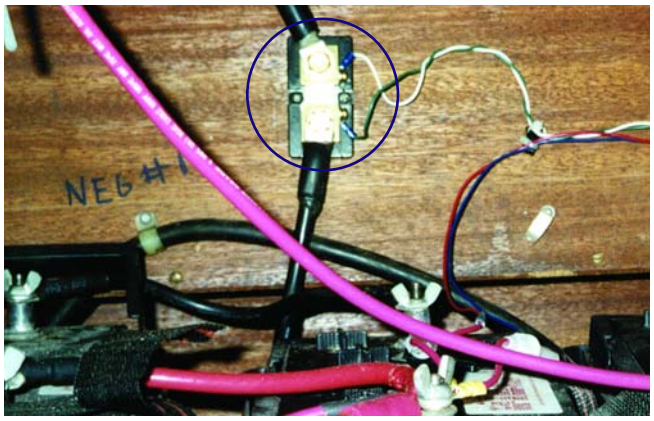
Much to my surprise, each panel and all circuits worked perfectly when turned on and put into service. The breaker switch indicators are amber for DC and green for AC with red lighting the labels from behind. The night lighting system is impressive, even somewhat sexy. The system has now run for a few months with no overheating or blown breakers.

Paneltronics includes meters to monitor voltage and amperage in its AC panel. To monitor our DC side, I installed a Xantrex Link 10. As amperage is the flow of electrical current through a power system, it's important to know at any given time how much current your system is

### DIY REFIT BILL

| | |
|---|---|
| 2, 100-amp alternators $270 each | $540 |
| 1 DC Parallel Circuit Battery Switch | $150 |
| 1 5202 Premier DC panel | $334 |
| 1 3307 Premier AC panel | $527 |
| TrueCharge 40+ | $500 |
| Link 10 | $250 |
| Ancor Marine Grade Wire and cable | $500 |
| Miscellaneous connectors, heat-shrink tubing, busbars, etc. | $250 |
| TOTAL | $3,051 |

Note: All costs are approximate and in U.S. dollars. Make sure to consider the ignition protection requirements for this gasoline engine powered boat. ABYC E-8 and E-9 are the guidance standards.



***Shunt for Link 10 is included with unit.***

using. Excessively high amperage can cause heat build-up that, at extremes, lead to a fire. When rebuilding a system, give strong consideration to the addition of monitoring devices. I don't think you'll be sorry.

## Improvements

We initially intended to sell the gen-set and purchase an inverter instead. But after using the gen-set last summer and earlier this year, we decided to keep it to charge batteries or run the air conditioner, and then add a slightly smaller inverter for the fridge, microwave and the few AC lights we need from time to time. With a 1,500- to 2,000-watt inverter and a gen-set we can have the best of both worlds. Adding a DC fridge may follow, but the new inverter easily powers our current household-type AC unit, albeit for only 12 hours or so on our current battery capacity, which inevitably also needs expanding. Still to install is a West Marine/ Yandina battery combiner (www.yandina.com). This small black box automatically connects the batteries together when there is a charge of 13.8 volts or more for the purpose of charging. When voltage drops below this value, it separates the batteries so one cannot drain the other. Everything is now grounded to the engine, but will be transferred to a large brass, tin-plated plate mounted to the hull when the boat is hauled for winter storage.

The planning and installation of "Wiking's" new electrical system took about 40 hours to complete. This project has proven to be less painful than I originally thought and works very well. There's still much work to tidy things up and of course an inverter to add when the budget permits, but we're quite content with the way things turned out.

[Ed: Dwight's original wiring refit article, "Classic Egg Born Again," appears in DIY 2001-#3 issue.]

*Now that Dwight Powell has nearly completed this major wiring upgrade, he plans to construct a new helm console for the newly installed FloScan fuel flow instruments (article appears on page 44) and some other electronic goodies.*

PROJECTS

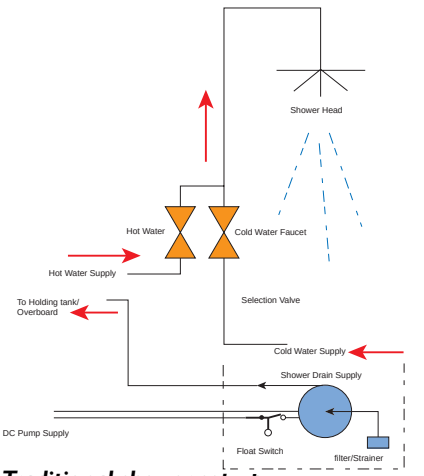
## WATER SAVER SHOWER

This spin on the basic shower set-up alters the water intake and sump drainage to allow long showers while conserving water.

[ BY JOHN PAYNE ]

A hot shower is one of the great luxuries on any boat. The biggest barrier to enjoying a long, hot shower after a cold, wet day is simply the need to conserve water. Water conservation conveys a greater cruising range by cutting down on the need to head for port for water. After coming across a similar system in a friend's boat, I opted to convert my shower drain system. Essentially the system upgrade allows you to have a very long and hot shower with a minimum of water consumption.

A shower sump usually has a submersible drain pump. A float switch also controls the pump. Jabsco manufactures a diaphragm pump that can be directly connected to the shower sump. I have also used the Whale Gusher pump with some success as these pump types seem to be less prone to clogging with hair and soap, a constant problem with submersibles and float switches. In this type of system, the shower drain sump has a suction line or pipe that goes to a separate diaphragm pump.

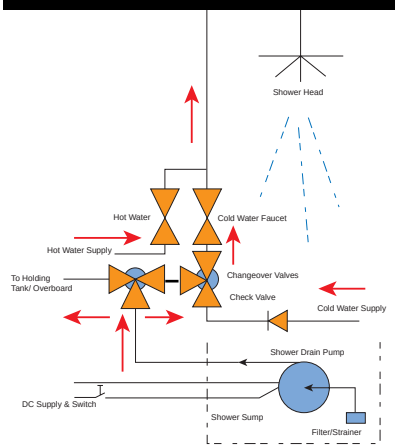



***Traditional shower set-up.***

A standard shower system, illustrated on the bottom right, consists of two water systems, the water supply system that delivers hot and cold water to the faucets and the shower-spray head. The drain, or grey water side of the system consists of the shower sump, drain pump, a float switch, possibly a strainer, the overboard discharge line or a line that discharges grey water to a holding tank. In this simple operation, the faucet controls the water pressure; the water flows from the showerhead and is collected in the shower drain sump; the water level activates the sump pump float switch that turns on the water pump to empty the sump.

Converting the basic system requires a few additional components. Insert a three-way valve in the drain line and another three-way valve into the cold water line to interconnect the two water systems. Connect a waterproof control switch to the float switch control circuit to supply current to the motor. Disconnect and remove the float switch. Adding a finer filter in the pump suction line, downstream from the coarse strainer helps to reduce recirculation of any soap or shampoo suds. I also recommend purchasing and installing a household-type, variable spray pattern, water conserving showerhead. You can also insert one-way check valves into the inlet side of the cold water to prevent grey water feedback into the cold-water system.

To use, set the sump drain valve in the recirculation position to direct water to the showerhead. Initially, the shower is started using the normal water supply and this allows the sump to partially fill. Alternatively, I also use a solar water-heating bag




***Water-saving shower design filters rinse water, then recycles it back through the system by adjusting the three-way valves as desired by the bather.***

and empty some or all of the contents directly into the shower sump. Close the hot and cold-water faucets and position the cold-water feed line valve to supply the showerhead with the sump water and turn on the cold-water faucet to supply the showerhead. Closing the pump switch starts the pump, which then recirculates the water continuously.

When finished, reposition the cold water and drain valves to direct water to the holding tank or overboard. A good shower can be achieved using just 1.9L (1/2 gallon) for the soap, another half for the rinse.

For boats without a pressurized water system, simply add water to the sump from a solar bag or boil water in a pot on the stove and dump it in.

*John Payne enjoys long, hot showers onboard his 10.6m (35') classic yacht berthed somewhere in England. This article is adapted from his book, "Marine Electrical and Electronics Bible," published by Sheridan House. His article on electronics troubleshooting appears on page 38 in this issue.*

## TRAILER LIFT GUIDE

No stop on the trailer's tongue jack could have left this boat low and dry.

[ BY STAN KUCZYNSKI ]

## Projects

One of Murphy's laws states that if it's not supposed to happen it will. Recently I acquired a used boat and trailer and, for the first time, had the need to run the trailer tongue jack out to its maximum travel. Cranking the support tube higher and higher, I expected to come to the end of the threaded rod where the inner tube should have stopped its travel. You can imagine the look on my face when the inner support tube just fell to the ground.

With my boat, "Morning Sun," a 7.3m (24') fixed-keel sailboat, tipping the scale at a little over 1,814kg (4,000lb), this could have been a real disaster. Fortunately, many years of rigging heavy loads taught me to stack cribbing under whatever I was lifting in case the jack should let go. This time proved no exception. Had the cribbing not been in place, I would have had two crushed legs.

To prevent this from happening again, I cleaned and painted the inner support tube to visually show me when it was getting near the end of travel. I prefer to use Krylon ColorWorks Epoxy Enamel. It's sold in a spray can, is moisture-resistant for use outdoors and cures to a super hard finish. First, I degreased the inner support tube and wiped it clean with mineral spirits. Next, I applied several coats of grey sandable primer and let dry. I marked the inner support tube with a pencil, dividing it into three sections. I covered the lower two-thirds of the tube and the wheel axle supports with newspaper and masking tape, and painted the exposed end bright red and set it aside to dry. Once cured to a hard finish, about 24 hours, the just painted area was taped off, the lower third of the tube remasked, only this time exposing the middle portion of the support tube. I painted this area yellow and let it dry overnight. Finally, I masked the previously painted red and yellow sections and painted the last one-third of the tube and the wheel support black. With the assembly fully cured, I applied a little wheel bearing grease and reinstalled the inner support tube onto the threaded rod, cranking the two sections together until fully compressed to completely lubricate the rod. All that was left was to reattach it to the trailer tongue.

Now when it comes time to elevate the hitch, I watch the inner support tube. When it gets to the yellow to red mark I know there is 7.6cm to 10cm (3" to 4") before separation. If I haven't reached the height I need at this point, it's time to stop, crank down the jack and place a block or other rigid object under the wheel to take up the space and add the needed extra height.

*About the author: Stan Kuczynski keeps his trailer sailer in Orlando, Florida.*

## NOTE-WORTHY

Having paper and pen always at hand for those quick navigation notes, the grocery list or whatever, is a necessity onboard my boat. Though this is not an original idea, it's so useful that I wanted to share it with DIY readers.

Make a smooth backing plate of copper sheathing, brass or even plastic to protect the surface

from continual pen point pressure. Cut the backing plate to the size required, cut a slot for the paper, and add two bars, soldered or screwed in place for the paper to slide through. Position the top bar at least 2.5cm (1") below the slot for ease in threading the paper. The bottom edge of the lower bar creates the tearing edge. Adding a pen or pencil holder encourages you to keep one handy.

Cut a slot in the bulkhead, slightly wider than the width of the paper, and then, behind the bulkhead, secure a roll of wide adding machine paper on a wooden dowel. The retaining pin, as shown in the photo above, added to the dowel shaft end must be removable in order to replace the roll. No more searching for a scrap of paper and pen.

*About the author: This project is one of many Bert Small has added to "Sea Eagle, a converted 6.7m (22') pocket cruiser, berthed in Salt Spring Island, British Columbia.*

PRO SERIES

# WET DECK? HERE'S THE FIX.

Deck repairs are certainly within the capabilities of a determined boatowner capable of some simple fiberglass skills. Here is how one professional shop carries out major deck repairs.

[ BY NICK BAILEY ]

There are plenty of fiberglass boats with cored decks in need of work. So many that deck core repairs are a staple of every glass repair shop. Unfortunately, the price of a large, professionally done deck repair on a small boat can exceed the market value of the boat. You'll never recapture the investment. Major deck repair is a labor intensive and technically challenging undertaking. It's definitely not a project for a beginner carpenter. It is within the range of a owner with some knowledge of woodworking tools and fiberglass assembly.

The first step is to evaluate the damage. Once this is determined, repairs can proceed.

## STEP 1 DAMAGE APPRAISAL

### Deck Mapping

Use a hammer to check the deck, tapping and listening for the characteristic dull thud of delamination. Record moisture meter readings every 30.4cm (12") or so and mark directly on the deck. Also indicate the suspected delaminated areas with the marker. Normally, the delaminated areas will also correspond to the highest moisture readings. If not, the core may be so degraded it has rotted away leaving behind a dry and empty cavity.

Draw a line joining the equal meter readings that are at the transition from wet to moist, from moist to damp, and from damp to dry (FIGURE 1). This provides a "weather map" of the deck complete with moisture level "isobars." It's a safe assumption that the fitting located in the middle of the worst moisture/delamation area is the source of the leak.

### Core Sampling

Confirm core condition by using a 5cm (2") hole saw to remove a sample or "coupon" of the upper laminate and core at several locations.


*Pegged moisture meter identifies delaminated area.*

*A "coupon" removed with deck laminate still attached.*

to remove the delaminated outer skin, dry out the balsa core provided it is sound and still firmly adhered to the inner skin, and renew the outer laminate with a new glass lay-up.

### Deck Hardware

Remove any deck hardware in the repair area and tag for later identification. Mapping the placement of all hardware before removal helps to position it when it's time to reinstall. Taking photos of the hardware is better yet!

## STEP 2 CUT HERE

Small to medium-size core repairs can be done at the dock but tarps need to be on hand to protect your work area in case weather interrupts repairs. For obvious reasons, exposed core cannot be allowed to get wet. Major jobs must take place inside a shop.

Mark the "cut here" line, basing the position on the evaluation process outlined above. With the coupon as a reference guide, use a circular saw with a good carbide blade set about 3mm (.125") deeper than the upper laminate thickness, or a grinder fitted with a 36-grit (or coarser) disc, to slice

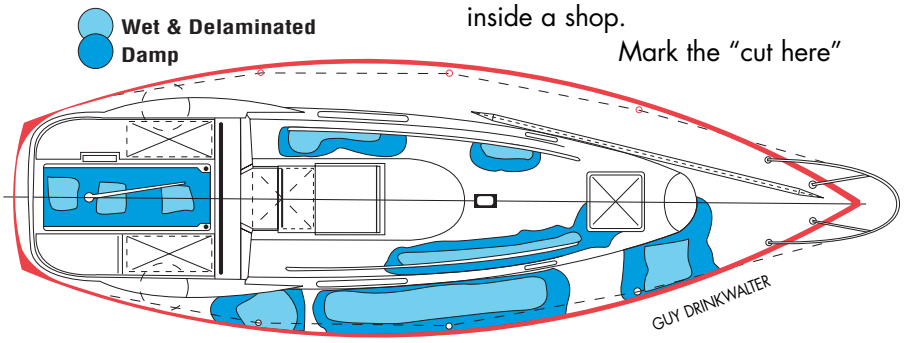
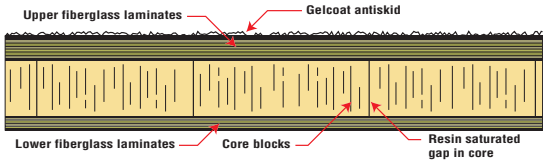



**FIGURE 1** *Create a map of all delaminated areas and hardware positioning.*

Such coupons don't include the inner skin, so the extent of delamination can be gauged in two ways. First, if the coupon lifts away easily from the inner skin and the outer skin falls off, the core is delaminated top and bottom and will need to be completely replaced. Secondly, if the top lifts off without adhesion but the core piece needs to be pried away from the lower laminate, the core is only partly delaminated. In this case, it may be possible




*Cross section of a typical cored deck.*

*Another common problem area is a bow pulpit base before repair.*

*A partially rotted balsa core sample.*

through the upper laminate. Pry it away or lift it from the core. It isn't practical to rebond the cutout panel so it's discarded or kept as a template for deck hardware positioning. Cutting exposes the lower laminate and core in varying stages of decay and delaminated areas are now exposed.

*Removal of wet balsa core at the pulpit bases.*

*Removing core under the babystay track utilizes a customized tool for digging core out from under the upper laminate.*

*Digging out the bad core*

*Bad core exposed.*

*Damp core that is intact is not removed but left to dry.*

*Moisture check shows drying in progress.*

### STEP 3 CLEAN UP

Scrape out all the loose core debris and discard it. Take care not to step on the exposed inner laminate as it's very light and easy to fracture.

Any damp core material in good condition that is well adhered can be left to dry out. Drying could take several days or even a few weeks, depending on the local conditions. Take moisture meter readings to monitor progress.

### STEP 4 PREP THE NEW CORE

Lightly prep grind the exposed surface of the inner skin to remove rough spots from residual resin and core fragments. It's important that the new core lies perfectly flat. Any bumps or ridges left on the inner skin can cause the new core to "bridge" over top of the bump leading to poor core bonding.

Bevel the edges of the cutout for a nice scarf to the new laminate. A scarf ratio of 12:1 or more is the norm. For example, a 7.6cm (3") scarf for a 6mm- (.25"-) thick upper laminate. The work surfaces are then carefully blown clean of dust and debris with compressed air and wiped with a clean rag wetted with acetone.

*Cleaned lower skin.*

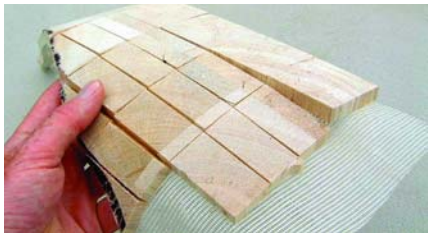
## Laminate Schedule

Preparing the materials requires some planning and calculation. To avoid big fairing problems later, the repaired deck must be no thicker than the original. In order to provide a resin-rich bed for the new core and also reinforce the old inner skin, it's necessary to start the lay up with a new layer of 1.5-oz. mat. This is an "extra" layer. The new laminate, to maintain the same thickness, will need a thinner core than before. For example, if the original core was 12mm (0.5") thick, the new core will be the next thickness smaller, probably 9.5mm (0.375"). Examine the coupon for thickness and tailor the upper laminate accordingly. For example, according to the Cook Composites & Polymers applications

manual (8th edition, page 79), seven alternating layers of 1.5-oz. mat and 24-oz. woven roving should give you 5.7mm (.226") of laminate. 1810 Stitchmat, which has the mat and roving together in one convenient cloth, needs about the same number of layers to achieve the same thickness. If in doubt, do some small-scale test laminates to confirm the thickness.

### Dry Fitting

Once the laminate schedule is established, make paper templates, and use them to size and cut the new glass. Trim the new core pieces, then dry fit and stack them nearby. Plug or tape off any pinholes or gaps in the lower laminate (which is in effect serving as a mold) to prevent resin running into the boat's interior.



***A piece of new balsa core ready for installation.***

## STEP 5 LAY UP

### Laminate and Core Placement

The first layer is very important because it serves to bond and seal the bottom of the new core. The laminating process requires fast coordinated work within the gel-time of the each resin batch. On larger repairs, two or three people will work together as a team.

Cover the lay-up table with plastic or other non-absorbent material (no cardboard) to wet-out the pre-fitted pieces of 1.5-oz mat.

Pour catalyzed laminating resin (unwaxed) onto the table and roll out a thick layer using a short nap paint roller.

One at a time, place the first laminate pieces on top of the resin, then pour more resin on top and roll in to ensure a thorough wetting.

Onboard, wet out the old inner skin with resin, place the pre-wetted laminate pieces over the old skin, prod into place with brushes and roll with a "bubble buster" to ensure full adhesion.

Back at the lay-up table, take up the thoroughly pre-wetted bottom face of the new core panel and

***Core replaced with solid glass filler ("potted").***

immediately set the panel into this squishy, resin-rich bonding layer. If needed, pour additional resin over the mat layer and spread evenly before setting the core panel. Firmly roll and tamp it into place. This provides the necessary full contact that promotes good bonding.

### Gap Filling and Potting

Inevitably, there are irregular gaps between the edge of the old core and the new, or between the individual panels of new core. After the core bonding has cured, these gaps must be filled with a solid material to ensure a void-free deck. A mix of resin and chopped fibers, thickened with colloidal silica, works well. Apply by trowel and prod into place, then level off even with the top of the new core.

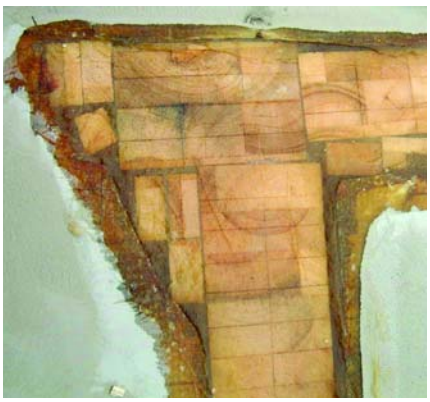
It's also a good idea when planning the layout of the new core to leave "core-free" gaps where hardware will be reinstalled. These areas are also filled or "potted" with the chopped glass mix. Potting is a technique that removes the core adjacent to the fastener and replaces it with solid material; either thickened epoxy resin or polyester resin and chopped fibers. This will ensure no leakage into the core in the future at this fitting even if the bedding compound fails. This is particularly useful at the chain plates. [Ed: See DIY 2000-#3 issue for the step-by-step installation of hardware in cored laminates.]

### Upper Laminates

To prepare for the top and final laminates, grind the filled areas and any high points on the core surface smooth until flush with the underside of the top laminate. This time the pre-wetting table is optional. Usually resin is poured directly onto the core and spread around with a paint roller as a thick wet coating. Lay the first layer, 1.5-oz mat, directly onto the wet core surface and apply more resin on top to complete the wet-out. This layer seals and bonds the core to the top skin. The remaining laminates now follow with each layer overlapping a little more onto the scarf edge of the existing deck. Use

***Potting of new core underway. Note chopped mix in bucket ready to be troweled into place.***

***Bow pulpit repair shows new core "potted" in place with chopped fiber and resin.***



***Close up of replacement core potted in place at babystay location prepped for upper laminates.***

***After filling and fairing babystay location is block sanded in preparation for gelcoat or paint.***

waxed resin for the last resin batch to ensure a complete tack-free cure.

### STEP 6 FILLING AND FAIRING:

Ideally the new layup is just slightly lower than the old deck surface. Prep the new glass surface by sanding smooth with 40-grit paper. After cleaning the surface, apply a fairing putty (this can be as simple as thickened gelcoat) and smooth with a large drywall spreader or a straight piece of Plexiglas. After the putty cures, sand with 40- to 80-grit paper on a long board or block. Repeat the sanding process as required to yield a smooth surface.

### STEP 7 REFINISHING

#### Smooth Areas

On a large repair job, it's simplest to refinish the smooth areas with a polyurethane paint system. [Ed: For tips on using these paints and details on the roll-and-tip application method, refer to DIY 1998-#2 issue or the MRT CD "Marine Painting & Refinishing".] Smaller areas lend themselves to gelcoat refinishing followed by the usual wet sanding and buffing.

#### Antiskid Areas

The most popular "Stucco" style gelcoat skid-resistant finish is just an air-dry gelcoat thickened with colloidal silica. It is simply rolled on with short nap paint roller. Tailor the texture by how much silica is in the mix, varying from aggressive for maximum traction to mild for a more skin-friendly texture.

It's difficult to match an existing skid-resistant texture and almost impossible in the case of a printed or repeating skid-resistant pattern. In most cases, to avoid skid-resistant pattern match problems, the complete skid-resistant surface is prep sanded with 80-grit, masked and gelcoat applied by spray, brush or roller. [Ed: Complete details on refinishing molded non-skid decks appears in DIY 2000-#4 issue.]

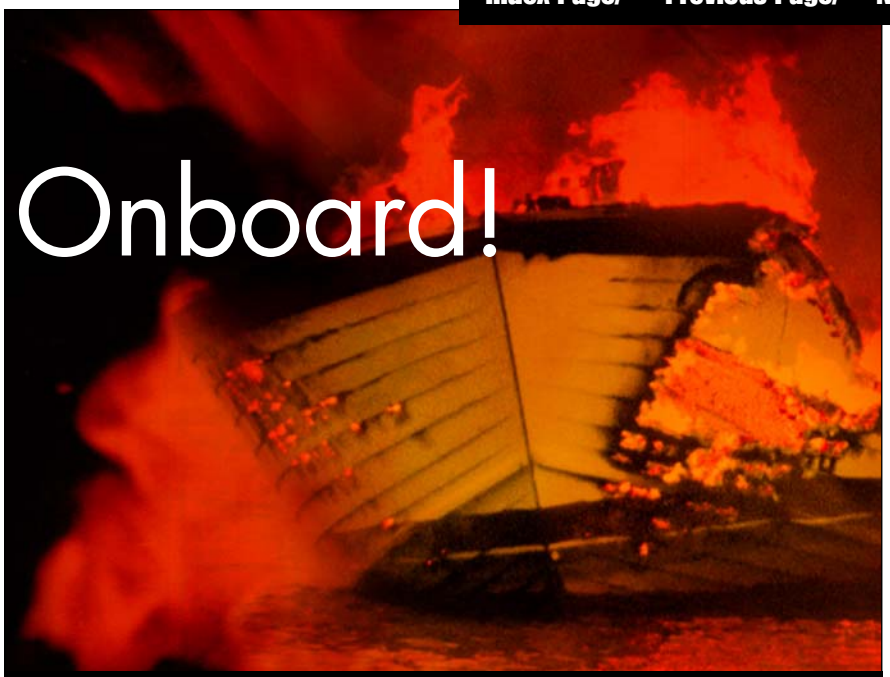
### STEP 9 HARDWARE REINSTALLATION

Use new fasteners and lots of polyurethane sealant when reinstalling the hardware. If holes are required through the core in an area that did not get pre-potted or filled with solid material, the option is now available to drill out the core and pot the individual fastener holes as needed.

*About the author: Nick Bailey has spent 25 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.*

[Ed: For additional information on cores and delamination, and the proper bedding of deck hardware, refer to the article titled, "Fiberglass Clinic: The Good, the Bad, the Ugly," in DIY 2000-#3 issue.]

# fire Onboard!



*"Good fire equipment may not be as sexy as a new electronic gizmo, but it's guaranteed to help you sleep better."*

Few boats have sufficient fire extinguishing systems to combat a fire, and even less are equipped to fight an engine compartment fire. The information in this article will inspire you to fireproof your boat.

[ BY SUSAN CANFIELD ]

You're at the helm, heading back to the marina after a weekend afloat. Suddenly, a crewmember below decks shouts, "Fire!" Are you and your boat prepared to respond effectively? If you can't extinguish the fire immediately, it will likely blaze out of control. Flames, smoke and toxic fumes will drive you and your crew overboard. Your boat will burn to its waterline. Unless you're docked at a marina when a fire occurs, there will be little likelihood of outside assistance. You're on your own and your success will depend on having the right type and number of fire extinguishers in the right locations, and knowing how to use them.

## Alphabet Soup

Fires are classified according to the material that's burning. Class A fires are fueled by ordinary combustible materials such as paper, wood, cloth, rubber and many plastics. Class B fires are fueled by flammable liquids or gasses. Class C fires involve energized electric equipment. Each type of fire is identified by a unique symbol (**FIGURE 1**).

Fire extinguishers are rated according to the classes of fire against which they are effective. For example, a Type BC extinguisher will be effective on Class B (flammable liquids) and Class C (electrical) fires but not on Class A (ordinary combustibles) fires. Small Class A fires can often be extinguished by water and that's pretty handy. Using the wrong type of extinguisher on a fire often just makes matters worse.

An extinguisher's Underwriters Laboratories (UL) rating indicates its fire fighting capacity compared to other extinguishers. For example, an extinguisher with a UL rating of 10BC will be twice as effective as a 5BC unit in putting out a Class B or C fire.

In the U.S., fire extinguishers for marine use must be approved by the United States Coast Guard (USCG) and labeled accordingly. Federal law requires your boat to carry the type and number of extinguishers shown in **FIGURE 2** if your boat has one or more of the following: inboard engine; permanently installed fuel tank; closed compartment for storing portable fuel tanks; closed storage compartments where combustible or flammable materials are stored; double bottom not sealed to the hull or not completely filled with flotation material.

| Old | New | Fire Classification System |
|---|---|---|
| A |  | *Class A - Ordinary combustible materials, e.g., wood, paper, cloth, rubber and many plastics, including fiberglass-reinforced plastic used for boat hulls and decks* |
| B |  | *Class B - Flammable liquids, including gasoline, diesel, kerosene, oil, oil-based paint, teak oil, paint thinners, acetone, varnishes, and flammable gasses, e.g., liquid propane gas (LPG) and compressed natural gas (CNG)* |
| C |  | *Class C - Energized electrical equipment. Turning off the electricity will change the status of a Class C fire to a Class A and/or B fire.* |

**FIGURE 1** *Fire extinguishers are labeled according to the types of fire against which they are effective. Older fire extinguishers are labeled with colored geometrical shapes and letter designations; newer units use pictograms.*

| Canada | U.S. | ABYC | LOCATION |
|---|---|---|---|
| Not over 6m One 5BC | Under 26' One B-I | Open boats under 16' One ABC | Steering position |
| Over 6m but not over 8m One or Two 5BC | | Over 16' to under 26' Two ABC | Steering position and galley or passenger cockpit |
| Over 8m but not over 12m One or Two 10 BC | 26' to under 40' Two B-I or One B-II | Three ABC | Outside engine compartment, steering position, and galley or passenger cockpit |
| Over 12m but not over 20m One or More 10 BC | 40' to 65' Three B-I or One B-II and One B-I | Four ABC | Outside engine compartment, steering position, crew's quarters, and galley or passenger cockpit |

**CANADA** • *Boats over 6m but not over 12m must carry a second extinguisher if equipped with a fuel-burning cooking, heating or refrigeration appliance.*
• *Boats over 12m but not over 20m must carry one 10BC extinguisher at each of the following locations: each space where a fuel-burning cooking, heating or refrigerating appliance is fitted, each accommodation space; and at the entrance to the engine room space. An axe and two buckets, each with a capacity of 10 L or more, must also be carried.*

**U.S.** • *A USCG-approved pre-engineered fire extinguishing system installed for engine compartment protection reduces total requirement by one B-I extinguisher.*

**ABYC / NFPA** • *Boats under 26' without enclosed accommodation spaces or galleys may be equipped with a bucket with attached lanyard and a BC extinguisher in lieu of an ABC extinguisher.*
• *On boats having a galley stove, one of the required extinguishers shall be readily accessible thereto.*
• *Extinguishers intended for machinery space protection are not required to have a Class A rating.*
• *One USCG B-I portable extinguisher may not be adequate if a discharge port is installed.*

**FIGURE 2** *The number of fire extinguishers required to be carried by powered pleasure craft is based on a boat's overall length. ABYC recommended minimums exceed both Canadian and U.S. Coast Guard's required minimums.*

# Portable Systems

Portable extinguishers are rated USCG B-I or B-II according to the amount of extinguishing agent they contain (**FIGURE 3**). In Canada, extinguishers must be approved by one of four entities: Board of Steamship Inspection (Transport Canada), Underwriters Laboratories of Canada, British Department of Trade and Industry for marine use, or the Canadian Coast Guard.

While one or more 10BC extinguishers may be sufficient for your boat to comply with federal requirements, they will not put out a Class A fire. That's why the American Boat & Yacht Council (ABYC), Standard A-4 Fire Fighting Equipment, recommends that all extinguishers onboard, unless intended solely for engine compartment protection, be ABC rated, multi-purpose or tri-class units, three terms that mean the same thing and are used interchangeably.

Most marine fires start in the engine compartment or galley, or involve electrical equipment of some sort. Engine compartment fires are typically Class B or C. Galley fires are most often Class A or B. Fires in accommodation spaces are generally Class A, although many start as Class C fires in battery compartments, electrical panels or cable runs.

## Agents: Good and Bad

Water, dry chemical and aqueous film-forming foam (AFFF) are the agents of choice for most fires outside the engine compartment (**FIGURE 4**). Water extinguishes a fire by cooling the burning material below its combustion point. Although highly effective on Class A fires, water makes a Class B fire worse by spreading the burning liquid. Water's conductivity makes it a potential killer (shock hazard) when used on Class C fires involving energized electrical equipment. Since water extinguishers are bulky and heavy, they're rarely used on recreational boats. But a bucket on a line can come in very handy when facing a Class A fire in the absence of an appropriate portable extinguisher.

Dry chemical extinguishers are a popular choice for most boat owners, no doubt due to their low cost. The active ingredient in dry chemical BC extinguishers is sodium bicarbonate; multi-purpose ABC units use ammo-

| USCG Type/Size | B-I | B-II |
|---|---|---|
| Dry Chemical (kg/lb) | .9/2 | 4.5/10 |
| CO2 (kg/lb) | 1.8/4 | 6.8/15 |
| Halon 1211 & 1301 (kg/lb) | 1.1/2.5 | 4.5/10 |
| Halocarbons | • | • |
| FE-241, FM-200, Halotron | | |
| Foam (L/gal) | 4.7/1.25 | 9.5/2.5 |

* See extinguisher label

**FIGURE 3** *USCG approved portable fire extinguishers are rated according to the amount of extinguishing agent they contain.*

*Thick residue from a portable chemical fire extinguisher coats the entire engine compartment, means an expensive cleanup for this unfortunate boatowner*

| Agent | Action | Fire Suitability | Clean Agent | Use Considerations |
|---|---|---|---|---|
| *Water* | *Absorbs heat* | *A* | *No* | *• Hazardous if used on Class B or C fires; electrically conductive* |
| *Aqueous Film-Forming Foam AFFF* | *Displaces oxygen* | *AB* | *No* | *• Due to its conductivity, water-based foam may be hazardous when used on Class C fires* |
| *Dry Chemical BC* | *Inhibits chemical reaction* | *BC* | *No* | *• Irritating if breathed for long periods<br>• Use caution in closed areas – reduces visibility, causes disorientation<br>•On small flammable liquid or grease fires, initial discharge at close range may cause spreading<br>Clean up multi-purpose dry chemical promptly to prevent corrosion* |
| *Dry Chemical ABC* | *Inhibits chemical reaction* | *ABC* | *No* | |

**FIGURE 4** ***These extinguishing agents leave a residue and are best used in areas other than engine compartments, electrical panels, etc.***

nium phosphate. Both suppress fire by inhibiting its chemical reaction. Pound for pound, ammonium phosphate is more effective but it's corrosive and should be cleaned up as soon as possible after use. When discharged in an enclosed area, dry chemical units create a dust cloud that can reduce visibility to the extent that it becomes disorienting to the operator. Since all dry chemical extinguishers leave a thick powdery residue that can be a real pain to clean up, it's best to avoid using these in the event of engine compartment or electrical panel fires.

Foam extinguishers snuff out fires by displacing oxygen. This water-based soapy agent has been used to fight Class B fires in industrial and shipboard settings for many years. It's fairly new to the retail consumer market, however and is not yet USCG approved. Nevertheless, Kidde's Fire Out Foam extinguisher, with its UL rating of 8A-70BC, merits serious consideration by boat owners. Foam tends to stay where it's sprayed and consequently helps prevent reflash. It's easier to clean up than dry chemical residue. Although effective on all classes of fire, AFFF is somewhat conductive. It poses a potential shock hazard for an operator who may be standing in a pool of foam that is also in contact with energized electrical circuits.

All of the other extinguishing agents typically used on pleasure craft are gaseous clean agents; they leave no residue after use and are not electrically conductive (**FIGURE 5**). They should be your agents of choice for fires in engine compartments and electrical equipment.

Carbon dioxide ($CO_2$) smothers a fire by displacing oxygen. It's particularly effective on Class B and C fires in engine compartments. A concentration of $CO_2$ sufficient to extinguish fire can, however, extinguish life as well. Anyone using $CO_2$ must take precautions to avoid being overcome by lack of oxygen. When used

**FIGURE 5** ***Clean agents, which leave no residue and are not electrically conductive, should be used in engine compartments, electrical equipment, etc.***

| Agent | Action | Fire Suitability | Clean Agent | User Considerations |
|---|---|---|---|---|
| *Carbon Dioxide $CO_2$* | *Displaces oxygen* | *BC* | *Yes* | *• Do not touch discharge horn with bare hands when operating; frostbite hazard<br>• Thermal shock can damage sensitive electronics if in direct contact<br>• Use caution in unventilated areas – $CO_2$ depletes oxygen supply, can cause respiratory failure<br>• Used primarily in enclosed areas such as engine compartments; less effective where winds or drafts will disperse agent/allow fire to reflash<br>• Shut down engines, generators and blowers to prevent dispersal/reflash* |
| *Halon 1211 and 1301* | *Inhibits chemical reaction* | *ABC* | *Yes* | *• Halon 1301 is suitable for use only in fixed fire suppression systems (See page 30)<br>• Halon 1211 and 1301 are no longer manufactured due to high ozone depletion potential<br>• Shut down engines, generators and blowers to prevent dispersal/reflash* |
| *Halocarbon FE-241, FM-200 Halotron* | *Absorbs heat; inhibits chemical reaction to a lesser degree* | *ABC* | *Yes* | *• FE-241 is suitable for use only in fixed fire suppression systems and normally unoccupied spaces; some ozone depletion potential (See page 30)<br>• Shut down engines, generators and blowers to prevent dispersal/reflash* |

| Agent | Maximum Compartment Volume | Minimum Extinguisher Size |
|---|---|---|
| $CO_2$ | 2 m3/66 ft³<br>4 m3/133 ft³<br>6 m3/200 ft³<br>7.5 m3/266 ft³ | 2.3 kg /5 lb<br>4.5 kg /10 lb<br>7 kg /15 lb<br>9 kg /20 lb |
| Halon 1211 | 3 m3/108 ft³<br>3.7 m3/130 ft³<br>5 m3/174 ft³<br>6 m3/217 ft³<br>11 m3/391 ft³<br>16 m3/565 ft³ | 1 kg /2.5 lb<br>1.4 kg /3 lb<br>2 kg /4 lb<br>2.3 kg /5 lb<br>4 kg /9 lb<br>6 kg /13 lb |
| Halocarbon FM-200 Halotron | 2 m3/108 ft³<br>12 m3/434 ft³ | USCG B-I<br>USCG B-II |

**FIGURE 6** *ABYC and NFPA recommended minimum portable extinguisher sizes for flooding an engine compartment via a fire port.*

outdoors or in open areas under drafty or windy conditions, $CO_2$ will be readily dispersed and the fire may reflash. The extremely cold temperature of the agent as it leaves the extinguisher can damage machinery and electrical equipment in close contact due to thermal shock.

Halon 1211 came on the market in the '60s and for many years was the most effective agent available for use in portable extinguishers. Halon 1211 readily extinguishes all classes of fire and, in normal extinguishing concentrations, is safe for use in occupied spaces. Unfortunately, Halon has a deleterious effect on ozone in the earth's atmosphere. Its production was halted worldwide by 1994. If you own a Halon 1211 portable extinguisher, however, you may continue to depend on it so long as it remains in good operating condition.

***Make sure you are aiming at the base of the flames before you squeeze the extinguisher's handle. The average dry chemical unit empties in 10 to 15 seconds — you can't afford to be off target. It's advisable to practice using a portable extinguisher before you need one.***


**FIGURE 7** *MarineEast's high-impact plastic Fire Port (US$8) available in seven models for inboard and outboard applications.*

The search for Halon replacements has produced three halocarbon-extinguishing agents that are USCG approved. All combat Class A, B and C fires by absorbing heat and, to a lesser degree, inhibiting the chemical reaction. FM-200 and Halotron are used in lieu of Halon 1211 in portable extinguishers; FM-200 and FE-241 are used as Halon 1301 replacements in fixed fire suppression systems. (More on these systems beginning on page 30.) Unlike FM-200 and Halotron, which are non-toxic, FE-241 can only be used in spaces that are normally unoccupied. Although less damaging to the environment than Halon, FE-241 does contain ozone-depleting hydrochlorofluorocarbons (HCFCs) and will eventually be phased out as well. All of the newer halocarbon agents require more juice to provide the same level of protection and their cylinders are proportionately larger (**FIGURE 6**).

## Fire-Proofing

Where you mount portable extinguishers is just as important as choosing the right type and size. Always mount one near the helm so that the minute you're alerted to a fire, you have fire-fighting power at hand. Additional extinguishers should be secured in brackets near the galley, engine compartment and living spaces. All units should be located adjacent to exit paths. You should never have to travel more than half the length of your boat to reach an extinguisher.

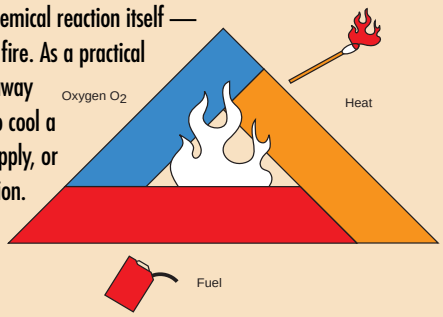
If the extinguisher near the helm will be exposed to weather or susceptible to physical damage, put it in a recessed box like those offered in marine stores and catalogs. If you mount a unit inside a cockpit locker, put a weatherproof "Fire Extinguisher" label on the outside where it can be easily seen. Also, make sure the extinguisher is immediately accessible when the locker is opened. Don't bury it under other gear.

## Engine Care

You should never have to open the engine compartment to fight a fire.

## TIP Fire Triangle

Three elements must be present for fire to exist: a fuel; sufficient heat to raise that fuel to its ignition temperature and enough oxygen to sustain combustion. Bring fuel, heat and oxygen together and you will get the exothermic (heat producing) chemical reaction called fire. Take away any side of this fire triangle — or the chemical reaction itself — and you'll extinguish the fire. As a practical matter, it's hard to take away burning fuel. It's easier to cool a fire, cut off its oxygen supply, or inhibit the chemical reaction.




Doing so will only feed oxygen to the fire and allow smoke and fumes to escape and spread.

Depending on the size of your engine compartment (**FIGURE 7**), discharging a portable clean agent extinguisher via a fire access port may be effective. There are several disadvantages to this approach. If the port is located in a horizontal surface, the extinguisher may not discharge fully unless it's equipped with a hose and nozzle. The rate of discharge may not be sufficient for the agent to reach an effective extinguishing concentration. Distribution of the agent within the compartment may be unsatisfactory. A portable extinguisher's slower rate of discharge (relative to a fire suppression system's) will allow more toxic by-products to be generated during extinguishment. Fire detection and response are dependent on an operator being present and making the right decisions. The potential for operator injury is greater than with an automatic system. The best solution is a permanently installed (fixed) fire suppression system that will operate automatically.

## Portable Extinguisher Maintenance

- Frequently shake dry chemical extinguishers to prevent caking of the agent.
- Inspect all units at least annually.
- After discharging a cylinder, it should be serviced.
- Every 6 years, empty and recharge a refillable dry chemical extinguisher.
- Every 12 years, refillable dry chemical cylinders should have a hydrostatic test .
- Every 5 years, refillable $CO_2$ extinguishers should have a hydrostatic test.

## Fixed Systems Maintenance

- Check gauge daily to ensure that cylinder pressure is in the normal range and that the indicator light at the helm is operational.
- Every 6 months, remove and weigh the cylinder to ensure that it remains fully charged. The pressure gauge indicates the unit's ability to discharge the agent, but not the quantity of the agent. If the cylinder's gross weight falls below the parameter printed on the nameplate, immediately remove it from service.

# Fixed Fire Suppression Systems

A permanently installed (fixed) fire suppression system is your best alternative for combating an engine compartment fire. You can have one custom tailored (engineered) for your boat or, far more economically, buy a pre-engineered system off the shelf. Available pre-engineered systems can protect engine compartments with net volumes ranging from .71 $m^3$ (25 $ft^3$) up to 42 $m^3$ (1500 $ft^3$). Installation is within the abilities of most DIYers and takes from two hours to a day or more, depending on boat size and system complexity.

A temperature sensor valve actuates the standard pre-engineered system automatically. When the valve temperature rises to the system activation point (which varies with the agent used and the volume of the compartment), the extinguishing agent is discharged.

Engine compartment blowers, engines and generators must be shut down immediately. Gas engines will normally stall due to the agent's effect on combustion, but diesel engines, if not shut down manually or automatically, will continue to run. In doing so, they can defeat the fire suppression system by ingesting the extinguishing agent and expelling it via the exhaust system, reigniting the fire.

A factory-installed pressure switch, used for cylinder pressure supervision, can also be used to shutdown equipment automatically. The pressure switch is normally closed with the system in charged condition. Discharge or loss of system pressure will open the switch. When the switch is used as an electrical disconnect for equipment shutdown, a bypass or shunt must be provided so that affected equipment can be returned to operational mode. If the electrical shutdown load exceeds the rated capacity of the pressure switch a separate engine shutdown/restart system must be used.

## System Planning

Use the worksheet on page 35 to assemble an appropriate system for your boat. Later, you can use the completed worksheet to request price quotes for a system.

Start by measuring your engine compartment's length, width and height from the keel, adjusting (subtracting) for hull curvature as appropriate. Then calculate the compartment's gross volume (L x W x H). Next, measure any permanently installed tanks (water, fuel or waste) located in the compartment and calculate their gross volume. Subtract gross tank volume from gross compartment volume to arrive

## TIP Storage Don'ts

You have a fire extinguisher onboard, maybe two, but can you grab them easily and quickly when needed? Too many boats have extinguishers mounted under a sink or hidden away in a locker.

**TIP Hold the Air**

The fire fighting effectiveness of all portable and fixed extinguishing systems is compromised unless you interrupt the engine, blowers and all sources of ventilation. Some larger yachts have an automatic system to close air intake vents.

at the compartment's net volume. Some boat manufacturers place a permanent label in the engine compartment specifying its net volume.

In some boats, the engine compartment may be open to a common bilge or to an adjoining compartment or locker. If the opening can't be sealed, the gross volume of the adjoining space should be added to the net volume of the engine compartment to determine the total net volume to be protected. The pre-engineered system you select must be capable of protecting this total net volume. Select a size that meets or exceeds engine compartment volume. When in doubt, always choose the larger size.

### Extinguishing Agents

Available options are recycled Halon 1301 and the newer Halon replacements FE-241 and FM-200. All are colorless, essentially odorless and gaseous clean agents, that leave no residue after use and are not electrically conductive. Recycled Halon 1301 should be available for another five years. Any Halon system that subsequently discharges will have to be replaced.

FE-241 and FM-200 operate primarily by cooling a fire. To a lesser extent, they also inhibit its chemical reaction. Although high concentrations of Halon, FM-200 and FE-241 are toxic, levels in pre-engineered systems are below the toxic levels. FE-241 contains ozone-depleting hydrochlorofluorocarbons (HCFCs), but is EPA-approved until 2024.

**FIGURE 8**

***To calculate engine compartment air changes, divide:***

$$\frac{\text{Maximum air consumption of engines, generators and blowers per minute}}{\text{Gross compartment volume less volume of installed tankage}}$$

### Tailored Options

Both automatic and automatic/manual system are available. Owners of smaller boats may choose an automatic/manual system simply for redundancy. Even though you may not be interested in installing a manual cable release, it may still be a good idea to order a system with manual release capability. The cost difference at time of purchase is about US$20, much less than what it would cost to ship a cylinder back to the manufacturer to have a manual-release valve installed.

Should you install an automatic shutdown/restart system? ABYC says, "Yes" if your boat is diesel powered and there is more than one engine compartment air exchange per minute **(FIGURE 8)**. Otherwise it's optional. If shutdown isn't automatic, there should be a placard at each helm station reading, "If fire extinguishing system discharges, immediately shut down engines, generators and blowers."

Select a system with 3, 5 or 8 circuits based on the number of engines, generators and blowers to be shut down. Pre-engineered shutdown/restart systems work electrically. If your engines shut down mechanically (air or fuel starvation), contact the engine and/or boat manufacturer for advice on converting to an electrical shutdown system. If your engines shut down through activation of a momentary device (push button or lever) you'll need a shut down system with optional time delay.

If you plan to include a manual-release cable, review the installation information below for guidance in selecting the correct cable length. If you want two manual release stations

***It took less than 20 minutes for this wooden boat to burn to its waterline during a Coast Guard demonstration.***

**TIP Why Not Multiples**

Don't buy two small fire suppression cylinders in lieu of one larger cylinder sized to the total net volume. Cylinders operate independently and activate in succession. In event of a fire, the first cylinder to detect 73.8°C (165°F) activates, knocks the fire down and reduces the temperature but not enough agent is released and the fire rekindles. Heat again builds, the second unit activates, but doesn't release enough agent to extinguish the fire.

(for example, one at the helm and one outside the engine compartment door), be sure to get a dual release adapter.

If you're a heavy sleeper, install a warning bell to alert you in the event your system discharges. Also, check to see if an actuator head guard is included as standard equipment. If not, order one if you are likely to damage the actuator or yourself when working near the cylinder.

### Installation Steps

From the moment you open the shipping container, handle the cylinder with extreme caution. Don't try to lift or carry it by the manifold or actuator components. Cylinder pressures can be very high depending on the model. If accidental or intentional discharge occurs when the cylinder is not properly secured, it can become a missile capable of causing serious property damage, personal injury or even death. (This is why you don't see these systems on the shelf in your local marine store.) Always wear eye protection when installing or servicing the cylinder.

Before you install your system, confirm that the cubic volume for which it was designed equals or exceeds your engine compartment's net volume. Check the unit for damage and weigh it on an accurate scale, one that's frequently certified by an independent agency (ask a local butcher or grocery store). Record the weight on the attached tag and verify that it falls within the parameters printed on the nameplate.

Installations of large cylinders are subject to requirements for positional orientation (vertical) or as limited by the manufacturer. Cylinders designed to protect smaller areas are installed vertically or horizontally. Select a location on your engine compartment's forward or aft bulkhead and position the actuator as near the boat's centerline, raised as high as possible. Direct the actuator towards the opposite bulkhead. If the cylinder is to be mounted on the overhead (ceiling), the actuator should be positioned as close to the center of the compartment as possible. The cylinder should be positioned parallel to the keel, with its top end facing toward the bow and the actuator pointing downward. If the cylinder must be installed near the forward or aft end of the overhead, secure it athwartship (90° to the keel) with the actuator pointed towards the underside of the engine. On sailboats, avoid installing the cylinder athwartship (cylinder orientation issue).

Don't install the cylinder on the underside of a hatch cover or on an access door that could be thrown clear by an explosion. Don't mount the unit where an accumulation of standing water could block the sensor or cause corrosion. Also, avoid positioning the actuator in close proximity to engine exhaust manifolds or turbo chargers

# Fire Onboard

*Sea-Fire FM-200 fire suppression system with automatic engine shutdown installed in a '86 diesel-powered Pearson 303. The shutdown feature prevents the extinguishing agent from being expelled from the compartment by the diesel engine that would otherwise continue to operate. Once the fire is extinguished, an override switch at the helm station allows restarting of the engine.*


*Manual discharge cables are sold in various lengths ranging from 1.8m (6') to 22.8m (75'). Cable kits include a pull handle, escutcheon plate, and pull pin to prevent accidental activation, nylon cable ties and installation instructions. An optional dual release adapter is needed for manual discharge from two separate control stations.*

*Automatic interrupt systems can shut down up to three, five or eight devices (engines, generators and/or blowers). These systems include a helm display unit with visual and audible alarms and an override switch for engine restart. An optional extender cable is needed if the Fireboy control and display units shown here are mounted more than 76cm (30") apart.*

| Extinguishing Agent | UL Rating | Cylinder Diameter/Height | Weight Cylinder/Contents | MSRP $US |
|---|---|---|---|---|
| *Dry Chemical* | *5B:C* | *97 mm/292 mm* | *2.3 kg/0.9 kg* | |
| | | *3.8 in/11.5 in* | *5 lbs/2 lbs* | *$15* |
| | *10B:C* | *97 mm/351 mm* | *2.7 kg/1.3 kg* | |
| | | *3.8 in/13.8 in* | *6 lbs/2.8 lbs* | *$16* |
| | *1A-10B:C* | *97 mm/351 mm* | *2.7 kg/1.1 kg* | |
| | | *3.8 in/13.8 in* | *6 lbs/2.5 lbs* | *$18* |
| | *3A-40B:C* | *114 mm/503 mm* | *5 kg/2.3 kg* | |
| | | *4.5 in/19.8 in* | *11 lbs/5 lbs* | *$53* |
| *AFFF** | *8A-70B:C* | *114 mm/419 mm* | *3.4 kg/NA* | |
| | | *4.5 in/16.5 in* | *7.5 lbs/NA* | *$36* |
| *$CO_2$* | *5B:C* | *184 mm/435 mm* | *6.1 kg/2.3 kg* | |
| | | *7.3 in/17.1 in* | *13.5 lbs/5 lbs* | *$138* |
| | *10B:C* | *278 mm/500 mm* | *12.1 kg/4.6 kg* | |
| | | *10.9 in/19.7 in* | *26.8 lbs/10 lbs* | *$178* |
| | *10B:C* | *278 mm/665 mm* | *16.2 kg/6.9 kg* | |
| | | *10.9 in/26.2 in* | *35.8 lbs/15 lbs* | *$198* |
| *FM-200** | *2BC* | *89 mm/419 mm* | *3.1kg/1 kg* | |
| | | *3.5in/16.5in* | *6.75lbs/2.75 lbs* | *$128* |
| | *5BC* | *109 mm/419 mm* | *5.0kg/2.5 kg* | |
| | | *4.3in/16.5in* | *11.0lbs/5.75 lbs* | *$218* |
| | *5BC* | *127 mm/445 mm* | *8.2kg/5 kg* | |
| | | *5.0in/17.5in* | *18.0lbs/10.75 lbs* | *$350* |
| *Halotron* | *5B:C* | *109 mm/389 mm* | *4.5 kg/2.3 kg* | |
| | | *4.3 in/15.3 in* | *10 lbs/5 lbs* | *$144* |
| | *1A-10B:C* | *185 mm/411 mm* | *10.4 kg/5 kg* | |
| | | *7.3 in/16.2 in* | *23 lbs/11 lbs* | *$280* |
| | *2A-10B:C* | *185 mm/434 mm* | *12 kg/7kg* | |
| * USCG approval pending | | *7.3 in/17.1 in* | *26.5 lbs/15.5 lbs* | *$372* |

**FIGURE 9** *When shopping, consider a portable extinguisher's size and weight as well as UL rating and cost. Listed sizes and weights are representative; actual measurements may vary among manufacturers. Prices, obtained from marine catalogs and online retailers, don't include shipping, hazardous materials fees or (except for dry chemical extinguishers) the cost of a USCG-approved bracket, which must be purchased separately.*

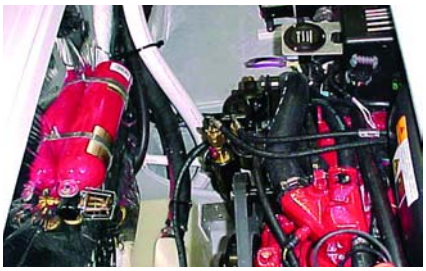
where radiated heat could cause an unwarranted actuation.

Once you've selected a location, use the template provided to drill holes for the cylinder brackets. Secure these with appropriate stainless fasteners and mount the cylinder.

Next, install the system status display unit near the instrument panel at the helm in a location in full view of the operator. Wire the indicator lamp in series with the ignition switch, fuse, electrical pressure switch (at the cylinder) and common ground per manufacturer's instructions. You'll need insulated 16 AWG (minimum)

## TIP Temp Monitor

Install a thermometer in the engine room to monitor engine room temperatures. Engines typically run at 54.4°C (130°F) but a well insulated, poorly ventilated enclosure can raise ambient temperatures beyond the activation levels of 73.8°C (165°F) for fixed fire suppression systems.



*Fireboy FE-241 automatic fire suppression system is standard equipment on the 2002 Four Winns 248V. The cylinder is mounted horizontally and high on the forward engine room bulkhead. Four Winns connects both the helm indicator light and engine room blower ground wire to the cylinder's pressure switch. If the system activates, the pressure switch opens, the Fireboy system indicator light at the helm changes from green to red, an alarm sounds at the helm and the blower is disabled, cutting off forced ventilation in the engine room.*

*A visual/remote discharge indicator light, mounted at the primary helm station on gasoline boats, is standard equipment with all automatic and automatic/manual systems. On diesel boats, a visual/remote discharge indicator light mounts at each helm location. Equipment manufacturers can provide second station display units as well as a deluxe optional display unit with visual indicator, audible alarm and test switch.*

*Sea-Fire's new self-activating Stinger fire suppression systems are designed for installation in small enclosed areas that are difficult to protect with traditional fixed fire suppression systems, such as in generator, thruster and electrical enclosures, flammable liquid storage areas, etc. High-tech polymer tubing attached to Stinger cylinders ruptures at 79°C (175°F) releasing FM-200 onto the fire. Intended to provide ancillary protection, Stinger systems should not be used in engine compartments in lieu of a USCG-approved pre-engineered fire suppression system.*

marine-grade stranded wire, properly sized crimp-on wire connectors (heat-shrink sealed preferred) and a 5amp in-line fuse with holder or circuit breaker. Wiring should comply with ABYC standards.

If your boat has a single gasoline engine, you can wire the engine compartment blower to the fire suppression system's pressure switch for automatic shutdown. Just be sure the total shutdown load doesn't exceed the rated capacity of the pressure switch. Also, don't forget to provide a means of overriding the pressure switch so you can turn on the blower to ventilate the compartment before restarting the engine.

If you're installing an engine shutdown/restart system, start by mounting the display unit at the helm. Then install the control unit in a convenient location accessible to the ignition wiring. Use the appropriate extender cable if the display unit and control box are separated by more than 76cm (30"). Complete and test all electrical connections per manufacturer's instructions. Wiring should comply with ABYC standards. [Ed: If you're not familiar with ABYC's electrical standards, refer to DIY 1998-#4 issue or the MRT CD "DC Electrical Systems."] If you have any doubt about your wiring abilities, employ a qualified marine electrician to do the installation or to supervise your work.

If applicable, install the manual release handle at the helm or elsewhere outside the engine compartment. Route the cable from the handle to the cylinder in the most direct manner and with as few bends as possible. If you install the release handle at the helm, the best path will typically be the one taken by the steering, throttle and transmission cables. The release cable must be installed so that it won't be subject to pinching, crushing, chafe, kinking or extremes of heat or cold. The total number of bends should not exceed 360°; for example, four 90° bends equals 360°. If the correct length of cable is used, there should be no need to form a coil. Use the nylon clamps provided to support the cable on straight runs only, never on a bend. Finally, connect the cable to the cylinder per manufacturer's instructions.

## TIP 5-Step Decision Process

In selecting the right fire equipment for your boat, consider: 1. The types of fire most likely to occur and their probable locations 2. Effective extinguishing agents for those fires 3. Advantages and disadvantages associated with each agent 4. Extinguisher size and weight relative to crew capabilities 5. Locations where extinguishers should be mounted.

## TIP Where There's Smoke

**THERE'S FIRE**

Electrical fires tend to smolder, creating a lot of smoke, but not much heat. Rather than wait for the heat to build and activate a fire suppression system, install an automatic/manual system with a manual cable release.

| Max Volume To Be Protected | Example | Halon 1301 | FE 241 | FM 200 |
|---|---|---|---|---|
| *0.7 m3/25 ft³* | *1986 Catalina 32* | *NA* | *$169* | *$189* |
| *2.1 m3/75 ft³* | *2002 Crownline 230 BR* | *$239* | *$180* | *$327* |
| *4.2 m3/150 ft³* | *2001 Silverton 351* | *$279* | *$210* | *$489* |
| *14.2 m3/500 ft³* | *2002 Sea Ray 460 DA* | *$769* | *$550* | *$1499* |

**FIGURE 10** *Pre-engineered fire suppression systems can protect engine spaces ranging in volume from 0.7m³ to 42m³ (25ft³ to 1,500ft³). U.S. prices were obtained from manufacturers' suggested retail price lists or websites (street prices are generally lower). All are for automatic systems that include a thermal sensor, cylinder mounting bracket and helm display unit with visual indicator.*

| Options/Accessory | MSRP $US |
|---|---|
| *Manual capability* | *$20* |
| *Manual release cable assembly with straight-out pull, available in lengths ranging in 0.6 m (2') increments from 1.8m to 12.2 m (6' to 40'); longer sizes may be special ordered* | *$46-130* |
| *Dual release adapter, allows manual discharge from two separate control stations* | *$101* |
| *Manual release cable angled pull-out adapter* | *$52* |
| *Automatic engine shutdown system with 3, 5 or 8 circuits, 12V, w/o time delay* | *$229-355* |
| *Extender cable - engine shutdown display to control circuit, 3m or 9.1 m (10' or 30')* | *$24-49* |
| *Standard display unit with visual indicator - for second station* | *$81* |
| *Deluxe display unit with visual indicator, audible alarm and test button – as upgrade and/or for second station* | *$81* |
| *Wire harness for second station display, 3m or 9.1 m (10' or 30') 28-48 Remote warning bell 12V* | *$119* |
| *Actuator head guard* | *$22* |

**FIGURE 11** *After identifying the system type, size, accessories and options you want, get quotes including shipping and hazardous materials fees from several sources. Don't mix and match components from different manufacturers.*

# Shopping Guidelines

**FIGURE 9** on page 32 lists the USCG-approved portable fire extinguisher types and sizes you'll typically encounter. When selecting fire equipment, consider: your boat's current market value; your insurance deductible; how long you expect to own your boat; how you plan to use it (inland, coastal, offshore); and the level of fire risk.

Marine supply stores carry inexpensive dry chemical extinguishers with USCG-approved brackets. Buy the largest sized multi-purpose ABC extinguishers you can conveniently mount and handle onboard. The cost difference between a dry chemical extinguisher rated 1A-10BC

| Fire Suppression System | | |
|---|---|---|
| **Worksheet Make/model/year:** | | |
| ***Engines #*** <br> ***Make/model:*** <br> ❑ ***Gas*** <br> ❑ ***Diesel*** | ***Generators #*** <br> ***Make/model:*** <br> ❑ ***Gas*** <br> ❑ ***Diesel*** | ***Blowers #*** <br> ❑ ***12V*** <br> ❑ ***24V*** |
| **All Measurements:** ❑ ***Meters*** ❑ ***Feet*** | | |
| **Engine Compartment** | **Tank #1** | **Tank #2** |
| ***Length*** | ***Length*** | ***Length*** |
| ***Width*** | ***Width*** | ***Width*** |
| ***Height*** | ***Height*** | ***Height*** |
| **Gross Volume** | ***Volume*** | ***Volume*** |
| ***Tank 1*** | **Tank #3** | **Tank #4** |
| ***Tank 2:*** | ***Length*** | ***Length*** |
| ***Tank 3*** | ***Width*** | ***Width*** |
| ***Tank 4*** | ***Height*** | ***Height*** |
| **Net Volume** | ***Volume*** | ***Volume*** |
| Special considerations, e.g., openings to adjacent compartments, engine compartment air changes/minute, engine shut-down method | | |

| Maximum Volume to be Protected: | | |
|---|---|---|
| ❑ ***Halon 1301*** | ❑ ***FE-241*** | ❑ ***FM-200*** |
| ❑ ***Automatic Only*** <br> ❑ ***Automatic/Manual*** <br> ❑ ***Helm display w/visual indicator at second station*** <br> ❑ ***Helm display w/visual indicator, audible alarm, and test button*** <br> ❑ ***At primary station*** <br> ❑ ***At second station*** | ❑ ***Engine Shutdown*** <br> ❑ ***Up to 3 circuits*** <br> ❑ ***Up to 4 circuits*** <br> ❑ ***Up to 8 circuits*** <br> ❑ ***12V*** <br> ❑ ***24V*** <br> ❑ ***Time delay*** <br> ❑ ***Extender Cable _____m/ft*** <br> ❑ ***Second station display*** | ❑ ***Dual release adapter*** <br> ❑ ***Angled pull-out adapter*** <br> ❑ ***Manual discharge cable*** <br> ***#1: _____ m/ft*** <br> ***#2: _____ m/ft*** <br> ❑ ***Warning bell, 12V or 24V*** <br> ❑ ***Actuator head guard*** |

and one rated 3A-40BC is about US$35. No matter where you buy the equipment, make sure that it meets federal requirements for marine use. If a USCG-approved bracket is not included, you'll have to order one separately.

If space allows, consider arming yourself with one of Kidde's new Fire Out Foam units, available through local fire equipment distributors (check the Yellow Pages), online retailers, Home Depot, Sears, etc. This extinguisher comes with a wall mounted hang-up hook; you'll need to special order a metal bracket (Kidde #466400).

Portable clean agent extinguishers ($CO_2$, FM-200 or Halotron) can be special ordered through many marine stores and shipped directly from the manufacturer to your home or boat. They are also available from fire equipment distributors and online retailers. Decide what type and size you want, and then compare prices. Be sure to order the appropriate USCG-approved bracket, and include shipping costs and hazardous materials fees when making price comparisons.

Fire extinguisher discharge ports for engine compartments are sold in larger marine stores and many marine catalogs.

Fireboy, Kidde and Sea-Fire produce USCG-approved fire suppression systems for the recreational marine market. Their pre-engineered systems meet the same standards and look very much alike. Prices start as low as US$100 for the smallest USCG-approved system **[FIGURES 10** and **11]** . I'd go with the company that offers the best life-cycle package: competitive price, readily available technical assistance, warranty protection, and factory proximity for system refills (as applicable) and service.

*About the author: Susan Canfield is a NAMS certified, SAMS accredited marine surveyor with Marine Associates in Annapolis, Maryland.*

### References

ABYC A4, Firefighting Equipment, Standards and Technical Information Reports for Small Craft, American Boat & Yacht Council, July 2001 (www.abycinc.org)

NFPA 302, Fire Protection Standard for Pleasure and Motor Craft, National Fire Protection Association, 1998 (www.nfpa.org)

# MAINTENANCE

## Osmosis: A Pessimistic Update on this Perennial Bummer

Is a fiberglass boat with blisters repairable or a structural nightmare? Because the inherent chemistry of polyester resin has resulted in an increase in blistered hulls and there are no long-term treatment guarantees, this professional says, "No" to both questions."

[ BY NICK BAILEY ]

Of all the really big jobs undertaken on a do-it-yourself basis, the repair of a bad case of osmosis blisters has to be one of the most brutal. Hire someone to peel the bottom and you can avoid the physical torture of working against gravity with a grinder over your head for endless hours. Then what? Epoxy fillers, barrier coatings and fresh antifouling will empty your pockets. Many hours of filling, fairing and painting are still to be logged. If you also happen to be a perfectionist you have my deepest sympathy.

When the job is finally finished, you will have the satisfaction of knowing your boat looks much better to the critical eye of whatever fish happens to be passing by. Heart warming isn't it? But of course it will also look better to the critical eye of a prospective buyer and their surveyor. The surveyor usually admits, that in most cases, simple gelcoat blistering is not going to adversely affect the structural integrity of the hull. It's a potentially costly cosmetic problem that damages resale value and not much else. There are exceptions.

In northern climes, boats haul for the winter and dry out. Osmosis damage rarely progresses beyond gelcoat blisters. In warm saltwater, however, a boat may not experience a lengthy haul out for years. In these circumstances, water absorption and the gradual breakdown of the polyester resin by hydrolysis, the process during which a substance chemically reacting with water is changed into one or more other substances, nourishes the growth of large blisters deep in the laminate. This business of having the resin leach away and the laminate rupture is a structural nightmare.

### Fault Finding

How do these things happen? Fiberglass hulls are supposed to be inert, insoluble or, at least, waterproof aren't they? In fact most are, but some hulls will exhibit an alarming tendency to blister. The laminate wizards of boat building have been scratching their heads on this subject for a long time. It's obvious that polyester resins in some boats are unsuited for long-term immersion.

At the risk of grossly oversimplifying the chemistry it can be said that the conventional polyester used in boat building is normally only 80% to 95% cured. The polyester polymer (made from dibasic acids, glycols and usually styrene monomer) is a long chain molecule with a lot of reactive or "unsaturated" sites. These locations are supposed to bind together or "cross-link" to form a tough solid as curing takes place. In practice, temperature, resin quality, humidity and the amount of catalyst all factor into how efficiently cross-linking proceeds during the cure. The leftover unlinked parts of the molecule are easy prey for water, the universal solvent. Water has no difficulty permeating unprotected gelcoat and resin and then begins to dismantle the big polyester molecules into corrosive acids and glycol. These in turn attack the surrounding polyester and feed the hydrolysis process. The breakdown accelerates and the chemical debris accumulates till it develops enough pressure to form blisters. Such blisters grow indefinitely in the presence of water and cheesy polyester.

### Fickle Fate

For the owner of a blistered boat, this ultimate betrayal by the very hull material we have sworn by for years is very depressing. The grim reality is the industry standard repair technique that requires the removal of the blistered material, drying of the hull, and the application of a new impermeable outer skin does nothing to change the poor chemistry of the original resin or remove the corrosive hydrolysis products leftover deep within the laminate. We pin our hopes on denying water access to the hull with barrier coatings but moisture can still work its way in (slowly) from the damp air on the inside of the boat. [Ed: Water intrusion into the hull from interiors is a secondary cause of hydrolysis.] Traditional repair methods offer no long-term guarantee of success.

HotVac (www.dryhull.com), a new blister repair system developed in England introduced is being to some of the bigger yards in North America. It's a US$20,000 machine that uses heated vacuum blankets to post-cure the resin to improve its chemistry and quickly remove moisture and hydrolysis byproducts. The yard then proceeds with the conventional blister repair technique. This is about as far from a DIY technique as I can imagine but apparently it works. Time will tell.

Meanwhile what should the boatowner do? It may still be worthwhile to do your own blister repair but don't be surprised if the blisters return in a few years. If you have a boat that has reblistered after a previous repair it's time to give up. There may be no cure.

***HotVac: A 10.6m (35') sailboat takes 10 to 12 days and costs US$1,600 to US$1,900. A 9.1m (30') powerboat costs slightly more, about US$1,800 to US$2,000, as the hard chines make for a labor-intensive application of the heating pads, and takes 8 to 10 days to dry.***

SAIL BOAT

# Repairing Water Soaked Rudders

A dry rudder is a rare and wonderful thing. As boats age, water gets into most fiberglass rudders at the point where the metal support stock enters the blade molding. Many also develop a crack between the two halves along the trailing or leading edge. Here's how to repair the damage before the rudder lets you down when you really need it.

[ BY NICK BAILEY ]

If I had to pick the repair most frequently encountered on older fiberglass sailboats, water soaked rudders would be near the top of the list. Warning signs include water dripping from the rudder for months after haulout, moisture meter readings pegged in the red zone, cracks, delamination, persistent blistering or any combination of these.

High moisture meter readings by themselves don't automatically mean a rudder failure is imminent or that a major repair is required. Nonetheless, a wet rudder indicates the potential for trouble. Ignore these signs of deterioration and you could be in for a worst-case failure when sailing on a windy day, fighting a bit of weather helm, the rudder blade suddenly snaps off.

## Construction

Most fiberglass sailboats have rudders built around a stainless-steel rudder shaft or stock that extends part way down into the core of the rudder blade. To provide a skeletal support for the outer rudder blade structure that transfers the steering torque from the rudderstock, a steel web (often a simple flat plate) is welded to the stock. The outer fiberglass skins are molded separately as port and starboard halves. These shells are jigged and clamped around the internal steel structure together with a large blob of polyester bonding putty (or chopped glass and resin). This holds the web and stock in place and bonds it to the outer skins. The remainder of the internal volume of the rudder blade is then filled with more putty or two-part expanding urethane foam that also bonds to the outer skins.

## Failure Modes

The type of filler used and the boat's geographic location are major influences on how a quickly a soaked rudder deteriorates. The two primary kinds of rudder failure depend on the rudder's construction and where the boat is used.

Corrosion induced internal web failure is mainly a saltwater issue and is worst in warm saltwater. Unfortunately, to inspect for internal corrosion you need to cut open the rudder. Short of surgery or core samples, look for any signs of rusty seepage and stay in touch with owners of sisterships. If you start hearing reports of failures, or see rust weeping from your rudder, don't postpone exploratory surgery.

Skin delamination and core breakdown is a big problem where boats are hauled for winter and temperatures fall below freezing. Any significant volume of water trapped in the rudder freezes and expands. The ensuing pressures within the molding cause the damage. Solid putty-filled rudders don't hold much water, which results in local skin delamination and frost heave rup-

*This rudder suffered a sudden breakage of the rudderstock, folded 90° and had the rudder skins peel off completely.*

*Close up of the broken rudderstock. The failure occurred where the lower stock, a smaller diameter stainless pipe, was inserted into the upper stock and welded in place. Some corrosion can be seen but striking a submerged object may have caused this failure.*

*Close up of the mild steel web exposed after the loss of the skins shows it partially encased in solid filler but the greater volume of the rudder interior is foam.*

tures of the outer skin. Foam core rudders can absorb a lot of water and suffer more cruelly. When water freezes inside, the cell structure of the foam is pulverized. Sounding the rudder with a hammer brings the characteristic dull, hollow "thud" that easily identifies a rudder with damaged foam core. A rudder in this condition always flexes too much so also look for stress cracks and a split trailing edge. These rudders require repairs to prevent a blade failure that will definitely spoil your day.

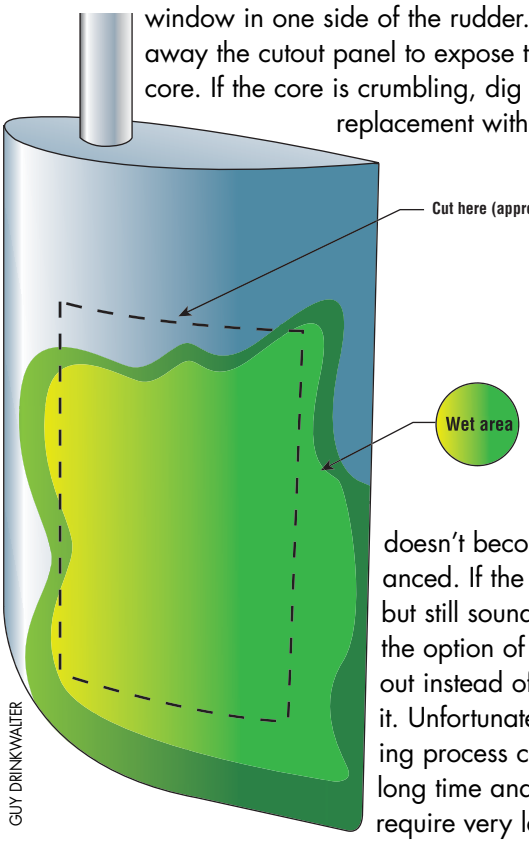
## Repair Steps

### STEP 1 PREP

All major repairs require removing the rudder from the boat. Next, strip all coatings using a random orbit sander and 40- to 80-grit sanding discs. With the hammer and a moisture meter as your guide, map out wet and delaminated areas and mark them for surgical removal. The simplest approach to replacing an area of wet core is to cut a large window (or windows) in the side of the rudder. Keep the cutline away from the perimeter of the rudder to preserve the original shape as much as possible. If the whole rudder is soaked, it may be simpler to split the rudder along the trailing and leading edge and lift off one complete side.

### STEP 2 OPEN RUDDER SURGERY

Using the edge of a coarse grinding disc, or a circular saw, cut through the outer glass skin to open an access window in one side of the rudder. Lift or pry away the cutout panel to expose the wet core. If the core is crumbling, dig it out for replacement with new. Be careful to preserve the location of the internal web and rudderstock so the rudder geometry doesn't become unbalanced. If the core is wet but still sound, you have the option of drying it out instead of replacing it. Unfortunately, the drying process can take a long time and will require very large cutout windows to allow air to get at the wet foam. It may be simpler to remove it.



### STEP 3 METAL WORK

Inspect the welds securing the internal steel web to the rudderstock for cracks or crevice corrosion that may require re-welding. Surface corrosion can be treated by grinding to remove rust followed by an epoxy anti-corrosion coating such as Amercoat Barust, Awlgrip 545, Interprotect 2000 or epoxy resin. If the web is encased in polyester resin and chopped glass fiber, you will need a hammer, chisel and a grinder to get at it.

### STEP 4 REPLACING THE WET CORE

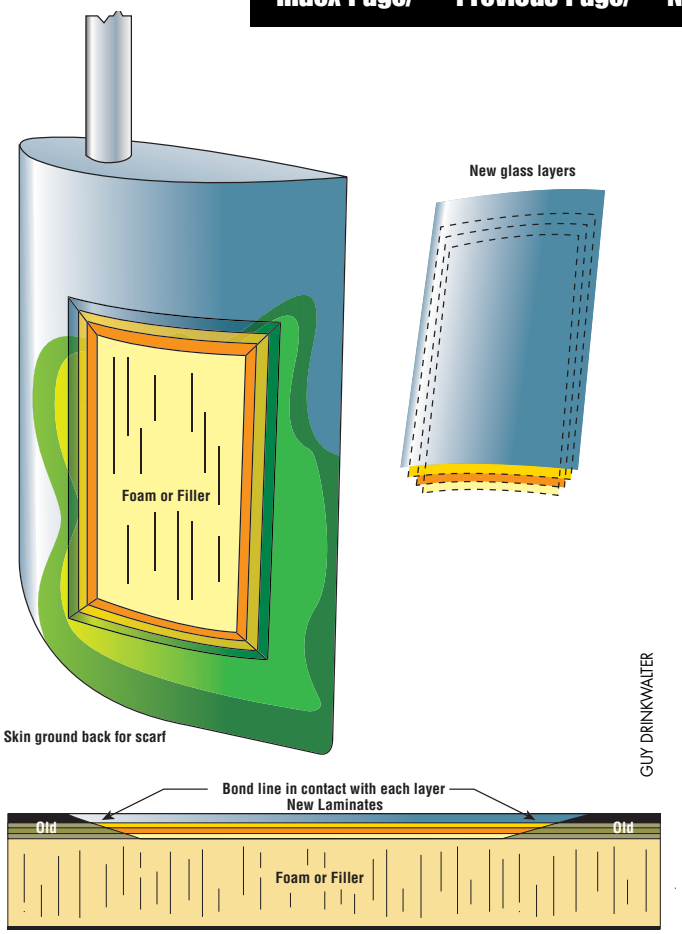
Once the wet foam is removed and the rudder dried out, core replacement can begin using A+B polyurethane foam and/or solid resin and chopped glass filler for the high load areas around the web. Be cautious about large-scale substitution of chopped glass and resin for foam as this adds strength but lots of weight. Avoid very large batches of polyester or epoxy-resin-based filler. The cure reaction is exothermic and evil things can result, ranging from spontaneous combustion to excessive cracking of the filler.

### STEP 5 FOAMING FUN

If you've never worked with polyurethane foam before try some test samples first to get a handle on the expansion and handling characteristics. Follow the manufacturer's directions! It's important to have everything ready in advance because once the foam is mixed and begins expanding it won't wait for you to get organized. Pour the mixed foam directly from the mixing bucket into the perimeter of the rudder first. This will ensure all outer voids are filled. Use enough foam so that the expanded volume comfortably exceeds the rudder volume. In some cases drilling 2.5cm (1") holes around the perimeter will be helpful either to vent the expanding foam or as a handy point to pour foam into the outer recesses of the rudder shell. Since expanding foam will try to push the two rudder halves apart, you should plan on clamping things down firmly prior to mixing the foam, especially if you are replacing most of the rudder core.

### STEP 6 GLASS PATCH TECHNIQUE

Next day, trim and sand to remove excess foam. Bevel the edges of any cutouts or vent holes with a 36-grit




grinder to give at least a 12:1 scarf ratio for fiberglass patches. Patches should consist of alternating mat and roving layers or Stitchmat. Use enough layers to match the original skin thickness. Cut all glass ahead of time and arrange the patch in layers of increasing size to match the opening. Working with small resin batches of waxed polyester or epoxy resin to ensure good open air cure, pre-wet each piece on a table covered with plastic or non-absorbent material, such as melamine, and transfer them one at a time into place. Don't use cardboard on your working surface. It absorbs solvents in the resin. Squeeze out excess resin and bubbles with a bubble buster roller.

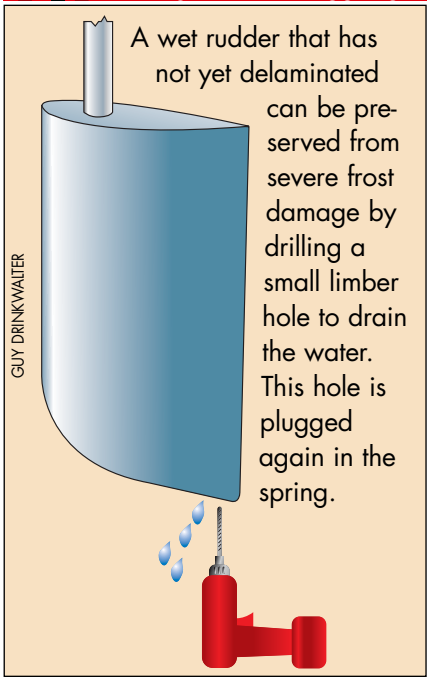
### STEP 7 RESKINNING THE RUDDER

Optional, but recommended, particularly if the outer skin is itself delaminated or stress cracked, is to wrap the entire rudder blade with a couple of layers of new fiberglass cloth. Use 1808 Stitchmat, or DB-120 (a +45-45 double bias 12-oz. cloth), a better choice due to its drape-ability, with a layer of 1.5-oz mat in between. First prep-sand your new patches. If not already removed, strip any remaining gelcoat with a random orbit sander using 40-grit discs. During lay-up, if possible, wrap the new glass around


Index Page/ Previous Page/ Next Page

the fore and aft seam between the two halves. This will be easier using the DB cloth. Fill and fair as needed and prime coat with an epoxy primer before re-application of your usual antifouling paint.

## TIP Temporary Measures

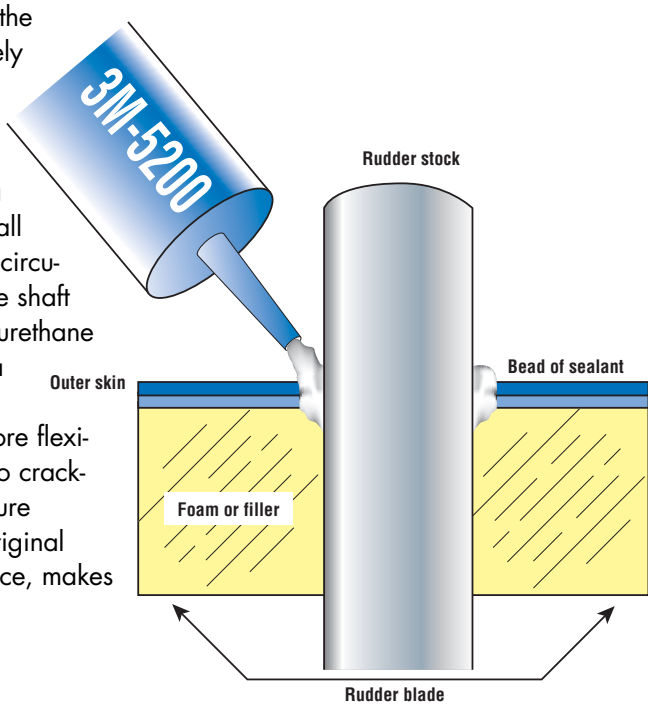


GUY DRINKWALTER

A wet rudder that has not yet delaminated can be preserved from severe frost damage by drilling a small limber hole to drain the water. This hole is plugged again in the spring.

### STEP 8 OUNCE OF PREVENTION

Finally, seal the opening where the rudder shaft enters the blade in order to prevent water re-entering the rudder. Remove the fiberglass immediately adjacent to the shaft to a depth and width of about 6mm (1/4") using a Dremel tool or a small chisel. Fill this small circular trench around the shaft with 3M 5200 polyurethane sealant. This forms a heavy-duty O-ring and, because it's more flexible and less prone to cracking during temperature extremes than the original metal-to-glass interface, makes a much better seal.




### STEP 9 FINALE

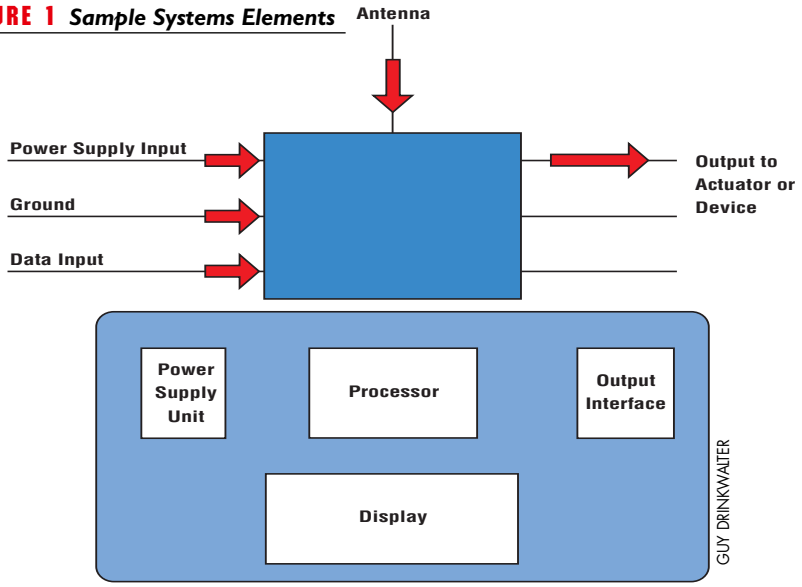
Reinstall the rudder. Hook up the steering. Launch and go sailing. This is the time to check all the steering system components for any other maintenance needs.

*About the author: Nick Bailey is a 25-year veteran of the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario. He and his wife Wendy Loat, competitively race "Looney Tunes," a classic Thunderbird.*

ELECTRONICS

# Step-by-Step Troubleshooting

**FIGURE 1** *Sample Systems Elements*




Installation errors, rather than faulty equipment, are more often the culprit in problems with electronics. When things go wrong, a logical process of systems evaluation is your best tool.

[ BY JOHN PAYNE ]

In an age where the microprocessor has revolutionized electronics' reliability, capability and performance, the ability to troubleshoot boat electronic systems has diminished. With that accepted, we know that the majority of failures can be traced to peripheral equipment and the boat power supply.

There are some measures a boatowner can take. Trouble-shooting electronic equipment requires a logical process of systems evaluation. This evaluation may involve the collection of evidence, such as signs of burning or overheating, unusual noises, visual sparking, strange error messages or confused data displays. These observations can be supported by the correct use of a multimeter and an understanding the information it presents.

## How it Works

It's important to understand the basic operations of the equipment or system before you start troubleshooting. It's very common to find faults caused by only improper operation of the equipment, or the so-called "fingers" problem.

With a basic understanding of the system, it's possible to break down the system into functional blocks, which makes the analysis process much easier. A circuit diagram shows all components in a system. Understand what is normal during operation, and what the parameters or operating range of the system are. All too often the performance expectations of the equipment are very different from the realities. The important factors to understand about equipment operations are: how to power up the equipment; how to navigate around menu driven systems; how to set up parameters within the system software, including input and output ports for signals; how to enter data into the system; how to select data or information; how to initiate manual operations; and how to understand error messages and codes when given.

Never troubleshoot based on what you were told by someone else. If one of the crew reported the failure, check it for yourself. You'll really save time if you actually verify that something is wrong before you start.

## Location, Location

It's important to know where all the electronics equipment and system components are installed. In many devices, such as autopilots, the control head is located separately from the processor unit, rudder actuator, compass sensors and navigation inputs such as the GPS. Similarly, a fish finder may have the control display at the steering station, the transducer forward in a bilge area, a separate speed sensor and inputs from GPS. A radar has a scanner located up the mast or on the pilothouse roof, with the display at a steering or navigation station, possibly a separate fluxgate compass, and a GPS input. With instrumentation there may be two banks of displays, with separate transducers for each function such as wind speed and direction, log and depth inputs etc. It's also important to check out the "neighborhood." Examine where each device's interconnecting cabling, power supply and grounding cables are located. Sometimes, electronics don't get along in near proximity, causing some serious problems. Lastly, check out the locations of all the connections, the cause of most failures.

## Shared Elements

Electronics share a common power supply, either from the battery, a common switchboard or control panel, energized by an alternator or battery charger. Degradation or any disruption in here can cause damage or problems for all connected equip-

ment. This is also allied with common interference sources. In many cases, more than one device will fail, caused by an abnormally high voltage or disturbance, such as a pulse from a nearby lightning strike. This assists in diagnosing failures, as a common cause can be established without wasting time concentrating on a single equipment item (**FIGURE 1**).

## Fine Tuning

The vast majority of equipment faults or performance problems occur after a new installation. Also, faults often arise where something was done to either the same equipment or adjacent equipment and cables or connections have been disturbed. The majority of problems usually turn out to be rather simple, and it's important to start with the basics. Don't try to apply complex theoretical ideas you don't fully understand. This results in a lot of wasted time and embarrassment. Just sit a while studying the operations manual, have a cup of your favorite brew, and think about the strategy. In any troubleshooting exercise split the system in two. It instantly isolates the problem into a specific and smaller area.

## Input Checks

The next step is to examine the unit's inputs. Begin by reading battery voltage using a multimeter, also referred to as a VOM for an analog unit, or DMM for a digital one. Low voltage affects the operation of most equipment. Check that main isolators switches are on and power is on to the switch panel. Where a meter is installed on the panel check that the correct voltage is indicated.

Use a multimeter set on the DC volts range to check that the equipment or system has the correct power input. If it should be 12 volts or have a range of 11 to 15 volts, for example, is the power supply correct? Check this with the equipment both off and on, as sometimes when on, the power supply reads fewer volts, indicating a problem. When testing for voltage, connect the negative probe to the equipment's negative and positive probe to positive to correctly measure the voltage potential between the two. Reversal of probes will simply show a negative reading on the display.

Voltage that reads "O" indicates the circuit supply is switched off. This means the isolator is switched off, a circuit breaker is off or a fuse has blown or circuit breaker has actuated. Check out each control item. In some cases, although not common, a switch or circuit breaker may be faulty. The inputs and output to these must be checked to verify the condition. If a fuse is blown, replace it, but if it blows again, the circuit or equipment has a fault. A less common cause in electronics is a circuit break such as a connection or a wire, either positive or negative. The most common cause is a faulty connection at one of the system components.

A low voltage reading indicates the supply voltage to circuit from the battery is low, or that there is additional resistance in the circuit, such as a faulty connection.

## Output Checks

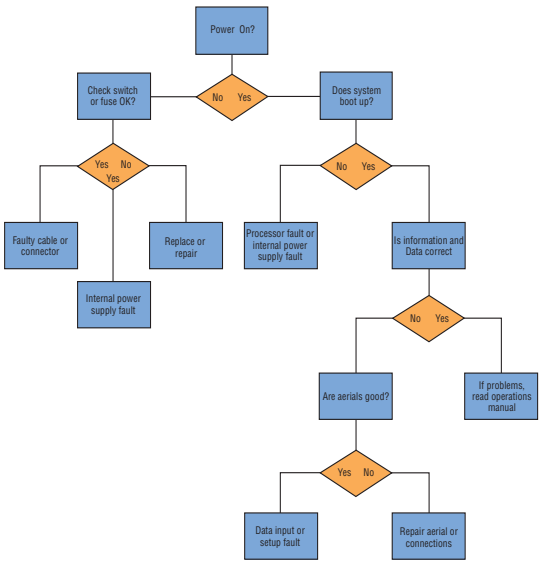
All systems have outputs. In some cases this is simply a display such as a radar screen or instrument display. This is the reported fault in many cases.

Does the system have an output? Does the system boot up or initialize? Where the output is displayed, is the information correct? If the information is incorrect and all the inputs are correct, then the processing part of the system may be at fault. A dead display usually indicates an internal failure.

Does the fault occur when other equipment is operating? Sometimes systematically switching off other equipment causes the fault to disappear, indicating external causes such as interference. A typical symptom is data errors, commonly caused by radio equipment. A cellular phone also causes some problems in autopilots and other equipment if left on or used near such equipment (**FIGURE 2**).

Does the output function operate, such as an autopilot actuator or pump? Is the output voltage correct? If there are VHF or SSB radios, is there a transmitted signal reaching the antenna.

**FIGURE 2** *Flow Diagram for Fault Finding*




## Final Analysis

If the inputs are correct and there are no outputs, then it's reasonably safe to conclude that the processor and output circuits may be at fault. In most cases, there is little that can be done to repair the system and your local service agent has to be called in. Here's an important caution. Don't open up equipment and start internal investigations. Generally, there is little that the average boater can repair. If the unit is under warranty, opening equipment will void the warranty.

*John Payne is a professional marine electrical engineer, consultant, surveyor and author of "Marine Electrical and Electronics Bible" and a new book,"Motorboat Electrical and Electronics Manual," published by Sheridan House. His website is www.marineelectrics.org.*

# On DECK: A Look at Lifelines and Stanchions

Having a lifeline or railing system can reduce the possibility of a fall overboard but the systems on many boats are poorly engineered and alarmingly inadequate. Such a system gives a false sense of security against the consequences of going overboard. How does your boat fare?

[ STORY AND PHOTOS BY JAN MUNDY ]

Lean against some "lifeline" systems and you're apt to snap a fitting or worse, dislodge a stanchion from the deck. Lifeline is a misnomer. A well designed "no overboard" system won't guarantee that you stay onboard, but it's better than nothing and may limit the possibilities.

Lifelines must be engineered and installed to withstand both static and dynamic loads. Three 90.7kg (200lb) guys leaning against a lifeline equates to about 272kg (600lb) static load. If one of these guys falls overboard and grabs a lifeline or stanchion, this doubles the loads. Few overboard protection systems can hold up to a 181kg (400lb) dynamic load! The key to keeping people onboard is to have a system that is sized, constructed and installed properly, and never having to rely only on one system.

## Comparisons

ABYC recommends a minimum rail and lifeline height of 61cm (24"), though higher rails, 91cm (36") even 1.06m (42") are better for adults. The suggested height of the lowest rail or lifeline is 23cm (9") above deck to prevent adults from rolling underneath. This won't stop small children or pets, so with these onboard, install lifeline netting that fills the gap between the top rail and the deck. Fasten the netting securely to the deck with nylon wire ties to a separate line or you'll defeat its purpose.

Stanchions and bases are made of cast or welded aluminum, stainless steel or rarely bronze. Lifelines are commonly 300-series 7x19 stainless-steel wire, usually vinyl coated. (316 is best if the wire's being shiny is your priority or in coated applications; 304 is stronger.) Since stainless steel needs oxygen to maintain it's corrosion resistance, when wrapped in vinyl, it's starved for the essential oxygen and rusts. The coating also makes it impossible to examine the condition of the wire. Typically, the coating chips or chafes where it passes through the stanchion, but all stainless steels will show some surface rust in a saltwater environment. If you don't like the look or feel of bare wire, consider rope lifelines. Made of 9mm (3/8") line, it's only subject to UV degradation and makes a more comfortable handhold when falling or being hoisted back onboard.

***Examples of stanchions fuse-welded to bases. Small welds with minimal surface contact to bases are easily fractured from loading, causing stanchions to sheer off. Welded stanchions also prevent removal when installing a storage cover. Bases are either fastened with screws, or on better-built boats, they are thru-bolted. Though bolts are stronger, if the stanchions fracture removal of bases is often hindered by lack of underdeck access to the nuts.***

### Backing Plates

Backing plates are all too often lacking. Backing plates (larger than the stanchion base) spread out loading on each stanchion base. Obviously, if the plate is too small, loads are distributed over a smaller area and the stanchion may fail at its point of attachment. Some systems have a subplate under the deck of the same dimensions as the base. While this is better than no backing plate, it limits the structural advantage.

A proper backing plate is made of 3mm (1/8") stainless steel or aluminum, plastics or other rigid composites like fiberglass, 5mm or 6mm (3/16" or 1/4") thick. Dimensions should be two to three times larger than the base. If you cannot mount a plate of this size because of the close placement to the deck edge, go with the largest size possible. Always bed stanchions with a polysulfide or polyurethane adhesive sealant. On cored decks, John Bamford of Stainless Outfitters (Tel: 800/268-0395, Web: www.stainlessoutfitters.com) advises the use of a compression tube as well. Without it, compressive loading on the backing plate and stanchion base will eventually crush the core.

### Weak Links

Tests conducted by the US Naval Academy onboard a Navy 44 sail training vessel, presented by assistant professor Paul Miller at IBEX (a marine trade exhibition and conference held in Ft. Lauderdale), concluded that stanchions and pulpits where the first to fail at a 453kg (1,000lb) load, wire terminals and gates failed between 1,360kg and 2,268kg (3,000 and 5,000lb) load and wire lifelines maxed out at 3,175kg (7,000lb). The system is only as strong as its weakest point.

An overboard prevention system works best when tight and securely fastened. Stanchions and pulpits must be strong and rigid. Albeit too much torque, especially on upper lifelines, overloads the pulpit and can pull it out of its bases or rip open the deck if it's a one-piece pulpit. A typical installation has swage or Nicopress fittings connecting the lifeline ends to the pulpit bail. Often a turnbuckle is provided to enable lifeline tension adjustment. A better solution is a rope wiping (use #4 polyester cord or equivalent) at all terminal ends. Should someone fall overboard, you instantly cut the line, hoisting him or her back over the rail without having the extra lift above the lifelines. This, of course, presumes that the person overboard is connected to the boat (harness) and is conscious. Pelican hooks on gate openings are a weak link and should be eliminated, where practical. Examine all connections and mounting hardware for corrosion and looseness. Also inspect nuts and washers underneath the deck at the stanchion base mountings, if possible.

Crew leaning against lifelines puts tremendous loads on stanchions and bases. On a taut system, the loads are pushing outboard loading the entire system. Where lifelines are loose and sloppy, the load is focused on the

### Pre-Loading

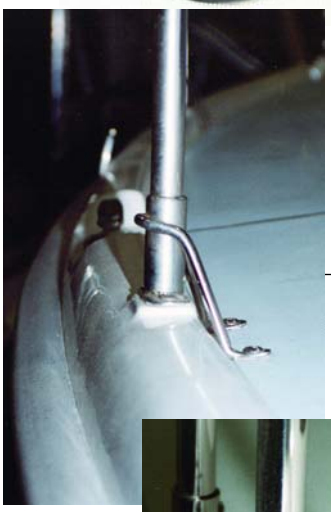
Always replace a lifeline system fitting that is suspect. "Heaving" on stanchions is not a worthy test. Testing a new system requires the tested components to withstand the test requirements of ABYC H-41, Reboarding Means, Ladders, Handholds, Rails and Lifelines. That test subjects the equipment to withstand a "400 pound (182kg) static load at any point, in any direction, without failure such that they no longer perform their intended purpose. If the system includes a gate, the system must pass the test with the gate open."

# Refit

*Terminating stanchion mounted in a socket base is the preferred installation to one welded to a base. Machine screws holding stanchion are preferred to Allen screws.*

*Combining aluminum bases with stainless-steel tubes is the ideal formula for corrosion. Aluminum causes the stainless steel to become brittle over time, resulting in stress corrosion cracking. (left top) A strong sideways force could easily fracture the screws that mount this socket base on the rail. (left bottom) In addition to the common Allen screws, this owner has installed machine screws to permanently secure stanchion to the base, though a better install is bolts with lock washers or nuts.*

*Stanchion welded to shaped stainless-steel plate mounts with cap screws to the toerail. This three-point mounting is better than a single fastening to the rail, but lacks the strength of a stanchion thru-bolted to a socket base.*

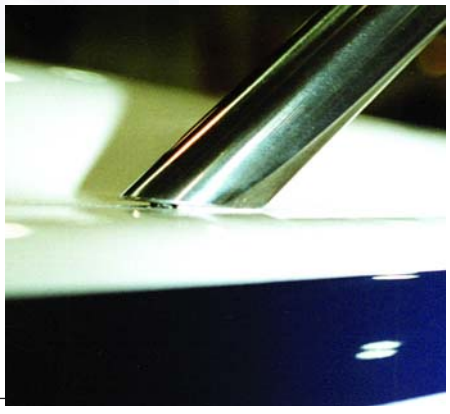


*Socket base relies on welded brace for support. Brace helps to prevent a bending failure, but adds a trip hazard that can send one overboard.*

*A better stanchion-to-base fastener than Allen screws is a thru-bolted clevis pin. A cotter pin is preferred over the split ring, which deforms and can come adrift. Even better is a bolt with a lock washer or lock nut.*

*What appears to be a strong socket base relies on a single screw to hold the stanchion and though it shows evidence of bedding compound, in all probability, is only fastened to the deck with wood screws.*

*Stud bolt fastens this terminating stanchion to the deck. If the stanchion becomes loose or breaks, there is often no access under the deck to repair it. (right) This manufacturer applied some sealant but not enough to seal the stanchion base, providing an entryway for inevitable water damage to the deck laminate and cabin interior.*



closest stanchion and base. For this reason, attaching "backrests" to lifelines only adds a comfortable perch but dramatically increases needless loads on the system. Also, don't clutter the rails with boat hooks, whisker poles and other gear. Keep your boat's overboard protection system independent of all other equipment.

Never rely solely on your boat's lifeline system to prevent falls overboard. Provide good deck traction (redo the non-skid if needed) and eliminate any tripping hazards. Wearing a safety harness that attaches crewmembers to the boat at all times when onboard is your best bet, even in calm conditions.

***If it's necessary to remove welded stanchions for a storage cover or when doing repairs, cut stanchions away from bases, install socket-type ones and thru-bolt stanchions to bases.***

***The stanchion welded to a base plate is a weak installation that depends on a welded brace and base fasteners (hopefully bolts) for strength.***

***Well-secured lifeline netting ensures small children and pets stay onboard. The oversize squares of this product from Johnson Marine provide ample room for passing small objects and lines through the netting.***

# FUEL WATCHDOG – MONEY IN THE TANK

A fuel computer is the only instrument that determines your engine's optimum running speed and mechanical condition, fuel range, ideal trim and load distribution. Install one and you can save as much as 20% in fuel costs.

[ DWIGHT POWELL ]

Accurately measuring and monitoring fuel consumption can tell you a lot about your boat's efficiency and condition of mechanical systems, and definitely save money in fuel and maintenance costs. Adding fuel consumption flow meters on our 11.2m (37') Egg Harbor Double Cabin was based on my desire to know, as precisely as possible, what is happening at any given time with the fuel and propulsion systems.

Fuel management instruments measure the movement of fuel through the fuel line, and through the magic of computer technology, provide the amount of fuel consumed by your engine(s) in U.S. gallons per hour (gph) and total gallons consumed. (Metric readouts are also available.) Linking to a GPS or Loran unit with NMEA 0183 output gives a readout in miles per gallon (mpg). The driver, by monitoring fuel consumption, can adjust throttle settings for the optimum speed-fuel consumption ratio.

We installed a FloScan TwinScan Fuel Flow and Tachometer. Both are analog gauges that combine port and starboard engine readings with an LCD window on the bottom that provides a digital readout of the total gallons consumed on the Fuel Flow unit, and fuel consumption per hour on the other gauge. Fuel flow is measured by a special sensor, mounted near each engine, that calculates the amount of fuel passing through the line, and then transmits this information to a gauge at the helm.

"Wiking," our 1968-vintage semi-displacement "trawler" weighs in at a heavy 9,072kg (10 tons). Power comes from twin 427 Crusaders and, like all power plants of that era, were designed for leaded gasoline. We have since rebuilt the engines to handle unleaded gas, upgrading the distributors, carbs; intake manifolds and added a Multiple Spark Discharge (MSD). [Ed: The article titled, "Extreme Power Boost," in DIY 2002-#1 issue, details the engine makeover.] But for all new or old engines, some fine tuning, continuous maintenance and adding a few modern conveniences, such as flow meters, can spell better performance, less gasoline consumption

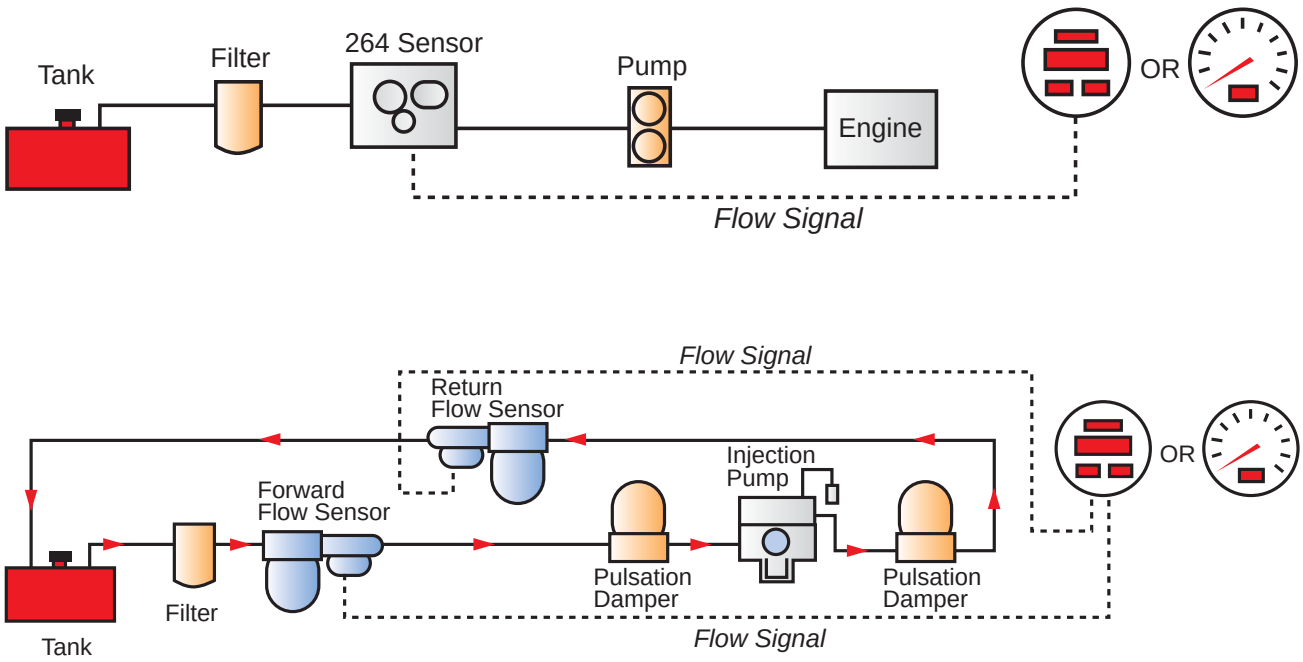
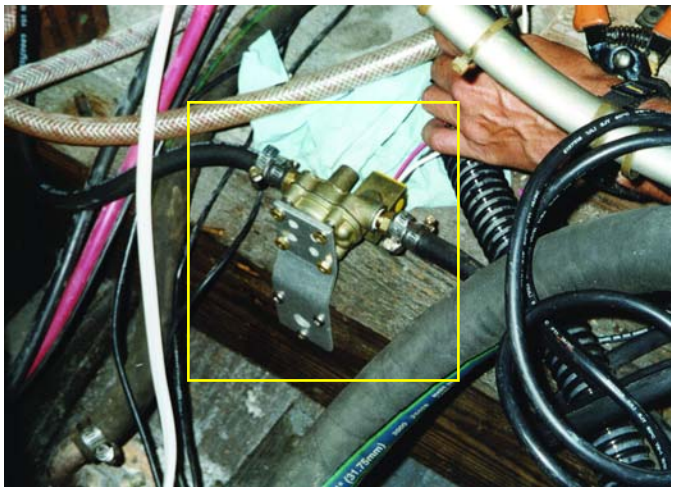



**FIGURE 1 SAMPLE INSTALLATIONS OF FLOSCAN FUEL FLOW METERS GASOLINE** *(top) engines require only one fuel flow sensor per engine, mounted between the tank and the engine. Diesel (bottom) engines have flow sensors mounted on the forward and return fuel lines and often pulsation dampers to prevent pulsating fuel from causing measurement errors.*



***In this gasoline engine installation, sensor is mounted with the supplied bracket, positioned so it's lower than the fuel pump so fuel flows up from the sensor. It connects in-line to the fuel line between the fuel-water-separating filter and the fuel pump. Installation is straightforward but requires using the proper sealant and double hose clamps.***

and significant dollars saved on fuel costs, and ultimately a cleaner environment.

## Installation and Testing

FloScan Instrument Company (Tel: 800/522-3610, Web: www.floscan.com) offers fuel consumption computers and fuel flow instruments for most gasoline outboards, stern drives and inboards and diesel engines. When ordering, you'll need to provide the boat make and model, and engine make, model number and horsepower rating. Our boat required a TwinScan Fuel Flow Meter, from 1 to 32 gph, and tachometer from 1 to 6,000 rpm.

Installation is relatively simple and required a very careful review of the instruction manual, help from my mechanic and about 8 hours time. While one could install this system without a marine mechanic, I would advise you at least get advice from a competent tradesperson or, even better, get them involved. I don't think it can be said


***Working from atop the dash, rather than lying underneath it, simplified the wiring of the gauges and allowed quick reference to the wiring diagram. Compact gauges fit standard 8.6cm (3-3/8") diameter holes.***

***At-a-glance instrumentation, each gauge contains port and starboard meters with red pointers to easily reference gallons per hour or speed and engine rpm (right). Throttle settings are adjusted for the most economical speed versus fuel consumption ratio as indicated by the LCD digital meters.***

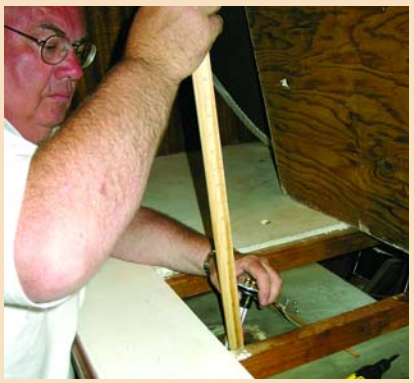
too often that the marine environment is much different from the automotive arena because of dampness and the enclosed spaces found on a boat.

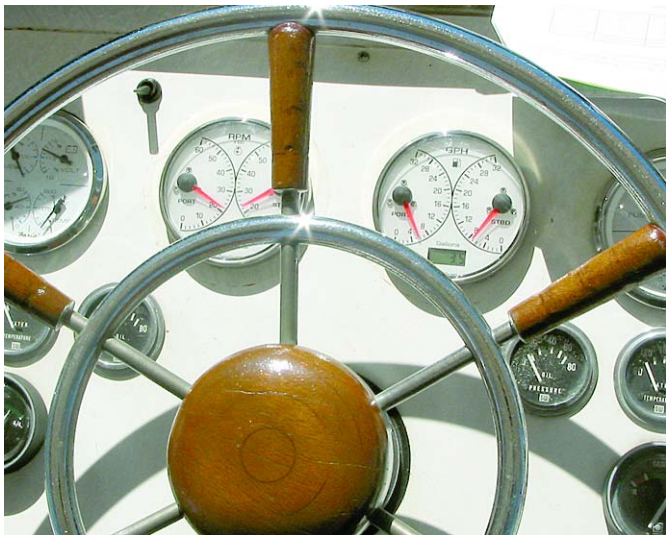
After selecting the best location for the fuel flow sensors, we ran the fuel hose and wiring neatly to their respective locations. While my mechanic installed the sensors in the engine room, I worked out the gauge setup on the instrument panel on the bridge and routing of the wires. Color-coded wires and a comprehensive wiring diagram made the job go very smoothly. Leaving extra long wire leads, wires were pulled out through the instrument holes, allowing me to take my time on the hook-ups and avoid trying to make sense of a maze of wiring behind the panel while working from underneath lying on my back. FloScan supplies all fuses, butt connectors and heat-shrink tubing for the job. Also mounted on the dash is a momentary On switch to reset the totalizer and a simple On/Off switch to change the tach digital readout between the synchronizer and miles per gallon. This switch is not included with the system but instructions are clear on its installation.

When I started the engines, both the gph meter and tach came up to power, performed their diagnostics as described in the instruc-

## Audit Check

To check the system's accuracy, we decided to conduct a parallel test using a yardstick marked off in inch increments. (We didn't trust the tank-mounted electronic fuel senders for a correct reading.) Since we cannot dip the two tanks from the outside, we removed the fuel senders and using our stick measured the levels. By determining the number of inches of fuel in each tank and therefore gallons, we had a starting point. After returning from a one hour run, we again removed the senders and dipped the tanks. Upon comparing our actual usage with the total as indicated by the TwinScan Fuel Flow instrument, the usage was nearly identical; a variation of .6 gallons between the two fuel tanks was easily attributed to an arithmetic error.





***Non-matching pointers provide instant warning of fuel-related problems as noted by the lower gph reading of the starboard engine on the TwinScan Fuel Flow instrument.***

tions and worked perfectly. I did find that while I could adjust the tachs to read very closely for each engine, there is no individual tach adjustment. When my ear tells me the motors are in synch, the tachs are 50 to 100 rpm different from each other. It's not my hearing for I've tuned guitars for most of my life and have a pretty good ear for this sort of thing.

## Performance Data

Before this installation, I always ran the engines at 1,800 rpm and traveled at about 8 knots per hour (kph). I cannot come up with any particular reason for this other than it seemed a decent speed and, without any scientific proof, not overly hard on the engines. I have read and believe it to be so, that while marine engines like to run long and strong, they also last much longer if they run at moderate speeds and are, of course, serviced regularly.

Carefully observing the tachs, we ran the boat at 1,800 rpm, and then throttled up to 2,000, and then 2,200 rpm, and then backed off to 1,600, finishing up at 1,400 rpm. At each increment, we let the boat settle, rechecked the rpm, and then recorded the speed and gph (Figure 2). Results were surprising! Obviously the more rpm turned, the more gas used. At 1,600 rpm, "Wiking" traveled at 7.5 kph and engines burned 4 gph and 4.5 gph respectively for a total of 8.5 gph. This is more than one gph less than at my "ideal" 8 kph cruising speed, and a drop to 7 kph burns a full gallon less! With gas costing CDN$3.38 per U.S. gallon at the marina pump, at 50 hours of use per year, for example, I'm saving about CDN$186 and cruising tolerably slower.

During our tests, the FloScan Fuel Flow meter noted that the starboard engine burned 1 to 1.5 gallons more per hour than the port. I haven't determined the cause of the malfunction, likely a result of a carb set too rich or perhaps off-spec engine timing, fouled spark plugs, new

**FIGURE 2**

| RPM | Speed(kph) | Port Engine(gph) | Starboard Engine(gph) | Total |
|---|---|---|---|---|
| 2,200 | 9.3 | 6 | 7 | 13 |
| 2,000 | 8.9 | 5.5 | 6 | 11.5 |
| 1,800 | 8.2 | 4.5 | 5.1 | 9.6 |
| **1,600[1]** | **7.5** | **4** | **4.5** | **8.5** |
| 1,400 | 7 | 3.5 | 4 | 7.5 |

NOTE: To convert to metric, there are 3.78 liters in a U.S. gallon. [1]Optimum cruising speed.

and therefore stiffer valve springs on the cylinder heads, even the high-output alternator robbing horsepower as it charges the house battery bank. More importantly, is discovering that this engine needs work to bring it to optimum performance, which could add life and therefore fewer maintenance bills in the long run. Running both engines at the same rpm will pay for those TwinScans even sooner!

## Added Insurance

It's conceivable that some might consider the addition of FloScan equipment to be a touch extravagant. This twin-engine installation cost US$550 for one TwinScan Fuel Flow Meter, US$350 for the TwinScan Tachometer and add another US$100 for miscellaneous wire and connectors, for a total outlay of US$1,000. This very high-quality fuel management system might seem a bit pricey at first glance, but the benefits soon add up.

With these meters, I have a visual "watchdog" of problems that appears instantly before the engine overheats or worse, breaks down and leaves you stranded. If fuel consumption increases from normal operating levels with no noticeable change in engine operation, you'll know to check for engine and drivetrain problems or a dirty hull bottom, perhaps fish net or line around the prop, trim tabs set improperly, even a potentially dangerous fuel leak. With FloScan providing accurate fuel consumption and knowing the tank capacities, we can easily determine our range, giving us added assurance that we'd likely never run out of gas. We won't pay for the system in one year, but I'm convinced that long after our original outlay is covered by fuel cost savings, we'll still be enjoying the peace of might these instruments provide.

*About the author: In the two years since purchasing "Wiking," Dwight Powell has rebuilt the engines, upgraded the wiring, reworked the interior, had the hull and deck professionally painted and new canvas fabricated. More work is planned for next season, including a new instrument console and dash, and articles documenting his progress will appear in future issues.*

PROJECT BOAT

# JUNKYARD PAYOFF

Investing in a used "bargain" boat means you'll likely need to wear a lot of hats: designer, foreman, mechanic, inventor, manager, referee, critic, optimist. Here's one man's recipe for success.

*Abandoned in a boatyard, this O'Day 27 needed lots of TLC and a caregiver with some technical know-how.*

*"Audacity," a restored 1975 27' O'Day, splashed for under US$4,000 has an estimated book value of US$14,000. "Now that the boat is in the water and not in the backyard, I miss it!"*


[ BY JAN MUNDY ]

If you're looking for a project boat to get you afloat, there are many bargains abandoned in yards or slips by owners who lost interest or became overwhelmed by some mechanical quagmire. Julian Hood had sailed a lot and never planned to own a boat, but when he found this "dollar" boat at a marina in Annapolis, Maryland, it was a deal too good to refuse.

The marina held the title of the abandoned 8.2m (27') O'Day sloop. After a self-survey with help from a boat knowledgeable friend, Julian remitted a deposit. (He didn't consider the boat's low cost warranted hiring a surveyor.) Closing the deal a few weeks later, he was now a boatowner, which meant rent payments to the marina. Fortunately, he negotiated the rent payments in the purchase price as he planned to leave the boat at the marina for the winter.

Aside from some delamination around deck fittings (nothing requiring major surgery), the boat was in good condition, equipped with all sails, but no engine. A previous owner had removed the original Atomic 4. Julian was advised to find a used one, rather than repower with diesel, a job costing more than the purchase price. At the Boston in-water boat show later that year, a marina was selling an Atomic 4 (A4) with about 300 hours running time for US$700. Julian offered $600, loaded it on a borrowed trailer, and drove home to Georgia.

## Odor Fatigue

With the boat sitting in his backyard, Julian's first task was to remove the years of mold, mildew and grime. Everything that wasn't nailed down was removed and scrubbed with water, bleach and TSP. After a thorough wash, the boat still smelled bad, so he replaced every hose. Foul odors, particularly from old head hoses, tend to permeate all things in the cabin.

## Strategy for Success

Now the refit could begin in earnest. With battery pack in hand, Julian checked the operation of all systems, hooking up bilge and freshwater pumps and electronic equipment. He had already decided to repair the boat as close to original condition as possible, sail it for a season or two, then make any necessary improvements. While fiddling with minor jobs, he put together a "business" plan, beginning with a list of all things wrong with the boat and how best to fix them. This list was then divided into "systems," such as engine, prop and shaft, cockpit, deck, DC power, etc. He then set up a timetable, scheduling various jobs, no matter how minor, for each day.

From his to-do list, he developed a parts listing and worked up a cursory budget. Julian's goal was to launch the boat for US$4,000 or less. With the mechanical skills to do most of the work himself, and hiring help for very reasonable rates when needed, he was confident he would complete the boat on time and within budget.

## Getting Started

Initial success on small jobs brought him instant rewards and provided the

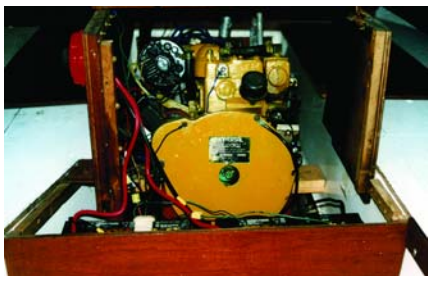
### TIP Easy Shim

When doing an engine alignment and adjusting the height of the mounts, use U-shaped shims that slide onto the bolts rather than washers that require lifting the engine off the mounts. After making the necessary adjustments, securely tighten the mounting nuts. Paint shim ends with Dip-It, a plasticized liquid often used to coat wire terminals, whip rope ends, etc. This provides a visual reference should the shims shift from vibration. Also, it peels off easily when it comes time to realign the engine again. Shims are available in different sizes at auto parts stores.

needed encouragement. Brass, bronze and stainless cabin hardware was badly corroded and required scrubbing in a muriactic acid bath, followed by polishing. All interior teak received four coats of gloss WoodPro (available from West Marine), sanding lightly between coats. Sails were delivered to a sail loft for minor repairs, and all lines thoroughly washed to remove moss and mildew.

## Mechanical Upsets

While the boat was still in the marina for the winter, Julian completely disassembled and rebuilt the engine. He purchased an engine manual and from magazine articles and websites, he discovered that A4's were always difficult to crank because of moisture accumulating on the points. He'd been advised to purchase an electronic ignition, costing US$300. Instead, he found a website that listed all the needed parts, and purchased these at a local NAPA auto parts



***Fitting new engine beds for the rebuilt Atomic 4.***

store that sold marine parts for US$98.

He now faced the problem of hoisting this 181kg (400lb) beast into the boat. A local welding shop had an outside hoist, so Julian loaded the engine in his truck, drove the boat down to this shop and was charged just US$10, which included helping him slide the A4 into the engine compartment.

This engine had a reduction gear that wasn't needed, so Julian removed it and had the drum assembly for the transmission changed to direct drive by a marine engine shop in Annapolis. He knew which jobs he shouldn't tackle himself.

Problems often arise when aligning a new engine installation. Julian devised a jig that simplified taking measurements. This jig, made of plumbing pipe, flat iron for crossbars and a couple of clamps, mates to the propeller shaft coupling and matches the footprint of the engine. After installing the engine, the height was fine-tuned using U-shaped shims, 12mm (1/2") on the stern mounts, 19mm (3/4") on the front mounts.

## Problem Solving

Every time Julian tackled a new job, he was challenged by something he hadn't planned to do. The propeller on the boat was a left-hand rotation, not the right-hand one he needed. Since the freshwater pump was mounted in a drawer, it needed to be relocated. Another problem was timing the engine after installing the electronic ignition. It took three tries before achieving the right stroke. Routing a new exhaust system involved innovative design to master all the bends that leaked during the

***Interior woodwork was cleaned, sanded and refinished with four coats of gloss WoodPro.***

***Jig made of flat bar, 25mm by 3mm (1" by 1/8"), clamped to a pipe with one end threaded to the Atomic 4 transmission coupling made quick work of the engine installation. The two pieces of flat bar are cut to length and spaced to equal the footprint of the engine mounts. Positioning of the aft cross-bar matches the actual distance between the engine coupling and the aft engine-mounting hole. To use, mate the jig coupling to the corresponding prop shaft coupling, align and support the jig. Its position determines the height of the engine mounts off the floor and their athwartship position. Subtracting 25mm (1") from the height measurement gave enough play to allow a final alignment of the couplings using U-shaped shims.***

engine post-launch check and had to be removed completely from the boat, tightened, and reinstalled. To quote Julian: "A good skill to develop is learning how to kiss your own rear in a telephone booth!"

## Electrical Scan

The electrical system was in surprisingly good condition. Aside from the need to route new wiring, other components checked out okay with a VOM (multimeter). Julian replaced the navigation lights and installed a new depthfinder and speedometer, which was rather straightforward once he summoned the courage to drill the transducer holes. He also verified that all systems worked properly and met ABYC Standards.

## Deck Refinishing

Dry delamination on the starboard side of the balsa-cored deck was repaired with epoxy. Julian drilled small, closely spaced pilot holes and injected unthickened epoxy resin into the voids. To prepare the deck for painting, he removed all hardware (except the toerail), which needed to be rebedded anyway. Taking photos of the hardware before removal provided a no-mistake reference when reinstalling. Decks were sanded, solvent washed, non-skid areas masked off, then painted with one coat of Bikini blue. A second coat mixed with sand was followed by a final coat. Teak brightwork was also removed, cleaned, sanded and refinished with four coats of semi-gloss WoodPro.

## Survey Needs

Once the boat was launch-ready, Julian arranged to have it surveyed. Besides the insurance requirement, a survey provided a means of grading his work, especially since this was his first refit. To ensure the boat was outfitted properly, he contacted the surveyor for a review of the system's checks and made the necessary corrections prior to the on-site survey.

## Lessons Learned

There are some services that a prudent DIYer knows are better done by professionals. "Safety first" dictates having a marina launch the boat and step the mast.

Launching in the morning and sailing in the afternoon is rarely the reality. Fine-tuning the engine, adjusting throttle and transmission linkages, for example, took Julian a few days. Calibrating the electronic ignition and fixing exhaust leaks consumed more time. Then there was the mast to step, rigging to tune, engine to realign.

Undertaking a major refit yourself involves learning lots of new skills, even inventing complicated devices to perform seemingly simple tasks. Julian had never worked with epoxy before and had little knowledge of boat systems. Before attempting any major boat refit, be sure you can invest the time to complete the project and have budgeted extra funds to outfit it. Otherwise, you'll have a nautical ornament for your yard.

*About the author: Julian Hood became hooked on sailing 10 years ago when working at a boat show. He had sailed the waters of Chesapeake Bay and the U.S. Virgin Islands on friend's boats, and taken an American Sailing Association course before purchasing "Audacity," a 1975 O'Day 27. Today, he and his wife sail the "Golden Isles," the waters off St. Simons Island in Georgia.*

# Good Boatkeeping

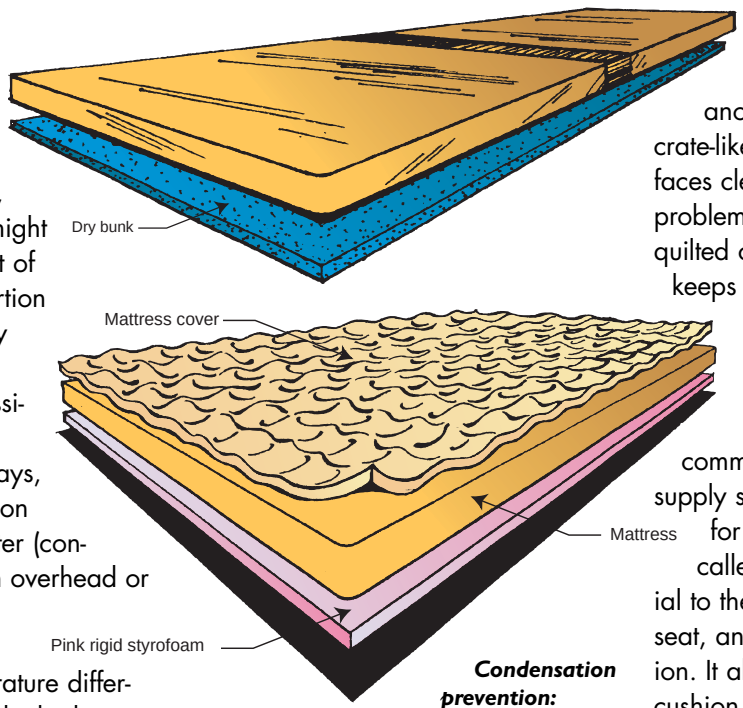
[ BY ZORA AIKEN, ILLUSTRATIONS BY DAVID AIKEN ]

## BEAT THE CONDENSATION BLUES

A leaky port is probably the most common source of unwelcome water inside a boat, but it's only one of many possible entry sites. Water dripping from undiscovered (often-undiscoverable) sources is far more annoying. A port can be recaulked or regasketed, but the mystery drip may remain forever untracked, particularly if the boat has a headliner. A hatch, port, vent, stovepipe, stanchion, wiring lead, toerail, any of these, might be the culprit, but short of tearing out a good portion of the interior, you may never know.

Even if it were possible to find and fix all these problem waterways, the issue of condensation onboard remains. Water (condensate) dripping from overhead or running down the interior hullsides is caused by atmospheric temperature differences outside and inside the boat. Whatever the cause, when conditions are ripe, water droplets will continue to fall or run until they are stopped. Often, the first surface to block this water is a bunk or seat. Cushion tops catch the falling drips, cushion bottoms absorb the running trickles and soon both are wet, creating the ideal environment for mold growth. Accepting that condensation is a fact of boating life, the wise boater will adopt ways to deal with it.

Insulation helps limit condensation. Use the 9mm- (3/8"-) thick dense Styrofoam designed for home use. It comes in accordion-folded packages of 1.2m (4') lengths that can be easily cut with a utility knife to fit the odd shapes inside the boat hull and lockers. Tape it into place or fasten to wooden cleat stock with screws and oversize washers to keep the screw heads from penetrating through the foam. Cut and tape a layer to place under the bunk cushions too. This raises the mattress off its base, allowing any water that has dripped onto the surface below to evaporate rather than soak into the cushion and activate the mildew spores.




***Condensation prevention: (above) Cover cushion with plastic bag before inserting into fabric cover and lay Dry Bunk between the cushion and its support flat. (below) Bunk cushion with Styrofoam underneath, egg-crate mattress cover on top.***

Some owners prefer to use the rough, honeycomb or web-like air-conditioner filter material. Again, the filter prevents water from touching the cushion bottom, and the airholes in the filter itself allow the water to evaporate.

To discourage water from soaking into cushions from the top surface, place foam rubber cushions into a heavy-duty plastic bags before putting on the fabric covers. This solution works well with seat cushions, and with the help of duct tape, can be adapted to bunk-size cushions too. The cover may get wet, but the plastic keeps the cushion material dry and curtails mildew growth. You may hear some crinkling when sitting down, but that's better than squishy foam. It's especially beneficial when a rainwear-clad captain drips saltwater onto the seat, as it's much easier to wash fabric covers than cushions.

Adding a pad on top of a berth mattress is another cushion saver. Egg-crate-like pads keep mattress surfaces cleaner and avoid the mildew problem that inevitably sets into quilted cloth mattress pads. It also keeps the occupants cooler, especially if the mattress happens to be encased in plastic.

Wet bunks are such a common problem that boating supply stores sell a special product for just such use, appropriately called Dry Bunk. Cut this material to the shape of your bunk or seat, and place it beneath the cushion. It absorbs moisture before the cushion material does. Airing it out frequently lets the moisture evaporate and keeps it smelling fresh.

If your boat has a wheelhouse or a semi-enclosed cockpit, use cushions that can be left out in any weather. This eliminates stowing wet cushions in sealed lockers, a catalyst for mildew. Closed-cell foam cushions covered with vinyl (ours are from C Cushions) are comfortable and long lasting.

*About the authors: David and Zora Aiken are the authors and illustrators of numerous boating, camping and children's books, including "Good Boatkeeping" and "Good Cruising" published by International Marine. They live aboard "Atelier," in Grasonville, Maryland.*