2002 ISSUE #2 –
DIY boat owner
the MARINE MAINTENANCE MAGAZINE

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CURRENTS

[EDITED BY JAN MUNDY]

Auto Versus Marine Parts

DIY reader Al Deaver called us regarding the article titled, "Extreme Power Boost" in DIY 2002-#1 issue. Deaver was concerned about the installation of the automotive version of the Multiple Spark Discharge (MSD) as pictured on page 46 and to the right. He pointed out that the unit in this installation is not the spark (ignition)-protected marine version and a conflict with the ABYC standard requirements for ignition protected electrical equipment in certain marine applications. He was also worried about its proximity to the exhaust riser. The author, Dwight Powell, contacted Autotronic Controls in El Paso, Texas, the MSD manufacturer, for clarification. Dwight's reply follows.

The reader is correct. I recommend all future installers use the MSD 6M-2 marine unit. Both the 6A (auto model) and 6M-2 (marine model) are identical in performance and basic construction. The 6A unit is considered water or splash resistant, while the 6M-2 unit is considered water or immersion proof and is

also potted in resin to prevent vibration damage. Both units are effectively sealed against any spark emission, except the wiring path. The 6M-2 unit also has watertight connectors, but since I installed my unit to ABYC standards using proper marine tinned-copper connectors and adhesive-lined, heat-shrink tubing, corroded connections are not an issue. It's unlikely a spark could cause any issues with the riser, as the standard requiring ignition protected components is intended to deal with a spark igniting volatile vapors, not with heat sources. If the heat riser were to burst, I'm confident that the MSD 6A's water resistancy would be adequate. As for onboard vibration, it's no more, and probably less, than most vehicles traveling on a roadway. Were my boat in saltwater and/or a performance boat, I would definitely use the marine model. [Ed: Product testing for compliance with the performance requirements of a standard, such as ABYC, are performed by an independent laboratory, such as Underwriters Laboratories (UL). This is the final consumer assurance of the product's safety in a marine application. The dynamics of vibration and water exposure in the marine environment extend well beyond those experienced in an automotive application. In the case of the MSD 6M-2 unit, the manufacturer should state whether the product meets all applicable ABYC standards, and that is what the consumer should seek when making decisions about marine equipment purchases. Where spark and electrical integrity in wet applications is at stake on a boat, nothing less should be accepted.]

Storm Tracking

I always believed that the number of seconds that pass between the lightning flash and the thunderclap gives the distance to the lightning. According to Ewen Thompson, a lightning specialist with the University of Florida, the actual calculation is to divide the time by five. If the thunder starts 20 seconds after you see the flash, the lightning is 6.4km (4 miles) away. A better rule of thumb is that, if you hear thunder, you are within range of a strike. — *JM*

Pass the Envelope Please...

Further to our answer to DIY reader Rob Weien's question on our Technical Helpline (see Talkback column, "Grounds for Underwater Metal Corrosion" on page 7), we received his response. "Wow! What a thorough analysis and spot-on advice. Taking your suggestion, I employed a professional to inspect the boat. He tested everything with a meter and found no large current flow nor any meaningful differences between the plate and adjacent metals (bronze thru-hulls). I've never had such a prompt and well-researched reply from a magazine at any time on any subject."

How to Build Fiberglass Components

I'm hoping to rebuild the engine box and several floor hatches on my 7.6m (25') cruiser. I would like to build them out of gelcoat and fiberglass. Any information that might guide me on my way would be greatly appreciated.

Chris Sines, "Vitalsines," Cape May, New Jersey

Turn to "A Bargain at Any Price," on page 50 for details on building and prepping the molds, applying gelcoat and laminating the glass mat and woven roving.

Flush Appeal

I read the article titled "Intelligent Sanitation" in DIY 2002-#1 issue with interest. I have heard that the Lectra/San takes several minutes to run through its treatment cycle. Can the toilet be used during this cycle? If it can be used consecutively (I frequently sail with a boat full of teenagers) what is the capacity of this unit? Once it reaches capacity, does the sewage simply back up in the discharge line then possibly into the toilet?

Ted Hugger via e-mail

According to Raritan, every time the toilet is flushed, the Lectra/San runs

(continued on page 4)

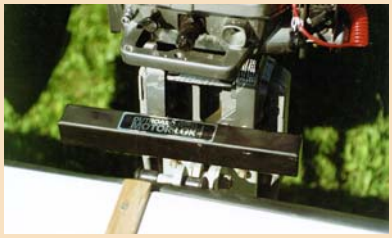
Theft Happens

It appears we are losing the battle against recurrent outboard theft. Having lost three engines in 8 years, and absorbing an increase in our insurance policy deductible, we now keep our outboard in locked "dry" storage until needed. Our first engine was locked to the kicker bracket with a heavy-duty chain, but it was easily cut and the engine lifted off the transom. Ditto on the second occurrence. Thieves trying for the third engine couldn't remove the Fulton lock that covered the motor's hold-down clamps, so they cut the chains holding the boat to the dock and floated (we suspect towed) it away. A few days later, the boat showed up, sans engine, but with what remained of the Fulton lock lying in the bilge. Examination of the lock showed it had been pried open (see photo below), until the threaded barrel-style lock mechanism snapped, revealing the weak link in an otherwise well-engineered device.

While we realize there is no 100% theft proof lock, the Fulton lock did hinder the process. This was not a quick-and-easy job. Just consider the logistics of first beaching the boat, then getting a pry bar under the lock from inside the cockpit, with a scant 30.5cm (12") clearance to the floor, and bending the lock housing until it breaks. We wanted a professional opinion, so we contacted the manufacturer who agreed to evaluate our damaged lock.

Since purchasing our lock, Fulton had redesigned the locking mechanism, available on 2000 and newer models. Engineers pry-tested the new lock to duplicate the condition of our damaged lock. Using a 91cm (3') wrecking bar placed in the slot between the two halves, they were able to bend the new model 100% further than our damaged unit before it failed.

If you know of other theft-deterrent measures, we'd really like to hear about them.



Fulton Outboard MotorLok has a locking mechanism on the bottom.

(top) Damaged motor lock was pried apart until the threaded barrel-style lock snapped. Though both sides were pried open, Fulton engineers suggested that an upward force on the short side (right) is what likely snapped the lock. (bottom) New model with redesigned snap-together locking mechanism took twice as much force to cause it to fail as our damaged unit.

A battery-operated alarm attached to an outboard sounds mega-decibels when the cord is cut, which hopefully sidetracks an unwary thief, especially if someone is listening and reacts quickly.

Currents

for two minutes to grind up the sewage and treat it. After a half dozen flushes or so the unit is full. At that point, with every flush, the unit pushes the treated sewage out the "exhaust," either overboard, as permitted in a discharge zone, or into a holding tank.

Surfing with DIY

Please advise me when the time comes to renew my DIY Ezine subscription. I really like downloading just the articles I want to print out at a given time. This saves a lot of paper storage. I have no intention of going back to your "paper" magazine.

Gene DiCrecchio, East Lansdowne, Pennsylvania

More Kudos

My husband, Jim, and I thoroughly enjoy DIY magazine. We're going to be adding it to our website where we recommend various books, periodicals, etc. We've also just submitted our subscription request. Keep up the great work!

Debra Cantrell, author of "Changing Course: A Women's Guide to Choosing the Cruising Life."

Why not 303?

As a manufacture's rep of chemicals that include marine maintenance products, I have seen and read your magazine from time to time as I travel around the U.S. calling on marine stores. DIY contains a lot of useful information. Recently, I was disappointed by misinformation in DIY regarding the use of chemicals in your maintenance articles. This inaccurate information is found in "All About Inflatables," in DIY 2001-#1. Howard Shure of Airworks states: "The only UV protectant recommended is non-silicone based 303 Protectant." This is absolutely untrue! In fact 303's main ingredient is silicone. At what length did you go to ensure that this is fact?

Richard Malland via email

It's not recommended to use formulations containing silicone compounds, such as Armor All, on inflatables as they make adding accessories or doing repairs all but impossible. Petroleum-based protectants are just as damaging as they can damage seams and age the fabric prematurely. We don't know the chemical composition of 303, and the precise formula of 303 is proprietary information. The manufacturer suggested we contact B&A Distributing, a large supplier of inflatable rafts in Portland, Oregon with multiple repair centers on the West Coast. This firm has been recommending 303 to its customers since the late-80s after months of extensive testing. "This is a 'for-real' product," says owner Dan Baxter who after 30 years is now retired. "This water-based protectant saved my customers thousands of dollars in replacement and repair costs," continues Baxter. "It does the job of protecting inflatable materials and does so without affecting the material, causing repair problems or a loss in bonding strength." Baxter recommends applying 303 at least three times per season or every 30 days when used in the sun. "It doesn't gradually diminish, instead it works at 100% for 30 days then it's gone." If 303 does contain silicone, then it obviously contains a category of silicone that has qualities that are neither equal to, nor perform the same as, "generic" silicone products.

WINNERS OF DIY DRAW

Winner's of DIY's Product Information Card Giveaway from the 2001-#4 issue are: Brian Wood, Newcastle Upon Tyme, UK; Rob Linehan, Punta Gorda, Florida; and Derek Austin, Victoria, British Columbia. All received a Vetus Fan 12. To enter to win this issue's giveaway, log onto DIY ONLINE at www.diy-boat.com and click on "Product Info."

Masthead

DIY boat owner the MARINE MAINTENANCE MAGAZINE

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Cover design: by Guy Drinkwalter

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Compass FAQ

Q: What is the average longevity of a compass?

A: Temperature extremes and UV exposure slowly cause hardening of O-rings, discoloration of the compass dampening fluid and clouding of the dial. Plastic domes may develop crazing after such exposures. I have seen 30-year-old compasses in good working condition because they were protected from vibration, UV and temperature extremes.

Q: How often do I need to adjust my compass?

A: There is no established schedule for this. Some magnetic fields are subject to considerable change without necessarily adding or removing equipment having magnetic components. If considerable deviation (greater than 20°) existed prior to the previous adjustment of the compass, it's prudent to at least swing ship at the beginning of every season or once a year. Such a condition would suggest the proximity to the compass of magnetic equipment whose magnetic field is subject to variance. Should you detect error in excess of 10°, compass period and sensitivity will not be consistent on all headings. It's advisable to adjust the compass in this case. For error less than 10°, it depends what mental gymnastics you are willing to endure in applying and interpolating deviation. A compass with deviation will not have the same error value or sign on all headings unless its only source of error is misalignment.

Q: What causes a bubble in my compass?

A: Air exists in all fluids. Some fluids may become air saturated when introduced under pressure, such as by a pump or syringe. When it's cold, liquid in the compass may be under slight negative pressure due to contraction. This condition could cause air in the liquid to be extracted and form a bubble in the top of the dome, only to be forced back into the liquid as the compass is warmed by sunlight or a temperature increase. It's important to keep in mind that there is a reason why your compass has acquired a bubble, and the cause should be corrected first (see below for possible causes) before refilling.

Q: What causes my compass to loose fluid?

A: A crazed dome that has cracked completely through to the inside, a failed diaphragm, a bezel O-ring that has lost resiliency or dried from age, or a failed filler plug or its O-ring. Often the leak is slow enough that the lost fluid evaporates before a wet surface may reveal the source.

Q: What kind of liquid do I use to refill the compass, and how do I fill it?

A: Some small, expensive compasses are hermetically sealed, so they cannot be filled or repaired. Not all refillable compasses use the same dampening fluid, which may range from silicone to petroleum base. Compass manufacturers select a liquid that is compatible with the O-rings, diaphragms and internal finishes. The fluid must be introduced under immaculate conditions, and after filling the compass, a vacuum pump is necessary to extract residual air from the liquid. I strongly recommend that you seek the expertise of a manufacturer-approved service facility.

— Robert Hempstead

[Ed: See DIY 2001-#2 issue's "Compass Points" for complete details on compass selection, installation, adjustment and calibration.]

SPARE PARTS

Electronics Bits

A.W. Marine in the UK has purchased all spares and main line products of Stowe Marine from Simrad. It can service and supply most parts for Navigator, Micro, Dataline and IS11 ranges, masthead units and transducers. More information is found at www.awmarine. com or email to info@awmarine.com.

Gasket Odds

When you are in need of a replacement gasket for hatches, windows, cockpit lockers, iceboxes or any other place onboard that requires a tight seal, check out the Trim-Lok website at www.trimlok.com. The site's catalog format lets you view profiles, dimensions and specs on myriad rubber trim products. For the non-web browsers, call the company at 888/847-6565 for a catalog. The company apparently accepts small order quantities.

CORRECTION:

There is a procedure error in the article titled, "Drive Train Tune-up," in DIY 2002-#1 issue. Page 31, second paragraph, states: "Remove the short piece of hose that attaches the stuffing box to the shaft log." This is incorrect. When the builder aligns the shaft, a laser or a string line is used to locate all the parts. The only time you need to remove the hose is to replace it. A rough alignment is done when the boat is on land. The final alignment is made after launching.

Talk Back Q&A

HELP LINE 1-888-658-2628

Opt for Marine Oil

Q: I have heard rumors that you should never put automotive oil in a marine engine. Could you clarify this? I have been running Mobil 1 synthetic oil in my sterndrive for years. *Mark Cavanaugh, Eastlake, Ohio*

A: Automotive oils are designed for use in engines that don't run at or near wide-open throttle (WOT) and don't have the load or stress factors that a marine engine endures. If your marine engine ever overheats, or is required to run at WOT while you try to outrun a thunderstorm, the automotive oils may cause damage due to a shear point that is lower than the recommended oils. Your motor oil may be the difference between making it to a safe harbor or losing your engine power at a critical time. Synthetic oil is great for cold winter starts but when was the last time you went boating at –35°C (-30°F). Mercury issued a service bulletin in 1997 indicating that synthetic oil, multi-grade oils, oils with solid additives and non-detergent oils are not recommended for MerCruiser products (unless otherwise stated in your owner's manual for high-performance products). Stick to the recommended oil and maintenance schedule for the most reliable engine service.

— Steve Auger, Mercury Marine

As the Juice Flows

Q: What's the procedure to determine the source of an unintended current draw? One of my newly installed battery banks is going flat too frequently. I suspect a defective (and new) bilge pump switch that doesn't want to turn off. How do I do the detective work to trace the device that is pulling power when it should not?

Joel Albert, "Charlie B," Deale, Maryland

A: Both AC and DC equipment commonly found on boats can be drawing current even when turned off. A common example is most AC-powered stereo and TV equipment that includes a remote control. If the equipment was truly off, the remote could not turn it on. The same thing goes for many DC-powered marine electronic devices that remain in standby mode when turned off. The only way to be sure they are off is to interrupt the battery power with an external switch. Most products that use a membrane keypad-based on/off switch fall into this category. To determine what is causing the unwanted current draw, you must begin at the battery and electrically trace the various circuits until you find the problem. First, turn off all DC circuit breakers and/or remove fuses on circuits that are connected to that battery. Connect a digital multimeter (DMM) configured for the highest available DC current (amps) mode in series with the positive terminal of the battery. In other words, disconnect the positive wire from the battery and put one DMM lead on it and the other on the positive battery terminal. If there are no loads connected, the current on the DMM should be zero. Safety dictates that, before you make this test, be absolutely certain that the DMM has fuse protection on this range. If not, put a fast-blow fuse sized at or below the DMM's current rating (commonly 10 Amps; but check the specific meter) in series with one of the leads.

Assuming the result of the above test is zero amps, turn on one breaker at a time and repeat the test. When the DMM reads current, you've found a load. If you believe you have a float switch that is sticking in the "On" position, fix that now. While many bilge pumps are capable of running for some time without pumping water, this is unhealthy for the motor and will eventually cause the pump to fail, and you may not realize that until you need it. When you finish with the meter, be sure you reconfigure it for volts, moving the test lead plugs into the proper holes. If you don't, the next time you use it to measure DC volts, you'll blow the internal fuse!

— Larry Douglas

A Reason to Clean

Q: While troubleshooting an electrical problem, I discovered there is voltage flow between the positive terminal of each battery and the metal tie-down rod on the battery hold-down bracket. This rod connects at the bottom by a steel half ring screwed into the fiberglass deck. I checked underneath and there are no screws or wires in this area. The top of the metal tie-down rod connects to a metal bracket that reaches across the battery case. My other battery has a plastic crossbar. Both have about 6 volts across the positive post to the metal tie-down/deck connection. There is no voltage leak from the positive terminal to case. Is this a normal occurrence?

Dale Justice, "Bottom Line," Vero Beach, Florida

A: While it's impossible to have a circuit without a conductor, 6 volts is a lot. If you put on some resistance such as a light bulb, it's likely the voltage on the meter will disappear and the bulb won't light. The only solution that makes any sense is that all surfaces are very dirty. Leakage across an electrolyte (dampness in your case) on all surfaces can cause voltage flow. If you undo the hold-downs, take off the crossbars and touch the positive post, you'll likely not get a reading. Wiping all sur-

faces with a paper towel and baking soda dissolved in water should resolve your current flow.
— Jan Mundy

Which Outboard Oil is Best?

Q: There are many different 2-cycle outboard motor oils on the market. Is there a difference?
Melvin E. Woodward, Gloucester Point, Virginia

A: The outboard motor oils that are available today have become product specific and selection depends on brand, age of your engine, type of fuel system and cost. If you have an older outboard that uses a 24:1 oil ratio, then there is no advantage in using expensive oil designed for a Mercury Optimax, for example. Conversely, don't trust a low-cost, generic oil to protect a new $17,000 computer-controlled outboard. The best oil for your outboard is the one recommended by the engine manufacturer. Stay away from unrecognized brands. If the price is too good to be true, then there is likely a catch. Ensure that the oil you purchase is recognized as acceptable by the NMMA or the engine manufacturer.
— Steve Auger, Mercury Marine

Grounds for Underwater Metal Corrosion

Q: Two years ago I installed a Dynaplate on our Westsail 43 to use as a grounding plate for the ham and single sideband radio. To avoid any chance (or so I thought) of galvanic corrosion, I didn't connect the plate to ground or bond it to the boat's grounding system. All was fine until the last dive inspection that found the plate had turned bluish-green and the four screws were starting to corrode. I cannot figure out what's going on, since the plate is electrically "floating" as are the bronze thru-hulls. Any ideas while we're still afloat?
Rob Weien, "Sea Bear," San Diego, California

A: Since your Dynaplate is sintered bronze (an alloy), it is subject to self-corrosion, galvanic corrosion and stray-current when immersed in an electrolyte (seawater) whether or not it's connected to a common bonding system. Since self-corrosion — electrochemical corrosion involving a single piece of metal, either a pure metal or an alloy — is typically a very slow process, it's not the likely culprit here. Galvanic or stray current corrosion are stronger candidates. For a galvanic cell to be formed, two dissimilar metals must be immersed in the same electrolyte (in this case water) and connected via a metallic path, either by direct physical contact or a conductor. The dissimilar metals involved can even be on two different boats connected via the green grounding wire in a

Talk back Q&A

marina's AC shorepower system. [Ed: Refer to "Breaking the Ground Circuit," in DIY 2001-#4 issue for a more detailed explanation.] Stray current (electrolytic) corrosion is caused by an electrical current from an outside source flowing between two metals immersed in the same electrolyte. Stray current is the most rapid of the three forms of corrosion. It can destroy underwater metals in a matter of days or, when the source of the stray current operates only intermittently, months. If stray current is involved, its source could be on your own boat or on a neighboring boat if you are normally plugged into a marina's AC shorepower system. With the boat afloat in its usual berth, check the corrosion potential of each of your boat's immersed metals using a multimeter or corrosion test meter and a silver-silver chloride reference cell. You can buy a Guest corrosion test meter, reference cell and workbook through West Marine for about US$230. If you do not have ready access to this equipment and/or are unfamiliar with its use, employ a qualified marine electrician (preferably one who is ABYC certified) or a marine surveyor to do a corrosion survey for you. You'll be able to determine whether galvanic or stray current is the culprit and take appropriate corrective action.
— Susan Canfield

Rudderpost Fix

Q: Corrosion has eaten through the bottom of my rudderpost, which has become soft. I need a new post or cut back the post and attach a new section. Where would you suggest that I look for either a new rudder or to repair the post.
Eric Lipper, "Docket," Houston, Texas

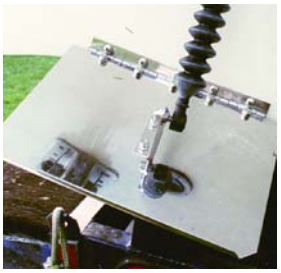
A: Assuming the rudder is a typical fiberglass shell with a solid polyester filler encasing a stainless-steel post welded to an internal steel structural web you have two options: repair or replace. To repair, disconnect the steering, remove the rudder, then split the two rudder halves apart to expose the internal structure. Chisel away the internal fillers to free the steel web structure and rudderpost. Repair or replace the corroded pieces as required. Rebond and reassemble the rudder halves and wrap with a new glass outer skin. Fill and fair the rudder, then epoxy prime and reapply antifouling. Reinstall rudder and connect the steering system. [Ed: Detailed step-by-step rudder repair instructions appear in DIY 2000-#3 issue.] If replacement is a better option, order a replacement rudder from an aftermarket supplier, such as Foss Foam (Tel: 352/529-1104; Web: newrudders.com) or the original boatbuilder if they are still in business. Disconnect and remove the old rudder. Once you have the new rudder, drill a new rudderpost for steering attachments, copying the dimensions from the old rudder. You may have to trim the rudderpost to the same length as your original. Reinstall rudder, reconnect steering and apply bottom paint.

— Nick Bailey

Painting Trim Tabs

Q: What is the scoop on applying antifouling paint on stainless-steel trim tabs and making it stick? Is a barrier coat a good primer?
Wendell R. Cover, "Sta-Sea," Baltimore, Maryland

A: Currently there are no direct-to-metal bottom paints. An epoxy barrier coat should be okay to use, but it's good practice to first apply a metal etch primer to ensure adhesion of the barrier coat, followed by a coating of antifouling paint. Trim tabs and running gear (props, shafts, rudders and struts) seem very tough to protect due to the dynamic movements in their usual operational mode.

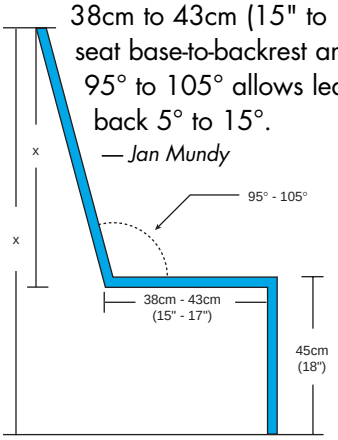


— Jan Mundy

Boat Ergonomics

Q: Do you have information on the optimum dimensions for dinettes that will lower to a bunk. The length and width are determined by the boat itself, but I need to figure out the seat height, depth, and back angle, etc.
Eamonn Flynn, "Stella Maris," Rockwood, Ontario

A: Boatbuilders follow the same rules of ergonomics as builders of all things designed to accommodate humans. Ideally, you want a dinette seat that allows the feet to rest firmly on the cabin sole, and is just deep enough to comfortably support the legs and back against the backrest. Recommended dimensions for a properly designed dinette has a seat height of 45cm (18") and depth of 38cm to 43cm (15" to 17"). A seat base-to-backrest angle of 95° to 105° allows leaning back 5° to 15°.
— Jan Mundy



GUY DRINKWALTER

Leaking Deck Joint

Q: My Tanzer 26 seems to be leaking under the rubrail that covers the joint between the upper and lower parts of the boat. The rubrail seems to be one continuous piece so I'm afraid to remove it for fear that I can't get it back on. What approach is recommended? I assume I have to get at the bolts to tighten the joint and do some sealing but how can I prevent damaging the rubrail?

Peter Henderson, "Tranquillity," Mimico Cruising Club, Ontario

A: Tanzer 22, 26 and similar rubrails are one-piece units stretched into place using special equipment. They are an absolute S.O.B. to reinstall. Recaulking the hull-deck joint is a problem. I would try prying the rubrail back a few inches at a time and working a polyurethane sealant, such as 3M 5200 in under the rubrail. An external bead of sealant can follow this where the rubrail butts up against the boat. Top or bottom may need to be caulked depending on whether it's rainwater that is leaking or the leak occurs while sailing with the rail under water. If in doubt, caulk both top and bottom.

— Nick Bailey

Rudder Alignment

Q: I have a twin inboard 30 Sea Ray Weekender. The rudders are not aligned perfectly parallel. Nor are they set to turn equidistant to each side. Should this be corrected or is there a reason for this?

Michael Patria, "Fish N Bones," Stratford, Connecticut

A: According to Mark Ellis, designer of the Legacy cruiser and other sail and powerboats, your rudders should not be aligned nor do they turn equidistant. Powerboat designers will either toe in or toe out the rudders so they go through the water at different angles to enhance performance. The difference in the angle of attack is usually determined by experimentation with the prototype hull. Subtle changes in the setup can make significant handling changes. To determine the exact angle and before making any changes to the setup, I suggest you first contact Sea Ray.

— Jan Mundy

TECH TIPS

TEAK BREW: To clean teak, mix 500 ml (1 cup) each of ammonia and clothes wash detergent (without bleach) in a bucket of warm water. Don protective gloves and do a spot test to be sure this solution doesn't harm sealants or bedding compounds. Next, apply this mixture to the teak with a sponge and leave to soak for about 15 minutes before rinsing. Don't scrub or pressure wash the teak. Both procedures can remove vital teak fibers.
Tom Green, TeakTrader

EASY BILGE PUMP LINK: As I've been unlucky enough to experience that "sinking" feeling, I've installed three high-capacity bilge pumps on my 21-year-old boat. Already installed was a small bilge pump wired to a small-capacity pump switch mounted on the bridge. Installing a 30-amp sealed relay costing just US$3.45 purchased from CarQuest Auto Parts negated having to replace the switch and route all new wiring for the pumps from the bilge to the bridge.
Kent Phillips, Vancouver, Washington

MORE NOZZLE PRESSURE: An easy way to increase water pressure when showering is to connect the water supply hose to a smaller diameter showerhead.

MOUSTACHE REMOVER: Naturally occurring brown tannin in southern waters is the cause of the ugly stains known as the "moustache" on boats

used there. It's a big headache for boatowners. While hosting a DIY Workshop at a BoatUS store in West Palm Beach, we tested various products and found a solution. StarBrite Rust Remover is a light acid base that instantly releases the tannin without harming the gelcoat. Just spray on, wipe off and rinse.

CLEAN WATER TANK: To remove the telltale brown calcium deposits from hot water, I simply wiped the brown deposit from the areas within reach through the tank inspection port, then used a high-pressure washer to "scrub" out the tank. For a final cleaning, fill the tank with 4L (5 gallons) of water and 836ml (1 gallon) of vinegar, let sit overnight, then drain and rinse.
Dudley Hattaway, Walnut Creek, California

IS YOUR ENGINE DRAWING COOL WATER? My engine start-up routine includes checking that water is being pumped through the raw-water strainer. A close visual inspection shows tiny bubbles swirling

about under the strainer's small plastic lid, but I have to stick my head down in the engine compartment to see anything. By placing an orange Ping-Pong ball in the strainer I can, at a quick glance and from some distance, see the ball "dance" in the flow of the cooling water. *Michael Wolfe, "River Queen," Sockton, California*

PLASTICIZING ALUMINUM: It's

notoriously difficult to keep aluminum covered with paint, which tends to flake off even after vigorous wire brushing and priming. After several years of repainting my window frames every few months, I covered them with a plastic film that still looks good after two years. Plasti Dip is a liquid plastic used to coat tool handles, whip rope ends, coat electrical wire connections and for many other sealing tasks available at hardware stores. Mix up a batch thinned with 1/5 part toluene (or lacquer thinner) and stir, then brush on. In a few places where the aluminum has continued to oxidize, the coating has lifted slightly, but remains generally intact and it's not noticeable to the casual glance.
Alan Porter, "Te Tiaroa," Victoria, British Columbia

STIRRER'S ASSIST: When applying antifouling paint, it's important to continually stir it to prevent separation of the biocide from the base. To make a stirrer, weld a discarded alternator fan blade to a rod the diameter of the your drill bit chuck. Run the drill in reverse to stir, as the rpm is too aggressive in forward.

TECH TIPS WANTED

If you have a boat-tested tip you'd like to share, send complete information along with your name, boat name and home port to DIY TECH TIPS:

P.O. Box 22473
Alexandria, VA 22304

Or email to info@diy-boat.com

ELECTRICAL

THE WEAK LINK

Fuses and circuit breakers prevent too much amperage from traveling through a wire, building heat through resistance that may damage electrical and electronic equipment, and more important, cause an electrical fire. You can avoid potentially dangerous problems by reviewing ABYC standards to make sure adequately sized circuit protection devices are installed properly.

[BY KEVIN JEFFREY]

"Electrical circuit" refers to a complete path for electrical current flowing through wires. A boat's power system is comprised of various electrical circuits formed by connecting a voltage source such as a battery bank or AC power source to one or more electrical loads (equipment that uses electricity) by means of a conductor (wire or cable). In a DC (direct current) circuit, battery voltage pushes electrical current through various electrical loads when they are switched on, using some of the energy stored in the battery to perform useful work. In an AC (alternating current) circuit the voltage source (shorepower, inverter or gen-set) pushes electrical current in a similar manner, again using energy in the process.

There are primary or main circuits, which typically include the main power sources, either DC or AC **(FIGURE 1)**. There are also secondary or branch circuits that are complete electrical paths within the primary circuits. All electrical loads on the boat, for example, are individual secondary circuits. Finally, there are internal circuits within each electrical or electronic device.

All electrical circuits must be protected from too much current flow, which can cause wire conductors to overheat and wire insulation to burn, and can damage internal circuits in individual appliances. Protection of an electrical circuit is in the form of an intentional weak link, typically a fuse or circuit breaker, which the industry refers to as a overcurrent circuit protection device (CPD). Circuit protection on board a boat must be taken seriously. A potentially devastating electrical fire can result when too much amperage travels through a wire and enough heat is generated to melt and burn the wire insulation and surrounding materials, causing a fire.

CPDs are meant to protect against unexpected problems, and shouldn't preclude proper wire sizing and adherence to proper electrical system design and installation practices. Sizing wire is relatively easy. You simply match the maximum sustained amperage in a given circuit and the total length of the circuit wiring with a proper wire size that will be safe and also prevent an excessive voltage drop for the type of appliance used **(FIGURE 2)**. [Ed: For specifics on wire sizes, factoring in voltage drop, length of run and whether or not the wire passes through a heated space (i.e. engine compartment), refer to DIY 1998-#4 issue, or "DC Electrical Systems" CD-ROM, or sections E-8 and E-9 of ABYC Standards.]

Sizing wire correctly can't protect against accidental grounding through wire chafe, equipment failure or grounding a circuit while performing system maintenance that temporarily allows a dangerous amount of current to flow. CPDs handle unsafe levels of current by opening the circuit, either through thermal devices or devices that sense a magnetic field created by excess amperage.

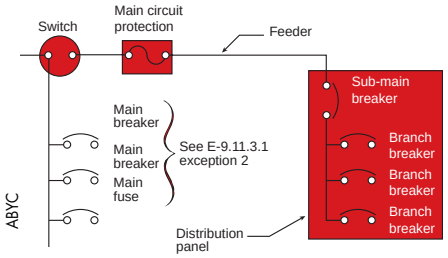


FIGURE 1
MAIN AND BRANCH CIRCUIT PROTECTION

Types of CPDs

Fuses are strictly thermal devices that melt at a predetermined amperage. They are reliable and relatively inexpensive, although total cost includes the purchase of a fuse mounting block and a protective cover of some type, spares, since fuses must be replaced after each overcurrent condition, and some form of circuit disconnect. Circuit breakers can be thermal or magnetic devices, or a combination of the two. Circuit breakers are typically more expensive than fuses, especially for high load circuits, but they also serve as circuit

RATINGS STATS

CPDs have ratings that help describe their intended purpose and how they function, as well as help customers make good decisions where and when to use them.

Amperage Rating: The amperage used to calculate the opening speed of the device, not the actual amperage at which the CPD will trip or "blow." It usually takes an additional 20% or so of amperage above the rated value for the CPD to trip.

Opening Speed or Delay: The relationship between the percentage a CPD is operating over its amperage rating and the length of time required for it to open. The higher the percent of current flow to amperage rating, the faster the circuit protector opens.

Interrupt Rating: How much current the fuse can safely handle in short circuit situations. Refer to Figure 4 on page 13 to determine what minimum interrupt rating is required.

Voltage Rating: The maximum voltage for the circuit in which the fuse is used.

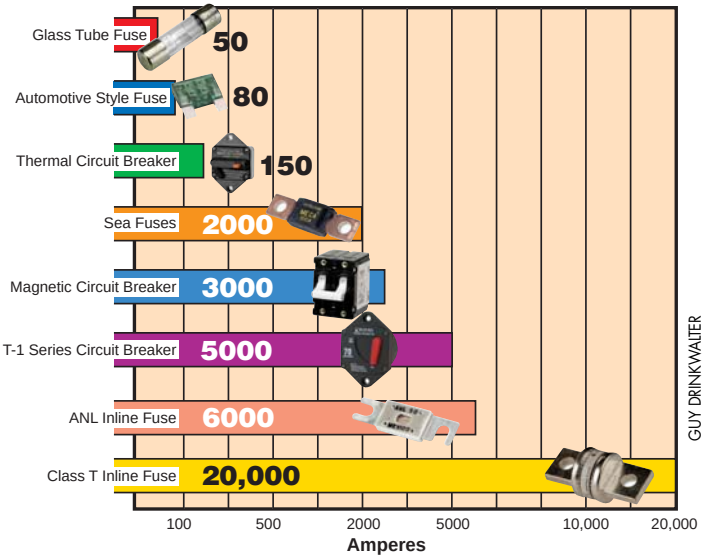
— *KJ*

Allowable amperage of conductors under 50 Volts with 105° C insulation

AWG Wire Size	Metric (Sq mm)	AWG CM area	SAE CM area	Ohms /1000 ft	Ampacity Engine Space Outside	Ampacity Engine Space Inside
18	.8	1,600	1,537	6.385	20	17
16	1	2,600	2,336	4.016	25	21.3
14	2	4,100	3,702	2.525	35	29.8
12	3	6,500	5,833	1.588	45	38.3
10	5	10,500	9,343	.9989	60	51
8	8	16,800	14,810	.6282	80	68
6	13	26,600	24,538	.3951	120	102
4	19	42,000	37,360	.2485	160	136
2	32	66,500	62,450	.1563	210	178.5
1	40	83,690	77,790	.1239	245	208
0	50	105,600	98,980	.09827	285	242.3
2/0	62	133,100	125,100	.07793	330	280.5
3/0	81	167,800	158,600	.06180	385	327.3
4/0	103	211,600	205,500	.04901	445	378.3

ABYC

FIGURE 2
ABYC AMPERAGE RECOMMENDATIONS



GUY DRINKWALTER

FIGURE 3
QUICK-REFERENCE COMPARISON OF CPDS

disconnects and since they are resettable the need to carry spares is not as critical. (**FIGURE 3** illustrates a quick-reference comparison of CPDs.)

CLASS T FUSE: Recommended by most inverter manufacturers, it has an extremely fast short-circuit response, a 20,000 ampere DC interrupt capacity, and is rated for up to 160 volts DC (VDC).

ANL FUSE: With a 6,000 ampere DC interrupt capacity, it meets ABYC requirements for main DC circuit protection on large battery banks with a voltage up to 32DC.

SEA FUSE: An economical choice for circuit protection between 100 and 300 amperes. It has a 2,000 amperes DC interrupt capacity and is rated for up to 32VDC.

AUTOMOTIVE STYLE FUSE: Inexpensive and widely available through automotive stores, it's the most economical choice for between 30- and 80-ampere circuit protection. It has 1,000-ampere DC interrupt capacity and a 32DC voltage rating.

GLASS FUSES: Available in current ratings from less than 1

Total Connected Battery CCA*	Main Circuit Breaker	Branch Circuit Breaker
12 Volts and 24 Volts	**Amperes**	**Amperes**
650 or less	1500	750
651 - 1100	3000	1500
over 1100	5000	2500
32 Volts		
1250 or less	3000	1500
over 1250	5000	2500
AC Shore Power Source	**Main Circuit Breaker**	**Branch Cuicuit Breaker**
120V - 30A	3000	3000
120V - 50A	3000	3000
120/240V - 50A	5000	3000
240V - 50A	5000	3000
120/208V - 3 phase/WYE - 30A	5000	3000
120/240V - 100A	5000	3000
120/208V - 3 phase/WYE - 100A	5000	3000

*Cold Cranking Amperes

FIGURE 4 HOW TO DETERMINE INTERRUPT RATING

Use the table above to determine the required minimum interrupt rating per ABYC, or how much current the fuse or breaker can safely handle in a short circuit condition.

up to 50 amperes, these inexpensive fuses are used for branch circuits in a variety of applications. AGC models are fast-acting fuses, while MDL models are time-delay fuses for high inrush motor type loads.

THERMAL CIRCUIT BREAKERS: The T-1 series CPD from Blue Sea is thermally responsive bi-metal breakers combining switching and breaker function in one unit. They are available with ampere ratings from 25 to 150 amperes, a voltage rating of 48VDC, and 5,000 amperes at 24VDC interrupt rating. Blue Sea's standard thermal circuit breakers are similar to the T-1 Series but have a 3,000-ampere DC interrupt rating, a 30VDC voltage rating.

MAGNETIC CIRCUIT BREAKERS: Available in a wide range of styles and ratings, there are standard DC and AC single pole circuit breakers used for protecting branch circuits in electrical distribution panels. Some low ampere models, rated as "quick trip" are designed specifically for electronics. Double pole AC breakers are available to switch both hot and neutral legs of a 120VAC circuit or two hot legs of a 240VAC circuit. Standard magnetic circuit breakers typically have a 2,000- to 3,000-ampere interrupt rating, although some models are available with a 5,000-ampere interrupt rating.

It used to be that only fuses could handle heavy DC loads, but high load circuits can now be protected with single, double or triple pole breakers, such as those from Blue Sea Systems and Paneltronics. In these devices breakers rated up to 100 amperes each are ganged to provide various levels of protection. Sizes range from 50-ampere single pole to 300-ampere triple pole models.

Sizing and Selecting

When choosing CPDs, take it one circuit at a time. First, choose whether you want a fuse or circuit breaker for each circuit. Circuits in an explosive vapor area, such as gasoline engine rooms, battery compartments and propane lockers, must be protected by a vapor-proof circuit breaker. Then, check to see what ampere interrupt rating is required for the application (see **FIGURE 4**). Next, make sure the CPD is rated to open at an amperage greater than the maximum circuit load and less than the rated amperage capacity of the smallest wire in the circuit. It's also useful to know the maximum momentary or surge current experienced in the circuit. Choosing CPDs that can withstand this surge and still offer the required protection means you'll avoid nuisance tripping. As a final check, make sure the CPD's voltage rating meets or exceeds the circuit voltage.

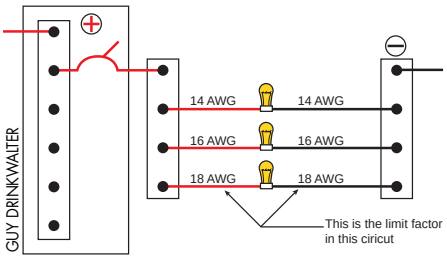


FIGURE 5 FACTORING WIRE SIZE

The smallest wire in a circuit determines the amperage of the fuse or circuit breaker.

Where to Install?

Before locating CPDs in your electrical system, it's important to understand the concept that CPDs are installed to protect individual wires in a circuit, and that they should be sized specifically for those wires. Secondary and small branch circuits use smaller (in number only, larger in size) gauge wires, so smaller CPDs should be used (**FIGURE 5**).

Ultimately every wire on board would be protected,

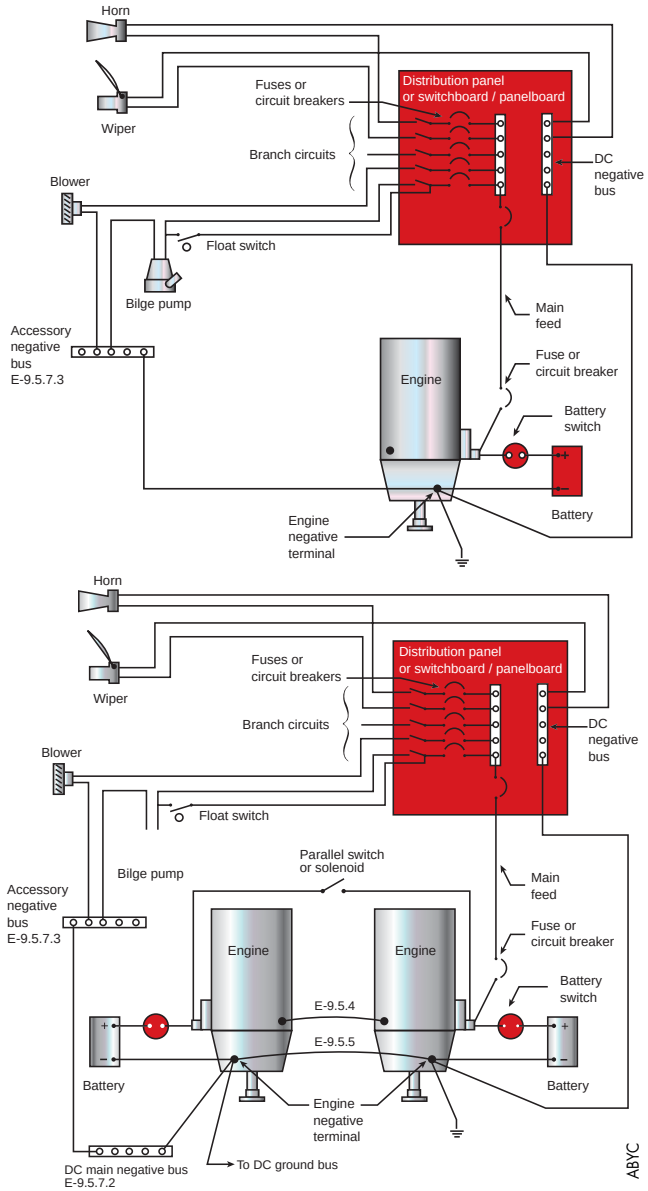


FIGURE 6 SAMPLE DC CIRCUITS TO ABYC STANDARDS
(top) Single engine and (bottom) twin inboard engine DC electrical systems without AC power systems.

but that is impractical. In the DC side of an electrical power system, ABYC standards take a reasonable approach to circuit protection by exempting mandatory CPDs from wires between batteries, battery switch and engine starter motor (**FIGURE 6**). CPDs are required within 18cm (7") of the battery switch and starter motor on wires leading to various loads, and within 183cm (72") on wires leading to loads directly from a battery. The 18cm (7") dimension can be extended to 101cm (40") if wires are enclosed in a sheath or other enclosure in addition to the wire insulation (**FIGURE 7**).

FIGURE 9
SAMPLE AC SELECTOR PANEL.

In the AC side, there should be a main circuit breaker at each AC

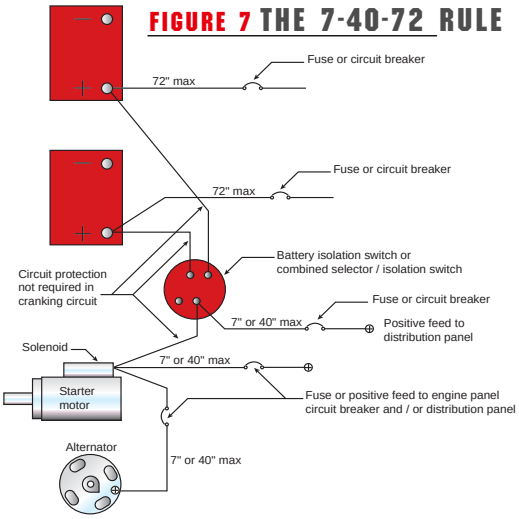


FIGURE 7 THE 7-40-72 RULE

GUY DRINKWALTER

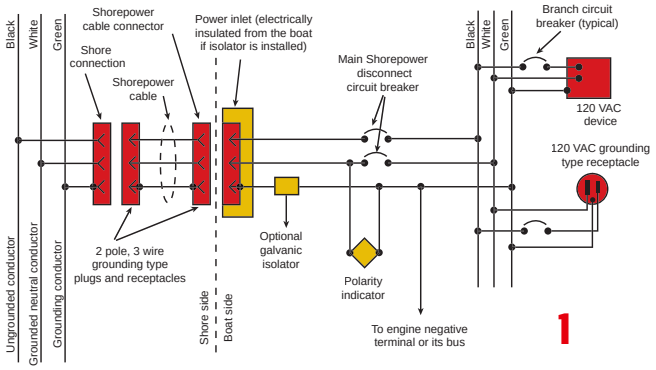
power source, i.e., at the shorepower inlet(s), generator output and inverter output (**FIGURE 8**). In addition, there should be branch circuit breakers on every branch circuit. On boats with multiple sources of AC power, the main circuit breakers can be conveniently located in an AC source selector panel (**FIGURE 9**). This type of panel allows only one AC power source to be capable of supplying power at any given time. In this case the main circuit breakers also are serving as manual circuit disconnect switches.

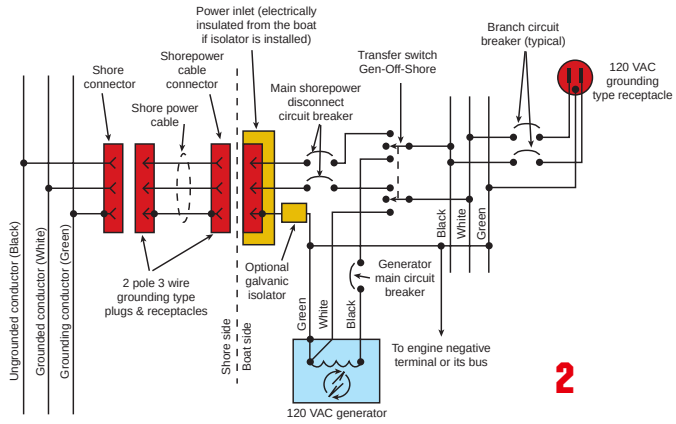
About the author: Kevin Jeffrey works as an independent electrical power consultant and is the author of the "Independent Energy Guide" and publisher of "Sailor's Multihull Guide" available soon in its third edition.

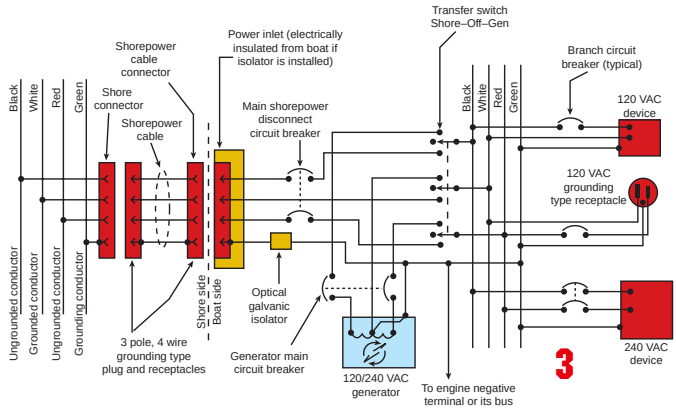
Resources

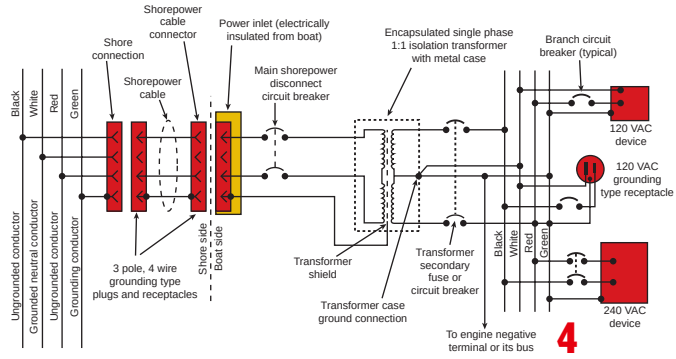
"Standards and Technical Information Reports for Small Craft," American Boat & Yacht Council; Tel: 410/956-1050, Website: www.abycinc.org

FIGURE 8
SAMPLE AC CIRCUITS TO ABYC STANDARDS
(1) Single-phase 120V shorepower with shore-grounded (white) neutral conductor and grounding (green) conductor. (2) A 120VAC generator included as an additional AC power source. In both diagrams the ungrounded conductor and the grounded neutral are protected with a single overcurrent protection device that simultaneously opens both current-carrying conductors. ABYC does not recommend fuses to serve this function. 120VAC branch circuits are permitted to be single pole in the ungrounded current carrying conductors. (3) Single-phase 120/240VAC system with shore-grounded (white) neutral conductor and grounding (green) conductor. Each ungrounded shore conductor connects through the shorepower inlet to the boat's AC electrical system through a single overcurrent protection device that simultaneously opens both ungrounded conductors. The shore-grounded neutral connects to the boat's AC electrical system without overcurrent protection. It may be used provided the overcurrent protection device opens all current carrying conductors in the circuits (in this case a 3-pole switch is needed). (4) An isolation transformer system with single phase, 240VAC shorepower input and 120/240VAC output from the transformer. Circuit protection is provided by a main shorepower disconnect on the shore side of the transformer and secondary overcurrent protection on the boat system side of the transformer. Each ungrounded shore current carrying conductor









ABYC

connects from the shorepower inlet to the primary winding of the isolation transformer through an overcurrent protection device that simultaneously opens both ungrounded conductors. 120VAC branch circuit breakers are permitted to be single pole in the ungrounded current carrying conductors. 240VAC branch circuit breakers must be two-pole and simultaneously open all current carrying conductors.

PRO SERIES

10 STEPS TO A PERFECT PAINT JOB

Painting a fiberglass boat may be the only solution to restoring gelcoat brilliance. You can do this yourself, but a professional touch guarantees spectacular results.

[STORY AND PHOTOS BY NICK BAILEY]

This Bayfield 25 was professionally painted 15 years ago and still gleams.

You've probably noticed a boat hull finish with a gloss so deep that it reflects every detail. While other boatowners struggle with routine buffing and waxing to win a brief victory over their dowdy gelcoat, this boat escapes with an occasional wipe down. These showstoppers have been professionally refinished with Awlgrip, Imron, Interspray or the like.

Professional polyurethane paints are usually formulated as either acrylic or polyester. The acrylic types are faster drying and more forgiving in comparison to the polyester varieties. They also tend to produce a softer, but less durable, finish. This may sound like a disadvantage but it translates to being easier to repair runs, sags, orange peel and dust specks or future scratches by wet sanding and buffing.

Step 1 Evaluation

A "standard" paint job presumes the original gelcoat is adhering well and is free of significant cracking or crazing. Damaged gelcoat requires removal by grinding and extra filling, fairing and priming steps to restore a fair and smooth surface. Recoating an existing paint job can be simpler than painting the original gelcoat, but damage that was "papered over" on the previous job will return to mar the new finish, so repair this damage now. If the previous coating is not the same formula as the new, the incompatibility could lead to total failure or a tendency for the old coating to peel off when removing the masking tape. You can test for adhesion, but where there is doubt, use 80-grit sandpaper to completely remove the original finish. [Ed: DIY 2002-#1 issue, page 47, describes how to perform a paint adhesion test.]

It's important to determine if the boat floats on its lines. A scum line can be a valuable clue to the true waterline. If this is the case for your boat, you will need to designate the correct waterline or shift weights onboard to correct trim or list. Consider raising the top edge of antifouling to about 5cm (2") above the waterline as polyurethane paints don't tolerate constant immersion and can blister if submerged for extended periods.

The paint job candidate, an early '80s C&C 34, has original gelcoat that is faded and dull but in fair condition.

Step 2 Setup

The yard lifting equipment moves the boat to the paint booth and blocks it there. Scaffolding goes up around the boat.

In the spray booth, polyurethane paints demand the controlled environment of a spray booth for best results.

Pro Series

A paint booth is fitted with an "air make-up unit" designed to supply high volumes of filtered, temperature controlled fresh air at one end and exhaust it out the other through a tall chimney. This airflow serves both safety and practical purposes. It protects the technicians by providing a safe working environment and prevents paint spray mist from hanging in the air and resettling on the wet surface as well as precluding a potentially explosive buildup of volatile vapor. Intense illumination is provided in the booth to ensure enough light to reveal the slightest flaw. In warm weather, 15.5°C (60°F) and higher, it's feasible to paint outdoors. Lots of pro paint jobs are carried out in the open air but it's hard to beat the finish quality that is possible in a proper paint booth.

Step 3 Initial Prep Work

Any chips, dings, nicks, or gouges in the hull that are deep enough to feel are filled and faired, sometimes with gelcoat, sometimes with filler. Fine scratches and abrasions usually disappear during prep sanding but if not, they are filled after priming. Stress cracks or any deep chips that break the glass laminate are ground out and repaired with new glass fiber and block sanded to level. Old

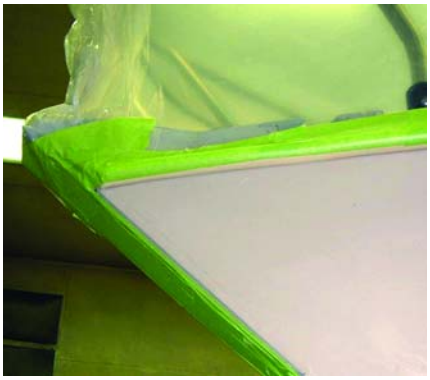
(top) Bow close-up before painting showing ding. Decals and some hull fittings will also be removed.
(inset) Bow ding filled and faired.

Professional painter, Earl Hadcock, makes repairs and completes masking. He uses the recommended solvent wash to clean the hull and remove any wax or oily residue that may cause paint adhesion problems later.

name graphics, registration numbers and pin stripes are removed. The painter may want to remove hull fittings if they cannot be masked cleanly and the fitting is simple to remove.

The hull is scrubbed with detergent and rinsed with freshwater and/or cleaned and dewaxed using proprietary cleaners recommended by the paint manufacturer.

Step 4 Masking



Plastic shroud encloses the deck and cabin of the boat in an air and dust tight cocoon.

Carefully mask all the edges of the paint job with 3M Fine Line #218 masking tape. This tape is backed up by regular masking tape overlapping the Fine Line almost to the definitive paint edge. A polyethylene sheet goes over the top of the boat, is trimmed to fit and taped to seal against the upper tape stack. This seals the deck and interior from sanding dust and paint fumes. Attach a brown paper skirt to the lower tape edge. It's not necessary to hermetically seal the bottom. Never use newsprint for masking as it can stain the paint surface.

Step 5 Prep Sanding

Prep sanding with a dual action (random orbit) air sander fitted with 15cm (6") sanding disc. Note blue wash on the hull as a sanding indicator.

Applying machinist's blue dye (diluted with acetone) to a dull hull finish before sanding helps identify the sanded areas. The dye can be a convenient indicator because, with sanding, the dye goes away, and when it's gone, you're finished.

Prep sand gelcoat with sandpaper that varies from 80 to 180 grit depending on hardness of the gelcoat. Pros use air tools but any good dual action (random orbit) sander using 3M Hookit system sanding discs works. Keep the sanding disc flat to the surface to avoid gouging or scalloping.

Step 6 Prep and Priming

Every polyurethane paint job requires a special epoxy primer for good adhesion and to seal the substrate. After final sanding, the primer provides a non-porous, ultra-smooth

Primer spray application, at least two coats are needed.

surface ready for the high gloss topcoat. Prep sanding alone isn't sufficient. The booth air make-up is turned on and compressed air is used to remove dust from the hull surface and the booth. Residual dust clinging to the hull is removed with a solvent wipe and tack rags.

The two-part epoxy primer is mixed and reducer solvent added to get the specified spray viscosity. The viscosity is measured by timing how long the mixture takes to run out of the bottom hole of a calibration cup. Some primers are applied at different viscosity depending on how much primer the painter wants to "build" onto the surface, which depends in turn the roughness of the prepped surface.

While the mix is sitting for the required 15-minute induction time (necessary to start the epoxy cure reaction) the painter suits up with disposable airtight Tyvec coveralls, solvent-proof gloves and approved respirator. A fresh air supply is not required at this stage. Two or three coats of primer are applied allowing approximately one hour between coats, and then it's left to cure for 12 to 24 hours.

Step 7 Fine Filling and Surfacing

The first primer step may not be the last. The pearly sheen of the primer

Hadcock applies surfacer with a drywall putty knife to squeeze it into minor surface imperfections.

reveals the true condition of the hull. Usually, as a minimum, some fine spot filling (surfacing) is needed to address pinholes or sanding marks. If there are large areas of fairing filler or surfacer left exposed after sanding the primer, a full second prime stage is recommended. Otherwise, the topcoat absorbs into the substrate unevenly. The darker the final topcoat color, the more visible the imperfections.

Step 8 Primer Finishing

Once cured, the primer is sanded with fine sandpaper, usually 280 to

Final prep sanding of epoxy primer with 320-grit paper.

320 grit. Hand sanding around edges and fittings must be done carefully to avoid cutting subtle grooves that will show in the final topcoat.

Step 9 Stripes and Topcoats

Dust on a wet topcoat is a big problem. The hull and the booth must be

Final dust removal with a tack rag.

carefully swept with compressed air and the hull surface wiped and tack ragged again.

Protective clothing is again worn plus a respirator with a fresh-air supply due to the toxic isocyanate present in all two-part polyurethane paints. Each type and brand of polyurethane topcoat has a different catalyst-to-paint ratio and additives. There are additives that accelerate

Spraying highly toxic two-part polyurethane paint requires protective gear including a fresh-air supply to the technician. Disposable suit is made of vapor-proof Tyvec.

Viscosity dilution check of the topcoat with reducer for proper spraying is gauged by the amount of time the calibrated cup takes to drain.
Mixed topcoat is poured one batch at a time into the pressure pot then small amounts of additives are added.

Spray application of the white boot stripe begins with a light tack coat and may need three to five coats to cover. Yellow and other bright colors take even more coats.

Care & Feeding of Painted Hulls

- Never wax polyurethane paint coatings as it dulls and yellows the finish.
- Don't shrinkwrap or allow any other plastic tarp to remain in tight contact with the surface as it traps moisture and causes blistering.
- Beware of haphazard winter tarps that can flap against and chafe the hull.
- Avoid fender chafe. Terrycloth fender covers don't help as they trap dirt and become abrasive.
- Don't use abrasive cleaners or scrubbers. Wash regularly with mild soap and water and a sponge or wash cloth.
- Stubborn fender smears can be removed with acetone, lacquer thinner or mineral spirits followed by a water wash.
- Avoid the use of two-part teak cleaners as the alkali and acids in these products can damage or stain the finish.
- Water spots and salt residue are a nuisance on dark hulls, but are easily removed with a distilled vinegar rinse.

— *NB*

the cure in cool conditions, others that make the coatings less sensitive to fish eye, an annoying pockmark that can erupt due to any residual contamination on the hull. The viscosity timer cup is again used to gauge correct dilution with spray reducer.

Most paint jobs are two colors, one for the hull and another for the boot and cove stripes. The stripe area is coated first (application techniques vary slightly with paint manufacturers) with three or more coats usually required. Once cured, the hull color application follows after applying masking tape to shield the stripe. The stripe width is contoured to give a consistent apparent width when viewed from a sight line level with the waterline. A small piece of tape is applied and then peeled away to test the fresh paint stripe for sufficient cure to apply masking without marring the finish. If the gloss survives this test, stripes are masked with 3M Fine Line tape for the edges with masking paper in between.

Applying hull topcoat.

Topcoat application follows over the remaining hull. Paint needs a minimum cure time of overnight up to 24 hours.

Step 10 Unmasking

It's best to remove the masking as soon as possible after the paint cures. At this stage the coating is still a bit soft and is easier to break at the mask edge. The tape peels best if it's pulled at a right angle to the surface. There will be paint overhangs where the paint does not tear cleanly and these must be carefully trimmed with a razor blade held flat against the hull

Mask removal is done as soon as possible after the paint has cured.

Post Painting

After removing masking, apply vinyl name and hull graphics, pinstripes, cove stripes etc. but take care to avoid scratching the "green" paint surface.

Beyond the initial 12 to 24 hour paint cure, most polyurethane paints continue curing for two or three weeks while the coating attains optimum hardness. During this period, take care when mooring and handling the boat to avoid scratching the shiny new finish.

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, where this paint job took place.

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PROJECTS

NEED MORE GAUGES?

Adding gauges to an existing sender is easy with this simple device.

[BY LARRY DOUGLAS]

Would you like to add another gauge to an existing gauge circuit but aren't sure how to connect it? Whether you'd like a second fuel gauge located at the upper helm station, or a remote oil pressure gauge from the AC generator installed at a more convenient location, here's what you need to know to add a gauge to almost any existing system.

Gauges attached to senders are all, in essence, specifically designed and calibrated ammeters. The gauge pointer moves as the sender controls the current, which is, in turn, controlled by the pressure, temperature or level that it senses. Nearly all gauges have three terminals on the backside. They usually are: I (ignition) or + for battery positive, S to connect to the sender, and N or - to connect to battery negative. The corresponding sender usually has one terminal that accepts a wire (the S connection), with the other terminal being the engine block that connects to the negative terminal of the battery. **[FIGURE 1]** shows the sender and gauge connected in series. In this case the current from the negative terminal of the battery goes to the sender, then through the gauge back to the battery.

There are two major standards for sender resistances, and a few other, less common, ones. The most common standard is 33 to 240ohms, and is used in most North American products. The other major standard is 0 to 90 ohms, often used in products from Europe and the Far East. The senders and gauges from one standard are not interchangeable with those of the other as the gauges will read incorrectly. Be sure you know which standard your equipment reflects since many aftermarket gauge suppliers build to both.

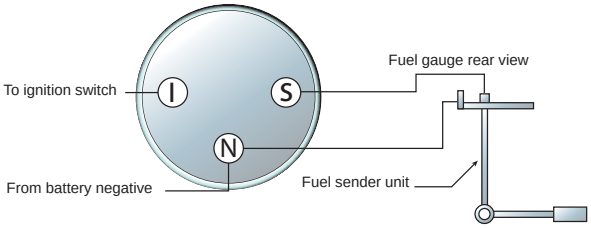


FIGURE 1

Example of fuel sender wired to fuel gauge.

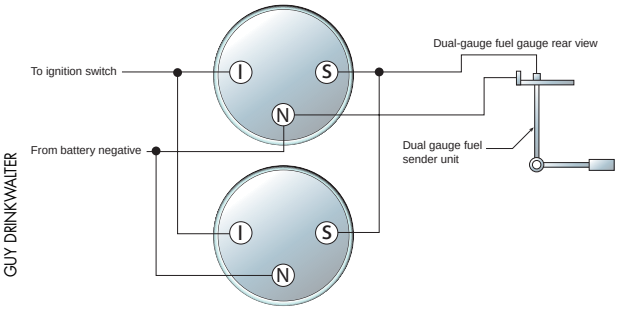


FIGURE 2

Example of fuel sender wired to two identical gauges.

While the series circuit makes connecting one gauge to one sender quite simple, it complicates connecting a second gauge to the same circuit. If you parallel the second gauge to the first, you've mismatched the sender and its load, namely the gauge, so both gauges will now read about 1/3 low. If the gauge indicates fuel level, perhaps you could live with that much error. That error is unacceptable and compromises safe operations if the gauge indicates oil pressure or coolant temperature.

To partially resolve this problem, many senders come in two-gauge as well as one-gauge models. They work properly only when two identical gauges (same manufacturer's model, for example) are connected as shown in **[FIGURE 2]**. You cannot, however, add a third gauge to this sender without degrading the accuracy. You can add another sender if it's practical. Provided they are designed for the same standard, it's usually possible to mix manufacturers of senders and gauges in single-gauge systems. For the best accuracy, it's a good idea to stay with the same brand. Never mix gauges from different manufacturers in multi-gauge systems using one sender. Each manufacturer builds gauges differently, so each of the two gauges could show a different value.

At some point it becomes impractical, or even impossible, to provide a gauge at every desired location where multiple senders are needed. Gauge-Echo from ESC Products is a gauge amplifier module designed to solve this problem

Two gauges in parallel using a single-gauge rated sender. Note that the gauges don't read full even though the sender float is fully in the full position.

and enables you to add gauges almost without limit. The only requirement is that all the gauges on each circuit must be of the same manufacturer's models. This is the same requirement as the dual-gauge sender noted above, and for the same reason. The Gauge-Echo comes in single and dual gauge models, and is therefore suitable for twin-engine operation as well as single. A typical hookup is as shown in **[FIGURE 3]**, which is easily accomplished by connecting to the existing circuit using the three terminals at the rear of the gauge. It works with either standard, of course.

FIGURE 3

Typical connection of two gauges wired to a GaugeEcho ge1. Both gauges read full and read the same.

Adding gauges to an existing gauge circuit is usually possible, but needs to be done correctly or accuracy will suffer. For additional information it's useful to consult the various gauge manufacturer's catalogs and web sites. My personal favorite is Thomas G. Faria Corporation (Faria Instruments) at www.faria-instruments.com. It's a gold mine of valuable information.

About the author: Larry Douglas is a marine electronics specialist, an avid DIYer, and president of ESC Products.

HAPPINESS IS FEWER HOLES

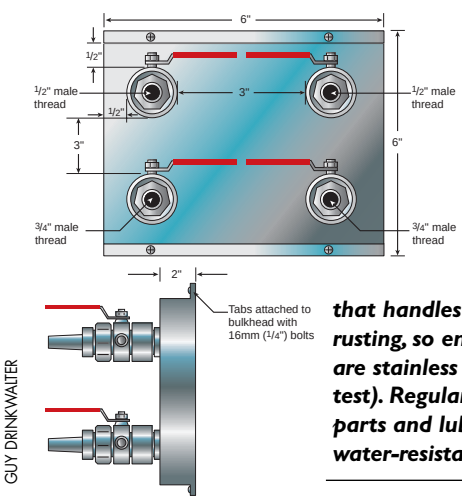
With engines, refrigerators, heads, air-conditioning and various other water dependent equipment onboard, most boats have multiple thru-hulls. Here's a nifty device to reduce their numbers, and limit the holes in your boat's bottom.

[BY SANDRA TURNEY]

While rebuilding my Contessa 26, I wanted to reduce the number of below waterline thru-hulls for safety reasons. Fewer holes in the bottom of my boat minimize the chances of flooding or sinking. I installed a water intake manifold, sometimes called a sea chest. This reduced the number of water intakes from four to one.

My design is simple. A 3cm (1-1/4") intake hose connects to the raw-water intake strainer and then to the manifold. The manifold then diverts the water via four ball valves: engine, sink, head and a spare for the future installation of a water-maker or a water-cooled refrigerator.

I was unable to find an off-the-shelf manifold on the market, so I designed one and had it fabricated by a local metal shop. It's a metal box that measures 15cm by 16cm by 5cm (6" x 6" x 2") and is made of 14 gauge 316 stainless steel. A stainless 3cm (1-1/4") OD pipe is welded onto the bottom of the box to accept the 3cm (1-1/4") water intake hose. Four stainless-steel standard pipe threads, two 12mm (1/2") and two 19mm (3/4"), are welded onto the side of the box, 7.6cm (3") apart. The respective pipe threads accept 12mm (1/2") and 19mm (3/4") standard ball valves. Four rings are welded onto the side edges to attach it to a bulkhead with 6mm (1/4") bolts. The male pipe ends on the box are wrapped with plumber's Teflon tape and the ball valves are screwed on tightly. Teflon tape is wrapped around the threads of the hose barbs and plug that are screwed into the ball valves. Custom fabrication of the box cost US$125, then you'll need to add the price of whatever valves and hose barbs are needed. [Ed: The use of stainless steel in this application should be considered a potential for a catastrophic failure from either stray current or galvanic corrosion. The manifold's direct connections to other metals and its state of constant immersion in raw (sea) water are factors in creating and/or aggravat-



Schematic of 14 gauge, 316 stainless-steel water manifold delivered to a custom metal fabricator for reproduction. Manifold reduces the number of water intake thru-hulls from four to one. Note that handles on the ball valves are rusting, so ensure that all handles are stainless steel (use a magnet to test). Regularly operate all moving parts and lubricate them with a water-resistant grease.

Another example of a water manifold installed on a new Valiant 50 consists of seacocks and ball valves to accommodate supply and demand.

ing such a potential. The welding method must also be scrutinized for the underwater application.]

After more than 2,414 km (1,500 miles) cruising, I haven't had any problems with water shortage when using the engine and, for example, the head flush water intake. A water shortage may be possible if you were using the engine, a water-cooled compressor and the head. Water capacity seems limited only by the size of the raw-water intake and the size of the manifold box. [Ed: Water starvation to any single demand may not be a significant problem in the writer's experience, but there are many variables that could affect that in other installations. Another potential problem is that of siphoning and/or back flooding from one manifolded service to another. These are not issues to be easily resolved by the amateur designer or fabricator. Make sure you consult the boatbuilder and the manufacturer's of any equipment or engine to be served by a water manifold system for advice before proceeding. A system intended to prevent a sinking might be exchanged for one that ruins an expensive piece of machin
ery.]

There was a problem of an air lock between the raw-water intake and the manifold due to winterizing of the water strainer. After pouring anti-freeze into the water strainer and pumping it through the engine, sink and head, the hose from the strainer to the manifold is partially empty. I solved this problem by priming the water strainer: fill it with water, screw the lid on tightly to create a vacuum, and use the sink hand pump to pump the water through and remove the air. When leaving the boat, I always close off the raw-water intake valve as well as all manifold valves. Both raw-water intake and manifold are located under my companionway steps, which gives me good access to see what valves are on or off.

About the author: Sandra Turney has completely rebuilt her 1972 Contessa 26, "Sandy's Beach." Last fall, she headed south from Ottawa, Ontario, to cruise the warmer waters of southern Florida and the Bahamas.

ANCHOR LOCKER VENTILATION

[BY BUTLER SMYTHE]

Mold on surfaces in anchor locker forms in a buildup of condensation compounded by poor ventilation.

Mold is a problem on many boats and ambient temperature and humidity variations amplify the problem. The anchor locker is one of those places where limited ventilation can result in humidity so thick that water hangs on the underside of the deck. Open one of those shallow, bow-mounted anchor lockers on many of today's sail or powerboats on a very hot day and you'll see that there is no escape for the buildup of heat and moisture. Even our Island Packet, with its large anchor locker and louvered door access from the V-berth, developed the black mold visible in the photo.

One easy solution is to install a ventilator that allows air to enter or exit the anchor locker (great for the cabin, too). Simplicity is the key here and some dangers arise when a ventilator allows entry of water, bugs and other undesirables. Trip or toe hazards and snag points for dock-lines or anchor rode also become concerns.

One ventilator that addresses all of those issues is the Vetus stainless steel mushroom ventilator. It's available in three sizes, is made primarily of stainless steel, except for the seal and interior closure knob, and can be closed and sealed from the inside as well as from the deck. When closed, it keeps out all comers. When open, it allows air to enter and exit sans bugs and water. Be aware of its open/closed position when underway, and if conditions warrant (rough seas, for example), close it!

This ventilator is easy to install by drilling the appropriately sized hole, sealing the deck or hatch edges with epoxy or another appropriate sealant to protect the core from getting wet. Pre-drill the holes for stainless screws (not supplied) and apply a bedding compound (I use 3M 4200) to the ventilator's mounting flange and to the fasteners. Position the vent and fasten it. Attach the included plastic interior trim ring if you want. That's it!

Put things away dry, let in some light and ventilate!

For areas where lines won't snag or won't impede movement, the Vetus cowl ventilator with Dorade box has the same great mushroom ventilator in its base. Installing either vent will help control the elements that cause mold to thrive. Bottom line? Put things away dry, let some light in and ventilate!

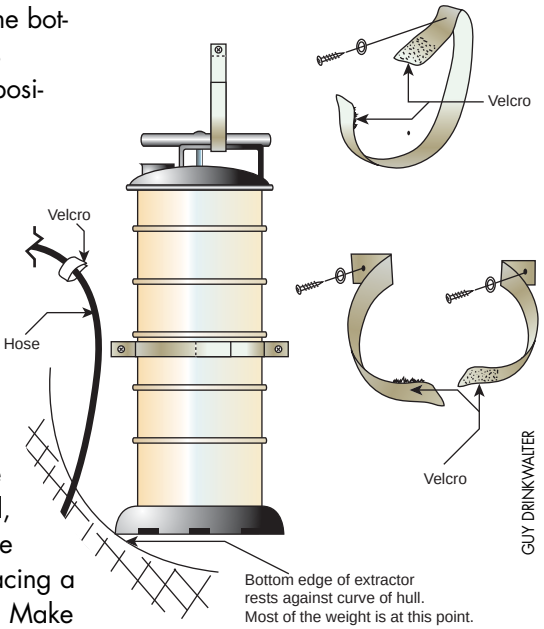
About the author: U.S. Navy vet (retired) Butler Smythe lived aboard his Island Packet 35 for nearly 6 years. He is now settled into life ashore and sails his boat out of Long Island, New York.

OIL EXTRACTOR STORAGE

This simple storage method has survived rough seas and a near knock down.

[BY KEVIN DEAN]

Oil extractors are a must-have for engine oil changes, but finding a suitable mounting location onboard can be difficult. A shelf is best, but an open space against the hull will work. Find a location where the bottom edge of the extractor rests against the hull in an upright position. To hold it securely, you'll need to make some straps. Wrap a strap of 5cm (2") webbing around the extractor and add 18cm (7") to this length. Cut this piece in half. Heat seal all ends to prevent fraying. Sew matching pieces of Velcro, about 6cm (2-1/2") long to one end of each strap. Again wrap the strap around the extractor and, holding it in position, screw the open ends to the bulkhead placing a washer under the screw head. Make a webbing loop for the handle and fasten (refer to photo for placement). Loop the tubing with both ends fitted into the rubber bushing and mount it on the bulkhead with two webbing straps fastened with Velcro. Caution: If you are mounting this assembly on the inside of the hull, glue a wooden cleat on the hull so that you can fasten the straps to it. Fastening these straps directly to the hull carries the risk of perforating it. Bed all the fasteners in sealant to prevent moisture penetration.



About the author: Kevin Dean sails "Via Sophia," a Morgan 32, on the West Coast of Canada.

Corrosion 101

SHADES OF STAINLESS STEEL

This segment in our corrosion series looks at stainless steel, an alloy that, contrary to popular belief, does rust under certain conditions, sometimes to the point of total failure.

[BY SUSAN CANFIELD]

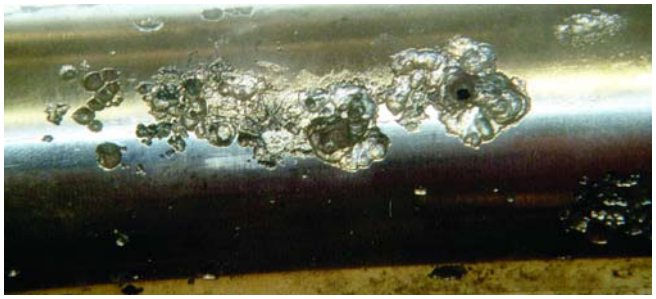
Boatowners tend to focus on the hazards of galvanic corrosion, which occurs between two or more dissimilar metals in electrical contact, either directly or via an external conductor, immersed in the same electrolyte. [Ed: Refer to DIY 2001-#4 issue for a complete discussion on galvanic corrosion.] What we often forget is that most metals in marine use are alloys, mixtures of two or more metals. In saltwater, an alloy can generate its own internal galvanic corrosion. Stainless steel is not rustproof. It's susceptible to self-corrosion, which normally proceeds at a much slower rate than galvanic corrosion. The problem is that this self-corrosion is typically hidden from view or difficult to spot. Consequently, when stainless-steel fittings and components used in the marine environment fail, the failure is catastrophic.

Stainless steel owes its stainless quality to chromium, which is alloyed with iron. The chromium reacts with oxygen, in the air or water, to form a thin layer of chromium oxide that is highly resistant to corrosion. With its protective film intact, stainless steel is said to be passive. Scratch or otherwise damage this layer and it quickly repairs itself so long as oxygen is available. In the absence of oxygen, however, the protective layer does not reform and the metal is then said to be active. As shown in the abbreviated galvanic table on page 29, passive stainless is more cathodic than active (anodic) stainless.

There are significant differences in susceptibility to corrosion among the many grades of stainless steel produced. Marine-grade stainless has higher levels of chromium, nickel and/or molybdenum than do lower

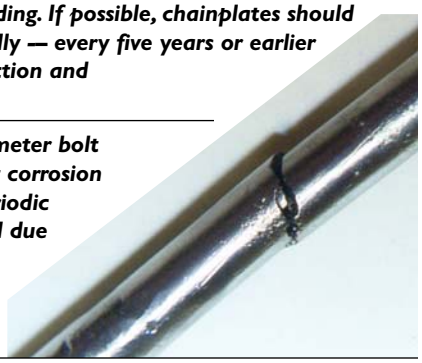
(continued on page 29)

EXAMPLES OF STAINLESS SELF-CORROSION



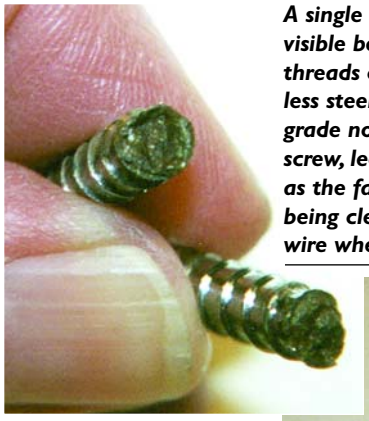
Crevice corrosion, caused by stagnant oxygen-deficient water, perforated this 4mm- (3/16"-) thick stainless-steel propeller shaft tube, allowing water to flood into the boat. Stainless steel was a poor choice for this application; a fiberglass tube would have been a better one.

Pitting corrosion occurs where a surface irregularity or scratch becomes more anodic than the surrounding metal. The intensity of pitting corrosion is due to the small area of the anode (the pit) relative to the larger area of the cathode (the surrounding metal). Regular cleaning and removal of salt deposits from the surface of the metal can avoid pitting. This 11mm- (15/32"-) thick chainplate is pitted where it passed through the deck molding. If possible, chainplates should be accessed periodically — every five years or earlier if leaking — for inspection and rebedding.



This 4mm (5/32") diameter bolt cracked due to pitting corrosion when removed for periodic inspection. It corroded due to prolonged contact with a wood beam supporting the sailboat's traveler.

Maintenance

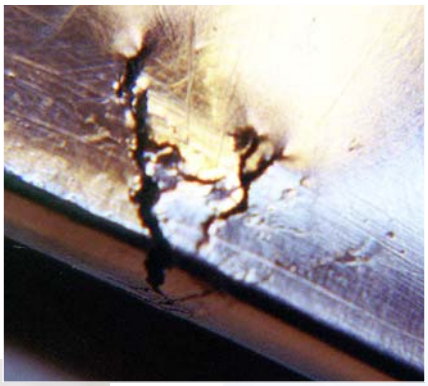


A single pit, barely visible between the threads of this stainless steel marine-grade nonmagnetic screw, led to failure as the fastener was being cleaned on a wire wheel.

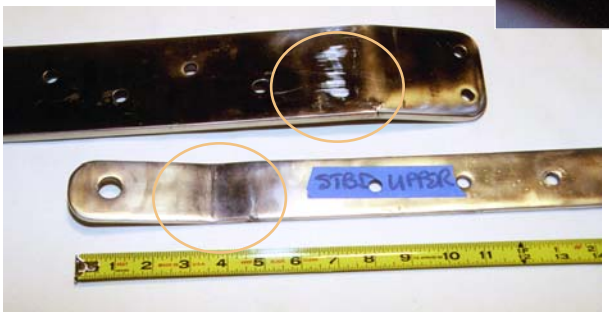
Centerboard pivot pins are subject to both crevice and pitting corrosion. They should be pulled with increasing frequency as a boat ages and inspected under a magnifying glass. If corrosion is found, the pin should be replaced.

From left to right: Stainless-steel stuffing box hose clamp, barbed tee, traveler bolt, wood screw, bowsprit bolt and centerboard pivot pin. All failed or were removed from service due to various forms of self-corrosion.

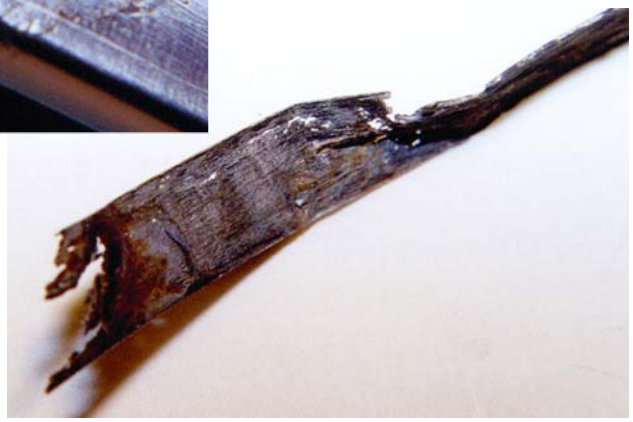
Some marine fittings, like this inexpensive towing ring, are actually chromed zinc (pot metal) or Zamak (a zinc-aluminum alloy). The threaded studs cast into this fitting are not marine-grade stainless. They have wasted due to crevice corrosion caused by elevated moisture in the boat's transom. Zamak fittings are poorly suited to the marine environment and are best avoided.



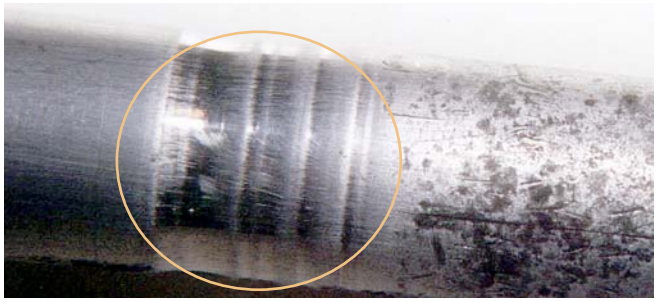
Pitting corrosion may initiate stress and fatigue cracking. This 12mm-(1/2"-) thick backstay chainplate cracked due to pitting corrosion when it was subjected to cold bending to better align it with the backstay.



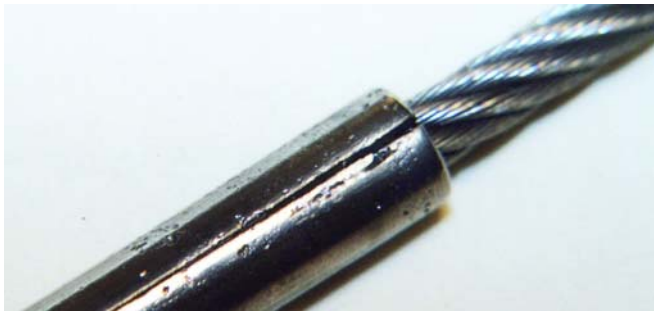
It doesn't take much pitting corrosion to seriously weaken a chainplate. Once pitting has started it has a tendency to penetrate deeply into the metal, much like termite damage in wood. Note that the affected areas on both fittings are located at the point where they penetrate the deck molding. Crevice corrosion is also frequently found on the face of chainplates fitted against a damp bulkhead or hull structure.



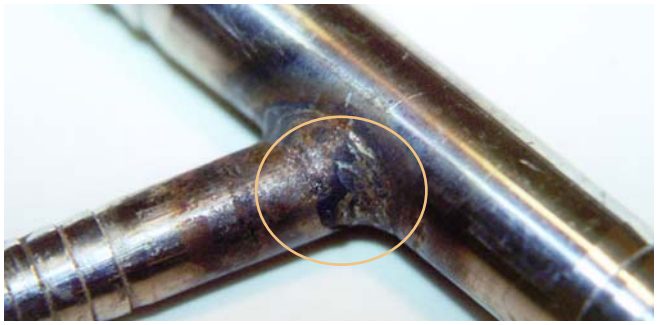
Propeller stuffing box hose clamps are susceptible to immersion corrosion in stagnant water. The presence of salt increases the electrical conductivity of bilge water and breaks down the protective oxide film formed by the metal. Always inspect the underside of hose clamps exposed to bilge water. While the upper portion of this clamp appeared to be undamaged, the lower portion had turned into a metallic lace and broke.



Corrosion fatigue (premature fracture) happens when self-corrosion occurs simultaneously with recurring stress. Cracks tend to originate at or near the surface as seen in this propeller shaft. Note the polished groove caused by over-tightening the stuffing box. Splatter from the leaking stuffing box combined with repeated torsional stress has produced a single long crack and numerous shorter ones just forward (to the right) of the stuffing box. This damage could have been avoided through proper stuffing box maintenance. [Ed: For details, see "Stuffing Box Repacking" in DIY 1999-#2 issue.]



Crevice corrosion occurs wherever stagnant oxygen-deficient moisture collects, such as at swaged terminal fittings, closed-barrel turnbuckles, threaded fittings and chainplates. Fittings like this swaged terminal, simultaneously subject to static tensile stress and exposure to a corrosive environment, are also susceptible to stress corrosion cracking. It's best to avoid the use of plastic rigging and turnbuckle covers that trap moisture and other corrosives, prevent good rainwater washing and also sabotage periodic inspection.



Type 304 and 316 stainless steels contain carbon. Differential heating of the metal in the area of a weld, such as those in this barbed tee causes the chromium to combine with carbon rather than oxygen, defeating its passivating film-forming role. These areas become anodic relative to the rest of the metal, causing it to corrode. This form of self-corrosion is called weld decay or intergranular corrosion. Weld decay can be avoided by heating objects that have been welded to about 1,050°C (1,920°F) and then rapidly cooling them. For large objects like tanks where this is impractical, a special low-carbon stainless alloy (identified by the letter "L" after its number, such as 304L or 316L) should be used.

grade alloys. Marine-grade stainless is also non-magnetic or has a very low level of magnetism; lower grade stainless is always magnetic with its higher percentage of ferrous metal in the alloy mixture. The various stainless alloys are identified by number. Type 304 is widely used in marine applications for fasteners, fittings and rigging. Type 316 and more specialized alloys like Aquamet 22 and Nitronic 50 have greater corrosion resistance than 304, however, they are also more expensive, and not necessarily as strong as 304. Corrosion resistance and strength requirements are two very separate issues. High corrosion resistance does not translate to increased strength.

When considering the various forms of stainless steel self-corrosion identified in the photos in this article, the word "insidious" comes to mind. Knowledgeable boatowners can minimize the risks associated with stainless steel through the selection of appropriate marine-grade alloys, surface cleaning and polishing, proper bedding of fittings and fasteners, periodic disassembly and inspection, and timely replacement. [Ed: DIY recommends removing all hardware and rebedding at least every 10 years.]

About the author: Susan Canfield is a marine surveyor with Marine Associates in Annapolis Maryland.

Resources

"The Boatowner's Guide to Corrosion," Everett Collier, International Marine, 2001

"Metal Corrosion in Boats," Nigel Warren, Sheridan House, 1998

Abbreviated Galvanic Series in Flowing Seawater

Cathodic/Most Noble	Potential in Millivolts
Graphite	+200 > +300
Aquamet 22/Nitronic 50 SS shafting	-250 > +60
316 SS (2% Mo) passive	-100 > 0.0
Monel (70% Ni, 30% CU)	-140 > -40
304 SS passive	-100 > -50
Lead	-250 > -190
Silicon Bronze	-290 > -260
316 SS active in still water	-540 > -430
304 SS active in still water	-580 > -460
Iron/Steel	-710 > -600
Aluminum	-1000 > -760
Zinc	-1030 > -980
Magnesium	-1630 > -1600
Anodic/Least Noble	**Potential in Millivolts**

Adapted from the "American Boat & Yacht Council's Standards and Technical Information Reports for Small Craft" (7/2001), E-2 Cathodic Protection

THRUSTER FAQ

Some things you should know about choosing, installing, operating and maintaining bow and stern thrusters.

[BY JAN MUNDY]

While waiting out a storm in a Lake Erie harbor, I was awed as the skipper of a sailing yacht smartly reversed course 180° in a narrow channel to return to the lake when he realized the harbor was too small for his boat. I've since witnessed many situations where a bow thruster made the difference between maneuvering a boat with ease and grace, or bump n'crunch, much like they park cars in Detroit.

Docking and handling a boat in close quarters can be an extremely anxious, stressful experience for able operators. When backing into a slip, for example, the stern is controlled somewhat by the propeller and rudder, but current and wind can rapidly take charge of the bow. Unless conditions are ideal, many skippers opt not to leave the dock. A bow thruster can transfer control back to the helmsperson, restoring confidence and enhancing ability. "Even experienced professional captains like to have a thruster on a windy day," says John Mardall of Vetus den Ouden (Tel: 410/712-0740; Email: vetus@aol.com; Web: www.vetus.com). "Once you have driven a boat with a thruster, you'll never have another boat without one."

If you're considering adding a thruster, here's what you need to know about selection, proper installation and routine maintenance.

Q: What are some of the selection factors when choosing a thruster?

A: Major differences in thruster design include single or twin propellers, metal or composite propellers, tunnel sizes, power supply, either electric or hydraulic, and retractable or nonretractable (the former sits flush with the hull when not in use). A desirable option is a time delay. When changing thruster directions, this device allows enough time for the propeller to come to a full stop, about two seconds, before changing direction. This takes a major shock load off the drive train, which prolongs the life of the thruster.

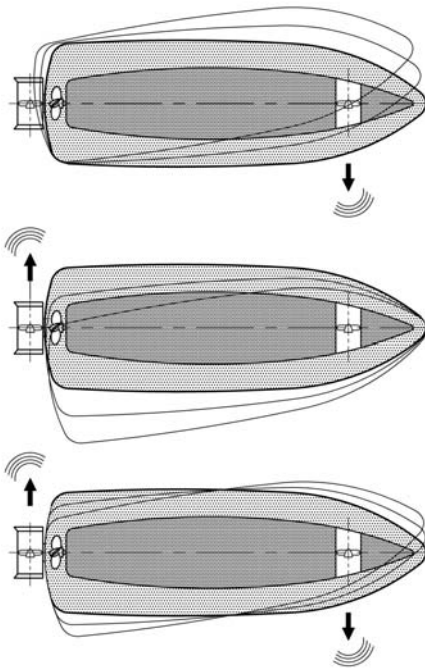
Q: What are the operating differences between a bow and stern thruster?

A: When backing into a slip, control of the bow can be lost to a crosswind or cross current, so you would usually put the bow thruster on first. A stern thruster becomes helpful when backing into either a very tight slip, where you have to position the stern in close quarters, or you want to "parallel" park, literally walking the boat sideways into the slip.

Instead of being in a glassed-in tunnel, a stern thruster typically mounts under the swim platform anywhere on the transom provided it has enough water cover and the water jet doesn't hit an obstruction, such as an outdrive.

Q: With twin engines I can "walk" my boat perfectly into a slip. Why do I need a thruster?

A: Know matter how skillful you are, it's difficult to steer on a windy day or in a strong current using only the engines. A thruster provides complete control of a boat's heading, regardless of the conditions and may mean the difference between going boating or staying at the dock. In unfamiliar harbors of unknown current activity, or where slips are tight and you need perfect control of your boat, a thruster gives you the "edge."



VETUS

Take control: (top) To move the bow to port, a bow thruster uses a side directional force out the starboard side; (middle) Stern thruster directed to port, moves the stern to starboard; (bottom) Operate the stern and bow thruster simultaneously to parallel park or "walk" the boat.

Q: Does a thruster increase hull drag and reduce speed?

A: To eliminate drag in a planning boat, the tunnel is positioned, if possible, so it's completely out of the water when the boat is on plane. In displacement powerboats or sailboats, the water in the tube is not compressible, so there is very little measurable drag. If you're really concerned, consider adding an eyebrow fairing in front of the tube, or a scallop behind the tube.

Q: Once you've decided to purchase a thruster, how do you determine what size?

A: Manufacturers provide detailed formulae for calculating thruster size, which are mostly based on boat length, displacement, windage caused by the height of superstructure and where it will be mounted relative to the turning point or center of rotation, which is the transom on most boats but can be farther forward depending on the underwater hull shape. It's always best to select a larger thruster than scale down to one that delivers minimal performance in adverse conditions. While equipment cost is marginally higher, there isn't much difference in installation charges between sizes. When selecting a thruster, consider this rule of thumb: What will it take to stop my boat's bow dead in the water in a 20-knot cross wind?

Q: What are the differences between electrical and hydraulic thrusters?

A: Length of run time is the main difference. Electrical units run on 12- or 24-volt DC power and, depending on the unit, have a maximum run time of three to five minutes. Considering that a normal thruster burst is between five and 10 seconds, limited continuous duty should not be a concern provided the proper size thruster is selected for your boat. Hydraulic units are much more expensive and can run continuously. Their installation makes sense on a larger boat that is already rigged for hydraulics with an engine-drive pump.

Q: What is the purchase price of a thruster and the installation cost?

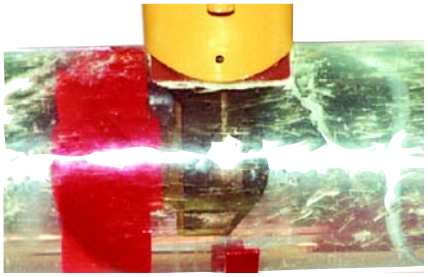
A: An electric unit for a 9m (30') powerboat or sailboat averages US$2,000. Cost of a professional installation ranges from US$2,000 to US$4,000, depending on yard haul out and labor rates, and the amount of interior renovation required.

Q: What determines mounting location of a bow thruster?

A: Correct tunnel placement is the single most critical factor. It must be located as far forward in the boat as possible to generate the maximum turning moment, but with adequate water depth over the top of the tube. There are also minimum tube lengths as specified by the manufacturer. Once a suitable location is found on the outside of the boat, it's common to discover that the tunnel will pass through a bulkhead or tank. Final tunnel placement is often a compromise between the installation criteria and modifications to the boat's interior.

Q: How difficult is it to retrofit a thruster?

A: Installation of the tunnel isn't complicated but it must be done by



Tunnel installation is not a job to be tackled by the uninitiated.

an installer experienced in structural fiberglass repairs. Once the tube is in, the actual installation of the thruster and wiring is relatively easy. Routing wires and control cables often involves removing the cabin headliner and some cabin furniture and cutting access through bulkheads. You'll save money if you do this work yourself.

Most thrusters can be installed in any position in the tube from vertical to horizontal. It's much easier to install and service the thruster when the powerhead is mounted vertically. Many boatbuilders don't do this as it takes up more room, but where it's an option, it's the best choice. If installed within 30° of horizontal, a support is needed under the motor to prevent movement in a pounding sea. As a practical matter, the thruster should be positioned in the tunnel within reach from one end to replace zincs, propeller, etc. It's

desirable to have an access hatch from the boat interior directly over the thruster powerhead to enable servicing. This is another item often overlooked by production boatbuilders.

Q: What power system upgrades are needed with an electric thruster?

A: Thrusters have powerful DC electric motors that draw a lot of current, from 100 amps to 600 amps. The most practical and cost-effective set-up is to power the thruster from a dedicated battery bank situated as close to the unit as possible. This allows for short cable runs and simplifies installation. Powering a thruster off the house bank commonly involves long runs of large cable to prevent power loss. Sometimes these large cables are difficult to route through the boat. The cost of the cables may be more than the batteries, and the labor to route same may cost more than both the batteries and cables. You will also have to address the charging needs of a dedicated battery bank.

The number and size of batteries depends on the size of the thruster and will be specified by the manufacturer. Completely sealed, maintenance-free AGM batteries are ideal for this application. Though expensive, they can take a large number of deep discharge cycles. If installing a separate charger dedicated to the thruster battery bank, it's good practice to upgrade to 24 volts. You'll get a longer running time and because of the high voltage, less energy is used up producing heat.

Q: What happens if something jams the thruster?

A: Most thrusters have a fail-safe device, either a shear pin or spline in the drive train, which breaks when an obstruction stops the propeller and before the gears are damaged. In most cases, pins are easily replaced from inside the boat. Be sure to carry spares.

Q: What's the best way to learn how to handle a boat with a bow thruster?

A: Do a trial run at the dock. Tie the boat securely to the dock with some slack in the lines and lots of fenders, then run the thruster in short bursts to get the feel for changes in boat direction. Just a light tap is all that's needed to pivot the bow. Next, practice moving the boat in open water, say around a buoy. The more you use the thruster before you need it in an emergency, the better. When docking, go slowly. Don't approach the dock at 7 knots and expect to have control.

SAILBOAT - RIGGING -

DON'T BE FOILED BY FOILS

Centerboards, swing or lifting keels are often overlooked components on sailboats. Carefree operation requires this equipment be inspected and maintained during every haulout. Here's how to remove, repair and reinstall.

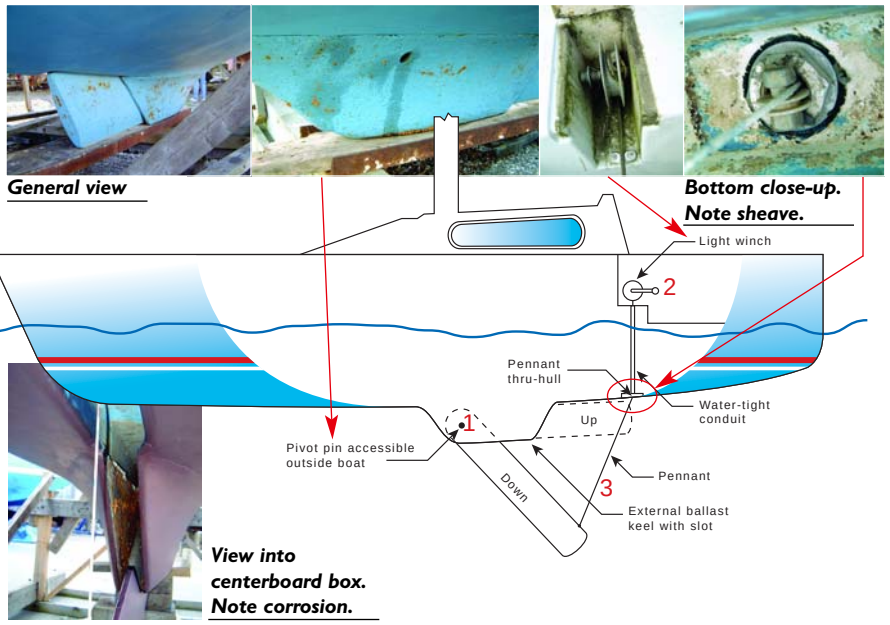
[STORY AND PHOTOS BY NICK BAILEY]

A boat with a centerboard gives the benefits of shallow draft and the windward performance of a deep keel in one neat package.

Strictly speaking, a centerboard (foil) does not carry the boat's primary ballast. This retractable underwater foil is designed to provide lateral resistance only. Ballast is in the form of a shallow keel or in some cases carried internally. A popular model has a ballasted iron swing keel. A retractable foil that also carries all or most of the ballast is more correctly referred to as a lifting keel. All the configurations have advantages such as flexibility and mobility, and ease in launching and retrieval from a trailer. On the con side, the more moving parts, the higher the maintenance and repair costs.

Wear Factors

Any centerboard, swing or lifting keel incorporates underwater moving parts. A typical centerboard usually swings up and down on a pivot pin. The pin can wear, corrode or seize. This never happens at a good time. To lift the board, a wire pen-

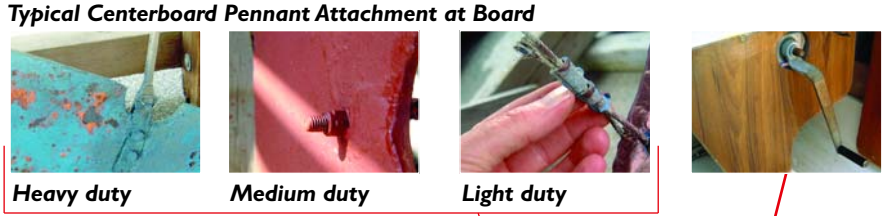


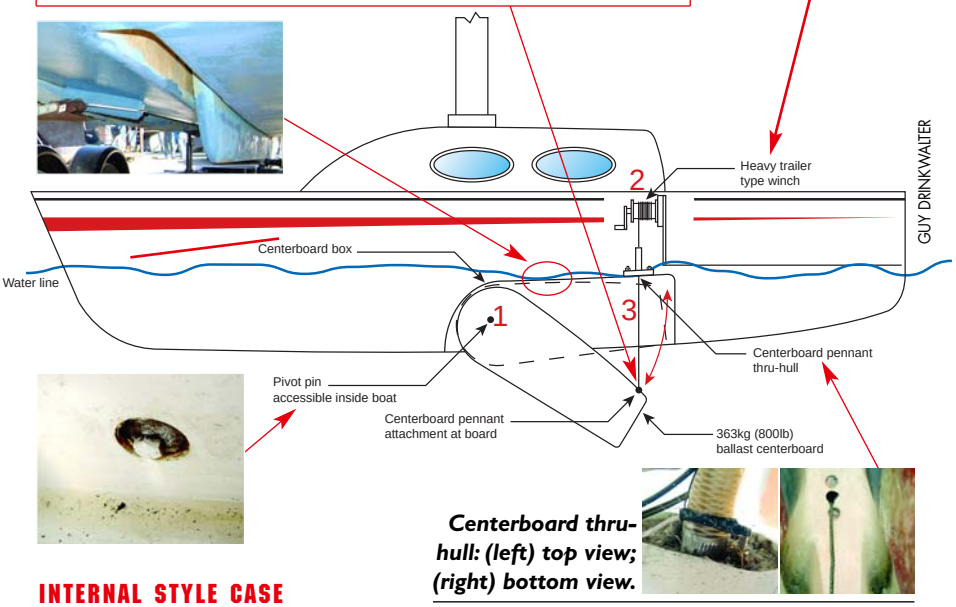
EXTERNAL STYLE CASE

Centerboard case is incorporated in the external ballast keel and has a light centerboard. Example: CS22, Redline 25

Lube Points:
1 Pivot pin (many models have a bushing that requires no lubrication)
2 Winch pauls and bearings
3 Cable

Typical Centerboard Pennant Attachment at Board





Centerboard thru-hull: (left) top view; (right) bottom view.

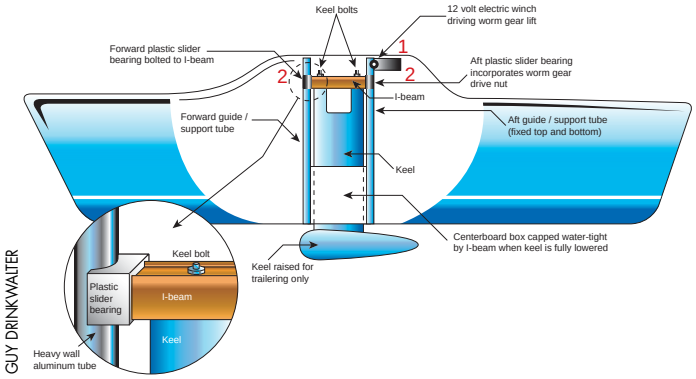
INTERNAL STYLE CASE

Boat has internal or water ballast and a light swing keel. Example: MacGregor 24
Boat has a heavy centerboard that doubles as a ballast keel. Example: Sirius 21

Lube Points:
1 Pivot pin
2 Winch pauls and bearings
3 Cable

nant is usually led through the hull and is attached to the lower aft trailing edge. The inboard end of the pennant leads to a winch or block and tackle system. This wire eventually corrodes, wire strands break, wire kinks, jumps a sheave or the assembly jams from some other malfunction or wear.

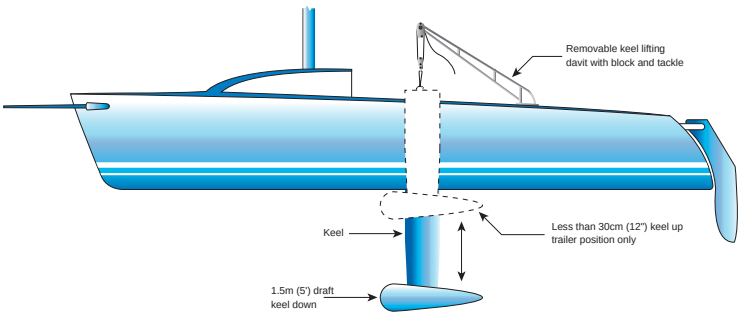
A lifting keel usually runs straight up and down on guide rails and has all the lifting mechanism components inside the boat. There are a variety of keel lift mechanisms. Some are simple, some are intricate, but all must handle heavy loads.



COMPLEX LIFTING KEEL

Keel is kept in the lowered position and raised only for trailering. Example: C&C Mega 30

Lube Points:
1 Worm gear
2 Plastic sliders



SIMPLE LIFTING KEEL

Example: Melges 24

No lubrication required, Teflon spray optional.

Various electrically driven worm gears, hydraulics, etc. get the job done easily when working properly. When a breakdown occurs, getting the keel back up (or down) manually can be a real struggle. That's when a good manual back-up system is a must have. All this gear is subject to wear, corrosion and derangement due to running aground. If nasty surprises are to be avoided it must be kept in top operating condition.

A Fouled Case

Some centerboard boats were not meant to live on the

water full time. They were intended to be "dry" sailed and stored on a trailer. Nonetheless, owners like to leave the boat in the water, the board always in the down position, and ready to go. Rarely is antifouling paint applied to the interior of the centerboard case. The area is simply inaccessible for coating. This results in fouling problems caused by marine organisms proliferating in the case, sometimes called a "trunk."

Tough armored critters like barnacles (in saltwater) and zebra mussels (in the freshwater) thrive in centerboard cases. Consider this classic scenario. You're struggling to get the boat onto the trailer and you see that the board is still not all the way up. You ponder the problem, but decide to drive home anyway. What could happen? After a short distance of jouncing on the trailer the board gets crushed farther into the centerboard trunk, past all the rock hard critters and into what is now a nearly permanent "full up" position; something you may not notice until the next sail when the boat refuses to go to windward and the board won't budge.

Diagnosing or fixing centerboards, or even applying antifouling, can be impractical if the boat is stored on a trailer during the off-season. With the centerboard fully retracted inside the case, it's invisible and inaccessible because of the low position of the boat on the trailer. If you want to enjoy the convenience of a wet mooring as well as the mobility of a trailer you must be prepared at least once a year to have the boat lifted high enough to fully lower the centerboard for inspection, maintenance, and application of whatever protective coatings are necessary.

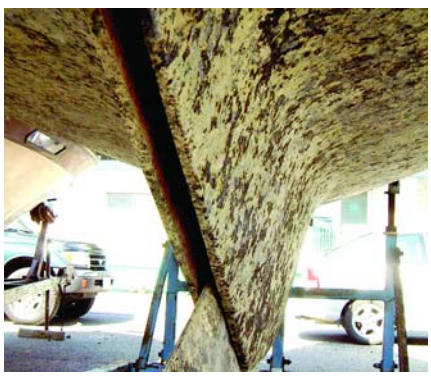
Yearly Upkeep

Use this checklist when performing annual service of a board or lifting keel. Call the boat's manufacturer or a professional if you're in doubt about the particular needs of your boat.

Wet Moored Centerboard Boats

• Check for fouling on centerboard and inside case. Scrape out as needed.

• If centerboard is steel or iron, inspect for corrosion. If coatings are in poor condition and a lot of rust is evident be prepared to strip the centerboard to bare bright metal with a grinder followed by a rotary wire brush to clean out the pitting. If available sand blasting is the ideal paint prep.



• Apply at least two coats of a good epoxy anticorrosion primer such as Amercoat/Devo Bar-rust, Awlgrip 545, Interlux Interprotect 2000 or even straight epoxy resin.

• Prep sand and repaint antifouling as needed. Make an extension tool to reach inside the centerboard case if necessary (see "Easy Extension Tool" on page 38).

All Centerboard Boats

• Lower and raise the board or keel a few times to inspect the entire mechanism.

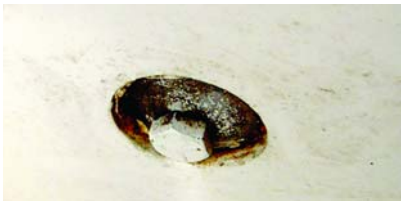
• Check the pivot pin to ensure it moves freely. Lubricate with a moisture-displacing lubricant or Teflon spray.

Pivot Pin Wear

HOW MUCH IS TOO MUCH?

This may be difficult to judge. All centerboards have some play at the pivot pin, some more than others. Use common sense and look for worsening play during haul out. If in doubt block the board securely and lift it with wedges to take the weight off the pin. Then remove the pin for inspection or replacement under a preventive maintenance program. For many external centerboard cases, the pin may be hidden under fairing putty on the ballast keel. In saltwater it will likely be corroded and difficult to remove. *—NB*

• When board is down, shake it to check for excessive wear and play at the pivot pin. If it wobbles badly the pin may need to be replaced or rebushed.



• Carefully inspect the entire pennant length for broken strands; cracked or corroded swages; worn or flat spotted blocks or guide sheaves. Replace any worn or damaged components. Grease the centerboard pennant cable with waterproof grease.

• Inspect and lubricate the pennant winch with grease or a Teflon spray.

Lifting Keels

Inspect keel lift slide rails and bearing pads. Keel lift bearing pads are almost always plastic, heavy-duty polyethylene or Teflon. Lubricate as specified by the manufacturer.

• Inspect lift mechanism for wear. Lube as recommended. Don't use petroleum-based lubricants, which are messy. A Teflon spray such as McLube Sailkote, Captain Phab Dry Teflon or similar can help.

• Follow all maintenance instructions as specified by the manufacturer.

Service Accessibility

If you plan to store your boat off-season at the same facility where you also moor it, check if haul out and relaunch is included in the storage fee. Where there is no extra charge or a nominal charge, it makes sense to invest in a conventional storage cradle that is tall enough to allow inspection and maintenance of the centerboard. If you have no option but to store on the trailer, you'll need to book a lift and a tall temporary cradle or stands to do your annual maintenance. The same goes for larger cen-

terboard yachts as well. Just make sure the ballast keel and hull are well supported.

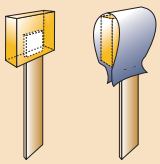
For owners who don't wet moor and launch the boat only for use, fouling is not a problem but you'll still need an occasional lift to inspect the system or repair a pennant or service a sticking pivot pin.

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.

Easy Extension Tool

Follow these instructions to make an extension tool for sanding and painting the centerboard case.

Cut a stiff sponge into the dimensions as shown, then using a knife cut a 38mm by 76mm (1-1/2" by 3") slot into the bottom edge. Insert a wood handle sized to fit the slot. A paint paddle (stir stick) fits well. Drill two small holes through the handle and sponge, and fasten together with bolts, washers and nuts. Tighten so fasteners are recessed into sponge. For sanding, wrap a 1/2 sheet of sandpaper over the sponge top and staple bottom edge to the handle.



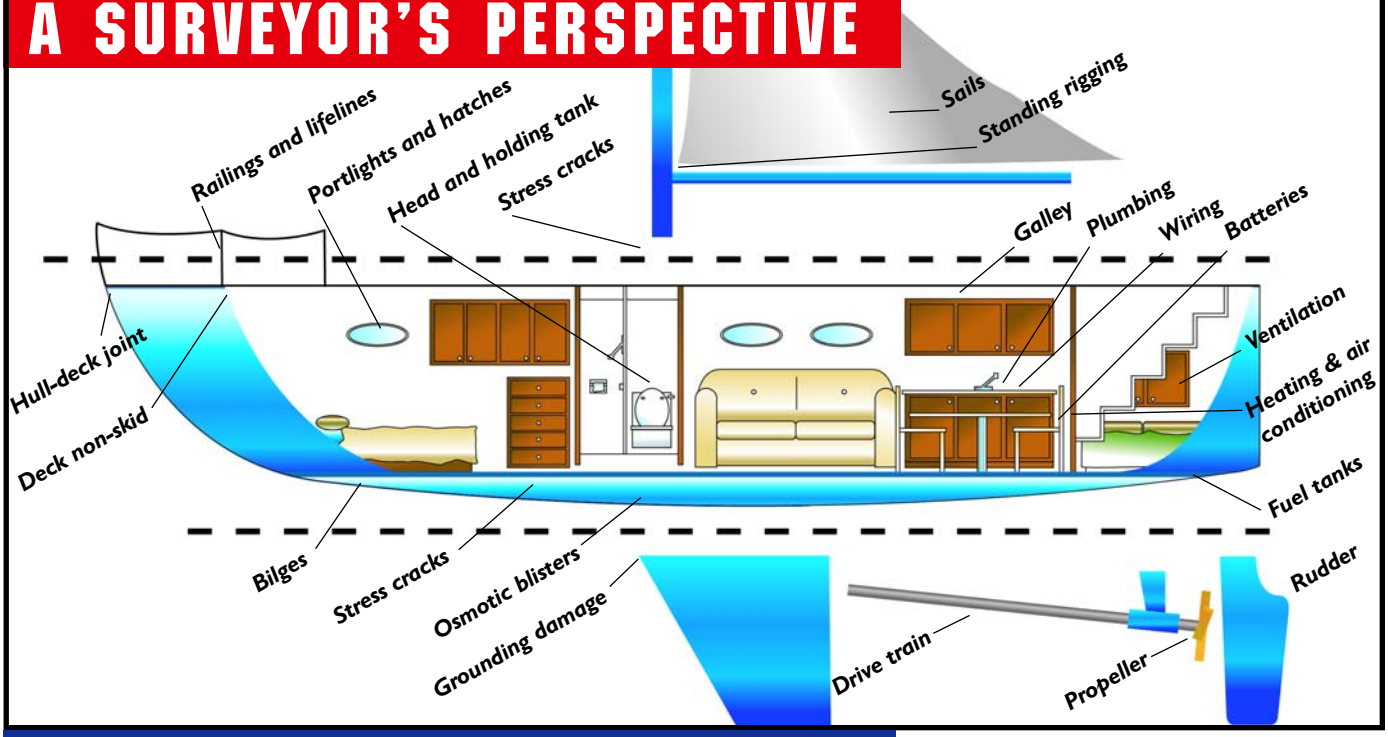
GUY DRINKWALTER

Use without sandpaper and the sponge makes a great paintbrush. Be careful not to overload the "brush" with paint to reduce drips. (This can be a sloppy job.) Alternatively, duct tape a regular brush to an extension handle.

— NB

BUYING RIGHT

A SURVEYOR'S PERSPECTIVE



GUY DRINKWALTER

There are some great buys on used boats if you know what to look for. A marine surveyor explains how to evaluate a boat's systems and performance before making a purchase offer.

[STORY AND PHOTOS BY SUSAN CANFIELD]

The process of buying a used boat is often an emotional experience. It involves considerable risk too, especially for inexperienced buyers. Even experienced boaters can make critical mistakes while boat shopping that cost them time, money and unnecessary stress. Doing your homework beforehand is key to being a happy boat buyer. If you skip the fundamentals, you may regret the day you signed that purchase contract.

As a marine surveyor, I'm amazed by some of the major problems I encounter during pre-purchase surveys, problems that cause the prospective buyer to walk, or even run away from the deal. Problems virtually any prospective buyer can and should discover before making a purchase offer. Unfortunately, many buyers don't know what to look for; others don't bother.

If you want to avoid the unnecessary delays and expense that accompany multiple surveys, make sure that your marine surveyor is not the first person to inject some objectivity into your boat selection. Use the accompanying checklists to guide you in your search. The knowledge you gain in the process will pay big dividends as long as you own your boat.

Getting your Bearings

Before you go shopping, consider how you plan to use the boat, such as for fishing, water-skiing, racing or cruising, and where you plan to boat in protected waters, along the coast or offshore. Focus your search on boats designed to suit your performance needs and your budget. Knowing how long you expect to own the boat will help establish an age range for desirable candidates. Typically, the older the boat, the more it will cost you to upgrade and maintain it. If you lack the skills and/or time needed for repairs and normal service maintenance, be sure to consider the cost of having others do this essential work for you. You can't escape maintenance costs: Either you'll pay when the work is performed or pay (often more) in depreciated value when you sell the boat.

Use references like the "PowerBoat Guide" or "Mauch's Sailboat Guide" or consult your surveyor (see "How to Choose A Surveyor?" on page 43) to generate

TIP BOAT BUYING STEP 1

Don't wait until you've signed on the dotted line to find a qualified marine surveyor. Do the self-survey, following the checklists on page 42, and engage a surveyor when you begin to look for that dreamboat. Surveyors know which boats do what and how well the various brands and models mature. Discuss your expectations and consider the surveyor's advisories when you start.
— Patrica Kearns

a list of boats that meet your selection criteria. Then, gather additional information on each of the boats on your list. Use a three-ring notebook or file folders to organize this information for future reference. Read boat reviews, visit manufacturer's websites and contact owners' associations. A great deal of useful information can be found using Internet search engines. My favorite is www.google.com. Just enter the make and model of boat you're interested in. You'll find boat reviews, boats for sale, owners' associations, boat manufacturers and more. You can access used boat prices via the BUC and NADA websites. I find it more helpful, however, to look at the printed versions of these price guides so I can readily see the full range of values for any given boat's production run. Both price guides are found in the reference section of many public libraries.

Know your Options

Once you've developed a list of likely candidates, contact several marine lenders if you expect to finance your purchase. Gather information on loan rates based on a hypothetical example drawn from your list of candidates. Don't forget to ask for the names of recommended surveyors in your area. Next, contact the appropriate government agencies to determine government registration or documentation requirements, applicable taxes and fees, and any equipment requirements unique to your intended operating area. Much of this information can be obtained via the Internet.

Contact several marine insurance companies to gather information on rates and policies. When planning to buy a boat under 9m (26') in length, contact your homeowner's insurance company for a quote. Many marine insurance companies maintain lists of surveyors whose reports they readily accept. Some, like BoatUS (www.boatus.com), post this information on their website.

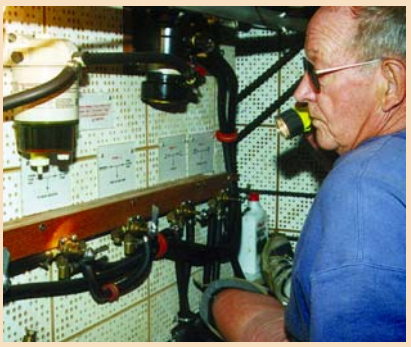
Where will you keep the boat? If needing a slip, call several marinas to obtain a copy of their rate sheet for skilled and unskilled labor, hauling, storage and launching, slip availability and a sample rental contract. If they have a list of recommended surveyors, ask for a copy. Next, visit several yacht brokerages to assess their professionalism, experience and specialization if applicable. Review a sample purchase agreement. Ask for the names of recommended surveyors. Both marinas and yacht brokers have a potential conflict of interest when recommending surveyors. If the names they provide differ significantly from those you receive from lenders, underwriters and experienced boatowners, beware. Honest marina managers and yacht brokers will typically recommend several experienced National Association of Marine Surveyors (NAMS) or Society of Accredited Marine Surveyors (SAMS) affiliated surveyors or other highly regarded non-affiliated surveyors.

TOOLS OF THE TRADE

Use a plastic-headed mallet or the plastic handle of a screwdriver to test the deck molding for delamination. Listen for the degree of vibration generated each time you strike the deck. If the molding is delaminated, you'll hear a dull thud rather than a sharp ring. Delamination due to moisture intrusion is most frequently found near load bearing fasteners that penetrate the deck core.

Look in the bilge! The rudder stuffing box on this trawler is located below the steering quadrant, visible here at the bottom of the lazarette. A flashlight and mirror will be needed to actually see the stuffing box. Prospective buyers will want to wear loose fitting clothing suitable for climbing into sometimes grimy compartments.

This trawler has an elaborate fuel filtering system; detailed labeling is provided to help the operator. Acoustical tiles that line the engine compartment also encloses the fuel tanks, making visual inspection without disassembly impossible.



A good flashlight and mirror are essential when checking for exhaust system leaks and deteriorated piping and clamps. According to ABYC standards, each section of exhaust hose should be double clamped.

Contact several of the surveyors recommended to you. Ask about their experience and specialization, if any. Obtain a sample pre-purchase survey report and fee information. (See "How to Choose A Surveyor?" on page 43.)

Now, armed with all the information you've gathered, calculate the actual cost of buying a boat. Start with the approximate purchase price, applicable taxes and registration fees, and costs of the survey, including a haulout. Estimate your annual expenses including (as applicable) loan payments, insurance, slip rental, maintenance and repairs. Consider setting aside additional money to upgrade the boat after purchase for such items as new electronics, upholstery, etc.

Explore, Examine, Investigate

Your next step is to assemble a basic boat inspection kit that includes a good flashlight, a plastic-headed mallet or plastic-handled screwdriver for percussion soundings, clipboard, paper and pens, and the checklists on page 42. Include a camera and inspection mirror. Here's where investing in a digital or video camera can be justified.

Start your inspection by looking at the boat as it floats in the water. Does the boat list to port or starboard? Does it float bow or stern down? If blocked ashore, a scum line at or near the waterline will often indicate a boat's list or trim. Is the hull symmetrical? Is there evidence of grounding or collision damage? If the boat is blocked ashore, sound the hull below the waterline with a plastic-headed mallet or the plastic handle of a screwdriver to test for delamination. The pitch of percussion soundings will vary as you pass over bulkheads, tanks, or other structural elements. Listen for the degree of vibration generated each time you strike the hull. If the molding is delaminated, you'll hear a dull thud rather than a sharp ring. Note the average size and distribution of any hull blisters.

On boats with inboard engines, grasp the end of the propeller shaft and try to move it up-and-down and from side-to-side. If the shaft rattles, the cutless bearing is worn and needs replacing. [Ed: See "Drive Train Tune-up" in 2002-#1 issue for step-by-step bearing servicing.]

Note the condition of the propeller, and drive casing on outboard- and sterndrive-powered boats. Corrosion, oil leaks and impact damage here are clues to problems. Check rudders for evidence of corrosion and check the rudder stuffing box for evidence of leakage. On sailboats, look for evidence of weeping from the hull-keel joint or keel and rudder moldings.

On deck, look for cracks in the gelcoat. Sound the deck molding for evidence of delamination. Check the condition of the non-skid. Do the hatches and portlights show evidence of deterioration? Are lifeline stanchions and/or railings secure? Check powerboat transoms for delamina-

tion. Note the condition of all canvas, such as a dodger, bimini, cockpit cover or enclosure.

On sailboats, check the condition of the mast and the mast step. If the mast is stepped on deck, check the condition of the compression post that supports it. Look for deformation and corrosion problems. Check wire shrouds and stays for broken strands and cracked terminal fittings. Is the standing rigging original or have there been replacements? Is the running rigging worn or mildewed? Consider the number and age of sails. Determine the type and general condition of the steering system. Evaluate visibility from the helm.

Moving belowdecks, check for odors (fuel, waste or mildew). Evaluate the boat's passive and powered ventilation systems. Look for evidence of water intrusion at hatches, portlights and load bearing deck hardware (chainplates, cleats, windlass, etc.). Are fabrics and finishes water stained? Do settee and berth

(continued on page 44)

PRE-PURCHASE CHECKLIST

Use this checklist to determine the boat's general condition and quality, and help you spot potential problems affecting value and safety.

Planning is Everything

INITIAL CONSIDERATIONS
How do you plan to use the boat?
How long do you expect to own it?
Do you have the skills, interest and time to repair and maintain it?
How much can you afford to spend per year?

BACKGROUND RESEARCH
Boat reviews
Owners' associations
Used boat price guides
Contact lenders
Loan rates
Surveyors' list

CONTACT GOVERNMENT AGENCIES
Registration/documentation required
Taxes and titling fees
Equipment requirements

CONTACT UNDERWRITERS
Insurance rates
Surveyors' list

CONTACT BROKERS
Experience/focus
Sample contract
Surveyors' list

CONTACT MARINAS
Rate sheet
Slip availability
Sample contract
Surveyors' list

CONTACT SURVEYORS
Experience/focus
Sample survey
Fees

COSTS OF OWNERSHIP
Mortgage rates
Taxes and fees
Insurance rates
Dockage or mooring expenses
Surveyor's fee
Upgrade costs
Maintenance costs

10-Point Self Survey

EXTERIOR HULL
Attitude at rest
Symmetry at rest
Collision or grounding damage
Percussion sounding
Osmotic blisters
Cutlass bearing
Propeller
Weeping
Corrosion
Transom

DECK
Stress cracks
Percussion sounding
Non-skid
Hatches and portlights/windows
Lifelines, stanchions and railings
Canvas

RIG (SAIL ONLY)
Standing rigging
Running rigging
Sails

STEERING
Rudder
Stuffing box
Steering system
Visibility from the helm

INTERIOR
Odor
Ventilation
Evidence of water intrusion
Abnormal wear
Bilges

ENGINE
External condition
Oil
Stuffing box
Exhaust system
Fuel tank/system

ELECTRICAL
Batteries
Wiring
Control panels
Shorepower connector

PUMPS & PIPING
Potable water tank/system
Waste holding tank/system
Dewatering systems

DOMESTIC SYSTEMS
Galley stove
Icebox/refrigeration
Heating/air conditioning

SAFETY EQUIPMENT
Coast guard required equipment

How to Choose a Surveyor?

Marine surveyors are not licensed, and their activities are not regulated. Their competence is based solely on reputation. Here are the facts you need to access when choosing a qualified surveyor.

[BY PATRICIA KEARNS]

Okay. You've set your sights on a fishing boat and the broker gave you the name of his favorite surveyor. You have a friend who knows a lot about boats who said he could do the job. Either fellow can get to it today. What's to lose? More than your shirt. It could be a big pile of money or, at worst, your life.

In North America, there are no laws that regulate marine surveyors. It's not like picking a doctor, lawyer or accountant that are licensed to practice. In choosing a marine surveyor, you must rely solely on reputation, and good reputations don't come cheap. You wouldn't chose the cheapest brain surgeon if you needed brain surgery. Same goes for a surveyor.

So, what defines "qualified?" Does the surveyor have a license? How much will the survey cost? How long will it take? Ask the surveyor for a resume of experience that includes his or her training and professional certifications and references. The lack of an affiliation or professional certification does not preclude excellent reputation. In surveying, it's reputation, reputation, and reputation. Ask for the surveyor's scope (in writing) of the inspection process and what you need to do to make sure the boat is ready for the look see. Interview the surveyor personally. He or she works for you and only you. Costs vary regionally. Find out what you get for your money.

That brings us to agendas. The only one you need is yours! The broker quite properly represents the seller's interests as the seller pays the sales commission. If a broker is pushing a surveyor, be wary. It's likely not in your agenda's best interests.

A surveyor is only as good as the value of the survey report. Fast turnaround on the survey report is not necessarily to your advantage. In these days of expectations for instant communications, marine survey reports are like medical lab test reports. Good procedures take time to do and results take time to analyze. That's the only kind of survey you want. Unless someone is standing in line behind you to buy this boat, take time to gather and digest the information you need. Also, make sure your lender and insurance companies accept the surveyor's work.

If you hear a surveyor's name come up consistently as a "best in class," remember only one thing. Reputation, reputation, reputation.

About the author: A NAMS certified surveyor with an enviable "reputation," Patricia Kearns has 30 years marine experience, including assistant technical director with ABYC and, most recently, as executive director of American Boat Builders & Repairers Association). She recently formed Recreational Marine Experts Group (www.marinexperts.com) based in Naples, Florida.

cushions show abnormal wear given the age of the boat? Check the bilges tor standing water, oil, fuel, etc. Examine seacock operation.

Note the external condition of the engine. Look for corrosion and evidence of fuel, oil and water leaks. Ask for a copy of the engine maintenance log. If the boat is in storage ashore, check to see if the oil was changed at layup. Does the engine intake seacock operate? Does the propeller shaft stuffing box (inboard engines) show evidence of leakage? Check the boat's fuel and exhaust systems for leaks. Is the fuel tank original or a replacement? If necessary, how difficult would it be to replace the fuel tank?

In evaluating the boat's electrical system, start with the batteries. Are the battery terminals tight and corrosion free? Is wiring throughout the boat generally neat, well supported and protected from chafe (good), or disorganized, dangling in the bilge and replete with wire nuts (a never-do on a boat)? Are all control switches clearly labeled? Does the shorepower connector show evidence of overheating?

Check potable water tanks for evidence of leakage. If necessary, how difficult would it be to replace water tanks? Does the boat have a waste holding tank? If not, does it have a Coast Guard-approved waste treatment system (Type II MSD)? Do the waste system intake and discharge thru-hull seacocks operate? How many bilge pumps are there? If not electric, what fuel does the galley stove use? What type of refrigeration system (if any) is installed? Does the boat have a heating or air conditioning system? And last but not least, what safety equipment is included? Are there PFDs, flares, fire extinguishers, horn, etc?

Check the DIY editorial archives (www.diy-boat.com/archives or call DIY for a copy) for past articles, back issues and CDs containing information on maintenance and service. Check your local bookstore, marine chandler or library for books on inspecting and/or buying a boat.

About the author: Marine surveyor Susan Canfield teaches "Surveying Fiberglass Boats," a five-day seminar for boatowners, marine underwriters, claims adjusters, and marine professionals interested in surveying. The course is offered in Annapolis, Maryland and at WoodenBoat School in Brooklin, Maine. For further information, contact Marine Associates Inc. at 800/582-2922 or marineasso@aol.com.

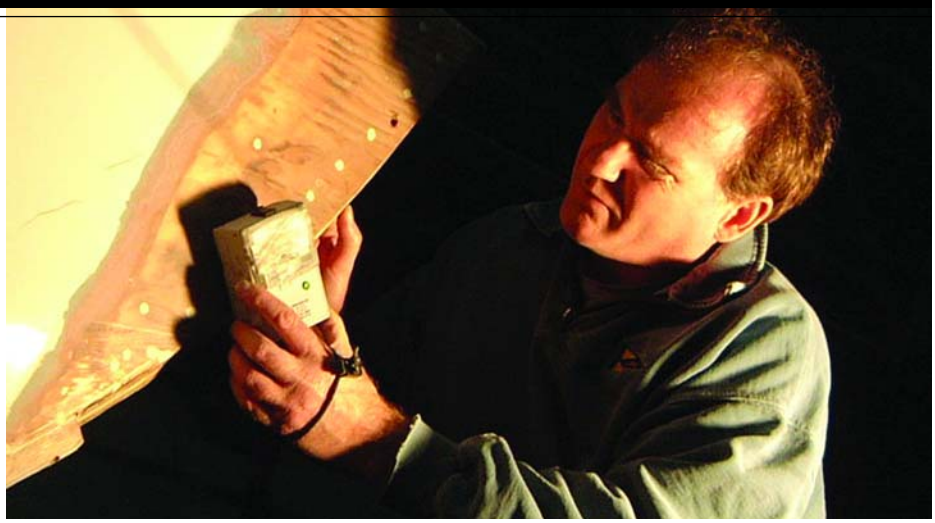
Resources

Mauch's Sailboat Guide, PO Box 32422, Jacksonville, FL 32237; 888/724-5672; www.mauchs.com • ***PowerBoat Guide***, American Marine Publishing Inc., PO Box 30577, Palm Beach Gardens, FL 33420; 800/832-0038, www.powerboatguide.com • ***BUC Used Boat Price Guide***, 1314 NE 17th Court, Fort Lauderdale, FL 33305; 800/327-6929; www.buc.com • ***NADA Marine Appraisal Guide***, PO Box 7800, Costa Mesa, CA 92628, 800/966-6232, www.nadaguides. com • ***Canadian Coast Guard Office of Boating Safety***, 200 Kent, 5th Floor, Ottawa, ON, K1A 0E6; 800/267-6687, www.ccggcc.gc.ca/ obs-bsn/main_e.htm • ***US Coast Guard Office of Boating Safety***, www.uscgboating.org • ***National Association of Marine Surveyors*** (NAMS), PO Box 9306, Chesapeake, VA 23321; 800/822-6267, www.namsurveyors.org • ***Society of Accredited Marine Surveyors*** (SAMS), 4605 Cardinal Blvd., Jacksonville, FL 32210; 800-344-9077, www.marinesurvey.org

REPAIR STATEGIES

Not just for the surveyor anymore, find out how a $250 tool can save your boat.

[STORY AND PHOTOS BY NICK BAILEY]



During a routine pre-launch moisture inspection, the author discovers a water soaked bow on his '60s vintage glass-over-ply Thunderbird.

The story is always the same. A fiberglass boat is for sale. "She's mint!" says the owner or broker. Sure enough, it looks to be in good shape but the buyer wisely insists on a survey before inking the deal. Or perhaps your own boat requires a survey before you can get the insurance policy renewed. The surveyor's report comes back with a long list of minor problems and a few ominous paragraphs stating: "High moisture readings with indications of delaminated core at the following locations."

Armed with the survey report, you contact the local repair yard for an estimate and are shocked to discover the cost to repair the wet core is a significant fraction of the boat's value, and maybe exceeds it! Why? Unfortunately, wet and delaminated core can only be properly repaired by major surgery. The outer laminates must be cut away and the wet core in the affected areas replaced or at least dried out if it's not too badly deteriorated. This is a time-consuming and expensive process.

"I had no idea the boat had these problems," is the owner's lament. "Everything seemed fine." All of which is probably true, but a leaking fitting may not show any visible signs as water seeps ever so slowly year after year, deep into the core. Once moisture gets into the core it can't escape. In northern climes in winter, the moisture freezes and expands. This frost heave can damage the balsa or PVC foam core structure and force the fiberglass skins and core apart. In turn, this frost-induced delamination makes it easier for water to spread throughout the core. Damaged areas continue to expand as long as water can gain entry. By the time you notice the deck has a spongy feel under foot or you spot the dreaded brown ooze seeping out from under a fastener on the deck head it's already too late. At those locations, deterioration has already reached an advanced state.

How can the insidious problem be detected before significant damage occurs? The only simple, non-destructive detection method is a moisture meter. This electronic tool is usually considered to be strictly for use by the boat surveyor or repair shop. The alternative is to purchase a moisture meter and do your own diagnostic check a few times a year. For simple diagnostic work you don't require an expensive unit.

Strange as it may seem moisture meters were not developed for marine use and most are not even designed for use on fiberglass. This tool is primarily used by lumber and paper industries to gauge the dry-

Examine deck fittings regularly with a moisture meter and rebed any that give a high moisture level to prevent further damage.

A high moisture reading signifies that water has entered the deck core.

ness of wood and paper. It also has a variety of uses in agriculture and the construction industry. This means you don't necessarily have to pay "marine" prices to get your hands on one. Meters that are specifically adapted for marine use cost more and will give you a more quantified reading of relative moisture content. The more general-purpose meter can still give a useful reading but it probably is calibrated for lumber.

Readings on fiberglass and core materials just under the outer skin will be relative readings or qualitative, which means they cover a range of wet here, dry over there, for example. Once you've tested the unit for sample readings on a variety of materials with known moisture levels, you'll begin to understand how to interpret meter readings. Regardless, you'll find places where moisture is sneaking into the core around leaky hardware on deck in time to rebed the fittings. If you find very high moisture over more than a few square inches, I recommend you call a surveyor or marine repair shop to assess the extent of the situation. Most older boats with cored decks have some moisture problems. Cored hulls are less prone to trouble simply because there are not as many holes drilled in them, but when trouble occurs in a cored hull it can be severe.

Moisture meters are also useful on wood boats. This spring I thought I had a minor paint repair to do on the stem of my 40-year-old glass-over-ply Thunderbird. While casually checking the stem with the shop moisture meter (a rather battered GRP 33 model purchased from J.R. Overseas) prior to doing what I thought would be a touch-up, I discovered the whole bow above the waterline pegged the moisture meter. Apparently the forestay fitting had been leaking for some time. I ground back the paint, fiberglass and epoxy fairing filler to expose and dry the wet plywood. Then, with fear and loathing, I removed the dubious looking false stem and found to my relief that the massive stem timber was still fresh, though wet. If I had not checked with the moisture meter I would have been none the wiser, while the soaked stem slowly turned to rot. In this case, I was happy to do a fiberglass and epoxy and paint repair instead of replacing the stem timber.

POWERBOAT
- RIGGING -

STERN DRIVE REALIGNMENT

The engine, transom assembly and sterndrive of your engine must be in perfect alignment to prevent major engine damage. To align these components as part of your annual maintenance, you'll need a custom tool, service manual and some mechanical know-how.

[STORY AND PHOTOS BY HARRY SWIECA]

If you hear your engine knocking when cornering, then most likely your engine and sterndrive (or outdrive) are no longer in proper alignment. Engine alignment is critical. Misalignment dramatically shortens the life span of the engine coupler, driveshaft splines, U-joint and gimbal bearing and results in high repair costs. Check alignment at least annually or as specified in your engine service manual, and each time the sterndrive is removed for service.

TIP Fine Tuning

Before moving adjustment nuts on engine mounts, draw a parallel line with white Liquid Paper (a.k.a. White Out) on each nut and where it touches the mount. This gives you a visual indicator of how far the nut has moved backward or forward of your reference line when realigning your engine.
— *JM*

Before checking alignment, be sure the boat is properly blocked. Depending on the size of your boat, making these adjustments will require special boat lifting equipment like a forklift or straddlelift with a qualified operator and crew. A non-trailerable boat hull must be supported equally all along the keel and transom, keeping the waterline parallel to the ground and the transom as level as possible. Make sure that there is nothing around the engine area that could apply pressure on the hull. If the boat is on a trailer, it's very important to support the hull equally at all points. Tilting the transom upward allows easier removal of the sterndrive while it's in the down position. If the trailer's rollers compress the area under the engine, then additional supports must be placed under the transom points to relieve the compression.

Alignment involves removing the outdrive and inserting an alignment tool (about $150) into the gimbal bearing, then into the coupler, and adjusting engine mounts as needed. If you don't have the proper tool, mechanical skills or knowledge, I recommend you take your boat to an authorized marine dealer. This work is best done during decommissioning and takes about 2.5 hours to do. Use the following directions as a generic guide and consult your service manual for more detailed instructions. Carefully follow safety precautions outlined in your manual prior to proceeding.

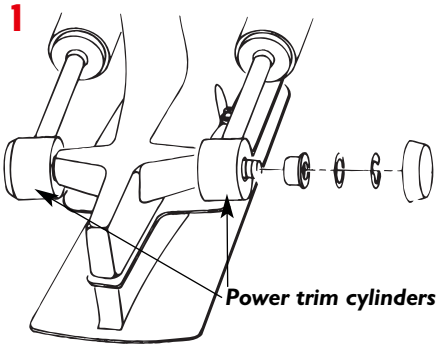
STEP 1

Put the drive unit in the in (down) position. Check the manual for gear position (typically neutral). Disconnect the power trim/tilt cylinders by removing both of the cylinder's pivot pins (**1**). Secure the cylinders up and out of the way to prevent damaging the hydraulic lines while working on the sterndrive. Disconnect the speedometer hose fitting from the gear case housing. Remove the locknuts and washers securing the drive unit to the transom assembly (**2**).

Grasp the drive at the end of the anticavitation plate (**3: PHOTO SHOWS CYLINDERS IN PLACE**). Lift it slightly and allow it to fall. The shock is usually enough to pop the drive free of the housing. Do this several times until the drive starts to separate. Support the drive while slowly sliding it off the housing studs, until a gap of about 25mm (1") appears between the drive and the gimbal housing.

In many cases, even after all the

1



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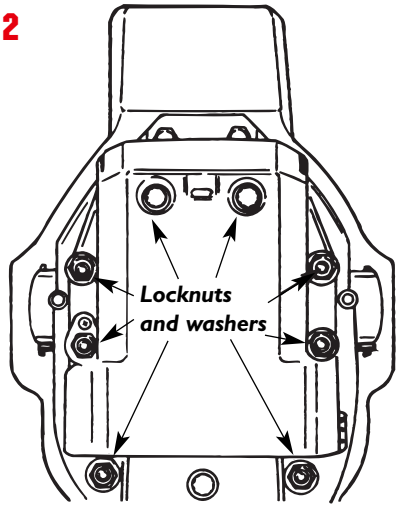
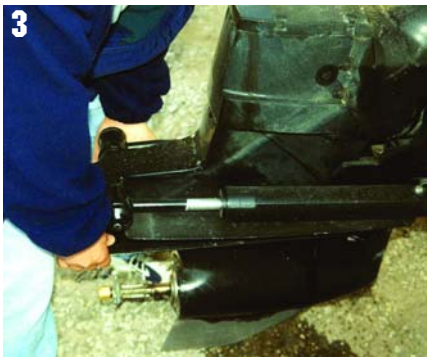


MERCURY MARINE



locking nuts have been removed, the sterndrive will not separate from the gimbal housing. This is caused by misalignment and can be a difficult problem to resolve. Cut wooden shims into doorstop shaped wedges. These are used to help separate the drive. Don't use metal wedges or pry bars to separate the drive. These damage the housing, resulting in water leaks and universal joint damage. Insert wedges between the drive and the gimbal housing, one per side. As you lightly lift and drop the drive, use a mallet to tap the wedges deeper into the spacing. Repeat this until the drive separates completely from the gimbal housing.

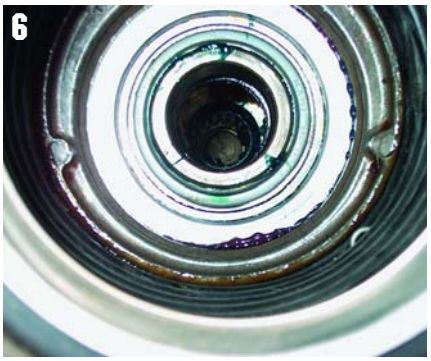
Release the shift cable, and remove the drive.

STEP 2

Carefully inspect the splines on the U-joint shaft for excessive wear (**4**). Also check the edges of the splines

for aluminum shavings from a worn drive coupler embedded in the grease (as shown in the photo).

Either of these indicates that misalignment has damaged the engine's drive coupler, which now must be replaced. If the shaft is in good condition, inspect inside the bellows for rust or moisture or other signs of damage. If cracks are found on the bellows, it should be replaced. On MerCruiser sterndrives built since 1984, this requires an exhaust bellows expander. This device holds the bellows in place while the hose clamp is being installed on the bell housing. This is not a DIY job as the skills required call for an authorized marine dealer's expertise. Now inspect the gimbal bearing. The bearing is a



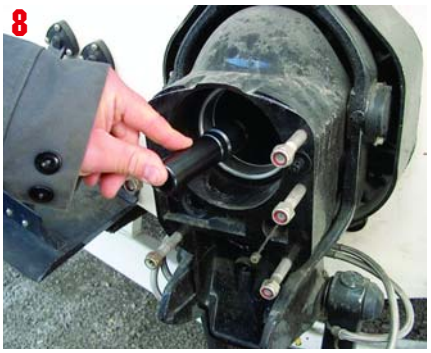
large flat ring deep inside the gimbal housing. Replace the rubber bellhousing gasket if cracked or brittle. Photo shows rust on U-joint bellows caused by water intrusion (**5**).

Using a flashlight inspect the matching splines of the drive coupler for wear or other damage (**6**). Insert your hand into the housing and grasp the center ring of the bearing and rotate it from side to side. It should operate smoothly without any vibration. Consult your manual if the bearing is difficult to move.

STEP 3

With the basic checks out of the

way, the next process is the actual alignment. Check your manual for the proper part number of the tool used to check alignment. Usually it's a 61cm- (2'-) long metal shaft



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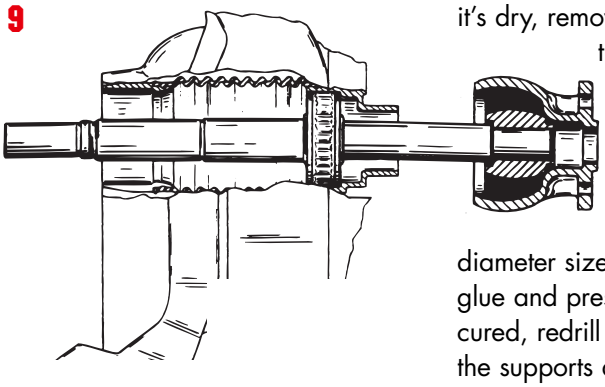

MERCURY MARINE

approximately 38mm (1-1/2") in diameter with several steps cut into the shaft (**7**).

Insert the small end of the shaft into the gimbal housing and gently push it through the bearing and into the drive coupler (**8**). It should move easily until it bottoms out with a loud knock (**9**). Do not force the shaft in as it binds easily, making removal very difficult. If the shaft goes in but doesn't bottom out, the front of the engine needs to be adjusted up or down until the shaft easily slides through the gimbal bearing and bottoms out in the coupler.

STEP 4

Engine adjustment is easy if you follow the rules.

- Never adjust the motor while leaning on it.
- Be sure the mounting bolts for the engine mounts are secure and torqued to spec.
- If lag bolts don't tighten into the stringer supports (engine beds), it's time for a close inspection of the support's structure. Use a probe to determine if the inner core of the stringer is dry, wet or rotted (**10**). If it's dry, remove the lag bolts, and fill the hole with epoxy resin thickened to a mayonnaise consistency. Another option is to cut a pin of hardwood dowel, of a diameter size so it fits snugly, then glue and press it into the hole. Once cured, redrill the fastener holes. If the supports are very wet or rotted, the engine must be removed, and the engine stringer supports rebuilt or replaced.
- Using a tape measure, record the original distance from the engine bracket down to the stringer. If you get the procedure confused, i.e. go in the wrong direction, you have a point of return and can start the process over.
- Open the locking tab (not on all mounts) on the engine mounts that secure the adjusting nuts before moving them.
- When making adjustments keep track of your up or down position by counting each nut flat as you make an adjustment (**11**) (or see "TIP" on page 47). This allows the mount to be returned to the starting position in the event it was moved the wrong way.

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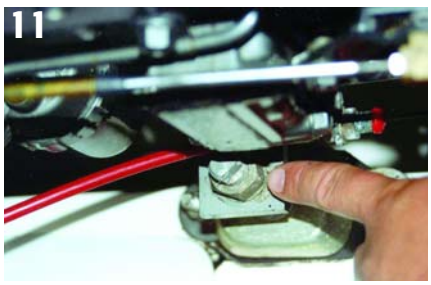

- If you cannot get the alignment correct you may have a failed engine mount or stringer of unequal height. Boatbuilders use a jig available from the engine manufacturer to locate engine mount heights. This tool doesn't measure from the stringer but uses the "X" dimension as a reference point. You'll need an authorized dealer's technician to do this.
- During final adjustments, be sure to lock the top locking nut each time you check shaft alignment. If you don't, the engine can change alignment during final lockdown of the nuts.
- After completing final adjustments, and confirming that the alignment shaft bottoms out (see Step 3), be sure to bend the securing tabs (if applicable) on the adjusting nuts back into place.

STEP 5

With the alignment procedure completed, reinstall the sterndrive according to the manufacturer's instructions, using the proper lubricants. Be sure the bell housing gasket and water passage O-ring are properly positioned (**12**). Coat studs and threads with a suitable lubricant, such as Quicksilver 2-4-C lubricant with Teflon. Coat drive unit pilot, U-joint shaft O-rings and shaft splines with engine coupler spline grease (or equivalent). Don't force the drive unit into the bell housing. If the drive doesn't slide all the way in, you may need to rotate the propeller shaft slightly to align the U-joint shaft splines with the engine coupler splines. Be sure to use new locking nuts to secure the drive, and tighten them following the two-stage torque procedure as described in your service manual. Reconnect the trim cylinders, lubricating components as outlined in your service manual.

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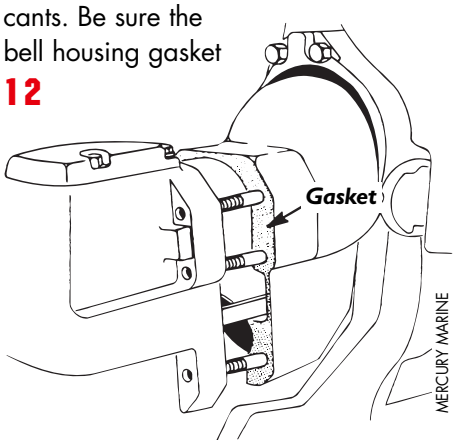


MERCURY MARINE

About the author: Harry Swieca is a certified mairne mechanic and is currently a marine surveyor for Davis & Company.

A BARGAIN AT ANY PRICE

Here's how one intrepid DIYer with vision and determination transformed the hull and deck of a mid-80s production boat. With a plan, the right tools and materials and the know how to use them, he brought this boat to new life as a modern, well-appointed bowrider.

[BY JAN MUNDY] [PHOTOS BY MARK YEATES]

What began as an inquiry on the DIY Technical Helpline in 1999 started a major boatbuilding project for Mark Yeates. A heart attack at 42 prompted his lifestyle change and the quest for a hobby to occupy his spare time during his recovery. Boatbuilding was a natural choice. Yeates worked for an industrial fabrication firm and had previously owned two boats. He purchased for $600 a bowrider hull and deck built in the mid-80s. This was his first foray in boat refitting and he reconstructed "Knotty Thots" from the keel up. He adapted his industrial experience to the project, which is reflected in the non-typical applications of some materials and processes representative of amateur fiberglass boatbuilding. Because of his industrial background, some of the materials and processes are non-typical of amateur fiberglass boatbuilding. A very methodical man, Yeates documented every step, filling two binders with layouts, correspondence with suppliers, building schematics, cost analysis and photos. He perused parts catalogs and boating magazines and toured boat shows for design ideas. Here is his story.

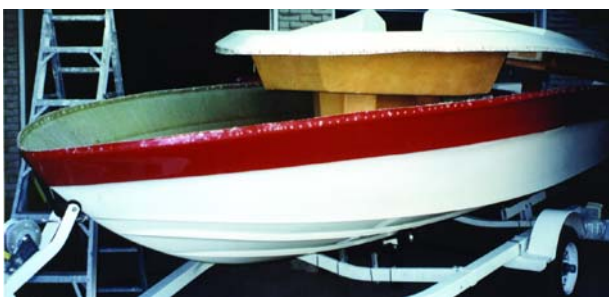
Bought May 1999: A 4.9m (16'3") hull and deck that closely resembles a Sea Ray bowrider of mid-80s design. "A bargain at $600."

Launched June 2000: A family boat for tubing and water-skiing "Knotty Thots" afloat just 15 months later. "I guess it was good therapy cause I'm still feeling good."

Mark Yeates knew that a plan was essential to the success of this project. Every boat project must start with a plan. At least that's the approach Mark Yeates took with his project boat. His first task was to measure and double-checked the length, width and depth of the cockpit, transom and hull. After a preliminary draft, all measurements were double-checked. From this he drew components to scale and began sketching interior layouts, about 10 of them. Feedback from family and friends narrowed the design choice. Wiring diagrams, deck hardware placement and other schematics followed as well as a bill of materials. Since the deck-hull joint was visibly misaligned, he began reconstruction with the disassembly of the deck and hull.

1 After drilling out hundreds of rivets, the deck is lifted off the hull revealing badly delaminated wood in the transom. So bad that water dripped from holes drilled for the eyebolts.

2 After cutting the inside edges of transom with a side grinder with a 14cm (5-1/2") diamond saw blade, the inner fiberglass laminate and



soggy 25mm (1") plywood core are removed, leaving the outer skin intact. Salvaging enough of the bad ply to use as a pattern, the shape is transferred onto 19mm (3/4") marine ply, then two pieces are cut. Ply layers are bonded together with vinylester resin sprayed on with a chopper gun. Once cured, the new transom core is glued to the outer skin with thickened epoxy resin. A new inner skin is built up of vinylester resin with three layers of 1.5 oz. mat, one layer of 24 oz. woven roving, two layers of 1.5 oz. mat followed by 3oz. fine cloth for a smooth finish on the inside. Aluminum angle bedded in silver-colored silicone seals the top edge and provides support for the outboard engine.

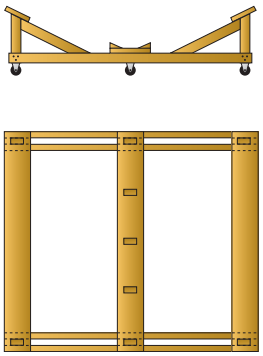
3 Suspecting a waterlogged bilge, the edges of the plywood-over-fiberglass floor are cut cleanly with the side grinder. Lifting the floor revealed water-saturated foam that Yeates freed with a shovel. Two-part urethane foam was then mixed in a pail and poured into the bilge between

the stringers. Expansion of the foam is difficult to control. Too much foam can push the hull sides out. Foam that expanded above the stringers was cut off and the excess tossed into the next section before pouring more foam. As the boat had no limber holes to allow water to flow freely through the bilge to the bilge pump, Yeates constructed a tunnel running from bow to stern made of fiberglass sheet bonded to the hull with thickened epoxy resin and foamed over to give complete floor support. An opening at the stern provides pump access.

4 A new floor is cut of marine plywood, encapsulated in 1.5 oz. matting and vinylester resin and attached to stringers with sealant and fasten-

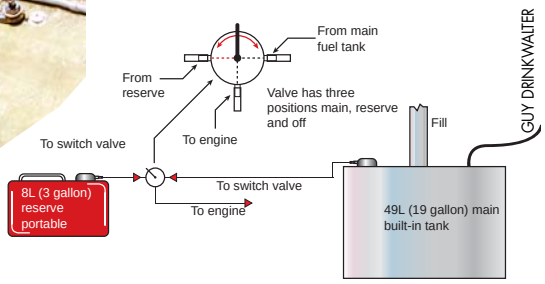
ers. Following his wiring diagram, Yeates installs navigation lights, docking lights, switches, wiring for engine gauges, stereo, horn and other accessories. Conduit protects wires from chafe. Once completed, a new floor is cut of marine plywood, encapsulated in 1.5oz matting and vinylester resin and attached to stringers with sealant and fasteners.

5 Deck goes back on and is riveted to the hull. Original metal rubrail is reinstalled along with a new rubber insert. [For tips on installing rubrails, refer to DIY 1997-#4 issue.] A custom cradle made of wood on wheels supports the hull and makes it very portable.



6 Mold takes the shape of a more modern circular splashwell interior to replace the square one. Once laminated and gelcoated, it's glued to the

splashwell. Next is the installation of a fiberglass grate that allows bilge access, a battery box, built-in gas tank and portable reserve fuel tank, "Just in case I run out of fuel," says Yeates. A switch mounted in the splashwell allows interchanging fuel tanks without swapping fuel lines.



7 Mold construction for interior liner comprised of three sections. Port and starboard are on the right in the photo, transom is on the left. Molds are made of 19mm (3/4") plywood, finished on one side. A larger-than-required size of plywood forms the base. Mold dimensions are penciled directly onto the ply. Components are then constructed from these dimensions and assembled using screws to facilitate removing the mold. "This is

Project Boat

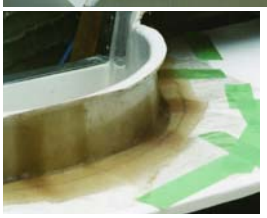
ing and sanding again. Mold areas that are visible receive a coating of black Furan, buffed to a brilliant shine using a medium coarse buffing compound. Next step is to apply five coats of Mirror Glaze mold-release wax, allowing the wax to dry then buffed off between each coat.

a must if you have any area that is an under cut," explains Yeates. Next step is to apply lightweight, sandable filler to form nicely round edges and hide the wood grain. Flexible plastic cut into different radius compresses the filler into the corners.

8 Completed port mold is first sprayed with a 40mils thick coating of Duratec Polyester Surfacing Primer, sanded with 80 grit and finished with 400 grit paper. Some areas required reprim-

9 White gelcoat is now sprayed on, about 18mils thick. Once the gelcoat is just slightly tacky it's time to apply the laminates of vinylester resin and mat using a chopper gun applied to a thickness equal to six layers of 1-1/2 oz. mat. Yeates consulted with a structural engineer for the laminate schedule. For tips on doing this task, see "Molding Parts" on page 55. Molds are left to cure overnight and finished by trimming off excess, grinding edges and sanding off any loose fibers. Molds are now dismantled and separated from laminated sections.

10 Interior liner fits perfectly! Locker tops are cutout. Mylar is placed between the liner sections and the floor, then a fiberglass flange is laminated to the bottom edges of each section. Mylar prevents contact with the deck and allows easy release of the laminated parts. Flange allows bolting of the sections to the floor with stainless steel screws. Interior is entirely modular to allow access to fuel tanks, battery, wiring, etc. It takes less than 30 minutes to remove the interior.

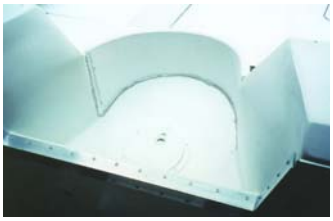


11 The original floor at the bow had a noticeable bow. It was necessary to cut the floor, push it down until level and fasten with screws, then install a new laminated floor constructed

of mat laid over wood and sprayed vinylester resin. After installation, the floor receives a coat of waxed resin, containing 5% parrafin wax dissolved in styrene then mixed in with vinylester resin, and white pigment added. Commonly used by boatbuilders and industrial manufacturers it gives a resin rich, non-tacky surface when added to the final outside layer of mat.

12 Helm seat support roughed in with 3mm (1/8") thick, 15cm (6") wide fiberglass channel (used for industrial walkways). Numerous molded plastic access ports for storage access mounted in the bow and stern. Support will be painted with white polyurethane paint.

13 Proboard, a bendable plastic, is cut then heated with a torch and bent to the needed shape. These form the backrests for the seats and will be covered with cushions. Rot-free, it's a better choice than plywood.



14 Finished curved molded piece is bonded to the splashwell interior.

15 The hull is wet sanded with 600 grit, then 800,

Builders Comments

I estimate the total monies spent on all materials and parts, including the trailer and 150hp engine, at $22,049. This doesn't include a value for my labor as I stopped counting the hours after completing the interior liner molds. I could have bought a new production boat for the same amount or less. But building allowed me to customize the interior, install my own safety standards, gain a hands-on understanding of the workings of all components, and it became a family project that involved my wife Ruth and son Patrick as well. All construction and installations comply with the Canadian Construction Standards for Small Vessels (comparable to ABYC Standards and Recommended Practices for Small Craft in the U.S.) available from the Canadian Coast Guard. Upon completion, I submitted a Single Vessel Data Sheet, survey and other forms necessary to apply for a boat capacity plate, just as a production boatbuilder must do. A label affixed to my boat provides a hull identification number, and notes the maximum weight and load capacity, and horsepower rating.

— Mark Yeates

Materials Bill

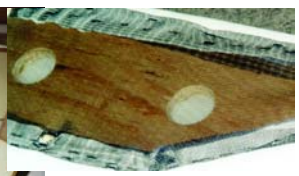
Boat, hull and deck	$600
Hull cradle	$27
Raw Materials	
Vinylester resin, 39L (10 gal)	$360
1-1/2 oz. mat, 4.5kg (10lb)	$31
Urethane foam, 26.5L (7 gal)	$90
Acetone, 19L (5 gallons)	$48
Duratec 3.8L (1 gallon)	$35
Furan 3.8L (1 gallon)	$35
Gelcoat, white 3.8L (1 gallon)	$47
Mold polish	$30
Proboard, black	$68
Waxed resin, 3.8L (1 gallon)	$47
19mm (3/4") Plywood, 1 sheet	$25
Stainless steel nuts and bolts	$14
Lumber for framing	$94
Miscellaneous mixing tubs, paint brushes and rollers, paint and primer, sandpaper, grinding discs, fillers, sealant, masking tape, tack rags	$167
Wiring	
Wire stripper, heat-shrink torch	$43
Fuse and switch panels	$40
Miscellaneous heat-shrink tube, connectors, conduit, wiring, negative busbar, fuses	$177
Tools	
Electric drill, hole saws, drill bits	$68
Staple gun	$49
Miscellaneous	$73
Equipment and Hardware	
Battery box	$12
540 Battery	$65
Bilge pump	$25
Blower	$25
Stainless steel deck steps	$24
Powerlight	$40
Pop-up cleats, 10	$265
Gas tank, 47L (18 gallon)	$150
Gas tank, 6.5L (2.5 gallons)	$35
Tank hold-down kit, tank and deck fittings	$182
Locker doors, 3	$160
Rubrail insert	$40
Fenders, 4	$40
Compass	$55
Horn	$22
Radio splash cover	$26
Speakers	$220
Repair of CD player	$46
Dual cable steering	$500
Ski bar	$175
Black vents	$77
Drink holders	$84
Windshield	$935
Graphics and pin striping	$452
Safety equipment: fire extinguisher, flares, lifejackets, wet suits	$335
Miscellaneous fasteners and hardware	$596
Seats and Upholstery	
Foam, 28kg (61lb)	$153
Vinyl 30m (32.5 yards)	$195
Stainless steel staples, 6 packs	$66
Quilt batting	$61
Fasteners	$10
Adhesive	$25
Plywood, 12mm (1/2")	$15
Carpet	$70
Trailer	
Trailer with load guides and spare tire	$1,800
Trailer hitch	$240
Engine	
150hp	$11,000
Rigging and cables	$300
Prop	$200
(Engine installation by a qualified marine technician)	
Documentation	
Survey	$100
Trailer license	$35
Other Miscellaneous	$1,025
TOTAL	**$22,049**

Note: Prices in Canadian funds

then 1,500 to remove gelcoat oxidation. Green polyurethane paint is applied over the red sheer stripe.

16 Beginning of helm reconstruction, a hole is cut for the Teleflex NFB helm pump. Conduit of schedule 40 pipe runs underneath gunwale on starboard side to house steering cables, engine harness and a messenger line to later route electrical cables as needed. Fiberglass angle on dash top and sides allows fastening of padded upholstery. Plywood pattern of dash is fitted. Dash panel will be constructed of 19mm (3/4") oak.

17 Foam doubles as patterns for the cushions, which are backed with plywood preserved in Thompsons Water Seal. Holes cut in plywood back allow for water drainage and fiberglass bug screen stapled to the back provides good ventilation. Yeates cut all the materials and his wife sewed and assembled the cushions.



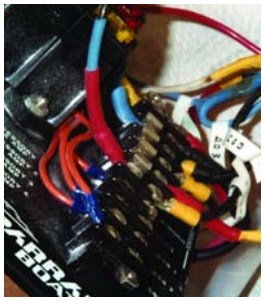
18 Removable ski bar installs between drink holders trimmed in 3mm (1/8") oak. When not skiing, a cushion covers the cavity.

19 Interior liner removed and outdoor carpet installed and glued down with contact cement.

20 Drink holders trimmed in oak, handrails, plastic waterproof speakers and padded walkthrough complete the bow seating area. Same oak trim around drink holders. A filler piece made of oak plywood, stained green and finished with five coats of clear polyurethane is later added. It fits snugly against the upholstered sides and top rests underneath the windshield. Gold vinyl trim available from a lum-

beryard mounted along edge so it doesn't mar the upholstery. Latches release so it folds in half.

21 A SeaRay shaped windshield is a perfect fit. Finished dash includes a compass, 12-volt receptacle for the solar panel (to charge the battery) and other accessories, multi-function engine gauges, and Chaparral rocker switches costing $5 each.

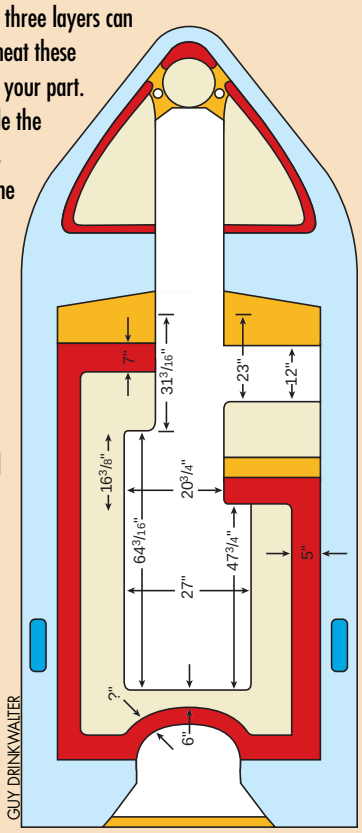


22 Launch day! A mid-80s hull design with all of today's modern conveniences: lounge, bench and helm seating (instead of the typical back-to-back sleeper seats), telescopic Powerlight stern light, pop-up cleats, stereo with CD player, docking lights, custom two-piece swing-down ladder and much more.

Molding Parts

Set up a worktable with all your materials. Since resin seems to track every where, wear old clothes or a Tyvek suit and use masking tape to cover your shoes or slip into plastic bags taped at the cuff. Keep acetone close to clean brushes and rollers; if resin kicks off these become garbage. Cover the table in plastic sheeting, waxed paper or foil. Precut the mat and/or cloth. Don't make the pieces too big, this is especially true for corners as small pieces allow rolling out the air much easier. I made one of the liner parts with sections that were too big, resulting in air pockets on the gelcoat surface that had to be filled and regelcoated later.

I usually work with three layers of 1-1/2 oz. mat at one time. Apply resin, about the size as the piece of mat you are using, onto waxed paper. Place the mat onto this and apply more resin. Follow this procedure for all three layers. Now, roll out the mat so it's saturated with resin and all air is removed. Once this is done, pick up all three layers at one time and place it in the mold and roll out any air. Because vinylester resin is very temperature sensitive, it's best to mix small batches. You might consider making a batch for a gel test and take note of the working time. Repeat this procedure, overlapping the edges of each section, until laminating is completed. In some cases more that three layers can be applied at one time but the heat these layers may generate can distort your part. Now, let the laminate cure. While the laminate is still "green," (mat is flexible but doesn't shift) trim the excess material with a sharp utility knife.



If parts require more material to obtain the desired thickness, rough up the mating surface with 60-grit paper. If lay up is done within a few hours after the first lay up cures, sand very lightly. Sand more aggressively if a few days have passed. Fiberglass dust can be very itchy to the skin and should never be inhaled. Wear long sleeves, gloves and use masking tape to join them. Wear a dust mask and eye protection. When washing, use lukewarm water. Hot water will cause dust particles to sink deeper into skin pores. Always work in a very well ventilated area when using resins.

Reinforce large parts that require extra strength with plywood, balsa or one of the special lightweight foams or cores. When using these materials, first rough up the surface with 60-grit paper. Then mix resin and thicken into a paste with filler, such as microballoons or cabosil. Apply this to the cured laminate and press the core material into it. Add some weight until the paste cures. Then lay up a few layers of mat to secure it in place.

— Mark Yeates

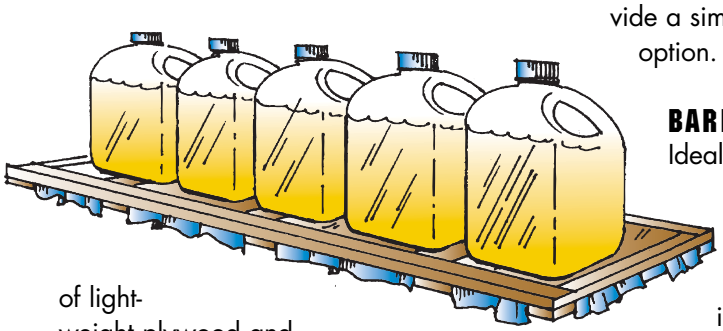
Good Boatkeeping

[BY DAVID AND ZORA AIKEN]

MORE DUCK FOIL

Necessity has sparked a number of solutions, if not actual inventions, to marina ducks taking up residence on swim platforms, many of which have appeared in the "Currents" column in past DIY issues. Here are a few more ideas. A super-simple solution is to cover the platform with a sheet of heavy gauge plastic and seal it securely with duct (not duck) tape. If you wrap the edges like a gift package, most of the tape will stick to the plastic, and you won't have the nasty problem of removing tape adhesive.

Another option is to take some 4L (1 gallon) plastic jugs emptied of their original contents and refilled with water. Line up the bottles near the outer edge of the platform so they are slightly less than a duck width apart. Lastly, build a pup tent



of lightweight plywood and sit it on the platform. (See photo in DIY 2001-#4 issue, page 3.) The sides are too steeply angled for the comfort of a sitting duck.

RAIL CUSHION

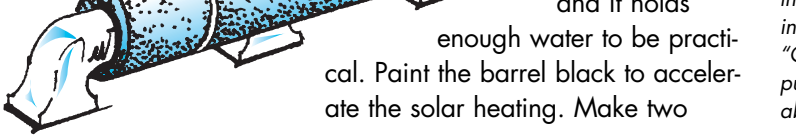
On a boat, foam-rubber pipe insulation has proved useful for handrail protection. Rails are the obvious place for a tarp tie-down, tying spare fuel cans and water jugs, or clipping a dinghy painter at the usual boarding location.

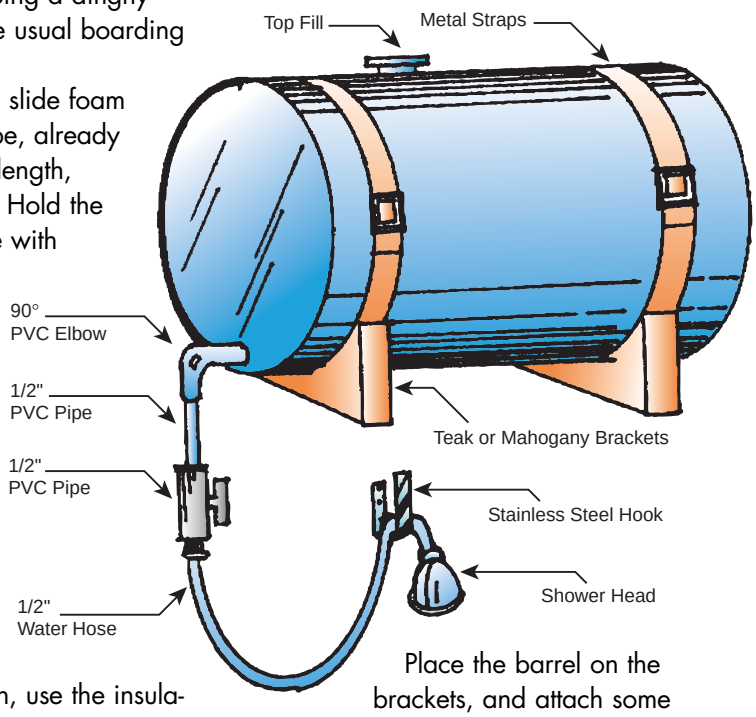
To make, slide foam insulation tube, already slit down its length, over the rail. Hold the tube in place with small cable ties. If you plan to be away from the boat for some time and want to add some UV protection, use the insulation to hide the varnish. Though not as nautical as a proper custom-fitted canvas cover, foam tubes provide a simple and effective option.

BARREL SHOWER

Ideal on the roof of a houseboat, this unfashionable cabin shower design is easily adapted for use on other boat styles, requiring only some simple modifications to the mounting brackets, or installed as a cockpit shower.

Start with a wood, plastic, even metal barrel. A 5L (6 gallon) capacity is manageable and it holds enough water to be practical. Paint the barrel black to accelerate the solar heating. Make two wood brackets, almost flat on the bottom edge to rest atop the roof, and curved on the top edge to match the barrel's shape. Pick a spot over the shower stall or head area and mount the brackets to the roof.





Place the barrel on the brackets, and attach some strapping to secure it to the brackets. Install a fill fitting on the top. Near the bottom of one end, insert a 90° PVC elbow, pointing downward, and attach a short piece of PVC pipe to the elbow. Cut a hole through the roof and feed the pipe into the head area. Seal well with 3M 4200 or equivalent.

From inside the boat, attach a valve fitting to the PVC pipe. Locate this water-control switch convenient to the shower area. Now attach a length of hose with a spray fitting or shower head on the end. Make up this assembly with individual parts, or buy a telephone-style shower attachment. Mount a U-shaped stainless steel bracket on a bulkhead to hold the shower hose when it's not in use.

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.