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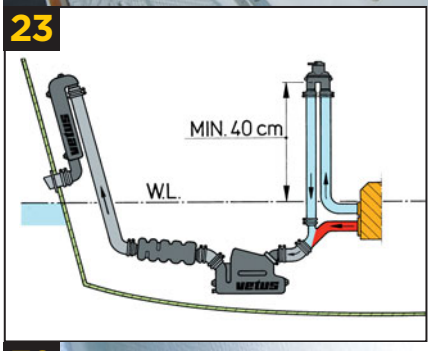

Currents

Edited by Jan Mundy

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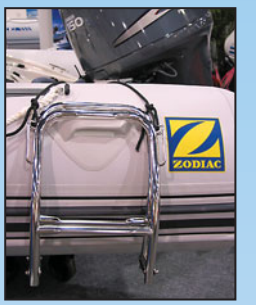
For the Love of Boats

Having lived on the West Coast for many years, Carol and I have acquired a variety of older wooden boats and skiffs and a collection of old inboard and outboard marine motors. The maintenance of this equipment is primarily my responsibility, which is why I await, with anticipation, each issue of DIY both for the technical information and to see photographs of other poor souls stuck working on their boats. Thank you for a great magazine.
Bill Smith, Prince Rupert, British Columbia

DIY EDITORIAL INDEX

Review or print a copy of the complete 1995-2003 Editorial Index by logging onto DIY ONLINE at *www.diy-boat.com* and click on "Archives." Or call us toll-free at 888-658-BOAT (2628) and we'll snail mail a copy.

NEAT BOATING STUFF

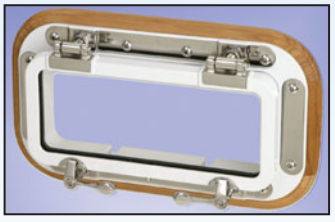


St. Croix's (www.davit.com) folding ladder lets you get onboard your inflatable from the water with ease and grace. Made of 1" (25mm) polished stainless steel, the ladder has three flat, foot friendly steps, grab handles, an adjustable lanyard to secure to the boat and the whole assembly folds for storage.

Sailboat owners with diesel engines as small as 25 hp now have the option of fuel flow monitoring. The new Series K from **Floscan** (www.floscan.com) provides electronic measurements of fuel consumption, measured at the engine, not at the fuel tank. This device determines optimum boat speed under power for maximum fuel efficiency, resulting in a 10% to 30% savings in fuel costs. It also keeps watch over engine and drive train performance by monitoring the optimum speed per hour reading. Easy to install by a skilled owner with simple tools, prices range from US$910 to US$2,290. [Refer to DIY 2003-#2 issue for complete details on installing a Floscan system.]

Is a head refit in your future? If so, look at the latest super bowl: the **Vetus** (www.vetus.com) Hato. This unique MSD hangs on a bulkhead (bracket included), saving valuable space underneath and eliminating the need for a raised platform, a practical solution where floor space is at a premium. Besides, it makes for easy cleaning of the head compartment. This porcelain beauty contains a discharge pump and macerator within its base that's coupled to a small 1" (25mm) diameter discharge sanitation hose. It's available in either 12-volt or 24-volt models, or AC-volt by special order, all which operate on either raw or pressurized water.

Never underestimate the importance of running clean fuel through a diesel engine. Clean fuel improves combustion for more efficient engine operation and power, extends injector life and results in less maintenance. The portable TK-150 from **Algae-X** (www.algae-x.net) cleans tanks and reconditions and transfers diesel fuel. At US$699, it's not cheap but it's a great addition to a club or marina's rent-a-tool program.



You won't need sealant when installing Tri-Matrix ports from **New Found Metals** (www.newfoundmetals.com). These ports use high-density, closed-cell foam that, when thru-bolted, compresses to form a tight, leak-free seal. Hinges and dogs fully adjust for cabin thickness and gasket pressure. Made of 316/316L stainless steel and ASA weather-resistant polymers, either acrylic or laminated and tempered glass lens and a one-piece inner seal that carries a 10-year guarantee, these ports are available in three sizes. The 5" x 12" (12cm x 30cm) port sells for US$166.95.

Without Trailer Assist™

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It happens more often than you know. A couple of feet too far and you're off the ramp, stuck and embarrassed with unhappy boaters piling up behind you. Fortunately, Trailer Assist includes winching your vehicle and trailer out of the mud and back onto the ramp—a service not offered anywhere else.

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CURRENTS

Trojan Owner's Site Launched

A group of Trojan devotees have launched www.trojanownersclub.com to function as a resource for all Trojan yacht owners. The site consists of a message forum, boat reports, boats for sale, newsletters and a member's boat section.

Capacity Regs

The USCG regulations require that monohull boats less than 20' (6m) in length display a maximum weight capacity label. The label is not required on multi-hull boats, pontoon boats (catamarans) or on sailboats, canoes, and kayaks or inflatable boats regardless of length. The Canadian Coast Guard requires a capacity label on all recreational boats 20' (6m) or less that are fitted with (or capable of being fitted with) a 10 hp or larger engine. Make sure you know your boat's capacity. While the law addresses only small boats, the dynamics of weight distribution affect the handling of all boats to some extent. For further information on trim and weight relationships, read Roger Marshall's "View from the Stern" column on page 64.

Structural Bulkheads

I was all the way to the last page of DIY 2003-#4 issue before I could find a problem. In "View from the Stern," Roger Marshall suggests that an owner can replace a bulkhead with honeycomb board. Though he cautions to do it only to a non-structural bulkhead, most owners simply won't know what is structural and what is not because they do not have the design knowledge. In today's plastic boat world, problems already exist regarding poor interior structural bracing, especially in cheaper boats. Owners already play fast and loose with "handy holes." Maybe a stronger caution would be in order to get professional advice first.

— Donald Bell, Bell Associates Yacht Survey and Appraisal, Seattle, Washington

Roger Marshall responds: *When I wrote the piece, I hadn't thought that a reader would tear out a perfectly good bulkhead and install a foam cored one. I presumed that a reader who was in the middle of rebuilding a boat might want to investigate the weight advantages of using a cored bulkhead. Depending on the material used for the core, the tensile and bending strength of a cored bulkhead could be equal to or exceed the strength of a solid plywood bulkhead, although the compressive strength may be slightly lower. In hindsight, I should have suggested that a reader who is rebuilding a boat would be wise to consult an engineer to work out the loads and placement of structural members to ensure that a cored structural bulkhead is adequately reinforced. In writing this piece, DIY ran out of column inches before I ran out of words so this point may not have been clearly made. Maybe this wasn't clear in the story which was already many more words than the editor wanted me to use.*

Where's the Magazine ID?

I recently picked up DIY 2003-#3 issue at a local West Marine and it was a pleasure to read the magazine. I initially couldn't find the issue number or date on the cover anywhere but then noted it on the first page. I then checked an issue from 2002 and it too was missing a date. Is there any reason for this?

Bulter Smythe, Annapolis, Maryland

We dropped the cover date in 2001 due to confusion with newsstand dates. You'll find the magazine date on the Contents page as well as at the bottom of every page.

DIESEL BEATS OUT GAS

"What is your boat's primary engine?" was the recent question posted on DIY ONLINE. Not surprising, 30% of all respondents had diesel-powered inboard engines and 2% with the hybrid diesel sterndrive. Gas engines where split into inboards at 22%, sterndrives at 20% and outboards at 23%. Jet drives accounted for 2% and electric for 1%.

To cast your vote in our new poll, log onto DIY ONLINE at *www.diy-boat.com.* Results are posted in upcoming DIY issues.

DIY boat owner the MARINE MAINTENANCE MAGAZINE

Publisher & Editor: Jan Mundy
VP Sales & Marketing: Steve Kalman
Designer: Joe VanVeenen
Illustrator: Sacha
Webmaster: Jeff Kalman
Circulation: Britton Hardy
Copy Editing: Patricia Kearns
Technical Advisor: Recreational Marine Experts
Cover design: Joe VanVeenen
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Wanna Install a Bow Thruster?

Most specialty jobs demand custom tools and few jobs are as challenging as a bow thruster installation. Cutting the thru-hull hole for the bow tunnel demands tools, gigantic tools. Check out these tools used by Florida Bow Thrusters in Cape Canaveral, Florida (www.floridabowthrusters.com). First, there's the drilling of a pilot hole with a 1-1/2"- (38mm-) diameter, 7' (2m) long bit on a 3/4" drill. Then the hole is cut using a hole saw that measures 13" (33cm) in diameter, 24" (61cm) in length. Cutting a hole of this size in your boat is certainly not a job for the inexperienced (or the timid).

— Jan Mundy

FLORIDA BOW THRUSTERS

Tech Tips, Impeller Wrap Plus

In the DIY 2003-#4 issue "Tech Tip" column, a reader offers a tip for impeller installation so the blades don't turn backwards. When installing a brand new impeller this would not be a problem. After installation, use a pair of needle nose pliers to correct the problem blade by turning it in the proper direction. When reinstalling a used impeller, a blade that was similarly corrected would eventually revert to its previously backward attitude and failure would be imminent soon after installation. Prudent boaters should replace an impeller every season. The “cost” of the job is in the labor and, since you’re in the pump already, why not invest a little extra for the peace of mind that a new impeller will bring to the job. Also before installing an impeller, put a light coating of multipurpose grease in the pump housing. This will ease insertion of the impeller and help prevent a dry start.

— Peter Godwin, Ontario Boat & Engine Works, Orangeville, Ontario

DIY WINS WRITING AWARDS

At the annual writing awards, conducted by Boating Writers International, DIY columnist Nick Bailey received a merit award for “School of Hard Knocks,” (DIY 2003-#2 issue) in the Boat/Engine Care and Maintenance category. In the Technical Writing category, Nick scored a 3rd place for “Close Encounters” (DIY 2003-#3 issue). In past years, DIY writer Susan Canfield, a SAMS-certified marine surveyor and owner of Marine Associates, a surveying firm in Annapolis, Maryland, won 2nd place in the Technical Writing category and a Genmar Trophy honorable mention for "Fire Onboard," which appeared in DIY 2002-#3 issue. DIY's Editor Jan Mundy received 3rd place honors for "Teak 101," in the Boat/Engine Care and Maintenance category, which appeared in DIY 1998-#2 issue.

WHAT OILS FOR YOUR OUTBOARD?

Motor oils sold for today's outboard engines have become product specific.

CURRENTS

Mercury, for example, offers several different oils for its products based on the age, fuel system and, of course, cost. For an older outboard that uses a 24:1 oil ratio, there is no advantage in using expensive oil designed for a Mercury Optimax. On the other hand, I would not trust a low-cost generic oil to protect my new 2004 $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, there is likely a catch. Ensure that the oil you purchase is recognized by the NMMA or engine manufacturer as acceptable.
— Steve Auger

IT'S NOT THE SECOND HAPPIEST DAY

The purpose of this writing is to clarify a myth about the two happiest days of a boater's life. My wife, Kim, and I recently accepted a position with my company to

transfer to the Los Angeles area. After a great deal of consternation, calculation and looking for boat slips we decided it would be best to sell our newest and most enjoyable family member, our 1985 Sea Ray Express, "Bearboat." Contrary to the popular myth, this was definitely not a happy day.

About two years ago, we were interested in buying a boat (instead of a cottage) and ended up with what turns out to be the first real hobby I have had in my 50 years of life. "Bearboat" was a lot more boat than we had considered but as the then owner told me, "bigger is better," we went for it. Since then, I've recorded the completion of over 100 projects in my maintenance log. I have been twisted, contorted and stuck in positions I never thought these old bones could muster. I have learned so much about how boats work and what makes them not work. I have repaired things I never would have dreamed of tackling before.

In the final analysis, everything that came up in my original survey was corrected, repaired or replaced. In addition, I completed numerous other projects that I believe would amount to a fairly complete restoration. Through the course of this wonderful journey, I can't begin to tell you what a tremendous resource DIY magazine, your technical line and DIY's MRT CD-ROM's have been to me. I have been in some tight situations where I was hearing a number of different repair strategies from various resources. With the wealth of experience DIY offers, I usually defaulted to your opinion and with great results. You saved me tons of headaches on so many different issues and put me on the right path. Whether a boat owner turns their own wrenches, does light maintenance or hires the work done, the information DIY provides makes you a better mechanic, owner or check writer. Considering the cost of owning a boat, everyone should have DIY Magazine and all the services you offer in their toolbox.

(continues on page 8)

Crystal-Clear

If you attended a boat show this past winter you likely noticed a radical change in gelcoat hull colors on new boats. Dark, solid colored hulls are out. Baby blue, melon orange, ashen yellow, tan and white with black and blue accent colors are in. Of course, you already new this after reading the report in DIY 2003-#3 that manufacturers would switch to more conservative colors for the 2004 models.
— Jan Mundy

SHOWCASE YOUR BOAT ONLINE

We are in the process of refurbishing our 1987 C&C 39' (11.8m) Landfall. Thanks to your magazine, we ordered the Peeler for the hull, which had a serious blister problem, and ordered DIY's MRT "Blister Repair" CD-ROM. The Peeler (www.claresmobile .com) worked like a charm; very easy and very clean after hooking it up to a vacuum. I've just finished stripping, cleaning and sanding the salon table and coating it with Cetol Clear Gloss. It came out great but definitely yellowed with the oil-base finish. Now I'm working on the salon stairs. I wrote to Ultimate Sole (www.ultimatesole.com) and will probably order the product to do the stairs and the floorboards. I plan on taking all the doors and drawers home to work on the wood. When the weather warms up, I'll begin to refurbish the salon interior walls. On our last boat (a 1984 Catalina 30, which we totally gutted), I used Cape Ann to do the interior and it came out great. (It only took every weekend 8 hours a day for 6 months to complete). I really want a high-gloss finish but will settle for a water-based product since I know it won't yellow. I really enjoy all this hard work though my work conditions are not the best (backyard or den, depending on the weather).

Dawn K Bohnenberger, E. Ship, New York

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(continued from page 6)

So, this was not a happy day, it was a sad day. Like saying good-bye to a trusted old friend. A wonderful retreat where I found peace in my heart and met some of the best friends of my life. In fact we sold the boat to our friends Bob and Debbie. They were as excited to take delivery, as I was sad to see her go. Bob has promised to keep "Bearboat" clean and in good repair. Thanks very much for your assistance throughout this most excellent adventure.

Jim Discher, now living in Long Beach, California

The first time DIY heard from Jim he emailed the Technical Helpline asking for information on a leaking stuffing box. During the past two years, Jim contacted DIY numerous times looking for expert help. As a new boat owner, his enthusiasm was invigorating, especially on the long nights when we burned the midnight oil to get an issue on press. We hope to see him on the water again.

PRODUCT SUPPORT EXCHANGE

After reading the article in DIY 2003-#4 about the great help given to one of your readers by Seaward Products, I just had to write about Katadyn North America (www.katadyn.com), suppliers of PowerSurvivor watermakers. My first contact with them was in 1996 when I purchased an Endeavour 42' (12.6m) cutter equipped with an 80II E Pur watermaker. It made freshwater but (after inspection) I found it had a scored ceramic piston. At that time, Pur (now Kataydn) sold me a complete new piston and powerhead at half price to replace the bad one that came with the boat even though the malfunction was not its fault. I was on the boat this winter (7 years later) and found that a pump O-ring seal was leaking. The rebuild kit sent to me from some place in Maine had the wrong size seals in it (serial # 865 and lower take a larger type). I located an O-ring that would fit at a local Yamaha dealer so I could at least put my unit back together. During reassembly, I tightened the piston head onto the push rod too far and a small portion of the black Teflon that coats the rod chipped off. Of course, this made a new leak (different from the O-ring leak) around the rod, which didn't take long to totally ruin the shaft seals. Upon returning home, I contacted Katadyn and explained all of the above to the VP of sales. He proceeded to find me the correct seals and even sent a new piston and a new redesigned rod without the Teflon coating on it. All of this at no charge! Now I know why good companies succeed.

— Dan Bomgarden, Winnebago, Illinois

If you have experienced either excellent or very poor service with a manufacturer, retailer, repair yard, etc., email your comments to the editor at tech@diy-boat.com or send snail mail to: In the U.S.: JM Publishing, P.O. Box 1072, Niagara Falls, NY 14304; In Canada: JM Publishing, P.O. Box 118, Lindsay, ON K9V 4R8.

DOUBLING HOSE CLAMPS: Fact Or Fiction?

Putting two clamps on a hose is certainly a good thing for clamp manufacturers but when is it really necessary or even required?

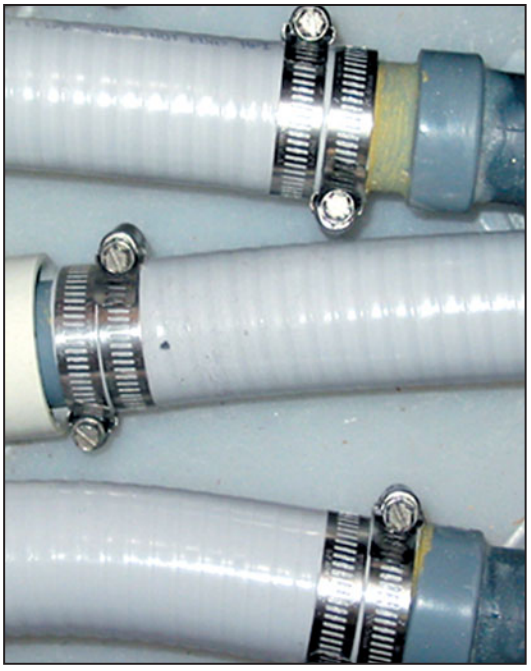
By Patricia Kearns

"Double clamp all hoses connected to thru-hull fittings." The foregoing directive is almost a standard phrase in marine survey reports. It's one of those things that we expect to see and respond to with alacrity to make sure that our boat is "safe."

If we accept that double clamping hose is a good thing, a necessary thing or even a mandated task, then we get out the box of clamps and get to work. If we have an inquiring mind, we might also ask, "Who says double clamping is a good, necessary or required thing?" It's a good thing because it sends us to the innermost reaches of our boats to check on clamps where we may likely find some broken or rusty ones and other nasty things like a mushy or chafing hose, a leak, a corroded seacock, et al. That proactive errand alone is a good thing. The question remains, "Is it required or do we double clamp because we have always done it?

Doubling hose clamps is an accepted marine practice that evolved from the times when hose was slipped over the end of a smooth pipe or pipe fittings before the widespread use of barbed fittings and tail pieces. The use of two clamps better assured that the hose would stay on the pipe. That's it. Simple enough and a "belt and suspenders" habit that continues in good marine practices today.

"Who says?" Have you ever tried to pull a hose off a barbed fitting? Today's boat and yacht piping systems, including fuel systems with two notable exceptions, use smooth pipe and hose. Getting a hose off a modern barbed fitting is a Schwarzenegger effort. Question? So, why the clamps at all? Answer? It's good marine practice but there are only a few connections that actually require double clamps.



Install lamp screws as shown instead of inline to distribute loading and stress on the hose barb.

The only U.S. law on the matter is found in Code Of Federal Regulations (CFR) 183.564 and it relates solely to a gasoline fuel tank fill system. "… (b) Each hose in the tank fill system must be secured to a pipe, spud, or hose fitting by:

(1) A swaged sleeve;
(2) A sleeve and threaded insert; or
(3) Two adjacent metallic hose clamps that do not depend solely on the spring tension of the clamps for compressive force.

There are only two places where ABYC standards require the doubling of hose clamps. You must double-clamp hose-to-pipe connections in engine exhaust systems and at the connections for the fuel tank fill hose (gasoline [same as in the CFR] and diesel). That's it! The rest is in the legends of "good marine practice."

Here's a little hitch in the tradition. There are situations where doubling clamps is not a good idea and that's where the addition and tightening of a second clamp will impinge on the hose and the clamp edge will actually cut the hose. This occurs when the pipe or tailpiece nipple is too short to allow for two adjacent clamps to secure the hose to the pipe end. Be careful when you're being careful. Sometimes, more is not better and sometimes, less is more.

About the author: Besides being DIY's proof editor, **Patricia Kearns** formerly was an assistant technical director of ABYC. She is a NAMS certified marine surveyor and operates Recreational Marine Experts Group, a marine surveying and consulting firm based in Naples, Florida.

Talkback Q&A

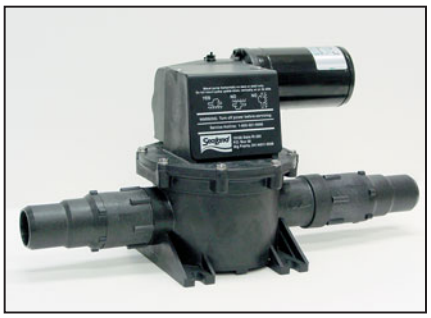
Helpline 1-888-658-2628

Finding Flush Fault

Q: My Sealand Vacu-Flush toilet keeps popping the circuit breaker. I found loose wires at the circuit breaker and tightened them but cannot locate the vacuum pump on my 1988 Formula 29PC. The unit's operating light dims on and off as it works, even when connected to shorepower. How would you recommend I go about troubleshooting this problem? Can the pump get clogged by something?

Tim Wenham, "Diver's Dream," Cleveland, Ohio

A: I discussed your problem with the "head" man, Mike Starito of Northeast Sanitation in Farmingdale, New York (www.northeastsanitation.com). Here's the official answer. "If the toilet is no longer operating and flushing, check for loose wires on the vacuum switch near the pump. A bad connection builds up resistance. Measure the amperage to the motor using a multimeter. It should pull a maximum of 10 amps. The circuit should also have a 10-amp breaker, so check the breaker. If you're pulling



more than 10 amps, you likely have a clog in the bellows in the vacuum pump. When clogged, it doesn't allow the motor to compress, which puts extra load on the motor, increasing the amperage and activating the breaker (a safety feature). So, you need to locate the pump and remove its cover. Before you don the gloves and mask, try this simple trick. Fill the toilet with hot water and flush. Do it again. This might eliminate the clog. This will only work if you used marine grade or RV toilet paper, which is water soluble. If however, you didn't use biodegradable paper, standard household paper can build up in the folds of the bellows, clogging the piping and stalling the motor. When this happens, the only remedy is to physically remove the buildup. Remove the cover over the bellows and go digging. Wear rubber gloves and eye protection when doing this job."

— Jan Mundy

AC and Vented Loops

Q: My 1998 express cruiser has a factory-installed Cruisair air conditioning and heating unit (AC). When cruising, the water is sucked out of the hoses and, when the boat stops, the water refills. Most times, this action forms an air pocket that prevents water from flowing through the recirculating pump. I have to remove the hose on the outside of the pump to let the air escape so the AC restarts. I have tried the following modification but without success: removed the strainer and extended the hose from seacock to pump (all are below the waterline); extended the hose vertically adding a reverse P-trap; and extended the hose vertically so it extends above the waterline and added a barb tee, which did help to release air but also introduced new air into the system. After reading your article on vented loops (2003-#3 issue), I'm wondering if this is a good fix for this unit.

Al Solari, "Cha Ching," Chrysler Park, Ontario

A: The basic problem is your AC system's centrifugal cooling water pump. Centrifugal pumps are not self-priming and should always be installed below the liquid level they are to pump. In your situation, the least expensive alternative would be to install a check valve

between the sea strainer and pump. The check valve would prevent a loss of prime after the pump shuts down. However, if the check valve gets clogged with debris it will leak and you'll have the same problem as before. You might, therefore, prefer to replace your AC system's present pump with a self-priming flexible-impeller pump. Should you choose this latter alternative, ask Cruisair's customer service (Tel: 804/ 746-1313, Web: www.tmenviro.com) for their pump recommendation. Vented loops (siphon breaks) are designed to admit, not release, air.

— Susan Canfield

Reading Moisture Meters

Q: I'm in Mexico working on my Freedom 39 balsa-cored blistered hull. When it was hauled out, the gelcoat was ground off, exposing hundreds of small blisters. Using a GRP 33 moisture meter, above the waterline are readings of 7.5 or 8 on the fiberglass scale. Some places below the waterline have identical readings but others are higher, 11 or 12. Higher numbers are also seen on the keel, which is lead encased in fiberglass. The service people say the readings should be below 5 before a barrier coat is applied, but between 5 and 10 would be okay if absolutely necessary to proceed. I'm skeptical of the yard's readings because of their lack of experience with cored hulls and because I'm not sure about their competence with the meter.

David Jensen, "Hopalong," Sacramento, California

A: I use a GRP 33 from J.R. Overseas Company almost daily. The moisture meter is a simple tool to use: hold it against the hull, press the button, and get a reading. I have found them to be trustworthy provided the meter is calibrated. The GRP 33 has a Plexiglas and copper calibration plate included with the kit. Regardless, the readings you report from your hull and topsides are much like what I'm used to seeing everyday. Ideally, you want to see the same reading below the waterline as one taken on the hull side a couple feet above the waterline, usually less than 10% on the wood scale. I have never seen any lam-

inate dryer than 3% on the wood scale. The readings you quote sound quite typical for a boat in the process of drying out. Ideally, a boat hull should be at 5 but getting to those last few low points on the meter can take a long time to achieve. The dryer the boat is when the bottom is resealed, the longer the hull will go before it blisters again and the more minor the blisters. In practice, if you can get the hull below 10 and within a point or two of the topside readings, you can push the envelope and proceed with sealing the bottom without incurring too much additional risk. Nonetheless, dryer is better. Lead or any metal within 1" (25mm) or so of the meter will give a high reading, as the meter is a electromagnetic device and is sensitive to any conductor, Including water trapped between the ballast and the skin. If in doubt, you should drill a limber hole to drain this area and glass it up later. Balsa core may or may not contribute to higher readings but it doesn't make any difference. You still want to see those magic "dry" numbers on the meter before you proceed. After all, the balsa core is part of what you are trying to dry out here. If it's wet, (25+) the hull won't dry out without special treatment, e.g., the Hot Vac system or even core replacement. If it's damp, (15 to 25) it will really slow the drying process. A GRP 33 meter reads to a depth of about 1/2" (12mm) so it will register the core moisture. Try to find a spot on the hull that is not cored

Talkback Q&A

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(often near thru-hulls) and take a comparison reading. Also, try taking a reading on the inside of the hull to compare. If you get a similar reading to the outside, you can assume the core is as damp as the outside skin. If not, the outside skin is where the moisture is concentrated. Another way to get hard data is to take a core sample (shown in top photo, previous page) from the inside in the wettest spot you can find. Drill a shallow pilot hole into the inner skin only (try to avoid making work for yourself by cutting all the way through). Remove the pilot drill from the holesaw mandrill and, with the holesaw, cut through the inner skin and core. Stop when you feel it bottom out on the outside skin. Pry or chisel out the "coupon" of inside skin and core only. Check the coupon and the remaining outside skin immediately with the meter or have the yard do this when you are there to see the results first hand. This way you have separated the hull elements and can analyze them, each isolated from each other. It's frustrating waiting for a boat to dry out. Like many aspects of boating, patience will be required.

— *Nick Bailey*

Restoring Hull Bottoms on Dry-Stored Boats

Q: The bottom paint on our recently purchased 1998 Maxum 2800SCR is in good condition. We were told that, since the hull bottom, when new, was sanded before the first bottom paint job, we now must maintain it with frequent paint jobs. As the boat is used primarily in the freshwater sections of the Potomac River and stored on a lift in a slip, must we paint it?

Alan Gorenstein, Potomac, District of Columbia

A: According to Jim Siedel of Interlux, when a boat is not kept in the water there is no need for antifouling paint. Over time, however, the existing paint will begin to fade and chalk. This is an aesthetic problem only and, while it doesn't harm the hull, it may damage

people's clothes if they come in contact with it. Use a paint remover (e.g., Interstrip 299E) to remove the coating. To remove the leftover stain in the gelcoat, blend 299E and 399 at a 50/50 ratio and apply while agitating the surface with a ScotchBrite pad. Next, compound the hull, follow with a glaze (e.g. 3M Finesse-it II) and then wax. These photos from Interlux show the steps involved. In the bottom photo, the boat looks brand new. If you decide to paint but don't wish to do this on a routine basis, Jim recommends using a hard paint, such as Fiberglass Bottomkote or Fiberglass Bottomkote Aqua, both of which retain their color longer than ablative or copolymer paints.

— *Jan Mundy*

More Pump Power

Q: I have a second water tank located about 12' (3.6m) from the water pressure pump. The hose runs downhill, except the first 2' (.6m), which is vertical. Both tanks connect to a manifold and there are no leaks. Water flow from the faucets is very poor. Seems like I need more suction but the pump allows for a 12' (3.6m) draw. What do you suggest for more psi?

Stephen Camp, "Argo," Greece

A: When DIY contacted Dick Lee at Flojet (www. jabsco.com) on Steve's behalf, we received this prompt response. "The simple fact is that pumps push much better than they suck. Pump suction is limited to atmospheric pressure that is about 15 psi at sea level. The length and size of hose is critical. For a 12' (3.8m) run, 5/8" or 3/4" (16mm or 19mm) should be adequate, as smaller hose increases pressure drop and causes a loss of flow. Any connections between the tank and the pump also reduce pressure and flow, unless they are full hose inside diameter."

Tips for Removing Non-Skid

Q: I plan to replace the original Treadmaster on my 1988 Fisher 34 motorsailer. Any advice on getting the old non-skid off?

Norris Y. Palmer, "Sweetwater," Grapevine, Texas

A: I've installed a synthetic non-skid but never removed this material so I forwarded Norris' letter to Plastimo USA, distributor of Treadmaster (Tel: 866/383-1888, Web: www.plastimousa.com) and received this reply from Steven Paley. "Unless Treadmaster is chipped along its edges or otherwise torn, it may not yet need to be replaced. Sprucing up its appearance with TreadCote, our proprietary rejuvenator, may prolong the life of heavily weathered or stained decking for another five

years or more. If it is truly time to replace it, however, you've also come to appreciate that Treadmaster's renowned durability makes the job a bit challenging. The proper way to remove old Treadmaster is by abrasion, that is, grinding and sanding. For this, you'll need a variable-speed angle grinder or sander/polisher tipped with a 10" (25cm) soft foam pad. A variable-speed belt sander can be useful at the intermediate stages and a small palm sander and hard hand sanding block will help with the finishing sanding. In addition, you'll want a variety of sandpaper disks, belts and sheets ranging from 40 to 100 grit. The large, flat areas that Treadmaster normally covers on deck are easy to tackle with the grinder. The trick is to remove all the Treadmaster and rough up the underlying layer of adhesive without gouging the deck material underneath. If the builder used epoxy adhesive, this should be relatively easy. If contact adhesive was employed, your wicket might be a bit stickier. Some pros prefer to just grind the top surface of the old Treadmaster away, sweeping the area with a belt sander and finer grit to remove the remainder. The devil, however, is in the edges. Great care must be taken not to scar adjacent flat areas, deck hardware or woodwork with coarse abrasives. Masking off painted or gelcoated surfaces at the edge of the Treadmaster helps, of course, but tape is no match for a 50-grit wheel on a grinder. One pro uses very thin pieces of sheet metal held with weights butted to the Treadmaster to avoid accidental brushes with nearby areas. Another uses an arsenal of scrapers, chisels and utility knives to cut the Treadmaster away in delicate areas. But there is no substitute for time, patience and hand sanding along the edges. One trick the pros use to alleviate the painstaking work along the edge is to cut the new sheet of Treadmaster 1/4" (6mm) larger than the old one in all directions. This way, the new sheet covers the old glue line and any blemishes along the edge. There is a certain beauty to all this sanding. Since the deck areas need to be roughed up prior to installation of the new Treadmaster, consider your work to be as much surface preparation as removal. Don't worry about normal scratches since epoxy adhesive will cover those. All you need to do before laying your new deck is to fill any deep gouges with epoxy putty and sand smooth. Your new Treadmaster should see you through at least another 15 years."

— Jan Mundy

[Ed: Refer to DIY 1998-#3 issue for details on patterning, cutting and laying new Treadmaster.]

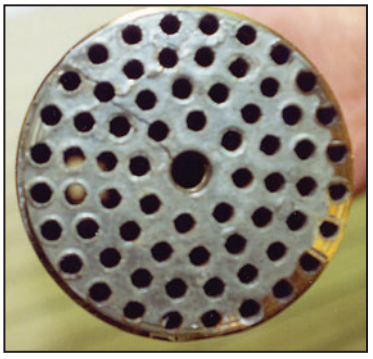
Boring Heater Cores

Q: At what temperature does silver solder melt? My heat exchanger core is plugged and I can't flush it so I want to heat it until the seaweed burns? Or do you suggest another method?

Gerald Loranger, "Dianna Marie," Prince Ruper, British Columbia

A: Caution! You are walking on thin ice! Volvo coolers and exchangers are made of many different materials. The tube bundle is a copper material, likely cupronickel, which is a little tougher than the standard copper used on many exchangers. Since the tube bundle is secured with silver/copper/phosphorous type of brazing alloy, the temperatures to melt this solder are between 1,190F to 1,500F (643C to 815C), much higher than standard silver solder. If the tube bundle is removable from the alloy housing, have it "cooked out" at a radiator shop. Don't use acids around the aluminum alloys. That's a deathblow. As a last resort, try the old-fashioned wooden dowel trick. Pass a dowel of the proper diameter gently through one tube at a time. A small gun bore cleaning brush also works well. Go gently into that cooler.

— Bob Smith

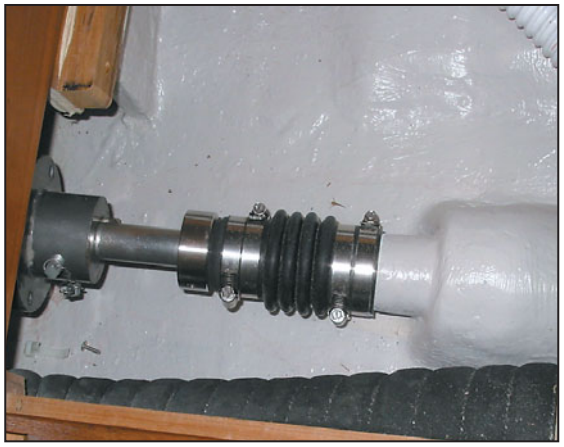


Shaft Vibrations

Q: I have an almost 11' (3.3m) long, 1.25"- (3cm-) diameter shaft that has vibration problems at times. It all started when I replaced the stuffing box, which supported the middle of the shaft, with a PSS dripless shaft seal. The Pathfinder engine has a Drivesaver and the strut is at the outboard end, within 1" (25mm) of the Max-Prop. Engine alignment and cutlass bearing are both good. The shaft was replaced due to corrosion under the cutlass bearing (the boat had no anodes when I bought it) but it didn't change the vibration problem. Vibration only occurs when I slow down then accelerate. If I slow down to 2 knots or less and accelerate again, I don't get the vibration. When the vibration occurs, boat speed is about a 1/4 knot less at the same rpm. The problem gets worse when sea growth adheres and unbalances the shaft, so I clean it often. The Max-Prop has 2,500 hours since the last rebuild and there's more play in the blades than I'd like. I'm sure the problem is caused by the long shaft unsupported in the middle and made worse by the looseness in the Max-Prop

blades. I thought of mounting another cutlass bearing in the stern tube, but the clearance is insufficient. Any other ideas, other than to go back to the original stuffing box?
DIY reader via email

A: When DIY contacted PYI (www.pyiinc.com), distributors of the Max-Prop and PSS shaft seal, we received this prompt response from Fred Hutchison. "From your description, I suspect that the original standard stuffing box was acting as a support bearing for the shaft. When the PSS shaft seal was installed, it removed any support from the shaft and this is the likely reason for the shaft whip. The rule of thumb for unsupported shaft length is 40 times the diameter of the shaft. So, for your 1.25" (3cm) shaft there should only be 50" (127cm) of unsupported shaft. While this calculation can be exaggerated, you currently have 132" (335cm) of unsupported shaft. A stuffing box has very little contact on the shaft and should never act as a support bearing, which would more than likely wear a grove into the shaft, as if the packing is too tight. The proper method to support the shaft is with a cutlass bearing at the inboard end of the stern tube or a pillow-bearing forward of the PSS seal inside the boat. This bearing should be as close to the center of the shaft as possible for the most benefit. As a point of reference, there is a cutlass bearing that has a 1.25" (3cm) ID and a 1.5" (3.8cm) OD that should fit in your stern tube. The play in the Max-Prop may contribute to the problem of shaft whip, but it's more than likely not the primary issue."



Drive Lubrication

Q: I would like to use synthetic motor oil and lube in my 1992 Mercruiser 5.7 with a Bravo II drive because I believe there would be advantages in ease of starting and longevity, all the good things about synthetic oils. The cost would be manageable since I only use the boat recreationally and change these fluids once per year. My concern is that I haven't seen any studies or data where this has been done and I've never seen Mercury suggest the use of synthetic oil. I would think synthetic use in the engine wouldn't be a big problem but I'm not so sure about the sterndrive. I suspect Mercury has some kind of additive package in their lube (it smells awful) that may or may not be required in a synthetic lube.
Dan Montague, New Freedom, Pennsylvania

A: Your question is one that has been asked many times since the introduction of automotive synthetic motor oils. The key to the phrase is "automotive synthetic motor oil." Mercury Marine issued a service bulletin in October of 1997 in connection with Mercruiser gasoline engine oil recommendations. The recommended oil for your engine is Mercury or Quicksilver four-cycle 25w40 marine engine oil. Mercury 25W40 oil is a blend of straight 25 weight and straight 40 weight oil designed for use in marine engines. If this was not readily available, a high quality SAE 30W detergent automotive oil with an API service rating of SH,CF/CF-2 could be used. The use of non-detergent oils, multi-viscosity oils, synthetic oils, low quality oils or oils with solid additives is specifically not recommended. Though I have not seen any lubrication failures due to the use of synthetic oil in a Mercruiser engine, my advice is to stay with the Mercury 25w40 for your engine and Mercury High Performance Gearlube for the sterndrive unit. Change them both every 100 hours or annually and you'll not have any oil based lubrication failures.
— Steve Auger

Tech TIP

PROLONGED CRANKING SOLUTION

If your diesel engine doesn't start right away, close the raw-water intake valve (seacock) to the engine. Continuous cranking will pump seawater into the waterlift muffler, putting your engine at risk of ingesting water from the exhaust system backpressure when the engine does start. Closing the water intake to the pump prevents the seawater pump from pushing water into the waterlift. As soon as the engine starts, turn on the valve so the water pump restores the cooling water flow, which will then circulate and be discharged overboard along with the exhaust gases.

Hal Roth, "Whisper," St. Michaels, Maryland, from the book, "How to Sail Around the World."

BUMP-N-GRIND NO MORE

To prevent fenders from rolling away and shifting when your boat is tied to a dock, rig a fender board made of StarBoard or a pressure-treated 2x4, drill holes in the ends, attach some line, position outboard of the fenders and fasten the board to stanchion bases or deck cleats. The fenders will ride vertically between the boat with the board taking the pressure at the dock piling.

OVERHEATING GET-HOME RIG

When your engine starts overheating and you go below to find that your raw-water intake pump is not working, you can remove the freshwater system's electric pressure water pump or a bilge pump or any other electric pump and rig it between the raw-water intake and your engine's cooling system, bypassing the broken raw-water intake pump. You can make this trick even easier by setting up an emergency kit with the right diameter hoses, cut to the right length, ready to connect to the selected pump and the engine and you're good to go.

DIY reader via email

BACKFIRE BLUES

When one of my boat's Crusader engines developed an intermittent backfire once warmed to operating temperature, and I suspected carbon buildup in a cylinder causing premature ignition, spraying a can of ValvTect De-Carb through the carburetor per the label instructions cleared up the backfire.

Paul Seifert, "Lil rivet," Cape Haze, Florida

BRUSH CLEANER

Paint brushes that have hardened can be usable again if you soak them in Interlux 202, a solvent based product sold to clean bare fiberglass of wax and other contaminants.

SLICK PROP Teflon water-repellent grease applied to the propeller makes it more difficult for marine critters to get a grip.

FOR CLEAN, SOFT, WHITE LINES

To a 5 gallon (4 liter) bucket, add a cup (236ml) each of Downy (fabric softener) and Wisk laundry detergent and then half fill the bucket with hot water and toss in all your dock and anchor lines, halyards, sheets, etc. Add more water if needed to cover and let "brew" overnight, then rinse well to remove all residue.

Richard Asztalos, "Charisma," Mt. Clemens, Michigan

WATER STOPPER Add some plasticine to your spares' kit and stuff it in the anchor line (or chain) deck pipe to seal it from water splashing onto the deck and flooding the bilge.

IF YOU ONLY USE IT ONCE

A must-have addition to your toolbox is the X-Out screw extractor, which removes stripped screw heads that fit an indented drive. Just place the X-Out bit into a 1/4" (6mm) variable speed drill set in reverse and, while running the drill at slow rpm, apply downward pressure and rotate the bit side to side. It cuts and reshapes the screw head and backs out the screw.

DIY's editor Jan Mundy bought a plastic case with three bits at a boat show for US$20.

RUST-FREE TOOLS

It's inevitable that the ever-present moisture in the marine environment will corrode tools carried onboard. Wrap each tool tightly in plastic wrap before storing in your toolbox to keep out the wet stuff. If you really want to go over the edge with protecting tools, spray them with your favorite marine lubricant and wrap them. This is especially worth the extra effort for the tools you don't use often. Protect them and they'll "be there for you" when you really need them.

CHARGED BULBS

To eliminate corrosion, increase longevity and reduce electrical shorts of trailer lights, navigation lights and other lights onboard fitted with incandescent bulbs, remove each bulb and coat the metal base with dielectric grease.

PATCH WORKS

Make a quick, temporary repair for small holes and tears in canvas covers, tops and sails with iron-on patches. The patches are available in a wide variety of colors, so you can be as creative as you like.

TECH TIPS WANTED

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

DIY TECH TIPS
P.O. Box 22473
Alexandria, VA 22304

Or Email to info@diy-boat.com

Reader tips are not tested by DIY, but we won't publish anything we feel might harm you or your boat.

PRO SERIES

LEAK-PROOFING Cabin Windows

The repair method and the likelihood of success in your efforts to stem leaks at windows or ports on your boat depends on whether these fittings are framed or frameless.

Story and photos by Nick Bailey

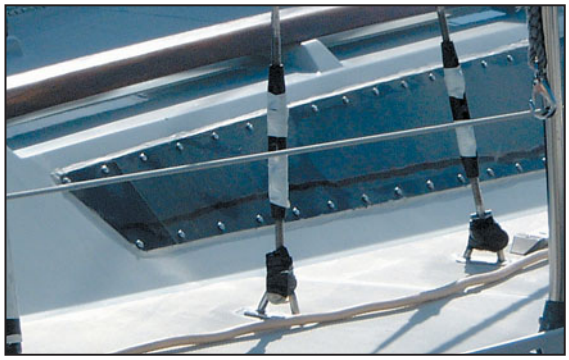
Notwithstanding the old joke about the boat being a hole in the water into which money is poured, we all know any boat with a cabin is just a floating conveyance designed to be wet on the outside and dry on the inside. Based on the service inquiries I handle every day the "dry on the inside" part seems to be hard to achieve consistently. One common leak source is the cabin window (or "fixed port," if you prefer).

It's more difficult than it looks to attach a transparent lens over an opening cut into the cabin trunk and keep it sealed. Boat builders have devised many approaches to fastening and sealing windows but the outcome generally falls into two categories: the window lens is either mounted or retained by a frame or is fastened without a frame. In the case of the frameless window, the lens attaches directly to the boat with adhesive, mechanical fasteners or a combination of the two.

To carry out an effective repair to leaky windows, it's important to understand the characteristics and most common failure modes of different window styles. Many window designs have inherent problems that may require re-engineering the installation from scratch if the repair is to sustain long-term success. Read on to see some of the common problems encountered and the repair solutions used by a professional shop for different types of windows.

The Dawn of Plastic

It wasn't long after fiberglass became the material of choice for production boat building that acrylic (Plexiglas) or polycarbonate (Lexan) began to replace glass as the predominant material for boat windows. These plastics are workable with standard woodworking tools and, unlike glass, they are flexible enough to conform to the curved surfaces of a typical cabin trunk. A lot of the early plastic windows were off-the-shelf fixed ports with aluminum frames. These were only available in stock sizes so many boat builders, looking for more distinctive styling, began to forego the frame altogether and simply attached the plastic window lens directly to the cabin.



The classic mechanically fastened "Frankenstein" window.

Frankenstein Mark 1

The first of the frameless windows mounted with mechanical fasteners was the Mark I or "Frankenstein" window. The window lens, usually a slab of acrylic 0.25" to 0.5" (6mm to 12mm) thick was mechanically fastened with screws or bolts over a gasket or bead of sealant laid between the lens and the boat structure. This simple installation was popular on boats built in the late '70s and early '80s but fell out of favor as maintenance problems persisted.

The lens colur of choice was usually a dark tint, which absorbs sunlight, heats up and then expands, pushing hard against the fasteners. This causes a variety of problems: cracks originating at the fastener holes would quickly migrate across the lens; fasteners work loose; the sealant (many of which don't stick that well to plastic) loses its grip on the lens and the leaks commenced. A Band-Aid solution was to drill the fastener holes over-sized to allow room for the lens to expand. This reduced lens cracking but the amount of thermal movement, especially with the long narrow windows popular on sailboats, would eventually break the seal. Unfortunately, this style of window is always prone to leaks and is a good candidate for re-engineering the installation with the addition of an external frame. Nonetheless, good repair technique can maximize the leak-free service interval.

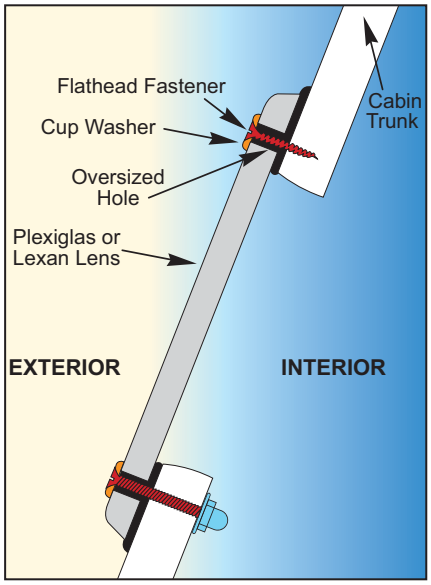
If the decision is made not to upgrade the window installation with a frame (see below), this is just a reseal job. The fasteners are removed and, starting at the location of the leak, the lens is gently pried loose by slipping a putty knife between the lens and cabin trunk. Clean all the old sealant off both mating surfaces. Carefully check the lens for cracks. If cracked, replacement of the lens is mandatory. This is also a good time to replace a weathered or crazed lens for cosmetic reasons. Use the old lens as a template, trace the shape of the new lens onto a sheet of new plastic and cut out with a bandsaw or jigsaw. In many cases, the lens also needs a bevel or cove cut into an edge of the lens with a router or belt sander. Edges also usually need sanding with 120 grit paper to achieve a smooth finish. When a shiny gloss is required at the cut edge, this is quickly achieved by kissing the edge with the flame of a torch. Next, the fastener holes are drilled in the lens and it is at this point some minor engineering improvements can be made.

Drill fastener holes oversize as needed

The fastener-free frameless window.

in the new lens. For example, if the original holes were drilled 5/32" (3.9mm) for a 1/8" (3mm) fastener, the new hole is enlarged to 1/4" (6mm). The limiting factor is the size of the washer used on the outside of the window. It should bridge the hole. Flathead fasteners with cup washers have the lowest profile and hold sealant best. Another technical upgrade is to reseal the window with an ultra-flexible professional glazer's silicone such as Dow Corning 795 or equivalent. These silicone sealants have the ability to stretch or compress 50% so they are flexible enough to maintain a seal despite the thermal movement of the lens.

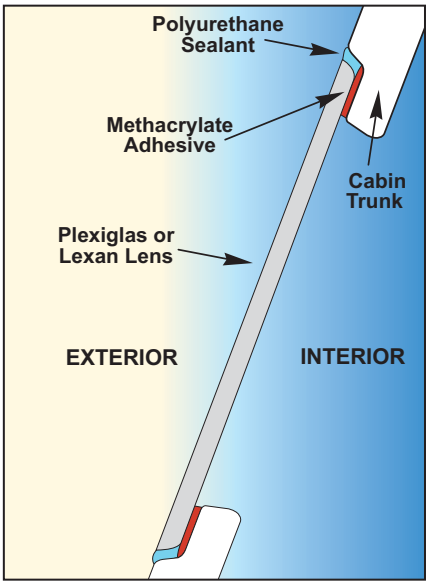
Now the new window is dry fitted. From inside the cabin, the outline of the opening in the cabin trunk is traced onto the protective paper on the inside face of the lens. The lens is lifted out and the protective mask is carefully cut and removed to expose the outer bonding ring of the lens. The exposed area is sanded thoroughly with 80 grit to ensure good sealant adhesion. To prepare for caulking, masking tape is applied to the cabin trunk about 3/16" (4.7mm) outside of the lens all around the outside perimeter of the window. The small, unmasked gap allows for a tidy external sealant bead when finished. Once the dry fit and masking is complete, the window is again removed and sealant applied to the cabin trunk in two or three fat concentric beads within the area in contact with the window. Special care is taken to make sure each fastener hole is well caulked. To make positioning of the window more precise, two or three fasteners are prefitted to the lens to act as registration pins. The lens position is fixed by engaging these fasteners into the correct cabin trunk holes just as the lens is lowered into place onto the fresh sealant.



Example of Frankenstein Mark 11 window installation.

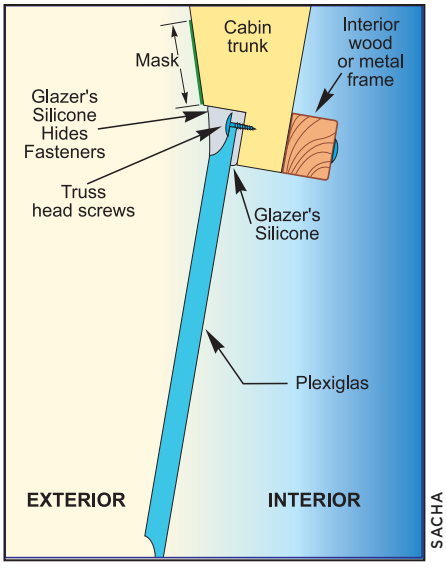
The remaining fasteners are now installed and the window is gently tightened using a sequence similar to torquing down an engine cylinder head. Care is taken to avoid over-tightening the fasteners, since the lens can crack easily and it's important to avoid squeezing out too much sealant. A thicker gasket of sealant has more compliance as the window expands and contracts. A bond line of about 1/16" to 3/32" (1.5mm to 2.3mm) thick is about right. Excess sealant that squeezes out is removed with a putty knife and the final caulking touch is achieved by smoothing a bead around the outside perimeter of the lens with a gloved forefinger. Masking tape is removed while the sealant is still wet. As soon as the caulking has cured, the protective mask on the lens is removed before it's exposed to rain, heavy dew or too much sun that render the masking painstakingly difficult to remove.

Despite my iffy prognosis for this window style, it's worth noting that some manufacturers have stuck with the mechanically fastened approach and have achieved a reliable window seal. A successful variant used by some boat builders uses screws and washers as retainer clips holding only the outside edge of the lens (e.g. no fastener holes through the window). The window sits in a recess and the perimeter fasteners are invisible, buried in the thick bead of black glazer's silicone that surrounds the window.



Typical installation of a frameless window without fasteners.

By the early '80s, boat builders, after many complaints, abandoned the Frankenstein frameless window to pursue the new technique of attaching a frameless window using advanced adhe-



Alternate frameless installation uses fasteners, hidden by glazer's silicone, to retain outer edge of the window without drilling holes through it.

sives. Besides offering better leak resistance, boat designers also wanted to improve cosmetics and were glad to leave behind the fastener studded look.

Windows in Bondage

A slick looking acrylic window glued in place with methacrylate adhesive is what I call the Mark II bonded window. This powerful adhesive supercedes mechanical fasteners and takes over the job of fastening the lens to the cabin trunk. The task of sealing the window is delegated to a bead of tough polyurethane sealant applied externally around the perimeter of the window. Particularly when flush mounted in a recess, this technique created a great looking, fastener-free window with what was supposed to be a bulletproof seal. Although this was usually the case in the early days (during the warranty period), as the years went by and these boats began to age, window problems developed.

Steven Roll applies Plexus A320 methacrylate using a special adhesive gun.

Methacrylate is awesome stuff. It has an adhesive bond so strong that often the underlying laminate fails before the adhesive does and that is not a good thing. As the window lens expands in the hot sun, a powerful force is exerted on the bondline. Something has to give. First, the expanding window causes the cabin trunk to flex. In many cases the only indicator of the huge stresses involved are the "crow's feet" cracks radiating out from the corners of the window. Second, the adhesive can fail, or worse, the gelcoat tears away from the underlying glass laminate at the bond line. With time, it's not uncommon to see the window pop loose, but only in one corner. Special repair techniques are required to repair the problems created by the methacrylate bonded windows commonly found on older boats.

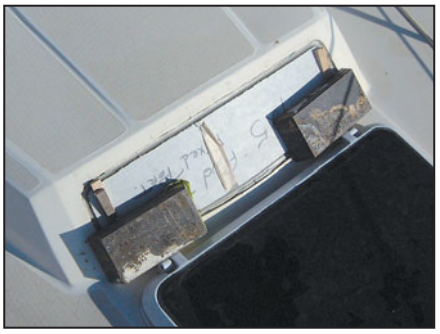
A leaking window of this type is first carefully assessed to determine exactly what repair is required. If the lens still seems to be well bonded, it may only be a simple matter of raking out and renewing the perimeter caulking. Nonetheless, if the lens is in any way debonded or loose, the perimeter caulking can't do its job of sealing the lens. If only one corner is loose, it may be possible to do a temporary repair by carefully installing one or two screws to secure the lens prior to raking and caulking the perimeter bead. A lens with more than a few inches of loose caulk requires complete removal and reinstallation.

The standard procedure is to first rake out the perimeter caulking and then carefully pry out the old lens, in one piece if possible. More often than not, however, the lens remains firmly bonded to some areas, so removal demands the use

Masking for perimeter caulking.

of a chisel or router. At this point, if removal might destroy the old lens, a cardboard template is made to preserve the pattern. After the lens pieces are removed, the residual adhesive is sanded away and any gelcoat or fiberglass damage to the bonding surfaces is repaired. If the old lens is salvageable, it's cleaned (or sanded) to prep it for reinstallation. If a replacement lens is required, it's cut following the instructions above.

Once the cabin surface and window is properly cleaned and prepped, a bead of methacrylate adhesive is applied to the cabin with a special mixing gun. The window is then immediately put in place and clamped firmly until the adhesive hardens. Methacrylate bonds and hardens almost immediately so the placement of the window is very much a one shot deal. The clamps, usually a few wood 2x4s jammed between the lifelines and window, are left in place for a few hours or overnight. To prep for the perimeter caulking the cabin and window are masked as outlined above and the sealant bead applied with a caulking gun. Theoretically, this style of window is not supposed to move around much so the less flexible polyurethane sealants (3M 5200, Sikaflex 252) can be used for the perimeter bead. In use, even a perfect repair may only last a few years before the window pops loose again.



Lead weights and wedges serve as clamps while the sealant cures.

Free-Floating Frameless Window

In the long term, any attempt to restrain the thermal motion of a large plastic window creates problems. The window eventually leaks or cracks or the cabin trunk cracks and the window comes loose. In the last 10 years or so boat builders have recognized this and have taken a different tack. Many boats are now built with frameless window installations where the plastic lens is free to expand and contract. This is achieved by using the aforementioned high flex glazer's silicone to both seal and bond the window in place. This technique, similar to the way the lens in a framed deck hatch is installed requires the window to be mounted in a wide recess and works best when the window is nearly flat or is pre-molded to the shape of the cabin. No mechanical fasteners are used and the window is allowed to float in a thick silicone gasket. Here it can expand and contract freely without breaking the seal or coming loose. This installation technique is difficult to duplicate in the field, as the window must be fixed in place and left completely undisturbed for the two days (more or less depending on the temperature) required for the sealant to cure completely.

Framed Windows

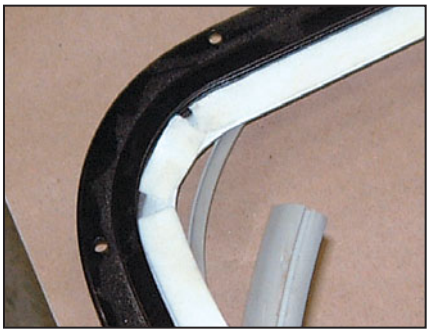
Framed windows, either off-the-shelf or custom, don't suffer the same kind of problems as outlined above but unfortunately are not 100% problem free. The advantage of a framed window is that the frame itself handles the job of fastening the window to the boat and the lens is freed from all those stresses. The flexible rubber gasket that secures the window in the frame also allows the lens to expand and contract. The disadvantage is the rubber gasket that eventually degrades and leaks.

Many older boats have off-the-shelf fixed ports with aluminum frames. Excellent replacement ports are still made today by all the major hatch manufacturers but are only available in certain sizes. Rubber gaskets in such framed windows slowly deteriorate from exposure to sunlight and pollution, especially ground level ozone. Occasional gasket leaks can be dealt with by working Permatex penetrating windshield sealant (available at automotive shops) under the edge of the gasket. The sealant between the window frame and the boat occasionally leaks for some of the same reasons as outlined above with respect to frameless windows. When you cannot stop the leaks, you have no choice but to replace the gasket, if one is available.

A gasket replacement usually requires removal of the entire window assembly. Fasteners are removed, the frame is gently pried away from the cabin trunk and the sealant cut with the edge of a putty knife. Once the window assembly is on the workbench, the old

Beclawat aluminum framed fixed port and replacement rubber gasket.

Clean off old sealant and polish the lens before reassembly.



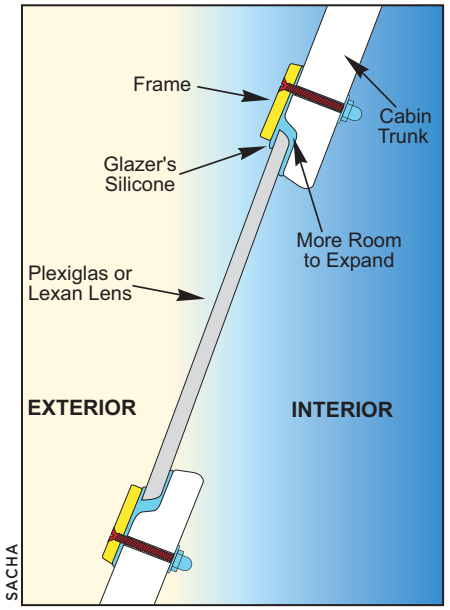
Double-sided adhesive tape bonds the lens to the frame

gasket is peeled out and the lens freed. Each make of window has its own tricks. The one shown below was made by the Beclawat Company in Belleville, Ontario, and was supplied by the thousands to Canadian boat builders during the '70s. It uses a unique rubber gasket (still available) to seal the outside of the lens against the frame and double-sided foam adhesive tape to bond the inner side of the lens to the frame's inner flange.

After removing the lens, all the old tape must be scraped off and the frame cleaned with solvent or a citrus cleaner capable of dissolving gummy residue. The old lens (if reusable) is also cleaned and polished before reinstallation. Acetone or lacquer thinner is never used to clean plastic lenses but stove alcohol is okay. If the lens is in poor condition, a new one is cut. The new gasket is measured and cut about 1" (25mm) longer than the old one to allow final trimming during installation. New double-sided foam adhesive tape is cut (3M ScotchBrite VHB tape works well for this), the protective backing peeled off and the tape firmly applied to the frame's inner flange. The protective mask is peeled from the front of the tape and the lens is carefully placed onto the sticky surface and immediately pressed firmly to maximize the bond. Starting at the bottom of the frame, the new outer gasket is pushed in between the frame and the lens until the detent cut into the gasket "snaps" onto the frame. To enhance the seal, a little clear silicone is smeared onto the sealing surfaces of the gasket as it's pushed into place. Next, the window assembly is refastened to the cabin with fresh sealant (either polyurethane or silicone works fine in this application).

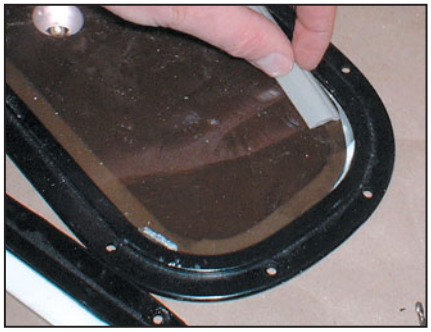
The Ultimate Frameless Solution

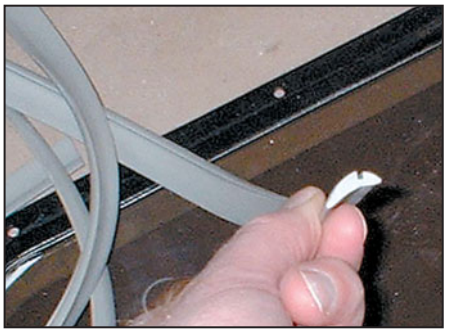
When a frameless window installation is repeatedly defeated by the problem of expansion, a completely different method of securing the window is needed. Here is where a retrofitted external frame offers a permanent solution. The addition of an external frame does two important things. First, it mechanically fastens the frame to the cabin and takes over the job of securing the lens in place. No fasteners go through the lens and no ferocious bonding adhesives are required to retain the lens. This equates to less stress on the lens and the boat. Secondly, the lens, now that it's free of being rigidly fastened, remains restrained by the frame and is caulked with flexible glazing silicone allowing it to expand and contract freely without problems.



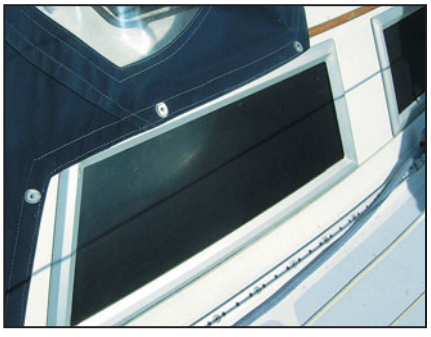
Sample add-on frame mounting.

Frames are made of polished stainless, painted or anodized welded aluminum or wood. In many cases, a trou-

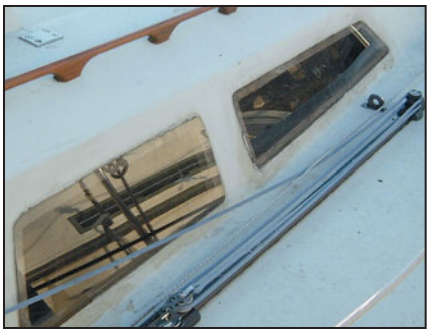




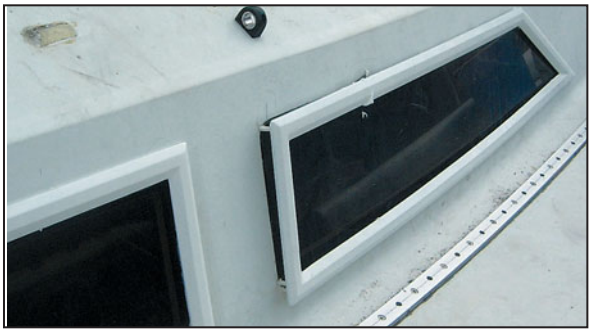
(left) Rubber gasket is pushed in until detent locks in frame. (right) Detent in sealing gasket.



(top) Custom stainless-steel frame; (bottom) anodized aluminum frame.



(left) A flush-mounted, bonded window after several amateur leak repairs. (middle) Tired flush mounted windows before add-on frames. (right) Flush mounted windows after add-on frames.



White painted aluminum add-on frame goes over top of flush mounted window.

blesome window doesn't need to be removed. The frame, together with a generous bead of caulking is simply installed over-top of the existing window. For maximum durability, the new frame is usually thru-bolted and acorn nuts are used on the inside of the cabin for best cosmetics.

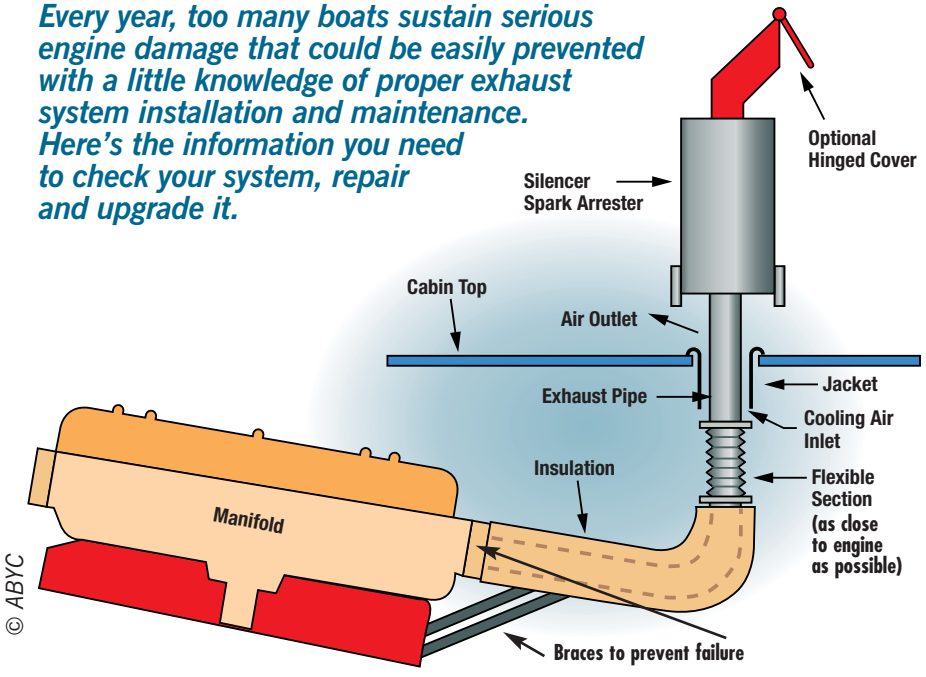
Many chronic window leaks have been banished forever by retrofitting a frame. (Including those on my own boat.) The only minor drawback is that an external frame doesn't appeal to everyone aesthetically. Compared to the way many windows look after repeated amateur attempts to seal leaks, an add-on frame is a big improvement.

About the author: **Nick Bailey** has spent 26 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.

ENGINE TROUBLE SHOOTING

Exhaust System Primer

Every year, too many boats sustain serious engine damage that could be easily prevented with a little knowledge of proper exhaust system installation and maintenance. Here's the information you need to check your system, repair and upgrade it.



Typical Dry Exhaust System
The exhaust passes through the exhaust manifold into the exhaust system piping. If this piping extends very far before it connects to a flexible section, it should be braced to prevent failure from vibration induced fatigue. The flexible section is there to prevent engine vibration from fatiguing the rest of the exhaust piping. All of the unjacketed piping should be protected with guards, jacketing or covers to prevent anything or anybody from being burned by heat that can reach over 1,000F (537.7C). As the piping ascends vertically, it should be surrounded with non-combustible materials and adequate ventilation to prevent heat damage and/or fire. A spark arrestor keeps sparks from spraying the deck and the hinged cover keeps rain water out of the exhaust when the engine is not running.

By Larry Blais

Engine exhaust consists primarily of fully burned and partly burned hydrocarbons. The fully burned (oxidized) hydrocarbons are water (H_2O) in the form of superheated steam and carbon dioxide (CO_2) a gas. The partly burned hydrocarbons are mostly carbon monoxide (CO), a potentially deadly, odorless, invisible gas, carbon in the form of soot and various other, partly oxidized and unoxidized hydrocarbons. Boatbuilders have been dealing with getting these hot, toxic exhaust gasses safely overboard ever since internal combustion engines were first installed in boats.

With the development of the American Boat & Yacht Council (ABYC) P-1 standard, Installation of Exhaust Systems for Propulsion and Auxiliary Engines, the industry has very clear guidance on how to design and install both wet and dry exhaust systems.

Dry Exhaust – The Simple Solution?

Dry exhaust systems were the first to appear and are still popular on commercial fishing boats. The hot exhaust gases are simply carried overboard through piping. This piping must not leak, so it needs to be made from quality materials and properly maintained. The piping must be adequately supported throughout its entire length to minimize failure from vibration, shock, expansion and contraction. Piping supports must be constructed so that heat cannot penetrate or transfer through them and ignite anything. A metal flexible section of piping should bridge between the engine and the boat to absorb engine vibration. (See the chart of accepted materials taken from ABYC P-1 on page 26.) Protective guards, jacketing or covers should be installed to prevent anything or anybody from being burned. Typically, the piping will ascend vertically through a protective stack to a high outlet so the toxic gasses will clear the deck. Some method of preventing sparks from escaping from the outlet, such as a spark arrestor, should be provided. A muffler, sometimes called a silencer, may need to be installed to reduce exhaust noise to a less obnoxious level. Most silencers also function as spark arrestors. Some means of keeping rain water out of the exhaust system when the engine is not running should also be provided, such as a hinged cover at the outlet. Commercial fishermen use everything from an inverted can to a bucket.

Wet Exhausts — Just Add Water

Wet exhaust systems are designed to mix water directly with the hot exhaust gasses, cooling them so they can travel through metal, rubber compounds and fiber-reinforced plastic, without cooking the piping, to a through-the-hull outlet that is usually close to or even below the waterline. These systems and their components must not leak so specially formulated hoses and piping have been developed. The materials used should be labeled for their suitability to this application, i.e.,

ENGINE

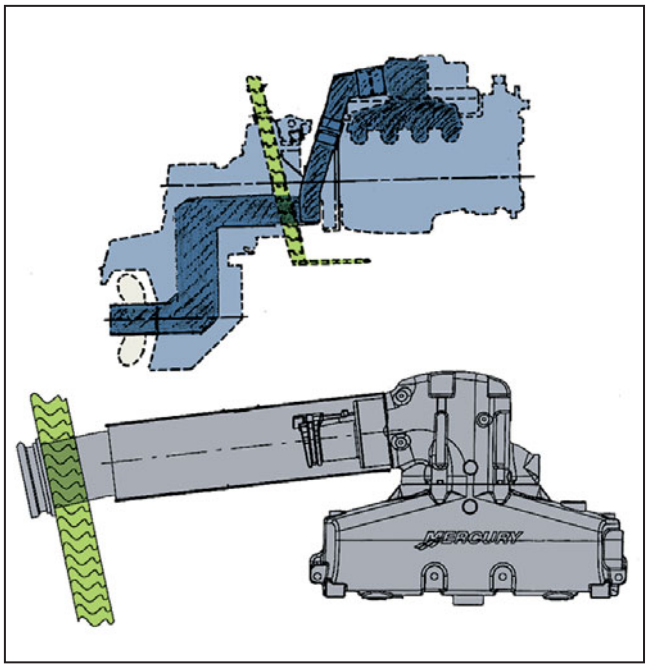
This cutaway drawing of an exhaust elbow shows how the cooling water is injected into the hot exhaust gasses, mixing with them and cooling them so they will not damage the exhaust piping that follows. Cast iron elbows exposed to saltwater can rust through the inner wall in as little as five years flooding the engine.

"marine wet exhaust." Proper support of all the components is required and all hoses must be secured with at least two clamps.

Wet exhaust systems require a source of cooling water. An engine's raw water pump usually provides this water, however a separate pump is sometimes used. If this supply of water is lost by a blockage or a pump failure, the hot exhaust will quickly damage the exhaust piping, so an indicator, audio or visual, should be installed at every helm position to alert to the loss of this exhaust system cooling water supply. This indicator responds to a high temperature sensor located on at or near the point of water injection.

Any section of the system from the exhaust manifold to the point of water injection that is not surrounded by a water jacket must be fitted with heat shielding material in the same way as is required in a dry exhaust system.

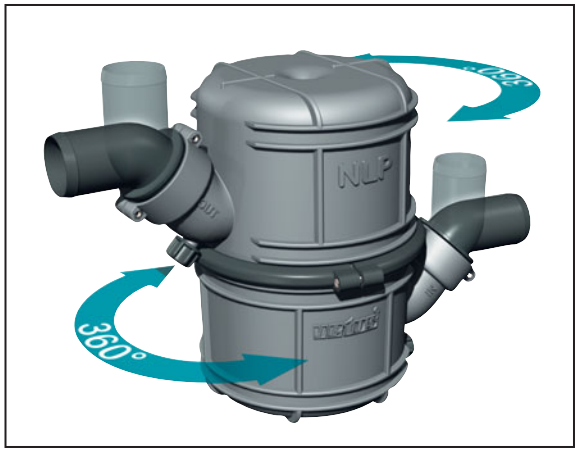
The design for a wet exhaust system depends on the engine location relative to the boat's waterline. The simplest system is found in many small powerboats where the engine and exhaust system cooling water injection point are well above the waterline. Here the piping runs at a slope (grade)



Many boats with sterndrives have little margin for error because the exhaust elbows are so close to the waterline. If they are loaded more heavily, encounter rough water or are towed, water has a good chance of spilling over the elbow into the exhaust ports of the cylinder head.

from the water mixing point directly to the outlet, usually in the transom slightly above the waterline. Much more complex systems are required when the engine is below the waterline and it is not practical to locate the exhaust system cooling water injection point high enough above the waterline to prevent water from flooding the engine. Here the much misunderstood and maligned waterlift is often used.

Exhaust systems that discharge the exhaust gases under-



An improved version of the waterlift is this two-chamber version by Vetus (left). Made of injection-molded plastic it's durable, corrosion-proof and lightweight. Engine exhaust pressure pushes down on the water, forcing it up the outlet pipe until the water level in the chamber is low enough to allow exhaust gasses to escape up the outlet pipe, carrying some of the water with it. The waterlift chamber must be large enough to prevent engine cooling water from backing up into the cylinders through the exhaust valves during normal cranking, starting and stopping cycles and while the engine is stopped. Two-chamber mufflers produce a much better dampening effect than single chamber units. (right) Installation of exhaust assemblies is greatly simplified with the Vetus NLP waterlock. Both the inlet and outlet hose connectors rotate 360° and the chambers can be offset through 300°. Note: Metal waterlifts should only be installed on freshwater boats. Stainless steel units have a tendency to cavity pit, especially when aggravated by hot saltwater, and aluminum waterlifts corrode around the welds.

This exhaust hose was badly burned through when the raw-water pump failed. Since this hose was plumbed to a below the waterline thru-hull, seawater filled the boat and it sank.

water are becoming more prevalent. The underwater discharge reduces noise and fumes. These boats should have flapper valves in the exhaust passageway called water shutters that help prevent water from backing up the exhaust when an engine is not running. These shutters must be frequently checked and properly maintained as they wear out and can be damaged by a lack of exhaust cooling water.

(top) This water shutter is designed to fit in an exhaust hose. (bottom) This water shutter has been so badly burned that the rubber flapper valves are broken, leaving just a little rubber covering the stainless steel crossbar.

Many engines have been flooded with water after raw-water pumps failed and hot exhaust gases damaged these shutters. Even boats that discharge their exhaust above the waterline may benefit from water shutters in the exhaust, as many risk water backing up the exhaust passageway and flooding the engine when the engine is not running, especially in heavy seas and/or while under tow. These shutters are available from many engine and exhaust system manufactures.

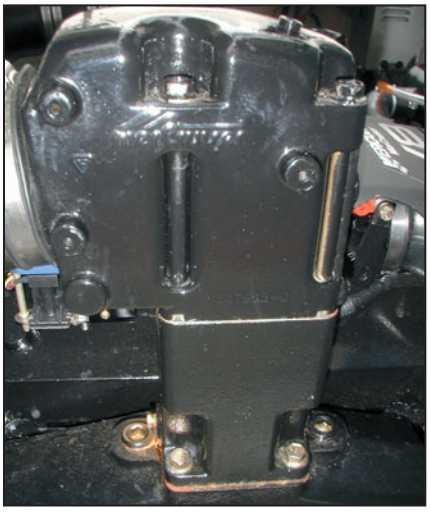
TIP QUICK CHECKS

- **Routinely check all hose connections for tightness.**
- **Regularly check all hoses for chafe and deterioration.**
- **Saltwater has a tendency to clog vented loops. At least once a year, disassemble and clean them.**
- **When laying up the boat for long term storage always drain the muffler through the drain plug.**

— Jan Mundy

This is one exhaust port of the engine that was flooded with water after the above shutter was destroyed and the boat was put under tow.

Vetus transom exhaust flapper with thru-hull connects directly to the exhaust hose.



Several production boatbuilders have discovered that they did not raise the exhaust elbows high enough above the waterline to prevent water from backing up in the exhaust system and flooding the engine internally after the boat was fully loaded, and/or in heavy seas and/or while being towed. Many engine manufacturers produce riser blocks of various heights that raise the exhaust elbow. Here is a 6" (15cm) riser block between the engine's exhaust manifold and the exhaust elbow. An elbow of this type is often called a riser because it raises the height of the exhaust loop.

By far the most common underwater exhaust system is the through the prop exhaust system found on many sterndrives. Here the water-cooled exhaust gasses exit underwater through the propeller hub where they are trapped in the prop wash reducing the fumes that can be sucked back into the cockpit. Other sterndrives may have exhaust outlets elsewhere such as in or under the anti-cavitation plate.

Recently, inboard cruisers with exhaust outlets integral in the boat's bottom have appeared. The most exotic are found on large high-performance yachts where the exhaust gases are discharged through slots in the bottom to reduce hull drag.

A recent development in exhaust system designs is the dried wet exhaust. In this system, the exhaust is cooled with injected water like a wet exhaust but then the exhaust goes through a separator where the water is separated from the now cooled exhaust gasses. Then each is discharged separately thus eliminating the gushing spray at the thru-hull discharge and, in the case of a genset, often reducing the noise level to a nice hum.

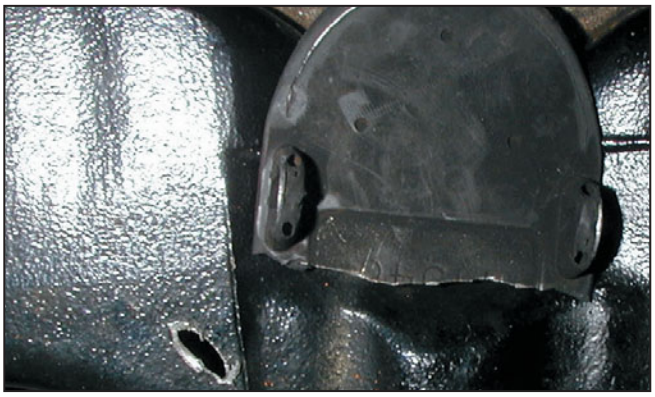
Every type of exhaust system requires constant attention to keep it operating safely. Inspect each of the components regularly. Look for cracks, rust, leaks, freeze damage and any evidence of overheating. If the raw-water pump fails on an engine with a wet exhaust, don't forget to check the exhaust components for heat damage. If the boat is operated in salt or brackish water, check the metallic components for corrosion. Jacketed cast iron riser elbows exposed

Exhaust Materials

	GASOLINE ENGINES		DIESEL ENGINES	
Components	Wet Exhaust	Dry Exhaust (11)	Wet Exhaust	Dry Exhaust
exhaust pipe	aluminum (14)	aluminized steel (11)	copper -nickel (4)	aluminized steel (11) (12)
	brass pipe (6)	carbon steel (9)(13)	fiberglass (10)	carbon steel (9)(13)
	copper-nickel (4)	nickel-iron-chrome (1)	galvanized steel	nickel-iron-chrome (1)
	copper tubing (7)	nickel-iron-chrome (2)	galvanized wrought iron (12)	nickel-iron-chrome (2)
	enameled steel	stainless steel (8)	nickel-copper (3)	stainless steel (8)
	fiber reinforced plastic (10)		nickel-iron-chrome (1)	
	galvanized wrought iron (12)		nickel-iron-chrome (2)	
	nickel-copper (3)		stainless steel (8)	
	nickel-iron-chrome (1)		synth. rubber hose*(5)	
	nickel-iron-chrome (2)			
	stainless steel (8)			
	synth. rubber hose*(5)			
silencer or wet exhaust waterlift chamber	cast iron	aluminized steel (11)	cast iron	aluminized steel (11)
	copper	carbon steel (9)(13)	enameled steel	carbon steel (9)(13)
	enameled steel	nickel-iron-chrome (1)	fiber reinforced plastic (10)	nickel-iron-chrome (1)
	fiber reinforced plastic (10)	nickel-iron-chrome (2)	nickel-copper (3)	nickel-iron-chrome (2)
	nickel-copper (3)	stainless steel (8)	nickel-iron-chrome (1)	stainless steel (8)
	nickel-iron-chrome (1)		nickel-iron-chrome (2)	
	nickel-iron-chrome (2)		reinforced plastic (10)	
	reinforced plastic (10)		stainless steel (8)	
	stainless steel (8)		synth. rubber*(5)	
	synth. rubber*(5)			
engine flexible section	copper (7)	carbon steel (9)(13)	copper-nickel (4)	carbon steel (9)(13)
	copper-nickel (4)	nickel-iron-chrome (1)	nickel-copper (3)	nickel-iron-chrome (1)
	nickel-copper (3)	nickel-iron-chrome (2)	nickel-iron-chrome (1)	nickel-iron-chrome (2)
	nickel-iron-copper (1)	stainless steel (8)	nickel-iron-chrome (2)	stainless steel (8)
	nickel-iron-chrome (2)		stainless steel (8)	
	stainless steel (8)			
	synth. rubber *(5)			
pipe connection	synth. rubber*(5)	flanged, screwed or welded (12)	synth. rubber*(5)	flanged, screwed or welded (12)
	flanged, screwed or welded (12)		flanged, screwed or welded (12)	

*This classification is for rubber-like flexible materials.
(1) 40. Ni., 21. Cr., 31. Fe., 3. Mo., 1.75 Cu., 0.60 Mn., 0.40 Si., 0.05 C.
(2) 29. Ni., 20. Cr., 44. Fe., 2. Mo. (min.), 3. Cu. (min.) 0.75 Mn., 1. Si., 0.07 C.
(3) 70. Ni., 30. Cu., Monel 400, K-500
(4) 70. Cu., 30. Ni., 0.75 Fe. or 90. Cu., 10. Ni., 1.5 Fe.
(5) See P-1.7.1.10, Flexible Exhaust Hose Connections.
(6) 85. C., 15. Zn.
(7) Minimum recommended: Type M copper.
(8) Type 316 L (low carbon)
(9) for temperatures below 482°C (900°F)
(10) Shall meet the test criteria 94V-0 when tested in accordance with UL 94, *Test For Flammability of Plastic Materials for Parts in Devices and Appliances.*
(11) for temperature below 677°C (1250°F)
(12) Threaded pipe and fittings shall be at least schedule 80 pipe or equivalent (see P-1.6.3).
(13) galvanized or ungalvanized
(14) Aluminum pipe shall be a minimum of schedule 40, with a corrosion resistance of 6061 or better, and may only be used in the self-draining, gas-only discharge part of dewatered exhaust systems.

Recommended materials for exhaust components as per ABYC P-1 standard, Installation of Exhaust Systems for Propulsion and Auxiliary Engines.



Here, an exhaust water shutter has worn through its hinge pin, shattered and lodged in the exhaust Y pipe where it wore a hole through the aluminum casting. This hole allowed water to flood the bilge and sink the boat. More frequent inspection of these shutters is a good idea.

to saltwater can rust through the inner wall in as little as five years, flooding the engine with saltwater. Where there are signs of water leaking out, there is also the possibility that water is going into the engine. This is by far the most common cause of major damage to gasoline inboards and engines with sterndrives used in saltwater. At the very least, these elbows should be removed and inspected every year once they reach four years old. Many owners who have experienced having their engines drown in saltwater simply replace the elbows every four or five years to be on the safe side. Cast iron exhaust manifolds will rust through as well, sometimes in less than 10 years, if exposed to saltwater. In these cases, a full freshwater cooling system that includes the manifolds would be a wise addition.

When it comes to exhaust systems, a little knowledge and attention will go a long way in making your boating experience a pleasant one.

About the author: **Larry Blais** is a master mechanic, master shipwright and marine surveyor who specializes in surveys that involve marine forensic analysis. He teaches classes for the United States Coast Guard, Havorn Marine Survey and Shipwright's School, University of Washington's Sea Grant program and hosts workshops in diesel care for the Northwest School of Wooden Boatbuilding.

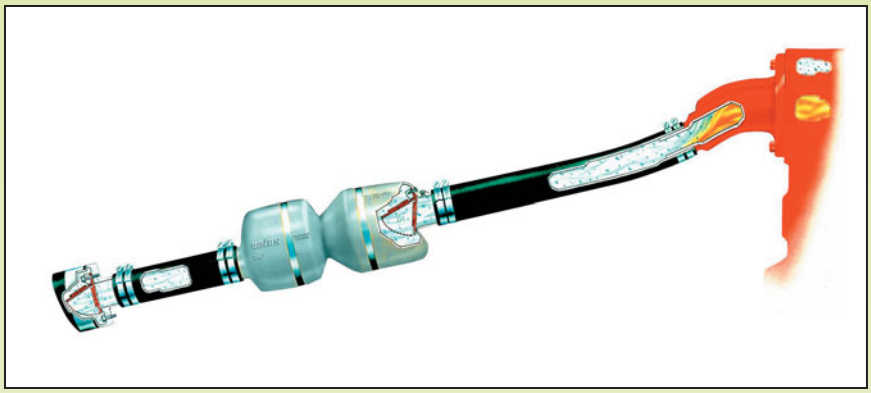
TIP *HIGH TEMP PROBE*

If you run a wet exhaust system without cooling water for even a minute you risk damaging exhaust hoses or burn a plastic muffler. The Vetus XHI exhaust temperature alarm provides a visual and audible alarm when temperatures inside the exhaust hose or the muffler exceed an acceptable level. Temperature sensors mount onto the exhaust hose immediately after the mixing elbow. The alarm taps into an existing buzzer or you can purchase a panel-mount alarm. Sure beats stretching over the side to manually check the water discharge temperature.

— Jan Mundy

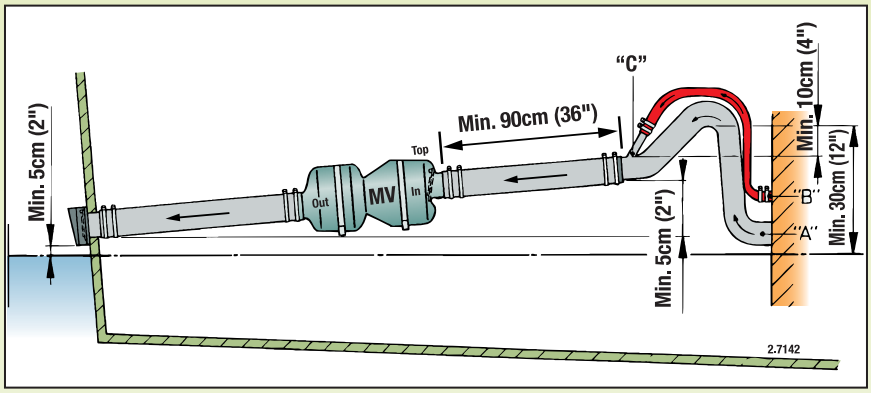
WET EXHAUSTS — DOs and DON'Ts

ENGINE and ELBOW WELL ABOVE WATERLINE



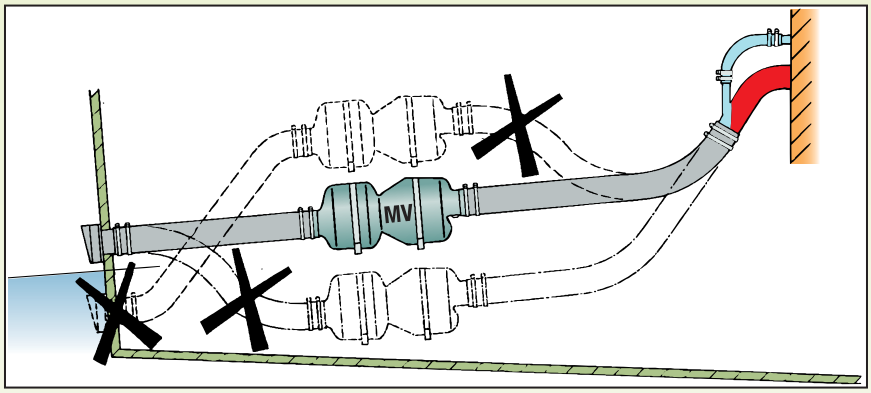
This exhaust system configuration is typical when the engine, exhaust elbow, cooling water injection point and exhaust outlet are well above the waterline. The exhaust and cooling water travel down the piping, through the silencer (muffler) and out the boat through the outlet connection at the transom. When the engine is shut down, water simply drains out of the system by gravity because of the constant slope (called grade) of the piping. One or more check valves (e.g. water shutters or flappers) help keep water from backing up the exhaust and flooding the engine when the engine is not running and the boat encounters following seas.

Engine Under Waterline and Elbow Raised



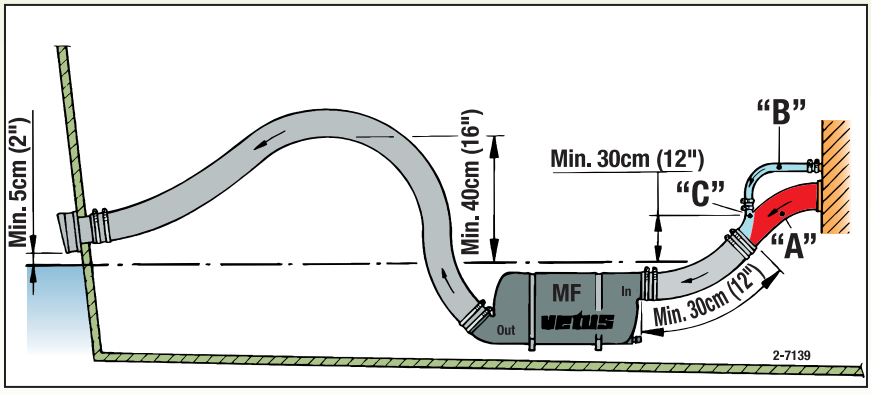
In boats where the waterline is higher, the exhaust elbow is raised to gain a safe height above the waterline. This raised exhaust elbow is often called a riser. The minimum distances shown are to the static (at rest) waterline and represent a general margin of safety. In actual experience, the waterline can change drastically due to loading and sea conditions. Installation of the exhaust system should take into account these conditions.

Silencer High or Low



If exhaust systems that depend on grade to drain out have low spots in the piping where water can collect, the back pressure could prevent the engine from starting. When the exhaust outlet is under the waterline, it only takes the failure of the clamps or hose to sink a boat. Exhaust outlets should not be installed under the waterline if it can be helped, unless the system is specifically designed for it.

Elbow Too Close to Waterline

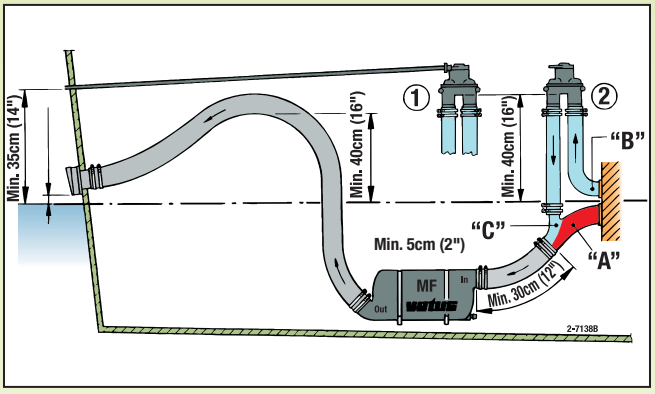


When the exhaust elbow and water-injection point are too close to the waterline and the elbow cannot be raised, a waterlift may be the answer. Certain precautions must be exercised with a waterlift system because the exhaust outlet piping is above the exhaust elbow. The waterlift chamber must be large enough to hold all the water that drains into it when the engine is shut off and then whatever water pumped into it by the cooling water pump during normal engine starting. If a hard starting engine is cranked enough, the water pump can flood the system and the engine. (Hence, the reason to close the water intake valve during repetitive cranking until the engine starts.)

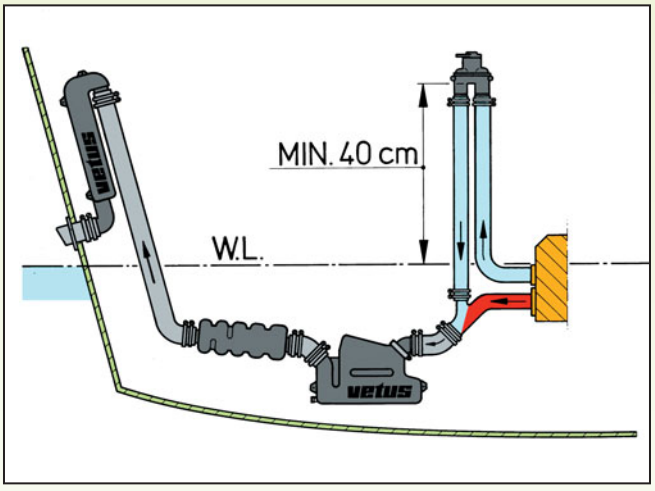
VETUS

Exhaust Elbow at or Below Waterline

When the exhaust elbow and water-injection point are at or below the waterline a waterlift system should have an anti-siphon device (a.k.a. vented loop or air vent) installed in a loop of the cooling water hose to the injection point. This prevents water from siphoning though the water pump into the waterlift system and flooding the engine. The vent bleeds off water so the device doesn't clog. This doubles as a telltale — no water stream discharging overboard means a loss in engine cooling water. Sometimes, the vent hose discharges into the cockpit, which allows a quick visual reference. More common is to plumb the vent overboard.



When the exhaust elbow and water-injection point are far below the waterline the anti-siphon device must be raised. A raised loop in the exhaust outlet piping helps to prevent water from entering the system through the transom. The Vetus gooseneck shown here can be install in many waterlift systems and may give an additional margin of safety.



ELECTRICAL

Charging Issues

Five common charging problems and their solutions.

By John Payne

Battery Charging with Isolators

Q: I am considering installing one isolator for each of the two main engines. Each engine has it's own starting battery. The charging output for each engine will go to its respective isolator, which will then be split so that one side of the isolator goes back to its dedicated starting battery. The other side of the isolator will be wired to a house battery. This will be the same for the second motor; one side wired to it's own starting battery and the other side wired to the same single house battery. Under this system, the house battery would have two charging leads coming in from two different isolators. This system would theoretically charge the house bank if either motor were running. Would this cause problems when both engines are running? What other options are available that accomplish the same task of charging the house battery with either engine? This same system will also have a parallel switch between the two starting batteries.

Nathan Onken, "The Roamer," Excelsior, Minnesota

A: This is a common scenario on dual engine installations. In practice, having two alternators charge the same battery would not cause problems. One tends to act as master and one slave, as there will be one with marginally higher output voltage than the other. Also, one regulator tends to read the output voltage of the other alternator and so you don't get any improvement in charging and charging always benefits from a smart regulator. The upside is that you have some redundancy in charging. I prefer, where it's possible, to have a relatively large house bank split into two banks, one for high current loads, the other for more sensitive electronics' loads. Each charge output then feeds a self-contained system. The house banks can have an emergency crossover switch.

Voltage Formula

Q: Is there a table that I use to predict voltage in my house batteries over a period of time? Three deep-cycle batteries, totaling 420 amps are monitored and I normally use 0.9 to 1 amp hours to power alarms and propane fridge when I'm not onboard. Battery voltage drops to 12.25 volts after using 33 amps, 11.75 volts after 100 amps. Is this in the normal range?

Andre Massicotte, Bayside, Nova Scotia

A: There is a standard table for battery state of charge on flooded-cell batteries. Your readings indicate that after 33 amps the battery is nominally at 50% charge at 12.25 volts and around 25% charge level for 11.75 volts. However, this is not a correct state of charge and state of charge tables are generally given as open circuit values. These are always higher and more accurate than ones taken as on-load readings, which are inaccurate. When you take readings, it should be without any loads switched on. This gives a lower voltage reading than a stable off-load one. This explains why after using 100 amps, the battery reads around 25%, instead of what should be 12.45 volts and 75% for batteries in good condition. Nominal 100% reading of a battery in good condition at 80F (26.6C) is 12.65 volts, 75% equals 12.45 volts, 12.24 volts equals 50% and 12.06 volts is 25%. Of course, the voltage readings are also directly correlated with the battery density readings. Also, note that these readings vary a little between batteries, battery chemistry and temperature. To get accurate readings switch off loads and measure an hour later when battery voltage recovers and stabilizes.

Solar Charging

Q: I run two 180-amp batteries, one engine and one house, and an isolator. How should I wire my batteries to keep them charged all the time? I plan to wire them directly to the bank but I'm concerned that, since the house battery is always the lowest, the charge will likely go to the circuit with least resistance and charge one battery. I was thinking to run from the solar controller (positive to battery one and then battery two) and then use a common ground for both. I leave my boat unattended for 30 days at a time and I must keep the batteries charged for bilge pumps etc.

A: I'm not sure about whether you are referring to a diode isolator or a switch isolator. Charging is not dependent on resistance. It's based on voltage. You can do as you suggest and connect the output of the switch isolator to each battery in turn. A simpler method is to simply connect or parallel all the batteries as one bank and charge them all together. A quality solar controller or regulator should maintain a float charge of around 13.2 to 13.8 volts. In fact, unlike deep-cycle batteries, start batteries don't self-discharge within 30 days, so just maintaining the charger on the house battery bank alone is sufficient. You can freshen up the start battery when you are on the boat.

Overcharging Problems

Q: When underway, the starboard engine voltmeter acts strangely. Sometimes charging shows 14.4 volts, rises to 15.4 and then returns to 14.2 volts where it stays for a while and then goes back to 15 or 16 volts. I have checked my batteries and the two voltmeters are okay. Any idea what else to check?

Walter Czycz, "Fairbanks," Horseshoe Bay, British Columbia

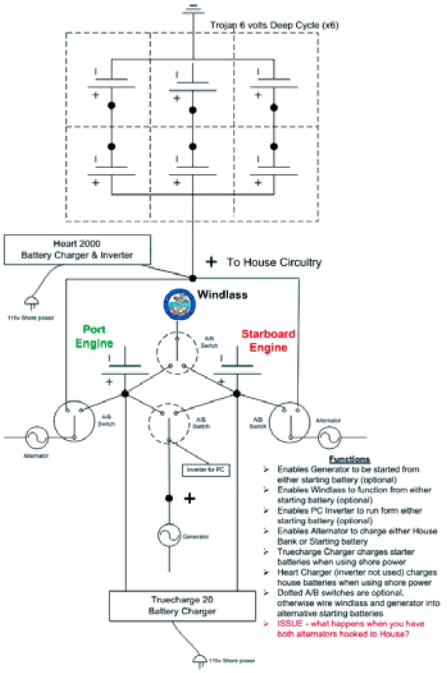
A: The symptoms you describe can be caused by a couple of things. First,

eliminate a voltmeter problem by swapping the voltmeters. If all checks out, do the same with alternators and verify the fault follows the change. This type of fault occurs with fast charging regulators whenever the sensor wire is disconnected or is loose. Again, if all checks out, the problem might be an internal type alternator regulator malfunctioning. Check the alternator brush gear. Sometimes a brush sticks and affects the regulator field control. In many cases, such faults also manifest themselves with interference on radios and other electronics.

Charging off Alternators

Q: I need a good 100-amp charge when underway to top up the battery banks on my 38' (11.5m) 1984 Chris-Craft Catalina with Mercruiser 454 inboards and alternators rated at 55 amps each. At the dock, I switch to a Heart 100-amp charger. Can I hook up my two engine alternators to charge a large battery bank according to the diagram below? My boating buddy, who has the same boat, was advised that this configuration is problem-free provided the engines aren't run for too long.

Peter Preager,
Aurora, Ontario



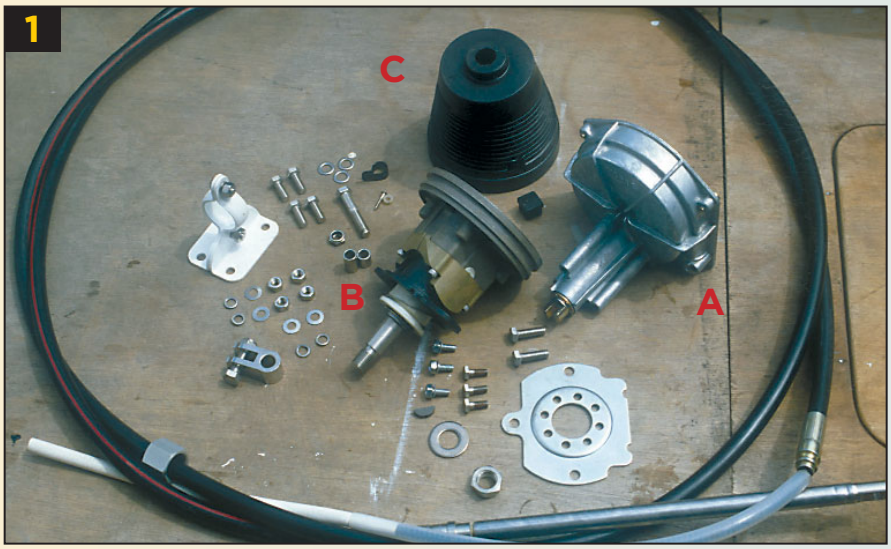
A: The short answer is yes. Having two alternators feeding the same bank doesn't cause any concern for overcharging as they are, in fact, both nominally 14-volt output. No matter how many alternators connect to one battery, the charge voltage remains the same. Charge input capability relates to the charge acceptance rate of the battery bank. Having two 55-amp alternators doesn't equate to a good 100-amp charge. Also, one regulator tends to read the output voltage of the other alternator so adding a smart regulator improves charging. You'll have some redundancy in charging. Where possible, it's better to have a relatively large house bank split into two banks, one for high current loads, and the other for more sensitive electronics loads. Each charge output then feeds a self-contained system. A good option is an emergency crossover switch on the house banks.

POWERBOAT RIGGING

Cable Steering UPGRADE

Despite the popularity of today's hydraulics, mechanical cable steering is still a viable proposition on smaller cruisers. Follow these steps to replace a stiff, worn and corroded steering system.

By Peter Caplan



The complete kit prior to installation consisted of the helm unit (A), tilt unit (B) and the tilt gaiter-cover, (C).

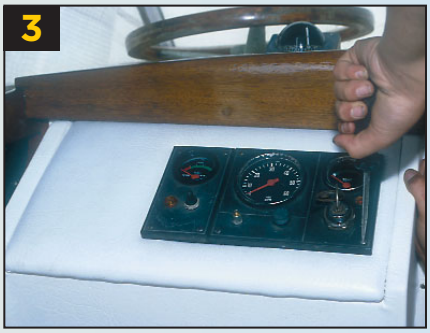
After many years of neglect, the original cable steering on my 40-year-old Coronet had become very stiff and steering the boat was hard work. While hydraulic steering is the standard on most modern boats, especially cruisers with two helm positions, it's by no means the only choice. When it comes to smaller cruisers, the advantages are less clear and there are some good reasons for staying with cable steering. Push-pull cable steering remains the usual choice for the smallest cruisers but it's also suitable for larger single helm cruisers. The heavy-duty cables used for this type of system offer minimum backlash and with the low friction materials used today, it's possible to achieve very light and positive steering.

After disconnecting the old cable at both ends, the nut in the center of the wheel is slackened and removed, and the wheel is pulled off the shaft.

The stiffness in this boat's steering had been attributed to the outdrive but, once the cable was disconnected, the outdrive turned freely and the steering remained stiff. There was also plenty of corrosion apparent on the old cable assembly. The cable termination at the helm consisted of a hooked end located in an opening in the inner drum and was clear that this arrangement was now obsolete so there this was not a matter of simply replacing the cable.

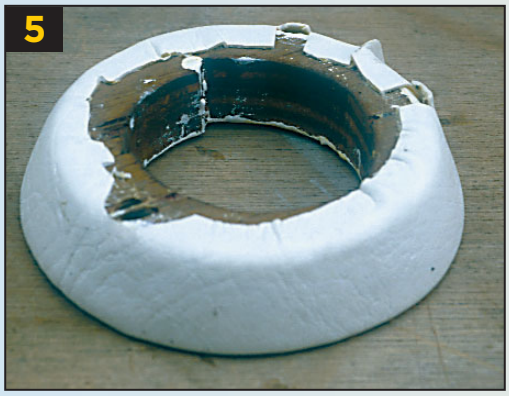
After looking at currently available options, I chose a Morse Command D290 drive assembly and helm kit. The adjustable tilt helm allows wheel position adjustments to operator preferences and steering from sitting or standing positions. At the outdrive end, the transom mounting cable bracket for the outer cable was already in place and still in perfect condition.

The key to smooth cable steering is a carefully run cable, with wide sweeping curves. Avoiding tight bends in the cable is a key to smooth operation and this was considered carefully when planning the installation. The job took four hours of actual fitting time and two days in total, including removal of the old system and custom fabrication work at the helm.



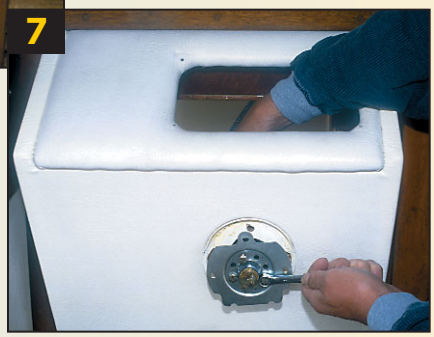
Removing the instrument panel gave easier access to the inside of the helm console…

…which made it much easier to unbolt the old steering head for removal.



The aperture for the wheel in the front of the helm console was too large for the new steering assembly, so a spacer was made using two pieces of 1/2" (12mm) plywood. These were glued together, cut into a rough circular shape with a bolt through the middle, sanded smooth by being spun in the chuck of an electric drill used as a very crude lathe. The spacer was sanded until it fit the aperture and then covered with white vinyl to match the console.

Spacer is glued into the aperture using a contact adhesive and the new helm unit is placed through the instrument panel aperture.



Place the adapter bracket for the tilt unit over the helm face and bolt to the helm unit. At this stage, the assembly is still loose in the console.

Inserting the bolts for the tilt unit between the console and the adapter bracket before being tightened was a tricky process. At this stage it was found that the bolt heads prevented the unit from sitting flush on the spacer, so it was removed and the spacer counter bored to provide recesses for the bolts.

Holes for the three bolts, which hold the entire assembly in position, are drilled through both the spacer and the console.

The whole assembly is now bolted securely into place. Bolts are not supplied with the kit due to the mounting variables.

Fit the new padded sport wheel and tighten the center nut before mounting its cover.

The trim gaiter slips over the tilt unit, where it clips neatly onto the flange around the base. Two tilt-release levers pass through slits in the sides of the gaiter. The woodruff key for the new wheel fits into its slot and some water-resistant grease is applied to the shaft taper.

POWERBOAT - RIGGING

Run the new cable through its pre-planned route. It's easiest to run it from the transom to the helm, as the latter end has only the inner cable protruding, whereas the transom end has a large nut on the outer cable.

Feed the inner cable into one of the two entries in the helm unit, while turning the wheel to pull it in. Which entry you should use depends on which side of the boat the helm is installed. Here it was on the port side, so the cable passes through the entry nearest the port side (when the openings are facing downwards). This ensure that, when the wheel is turned to starboard, the cable pulls the tiller bar of the sterndrive (or rudder) to steer to starboard. Once the outer cable enters the opening, it's secured in position with a locking nut and bolt through a groove in the cable spigot.

The spent core cover has a similar spigot on its end, and is secured in the other opening to protect the end of the cable that protrudes when the wheel is turned to full starboard lock.

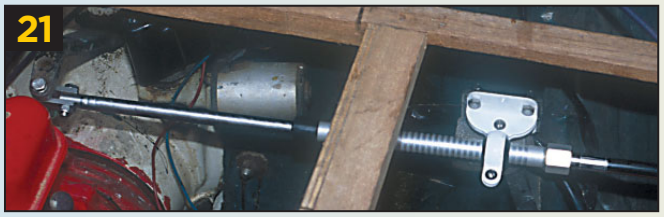
At the other end the grooved mounting tube passes over the end of the inner cable and secures to the outer cable with the captive nut.

Bolt the end swivel to the eye in the end of the inner cable. Torque the nut to 50 inch pounds (13.904 Newton meters) and then slacken a quarter of a turn to allow the swivel to pivot freely but without any play.

Grease the swivel bushing and place into the swivel, where the bolt inserts through it. Next, pass the bolt through the steering arm and fit the washer along with the locknut and tighten to 150 inch pounds or 12.5 foot pounds (41.7 Newton meters). Depending on the hole diameter in the steering arm, a further bushing is provided, if required.

Clamp the two halves of the ball bushing in the appropriate position around the grooved mounting tube, after centering both the outdrive (or rudder) and the steering wheel.

The two halves of the anchor bracket are placed around the ball bushing and fixed together using the two bolts and nuts provided. Anchor brackets are formed so that this bushing clamps tightly within the recess on the steering arm. Now, bolt the assembled anchor bracket to the transom mount using the four nuts, bolts and washers provided.



Once the basic installation is complete, all connections are checked for excessive free-play or tightness and adjusted accordingly.

Adjusting the tilt of the wheel is a simple matter of pulling out the locking bar against spring pressure and moving the wheel to the desired angle.

The tilt assembly is adjustable to any of five positions from fully up to fully down as seen here. Although the fully down position would be unsuitable on this boat, helm positions with the wheel set at an angle would derive even greater benefit from the tilt option.

The finished job is neat and provides comfortable steering for every helmsman whether sitting or standing. In use, the new steering has proved to be a huge improvement over the worn-out original system. It turns effortlessly with no backlash.

DIY BILL

Teleflex discontinued the Command 290 helm assembly when it purchased Morse, rather than offer two competiting rack steering kits. The TeleflexMorse SS141 rack steering kit replaces the Command line and installation is similar to the details in this article. As a bonus, the SS141 offers improved performance both in lost motion (when you turn the wheel and nothing happens), improved efficiency (the amount of effort it takes to move the wheel) and four turns lock to lock. All this translates into a smoother feel, less effort and a better steering boat. Below are the estimated cost of components in U.S. dollars to install the SS141.

SS141 Rack Steering Kit	$144.99
SSC5216 16' (4.8m) Steering cable	$131.43
Wheel, Quest #8021	$30.58

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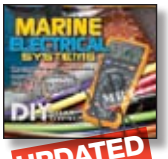

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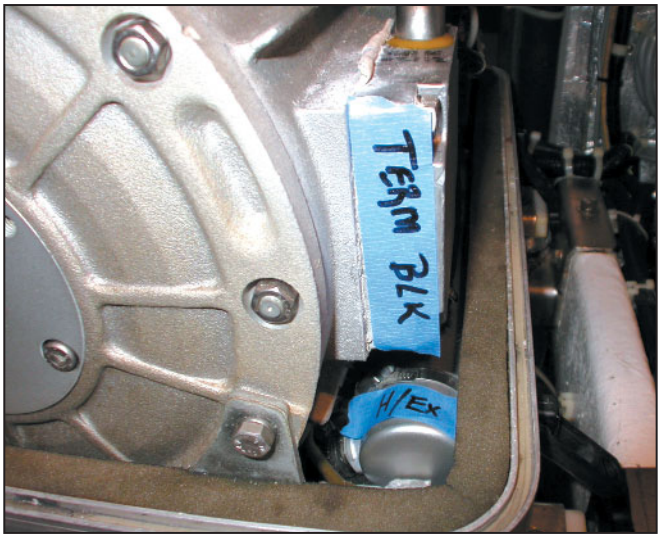
Running Hot In The Tropics

How to cure an overheating Fischer Panda generator and some tips on maintaining all engine cooling systems.

Story & photos by Peter Hall



Location of heat exchanger and water terminal block before retrofit.

Peter Hall contacted DIY's Technical Helpline with a concern about his Fischer Panda generator overheating. His usage averaged three hours daily and the generator was faithfully run for three minutes under no load to cool down before shutdown. After a month of operation in Caribbean waters, the raw-water (saltwater) cooling system becomes clogged at the heat exchanger and starts running hot due to a significant reduction (one-third less) in saltwater flow. At one stage Fischer Panda, who apparently admitted to overheating problems with other units operating in the Caribbean, were going to replace his generator but reneged. It appeared to Peter that he was accumulating salt and minerals and "baking" it onto the aluminum housing, which then fall off and clog the heat exchanger. He sent two samples of debris collected after cleaning the heat exchanger to the company. Follow-up emails to the manufacturer and its authorized dealer in Florida were not answered. Peter was considering two options: purchasing a generator that works in saltwater or replumbing the system so the raw-water flows through the heat exchanger first, a refit he suggested to the dealer but was told, "can't."

DIY's electrical expert John Payne communicated with Fisher Panda on Peter's behalf. Fischer Panda confirmed receipt of the debris samples and confirmed that the buildup of crystals was normal but forming in large pieces to block the heat exchanger was not. Fischer Panda agreed to ship a cooling water retrofit kit to Peter's next port of call in Venezuela. Details of his refit follow along with some great tips on maintaining all engine cooling systems.

Most sailors who venture to the tropics with their boats experience equipment breakdowns and operational failures, usually caused by factors that could have been prevented "if only they had known." This strange behavior in equipment, which ran perfectly in their home waters, results in severe cruiser frustration, fat bills from couriers to fly in spare parts and less time spent enjoying "paradise."

For example, within weeks of getting to the Caribbean my new Fischer Panda Mini-8 generator began to overheat. The thermal protection switches on the Fischer Panda abruptly shut it down. A seal leak in the Johnson model F4B-9 seawater pump restricted the cooling seawater flow that led to the overheating condition. A few months later, I noticed that the generator was running hotter than normal. Again, seawater flow was inadequate. After several changes of impellers, which temporarily solved the problem, and with no visible signs of a leak, I changed the pump for a new one. The result was good initial seawater flow for a few days and then recurring shutdowns due to overheating as flow deteriorated. Ready to turn my state of the art generator into a boat anchor, I instead resolved to take a systematic management approach to resolving this annoying problem.

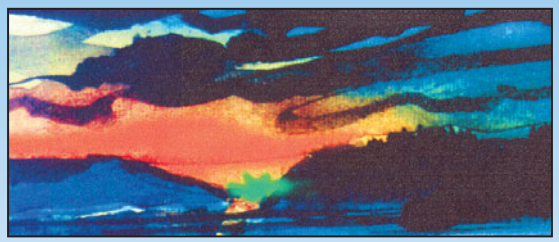
Trouble in Paradise

The Mini-8 is an 8 kW seawater-cooled asynchronous alternator driven by a freshwater-cooled Kubota Z482 two-cylinder diesel running at 3,600 rpm to produce 220/110-volt 60-cycle current. It's German engineered and built, innovative and very compact. It was installed by the boat builder, Queen Long in Taiwan, and commissioning, installations of optional equipment and pre-delivery activities were done in Ft. Lauderdale by Hylas Offshore Yachts, who also registered the 35-hour check and warranty for the Panda.

The alternator shares the engine-driven seawater-cooling system. Seawater first cools the alternator housing. It then flows to the heat exchanger to cool the engine and then out to the engine exhaust. This is pretty standard stuff for most engines, except for the unusual seawater-cooled alternator. Each month, I reverse the flow (pump to heat exchanger then to generator and exhaust) for a few minutes (I keep two lengths of hose to do this) and a significant amount of debris exists the exhaust. After this, the saltwater flow goes back to normal 6.3 gallons (24 liters) per minute and the generator runs at proper temperature and then, progressively, the saltwater flow drops and the procedure has to be repeated.

Surface seawater temperatures in the south Caribbean average 77F (25C) with some anchorages even higher. Overheating engines easily boil seawater. This leads to the formation of scale.

Witness the Green Flash



Green flash at sunset. Watercolor by DIY reader Bert Small, Seagull Art Studio & Gallery (seagullart@saltspring.com).

Many boaters have reported seeing a green flash in the last rays of a setting sun. Though some may not agree, I believe the effect is caused by a color change. When you stare at any primary color and that color is suddenly removed from sight, you see an image of its complementary color for a brief second or two as it fades away. In this case, the red of the sun becomes a green flash.

To demonstrate my theory, stare at a large solid red dot placed on white paper, about 8" (20cm) away, for about 15 seconds, then shift your gaze to the white paper beside the circle. Give it a second or two to develop and a green circle appears, then immediately fades away. You have just witnessed the green flash.

— Bert Small

Water vapor exiting from the exhaust is an indication of an overheating engine (it could also indicate water or coolant getting into the cylinders). Apparently, if seawater rises above 122F (50C), it's a sure recipe for the formation of scale.

It took me months to figure out that scale forms in the alternator housing. This scale falls off the housing and then blocks the heat exchanger and the hose leading to it. This debris causes the seawater flow to decline, which means everything runs even hotter and makes more scale. The thermal protection switches didn't help either as the abrupt shutdowns led to even more scale.

The debris collected is made up of white and gray flakes and small stones, which break up easily and bubble when placed in white vinegar. This is not to be confused with the wet and gooey gray stuff that I understand to be indicative of galvanic corrosion, a problem I hope never to have.

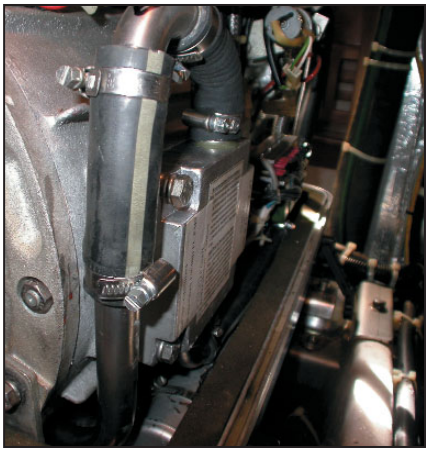
Cooling a Panda

If you have a Fischer Panda and are operating outside normal operating temperatures, here are some things to try. Buy two lengths of hose to fit. Clear hose will work. Jury-rig the hoses so that you reverse the seawater flow and back flush the heat exchanger to see if it's clogged with debris. The pressure from a garden hose is not enough to do this. Have someone with a sieve (borrow one from the galley) collect the debris that exits the exhaust and save it for an evaluation. Remove the water terminal block, which functions as an expensive anode and directs seawater in and out of the alternator housing. Check for debris caught in the hose leading from the block to the heat exchanger. In any event, the block should be removed and inspected at regular intervals to check for corrosion. Descale or replace the heat exchanger with a new one. Check with Fischer Panda service for the best way to clean the heat exchanger if you choose this option.

After DIY contacted Fischer Panda, the company kindly provided, free of charge, a retro kit that consisted of a new heat exchanger, water terminal block and hoses already configured for the change. Seawater now flows through the heat exchanger first so any scale coming off the alternator housing can exit directly to the exhaust. A surprising amount of debris continues to exit the system, even though temperatures are well within spec. (An option not explored with Fischer Panda was to plumb separate cooling systems for the generator and engine, however that's a big retrofit and adds yet more holes in the hull.)

The retrofit turned out to be a simple procedure although it looked very difficult at the start. Temperatures are normal after 50 hours of operation. Seawater flow is now a robust 6.8 gal-

Engine front view showing seawater and coolant pump.



Seawater now exits housing (at terminal block) direct to exhaust.

Fischer Panda Seawater Flow

Original Installation
Seawater Pump >> Generator Housing >> Heat Exchanger >> to Exhaust

Retrofit
Seawater Pump >> Heat Exchanger >> Generator Housing >> to Exhaust

TIPS *Prevent Running Hot and Control Scale*

• Install a temperature gauge on your equipment. If you don't have one, or can't install one, buy a portable temperature gauge and several thermocouples so that you have the means to monitor temperatures. Use sticky tape to attach the thermocouple temporarily to the area you wish to measure. The gauge can also be useful to monitor other equipment.

• Get baseline data for evaluation; for example, start with the hot and cold side of the heat exchanger. There needs to be a temperature differential for the heat exchanger to do it's job. Determine required seawater flow. Then hold a bucket below the exhaust and measure the actual amount of discharged over time. For example, the Fisher Panda Mini 8 should have 5.5 to 7.6 gallons (21 liters to 29 liters) per minute of seawater flow.

• Take a step-by-step approach to eliminate probable causes of an overheating engine. Running at over capacity is a usual reason, so know the generator's capacity and stay below that. Another reason is

Measure temperatures to obtain baseline data.

below spec seawater flow. Low seawater flow can be caused by partially closed or blocked seacocks. Plastic bags, barnacles and coral worms are major factors to check for in the Caribbean. So are undersized or leaking hoses and missing vanes on impellers. Also, what might appear as a minor pump seal leak, indicated by a few salt deposits at the weep hole, can drastically reduce pump flow.

• Check that the thermostat functions properly. Some people remove it, but this may not work with your specific engine design. Also, check the radiator cap. It might not allow the proper pressure to build up in the coolant system. More serious problems could be a malfunctioning coolant pump or a blown head gasket. However, at that stage, it might be time to find a qualified mechanic.

• Bleed the engine coolant system for possible air locks. An overheating engine can boil the coolant, resulting in an air lock at the highest point in the system. Not knowing this early on was a contributing factor to my frustration. Be sure to perform this duty before restarting an overheated engine. Kubota has two bleed screws, one at the thermostat and the other at the top of the coolant pump. Basic procedure is to start a cold engine and run without load for 2 minutes. Then shut down, open a bleed screw and close when coolant appears. You may need to repeat this procedure several times until all air is expelled.

• Always idle the engine without load at least 5 minutes before shutting down.
— *Peter Hall*

lons (26 liters) per minute and I no longer need to pull hoses every few weeks to clear out debris.

Scale Antidotes

If used in seawater, any equipment that is raw-water cooled, whether engine, generator or outboard motor is subject to scaling over time. Prevent the build up of scale by practicing a few simple procedures (read " Tips to Prevent Running Hot and Control Scale" above). Strictly monitor and control operating temperatures and especially make sure you cool down the engine before turning it off. Get a timer, set it for a minimum of three, preferably five minutes and idle without load before shutting down. Then enjoy a sundowner and look for the green flash at sunset. ⚓

About the author: **Peter Hall** has raced and cruised sailboats for 40 years and for the past 5 years, he and his wife have wintered onboard in the Caribbean. When we went to press, they were aboard "Halliday Girl," a 2001 Hylas 46, off the north coast of Venezuela.

ELECTRONICS

RFI: HOW TO TROUBLESHOOT

Buzzing, humming, high-pitched whines, static, turn on/turn off spikes, signal loss — all examples of interference that affects the performance of sensitive electronics. The key to understanding how to troubleshoot is to understand the causes.

By John Payne

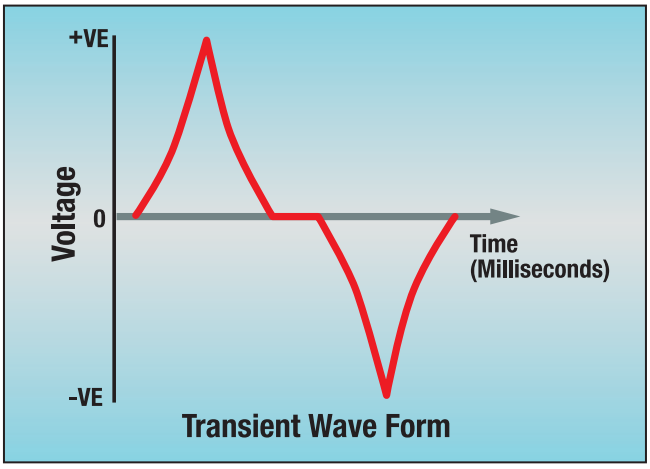
Noise sources on a boat are often classified as radio frequency interference (RFI) or electromagnetic interference (EMI). They are major enemies of electronic systems, corrupting your GPS position fixes, degrading radio communications and causing general electronics' performance problems.

RFI is essentially interference and noise that is superimposed as a disturbance or voltage transient either on the electrical power supply or the data and signal lines. This is then processed along with the good data to corrupt or degrade the processed information.

Transient or Induced?

The voltage transient is probably the most damaging and comes from many sources. The best-known effect is the corruption of GPS and Loran data where the power is taken off an engine starting battery. When a significant load is applied to the battery, there is a momentary voltage drop creating what is often called a brown out condition and then is followed by a voltage increase. This low-voltage disturbance can exceed 100 volts in some cases, damaging power supplies, wiping memories or corrupting the data. The same applies to two battery systems where the house bank supplies items such as electric toilets and other heavy current draw equipment. A starting battery voltage can have a 3 to 4-volt dip on starting. The variation or interruption of current in the equipment power conductor also causes transients.

Induced interference is the second common RFI noise source. Electrical fields are radiated from cables and equipment and this is induced into other closely located cables or equipment. The most common causes of this are cables running parallel or within the same cable bundle, known as mutual coupling. Always run power supply cables and data cables separately and make cable crossovers at 90°. In particular run power cables to sensitive equipment separate to main power cables to reduce inductive and capacitive coupling to signal conductors.

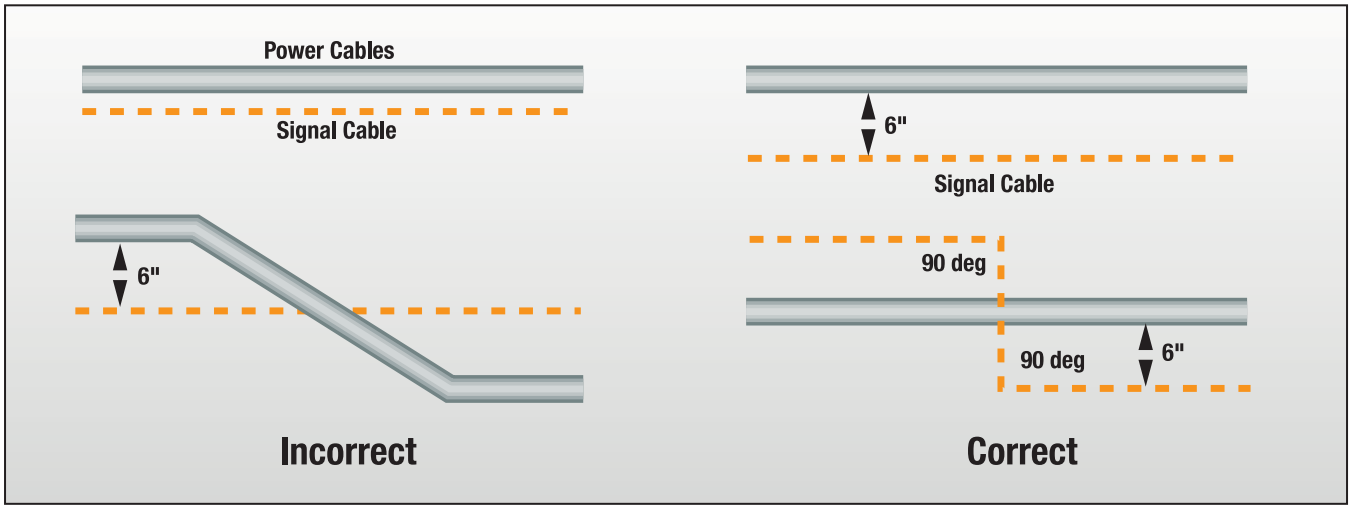


An example of transient waveform.

Common Sources

Noise occurs in different frequency ranges and similarly, equipment may only be prone to problems within a particular frequency range. Multiple noise sources can cause a gradual degradation of electronics components and when the cumulative effects reach a certain point, the devices fail.

- **Arcing Noise.** These are repetitive spikes that are caused by commutators and sparking of brushes. The brushes on any alternator, particularly if dirty, can cause sparking and noise. Charging systems commonly cause this or when loose connections exist. The most common cause is loose or poor engine return paths for alternators, when the negative path arcs across points of poor electrical contact. This is also caused by ignition systems from distributors and spark plugs being impressed on a DC system, often through radiation to adjacent cables. When troubleshooting, always determine what is running at the same time.
- **Induced Coupling Interference.** Wiring that is installed in parallel with others can suffer from inductive coupling interference causing buzzes and humming sounds on the radio. This occurs like a transformer with a single turn primary and secondary coil, with the magnetic effects causing the induction. Low ground impedance and unbalanced circuits are the most prone with serial data, multi-cable control and co-axial cables being the most susceptible ones. It's important to keep signal cables from running in parallel with main power wiring. When troubleshooting, always determine what is running at the time as this impacts which cables are involved and will help localize the problem area.
- **Ripple Noise.** Ripple is created in any rectifier bridges (diode, silicone-controlled rectifier (SCR), etc) such as alternators, chargers, fluorescent lights and inverters. It's usually a high-pitched whine. Good quality equipment has suppressed electronics. Ripple badly degrades communications' audio quality. When troubleshooting, again determine which lights are on, or whether chargers or engines are running.



A distance of at least 6" (15cm) should separate signal cables from power-carrying wires.

- **Static Charges.** These have a number of sources. External charge interference arises due to static build-ups in sailboat rigging. On reaching a certain voltage level, the static charge discharges to ground to cause interference. Another common cause is when dry, offshore winds occur and a static charge builds up on fiberglass decks. The problem is prevalent on large fiberglass yachts with large deck areas. A lightning protection system can ground these charges. Engine and shaft charges also cause interference and this can arise due to static build-ups, both induced and those due to moving parts in the engine. The static charge discharges to ground to cause interference. Shaft interference can arise due to static build-ups on propeller shafts. The static will cause interference when it discharges to ground on reaching a high voltage level.
- **Surge (electromagnetic pulse).** This can be caused by lightning activity. Pulses can be induced into electrical wiring and aerials.
- **Spikes.** Turn-on spike results from the initial charging of power supply input filters on power supplies. Turn-off spikes arise when reactive loads are switched and the magnetic fields collapse on inductive loads, such as transformers, relay or contactor coils, solenoid coils, pump motors, etc. metal oxide varistor (MOV) suppressors are often put across the coils.
- **Solar Activity.** This is caused by ionospheric and solar or sun spot activity. Usually it results in signal losses or major corruption. When troubleshooting this condition, always check whether storms are in the area.

Troubleshooting

Once sources are defined, RFI troubleshooting is the relatively simple method of locating the noise source. The listed causes must be verified one by one to eliminate them. It's a matter of logic and the systematic switching off of each device to locate the noise source. When the noise stops, the cause is located. A simple process of elimination, although it isn't always that easy. In many cases, it may consist of identifying two or more sources that are overlaid to cause a cumulative noise effect. Some RFI noise is simply intermittent, such as static discharges or lightning pulses, which may not even be visible locally.

What tools do you need? A small, cheap battery-powered AM radio is a good tool for tracking down and sniffing out radiated sources of noise on board, with static causes being easily picked up. Passing it close to the cables or equipment is the method used. Some noise is simply related to time of day. Interference from solar activity and ionosphere factors, for example, on radios are sources that

must be considered. These may affect GPS, SSB and HAM radio and satellite communications all simultaneously, giving the appearance of some greater problem. If you have determined that RFI is around noise and dust, you may already have the answer.

When troubleshooting a GPS or radio, first disconnect the antenna and, if the noise continues, it's probably caused by the electrical system. If RFI increases when the GPS or radio aerial is reconnected, then the cause may be atmospheric or from some other emission or is being picked up from the antenna feed cables. It's important to understand that RFI may originate from more than one path, so ensure all possibilities are investigated.

Metallic Sounds

Ticking on the radio is a common problem. When the ticking noise varies with the speed of the engine, then you are probably experiencing ignition noise or alternator based causes. Usually this only affects the power wire for the equipment. Sources of this noise are usually the distributor, the ignition coil, spark plug wires and spark plugs. If ignition noise is identified, move the power wire as far as practicable from any of these sources. If this does not improve things, then check all of these components. Also, check that plug wires and spark plugs are RFI shielded.

Suppression Methods

There are a number of methods that can be used to reduce or eliminate interference. The use of shielded cables along with proper installation is one. The use of suppressors, such as a filter or capacitor installed close to the noisy equipment is common and this effectively short circuits noise in the protected frequency range. Filters may take a number of forms and suppressor capacitors may need to be installed on alternators. Cable separation is another major suppression method.

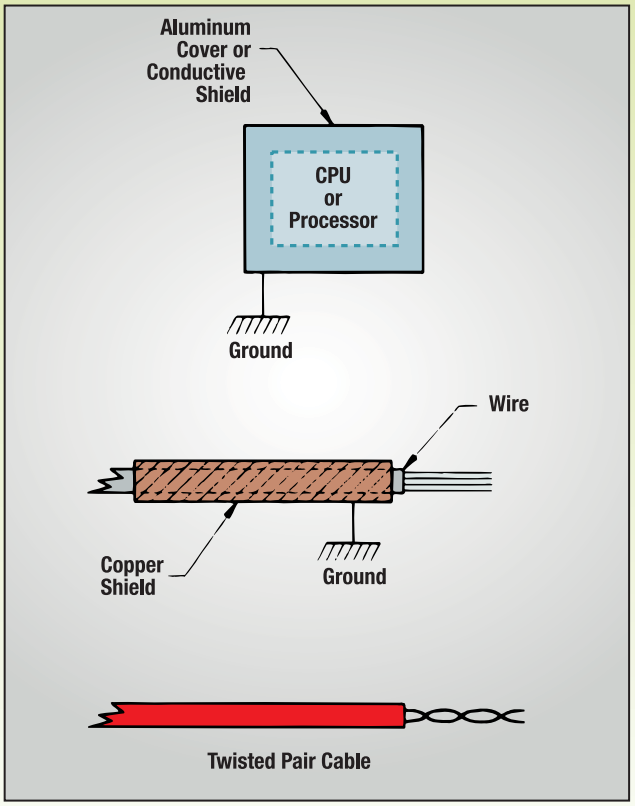
About the author: **John Payne** is DIY's electrical specialist and author of "The Marine Electrical and Electronics Bible," and "The Motorboat Electrical and Electronics Manual" (Sheridan House), and founder of the Marine Electrical School (www.marineelectrics.org).

Proper Grounding

The proper grounding of electronic equipment is essential for optimum performance. Most RFI problems, such as noises, hums, buzzes, interference or cross talk, etc. are, in many cases, caused by bad electronic grounding.

Ground signals carry currents and currents run through the wires. If there is any difference in voltage between the two ground points, this causes current flow and problems. Currents that flow through the various grounds are known as ground loops. The ground in electronics is a reference voltage point for all signals equal to 0 volts. To prevent ground loops, all signal grounds should be connected to one common point. Cable shields are designed to protect against interference from unknown or unspecified sources. The effectiveness of shields is measured in terms of transfer impedance. This is a measure of effectiveness in capturing the interference field and preventing it from reaching the conductor pairs inside. Data cables also have shields that are made from a foil-polymer laminate tape or have layers of braiding. These also may have a drain wire installed to enable termination of the screen to ground. Most equipment manufacturers also specify the termination of shields to ground. Never ground at both ends. Always ground one end only and, typically, this is at the equipment end. In many cases, shields are not connected at all, so check and connect them, as it may be a source of RFI.

— *JP*



Methods of screening: (top) cables are grounded by a metal screen; (middle) shields protect against interference from unknown sources; (bottom) wire pair twisted together reverses electrical fields effectively causing cancellation.

SAILBOAT RIGGING

Rigors of Rigging

You've waxed the hull, oiled the teak and serviced the engine but when was the last time you inspected the mast and rigging? On older boats, replacing the mast is a very costly investment. Careful inspection of standing rigging and its terminal connection hardware and keeping these free of dirt and corrosion will go a long way to preventing premature damage and failures.

Story and photos by Jan Mundy

Masts, booms and rigging are the least maintained items on most sailboats. Structural flaws, wear and corrosion are the primary suspects when a mast falls down. Once it's up, it's rarely given much consideration again until something goes wrong. Boats that get a winter vacation from service often enjoy the benefit of a chance to look at the rig and rigging if the mast is unstepped for storage. A sloppy forestay, elongated attachment holes on chainplates or tangs are all clues that the mast and rigging needs a thorough inspection. And don't forget the internal points of rigging attachment, those chainplates that are often buried behind joinery.

Wash the mast with soapy water and rinse well to remove acids, salts and grit on sheave and block bearings. Now, we're ready to go. Grab a magnifying glass, a penetrating dye (available from a welding shop), spray lubricant, straight edge (ruler), barrier solution and sealant and let's look at the problem areas starting at the masthead.

The Stick

Starting at the top, examine the masthead carefully at the point of attachment of every piece of hardware. We're looking for cracks radiating from fastener holes or wear at rigging connection points. Aim that magnifying glass at any welds glass to check for cracks. Brush or spray the penetrating die on welds and swage fittings to look for microscopic cracks that, when stressed, can grow and let go, bringing the mast down. Production masts have cast heads fastened with rivets. Check that rivets aren't popping out and fasteners are tight and refasten as needed with Loctite (the red one). Use your magnifying glass to examine tangs for cracks where their angles are formed.

Malfunctioning sheaves cause big problems at the masthead. Sheaves are usually made of nylon or aluminum. Nylon sheaves tend to deteriorate from UV exposure. Aluminum ones typically have oil-impregnated, self-lubricated bearings that eventually wear out. Spin sheaves to make sure they turn freely. Check bearings and look for side wear. Often the axle bolt doesn't sit horizontal to the sheave and halyard tension causes side loading. A nylon sheave with a badly worn center indicates a too small bolt or overloading.

Worn sheaves sometimes have flat spots where wire halyards run over them. Sheaves are cut differently for wire than rope. Most older masts had wire-to-rope halyards and sheaves designed for wire only. With the minimal shrinkage lines available today, most halyards on new rigs are now rope and rope-only sheaves are used. If you switch from wire to rope halyards, you will need to change the sheaves.

Check for side-to-side play between stacked sheaves. A sheave that doesn't fit properly causes side loading and wears against the housing producing a sharp edge. Where there is excessive play, add a 1/16" (1.5mm) Teflon (or other thin plastic) spacer between the sheaves to prevent a halyard from jumping the sheave and jamming.

While you're at the masthead, remove the axle bolt retaining the sheaves and apply a spray lubricant, not oil, which collects dirt and dust, causing the sheave to jam. While you're at it, clean and lubricate the mast track.

Both deck and keel mast steps are prone to corrosion from standing water and should have a drain hole. A deck-stepped mast rests in a cast foot or a taller tabernacle that provides extra vertical support. For added support, the mast bottom needs a compression tube, preferably welded in. Made of 1" aluminum tube, it's cut to fit the exact inside width of the mast then thru-bolted with the step retaining bolt.

Check halyard splices, shackle attach-

TIP

Greenhouse Effect

When storing a spar, never cover it with plastic. Plastic retains moisture, resulting in corrosion where aluminum and stainless steel are mated. And if the mast is painted, the coating will blister.

ments and halyard alignment out of exit boxes. Wear plates installed on exits helps to reduce rope chafe. Consider replacing any halyards that have become stiff from UV exposure.

Spreader Failure

Spreader attachments are either welded or fastened with screws, bolts or rivets. Cast bases can fracture, typically when a mast is unstepped and stowed on a rack. Check tightness of screws and bolts and look for cracks in castings and along weld lines. Look for symptoms of wear on the clevis pin that captures the spreader on its base. Correct shroud alignment with spreaders is critical. Sometimes the spreaders, especially the aerodynamic, foil shaped type, are ground with a bit of rocker at the inboard end so they tend to move. They shouldn't. The normal mast pumping action eventually elongates the bolt hole and the spreader grinds away the base, causing it to crack or split. Spreaders are self-aligning (fore and aft only) so once your rigging is up and properly aligned there should be no movement. Vertical spreader alignment must be adjusted to "bisect," i.e., maintain the correct angle of the spreader tip to the standing rigging. Custom masts have fixed spreader bases to prevent any movement.

One reason for spreader failure is lack of an internal mast compression tube. Remove the spreader base, if possible, and look for a tube. Better built masts have a welded-in compression tube that spans the mast inside diameter to link both sides of the extrusion together and equalize the loading. A tube can be refit by a mast manufacturer but it won't be as strong as a welded-in tube.

A common problem in winter climates is "pregnant" spreaders. Masts stowed on a rack with hollow spreaders in an up-down position fill up with rainwater that then freezes, causing aluminum to expand and crack or break the tips or form a bulge in the trailing edge. Best to remove spreaders during long-term storage.

Many spreaders have a cast aluminum tip welded into the end. Stainless-steel rigging passing through the tip is captured with a cap, plate or screw, and then the end is taped so it doesn't chafe headsails. Tape traps water, reacts with the aluminum and stainless steel and, as dissimilar metals, dissolves the aluminum casting. Spreader tip corrosion is a widespread problem.

This is not just a saltwater problem. Acid rain can dissolve aluminum. At least once a year, remove the tape from the spreader tips, inspect and clean them and allow them to dry completely before retaping.

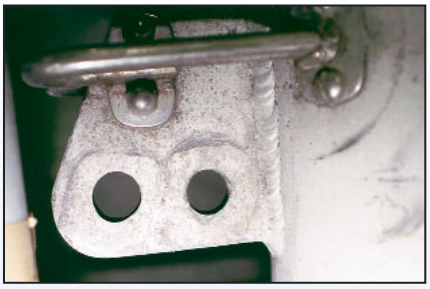
Hinge Point

The same visual inspection you performed at the masthead and spreaders also applies to the gooseneck, which is the strange name given to the hinge that secures the boom to the mast. Check castings, sheaves, fasteners and gooseneck alignment. Use the magnifying glass to examine the gooseneck fitting for cracks. A surveyor we know has reported often finding the clevis pin at the gooseneck fitting adrift from the loss of its securing cotter pin. While doing its

(top) Without a compression tube, this spreader failed. (bottom) Every thru-bolt going through a mast or boom should have a compression tube as shown in the mast base where it's pinned in a deck step.

Metal doesn't have to look like this! Restore pitted and dulled aluminum by scrubbing with a Scotch-Brite pad and soap and then rinse and wax frequently to retard further damage. Note where the casting broke due to elongated pin holes. This has been welded to make it usable. Early masts had cast stem fittings; now most are fabricated and welded.

This double mast conduit design allows a second wiring conduit to slide over the inside extrusion.



Wrong size pin has caused holes to stretch (elongate) in this masthead tang. Always insert a correctly sized clevis pin.

Isolating stainless-steel fasteners with a dab of Tef-Gel under the head and around the screw body would have prevented corrosion between fastener, tang and the aluminum mast.

work, this clevis pin tries to back out of the connection point and shears off the cotter pin.

Look for cracks radiating from vang and mainsheet attachment points on the boom caused by excessive loading. (Note: Upgrading from a rope vang to a rigid vang can break a boom that wasn't designed for such high loading.) Compression tubes at these high-stress points are recommended. Check bails for wear and for loose attachment. Be sure you've installed the correct slugs or slides. The wrong size hardware permanently damages the track and the only solution is a new boom. (Ditto for mast tracks.) Clean and spray the track with a Teflon lubricant.

Standing Rigging: Wire

Damage (kinks and crushed wire) to standing wire rigging often occurs when stepping and/or removing or moving the mast or when it's stored incorrectly on a rack. Wire kinks should never be straightened by force. Even a gentle bend is enough to order a replacement wire. When stowing a mast, place foam or carpet between the rigging and mast to prevent damage. Also cover the rack where it touches the mast. To prevent kinks, be sure no rigging gets trapped under the mast. Take the same care with furling gear to prevent damage to a foil.

Wipe all wires with a cotton ball or nylon stocking to uncover any "meat hooks." Never use your bare hand. A single burr is sufficient to condemn the wire (and tear your skin). Rigging that is heavily rusted or randomly discolored should also be replaced. Examine every end fitting for cracks. Look for fraying and rust where the wire enters the swage or mechanical terminal (e.g. Norseman or Sta-Lok) that suggests corrosion damage. Lay a ruler alongside the swaged fitting to check for alignment. Replace any rusted or bent terminals. Dab silicone sealant at the wire-terminal juncture to reduce the chance of further water intrusion.

Standing Rigging: Rod

At one time, the life expectancy of rod rigging was quoted in years, now it's rated in miles or wear cycles. The breaking point can be seen in the analogy to a wire coat hanger. How many times can you bend the rod (wire hanger) before it fails?

Rod rigging should be inspected at least every two years. Before doing this, you'll need to clean the rod. Varsol and scrubbing with a ScotchBrite pad works best. Navtec, the original rod manufacturer, recommends a careful, end-to-end visual inspection with a magnifying glass. Typical problem areas include: cracks at the mushroom-shaped ends (not to

TIP *Bet you didn't know that...*

Turnbuckle screws should always be of a dissimilar metal than the body. This means coupling a stainless-steel turnbuckle body with a bronze screw, for example. Most boats are rigged with all-stainless or all-bronze turnbuckles. When dirt collects on the screws and then these are turned, similar metals tend to gall. When this happens, the two parts marry forever and are nearly impossible to take apart. (A good reason for keeping screw threads clean and well lubricated.)

be confused with score marks from the heading process); cracks where the rod bends over spreaders; kinks at terminal connections; seized ends that prevent pivoting of the rod as the system is designed to do so it sticks, bends and snaps; damaged tie bars and of course, bent rod. The only sure method to test rod is destructive testing, at which point replacement is the only sensible option. Rigging usually fails without warning and it never breaks at a good time. When in doubt, replace it. One of the methods of securing rod rigging to the mast is with aluminum (older masts) or stainless-steel (newer masts and more durable) tie bars that pass through the mast. Problems occur when routing wire-to-rope halyards through the mast. If the halyard lands on the wrong side of the tie bar, over time it saws through the tie bar, which disconnects the rod from the mast, potentially dropping the mast. Make sure halyards are routed correctly inside the mast.

Deck Level

Keep turnbuckles clean by scrubbing with a toothbrush that's dipped in boat soap. Regularly lubricate with lanolin or a dry Teflon lubricant to prevent cross-threading, particularly if the screw and body are made of the same metal. Never apply a petroleum-based grease, which tends to attract dirt.

Be aware of turnbuckle screw thread length (more is better) and always safety lock the screws, either with clevis pins or wire. Do not use the round split rings. They deform and fall away. A blob of clear silicone on the sharp cotter pin ends will protect skin and clothing. To loosen a seized screw, try StarBrite's antiseize lubricant and always replace any screws with damaged threads. Also, using your ruler, check that turnbuckles are straight and replace any that are bent. Check toggles for wear, cracks and bent clevis pins. Pinholes in the surface of cast bronze toggles are signs of "blow holes" in the casting and they signal the need to replace the toggles.

Look for cracks where chainplates bend and around clevis pin holes. Examine the bolts holding the chainplates for wear or distortion. Check for crevice corrosion around the base (at deck level), caused by standing water. Check for misalignment with the standing rigging, which causes chainplates to flex and puts uneven stress on pins and jaws of toggles and turnbuckles. (Tip: With the mast up and tuned, disconnect one wire at a time and watch carefully to see if the chainplate moves; reattach this wire before disconnecting a second wire.)

Corrosion

Corrosion is caused by dissimilar metals in the presence of salt or acidic water; stainless steel and aluminum being the two metals most often found on masts. Oxidation or pitting of aluminum or rust around stainless-steel fasteners is a sure sign of corrosion. On painted masts, peeling paint around stainless-steel fasteners signals corrosion activity. If you see

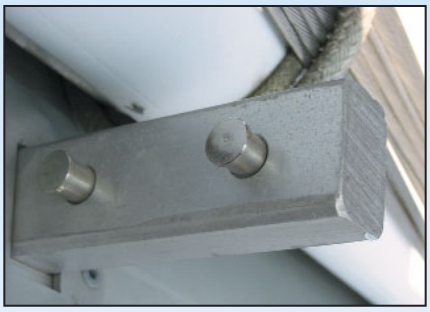
(continues on page 49)

Susan Canfield

Corroded (exfoliating) mast step due to standing water in bilge.

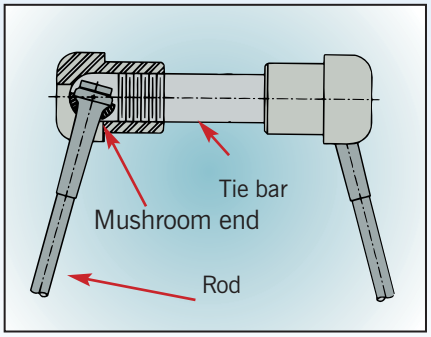
Susan Canfield

Mast heel casting showing galvanic corrosion due to standing water in bilge. The corrosion would have been worse had dielectric material not been placed between mast heel and step.



A 5/8" (16mm) clevis pin goes in a 5/8" (16mm) hole. If you lose a pin never replace it with a smaller diameter one.

Example of spreader tips that were taped and trapped water resulted in corrosion. Spreader tip corrosion is a common problem.

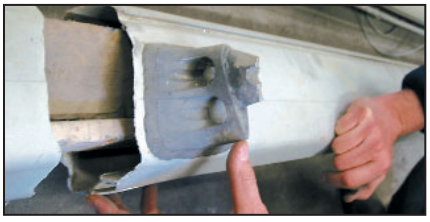


(top) A mis-routed wire halyard has channeled these Navtec rod-rigging tie pieces. (bottom) Example of rod rigging attachment to a mast.

SAILBOAT RIGGING

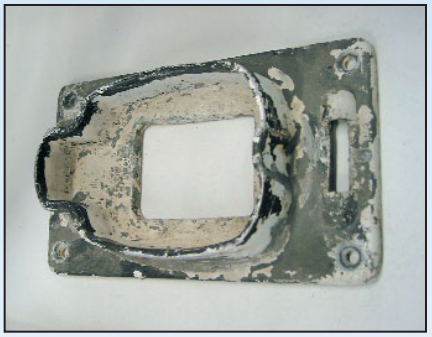
Dissimilar metals caused this aluminum casting to corrode. This one was originally black when new but has faded.

Assortment of plastic sheaves show: UV damage; the sheave or a spacer of the incorrect width caused a halyard to jump the sheave and break the sides; a wire halyard has cut into the plastic sheave.



When a cast spreader base fractures, it's an expensive fix. The mast is completely dissembled of wiring and rigging, the base is removed and a new one welded on.

Mast mounted winch base shows signs of corrosion from trapped water.



Cast aluminum steps and saltwater (even acid rain) are prone to corrosion. The design of these deck steps offers little support to tall masts.

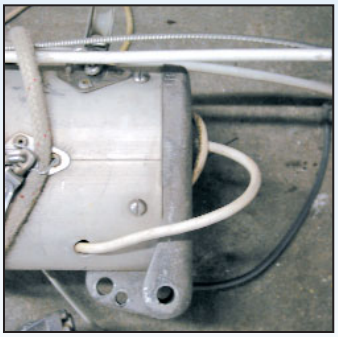
Flaking paint on the mast and boom gooseneck are clues that corrosion is occurring.

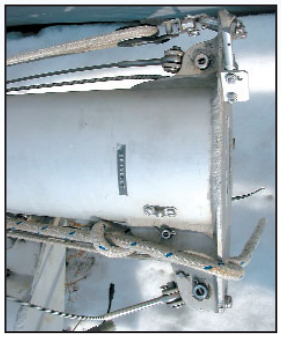
TIP
Noise Barrier

If the sound of wires, cables and halyards slapping inside an aluminum mast irritates you, slide lengths of foam pipe insulation through each group of wires before restepping the mast.

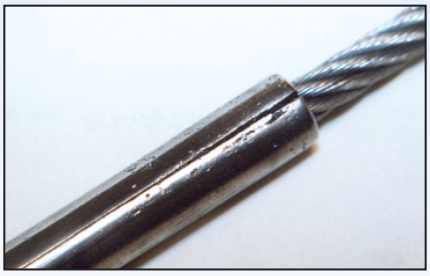
For free-spinning sheaves, remove axle bolt and apply a spray lubricant.

(left) Rod rigging on an '80s Pearson 43 is inspected by a worker at Klacko Spars. (right) Rod end is pushed into the turnbuckle and checked for cracks. Mast termination points are often inaccessible without destroying the rod end.





Examples of mastheads: a cast piece (top) on an older C&C is mechanically fastened; (bottom) a newer masthead has a welded-on cast head.



(top) Water seeping under the wire has caused this swaged stainless-steel terminal to pit and crack. (bottom) Waterproof the wire terminal joint with a dab of silicone sealant.

It's common to have a toggle at the bottom of the forestay but more critical is to have a toggle at the top. Put one at the top of the backstay as well.

(continued from page 46)

an evidence of corrosion occurring, remove the fitting to investigate the damage. To electrically isolate dissimilar metals when installing fasteners some nonmetal barrier must be put between the two mating surfaces of dissimilar metals. Apply Tef-Gel or a sealant or similar but never silicone. Check with a professional rigger for suggestions about the latest, greatest formula for electrically isolating dissimilar metals on the mast.

Wiring and Cables

Routing wires and cables down a conduit inside the mast separates them from halyards and eliminates the annoying slapping but not all masts, especially older ones, have conduits. Newer masts have integral conduits or a provision to easily install them and, typically, are fitted with two conduits: one from the masthead to the step and a second one at the spreaders to run wires for spreader lights. Refitting a conduit is not an easy task. PVC pipe is run up the mast and held with couplings spaced about every 5' (1.5m). To fasten the coupling requires drilling two holes: one to pass through a hook-type tool that braces the pipe against the mast while drilling the second hole and riveting on the pipe. When that's done, the first hole is filled. Conduits are not a critical component. If you can tolerate the noise, don't sweat it.

Check antenna and instrument mountings. Protect cables with a grommet or form a gasket of silicone sealant where they pass through the mast. This will protect them from chafe and provide strain relief.

Stray current causes all sorts of problems. Paint will literally jump off the mast and things will corrode at an accelerated rate in a saltwater environment. Normally, this is a grounding issue so be sure no electrical wiring is exposed to direct contact with the mast.

All it takes is just one end of any wire or connector to fail and a mast can come down. Every year, insurance companies write off dozens of sailboats because of mast or rigging failures. On older boats, the loss of a mast (and sails) often adds up to more than the boat's insured value. Routinely inspect your mast and rigging and replace components as needed. Rigging is an expensive upgrade. Planning annual upgrades; for instance, replacing the forestay and backstay one year, uppers and lowers the following year, makes less of a dent on the budget.

About the author: **Jan Mundy** is editor of DIY.

Special thanks to Klacko Spars, Oakville, Ontario (905/825-0015) for research assistance with this article.

Boat Upkeep

Preventative maintenance is time well spent when you consider the reduced repair bills and greater trade-in value of your boat. Here are a few tricks to keep your boat shipshape.

By Jan Mundy

REVIVE URETHANE SHINE

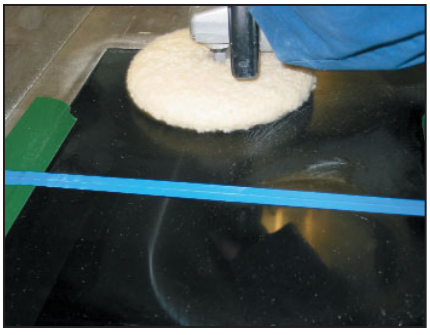
Q: I have been told that it's possible to bring back the shine to Awlgrip by first using the 3M Marine Super Duty Rubbing Compound or 3M Imperial Microfinishing Compound followed by 3M Marine Finesse-it II Finishing Material applied with the 3M Superbuff Buffing Pad and Polishing Pad. Do you have any comments or other recommendations?

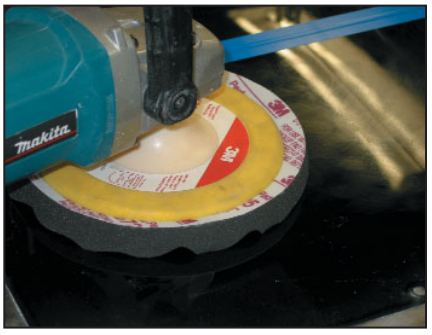
Thomas Plocek, "Strawberry," Shelter Island, New York

A: Never use 3M fiberglass products, which are the ones you mentioned, on a painted finish. Instead, 3M has a Perfect-it system for urethane finishes that includes a color restorer and glaze. If your boat has an aged polyurethane finish and you have applied the Awlcare Protective Sealer and are unable to regain the gloss, the Perfect-it system will revive the paint and give you a few more years before the surface needs repainting. This should be considered as a last ditch approach and should never be applied to a finish in good condition. Using the incorrect products or wrong technique can destroy a painted finish. This is the main reason why manufacturers of urethane coatings, such as Awlgrip, Brightside, Epifane, Interthane, Sikkens and others, don't endorse sanding and buffing of their coatings.

This is a Band-Aid fix. Just like restoring dull and faded gelcoat, you are removing layers of dead material and the paint is only so thick. As aging and fading continues, you'll have to repeat the process. Eventually, repainting is the only cure. For boats painted with a marine enamel, the same repair technique applies.

3M Perfect-it is a four-step system: sand to remove any defects and then compound to remove sanding scratches and sander swirl marks, follow with a glaze to remove swirl marks from compounding and deliver a high gloss and then wax to protect the hull from UV damage. After washing the hull with boat soap, sand the hull with 1,500 grit wet paper or 1,200 grit dry paper. Dry sanding is faster; wet sanding is messy and there's the slurry to clean up. Always use a sanding block when hand sanding.





Wipe off the sanding residue and apply the Perfect-it rubbing compound with white foam or wool buff pad, your choice. (Foam is not as aggressive as wool.) Mount the pad on a soft foam pack-up pad and run the polisher/sander at 1,800 rpm. Begin buffing by applying a medium pressure on the surface, then light pressure. As paint is softer than gelcoat, there's a better chance of burning through it than gelcoat. Do a test spot first in an inconspicuous area to determine the amount of pressure required.

Next step is to apply the glaze. This is what gives the paint a mirror-like

gloss. Apply glaze with a black foam waffle pad; never use a wool pad. (Waffle pads work fast and generate less heat.) Again, start with medium pressure and then lighten up. This helps to dry the glaze and buff the surface to a high gloss. When applying compound or glaze, be careful you don't scorch the paint. Work in the solution over a small area, say a 2' (61cm) square area. These products act as a lubricant and, once you see the solution work into the paint, stop. Aged, badly faded painted finishes may require additional compounding.

Since glaze has no UV inhibitors, the last step is to apply a quality marine wax to protect your glossy finish from sun damage. Apply wax, either the traditional way by hand or by machine, which spreads the wax faster and uses less material, allow to haze and buff with a black foam pad.

— Jan Mundy

Awlgrip Touch-Up

Your boat is newly painted with Awlgrip (or another brand of polyurethane paint) and, though you've been vigilant, you slightly but conspicuously crease the finish following a close call with a fixed object. What to do? Don't try to fill the scratch with wax or other filler. Instead, follow this advice from Nick Hall of Awlgrip. For a small scratch or ding the best thing to do is:

1. **Wipe the scratch or ding clean with denatured alcohol using a clean cotton cloth.**
2. **Don't sand. Sanding just increases the size of the area needing a touch up.**
3. **Mix a small quantity of the original color and Awlcat #3 brushing converter (H3002). The mix ratio is two parts by volume color base to one part Awlcat #3. You don't need reducer for this small area.**
4. **Carefully color in the scratch or ding using an artist brush. If you apply too much, wipe it off with a clean rag dipped in alcohol and try again. Some colors and some scratches will need more than one coat. Don't try to fill the ding with paint. All you want to do is establish color.**
5. **From close up your repair will be visible but stand back a few feet and it likely looks okay. If the spot needs more than this treatment, a professional paint shop should do a blended repair.**
6. **Maintain your Awlgrip finish by keeping it clean and apply a protective sealer on a regular schedule; typically, two to three times a year on the deck or cabin, once a year on the hull. Doing this doubles the life of your paint job. Never apply wax on any urethane finish.**

— Jan Mundy

Spot Treating Rust Spots

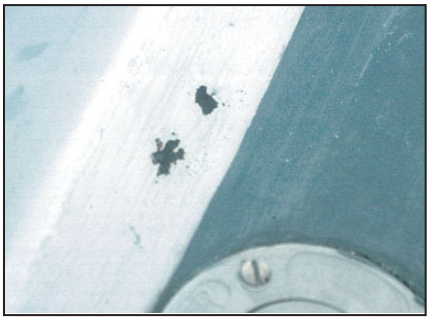
An easy method to repair nicks and dings on steel boats before the rust takes hold.

By Peter Caplan

Even the most fastidiously maintained steel boats suffer the occasional rust spot. Contact with docks and other stationary obstacles, which would cause serious damage to a fiberglass boat, only scrape the paint from a steel hull. Sometimes, an object is accidentally dropped and, although no damage is apparent at the time, a few months later, when moisture has found its way through a microscopic hole in the protective paint coating, a small bubble appears in the paint surface indicating that rust has formed beneath.

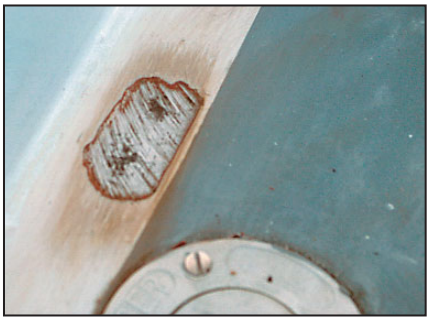
Because of the strong bonding characteristics of epoxy coatings, they don't lift as readily as ordinary enamel or urethane paints when rust forms beneath the coating. It may take six months or more before any sign of a problem appears. By then, the rust might have spread beneath the coating. This is not a big repair but it's essential that the paint coating be removed completely to expose clean metal. This can be as little as an inch around the original pinprick. If left unattended, the area will grow larger.

The following sequence shows step by step how to repair minor rust damage.



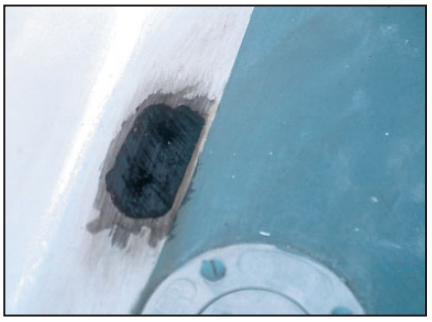
Two small spots on the deck paint are the only symptoms of a developing problem.

Using a sharp wood chisel and small hammer, the paint is chipped off until clean, rust-free metal is exposed all around the rusted area.



Clean the repair area with coarse abrasive paper or emery cloth and feather the paint edges.

Paint the metal with rust inhibiting product, being careful to cover all the exposed metal.



Once cured, the surface turns a blue-black color.

Paint the repaired area with successive coats of matching epoxy paint or a compatible coating. Alternatively, fill the repair with compatible epoxy filler as shown in this example. Once the filler has cured, paint over it with a color matched topcoat.

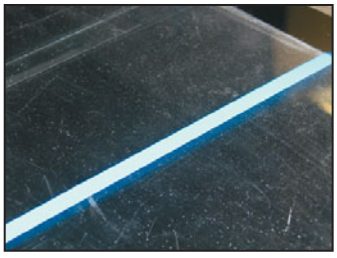
PROPANE TAILINGS: *Check Before You Connect*

If the LPG supply tank is near empty when you're refilling your propane (LPG) bottle(s), the debris or "tailings" in the tank bottom are released into your bottle as it's filled. Known as "propane tailings," this residue travels through hoses and lines and can damage regulators. Run a cotton swab or your fingertip around the vent end of the regulator. If it has an oily film, your system is clogged with tailings. To reduce the risk of regulator damage, purchase propane from a reliable source, frequently check the regulator for tailings, especially before reconnecting, and carry a spare regulator.

TIP
For Your Mess Kit

Keep a rust inhibiting product onboard a steel boat as any minor damage that cannot be dealt with immediately can be coated with the product to arrest the rust from spreading for up to six months until you can do a proper repair and recoating.

A CLEAR VIEW



The marine environment is harsh on acrylic, Plexiglas and Lexan ports, hatches and windows. Normal wear and the sun's rays soon degrade and etch the "plastic." While this doesn't harm the material, it does affect the quality of visibility when viewed from inside the cabin. The best treatment for new or undamaged plastic lenses is to keep them coated with a UV protector designed for plastics, which also prevents dirt from adhering to the surface. It doesn't take long for UV exposure to discolor the plastic. After cleaning, wipe the surface dry using a chamois, loop-fiber rag or one of the new 3M High Performance Cleaning Cloths. Never use a smooth rag, such as a cotton one, which can scratch the surface. Be sure no water is left on the surface as the sun will boil the water and leave a permanent discoloration.

After 12 years and few applications of a protective coating, the opening ports on our boat were badly scratched. We had tried various plastic cleaners but without success until we discovered the missed step. Just as you get a better finish when buffing gelcoat with mechanical advantage rather than hand rubbing, the same is true when overhauling plastic lenses. Purely trial and error, since of course, none of this information is mentioned under "Directions" on the product label.

Take any liquid cleaner/restorer intended for Plexiglas (this doesn't work on Lexan). There are several brands depending on how aggressive your cleaning needs. Attach a white wool pad to a power drill, apply some solution to the pad and, running the drill at 2,000 rpm, "buff" the surface. I used 3M Plastic Protector (no longer available) and it did an excellent job of removing the fine scratches. After cleaning, follow with a plastic protector that contains UV inhibitors. Repeat applications of a protector during the season will protect plastic surfaces from further damage.

– Jan Mundy

DIY TOOL BOX

Basic maintenance tools for the veteran DIYer.

By Steve Auger

If you are going to be an efficient DIYer, you'll need the proper tools and equipment to safely complete service jobs. Most boaters start doing their own maintenance to help reduce the cost of owning and operating their boats. Using the correct tools, combined with an organized approach to maintenance or diagnostics can ensure that your boating will be as trouble free as possible.

Let's start with the basics. The first item on your list is an approved service manual for the engine, drive or auxiliary system, such as a generator. The service manual contains information such as specifications and procedures that allow you to safely diagnose and maintain your boat while minimizing damage to your boat or its equipment. Next, you'll need shatter-resistant safety glasses (they are much cheaper than a new set of eyes), a pair or two of quality work gloves and a first-aid kit to treat the inevitable cuts and bruises.

If price or available storage space for tools were not an obstacle to acquiring all the cool tools we love to have, many of us would "buy the ranch." Being a rational boat owner, you'll need just a few basic hand tools, such as wrenches, socket/ratchet sets, screwdrivers, Allen wrenches, etc. Boats built in North America in the 1980s used fasteners and measurements that require SAE imperial-style hand tools (wrenches and sockets sized in 1/16" increments). Boats built in Europe or Asia and those built in North America after 1990 are typically constructed using metric fasteners and measurements. In this case, you'll need wrenches and sockets in 1mm increments. Some boats are equipped with both imperial and metric measurements, so you'll need both sets. Your service manuals should indicate the fastener type used on a given system.

For small hand tools, I recommend a kit that includes imperial wrenches and sockets from 1/4" to 7/8" and metric wrenches and sockets from 6mm to 22 mm. Purchase kits made up in plastic cases that lock the tools in place. A quick glance will enable you to determine if any tools are missing from the kit when you have finished your work for the day. Be sure to check down low in the bilge for lost tools. Purchase a screwdriver kit in the same format that includes three sizes (small, regular and large) in standard flat tip (slot), Philips (star head), Robertson (square tip sold only in Canada) and Torx, the screwdriver for the new millennium in sizes t-10, t-15, t-20 and t-25. You'll need side cutters (diagonal pliers) needle nose pliers, slip joint water pump pliers, combination inside/outside snap ring pliers and a large and small set of Vise Grips.

As you perform different repairs and maintenance, you'll also need things like files, scrapers, tape measure, oil filter wrench, battery post brush and a couple of adjustable crescent wrenches (these are wonderful as they fit both metric and imperial fasteners). A 4' (1.2m) piece of 1/8" (3mm) rope makes a great preventer of lost or sunken tools. Just tie one end to your wrist and the other end to your tool of choice. You'll save lots of tools from a dunking in the bilge or worse, overboard. A magnet on a rope is handy to retrieve metal tools from the bilge, just be sure to keep it away from the compass. Don't forget a small hammer, pocketknife, flashlight and a good container to transport used engine fluids to the recycling center.

When working on engines, place a small fire extinguisher near the opening to the engine compartment. We hope you never need it but when you venture into a new world, there is no such thing as too prepared.

PAD CARE

With a little TLC, the wool pads used to apply rubbing compound, glaze or wax will last a boat life or longer.

Before using a new pad, you should condition it with a spur. The Ferro Pad Conditioner is a brush-type, non-corroding plastic "spur" that removes residue from the manufacturing process. To use, turn the polisher/sander upside down so the bottom of the pad is facing up. Rotate the pad slowly, about 1,200 rpm and pull the Pad Conditioner towards you (opposite of a spur), working from the pad center to the outer edge. During buffing, periodically clean the pad with the brush to help attain maximum pad life and a swirl-free finish. After use, let the pad dry and then remove the residue with the Pad Conditioner. When pads become very dirty, toss them in a washing machine with cool water and mild detergent. Always store wool pads dry and in a sealed plastic bag. This prevents dust and dirt from adhering to pads and being transferred to and scratching a gelcoat surface.

– Jan Mundy

5 Causes of Hull and Structural Problems

You may not be able to undertake extensive repairs after the damage is done, but you can avoid such repairs if you follow straightforward maintenance procedures.

By Nick Bailey

Delamination: The bane of fiberglass hulls and decks. Keep hardware sealed, check laminate with a moisture meter, sound the hull and deck and listen for a flat or dull sounding feedback. Squirm into lockers and check tabbing. Lift floorboards and clean the goo from the stringers so you can see what's going on. Delamination is repairable but at what cost?

Fatigue: Boats, like living things, grow old. Look for cracks in glass and metal hulls and structures. These too are amenable to patching and reinforcing if caught in time.

Rot: The nemesis of the wood boat and the glass boat with a wet and delaminated wood core encapsulated in fiberglass. Poke and prod with an ice pick in those hard to reach corners. Get out the moisture meter. Use your nose. A wood boat that smells bad most likely is bad. The good news is that hulls and decks can be re-cored, planks and transoms replaced, ribs sistered etc. Have faith. Open your wallet.

Corrosion: Rust never sleeps. Steel (even stainless steel) and aluminum are not immune. Add stray electrical current and it can be all over in a hurry. Look for pitting and for the potential for perforations in the metal where bilgewater is trapped along stringers. Use a chipping hammer to knock off the rust. The rust may be the only stuff left. Have a surveyor do an ultrasound. Weld patches and replate, sandblast and epoxy coat. Keep a dry bilge and tidy wiring.

Hydrolysis: I bet they never told you that polyester resin could break down and dissolve after sitting in water long enough. They call it hydrolysis, more commonly known as osmosis or blisters. The resin actually leaches away leaving behind white resin-starved fibers. The residue forms osmosis blisters. These continue to grow as long as they have an uninterrupted source of water. Epoxy barrier coats are a good prophylactic but peeling and relamination of the outer layers may be required if blisters and leaching are bad enough.

TIP *SALT REMOVER*

To remove baked-on salt residue from a fiberglass or painted hull, wash the surface with distilled white vinegar diluted in hot water. Follow with an application of Awlwash and then hand apply Awlcare. Never use a power buffer with pads.
— JM

PROJECTS

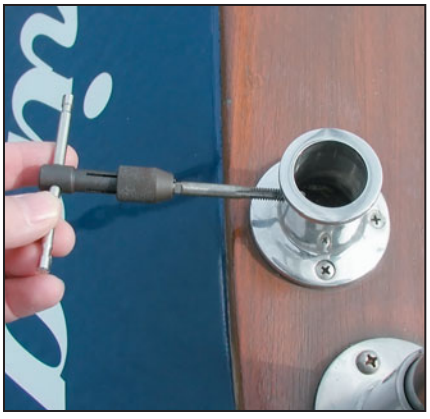
Indicates the level of difficulty with 10 being the hardest, 1 the easiest.

FLAGPOLE MODS

3

The small locking hex nut in my stern flagstaff mount frequently needed tightening, a task that required me to go below and retrieve a 1/8" (3mm) hex wrench. This quick project simplified the process by replacing the hex nut with a stainless-steel 1/4" (6mm) eyebolt. By running a 1/4" (6mm) tap through the existing hole, I can now tighten the flagpole without a tool. The eyebolt also provides a handy place to which I can lash the ensign cover. It also makes a quick cigar holder when the first mate's not looking.

— *Chip Lohman, "Whispering Swan," Quantico, Virginia*



RUBBADUBSAIL IN THE HOT TUB

By Robert Beringer

1

Sails are usually the second most expensive replacement item on a boat, second only to the engine. Anyone who has sailed in a good blow will appreciate that sails are constantly under tremendous pressure and the outright abuse they endure from saltwater spray, luffing, chafe, etc. With every hoist, tack, reef or day in the sun, sails age a little bit. They need TLC to keep them going. Being the thrifty type, I'm keen on getting the sails to last as long as possible. The sails on our 1992 Catalina 34 are, after all, only 14 years old.

Keeping sails clean is the first step. (Patched is the second, but that's another subject.) According to Maine Sailing Partners of Yarmouth, Maine, the most important reason to wash sails is to remove salt and other soluble microscopic dirt contaminants and prevent the mold growth that can permanently stain sails and make them smell bad.

"Salt crystals in the fibers of sailcloth can abrade and weaken the fabric over time. They are also hygroscopic, which means they tend to absorb water out of the air, making an excellent growth medium for mold and mildew."

Professional sail cleaning, while it does a superb job, isn't cheap. The going rate for a main and genoa wash hovers around US$4.25 to US$4.75 per foot (boat length, not sail length). For me, that's the equivalent of a year's worth of diesel fuel. A clothing washing machine isn't meant to handle stiff sailcloth so a trip to the coin laundry is not a practical option.

One cold December night, after a late decommissioning of the Catalina, I lounged in our hot tub with a cold beverage and considered the annual trip to the local sail loft. Just then, in a Newton and Apple moment, the first mate steps out of the house and waves a bottle of laundry detergent in my face. "We're almost out," she declares. "Pick some up after work tomorrow." My eyes bugged out when I realized the obvious: I was sitting in my own personal sail washing machine. "Everybody out," I hollered, "Tub's closed for the next few days."

Hot tubs can save you money (a weak argument to buy one, but try it anyway).

To convert your hot tub into a sail cleaning machine follow these steps. Crank the heater to max, usually 97F (36C) on most hot tubs, for 24 hours. Remove the filter and shut off the system. Pour in 1 capful of detergent per 15 gallons (58 liters) of water. Add more if sails are very dirty. Don't use bleach. Remove battens and feed sails into the tub the same way you douse a jib into the forepeak, starting with tack or clew and completely unfurled. Cover tub, turn on and let soak for at least 24 hours. Haul sails from the giant bubble bath, spread them on the lawn and hose off both sides with freshwater. If the day is calm, hasten drying by tying a line to the headboard, throw the line over a tree branch and run it up like a halyard. The results, I feel, were as good as any I had seen at a sail loft. I drained the dirty water from the hot tub into my garden for some extra nitrogen rich fertilizer.

— *Robert Beringer is a freelance writer and career consultant who sails Chesapeake Bay on "Ukiyo," a Catalina 34 berthed in Galesville, Maryland.*

HOW TO REPLACE AN ENGINE DAMPER PLATE

6

The noise started during a recent trip on the "Arctic Mist," a Jefferson 40. It was only apparent when the engine was idling and out of gear. Engage the engine with the transmission and the noise stopped. On closer inspection, the noise seemed to be coming from the port engine's transmission. Owner Jim Stover had previously replaced the damper plate on the starboard engine and he thought the noise was similar. The decision was made to order a new one for the now noisy port engine, as this seemed the likely culprit.

I arrived at the boat early one morning a few days later to help Jim, who assured me that changing the plate was a simple job, considering that the boat had a spacious engine compartment. On a smaller boat, however, it could have been very tight indeed.

The engine's drip pan was removed and a large wooden block and wedges were positioned to support the rear portion of the engine block when the rear engine mounts are removed.

The propeller shaft coupler flange was then unbolted from the transmission half of the engine coupler flange (**Figure 1**) and the propeller shaft turned and pushed back out of the way. Then, four of the regular upper bell housing bolts were removed and replaced with four temporary bolts 5" (12.7cm) long. These support the bell housing when it's pushed back to allow removal of the damper plates.

With the remaining bell housing bolts and the rear engine mounts removed, the engine rested on the wooden supports (**Figure 2**). The bell housing was pried apart as gently as possible and moved rearward as far as the longer temporary bolts would allow (**Figure 3**). This permitted a hand and a wrench to fit inside the opening.

We were surprised to find that the old bolts holding the damper plate onto the backside of the flywheel were too short to reuse on the new damper plate. As the original plate was made of stainless-steel sheet and the new one is cast aluminum and about three times thicker (**Figure 4**), it required 1/2" (12mm) longer bolts. This then raised a question, would the new bolt heads have enough clearance between them and the bell housing when the engine turned over?

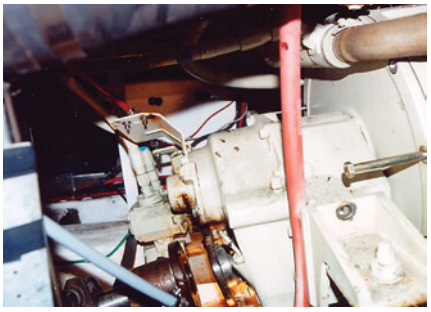


Figure 1

Mechanics refer to the transmission, a Meccanica Paddana made in Monteverde, Spain, as an IRM 200A model. It seems to have an excellent reputation and the dealer who sold Jim

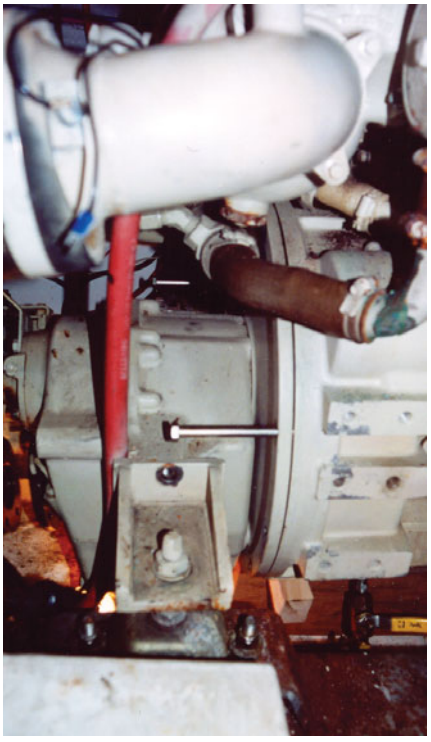


Figure 2

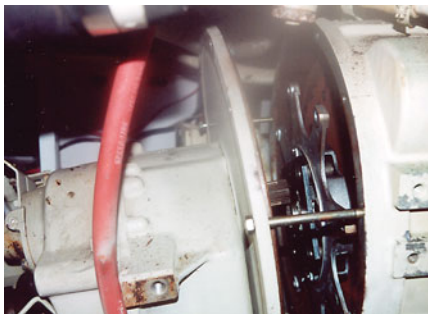


Figure 3

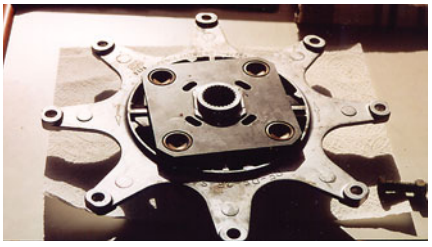


Figure 4

the new damper said he had only replaced one in 15 years.

From start to finish, the job took about four hours, which included two runs for new nuts and bolts, reinstalling the transmission and rear mounts and realigning the engine to the shaft. This came out at 0.001 difference between the top and bottom of the coupler flanges, not bad for the first attempt. With a test drive affirming a successful transplant, the job was completed.

When the original damper plate was removed, it showed no signs of failure. No broken springs, no apparent cracks, only some scattered signs of rust. As Jim had already invested in the new damper plate (US$270), he went ahead and finished the installation. What he did find, in disconnecting the propeller shaft and transmission flanges, was that the four nuts and bolts holding them together, were loose. The aircraft-type design of the nuts had kept the bolts from working their way off the bolts.

The loose boats were probably the original source of the noise. When examined, we found that the coupling bolts had been flattened and the threads destroyed. If you haven't checked the bolts holding the shaft coupling lately, now might be a good time.

— Donald Boone, Carlsborg, Washington

NEW LIFE TO LIFELINES

2

I have cleaned the vinyl coating on the lifelines on my 42' (12.8m) Endeavor many times with different cleaning solutions and mediocre results. While surface dirt and stains were wiped away, they still appeared sun-damaged, yellowed and cracked. A friend soaked his boat's lifelines in household bleach only to turn them purple. After trying other cleaning methods, he finally covered them with shroud covers (split plastic tubes). They looked better, but I found them to be unsafe when racing because they would spin in your hand when moving about the deck.

Replacement is pricey relative to the cost of painting the vinyl cover. Corrosion is the destructive enemy to stainless steel wire, especially on saltwater boats. When the vinyl cover cracks and splits, inspect the terminal fittings for corrosion. In this case, lifeline replacement is your only consideration. For vinyl covers that require a cosmetic uplift (faded or minor hairline cracks) painting may be a worthy option. [Ed: Plastic coatings are merely eyecandy. Better to replace these with plain stainless steel wire so you can monitor their condition.]

Step 1: Attach the lifelines from the bow pulpit to the companionway stanchion, skipping the other stanchions.

This makes them easier to work with. Clean the vinyl cover with an Interlux 333 soaked rag wrapped around bronze wool. [Ed: don't use steel wool breaks off in tiny shards that will rust and stain every area of the boat on which they settle.]

Step 2: Tape the swages and turnbuckles.

Step 3 Brush on Pettit EasyPoxy mixed with a little thinner. A small foam brush works best. Use sufficient thinner to eliminate brush strokes and attain a smooth finish. Let dry. Lightly sand with 220-grit paper or bronze wool. Apply a second coat, let dry and restring the lifelines. When my crew arrived for our first spring race, they thought I had purchased new lifelines.

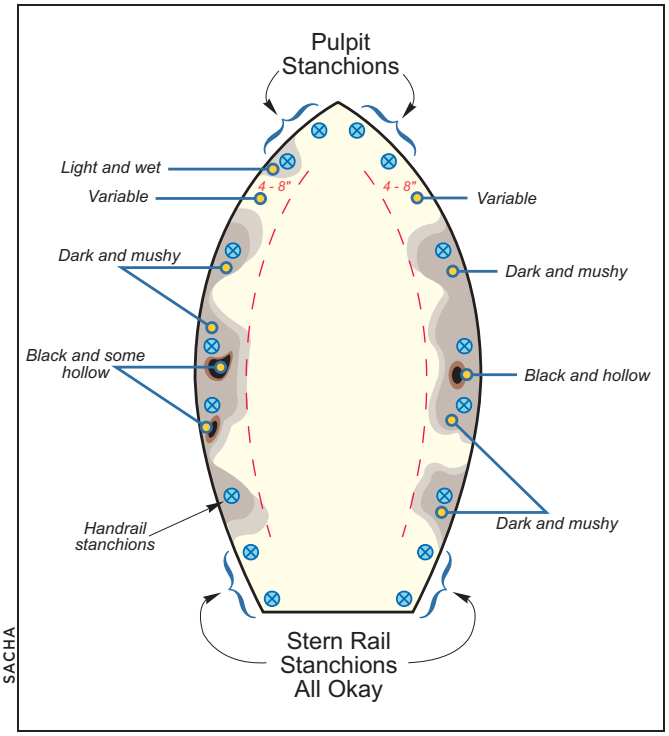
— Richard Asztalos, "Charisma," Mt. Clemens, Michigan

A DIYER'S APPROACH TO SOGGY DECKS

While it's not the industry standard used by professionals to repair delaminated cored decks, this method has merit.

7

We purchased a 36' (11m) Gulfstar motorsailor in 2002. Being an older boat (1972), we decided on a hull and superstructure survey omitting rigging, engine, sails, etc., our rationale being that if we had a solid foundation we could, in our own time, build, alter, repair or renew any of the ancillary items.



Deck mapping, first by tapping with a ballpeen hammer then drilled holes in a grid pattern, revealed the perimeter of the damaged balsa core.

The survey was done without us present, a big mistake. When the boat arrived in Port Stanley, Ontario the boat was found to have numerous defects. The most noticeable was loose stanchions caused by waterlogged and mushy balsa core in the side decks.

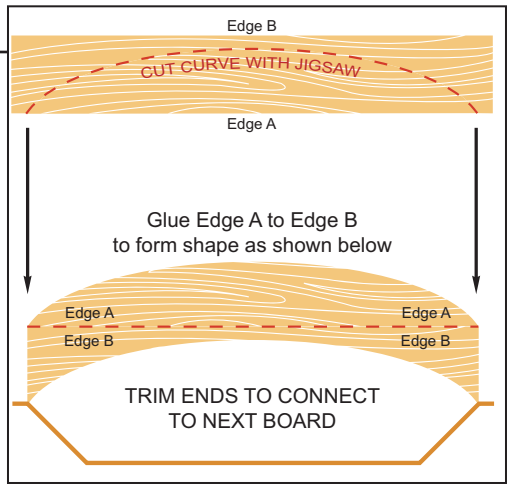
Most deck core repairs are done by cutting and lifting the outer fiberglass skins, replacing the balsa core and relaminating the skins. [Ed: For complete details on this professional repair method refer to DIY 2002-#3 issue or DIY's MRT "Fiberglass 101" CD-ROM.] Unfortunately, the damaged core extended around almost the whole perimeter of the decks excepting the bow and the transom. To cut this out would "take the lid off" and expose the core to the weather and no possibility of drying out (I was working outdoors). After considerable thought, I opted for an entirely different method of repair and one, which I consider is now much stronger than the original design.

Step 1

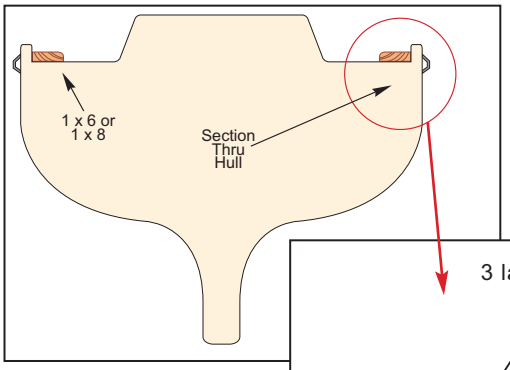
Remove all deck hardware, cleats, stanchions and bases, label and set aside. Cover all bolt holes and spider cracks with masking tape to seal against further moisture ingress. Mark stanchion positioning on the topsides by the caprail with tape as their prior positions will not be visible after completing this repair.

Step 2

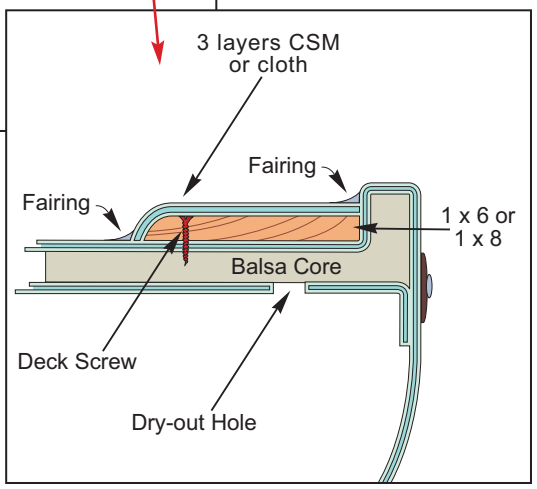
Using a lightweight ballpeen hammer tap the deck area and mark the suspect defect areas. Drill test holes to verify the results. Residue on the drill bit showed deterioration ranging from none to slightly wet to dark and mushy to composted wood with cavities.



Curve was cut in pine boards and then edge glued together to match curvature of toerail.



Cross-section.



SACHA

Step 3

With the perimeter now marked out, drill 3/8" (9mm) holes at roughly 2" (5cm) square centers in the mushy spots and 4" (10cm) square centers in the black and hollow sections.

Step 4

Drill a series of 1/2" (12mm) diameter holes from underneath in the headliner around the perimeter of the affected area approximately 6" (15cm) apart to relieve moisture and assist in any future drying process. These holes will be covered with decorative plastic caps, available in a variety of colors, after the decks have completely dried out.

Step 5

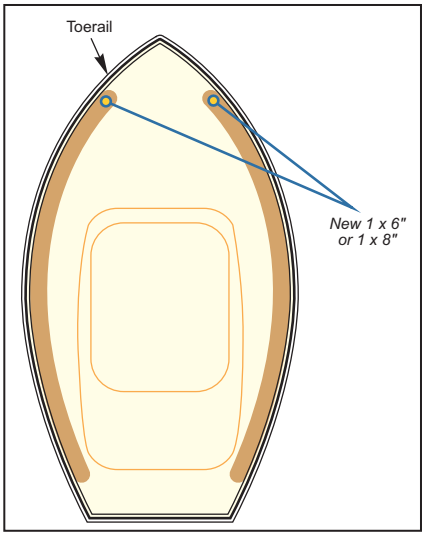
Inject drilled deck holes with low expanding foam (canister). Dark water squirted out in many places both from the top and from the dry out holes in the headliner. To determine the amount of foam to use (too little is better than too much), I squirted foam on a board and found that a six-second spurt produced a 1-1/8" (28mm) foam "worm" about 12" (30cm) long. Not exact science, the math worked out to a two-second spurt each on the smaller grids, four seconds on the 4" (10cm) square grid. A week later, I again tapped the deck to check for remaining soft spots (there were none).

Step 6

Test the dry out holes in the headliner with a paper towel twisted to the point and pushed into the holes. Most were just damp. Repeating this wet test six weeks later yielded a dry laminate.

Step 7

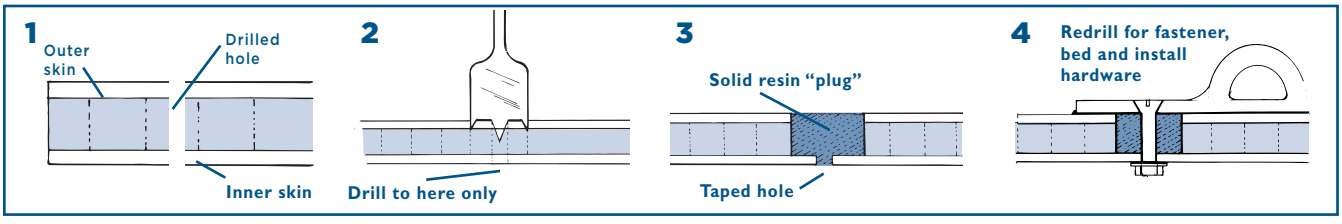
Cut 1x6 or 1x8 boards to form a false bulwark or legerboard around the deck perimeter. I used #2 grade pine, which is easy to cut and bonds well with epoxy resin. Boards were cut (see top left illustration) to obtain the needed curve then placed against the toe rail and edge fitted using a power hand planer. A router with a 1/2" (12mm) radius cutter finished all inboard edges to give them an aesthetic appeal and to allow the glass cloth to lay flat (see cross-section above).



Ledgerboards cover stanchion bases, cracks and water-damaged balsa core.

Step 8

Where the boards fit on deck, prepare the surface by grinding off the



David Aiken

To prevent water from migrating into a cored deck always, mount hardware using the potting technique (refer to DIY 2000-#3 issue for additional details). (1) Core is drilled with small pilot bit; (2) ream everything out with speedbore drill or small holesaw to remove all material to the depth of the the inner skin; (3) hole plugged with thickened resin mixture; (4) hole redrilled for fastener, hardware properly bedded and installed.

Boards glued on and painted.

gelcoat to the fiberglass. Tap the deck and listen for any hollow areas. Where these exist drill 3/8"- (9mm-) diameter holes and fill with low expansion foam (household type). Don't over do it or you'll lift the deck. Clean off all residue and wash with solvent or Interlux Solvent Wash 202 being careful that it doesn't run onto the foam.

Step 9

Lay down one 8' (2.4m) board at a time. To do this, mix up a batch of two-part epoxy resin and glue powder to a mayonnaise consistency. Apply a thick layer of this mixture to the joining surfaces of the deck and board. Lay down one board. To secure, drill pilot holes with a 1/16"- (1.5mm-) diameter drill staggered on 9" (22cm) centers and power screw the board tight to the deck with rustproof 1-1/2" (38mm) long deck screws (these are green or blue). Be sure to countersink the heads. Continue gluing and laying down boards until the deck is covered.

Step 10

Apply three layers of chopped strand mat (CSM) to the exposed wood. Mix thick glue powder and epoxy resin and apply as a fairing compound to the deck and toerail.

Step 11

Grind, fill, fair and sand to finish. Apply two coats of color-matched polyurethane paint.

Step 12

Redrill and rebed stanchion bases and other deck hardware where marked with tape. All were installed using the potting technique: cut out a 3/4"- (19mm-) diameter plug using a holesaw, tape the bottom hole, then fill with epoxy resin thickened to a mayonnaise consistency, let cure and drill holes for fasteners as needed. In all this job involved about three weeks continuous work but this is now one very strong boat. Looks good, too!

— Ivan Forster, "Dreamcatcher," London, Ontario

ROLLING A BOAT OVER

When DIY reader Richard Ross retired from hog farming, he decided to build a boat, a Glen-L design 27' (8.2m) long, 8-1/2' (2.6m-) wide cruiser. Building the hull upside down, he then needed to roll it over. He accomplished this with his farm tractor, a welded pipe-rope assembly, some old tires and one assistant. The photos below detail the procedures.

1 To make the bracket, solidly weld a 16" (40cm) piece of 2"- (5cm-) diameter pipe to two pieces of angle iron. Bolt this to the tractor loader bucket using 1/2" (12mm) bolts.

2 Clamp a piece of scrap plywood to the boat's gunwale to protect it from contact with the bracket. Tie a 1/2" (12mm) line to the rib closest to the boat's center of gravity and wind it four times around the pipe then feed it under the bucket.

3 With a helper positioned behind and to the side of the tractor and holding tension on the line, the tractor lifts the gunwale straight up. When the hull starts to slide off the construction framework, drive the tractor ahead about 3' (91cm), gently lowering the opposite gunwale onto old car tires. As soon as gravity tries to right the hull, set the tractor brakes and slowly play out the line, rolling the hull upright. Now block the boat level.

(continued from page 64)

Another trim problem specific to planing powerboats is that of putting too much weight forward. When the boat gets up on plane, the extra weight forward tips the bow down and the boat comes off plane, which brings the hull back into balance and lets it get up on plane again, but when the boat gets onto a plane the bow goes down and so it continues. Ad infinitum. This dynamic aberration is called porpoising and can only be eliminated by moving weight farther aft until the boat trims level, both in displacement mode (sitting stationary) and in planing mode.

So, how do you determine whether your boat will float level? The easiest way is to put it in the water and adjust weights until you get level trim. When designing a new boat, the designer must make special calculations to be applied to the design in order to achieve proper trim. (In designer terms, the weight times the distance from the LCF gives a moment. When the boat is designed a figure known as the moment to change trim 1" (MCMT 1") is calculated. By finding the moment of the added weight and dividing it by the MTCT 1" you can calculate how much the boat will change trim. There are other minor corrections that are made, too, but beyond the scope of this column.) The designer cannot just design, build, launch and take the chance that the boat will be properly trimmed. Of course, if you want to make the calculations and you do them correctly, you can do the same thing on your restoration project.

A weight calculation is an estimate of the weight of every single piece of material in the boat. It usually takes several weeks to complete and is often given to beginning designers because it's such an onerous chore. When complete, the estimate is compared to previous designs to ensure that it is realistic. The finished weight estimate should be within 2% or 3% of the total boat weight. (That's why builders paint the boottop a few inches higher than the designed waterline.) A complete weight estimate includes the vertical and longitudinal center of gravity (VCG and LCG) of each item onboard. This VCG and LCG estimate is used to figure out the stability and trim of the vessel. Of course, when the boat is launched, gear often needs to be moved around, but moving heavy items usually gets very expensive, so it behooves the designer to get it right the first time.

But there's more if your eyes haven't glazed over yet. What happens if a new boat is launched and the boat floats out of trim? In the old days, builders would surreptitiously launch the boat before the official launching, check the trim and boottop level, haul the boat, correct any trim problems by putting strategically located lumps of lead in the bilge, paint the boottop in the right place and relaunch the boat at the official launching. Today, designers use sophisticated computer programs to determine exactly where the boat should float and builders surreptitiously launch the boat, check the trim and boottop level, haul the boat, correct any trim problems and so forth. Some things never change.

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

View from the Stern

IS YOUR BOAT IN TRIM?

By Roger Marshall

When upgrading your boat's equipment, the added weight and, specifically, where you put it can adversely affect the trim, safety, stability, performance and maneuverability of your boat.

I once went to a launching where, after the splash, the bow of the boat sank about 5" (12.7cm) below the boot-top and the stern stuck up in the air like a beached whale. The audience gave a collective "oops!" while boatyard workers ran around looking for lead ingots.

When you upgrade or modify a boat, it's easy to forget about its trim as you keep adding heavy gear in every odd corner. For example, you might decide that you need to add anchor chain, a bow roller, bow thruster and two more anchors to your potential round-the-world cruiser. Do this and you'll probably add several hundred pounds of weight to the boat's bow while removing buoyancy when cutting out the bow thruster tunnel. That usually adds up to a boat that floats down by the bow.

All boats, whether they are power or sailboats, are designed to float on a level waterline, unless there are specific reasons for unusual trim angles. For a designer, this waterline can be in the light ship mode: that is, with no crew, fuel, sails, water or provisions onboard. It can also be in the half-load condition where half the fuel, water and provisions are aboard with full crew, or in the full load condition, when all gear, crew and stores are aboard. The half-load condition is the nearest to actual sailing conditions. Ideally the boat should float level under all these conditions, but often, especially if the tanks are forward or aft, the boat goes out of trim from no load to full load condition. Note that level trim refers to the attitude of the boat from forward to aft, heel or list refers to the transverse condition and we'll look at that in a future column.

So how do you keep your boat in good trim? First, consider where you are going to put heavy objects such as anchor chain or batteries. The best idea is to concentrate the major weights in the middle of the hull. Build your new chain locker as far aft as possible. In my book, "The Complete Guide to Cruising a Cruising Sailboat," I show a chain hawse that doubles as a forward hatch ladder and helps to get the chain stowed farther aft. Stow your anchors secured below deck rather than on the bow when voyaging offshore. (Keep them on the bow roller when coastal cruising so that you can drop an anchor when needed or in an emergency.) This means allowing for anchor storage space on deck and installing anchor chocks to secure the anchors when not in use.

Susan Canfield

This Defever 49 floats down by the stern with a port list due to the large RIB, outboard engine and hydraulic hoist located on its boat deck. In addition, the stern thruster fitted on the lower transom requires a dedicated battery bank in the lazarette. Other aftermarket installations include a bow thruster (with dedicated battery bank forward), a hydraulic stabilizer system and a second generator at the aft end of the engine room. The resultant added weight and its placement adversely effect stability, performance and maneuverability.

When refitting your boat, consider where you are locating gear. For example, many builders put the fuel tanks outboard of the main engines to keep the heaviest weights located near the center of the hull. By concentrating weights near the center of flotation you improve the boat's performance throughout its range. Note, that I specify the center of flotation, not the center of buoyancy. The factor that controls fore-and-aft trim is the location of the longitudinal center of the waterplane or the longitudinal center of flotation (LCF). In an ideal situation the longitudinal center of gravity (LCG) sits on top of the LCF. If the LCG moves, due to filling fuel and water tanks, etc., it moves away from the LCF and the boat changes trim. Buoyancy affects trim only in a minor way in that the center of buoyancy may move slightly due to the change in hull shape and volume. Where is the center of flotation? You won't go too far wrong if you assume it's between 50% and 55% of the waterline length aft of the stem at the waterline.

What not to do? If you add an anchor chain and a heavy anchor to the bow of a boat that is not designed for it, you can put the bow down by a considerable amount. This makes it easy for green water to break across the foredeck instead of keeping the foredeck high and dry. Okay, you say, I'll just put the dinghy on davits aft to balance the increased weight forward. Not a good idea. You've now hung heavy weights off both ends of the boat. Like a seesaw, a heavy weight at both ends makes the ends go up and down more (pitching) and this motion lessens your enjoyment of your boat.

(continued on page 63)